Dialectics of Force: Ontobia

A New Edition and Translation

New York

ALSO BY ALEX BATTLER

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Alex Battler

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To my wife

In this book, for the first time in world scientific literature, the category of Force is presented as an attribute of matter alongside motion, space, and time. This has enabled the author to develop a different approach to the Big Bang, to give a new formulation of the border between life and the inorganic world, and to offer his own interpretation in the disputes on the mind–body problem. The category of Ontological Force formulated by the author has allowed him to develop a new definition of the concept of Progress, which creates a methodological basis for fruitful research in the fields of the social sciences and international relations.

This book is intended for instructors and students of philosophy and the natural sciences as well as for all those interested in the problems of the universe, life, and man.

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PREFACE

> It must be so; for miracles are ceas'd;
> And therefore we must needs admit the means,
> How things are perfected.
>
> *Shakespeare*

I assure you, dear reader, it was not my own desire that drove me to start working on this book, which took me almost three years to write. In that time, I could have published several books on topics more familiar to me: foreign policy and international relations. The responsibility for my long silence rests with a woman (the French got it right: *cherchez la femme*), and this woman is my wife. For around 15 years, she has been insisting that I finally write a book about *force* that will explain *everything*.

It was some 25 years ago when I pondered the Communist Party's formula, which was well known in Soviet times—the balance of powers in the world is shifting in favor of the forces of peace, progress, and socialism—and I asked a naive question of my mentor: what exactly is this "force"? He replied that is something that every schoolboy knows. Then I asked him to explain the difference between force and power and how they might be measured. I cannot reproduce his answer here in acceptable language; essentially, he told me where to go and to stop wasting time on foolishness. "You're not a German, after all, to dig into concepts and categories," he added unexpectedly.

Having received no answers to my seemingly simple questions, I decided to devote some of my spare time (in those years, I was researching Japan and China) to "foolishness"—that is, to investigating the literature on force. To my surprise, I discovered perfect chaos on this subject in the minds of the political scientists and scholars of international relations whose works I managed to read (about 100 monographs in all). It became clear to me that this topic was not as simple as it initially seemed. Moreover, several theoreticians have advised their readers to avoid the tangled topic of force since it is not something one can hope to escape. I decided to leave the topic alone and continued researching the problems of international relations in the Far East. However, no matter what I was working on, the problem of force kept cropping up and demanding a scientific explanation.

Some people might ask why on earth I was curious to this problem. After all, many authors write about politics and international relations using the word *force* all the time (e.g., center of force, politics of force) without bothering with the question of its meaning. It is something that is, in any case, supposed to be obvious to everyone. It is true that many authors write as if that were so. However, their writings have nothing to do with science—they are mere political fiction. Even a number of official documents fall into this class; for example, the so-called conceptions of foreign policy or the national security of modern Russia. I have labored more than once to demonstrate the illiteracy of these authors and their documents. When fiction is made the basis of actual foreign policy, the resulting course of action inevitably results in failure, as the foreign policy of the Soviet Union in its last years and today's Russia shows.

Be that as it may, the moment came when I began to define for myself the category of Force in foreign policy and international relations, which immediately simplified for me the task of predicting the activities of this or that state in the world arena. But these were all definitions of force as a reflection of something more fundamental that I was unable to discern on the ontological level. Therefore, my definitions were incomplete, or, rather, they did not grasp the essence of force in its entirety. In spite of this, I continued to avoid delving too deeply into understanding force, being mindful of warnings from scholars who had already been burned by tackling this category. However, under pressure from my wife, I decided to come to grips with this problem after all.

Since I knew already that theorists in neither the area of political science nor that of international relations would be of any help to me in this endeavor, I decided, as a start, to browse through the philosophical literature, beginning with the ancient Greeks. I had to find out how this category was understood in the parlance of philosophers. Then I planned to determine in what form and through which phenomena force manifests itself in the inorganic (the sphere of Cosmogony and Physics) and the organic world. Quite unexpectedly, I found myself in the thick of issues in natural philosophy at the heart of scientific battles whose existence I had never suspected.

When I started work on the chapter on consciousness and thought, in a book by Ernst Haeckel I came across the name of the German physiologist Emil Dubois-Reymond, who said the following in his famous speech "On the Limits of Cognition of Nature" (1880): "Regarding the puzzles of what matter and force are, and in what fashion they can think, he [the scientist—*A.B.*] must make once and for all a much more difficult confession, expressed in the verdict 'ignorabimus' (we won't learn)."[1]

In this speech, Dubois-Reymond spelled out the seven major puzzles of the world:

1) the essence of matter and force;
2) the origin of motion;
3) the origin of life;
4) the purposefulness of nature;
5) the emergence of senses and consciousness;
6) the emergence of thought and speech, which is closely tied to thought;
7) the problem of freedom of will.

In Dubois-Reymond's opinion, four of these puzzles are completely transcendent and unsolvable—numbers 1, 2, 5, and 7. Three others, though difficult, are solvable—numbers 3, 4, and 6. Haeckel, though, when he was addressing these puzzles, declared, "We, as yet, do not know."

Despite Haeckel's optimism, I found myself in a slight panic since, in this present work, I had become entangled in different ways in the thickets of all these puzzles (the last one of which I was planning to address in my next book). If I had only come across this book of world puzzles before I started my research, I would most likely have refrained from beginning my own book. Then I remembered the English philosopher and economist John Stuart Mill, who wrote (if I remember correctly) in his *Principles of Political Economy* (1848) that, if a capitalist had studied his book, he would likely never have started up a business. It appears that many achievements come about only because their authors do not know in advance of the difficulties ahead. I guess that Napoleon was right after all when he said that the main thing is to get engaged in

1 Haeckel, *Die Welträthsel*.

the battle and then let the chips fall where they may.

When, in my ignorance, I became involved in this battle for the recognition of force in philosophy—force in the inorganic and organic worlds, and in the realm of psychology as well—I discovered the most savage arguments between different schools and trends about these very puzzle-problems. I was obliged to develop my own position on these matters and, occasionally, offer my own solutions.

I will talk of this position in more detail in the introduction. At the moment, I would like to draw your attention to the following:

Ordinarily I do not discuss my works with anyone until they are published. I am repelled by the practice of specialists working on the same topics talking over ideas among themselves. I have horrible memories of how it was done in the Soviet Union (and I suppose that the practice is still alive in that land to this day), where your idea was first discussed in your "sector" and then in your department of the institute so as to receive approval for publication "with note duly taken of criticisms." Since all books without exception underwent this procedure, upon publication they appeared practically the same irrespective of who the author was. Can you imagine Aristotle "taking due note" of criticisms by Plato, Leibniz of those by Newton, Hegel of those by Schelling, or Marx by of the above-mentioned Mill? If it had been done this way, none of them would have become what they were; their works would have been faceless, in compliance with the views dominant at that time, i.e., without a hint of new ideas.

However, in writing this book, I was forced to forget my rule since I was straying outside my turf. Even though I had of necessity read many books on physics, biology, and psychology, I still did not feel sufficiently confident in these areas. For this reason, I was obliged to subject the sections on physics and biology to the scrutiny of specialists: the cosmonaut Yuri Baturin, one of whose areas of expertise is cosmology, and Georgy Lyubarsky, a biologist and leading expert at the Zoological Museum of Moscow State University.[1] Their comments proved to be extremely valuable to me; not only did they help me correct some of my terminological mistakes, but they also assisted me in formulating my thoughts on various problems somewhat differently. Mr. Baturin, among other things, compelled me to read a great deal of additional

1 Unfortunately, I was unable to get the chapter on psychology checked in the same fashion, for I could not find a scholar (in Russia) who studied the body–mind problem in the spirit of the present work.

literature, including works about information entropy. I would like to express my sincerest gratitude to both of them. Should professionals find any incongruities in the parts of my book dealing with physics or biology, it will be only because I inserted them after my esteemed reviewers had finished looking at the text.

Let me add that many of Mr. Lyubarsky's criticisms proved useful to me, and I complied with them gratefully. At the same time, I left untouched many things that had my well-disposed reviewer perplexed. Specifically, I am referring here to Chapter III ("The Origin of the Organic World…"). G. Lyubarsky many times brought up the names of several Soviet (or Russian) biologists I had failed to mention while offering a detailed analysis of the works of several Western biologists whose views he considers "trivial" or "unscientific"—and why did I have to "promote" Karl Popper while there are other interesting philosophers? I expect that similar questions or "befuddlements" may occur to many Russian readers "hurt" by the insufficient attention given to Russian scientists. Even though I perceive such reactions to be just, they may lose ground when one considers certain circumstances that are unfamiliar to Russian readers' perceptions. (The explanation of this may be of interest to the Western reader as well.)

Even though the original text was written in Russian (my native language), I am not a Russian scholar but rather a representative of the Western scientific community; therefore, my book is geared first and foremost toward the Western reader. To Western readers, even those in the sphere of science, Russian names, with very few exceptions, say little. This, by the way, is a criticism I level against Western science in this book. Wherever it is useful (or sometimes just for the sake of mentioning them), I insert or refer to Russian scientists.

In addition, although some Western scientists may express views that are, in Lyubarsky's opinion, "unscientific," they are nonetheless widely discussed in the scientific literature; in other words, they constitute a kind of background for certain problems. Of course, there are other philosophers besides Popper, but he is for many a great authority on the subject of determining the boundaries of science, as is attested to by frequent references to his works rather than to, say, the works of Deborin, Mitin, or Kedrov—Soviet-era philosophers.

This applies to biology, too. Of the ten Russian biologists mentioned by Lyubarsky—who are, perhaps, major figures—not one is to be found in the bibliographies of the modern Western works that I have used in my monograph. They are absent even in the bibliography of Stephen Jay

Gould's *The Structure of Evolutionary Theory*, a fundamental work of 1,433 pages. This does not at all mean that Russian scientists are at a lower level than their Western counterparts. It is just that Russian science is limited by national boundaries while Western science encompasses the entire world and sets the tone for the progress of science and technology.

Moreover, my choice of this or that scientist was determined not by his contribution to science (I then would have had to write an entirely different book) but rather by the degree of connection between his views and the problems analyzed in this book. Among contemporary Russian scientists, the problems tackled in this book are practically not discussed at all.

There is one more thing to consider: I live in the West, so I have limited access to Russian sources. Moreover, those Russian scientific magazines that are represented online offer the titles of their articles but not the texts.

At this point, I wish to draw the reader's attention to the following fact: several selected parts of my work (and later whole book) have been posted on my website. I needed to gauge the degree of my text's accessibility for the regular reader. I received a number of e-mails in response that contained complaints about excessive quotation and abuse of certain scientific terms. I was advised, in the first case, to put others' ideas into a popular retelling style and in the second to replace technical terms with "normal words."

In this connection, I want to warn the reader right away that this book is not a popular essay that can be browsed in the subway or when having a cup of tea. This is a scientific analysis of an extremely difficult problem that has been discussed by scientists for over 2,000 years. Moreover, regardless of the results I have arrived at in solving the problem of force, what is important here is the process of achieving the stated goal, what Hegel called "result together with its formation." The perception of this realization requires mental effort, including understanding my predecessors' original texts, rather than simplified interpretations of them. I quote different authors rather than recount their ideas precisely because the idea itself is often not as important as the road taken to get to it, i.e., the logic of thought and the manner of presentation. It is only by following that road that the reader himself starts to think and to understand. When reading, say, a textbook on philosophy, a person receives information that is quickly forgotten. But the reader who studies the original—say, Aristotle's *Metaphysics* or Hegel's *Science of Logic*—learns to think. It is no accident that many

Russian thinkers of the 19th and 20th centuries "underwent" Hegel; let it suffice to name Belinsky, Herzen, Chernyshevsky, Pisemsky, Bakunin, Plekhanov, and Lenin. Curiously, those who failed to train their brains on the works of "the objective idealist" Hegel remained either second-rate politicians or theologians of no note who had no influence on their country's development. It is for this reason that I often intentionally overdo quotations from, say, Leibniz, Kant, or Hegel: I want the reader to use his brains.

As for special terms, their use is unavoidable in principle since each science has its own specific lexicon. Just in case, I put together a small glossary of terms. Perhaps I failed to include some terms there, but please bear in mind that this book is not intended for the uneducated reader who consumes bestsellers by Danielle Steel or some corresponding Russian hack. My reader is a person who reflects on questions such as what life is, what its meaning is, and why the universe exists.

In this book, I present my answers to these questions. As almost always, they are not identical to the ideas provided by most of the scientists mentioned in this book and certainly to those of many others who remained outside my research. Thus, I invite criticism of my views and ideas but in writing only (in the mass media or on my website) rather than in backroom talks.

To sum things up, in this book, I formulate:

– ***a definition of force as an ontological category;***

– ***the manifestation of force in the inorganic world within the framework of the idea of the Big Bang;***

– ***a definition of force in the organic world to determine the boundary between life and nonlife;***

– ***a solution to the mind–body problem (i.e., what consciousness and thought are), which has led me to a new formulation of the concept of Progress.***

This being done, I consider the natural philosophy part of my analysis of force to be complete. The next book, *Society: Force and Progress*, will be dedicated to the analysis of force in social relations. The last part of the odyssey will deal with defining the concept of Force in the sphere of international relations.

Finally, a few more words about the person without whose persuasion this book would never have been written—my wife. Valentina has the unique ability to deprive me of rest. In fact, this is true of my previous books, too, as well as, I suspect, the books to come. Before I even finish a work, she starts to offer the next intriguing problem. She creates truly unique conditions for my creative work, providing the necessary technical functions such as editing, proofreading, formatting, information searches, etc.

Valentina—an artist and a poet—is a creative person who paints in the Chinese style and writes poems to accompany them in Russian and English. So it is to Valentina that I dedicate this book on force. It may not explain *everything* the way she told me to, but at least it explains the force of my love for her.

In conclusion, I would like to thank my Canadian translator, Pavel Sorokin, a unique person possessing multifaceted knowledge in many areas of science and art. He has been the first of my translators to be able to adequately translate texts in four scholarly and scientific disciplines (philosophy, astrophysics, biology, and psychology) while preserving the author's style. I am truly grateful to him for his thorough work.

* * *

This book is a new edition and translation from Russian. In this latest revised version, I did not add new materials on the topics outlined in the table of contents and set aside the deepening of these topics for a while. I intend to include new materials and even reflect on some topics in a new light in my next series of books called *Mirology: Force and Progress in World Relations*.

INTRODUCTION: LEXICON AND METHOD

> Eating and drinking are reckoned a more intelligible business than thinking and understanding.
>
> *Hegel*

In everyday life, we constantly come across expressions such as *the power of love*, *strength of spirit*, and *force of life*. These words confuse no one; we all understand each other just fine. However, if one poses a simple question such as what is love?, what is life?, or what is spirit?, everyone will provide different answers. This applies not only to ordinary people but also to people who are supposed to be intellectuals (scientists, authors). I once read a book written by a philosopher in which he had collected the definitions of *love* given by some of the best-known personalities in the realms of science and culture, and all these definitions taken together still did not make clear what love is.[1] The situation is the same with the words *life, spirit,* and *force*.

Force will be the hero of this book, though the question, which force?, may arise immediately. Force as might or force as violence? Or perhaps force as authority? But let us proceed without haste. For the time being, I will simply make use of the word *force* without drawing distinctions.

However, in my opinion, the problem of translation arises at once. How to translate into Russian, for example, the expression *powers of forces* used by Newton in his famous *Mathematical Principles of Natural*

1 Chertkov, *On Love.*

Philosophy? This phrase is rendered into Russian with the same word, *sila*. Or how about the expression *strengths of forces*, which I have come across more than once? Since two different words are used in these phrases, it stands to reason that different phenomena stand behind them. For example, in the Russian and English translations of Hegel's *Science of Logic*, in one place the German word *Gewalt* has been translated respectively as *moshch'* (might) and as *power*, even though *Gewalt* means *violence*. This has resulted in a serious perversion of Hegel's thought.

There are no fewer problems in translating this word as the ancient Greek philosophers used it. Let us recall that, in the Greek language as used, for example, by Aristotle, we encounter the words *dunamis, energia,* and *entelecheia*. The first of these is translated into Russian as *vozmozhnost'* (possibility) and into English as *power*. *Energia* and *entelecheia* are translated into Russian as *deistvitelnost'* (reality) and *deyatelnost'* (activity), with the latter sometimes also translated as *sila*. In the English language, both are rendered sometimes as *force* and sometimes as *power* while *entelecheia* is most often translated as *actuality*. The problem is that the Greek authors themselves put different meanings into these words. For that reason, in every concrete case—when quoting, say, Aristotle—the meaning of the word used must be specified.

With Latin, things are much simpler. In that language, for the most part, two words are used to signify force: *potentia* and *vis*. The former means a passive force while the latter means an active one. However, they are both translated into English sometimes as *force* and sometimes as *power*, *vis* often being left untranslated or, on occasion, transformed into *vis viva* (living force).

The greatest difficulties arise in the case of the English language, in which the equivalent of the Russian word *sila* has undergone a very extensive development, splitting up into *force, power, might, strength, violence,* and *authority*. As an aside, this variety has created confusion in the social sciences, especially in the area called international relations. The only author who attempted to draw distinctions between these words on the level of terminology was, unusually, a woman: Hannah Arendt, whose work I will have to address in the corresponding part of the subsequent monograph. At this point, it is appropriate to provide the definitions of these words as found in Webster's dictionary, although even that is not so simple. For example, Webster's defines the first meaning of strength as "the quality or state of being strong" and the second as "power to resist force."[1] However, considering the contexts in which these words are used, they mean approximately that *force* is force in the inorganic world; *vis* is force in the organic world; *power* is force in society; *might* is what is called *moshch'* in Russian; and *strength* is individual force, close in meaning to the Russian word *tvyordost'*. The table below shows approximate translations of these words:

English	Force	Power	Might	Strength	Violence	Authority
German	Kraft	Kraft Macht Energie	Macht	Stärke	Gewalt	Autorität
French	Force Pouvoir	Puissance	Puissance	Force Puissance	Violence	Autorité
Italian	Forza	Forza Potenza	Forza Potere	Forza Vigoria	Balìa	Autoritá
Russian	Сила	Сила	Мощь	Твердость	Насилие	Власть
Latin	Ops Vis	Potentia	Potestas	Robur	Violentia	Imperium Potestas
Greek	ΒΊΑ ΔΎΝΑΜΗ ΙΣΧΎΣ	ΙΣΧΎΣ ΕΞΟΥΣΙΑ ΔΎΝΑΜΗ ΕΝΈΡΓΕΙΑ	ΚΡΑΤΑΙΌΤΗΣ ΙΣΧΎΣ ΔΎΝΑΜΗ	ΔΎΝΑΜΗ ΙΣΧΎΣ ῬΩΜΗ	ΒΊΑ ΒΙΑΙΌΤΗΤΑ	ΕΞΟΥΣΙΑ ΚΎΡΟΣ

I repeat that these are just words, not even terms. A word becomes a term when it is given a specific meaning. For example, the word *might* is used to signify many things: the might of a state, the might of reason, the might of the economy. However, when I specify that I am using the word *might* to mean only *economic might* (disregarding the state, reason, etc.), it becomes a term with a precise meaning relating to economics. This is the first stage in moving away from ordinary consciousness toward scientific cognition, though it is not yet science. Scientific research begins when the researcher switches to the language of concepts and categories. In cases in which a science is only beginning to form, it is unreasonable to expect the use of definite concepts and categories from the very start; they do not yet exist at the initial stage. The process of research is conducted in such cases based on mere words, or terms, at best. Reasoning on the basis of words, for example, is typical for such a field as "international relations." As was noted perfectly correctly by the

1 *Webster's Seventh New Collegiate Dictionary*, 868.

renowned psychologist Lawrence Weiskrantz, “Definitions and precise theoretical constructs are the final product, not the starting point of inquiry.”[1] Once the final product—concepts and categories—has been constructed, it is fair to say that this concrete area of knowledge has become a new science.

The problem with the word *force*—as well as the words *life, love,* and *spirit*—is precisely that they have not yet acquired a conceptual content, at least not in the social sciences. However, let us recall Hegel’s words: “Only in its Notion does something possess actuality, and to the extent that it is distinct from its Notion it ceases to be actual and is a non-entity; the side of tangibility and sensuous self-externality belongs to this null aspect.”[2] In other words, it belongs to the existential side of life but not to its scientific part. Therefore, the phenomena that stand behind the above-discussed words are still not understood, are barely studied, and are unpredictable.

Here lies the paradox: in spite of all this: it is precisely these words that have been used to lay the foundations for many scientific theories and even laws. Such developments are possible.[3] Newton wrote of this with some irritation in his *Principles*: that he was incapable of discovering the phenomenon of gravity since “I frame no hypotheses”—I practice experimental philosophy. The physicist Henri Poincaré formulated this idea laconically: “It is not important to know what force is; it is important to know how to measure it.”[4] If so, the question arises as to what it is that is being measured.

To a certain degree, I followed this rule myself when I formulated the laws of *poles of power* (might) and *centers of power* without knowing what power is in its essence.[5] A very serious danger emerges in the process: is it really force that we are measuring? Could it be something else? At the intuitive level, everyone senses that force is something fundamental. But what is it?

Political scientists and scholars of international relations have given many definitions, and they will be presented in the appropriate place. However, these all remind me at once of that fortunate statement by Yu. Baturin: “In science they sometimes speak none too clearly of things

1 In Marcel and Bisiach, *Consciousness in Contemporary Science*, 183.

2 *Hegel’s Science of Logic*, 50.

3 For a philosophical justification of this paradox, see Klaus, *The Power of the Word* (Gnoceology and the Practical Analysis of Language).

4 Poincaré, *On Science*, 73.

5 See Battler, *The 21st Century: The World without Russia*, 267–72.

that they do not have a very clear idea about. It is much more dangerous, though, when they speak clearly of things they do not understand clearly."[1]

Clarity can be introduced only through establishing a hierarchy of linguistic signs and their meanings while translating them into a scientific language that operates with concepts and categories. It is well known what great importance philosophers have accorded to the problems of scientific language, for example, by Condillac and Leibniz. Even a simple explication of the lexicon on the terminological level frequently clarifies the essence of problems. When terms are elevated to the level of concepts and categories in their hierarchical interrelation, this creates the possibility of transforming an area of knowledge into a branch of science.

The present work is an attempt of this sort. The methodological basis is the dialectics, the nucleus of which is Hegel's dialectics, and dialectical materialism that emerged in the 19th century through the efforts of two giants of man—Marx and Engels. For this work, two outstanding books are particularly important: *Dialectics of Nature* by Engels and *Science of Logic* by Hegel. The scientists in the West, however, with rare exceptions prefer Kant to Hegel. There is a reason for this, but a discussion of the subject is outside the scope of this book.

Let us recall that Hegel had a reason for criticizing those mathematicians who asserted the truth of proofs in physics, on the grounds that mathematics is unable in principle to uncover "the qualitative nature of moments." The reason is clear: "This science [mathematics—*A.B.*] is not philosophy, does *not start from the Notion*, and therefore the qualitative element, in so far as it is not taken lemmatically from experience, lies outside its sphere."[2] In other words, the quality of nature—its essence—can be uncovered only through notions (concepts), through definitions of concepts that "are laws."

However, even if we agree that without concepts and categories it is impossible to cognize essences and phenomena, another problem emerges: that of distinguishing a concept from a category. Often even great philosophers use these words as synonyms. For example, Vladimir Lenin offers a treatment of matter as a category, and then, in the same place, he speaks of it as a concept.

Here we encounter the problem of the inseparable unity of category

1 Quoted in Shakhnazarov, *The International Order: Political–Legal Aspects*, 30.
2 *Hegel's Science of Logic*, 273.

and concept. In the words of M. Bulatov, "It is present in those texts in which one means at the same time the category's relations to things split into rubrics, and their own internal content."[1] Therefore, we must determine at the very beginning what is a *concept* and what is a *category*. This topic in itself is one of the problems of philosophy, with different solutions offered by different philosophers and currents in philosophy.

Of course, the deepest and the most interesting definitions of these terms were given by Hegel. In his theory of cognition, he made a clear distinction between objective logic (the doctrine of being—categories) and subjective logic (the doctrine of the concept—a concept as such). He goes on to specify that "the Concept is the Universal which is at the same time determinate; that which remains in its determination is the same Whole or Universal or it is the determinateness which grasps together within itself the different determinations of an object as a unity."[2] Naturally, Hegel's dialectics lead him to recognize the internal contradiction of the notion since "*any* Notion whatever to be a unity of opposed moments to which, therefore, the form of antinomic assertions could be given."[3] In that same work, Hegel gives a definition of the term *category*. He writes, "According to its etymology and Aristotle's definition, category is what is predicated or asserted of the existent" (ibid., 410).

As mentioned above, there exist other ideas about concepts and categories inherent to different schools or currents in philosophy that deserve to be analyzed in a separate work. Here I shall limit myself to presenting my understanding of these terms, which boils down to the following:

A category defines the most general properties of being or reality such as matter, time, and space. Notions are aspects of categories or forms of thought that reflect some particular side of the categorical being. To put it more simply, categories are used to analyze "thing-in-itself" while notions are used to analyze "thing-outside-self," i.e., to cognize the essence through its manifestations.

It is necessary to note that the word *category* is also used in the sense of systematizing, putting into rubrics, splitting up this or that group of objects. It is this meaning that is used to define the term, say, in the *Oxford Companion to Philosophy*: "Categories. The most fundamental

1 Bulatov, *Logical Categories, and Notions*, 107.
2 Hegel, *The Philosophical Propaedeutic*, 105.
3 *Hegel's Science of Logic*, 191.

divisions of some subject-matter."[1] This meaning is easily identified, and, in this work, I shall be using this word for the most part precisely in its ontological meaning.

To reiterate: *Notion* is an area of thought in the sphere of subjective reality in which the objective reality is imprinted. *Categories* are embedded in objective reality itself; they reflect existing being in thought.

One more important thing needs mentioning: the transformation of categories into concepts and vice versa. A category is transformed into a concept when that of which it is a reflection is cut away from it, i.e., being or its attributes. What happens is a transition from objective reality to subjective reality, which, even though tied to the former through reflection, already has an independent meaning as a method of thinking. For example, force can be viewed as a category of being, but it can also be viewed as something mutually related to other reflected phenomena—might, for example—and then it becomes a concept. In the same fashion, concepts can be transformed into categories when functions or properties of being are added to them. They become categories even more assuredly when they are endowed with functions of division, etc.

In principle, I should have described here the method of cognition I chose for this work. There exists an infinity of these methods; the choice depends on the scientific milieu in which the researcher dwells and on the literature toward which he gravitates due to his preferences or particular circumstances. In this connection, I shall refrain from asserting that some particular method of research is to be preferred, but for a host of reasons, I gravitate toward a method of research that is not recognized by the majority of scientists in the West—dialectical materialism. Its core is the dialectics of Hegel, which can be described schematically on the epistemological level.

According to Hegel, ordinary consciousness, or understanding, proceeds from the separateness of the content of cognition and its form, i.e., truth and reliability. In the first stage of cognition, it is supposed that the matter of cognition exists in itself, outside of thought, as some world at hand. Thinking is connected to this matter as some form from outside, filling it and acquiring a certain content within it. It follows from this that Hegel viewed notions as something subjective, set opposite to the object in the capacity of "outside reflection." Here the

1 *Oxford Companion to Philosophy*, 125.

notion—or, more exactly, knowledge of the object—opposes the latter as direct. The notion only verifies the presence of the object through its manifestations. The truth still remains "in-itself." This is only natural since thinking that grasps the manifestations of the object is abstracting understanding and conducts itself as ordinary common sense, capable of reflecting the sensuous reality—which is precisely from what its meaningness or actuality derives. However, common sense is very assertive, and it often passes itself off as a reason even though in reality it is not, cognizing as it does only sensuous reality (= subjective truth), i.e., phenomena rather than the nature of things.

The second stage is the stage of objectification of the notion when it steps out of its subjectivity and "out-of-selfness" and merges with the object of its reflection, becoming adequate to it. Then comes truth, which is "the agreement of thought with the object, and in order to bring about this agreement—for it does not exist on its own account—thinking is supposed to adapt and accommodate itself to the object" (ibid., 44).

The projection of this idea onto any topic means that, in subjecting ourselves to the object, we have discovered the truth "for ourselves." In other words, having shown common sense, we merely discovered the presence of the object. It is necessary here to keep in mind one important thing: even if we admit that a certain notion really does adequately reflect reality, it is in this case, only a change in the mode of thoughts and perceptions. "In its relation to the object, therefore, thinking does not go out of itself to the object; this, as a thing-in-itself, remains a sheer beyond of thought" (ibid., 45). That is, the self-aware process of definition does not change, in this stage, the object itself (for example, economics or politics); it belongs exclusively to thinking. *This* thinking, though, is different from the preceding thinking: understanding has become elevated to reason or, put differently, negation of understanding by reason took place. There is progress here, a certain leap. Nevertheless, a substantial minus remains: even the changed thinking (reason) does not touch upon the essence of the object the latter remains on its own, "the empty abstraction," the "thing-in-itself."[1] This Kantian doctrine in its purest form remains if only no subsequent move takes place; i.e., until things and thinking about them become adequate to each other—thinking in its imminent definitions and the true nature of things will form a single content. According to Kant, this is impossible in principle

1 Lenin, *Complete Works in 55 volumes* (subsequently CW), 29: 83. [Translated from Lenin, *Philosophical Notebooks*.]

since his "thing-in-itself is an empty abstraction." And Hegel, as stressed by Lenin, "demands abstractions, which correspond to the essence" (ibid., 84) since, as the progress of consciousness shows, "it is only in absolute knowing that separation of the *object* from the *certainty of itself* is completely eliminated: truth is now equated with certainty and this certainty with truth."[1]

Thus, in the third stage, a unity of the subjective and the objective is attained in which the notion finds its adequate expression. This mutual penetration of opposites—the thought and the object—means the revelation of the truth.

Let us here recollect that the progress toward truth unfolds in the following sequence: "The understanding *determines,* and holds the determinations fixed; reason is negative and *dialectical*, because it resolves the determinations of the understanding into nothing; it is positive because it generates the universal and comprehends the particular therein" (ibid., 28). The joining of the two results in "positive reason, or intuitive understanding," which equals the positive.

Anyone familiar with Marx's "Theses on Feuerbach" will notice that the reasoning of Hegel reproduced above served as the foundation for the former's criticism of the German materialist's conception of cognition. According to Marx, Feuerbach's main shortcoming is "the thing, reality, sensuousness is conceived only in the form of the *object or contemplation*, but not as *sensuous human activity, practice*, not subjectively."[2] This approach contradicts Hegel's views in principle in which the active aspect of thinking, its merging with the object, is excluded; i.e., thinking as object-oriented activity. This approach ultimately leads to the separation of thinking from the object, the separation of theoretical activity from practice; as a result, both thought itself and practice begin to decay. Marx was opposed to this. He wrote, "The question whether objective truth can be attributed to human thinking is not a question of theory but is a *practical* question. Man must prove the truth, i.e., the reality and power, the this-sidedness of his thinking in practice" (ibid.).

* * *

1 *Hegel's Science of Logic*, 49.

2 Marx, Engels, *Collected Works*. 2nd edition, 3:1. (subsequently ME). [Translated from Marx & Engels: *Collected Works* in 50 volumes.]

Let me state again: there exist different principles of the thinking activity of reason and understanding. Within ordinary consciousness, one usually operates with words, which offer the possibility of describing the phenomena of the surrounding world. Unfortunately, the area of knowledge that encompasses foreign policy and international relations—where the concept of force is key, in my opinion—does not possess its own language (i.e., a conceptual apparatus) and makes do with terms at best. These terms have yet to acquire conceptual definiteness. Therein lies their vulnerability, which means at the same time that this area of knowledge is not yet a science. Foreign policy and international relations as a sphere of research continue to rely on common sense, which reflects at best the sensory perception of understanding. In this connection, Hegel wittily remarked, "Live and let live"; i.e., sensory perception recognizes definitions and terms as "indifferent" to each other, with no contradictions, no conjugacy.

Therefore, introducing conceptual apparatus to this sphere of knowledge is long overdue. Through concepts, opposites are cognized in their unity; the positive is learned in the negative and the negative in the positive. Reason retains concepts in their definiteness and carries the knowledge of the absolute.

Does force possess this abstract conceptual power in the area of social life and international relations? The present work is precisely an attempt to answer that question. It consists of three parts, or books:

One: *Dialectics of Force: Ontobia*

Two: *Society: Progress and Force* (Criteria and First Principles)

Three: *Mirology: Force and Progress in World Relations*

As I pointed out already in the preface, contemporary political science and the theory of international relations have proved unable to define the essence of force. This is not at all surprising since even physicists—people who use this word all the time—debate its essence. However, in nature, phenomena do not exist separate from their essences. In order to understand force, it has been necessary to turn to philosophy, which has not been able to avoid analyzing such a pivotal category.

In Chapter I, I present different philosophers' views on the topic. My choice of authors was determined not so much by their importance in the history of philosophy as by their attention to the category of Force. Though every one of them made certain contributions to the analysis of the phenomenon in question, all of them together could not quite satisfy me, and ultimately I was compelled to give my own definition of this category in accordance with my conception of being. I had to introduce a new word for this definition: *Ontobia,* or *ontological force.*[1] In my opinion, it may prove to be a very useful category for understanding the essence of force.

Chapter II examines the manner in which this ontobia reveals itself in the inorganic world, mostly through the prism of conceptions of the Big Bang and operation of the second law of thermodynamics. It was important here to show that *force as an attribute of being* can manifest itself in different guises such as energy or "dark matter."

Chapter III looks at the manifestation of force in the organic world. This chapter is important from the perspective of solving the problem of the boundaries between animate and inanimate nature, i.e., *what the criterion is for living and non-living matter.* I had to become involved in discussions about this problem *nolens volens*. My solution is unusual, and it placed me in opposition to all modern areas and trends of thought.

Chapter IV is devoted to problems of the mind and the analysis of the equally controversial questions of *what consciousness and thought are*. I also needed to find out in what fashion—or through what phenomena—thought expresses itself in psychology. On the basis of combining philosophy and psychology, I have presented a conception of thinking that has led me to a definition of progress that differs qualitatively from all known formulations.

The conclusions, formulations, and regularities tied to ontobia provide, in my view, the methodological tools for analyzing the *manifestations of force in society and international relations*. In other words, the conception of force presented in this part of the book makes it considerably easier to forecast social and international phenomena; the correctness of the time frames will in practice depend only on the availability of databases.

In my research on force, I have drawn on a wide selection of writings from the domain of the natural sciences (physics, biology, and psychology),

1 The word *ontobia* consists of two Greek words: *ontos* (essence) and *bia* (force).

authored for the most part by contemporary scientists in the English-speaking world. I made use, naturally, of works by German and French authors in their Russian or English translations regarding the matter of philosophy conceptions and theories of *naturphilosophie* from the 19th to early 20th centuries. Being Russian in origin, I could not avoid using some works by Russian scientists, though only a limited number, for the simple reason that their names, even the great ones, are unknown to the Western reader. In other words, their ideas are not subject to scholarly discussion in the West; they are not even given simple attention. There are certain reasons for this, but I shall not delve into them here.

Despite the abundance of literature listed in the bibliography, there is not one book there in the area of *naturphilosophie* that is dedicated to force as such.[1] In one aspect or another, force has been analyzed in works of a more general scope from the philosophers of antiquity until the end of the 19th century. Then, in the 20th century, the analysis of force was picked up by the social sciences, mainly in the aspect of power or authority. In spite of this, force did not become either a category or a concept; i.e., it did not become the core of even one scientific conception or theory within whose framework one could formulate the regularities of its functioning or manifestation. Nonetheless, there does exist a certain range of literature—not very large in quantity—that attempts to use system analysis of the fundamental problems of human knowledge: How and why did the universe emerge? What is life, what is man, and what is he necessary for? Among the authors of this kind of work, I would like to single out the names of the following scientists of the 20th and early 21st centuries: V. I. Vernadsky, I. S. Shklovsky, Walter Hollitscher, Pierre Teilhard de Chardin, J. Bernal, Arthur Young, Armand Delsemme, Roger Penrose, and Steven Weinberg. The value of their works lies in that these scientists trace Being from its beginning to man—based, of course, on their own scientific and ideological views. In the present case, it does not matter whether I agree with their views or not; to me, it is important that they managed to span a wide range of different branches of science without losing the main thread of their analysis. Of all 19th-century works, the one most relevant to the topic

1 I have a confession to make to the reader: it turns out that such a book does indeed exist, but, unfortunately, I only read it after this book of mine had already been published in Russian and translated into English. It is Herbert Spencer's famous work *First Principles*, which I had laid aside, intending to use it in another of my work and, not suspecting that his theory of evolution stems from the universal conception of Persistence of Force.

of my research is *Dialectics of Nature* by Engels; it amazes not only with its universal grasp of different sciences, but also with its predictions that came true in the 20th century. I believe that no textbook on natural sciences is worth the paper it is printed on unless it presents, even if only briefly, the ideas and views of the scholars listed above.

The reader has certainly noticed by now that I frequently quote Hegel. There is good reason for that; I deeply believe that no matter what ideological labels are attached to this name, it is impossible to reflect on any topic of study to its full extent without his methodology. In the time elapsed since Hegel's books *Phenomenology of Mind* and *Science of Logic,* mankind has not invented a better mechanism for developing thinking. My special attitude toward Hegel is due to the fact, among others, that it was Hegel who led me toward the definition of force that took on the form of the category Ontobia.

CHAPTER I

THE PHENOMENOLOGY OF FORCE

1

Foreword

> And we see that a certain force acts in everything.
>
> *Nicholas of Cusa*

It is intriguing that the topic of force has never emerged in the history of philosophical thought as a problem that would give rise to schools, currents, or areas of thought. Philosophical conflicts have centered for the most part on the categorical-conceptual pair *matter–spirit* and the related troubling question, which comes first? Two different answers have resulted in two dominant philosophical outlooks—materialism and idealism —which have been in the contest for over two-and-a-half millennia and are still battling today. Force, however—along with the categories of Matter, Motion, Time, and Space—is always present in these arguments under one name or another, sometimes right alongside Matter and Spirit, occasionally even replacing them. It is immediately noticeable that philosophers of both camps have used Force as a categorical *tool.* This shared interest in force may mean that it transcends ideologies and currents and that it contains, therefore, something universal. If this postulate were to be proved—or even if it could be given only a theoretical basis—then force could become the basis for creating a theory that would unite three worlds: the inorganic, the organic, and the social worlds. But that is only my assumption.

In the beginning, I would like to present two opposing views on force from scholars whose weight in the study of the phenomena of life is undoubtedly great. The first belongs to Leonardo da Vinci, who wrote, “Force arises from dearth or abundance; it is the child of physical motion, and the grand-child of spiritual motion, and the mother and origin of gravity."[1]

The other belongs to the renowned English philosopher George Berkeley, who lived a century later than Leonardo. In his text *Alciphron, or the Minute Philosopher,* Berkeley gave an entirely different evaluation of force:

> E u p h r a n o r. …Let me entreat you, Alciphron, be not amused by terms; let aside the *word* force, and exclude every other thing from your thoughts, and then you see what precise *idea* you have of force.
>
> A l c i p h r o n. Force is that in bodies which produceth motion and other sensible effects.
>
> E. It is then something distinct from those effects?
>
> A. It is.
>
> E. Be pleased now to exclude the consideration of its subject and effects, and contemplate force itself in its own precise idea.
>
> A. I profess I find it no such easy matter.
>
> E. …And that which it seems neither you nor I can frame an idea of, by your own remark of men's mind and faculties being made much alike, we may suppose others have no more an idea of than we.[2]

One has to admit that Berkeley was partly right; to this day, neither the social nor even the natural sciences have developed a clear, precise idea of force. This is despite the fact that force is one of the most frequently used terms in any branch of science. Moreover, the world has been using laws of force for a long time—in physics, for instance—but it remains a puzzle what force is in itself.

Practically all philosophers of note have addressed problems related to force, believing that they had grasped its essence. Nonetheless, not one of their interpretations of force has become generally accepted. Not one has become a universal category or a universal concept. In other words, none became a law that would be of such persuasive power in the process of cognizing nature and society as, say, Hegel's laws of dialectics.

This conclusion means only that researchers still have a wide-open field in which to analyze this elusive force. One of the important stages of analysis is the review of works of predecessors who engaged in the topic. Naturally, as this is the first stage in approaching the concept of force, it is the point of departure for this work.

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1 Leonardo Da Vinci, *Notebooks*, 859.

2 Berkeley, *Alciphron, or The Minute Philosopher,* 294.

Even though, as noted above, the word *force*—sometimes even given a conceptual or categorical hue—has been used by practically every philosopher, I shall here present in my analysis the views of only those authors who attempted to give a definition of force and to understand what force is in itself (or force-in-itself), i.e., to elevate this word to the level of a concept or category. For this reason, I have declined to present in this chapter, with a few exceptions, views on force held by people in the natural sciences since the word interested them not from an ontological perspective but rather in its applied meaning in accordance with their area of research. I have, therefore, omitted such names as Roger Bacon, William Gilbert, Nicolas Copernicus, Galileo Galilei, Johannes Kepler, and many others.

Those who attempted to understand force on a philosophical level were rather few. I do not intend to criticize those authors; they lived in remote times, immersed in different paradigms of science, and it would be silly to accuse them of failing to understand something from today's perspective. On the contrary, one cannot help being astonished by and admiring of their insights, these often-brilliant guesses about the infinite complexity of matter made hundreds or even thousands of years ago. My objective is to present the ideas of these selected philosophers about force and the context in which they understood or analyzed the word. In other words, I show whether they viewed force as a quantitative measure of something or as a certain quality, as an independent phenomenon of being. Hence the necessarily abundant quoting (it is difficult to give a synopsis of a philosopher's work without distorting his thoughts) with some commentary and summaries. My own interpretation of force will be given in a separate paragraph.

Even though this foreword has already reached an excessive length, I am obliged to say a few words here on the subject of materialism and idealism.

It is not by chance that Western philosophy started with the elemental materialism of the Milesian school, as the first stage of the process of thinking commences with summarizing sensual perceptions. At this level, the most frequently noticed phenomena became the "primary foundation" of all existence (water, air, fire, earth). A certain stage of development of philosophical thought was needed to make the transition from the sensual to the rational ("positive reason," in Hegel's words), which proceeded to form concepts that propelled ideological trends. The combination of the two gave rise to a whole assortment of philosophers—the so-called deists—who cannot be placed unequivocally in either the materialist or the idealist camp. In the course of its development, materialism, it should be noted, went through the classic Hegelian triad: from naive to mechanistic and then to dialectical materialism. Idealism, on the other hand, remained basically the same despite its many varieties, since the idea of God always comes through to save the system in the end. Whenever a theory cannot be completed or the depths of some problem cannot be plumbed, God comes to the rescue. Nonetheless, idealism contains a tremendous potential for thinking: dialectics. Prior to Marx and Engels, dialectics developed for the most part in the realm of idealism, for sophisticated methods of thinking were needed to prove the "existence" of God or of inexplicable puzzles of being something of which the elemental or metaphysical materialists had no need. This does not mean that the division of philosophers into two camps was precisely defined by their views on matter and spirit. From the very start, elements of both often became intertwined, especially as the early Greek materialists did believe in gods. The place they accorded to these gods, however, is another matter. Hesiod, for example, wrote:

> Verily at the first Chaos came to be, but next
> wide-bosomed Earth, the ever-sure foundations of all.

2

Ancient Greek Philosophers On Force

Let us start with Anaximander (610–546 BC). Not only did he introduce the term *apeiron* (the infinite), but he also explained the emergence of things not through simple elements, but through involvement of opposites in the eternal motion of the apeiron. Aspects of dialectics were also present in the works of Anaximenes (6th century BC), who championed the primacy of air, and to an even larger degree in those of Heraclitus (520–460 or 535–475 BC) with his "inextinguishable fire." Of greatest interest to us, however, are Anaxagoras (500–428 BC) and Empedocles (490–430 or 484–424 BC). According to Anaxagoras, everything consists of an infinite multitude of small material particles that are qualitatively different from each other—the so-called "seeds of things" (*homeomeria*). They transform into one another, producing juncture or disjuncture, which leads to the emergence or death of things. Anaxagoras saw the cause of their motion and, more importantly, the cause that brings order to their motion itself as being in *nous*, i.e., thought (reason, mind). The word itself had apparently been introduced to philosophy earlier by Acusilaus, but Anaxagoras endowed it with a systemizing meaning. He wrote, "All things were mixed up together; then Mind (nous) came and arranged them all in distinct order."[1] Even though Plato later interpreted the category of *Nous* as a spiritual principle of bringing order to the world (other philosophers giving it materialistic interpretations), the important thing is this: matter that was initially immobile and then acquired a chaotic form becomes orderly at some point thanks to reason, i.e., the laws of nature.

It is surprising how much this approach is reminiscent of today's arguments as to whether the laws of nature emerged sometime after the Big Bang or existed as potential within a singular state of matter. The category of *Nous*, which played a decisive role in the establishment of man as homo sapiens—intelligent man—becomes even more convincing when one perceives it in the literal meaning of thought–mind.

Empedocles, being an elemental materialist, believed that everything in existence is formed by the four elements—Zeus (fire), Hera (air), Hades (earth), and Nestida (water)—and by two main opposing forces—love (friendship) and enmity (hate). The latter represent a certain thin material layer that facilitates the constant juncture and disjuncture of the tiniest particles of the main elements (is this not rather the modern interpretation of physical vacuum?). However, these two opposing motive forces cannot be simply identified as pulling together and pushing apart. In Empedocles's conception, love divides the homogeneous and unites the heterogeneous, and it thus "makes one of many." Enmity, on the other hand, divides the heterogeneous and unites the homogeneous, and thus "makes many of one." This view forms the basis of Empedocles's theory of the cosmos.

Out of this philosopher's seemingly naive reasoning, some interesting

1 Quoted in Diogenes Laertius, *Lives and Opinions of Eminent Philosophers*, 95. [Translated from Diogenes Laertius, *The Lives and Opinions of Eminent Philosophers*, trans. by Charles Duke Yonge.]

things follow: matter (the elements) is in itself passive; in order that it come to life and be set in motion, certain motive forces are needed. In Empedocles's interpretation, these are love and enmity, and the two forces carry opposite signs—plus and minus. This does not mean that the plus is better than the minus or vice versa. To Empedocles, both forces are necessary for the motion of matter precisely as opposites, which Anaximander spoke of without delving into details. In Empedocles's work, these forces are still separate from matter even though they are a sort of matter themselves.

Another philosopher, Democritus (460–370 BC), combined these forces. His merit is not only that he started talking for the first time about atoms; his most important idea was that atoms have the property of motion, which is transferred through collisions, and this is the source of development. He wrote, "The atoms were infinite both in magnitude and number, and were borne about through the universe in endless revolutions. And that thus they produced all the combinations that exist; fire, water, air, and earth."[1] Among other things, the idea of the whirlwind is important here. Diogenes Laërtius writes, quoting Democritus, "that everything that happens, happens of necessity. Motion, being the cause of the production of everything, which he calls necessity" (ibid.).

It is amazing how much these views are reminiscent of modern theories of cosmogony. Nonetheless, it must be stressed that almost all philosophers before Socrates (with the exception of Democritus) postulated motion and that which is moved (matter, usually) as separate things. Socrates (469–399 BC) was the first to speak of self-motion.

Even though the quotation below (from the *Phaedrus*) speaks of self-motion of the soul rather than that of matter, the idea of self-motion is itself yet important. Socrates said, "The soul through all her being is immortal, for that which is ever in motion is immortal; but that which moves another and is moved by another, in ceasing to move ceases also to live. Only the self-moving, never leaving self, never ceases to move, and is the fountain and beginning of motion to all that moves besides."[2] The most meaningful thing here: there is no original impetus (therefore God is not needed), no beginning. There is only the eternally-be-in-motion soul, a concept whose name could later be easily changed to matter.

In any case, philosophy as a science really starts with Aristotle (384–

1 Quoted in Diogenes Laërtius, 346.

2 Plato, *Collected Works in 3 volumes*, 2: 180–1. [Translated from Plato, *Phaedrus*.]

322 BC). He was the first to set out the philosophical tool of categories and to systemize different branches of knowledge, bestowing on them certain wholeness in the shape of different sciences. This enabled him to operate on the categorical level, i.e., scientifically reflect on the eternal problems of being and essence, which is apparently what assured the viability of his ideas over the next nearly 18 centuries. I, however, am interested in his views on force. Aristotle needed this category to explain one of the four causes of being, namely, motion: "That from which the change or the resting from change first begins."[1] (The other three causes are matter, form, and goal.)

In *Physics,* Aristotle reflects on "the force of place," on "the finite force" in the infinite, and "the infinite force" in the finite. Through complex reasoning, he arrives at the following conclusion: "But our present problem concerns the appearance of continuous motion in a single thing, and therefore, since it cannot be moved throughout its motion by the same movement, the question is, what moves it?"[2] He does eventually supply an answer to this question, but it is, as it were, smeared over many pages of the *Physics*, so it makes sense to look at his *Metaphysics,* where the answers are more concentrated.

In that classic work, Aristotle writes, "'Potency' (dunamis)[3] means a source of movement or change, which is in another thing than the thing moved or in the same thing qua other" (ibid., 1: 162, 1019a, 15). (In my opinion, the word *force*, or rather *potential force*, would more precisely convey the essence of the word *dunamis*.) Further, motion itself, according to Aristotle, is divided into different genera (classes). "There being a distinction in each class of things between the potential and the completely real, I call the actuality of the potential as such, movement" (ibid., 1: 289, 1065b, 15).

It follows from this that motion is a certain tendency of matter as a possibility for realization of form as reality. It is tied closely to matter through form, which is defined by "things," for "there is no movement apart from things; for change is always according to the categories of being" (ibid., 1: 288, 1065b, 5).

1 Aristotle, *Collected Works in four volumes*. *Metaphysics*, 1: 146, 1013a, 30. [Translated from Aristotle, *Metaphysics*. Translated by W. D. Ross.]

2 Aristotle, *Physics*, 3: 261, 267a, 20. [Translated from Aristotle. *Physics*. Translated by R. P. Hardie and R. K. Gaye.]

3 In the English variant, the word dunamis is translated as potency (or capacity, or potentiality), i.e., in this case as force-power. This word came to English from the Latin potentia.

Subsequent reasoning makes it clear that this discourse is about a self-moving thing—nature, in other words. Moreover, it is precisely that "NATURE has been defined as a 'principle of motion and change'" (*Physics*, 3: 103). In another place, Aristotle proclaims the infinity of motion. He writes, "But it is impossible that movement should either have come into being or cease to be (for it must always have existed)" (*Metaphysics*, 1: 307, 1071b, 5).

But where is force in all this reasoning? *Dunamis*, *entelecheia*, and *energia*[1] are different stages of motion (for quality, quantity, and place, respectively) and are tied only to the "thing." Miraculously, Aristotle managed to separate nature and things from matter, and motion from the latter. He even criticizes Empedocles in this connection since "Empedocles also has a paradoxical view; for he identifies the good with love, but this is a principle both as mover (for it brings things together) and as matter (for it is part of the mixture). Now even if it happens that the same thing is a principle both as matter and as mover, still the being, at least, of the two is not the same" (ibid., 1: 317, 1075b, 5).

Aristotle believes "matter is potentiality, form actuality (entelecheia)" (*On the Soul*, 1: 394, 412a, 10). "There is no movement in respect of substance" (*Metaphysics*, 1: 296, 1068a, 10). "There must, then, be such a principle, whose very essence is actuality. Further, then, these substances must be without matter; for they must be eternal if anything is eternal. Therefore, they must be actuality" (ibid., 1: 307, 1071b, 20). He locates that essence, naturally, in God (ibid.,1: 310–11, 1072b, 25, 30).

On the strength of this final conclusion, Soviet philosophers in times past labeled this doctrine of Aristotle as theology, or a doctrine about God.[2] I consider their verdict incorrect, or at least imprecise. First, one should note that the very conception of God that Aristotle used to counter the views of Anaxagoras and Empedocles, Leucippus, and Plato, appears quite weak and hardly argued. Something else is

1 With the word *entelecheia*, the philosopher designates *accomplished motion*, while potential motion is called *dunamis*. Close to entelechy is the word *energeia*, which means movement or activity. Aristotle writes, for example, "For the deed is the goal, and the activity is the deed, which is why 'activity' (energeia) is derived from 'deed' (ergon) and directed toward 'accomplishment'" (entelecheia)" (ibid., 1: 246, 1050a, 20). The word *dunamis* in those times was used as a technical term in mathematics in this context: one value is *capable* (is a *potency*) with respect to another if their squares can be measured by a common unit. One also has to keep in mind that the thing is not matter.

2 See, for example, the foreword by V. Asmus to the works of Aristotle (1: 22).

more important: God himself is derived in Aristotle's work through the activity of the *thought*, which is capable of absorbing the object of thought and its essence. "And life also belongs to God; for the actuality of thought is life, and God is that actuality" (ibid., 1: 310, 1072b, 25, 30). It follows from this that Aristotle's God is dissolved in man's thought or, in other words, that man, as thought that is alive and active, is God. Thus, materialism in Aristotle's work triumphs over theism, and ever-moving nature takes over the original impetus—energy tirelessly generates entelechy, i.e., induces nature in motion.

* * *

Now for a few words about the medieval philosophers. For obvious reasons, they studied for the most part the gracious doings of God, leaving little space for nature. Nonetheless, several of them did mention force as an important concept, even if only cursorily. For example, Bonaventure (1221–1274), professor of theology at the University of Paris, who went on to become a bishop and then a cardinal, viewed the world through the conception of the metaphysics of light and the theory of "fetal proofs." In Bonaventure's understanding, light is not a material substance but rather a force that acts in matter. To translate this into Aristotle's language, light is the form of everything corporeal, and it is naturally separate from matter.

Another philosopher, John Buridan (circa 1300–1358), a rector of the same University of Paris, proposed the idea of the impetus, which is practically identical to the concept of force. Buridan believed that a body that has been given an impetus (say, a thrown stone) keeps moving until its impetus, or force, is overcome by a stronger one. At the same time, the resistance of air and the body's own mass weaken the impetus given to it, and eventually the body stops moving, with the result that the impetus dies. Such reasoning anticipated the law of inertia formulated much later by Newton. The word *force* was treated in an analogous key in the works of Roger Bacon and other medieval philosophers. Taken together, they are of little interest for the present work for the reason that has been noted in the foreword. Therefore, I now move on to the philosophers of the Renaissance and Reformation epochs.

3

The Philosophy of Force in the Works of European Philosophers of the 15th–19th Centuries

Nicholas of Cusa (1401–1464)

Nicholas of Cusa, one of the major German philosopher-theologians of his time, believed less in God than in the human ability to cognize the world, and naturally, he could not do without the concept of Force. In one of his many writings (*The Short Works of 1445–1447*), he wrote, "The singular (united) and the modus" (*modus* was Nicholas's word for matter), which manifest in themselves substances and actions, are recognized through visions; "and we see that a certain force acts in everything."[1] Its essence is cognized by the intellect in "the modus of absolute detachment," which is "the absolute force" that contains in itself "all degrees and modes of force."

Nicholas of Cusa clarifies that the intellect is itself already a force capable of recognizing the forces that pertain to the heavens, the forces of the plant and animal worlds as well as the inanimate world (for example, minerals), and so on. "When paying attention, you find force and its modus in everything. Force is thus that singular that is in everything all that in its modus is in communion with that singular" (ibid., 317).

This regards things that are considered ordinary today but that were not at all simple in the 15th century, in the time before the sensualists and Hegel. Force is an innate property of matter itself (modi), and its manifestation is found out through the senses and through sight in particular, i.e., through God (the Latin word for God—*Deus*—originates

1 Nicholas of Cusa, *Collected Works in two volumes*, 1: 316.

from the Greek word for *I see*). It is merely a reflection of force. We recognize its essence without God through the intellect (mind), which is also a force as an element of the same modus. Cognition takes place in the joining of the modus and the intellect through unification (synthesis, to use Hegel's word). In the 15th century, this type of reasoning meant a blow against the scholastics.

Nicholas of Cusa, in spite of his theology, constantly emphasizes the different essences of force and body in different substances. For example, in another work, *The Ball Game*, he writes, "An animal's soul is a substance and force that needs a body because it does not function in any way outside a body, and, therefore, it apparently perishes when the body perishes."[1] Forces possess a different nature in "the triangle, the quadrangle," or in other natural essences.

The substance of the human soul is a cardinally different thing "since it is an intellectual and never-draining force that, apparently, never perishes" (ibid.). For through the intellect—i.e., through knowledge—it is constantly passed on to other people and will exist for as long as mankind does.

Nicholas of Cusa anticipated by several centuries the discovery of the laws of force in physics and in the realms of biology and the social sciences by stressing, on the one hand, the qualitative differences between natural forces in different moduses, and by offering the hypothesis, on the other, of a single force in the universe that is possibly the cause of its emergence. That is a topic for the 21st century!

Leonardo da Vinci (1452–1519)

In his famous *Notebooks,* the artist and brilliant thinker Leonardo da Vinci committed to paper his views on practically all the sciences known in his day, including his views on force, which occupies a special place in his system of views on nature. He writes, "Force, with physical motion, and gravity, with resistance, are the four external powers on which all actions of mortals depend."[2] In the English translation, the word *forza* is rendered as *force* and *impeto* as *power*. The problem with this translation lies in the fact that *impeto* can mean at the same time potency, force, and

1 Nikolaus von Kues, *Vom Globusspiel*, 28.
2 Leonardo da Vinci, *The Notebooks*, (#859).

impulse while *forza* can mean both force and gravity (weight). In order to understand what this scientist meant, it is necessary to correlate these words in other contexts; it will then become clear whether they are used as synonyms or if they reflect different phenomena. One should keep in mind that the interpretations of force in the *Notebooks* are scattered over different sections that are not always connected to one another.

In one of these sections, we read: "Only force and gravity can be causes of motion."[1] Thus, motion is no longer force—it is something external to force and gravity, and vice versa. In another place, Leonardo draws an apparently conscious distinction between force and gravity, for "gravity is overcome by force, same as force is overcome by gravity. Gravity in itself can be seen without force while force cannot be seen without gravity....The longer weight falls, the greater it grows; the longer force falls, the lesser it becomes. While one is eternal, the other is mortal. Gravity is natural while force is accidental" (ibid., 82)

In this fragment, Leonardo appears to anticipate the later formulated regularities in the relationship between mass, force, and speed; i.e., he predefines the regularities of manifestation of a body's motion. It is precisely in the manifestation (thing-outside-self) that a certain singularity becomes split into force and weight while, in essence, "weight is a certain accidental force that is being created by motion" (ibid., 83). It follows that all three phenomena are mutually caused; i.e., they do not exist one without the other.

In response to the direct question, what is force?, Leonardo writes:

> Force is a spiritual, incorporeal, and invisible impulse that is awakened to short life in those bodies which as a result of accidental violence are out of their natural position and state of rest: spiritual I said because in this force is active life; incorporeal I said because the body that creates it increases in neither weight nor form; short-lives I said because it always tends to overcome its cause, and having done this, dies (ibid., 77).

It follows from this explanation that by "spirituality," Leonardo does not mean something divine as theologians would interpret it; he emphasizes the life-activity of force as such. "Invisibility" means an

1 Leonardo da Vinci, *Selected Work,* 64.

absence of physical parameters; therefore, discovery of force is possible only through moving gravity. The "short life" of force implies its initiating essence, which is why in this case the word *impeto* (impulse) is used. Having given a push to the body, having triggered the collapse of gravity, force starts to peter out, "grow smaller," as if it had fulfilled its role.

Thus, force is the source of motion and gravity, which are indivisible in essence. At the same time, gravity can exist without force since gravity is an attribute of the body, which is a thing, or matter. This means that bodies can exist without force, for example, when they are " being in natural rest."

As a result, Leonardo presents, on the one hand, a body in rest can exist (thing, matter), and on the other hand, force, motion, and weight. Even though the latter—weight —may be recognized as a certain link between body and force, this position is, nonetheless, quite vulnerable, for it implies the possibility of matter existing without motion or force. Leonardo would have only had to unify all these attributes to completely thwart his critics. Still, what he did say suffices to place him ahead of all his contemporaries.

Bernardino Telesio (1509–1588) and Francis Bacon (1561–1626)

Telesio, one of the influential philosophers of the Italian Renaissance, came to my attention thanks to Francis Bacon's work *Of the Principles and Origins of Nature*. In this book, the English philosopher gives a detailed analysis of the Italian's views on "the first active principles of being": heat and cold. Telesio presented his philosophy in the book *On the Nature of Things According to Their Own Principles*, in which materialism is everywhere in evidence, although God is given a certain role. This philosopher believed that all things are corporeal, material, and subject to the principle of their unchanging essence. In itself, though, this material principle is passive, devoid of motion or activity. Matter is put into motion by two other opposing active principles—heat and cold—which are in a constant struggle. This approach was clearly borrowed from the ancient Greeks. Bacon maintains that Telesio did actually "restore the philosophy of Parmenides" (6th–5th centuries BC) with its fire–earth dichotomy. In the Italian philosopher's interpretation, though, unlike that of the Greeks, the above-mentioned principles, even though bodiless, cannot manifest themselves outside of matter, outside of the substance of things. This approach does remind one of the reasoning of Parmenides—that is, the following section on thought:

> It is the same thing, to think of something and to think that it *is*, since you will never find thought without what-is, to which it refers, and on which it depends.[1]

What does Bacon criticize Telesio for? That matter is passive, and its motion depends on heat and cold. Bacon makes a qualification, however:

> In some places, he [Telesio] seems to ascribe to matter (even though indecisively, in passing) certain properties of its own: firstly, that it does not increase or decrease from the influences on it of forms and active origins, always preserving its total sum; secondly, that inherent to it is the motion of gravity or falling, and that he also speaks of the blackness of matter.[2]

In another place, Bacon writes with some condemnation of the Italian's admission that "the sum of matter is eternal and cannot be increased or decreased" (ibid., 71).

If indeed this is what Telesio wrote (I quote him here from Bacon's writings), then he, not Lavoisier, should be ascribed priority in the discovery of the law of conservation of mass as well as speculation about "black holes." Moreover, Telesio made certain statements in connection with the effect of heat on matter that were subsequently formulated as the second law of thermodynamics (ibid., 54). Still other references by Bacon to Telesio reveal the latter's conclusions about closed and open systems, a problem that is actively discussed to this day.

However, Bacon was actually put off by the idea of the "eternity of matter," which makes matter passive, "deadening" it, as it were. Moreover, in Bacon's opinion, there exist certain "actions and consequences…that can by no means be attributed to heat and cold" (ibid., 70). As for those

1 Parmenides of Elea, *On Nature (Peri Physeos*).

2 Bacon, *On Principles*, 44–5.

things that do emerge from heat and cold, the latter are not causes in the proper sense of the word but merely "factors and tools."

What has been said does not mean that Bacon rejected heat altogether. First, he puts limits on its effects, and second, he views heat itself as a form of motion. In *The New Organon,* he specifies his thoughts: "I would be understood to mean not that heat generates motion or that motion generates heat (though both are true in certain cases), but that heat itself, its essence and quiddity, is motion and nothing else."[1] Bacon sees the moving force of all aggregate matter in its mass, "thanks to which this matter preserves undiminished its quantity"; it is precisely this force of mass that "causes one body to oscillate, moves another from place to place, is solid and firm in itself and establishes with indisputable authority the laws of the possible and the impossible" (*On Principles*, 73).

Bacon reflects also on the force that supports the cohesion between particles of matter. He appears to be groping his way toward the law of gravity. He is dissatisfied in this case not just with the principle of heat–cold, but also with that of "empty space" (vacuum). Bacon promised to undertake an analysis of vacuum in this work but did not (the work remained unfinished). Nonetheless, his reasoning on this topic was clearly pointing toward the idea of gravity. He writes, "For the tie of matter is stronger than the antagonism between heat and cold, and the mutual dependency of matter does not reckon with the variety of specific forms. Therefore, the force of cohesion between parts of matter is absolutely independent of the principle of heat and cold" (ibid., 76).

Let me quote here one more thought by Bacon that, although it is not directly related to force, is very important for the subsequent parts of this book. In *The New Organon*, Bacon wrote that, customarily, in the theory of cognition, the scientists seek to establish four causes: the material, the formal, the efficient, and the final. He believed that the scholastic manner in which the first three causes are analyzed contributes nothing to true science. "But of these the final cause rather corrupts than advances the sciences, except such as have to do with human action" (*The New Organon*, 103).

It is amazing that someone could write this in the early 17th century. It is little wonder that Francis Bacon is shunned by many contemporary cosmogonists even in his homeland of England. Their "thinking atoms" or "finite foreordainment" of nature are clearly at odds with the views of

1 Bacon, *The New Organon*, 135–6.

the real progenitor of English materialism, in whose writings "matter, surrounded by a sensuous, poetic glamour, seems to attract man's whole entity by winning smiles."[1] And it could not be said better.

René Descartes (1596–1650) and Isaac Newton (1642–1727)

Descartes is correctly called a dualist, since in his philosophical works God and matter coexist harmoniously and peacefully without contradicting each other in any way. From his *World, or Treatise on Light*, one learns that the world was created by God "five or six thousand years ago."[2] After that, apparently, came the realm of Nature, which to Descartes meant matter itself. The latter possesses extension and the properties (modus) inherent in it, namely, shape, size, location, order of particles, and their quantity, divisibility, and relocation. In Descartes's view, matter possesses the property of motion, or, more precisely, relocation from one place to another. In this connection, Descartes makes a substantial qualification of in another work, *The Principles of Philosophy*:

> And I say that it is the transporting and not the force or action which transports, with the view of showing that motion is always in the movable thing, not in that which moves; for it seems to me that we are not accustomed to distinguish these two things with sufficient accuracy. Farther, I understand that it is a mode of the movable thing, and not a substance, just as figure is a property of the thing figured, and repose of that which is at rest." (ibid., 477-8)

This means that in the state of rest (another extremely important modus), matter is immobile. Motion itself is a modus, i.e., is a property of matter in motion only, not a substance of matter in general. This property possesses "force, or the ability of motion" (*On Light*, ibid., 179). Thus, Descartes limits the sphere of force's effects, ascribing it to

1 ME, 2: 142–3.

2 Descartes, *Selected Works*, 193. [Translated from Descartes, *The Principles of Philosophy,* selections.]

manifestation only, and then manifestation only of matter in motion. On a single occasion, in *The Principles of Philosophy*, he offers a different interpretation of force, this time in application to *things*:

> Thus what is joined to another thing has some power of resisting separation from it; and what is separated has some power of remaining separate. Again, what is at rest has some power of remaining at rest and consequently of resisting anything that may alter the state of rest; and what is in motion has some power of persisting in its motion, i.e., of continuing to move with the same speed and in the same direction. An estimate of this last power must depend firstly on the size of the body in question and the size of the surface which separates it from other bodies, and secondly on the speed of the motion, and on the various ways in which different bodies collide, and the degree of opposition involved.[1]

It follows from this quotation that force is inherent, after all, in bodies as material substances, and it can be measured through a number of quantitative parameters of the body. In particular, Descartes suggests measuring mechanical force through multiplying mass by speed (mv), the product of which in modern physics is defined as the quantity of motion. In *The Principles,* we read, "All bodies that together make the universe consist of one and the same matter, infinitely divisible and in reality divided into a multitude of parts that move differently, with their motion being somehow circular, and the quantity of motion in the world is preserved constantly one and the same" (*Selected Works*, 511). This statement in fact is a formulation of the law of conservation of the quantity of motion in the universe. The principle of inertia, which encompasses both motion and rest (when v = 0), is also formulated within the framework of this law.

For all this, it is necessary to say clearly that Descartes analyzed force from the standpoint of physics, not philosophy. Perhaps this approach was due to his negative attitude toward the descriptions of force by earlier philosophers, whom he regarded as scholastics.

The same can be said of Newton, who proclaimed with a certain challenge (I quote it again), "I frame no hypotheses." The principles of his philosophy are mathematical rather than philosophical. He admitted openly that he was researching not causes but only phenomena

1 Descartes, *The Philosophical Writings,* 243–4.

pertaining to physics. For example, here is one of his definitions of force, formulating the law of inertia: "The *vis insita*, or innate force of matter, is a power of resisting, by which every body, as much as in it lies, continues in its present state, whether it be of rest, or of moving uniformly forwards in a right line."[1] When speaking of the power of gravity, Newton admitted, "I have not been able to discover the cause of those properties of gravity from phenomena" (ibid.).

The interpreters of Newton's laws are another matter, in particular Newton's follower Samuel Clarke, with whom Leibniz corresponded. Clarke sought to prove that the force of matter that is called the force of inertia is passive due to which matter retains its state. This force of inertia is always proportional to the quantity of matter; therefore, it is always the same, immutable, regardless of whether matter is at rest or in motion, and it is never transferred from one body to another, etc.

Leibniz, meanwhile, being in agreement with Newton about the quantity of motion not remaining the same, tried to explain to Clarke the idea of "the difference between the quantity of motion and the quantity of force."[2] Their correspondence proves yet again that it is possible to be a physicist of genius and a worthless philosopher. Leibniz, though, managed to combine genius in both spheres of knowledge: philosophy and the natural sciences.[3]

Here I would like to state that the phenomenon of inertial force, I believe, has never been applied to the analysis of societal development. I believe that an attempt to consider the force of inertia and the inertia of force with respect to the state of society may be fruitful. But let us not get ahead of ourselves. It is not known yet what force is.

1 Newton, *Mathematical Principles of Natural Philosophy*.

2 Leibniz, *Philosophical Writings*, 236.

3 In this connection, one has to mention the name of the Soviet philosopher B. G. Kuznetsov, who analyzed Newton's phenomenological force and Leibniz's metaphysical force. He showed convincingly how the transformation of physical into metaphysical force takes place, i.e., into force as the foundation of being or of the substance-monad. To put it more simply, Newton uncovered the manifestation of force in a limited part of the material world while Leibniz individualized "the eternal foundation of being of every real object." See Kuznetsov, *Mind and Being*, 183–200.

Benedict de Spinoza (1632–1677)

Spinoza gives an interesting interpretation of might in his *Political Treatise*. He asserts, “The power, by which natural things exist, and therefore that by which they operate, can be no other than the eternal power (potentia) of God itself.”[1] That is, God is the source of might (to Spinoza, God is nature). In other words, might is born from nature. Just one paragraph later, Spinoza continues, “And so by *natural right* I understand the very laws or rules of nature, in accordance with which everything takes place, in other words, the power of nature itself. And so the natural right of universal nature, and consequently of every individual thing, extends as far as its power” (ibid.).

It follows from this postulate that man, being a part of nature, also possesses might, which is used to preserve his being. His rights to being, at that, are adequate to his might since “each has as much right as he has power.” It is stressed here that might is not a physical quantity but rather a phenomenon of spirit or mind. Spinoza writes, “Nay, inasmuch as human power is to be reckoned less by physical vigor than by mental strength, it follows that those men are most independent whose reason is strongest, and who are most guided thereby” (ibid.).

In Spinoza’s view, therefore, might is concentrated in the mind. The joining of minds (i.e., powers) between two or more people increases their rights toward nature: “And the more there are that have so joined in alliance, the more right they all collectively will possess” (ibid.). The joint might of a people is called *dominion* (*imperium*). Thus might is concentrated in the hands of the state or in the hands of those “to whom [they] are entrusted by common consent affairs of state” (ibid.).

It follows from Spinoza’s reasoning that, first, might is innately inherent in nature (God) and thus also to man as a part of nature. Second, a man’s right to self-reproduction (to the preservation of his being) is proportional to his might (there is as much right as there is

1 Spinoza, *Political Treatise,* ch. II. Spinoza wrote his work in Latin and used the word *potentia*, which was translated into Russian as *moshch* (might). In other cases, this same word is translated into Russian as *sila* (force), for example, when translating Leibniz. This same word, *potential*, is translated into English as *power*. The word *force* is closer to Spinoza’s idea than *might*, but I am constrained in this instance to preserve the text of the translation.

might). Third, might is a quantity that is mental (soul, mind) rather than physical. Fourth, it increases when people are joined together in a state that gathers together their combined might.

The dialectics of the opening (unfolding) of the concept of might is absent in Spinoza's line of thought. Nevertheless, he did cast light on a very important matter: man and society (the state) reproduce their being thanks to the might (power) that they innately possess.

John Locke (1632–1704)

John Locke's main work, *An Essay Concerning Human Understanding*, analyzes the concept of Power. Locke immediately notices, however, "my present business being not to search into the original of power, but how we come by the idea of it."[1] This does not mean that power is some abstract idea that exists independently (in the Platonic sense); it has its own material substance. Locke writes, "*Powers* make a great Part of our complex Ideas of Substances" (ibid., 190). He then specifies that all complex ideas of substance are powers, just like the simple ideas of substance (for example, "there is power in sugar") (235). He means by this that the ideas of secondary qualities correspond to powers possessed by atomic bodies outside of us. They are manifested in the idea of power, along with motion and thinking. Power, however, proves to be more important than the preceding two ideas, for it is power that sets both thinking and motion in action, and power also pertains to action. Therefore, first, power is one of the main ideas of action, and, second, all the complex ideas of substance—i.e., matter—possess it.

The perception of power proceeds in accordance with Locke's sensualist conception, i.e., through sensations. The latter, in turn, accumulate in the mind, which arrives at the idea of power. Cognition of the idea is thus possible because "power includes in it some kind of *relation* (a relation to action or change)" (ibid., 163).

Locke distinguishes between two kinds of power: active and passive. Active power causes a change while passive power allows this change to take place. He qualifies, by the way, that "active power" is the more proper signification of the word *power* (ibid.).

Locke then proceeds to analyze two powers: will and reason. From

1 Locke, *An Essay Concerning Human Understanding*, 163.

this point, he goes on to the idea of liberty. “Liberty is a power to act or not to act, according as the mind directs.” The general idea of his reasoning in this area is that there can be no liberty where there is no thought or will but that there can be thought and will where there is no liberty. In the latter case, thought and will do not possess power (or the idea of power). Otherwise, if power disappears in the chain thought–will–power–liberty, liberty does as well. Only a strong mind and a strong will presuppose liberty.

Of greater importance, in this case, is the philosophical side of Locke’s conception of power, which boils down to the following: power is one of the fundamental ideas of mind about changing substance. Locke specifies neither the direction of power’s effect (in change, it is merely manifested and recognized) nor the cause of its being embedded in a substance. His is a purely mechanistic statement of a certain phenomenon that could be labeled with another term—say, *manifestation* or *reflection* of substance. Moreover, it does not follow from Locke’s reasoning that power may exist prior to its being recognized by the mind, i.e., objectively. Such an approach, evidently, was characteristic of all the sensualist-materialists; for that they were justly criticized not only by Hegel but also by Leibniz and, of course, Berkeley.

Nonetheless, Locke did notice that power manifests itself “in relations” and is registered in consciousness as a fundamental idea that can explain other complex ideas, such as, for instance, liberty. He endows the concept of power with a positive charge in the sense that the presence of power in both nature and social phenomena enables them progressive development.

Gottfried Wilhelm Leibniz (1646–1716)

Leibniz reflects on the nature of force in many of his works. Let us start with a special one: *On Nature Itself; or, on the Inherent Force and Actions of Created Things* (1698).

In this book, Leibniz derives the foundation of the laws of nature, which “should not be sought in the conservation of the same quantity of motion as it seemed to most, but rather in the fact that it is necessary that *the same quantity of active power be preserved* indeed (something I discovered happens for a most beautiful reason) that *the same quantity* *of motive action* also be conserved."[1] "For there can be no action [*actio*] without a force for acting, and, conversely, a power [*potentia*] which can never be exercised is empty" (ibid., 160).

Leibniz ties motion to force in a clearer and more precise way than Locke. He finds a place for force in essences: "A *first entelechy* must be found in corporeal substance, a first subject of activity…which added over and above extension (or that which is merely geometrical), always acts but yet is modified in various ways in the collision of bodies through conatus and impetus" (ibid., 162). This substantial principle is what is called *the soul* in living things and the *substantial form* in others; "insofar as, together with matter, it constitutes a substance that is truly one, or something one *per se*, it makes up what I call a monad" (ibid.).

Thus, the soul (sometimes, the spirit) is likewise essence that possesses force. In other works, Leibniz develops and clarifies the above ideas while, at the same time, analyzing the manifestations of forces-essences.

Among Leibniz's many works is a small one titled *On Body and Force, Against the Cartesians* (1702). Although it concerns physics, the treatise is written from the perspective of philosophy, i.e., the perspective from which we are seeking to understand what force is.

Leibniz believes that "every body always has motive force, indeed, actual intrinsic motion, innate from the very beginning of things" (ibid., 250). He calls this *active force*, or *entelechy* (from the Greek). This is different from passive mass and the modifications thereof. Leibniz goes on to specify that a body possesses power—i.e., *potentia*—which is subdivided into two forces: passive and active. "Passive force [vis] constitutes matter or mass [massa], and active force constitutes entelechy of form" (ibid., 252). The function of passive force (that is, mass) boils down to the capacity of resistance, including motion itself. At the same time, the active force, entelechy ("which one usually calls force in the absolute sense") "involves an effort [conatus] or striving [tendentia] toward action [actio]" (ibid.).

There are two varieties of entelecheia, primary and derivative—i.e., either substantive or accidental. The primary active force, together with matter—i.e., the passive force—forms the unity of a corporeal substance. "This entelechy is either a soul or something analogous to a soul, and always naturally activates [actuo] some organic body" (ibid.). This first entelechy is a union of soul and passive matter, but their roles in this

1 Leibniz, *Philosophical Essays*, 157.

unity are different: the soul gives life to this unity while the passive force resists "not only penetration, but also motion." This, in Leibniz's conviction, applies not only to animate things but also to those "that are not alive in the proper sense" (ibid., 253).

Despite this seeming mysticism (the soul), Leibniz did grasp the essence of the thing's state of rest—that substance (both in the organic and the inorganic worlds) exists in a definite form for as long as its structure, defined by the locations of its elements (soul), maintains a certain stability, this in turn being defined by the nature of its temporal and spatial existence. It can be violated or even destroyed through collision with other substances or, using Aristotle's terminology, a superior entelechy. The derivative (accidental) force may be such an entelechy. This is what is called "impetus, conatus, or a striving [tendenzia], so to speak, toward some determinate motion, and therefore, it is that by which a primitive force or principle of action is modified" (ibid.).

Leibniz drew a clear distinction between derivative force and motion (or action). Action requires the passage of time "so that action is the product of force and time, considered in every part of body." Accordingly, "action is jointly proportional to [the size] of a body, to time, and to force or power." Moreover, in particular cases, motion itself "ought to be attributed to the force God places in things" (ibid.). A bit later, though, Leibniz, with no embarrassment whatsoever, criticizes the Cartesians for their inclination to ascribe actions to God—which he has just done himself—and rejects such appeals to the deity, for that option "is hardly good philosophy." The philosophical solution is that both the primary and the derivative force are present in every corporeal substance. These forces undergo changes, becoming modified when bodies collide. In collisions, as well, the primary force changes through the derivative one.

As a result, in Leibniz's interpretation, all forms of change reduce in the end to the only change of force itself. He likewise reduces the bodily qualities themselves to forces. "Power in general, then, can be described as the possibility of change,"[1] he says.

Summarizing, it is possible to say that, to Leibniz, force was the main attribute of his favorite monad, i.e., life. Change is inherent in force, which can be cognized only by the intellect, for "this inherent force can indeed be understood distinctly, but it cannot be explained through the imagination" (*Philosophical Essays*, p. 159). Dynamism is

1 Leibniz, *New Essays in Human Understanding*, 169.

inherent in force, which changes in the process of collision and alters other forces.

Leibniz summarized his views on force in a very curious fashion in his *Theodicy: Essays on the Goodness of God, the Freedom of Man & the Origin of Evil* (1710). He wrote:

> Possibility is only an *attribute*, or a certain state: but force, when it is not an integral part of substance itself (i.e., the *derivative force*, not the *primary* one), is a *quality*, distinct and separable from substance. I showed also how one can understand that the soul is the force *primary, modified* and diversifying through derivative forces or qualities, and how it manifests itself in separate actions.[1]

Condillac and later Hegel were to mock Leibniz's force-soul. If Leibniz had specified the actions of forces in different classes of matter, he might have left his opponents no grounds for cracking jokes.

Julien Offray de La Mettrie (1709–1751), Étienne Bonnot de Condillac (1715–1780), and Denis Diderot (1713-1784)

La Mettrie. The militant materialist and atheist La Mettrie endowed matter with "three dimensions": extension, motive force, and the ability to sense.[2] Naturally enough, we here want to ascertain what the motive force is.

In La Mettrie' constructions, matter is passive; therefore, its inherent motive force and extension are "merely the possibility (puissances) of the substance of bodies" (64). At the same time, extension has the property of assuming different *forms*. This assumption of forms is possible due to the motive force, which is "active motion," ultimately identical to the form itself having become active. La Mettrie qualifies that matter began to move not through the effect of "some other acting force," but because "the moving force is within the substance of bodies" (ibid., 64–5).

The question arises of how a particular passive substance started

1 Leibniz, *Works in Four Volumes*, 4: 181–2.

2 La Mettrie, *Works*, 59.

to move, that is, what was the cause of the motion? The answer is as follows: some parts of substance "that take on different forms cannot give them to themselves; they are given forms always by other parts of that same substance, which is already draped in forms. So the action of these parts that impact one on another gives birth to forms through which the moving force of bodies becomes truly active" (ibid., 65).

In his reasoning on force, La Mettrie did not arrive at the category of Contradiction within matter, which had been grasped earlier by Leibniz and would later be brought to its logical completion by Hegel. He only ventured a guess about interrelations (but not interactions) between parts, totally rejecting the external interaction between matter and form. Still, it was obvious enough to him that "matter contains in itself a life-instilling moving force that is the immediate cause of all laws of motion" (ibid., 66). This brilliant guess was confirmed by the subsequent development of physics.

Condillac. Having presented Leibniz's conception of force, I feel compelled to mention its criticism by Condillac, who was the famous opponent of all systems. In his *Treatise on Systems,* he criticizes all system-building philosophers (whom he calls *metaphysicians*), especially Descartes, Malebranche, and Leibniz, the latter in particular being panned for his monads and his force. It should be noted here, in all justice, that Condillac rails against not just the force-monad but against all forces in general, which subsequently became extremely important concepts in classical mechanics: the centrifugal and centripetal forces (formulated originally by C. Huygens), forces of gravity (Newton), the concept of quantity of motion (Descartes), and so on.[1]

Condillac builds his criticism of the living force—Leibniz's monad—on the following logic:

> In every monad one can find all the active force inherent to it and all that it can produce, assuming that it meets no resistance. One can also find in it all the resistance that it offers to any action proceeding from some external cause, but one cannot find in it the states and connections of all things. These states and this connection consist of relations of action and undergoing action. The monad's force does not produce outside all the effect it is

1 Condillac, *Works in Three Volumes*, 2: 84.

> capable of; it produces the effect commensurate with the resistance it meets. Therefore, in order to learn how the monad is connected by its action to the rest of the universe, it is not enough to consider it alone; one should keep in mind all other substances as well. Therefore it is impossible to find in one sole monad the state and the connection of all monads, assuming that they influence or are influenced by each other. (ibid., 90)

Moreover:

> On the one hand, they say that it is an effort; on the other hand, that it meets no impediments. However, should one proceed from our notion of what is called effort and impediment, then effort is useless if there is no impediment to be overcome. Therefore, when simple objects meet no resistance, they have no force; and when they do have force, there is resistance, too. (ibid., 85)

Condillac failed to understand that within a body itself, mutual repulsion of forces (passive and active, or reflection from the essence) takes place, as well as an active (accidental, in Leibniz's words) force that interacts with external forces. It is precisely through relations or interactions that forces manifest themselves or are provoked. Nevertheless, he was perfectly correct to write, "Under this assumption the monad does not depend on any other object; all by itself, owing to the action of its own force, it is all that it is, and contains in itself the cause of all its changes" (ibid., 90). This means only that every monad (substance) is internally contradictory and exists in a state of self-motion. Here, the main difference between the materialist-mechanists and the idealist-dialecticians is expressed.

Diderot. Denis Diderot gives us an entirely different approach. In his small article "The Philosophical Principles Regarding Matter and Motion,"[1] he exposes with amazing precision the essence of force in its interrelations with matter and motion. Diderot writes against those philosophers who, first, admitted the existence of bodies devoid of activity or force and, second, could picture a body's motion only under the impact of a force existing externally to matter.

Diderot insisted, "The body is full of activity and force both in itself

1 Diderot, *Works in Two Volumes,* vol. 1.

and through the nature of its principal properties, whether we regard its separate molecules or the whole mass" (ibid., 445). It follows from this that the body, or matter, is not separable from either force or motion; all three attributes are united in one. The word *molecule* as a concept was introduced by Pierre Gassendi a century before Diderot, by whose time it had become quite popular and came to mean the tiniest particle of matter exceeding an atom in size.

Diderot insists that rest is an abstraction and that it does not exist in nature; motion is inherent to the body as its real property. Like Leibniz, he distinguishes two forces: one that is external in relation to the molecule and one that is internal and inherent in the molecule's quality. The former manifests itself in the interaction between molecules and the latter in eternal self-development. On this point, Diderot goes beyond Leibniz, as is evident from the following reasoning:

> The force that affects the molecule spends itself; the molecule's internal force is inexhaustible. It is unchangeable, eternal. These two forces can produce two different kinds of *nisus*[1]: The first kind is the nisus that can be interrupted; the other is the uninterrupted nisus. Therefore, the assertion that motion is a real opposite of matter is absurd. (ibid., 446).

It follows from this that external force is its manifestation in interaction between bodies while the internal force is an attribute of matter itself and of its motion. Diderot bestows the same qualities upon atoms and, therefore, on all material structures.

Relying on his own experience as a physicist and chemist, Diderot draws an additional very important conclusion, to which his contemporaries failed to pay attention. He writes, "There are as many different laws as there are differences within internal forces inherent to each of the elementary molecules that make up the body" (ibid.). If we generalize, this conclusion can apply not only to molecules but also to every variety of matter; namely, force, being an attribute of matter, manifests itself in laws differently, in different guises, depending on the forms of its motion. This philosophical formulation of the question subsequently found clear confirmation in Newton's law of the force of gravity, in the regularities of forces' actions in the electromagnetic field, and also in the interactions between the strong and the weak

1 Nisus (Lat.) —tense state.

forces. Material forces take other guises that are formulated in laws corresponding to their type of being: in the organic world, in human psychology (psyche), and, finally, in society.

As a result, in Diderot's interpretation, matter is active; it moves under its own force, and, at the same time, it has infinite variety. Moreover, he draws a conclusion that has remained relevant to this day: "It is impossible to suppose the existence of anything at all outside the material universe; one should never make this kind of suppositions, because nothing can be deduced from them" (ibid., 448), i.e., no demons, spirits or gods. Even though Diderot did occasionally mention gods (though not in the context of natural philosophy), he needed them primarily to avoid the fate of La Mettrie, who had been exiled from France for his uncompromising materialism.

Immanuel Kant (1724–1804)

Among Kant's many works, there is a not very popular and little known one that relates directly to the topic of this book—*Metaphysical Foundations of Natural Science*. In it, the philosopher considers the different forms of matter's motion. Of particular interest for my research is the second chapter, "Metaphysical Foundations of Dynamics," wherein motion is investigated as pertaining to the quality of matter that is called the original moving force. It should be said that, in the first part, the discourse revolves around motion as a purely quantitative value that ignores the quality of the moving matter. That is, motion is regarded here as if without matter, for "that space which is itself movable is called material, or also relative, space."[1]

Proposition 1 in the second chapter runs, "Matter fills a space, not by its mere existence, but by a special moving force" (ibid., 41). In his subsequent proofs, Kant says that "the cause of a motion is called moving force" (ibid., 42). This extremely important claim nonetheless implies certain assumptions: matter can exist without a special moving force, for example, when it does not need to fill a space. Moreover, if there is a moving force, there can also be a nonmoving force, some sort of passive force. Kant himself, though, ignores these matters.

1 Kant, *Metaphysical Foundations of Natural Science*, 18.

Kant does identify, naturally, an "attractive force" and a "repulsive force," which he calls the two motive forces of matter that cannot be separated from each other in the concept of matter. But then Kant poses the question of why it is that "impenetrability given immediately with the concept of matter while attraction is not thought in the concept, but only attributed to it by inference" (ibid., 57). It is because these phenomena cannot be sensed; they are hidden too deeply in the essence of things, and for that reason they can only be thought. This is precisely the answer begged by the question.

For this "mind-conclusion," Kant was criticized by Hegel, who noted that "a determination which belongs to the concept of anything *must* be truly *contained in it*."[1] Kant is consistent here, though, from the perspective of his general philosophical conception. He believes that what is verified by experience and the senses (the force of repulsion) is contained in the concept of matter while what is outside the senses and experience is included in the *concept* of matter but not contained in it. The most important thing here is that all motion and, accordingly, all moving forces are perceived through the senses; i.e., they are given only as phenomena, that is, reflections of things, but not as things in themselves, which are, according to Kant, unknowable (agnosticism being consequent on this).

Hegel criticized Kant also for his conclusions regarding the interaction of forces. In Explication 7, Kant stated, "A moving force by which matters can directly act on one another only at the common surface of contact, I call a superficial force; but that whereby one matter can directly act on the parts of another beyond the surface of contact, a penetrative force" (Kant, ibid., 67). Hegel analyzes this topic in detail, connecting the superficial force to the force of repulsion and the penetrative force to the force of attraction (*Science of Logic*, 182). This definition by Kant is obviously unfortunate since it does not specify the location and the active mechanism of the "penetrative force" outside "the parts in contact," which is supposedly the sphere of action of the "superficial force." This is a step backwards even from Leibniz, who saw the internal, primary forces as being in contradiction with the accidental, external ones, it being the interaction between these forces that moves matter (the spirit). Kant sees them as interacting only with external forces ("Every change in matter has an external cause").

Nonetheless, despite the imprecision in his definitions of reflection

1 *Hegel's Science of Logic*, 180.

and substance and inconsistencies in the description of the "superficial" and other forces, Kant's central thought is important: "The concept of matter is reduced to nothing but moving forces; this could not be expected to be otherwise, because in space no activity and no change can be thought of but mere motion" (ibid., 78).

The idealist Hegel, strangely enough, gives a high evaluation precisely to this materialistic interpretation of the movement of forces offered by Kant: "Namely, the derivation of matter from these two opposite determinations as its fundamental forces, must always be highly esteemed" (*Science of Logic*, 181).

What is important is that Kant tied matter, motion, and force together into one whole.

Friedrich Wilhelm Joseph von Schelling (1775–1854)

Schelling wrote his brilliant work *On the World-Soul*[1] at the age of 22. Its main topic is force, analyzed primarily as a category of nature in dialectical interaction with motion and matter. Schelling postulates from the very start that two types of force exist in nature: a positive force that induces motion (the force of repulsion) and a negative force that returns motion to itself (the force of attraction). "Both these conflicting forces, viewed simultaneously in unity and in conflict, lead to the *idea of an organizing principle* that forms the world into a system" (ibid., 98).

The movement of forces does not take place in empty space, naturally; it takes place in material nature, where "absolute rest" does not exist. Therefore, each force must be viewed "not as absolute, but only as wrestling with the force *opposite* to it" (ibid., 95–6). Schelling constantly reminds us that it is only the positive force that gives birth to the negative force since in nature, one force does not exist without the other. The forces themselves are not some abstraction invented by thinking, but "every force in nature acts through a *material* principle" (ibid., 97). Stated more precisely, "the phenomenon of each force is *matter*" (ibid., 105).

1 The complete title of this work is *On the Soul of World. A hypothesis of the highest physics for explaining the universal organism, or the development of the first foundations of nature philosophy on the basis of principles of gravity and light.* Schelling, *Collected Works in 2 volumes,* vol.1.

Duality of force is determined by the properties of matter itself, which in its substance is homogeneous. It is precisely because "it is homogeneous *to itself*, it is capable of *bifurcation*, i.e., of real contraposition. Each *reality* already implies bifurcation" (ibid., 101). Both of these properties—universal duality and universal identity—are inherent to matter innately; it acquired them "right away in the process of universal decay that preceded the forming of the world" (ibid., 102). It is amazing to note that, even though Schelling is speaking of "luminous bodies of the world system," his logic is perfectly applicable to explaining the quality of matter after the Big Bang.

Summarizing briefly, we can draw the following conclusions: Schelling sees force as an attribute of matter. Its motion is determined by the interaction, or more precisely struggle, between the positive and negative forces. Their opposition is caused by the nature of matter itself, which is innately dual. Schelling supports these generalizations with examples from the areas of physics, chemistry, and the organic world.

Here we encounter for the first time an interpretation of force that is embodied in the unity of matter and motion: neither exists without the other. In fact, embedded in this interpretation is the idea of the law of unity and the struggle of opposites formulated later by Hegel, possibly under some influence of this work by Schelling.

Georg Wilhelm Friedrich Hegel (1770–1831)

In *The Phenomenology of Mind*, Hegel analyzes the notion of force in part III, "Force and Understanding: Appearance and the Supersensible World." [1] To start off, he considers force as a notion belonging to reason. On this level, the unfolding of matter proceeds over several stages, i.e., through motion, which is what "is called *force.*" In other words, force is matter in motion. But it possesses two aspects. First, the force of the unfolding of independent matters in their being is its *external manifestation*. Second, force as disappearance ability (*Verschwunden sein*) is a force pushed from its external manifestation back into itself, or *force in the proper sense*. In fact, both forces are the same since the force that was pushed away must manifest itself, and the manifested force in

1 Hegel, *The Phenomenology of Mind*.

exactly the same way is *within itself* the real force. But this distinction for the purpose of maintaining unity is apposite only in thought, i.e., as the notion of force (what Hegel calls "being-for-another"), not the reality of it. In order to cognize this reality, one must liberate force from thought and discover what it is in essence "*in-itself and for-itself*" on the substantive level. Hegel answers this question as follows.

There is a difference between the notion of "force pushed back into itself" and "the unfolding of independent matters" since the latter possess "stable existence." In other words, there would have been no force if it had not existed in this opposed fashion. Hegel means that the notion and the substance are *independent*. At the same time, the perceiving and the perceived are one and indistinguishable, and each side is "*reflected* into-itself, or it is for-itself." Therefore, both sides are aspects of force.

But the second force possesses *objective* form, being in motion as the milieu of unfolded matters. In this capacity, it acts as the inciting source toward that force that is being incited. Here is where the most interesting material begins: to Hegel, these are not interrelations based on the principle of cause and effect. He writes, "As a result, this distinction, which took place between one force regarded as inciting and the other as incited, turns also into one and the same reciprocal interchange of characteristics" (ibid., 186). That is, the conceptual and the substantial side of the aspects are convertible since "they have thus, in point of fact, no substances of their own which could support and maintain them.… The true nature of force thus remains merely the thought or idea of force" (ibid., 189). And later: "The notion of force rather maintains itself as the essence in its very actuality: force when actual exists wholly and only in its expression; and this, at the same time, is nothing else than a process of canceling itself" (ibid.).

It follows from this that, for Hegel, notions are more real than reality itself. His entire philosophy is built on this outlook. Nonetheless, in his later work *Science of Logic*, Hegel offers a somewhat different interpretation of force, with its precondition being material substance itself, albeit in a very nebulous form. In Book Two (*The Doctrine of Essence*), in Part Two (*Appearance*), and in Chapter Three (*The Essential Relations*), Hegel analyzes the notion of force, which he needs to bring "the whole and the part" to life. Let us see how Hegel's force comes alive and from where it originates.

Hegel postulates force as a negative unity in the definition of immediate being, i.e., as *an existing something*. But inasmuch as it is reflected, it belongs to "the existing thing, or to matter." But force is not a *form* of this thing—i.e., the thing is not defined by force—the thing is indifferent to it. In other words, the thing does not possess force. On the contrary, as a side posited in its essence, it has the thing as its *precondition*; i.e., force is tied externally to the thing, or to matter, and is *inserted* into it by some outside power.[1] At this stage, it is still dead, or it does not yet manifest itself; it is "the resting definiteness of the thing," which in that era was often called *matter* (for example, magnetic, electric, and other matters). As matter, it is not active. But on the other hand, force contains in itself immediate existence as an aspect, i.e., contains it in itself, not as an existing thing. It is "negative unity reflected into itself" (ibid.). Therefore, the thing here has no importance to it. As for its existence, force declares it only through manifestation (*Äusserlichkeit*).

It may appear at first glance that Hegel here separated force from thing, just as in *The Phenomenology of Mind*, enabling them to exist in parallel. In fact, he described their relations in dialectical form, through reflection. Even though force is "the real immediacy," the latter is "an existing something," and this *something* manifests itself as the former. Only in pushing away from this "former" does it acquire its own meaning and achieve certain independence when it no longer needs the thing. It is approximately the same as the relation between the brain and thought. The brain is something while thought is a moment. The brain gives birth to thought while thought is reflected in the brain. That is, thought has the brain as its precondition (though not only that; this topic will be discussed in a separate chapter). (Note: Not every brain gives birth to thought, but no thought emerges without a brain.) In other words, even in the initial stage of defining the something-force, Hegel does not abstract from matter. It is a different matter when he says, "Nor is it, therefore, merely a determinate matter; such self-subsistence has long since passed over into positedness and Appearance" (ibid.).

So how does force manifest itself? Through the resolution of contradictions, naturally, since force is the identity of positive reflection and the reflection that is subject to negation. "Force is thus the self-repelling contradiction; *it is active*" (ibid.).

To repeat: Force *qua* aspect is a negative unity, or a substantial inside-itself-being, and it is different from immediate existence. Its

1 *Hegel's Science of Logic*, 520.

unity means the transition of the former into the latter. And then "force as the determination of the reflected unity of the whole, is posited as becoming existent external manifoldness *from out of itself*" (ibid.).

In this stage, though, "force is at first only an activity *in principle* [*ansichseinde Tätigkeit*], an immediate activity." But this is not quite activity, but merely a *pre*-positing action, relating to itself. There is a need of another force that yet lies "*beyond* its *positing* activity" and would incite it.

At first glance, this seems to mean that another, external force makes its appearance. In fact, though, it is merely a reflection of its own aspect in its own unity. In other words, this external force is in fact its own *pre*-positing activity, or, in Hegel's words, "The conditionedness through another force is thus *in itself* the act of force itself, or force is in so far at first an act of *presupposition, a* merely negatively *self*-relating act" (ibid., 521). But since *pre*-supposition of action also means reflection into itself, i.e., the resolution of its negation, it reveals itself as an *external* force, and this comes to pass in the guise of a *push* (*Anstoss*) for another force. Thus transpires the *discovery* of force, i.e., that which had externalized it. "Thus force, *in its Notion,* is at first determined as self-sublating identity, and *in its reality* one of the two forces is determined as soliciting and the other as being solicited" (ibid., 522). As a result, the force in-itself-being transited, or, rather, "transformed (othered)" itself into a force of "being-for-another." What transpired is other-establishment, i.e., its discovery in real being. The essence is precisely this: "the activity of force consists in *expressing itself*" (ibid., 523). (Note: The push through which it is incited to being "is its own soliciting.")

Let us now summarize Hegel's principal ideas on force.

First of all, force is an aspect of an existing being. The being is the thing, or matter. The thing is a condition of force's manifestation. That is, thing and force are not equal, not identical.

Manifestation of force takes place as a consequence of an internal contradiction that is resolved in the interaction of the inciting and the incited forces. Therefore, the source of motion is in itself; hence, it is active and acting.

In other words, force is not a thing, but the thing is its condition as the moment of being-for-itself. It is internally contradictory, and in the interaction of reflections of different types—some of which are forces in themselves (the so-called external forces)—force reveals itself in other-being, i.e., in the real world. In Hegel's theory, force can thus be defined as an aspect of being that reveals itself in interaction with another force.

It should be emphasized here that all phases of its development take place on the conceptual level; i.e., force is an aspect of the *conceptual* being, not the real being; the latter is merely a condition, or presupposition. Therefore, as Hegel stressed many times, the source of force's development is force itself, or, more exactly, the logical operations involved in the understanding of force but not the thing, not the matter. Here we have that very case of which Marx said that Hegel had the entire construction standing on its head. All that remains is to set it on its feet, and then the logical operations used by Hegel in his reflections on force may be used fruitfully in further concretization of the concept of force in different material substances.

Force and violence. Since we will later need in one way or another to make use of the notion of *violence*, we should consider Hegel's understanding of this phenomenon.

Hegel wrote in the chapter on force that in its *pre*-manifested state (when force is, as it were, hiding in the thing-in-itself), its behavior is *passive*. In Book 2, Section 3—"Action and Reaction"—he analyzes the notion of violence, which is experienced by "the passive substance." "Violence is the *manifestation of power*, or power as *external*.…The act of violence is equally an act of power" (ibid., 567). The further course of Hegel's reasoning is that "the passive is the self-subsistent that is only something *posited,* something that is broken within itself." Hence, "therefore not only is it possible to do violence to that which suffers it, but also violence *must* be done to it" (ibid.). This gives violence the opportunity to discover its might and at the same time to let the passive substance manifest its existence. Indeed, it is the cause of violence since if it had not been a passive substance; it would not have been an object of violence and, therefore, would not have been revealed.

This approach to violence will subsequently prove to be quite useful for us. It boils down to three things. First, violence is a phenomenon of might but not might itself (or might as something external). Second, the passive substance in conformity with law demands that violence be inflicted on itself. Third and finally, the passive substance is the source of violence.

Ludwig Büchner (1824–1899) and Joseph Dietzgen (1828–1888)

After Hegel, analyses of force were undertaken for the most part by natural scientists of the materialist persuasion. This is easily explained from the historical perspective since by the mid-19th century, the development of physics, with its laws of force and energy, had become explosive. Helmholtz, Haeckel, Du Bois-Reymond, Liebig, Vogt, Büchner, and others were natural scientists who wrote on force from the perspective of philosophy. It is curious that their ideas on force were criticized severely by some of their fellow materialists, those of the Marxist persuasion, the dialectical materialists. Let us consider, for example, Büchner's work *Force and Matter*, which is possibly unique, the only work ever devoted specifically to the problem of force.

In Chapter One, Büchner offers a number of quotations from well-known naturalists (Moleschott, Dubois-Raymond, Cotta), the gist of which boils down to this: "No force without matter—no matter without force!"[1] The two cannot exist separately from each other; otherwise, they turn into empty abstractions or empty concepts. Proof of this claim is found in the physical world (the inorganic world) and its particles, of which this world consists. "All the so-called imponderables," Büchner writes, "such as light, heat, electricity, magnetism, etc., are neither more nor less than changes in the aggregate state of matter—changes which, almost like contagion, are transmitted from body to body.… Electrical and magnetic phenomena…arise, as experience shows, like light and heat, from the reciprocal relations of molecules and atoms" (4). Therefore, "*force is a mere property of the matter*" (ibid.). On this basis, Büchner criticized the idea of the world having emerged from "an individual creative power" (God) and its finiteness and temporariness. He asserted the self-development of nature and the eternal existence of the universe.

This reasoning on force applies to the inorganic world as well, including man. In the chapter "Thought," Büchner defends Vogt, who had stated, "Thought stands in the same relation to the brain, as bile to

1 Büchner, *Force and Matter: Empirico-philosophical Studies, Intelligibly Rendered*, 2.

the liver, or urine to the kidneys" (ibid., 136). For this vulgarism, Vogt was subjected to criticism Büchner considered unwarranted.[1] He writes that, in fact, this claim—preceded, by the way, by the phrase "to express myself rather coarsely"—states the dependence of thought on the brain. He writes, "The brain is, then, only the carrier and the source, or rather the *sole cause* of the spirit, or thought; but not the organ which secretes it"[2] (ibid., 137).

However, Büchner really did fall unwittingly into a trap when he wrote that the spirit, soul, and thought are indeed nonmaterial. "It can be perceived by our senses as little as any other simple force, such as magnetism, electricity, etc.—merely by its manifestations" (ibid., 136). Here lies the trap:

> We have defined force as a property of matter, inseparable from it, yet, with regard to our *conception,* they are widely distinct, and in a certain sense opposed to each other. At least, we know not how to define force or spirit otherwise than by something immaterial or opposed to matter. In contrast with this, we find that bile and urine are not a sum-total of ideal force effects, but are themselves material bodies and the proceeds of materials. (ibid., 136–7)

This quite striking primitivism in the presentation of such important ontological problems of philosophy was apparently the grounds on which Engels dismissed the vulgar "materialism of various Vogts and Büchners," with the latter in particular offering "no thought, but mere cribbing."[3]

While these sorts of opinions could have been considered progressive back in the 16th–17th centuries, in the second half of the 19th century, especially after Hegel, this kind of materialism served more to discredit it as a school of philosophy than to develop it.

Dietzgen, an autodidactic philosopher, of whom Marx had a high opinion, offers a curious criticism of the force/matter conception in the works of Büchner and Liebig. Just as they do, he admits that "there is no

1 Lenin interpreted (quoted) this phrase thusly: "The brain secretes thought *in the same way* that the liver secretes bile." Lenin, *Materialism and Empirio-criticism*, 34.

2 This assertion differs little from Engels's and Lenin's opinions on the subject. The former wrote of thinking and consciousness as products of the human brain; the latter wrote that thought is a function of the brain. See ME, 20: 34; Lenin, *Materialism and Empirio-criticism*, 77.

3 ME, 20: 368, 520.

force without substance, no substance without force."[1] Dietzgen differs from them in this: in his opinion, Büchner and other materialists of his stripe believed that force and matter are one and that separating and singling them out is a mere invention, fantasy, hypothesis, or idea without essence (from Büchner's book *Nature and Force*). It was said above that Büchner wrote even of "contraposing" force and matter to each other. There is an obvious contradiction here since a single material essence cannot manifest itself simultaneously as a material substance and an immaterial force. This would mean that some sort of spirit is embedded in the force of matter. Dietzgen writes:

> When the idealist naturalists believe in the non-material existence of forces, which are as if sitting within matter, which we do not see, do not *perceive* sensually, and in which we are nonetheless supposed to believe, they are then in this respect not naturalists, but speculators, i.e., spirit-seers. But equally nonsensical is the materialist's claim that the intellectual distinction between force and matter is a hypothesis. (ibid., 63)

Dietzgen claims that force and matter are the same, that they are "indivisible." "In embodied sensitivity force is matter, matter is force" (ibid., 61). And forces can be "seen" since "vision" as such is nothing other than a force. "Sight is as much an action of the object as an action of the eye; it is a double action, and every action is forces" (ibid.). After the same principle, force can be felt, smelled, heard—for example, the forces of heat, cold, and weight. "In other words, this means: what we see, hear, feel is not things, but their actions, or forces" (ibid.).

Thus, force is action, action is force, and, therefore, force and action are identical. In this case, both phenomena lose their notion or content; i.e., they become empty identities or truths without development.

Dietzgen falls into yet another trap when he writes, "When we look with spiritual eyes, matter is force. When we look with bodily eyes, force is matter. Abstract matter is force, and concrete force is matter. Matters are objects for the hands, for practice. Forces are objects for cognition, for science" (ibid., 62).

Translating this passage from popular to the philosophical parlance, we read, in ontology, force is matter, and in gnosiology, matter is force. It turns out that everything depends on the point of view rather than

1 Dietzgen, *Selected Philosophical Works*, 63.

on the essence of being itself. Dietzgen thus tumbled into that very subjective idealism against which he had been campaigning so furiously.

* * *

It should be said that throughout the 19th–20th centuries, all philosophers who championed the conception of *matter-force* were labeled as materialists with a negative connotation. This was justified to a certain degree since the more prominent popularizers of materialism were not professional philosophers but rather natural scientists for the most part, or not-so-well-educated associate professors such as Eugene During or self-taught Dietzgen. Naturally, the idealists, being better versed in dialectics, had no difficulty in using the language of philosophy to ridicule the vulgar materialists. The philosophical works of Marx and Engels were only read within the narrow circle of their followers, and most of them were not even published. However, even after their publication in the 20th century, bourgeois philosophers, apparently for political reasons, did not read them. At least it is almost impossible to come across a reference, even a critical one, to, say, *The Dialectics of Nature* by Engels. Until today, among Western philosophers, especially those of Anglo-Saxon extraction, the word *materialist* is associated with primitivism or with socialism, which to them are the same thing. In the subsequent parts of this book, we will have the opportunity to judge the worthiness of these philosophiers' own works. Here, it is necessary to state briefly once again that all the above-mentioned philosophers tied force, in one manner or another, to matter and motion. The materialists did it on the substantial level while the idealists did it on a conceptual level. Some of them believed that force manifests itself in interaction with other, external forces, and others believed that force has the property of self-motion as a consequence of contradictions between internal and external forces of substantial or reflected integrity.

After all the above reasoning, several points remain unclear. In particular, the philosophical analysis of force was built based on the conception of the material being of the inorganic world or its reflection in thinking. And though some philosophers traced force to society (Spinoza) or to life (Leibniz), it was nonetheless not regarded as a phenomenon that manifests itself differently in different material substances. This could mean that, in their view, force "works" only on the ontological level, i.e., within the framework of the principal categories describing the fundamental attributes of matter, such as, for example, motion, space, and time. It appears to be no accident that in those works of Kant and Hegel that are dedicated to the analysis of society, force does not serve as a conceptual tool for exploring the topic. This is the second point,[1] or in other words, force as substance of matter does not evolve but rather is simply fixed as an attribute of the inorganic world.

One more point follows from the above two: force did not become a philosophical tool for the cognition of phenomena and essences beyond the limits of the philosophical and the inorganic worlds. However, even on the philosophical level we still have not determined whether force is a category of being or a concept, a reflection of being. If force is a category, then we need to determine through which concepts existential force manifests itself to us in being-for-other; if force is a concept, then we should discover and designate that substance (being-for-self) that became reflected in the concept of force. Depending on the chosen approach, we must build—rebuild—the entire categorical–conceptual apparatus of cognition of force.

4

The Philosophy of Force in the Works of 20th-Century Western Philosophers

In subsequent chapters, I will be making constant use of works by modern philosophers and scientists, including for the purely personal reason that they are my contemporaries. At present, I would like to submit the views of two thinkers on force. The first is Pierre Teilhard de Chardin (1881–1955), who is fairly well known, primarily by virtue of his book *The Human Phenomenon*. The second, Arthur M. Young (1905–1995),

1 Though subsequent authors who wrote about the organic world and society constantly have used the word *force*, they derive it not from its sources but based on other phenomena that have no connection at all to ontology.

the author of the book *The Theory of Process*, is less known, although some philosophers have called him the most important thinker of the 20th century after Einstein.

Energy and Quanta According to Pierre Teilhard de Chardin and Arthur Young

When scholars who are not philosophers analyze the concept of Matter, they usually become confused by the categories of "thing-in-itself" and "thing-outside-itself." This is as true of researchers in the 20th as in the 19th century. As an example, let us take the above-mentioned two major scholars, the Frenchman Pierre Teilhard de Chardin and the American Arthur Young.

Teilhard de Chardin ascribes three aspects to matter *qua* "thing-in-itself": plurality, unity, and energy.[1] However, the categories of Plurality and Unity do not refer to substances; they are conceptual definitions used in investigation of matter that is manifesting itself in motion. Energy, though, can be viewed as an attribute or substance of matter, although, in fact, energy is one of the forms of matter. It all depends on the meaning one puts into this word. Let us see what Teilhard de Chardin has in mind. He writes:

> Energy [is] the third aspect of matter. Under this word, which conveys the sense of *psychological* effort, physics has introduced the precise formulation of a capacity for action, or more exactly, for interaction. Energy is the measure of what is transferred from one atom to another in the process of their transformations. Energy, then, is a power of bonding; but also, because the atom seems to be enriched or depleted in the course of the exchange, a power of building up. From the standpoint of energy, as it has been renewed by the phenomena of radioactivity, minute material particles can now be treated as transient reservoirs of concentrated power [emphasis mine–*A.B.*]. (ibid., 13)

It does not follow from such definitions that energy is an attribute

1 Teilhard de Chardin, *The Human Phenomenon*, 12.

or, in Teilhard de Chardin's expression, an aspect of matter *qua* objective reality. First of all, it requires a "psychological" comprehension by physics, for example. Second, matter is taken not as totality but only as a set of its structural components, in this case, atoms. Third, if, as seen from the perspective of energy, particles are "reservoirs" of might (or power), then this is a manifestation of matter in one of the regions of the universum but not in the whole universum. On the level of substance definition, it is impossible to say that time and space are something from the perspective of energy. What would they turn out being, for example, from the perspectives of the biological or social? Energy, moreover, cannot be an "aspect" of matter. Matter does not possess a mere three aspects as Teilhard de Chardin suggested; it has an endless number of them. Philosophical language must be applied to substantial phenomena rather than to everyday speech.

If Teilhard de Chardin were speaking of manifestations of matter in physical spheres, then his definitions would make some sense, but he is writing about substances. He commits an even greater error when he defines matter as the "thing-outside-itself." He defines matter as unity (he specifies it as a "thing-in-itself") in its manifestation as a "thing-outside-itself," i.e., in this case, in the world of atoms. He sees this unity as consisting of a system, a whole, and a quantum. In this case, he substitutes an ontological approach with a systems approach without noticing the transition into gnosiology. The quantum really can be viewed as a substance of matter (for example, as a quantum of action, which will be discussed later). *System* and *whole* are conceptual terms belonging to only one of many approaches to cognition. It was precisely in connection with the interpretation of the bond between matter and force that Hegel sharply criticized Kant for a ligament of phenomena and being.[1]

However, not even the quantum, in Teilhard de Chardin's understanding, is an attribute of matter but is rather "the infinitesimal center of the world itself" (ibid., 16). From the physical point of view, he is correct since force *qua* attribute of matter manifests itself through forces in mechanics, through electromagnetic and other forces. Here he once again substitutes an analysis of an ontological perspective for the worldview of physics.

The points made above might seem to be mere details, but details of this sort lead straight into the arms of theology, which puts the scientific

1 *Hegel's Science of Logic*, 178–86.

credentials of Teilhard de Chardin's entire theoretical project in doubt. In order to assure ourselves of this, let us address the works of Arthur Young, whom his disciples consider one of the greatest cosmogonists, mathematicians, and philosophers of the 20th century (although he is better known for developing a commercial helicopter for the Bell Company). However, this philosopher is interesting because of his attempt to join science and religion, an exciting activity in which many outstanding people have been involved.

Young claims, "The beginning of all things is light, by which we mean photons of all frequencies or wavelengths.…The photon may be defined as a unit of action equal to Planck's constant.…Action is the product of time and energy. If we extract time (divide by time), we obtain energy!"[1] Elsewhere, he calls the photon as "the quantum of action," which "always produces a change of state."[2]

Here we must note right away, according to Young, that the quantum of action—the photon—is primary, and it is the creator of all things in the following way:

> First, behind the things, molecules, cells, organs, etc., there is some agent that changes the state of molecules, cells, organs, etc. Secondly, that agent is light, the photon or quantum of energy, which conveys a very small amount of energy that can trigger specific reactions and control their timing. Thirdly, longer-period quanta can control shorter-period quanta, because being longer they can "comprehend" or subsume what is shorter than their own period, and hence control the shorter-period and greater-energy activities of their environment. Fourthly, degradation of energy, or descent into matter, which produces atoms and then molecules, creates a great variety of molecular material with new combinations forming and dissolving. These combinations are sensitive to temperature. Finally, at this point the stage is set for life. The quanta with the longer period can begin to sort energy, create order, and build organisms.…Life so construed implies evolution, whose higher stages follow.[3]

From this extended quotation, we learn that, in the beginning,

1 Young, *Which Way Out? And Other Essays*, 162, 163.

2 Young, *Has There Ever Been a Paradigm Shift?*

3 Young, *Science, Spirit and the Soul.*

there was light, and then all the rest come. Here Young improves on God Himself, who, according to the first page of the Bible, first created the heavens and the earth, only then getting around to light. Moreover, like all idealists without exception, he naturally puts energy in opposition to matter. Energy is considered to be on a higher plane than matter since the former is "degrading" into matter. It does not occur to Young for some reason that energy is a form of matter. However, it is to his credit that he at least presupposes the mutual transformation of energy into matter and back. At the same time, in spite of energy's degradation into matter, the latter generates life, and what is particularly interesting with the emergence of man—whose attributes are spirit, soul, thought, and body—even immortality is a possibility (for the soul, of course, not for the body). The logic here is straightforward: "The soul is simple substance, energy if you like, and if energy is conserved, so is the soul" (ibid.). Energy, we remember, is a quantum of action, or photon, which is not of limited temporal duration, meaning it is immortal.

Young describes in detail seven stages of the photon-goal's unfolding into the photon-soul. He writes:

> We can anticipate that human evolution, beyond the purely animal necessity of survival, is dependent on, and interrelated with, what is beyond mankind: superbeings or gods. And it is pertinent here that a belief in powers of a higher order, in gods or in a god, has characterized almost all peoples and cultures. The possible exception is modern Western culture, where the belief in science has tended to supplant the belief in gods. (ibid.)

This confession by Young about the West is intriguing. The belief in gods was a necessary stage in the development of mankind in the era of primitive man's powerlessness before nature and in periods in which religions were turning into political tools of power. However, as mankind was developing and learning about the world, religion was turning into a brake on development. The West moved ahead and turned to belief in science.

Let us return to Young. God plays a decisive role in his writings, and not only in directing the soul; He precedes even the photon, the quantum of action. Although *power* (Young used this word for the photon) exists independently of different kinds of energy, "the intentions of the operator [to breathe life into power, apparently—*A.B.*] were a critical factor" (ibid.). The operator is none other than God.

In the relevant section, I shall revisit some of Young's reasoning regarding the spirit and soul. Here I will note only that in the above-mentioned work, what was an impressive beginning ended in a banal manner—in the Almighty, in an idealism of the purest sort that is no different in essence from that of Berkeley or the agnosticism of Hume or even earlier philosophers. This collapse into the quagmire of mysticism cannot be averted even by using the modern terminology of quantum mechanics. There will be a special discourse about the "thinking quantum" in Chapter IV, which is on consciousness.

The photon is without a doubt an amazing elementary particle (it has a mass of zero, spin of one, an electric charge of zero, and a lifespan that is stable, and it does not disintegrate) that is created at the very moment radiation begins. But considered as a particle that transmits interaction, the photon does not exist alone; there are other elementary particles as well, for example, the leptons (electrons, muons, taus), as well as many varieties of mesons, baryons, and, finally, gluons with spin equal to Planck's constant and rest mass equal to zero. The photon—or, rather, photons—are *carriers of interaction* between charged particles of the electromagnetic field in the process of interaction between them. The photon thus cannot be primary in relation to all matter. At best, it is part of matter, existing as one of its forms along with other elementary particles. It cannot exist without matter or give rise to it since it is itself matter in the form of electromagnetic field particles. Moreover, the material nature of the photon manifests itself, for example, in the fact that gravity affects it in the same way as it does all other material particles. This is one of the reasons why the trajectories of photons diverge from straight lines when they pass close to the Sun, for example.[1]

Should one choose to work from the perspective that pure action creates everything including material particles, it might seem to be a good idea. *Action* cannot be divided or measured; it is a single whole. However, action is always interaction (you cannot clap with just one hand); it cannot exist in a "pure" form without a material basis. Nevertheless, Young's disciples assert, "No, as a matter of fact, it can." Frank Barr states, "Action appears to be ontologically prior to mass, charge, space, time, particles, forces, or fields."[2] Barr did not bother to

1 For more detail, see Erdei-Gruz, *Principles of Matter Composition*, 24–7.
2 Barr, *The Theory of Evolutionary Process as a Unifying Paradigm* (1997).

identify prior to whom or what action "appears," but he did refer readers to an authority (David Bohm), who had said that the quantum of action is "the building material" of existence.

In developing his theory that the photon determines the process of the universum's evolution, Young arrives at the conclusion that this process was predetermined from the very beginning, i.e., prior to the origin of man. He does not state this definitely anywhere, but it follows from his above-mentioned idea of seven-stage evolution. His disciples, however, write of it without mincing words, almost defiantly. One of them, J. Saloma, while creating his own theory of process on the basis of Young's constructions, writes, "The theory of process is first and foremost a contemporary statement of teleology—the study of evidences of design in nature or the idea that natural processes are directed toward an end or shaped by a purpose."[1] However, "science can never penetrate its mysteries." F. Barr writes equally candidly, "Process theory clearly acknowledges teleology, the process of direction toward a purposeful end or ultimate goal" (ibid.).

In philosophy, this approach is called *immanent teleology*. It ascribes an internal goal to the development of nature and almost always transforms into a conception of "the great purposefulness" established by God. One must admit that quite a few great philosophers of the past have played a role in idealism (Aristotle, Leibniz, Kant, Hegel, et al.). There have also been many of them in the 20th and even 21st centuries. It would appear that it is impossible for the time being to get along without God.

5

Ontological Force, or Ontobia

Ontobia constitutes the reality of the objective world along with matter, motion, time, and space. The correlation between these categories needs to be determined. Expressed in the language of

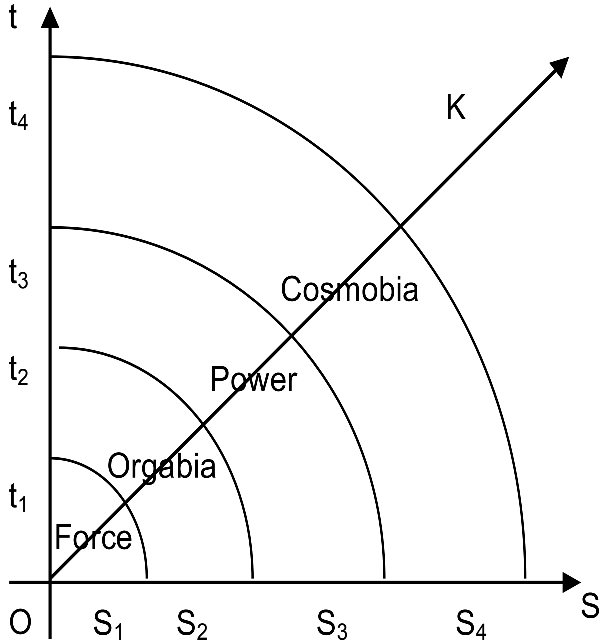
1 Saloma, *The Theory of Process 1: Search for a Paradigm* (1991), 13.

dialectical materialism, these correlations can be described as follows: time and space are forms of the existence of matter, which manifests itself as substance, energy, vacuum, radiation, diffuse matter, etc. Dialectical materialism asserts also that matter does not exist without motion even though it does not explain the source of this motion.

This omission is evidently due to the fact that in his *Dialectics of Nature*, Engels criticized Büchner's version of the force–matter concept, allotting to force solely the domain of classical mechanics. In consequence, the category of ontobia dropped out of the range of attention of the philosophical side of dialectical materialism. However, as the classical philosophers were correct to assert, matter, motion, and ontobia are tied together inseparably, and this connection manifests itself in ontobia's being the source of the motion of matter.

But where does ontobia come from? Using Hegel's terminology, I would define it thus: ontobia as such is in itself, for it is its own self being-for-itself thanks to being-outside-itself, i.e., outside-being. Its external manifestation, recognized in motion, is that through which we recognize it; i.e., in its manifestations, force is *posited* as motion. In other words, where manifestation occurs, its essence also exists; otherwise, there would have been nothing to manifest. Therefore, motion is the being of ontobia, and motion itself is the being of matter. It follows that ontobia, along with space and time, is an attribute or, otherwise expressed, a form of the existence of matter.

Time expresses the duration of being and the sequence of states of all material substances in the universe while space characterizes their extent. Ontological force, or ontobia, is the *source* of matter's motion. This means it is not matter, as neither mass, time, nor space. However, as the source of matter's motion, ontobia in fact determines the quality and structure of matter, as both manifest themselves through motion. Therefore, ontobia does not exist on its own without matter, just as matter does not exist without ontobia. We can state roughly that it resembles the soul or thought of man—neither exists without man, but neither is matter; neither mass, time, nor space pertain to them. However, while soul and thought are properties only of man (and not even of every man), ontobia is an attribute of all being. Ontobia is an abstract philosophical category. It is the *universal*, but it manifests itself through the *particular* and the *individual*, moving into the rank of concepts that reflect the different structures of matter that is in motion as an integral part of it.



In this graph, the vector K designates motion (*kinisi*). The space–time segment t_1S_1 embraces the micro- and macroworld; in it, ontobia (O) manifests itself as a physical force (F) that determines the structure of matter in the inorganic world. The segment t_2S_2 is the organic world; this is the domain of the organic force, orgabia (Orb); i.e., the regularities of motion in the organic world are governed by another force, namely Orb, which includes in itself the previous force F. The sphere of man and society—the segment t_3S_3—includes the previous two spaces and their forces, but here the dominant force is power (P). Finally, the next segment, t_4S_4, which encompasses the universe, contains all the previous forces, where the universal force Cosmobia (C) is dominant (possibly, and I would guess that its concrete manifestation is the force of gravity or some as yet undiscovered intergalactic force opposite to the force of gravity). It must be kept in mind that ontobia is not the sum of all the forces mentioned since each determines the structures of matter that are different in quality. I repeat, it is an abstraction that is realized in concrete forces (the particular), which in turn manifest themselves in forces of individual substances (the individual), returning into itself, i.e., into ontobia (the universal). This is the famous Hegelian triad: the universal/the particular/the individual (*die Allgemeinheit, die Besonderheit, die Einzelnheit*).

Ontobia is not just the source of matter's motion; it simultaneously determines the direction of motion that depends on the structure of the material substance and thus attaches this or that quality to it. The quality itself is determined by the temperature parameters and the speed of the substance. It follows from this that all the fundamental properties of the universe—matter, motion, force, space, and time—are united, interconnected, and simultaneous. (Perhaps the situation is different in the singularity within the framework of the idea of the Big Bang, which we are going to discuss in the next chapter.)

However, since force initiates motion and determines the quality of matter, it is simultaneously a quantitative parameter that can be evaluated in units of measurement. When we measure a force quantitatively, we are in fact determining the substance's quality and thus its location and the duration of its existence. In principle, if we had no possibility of measuring force quantitatively, we would have had no need of it as a scientific tool of cognition; simply ascertaining the presence of motion would have sufficed. This is why practitioners of the natural and social sciences have never paid attention to philosophical debates on force, for the classical philosophers disregarded this question. But it is not enough to state that force itself is an attribute of matter and that its "opposites in their sources" cause matter's motion. The main merit of this category is that it allows us to cognize the laws of being—i.e., the laws of force—and ultimately predict the direction of motion of being itself. For example, when we say that force is inherent in every material object—an elementary particle, for instance—and that this is why it moves in space and time, we are merely stating that it moves. Hegel rightly wrote in his *Phenomenology of Spirit,* "*Mere* electricity is a *force*, but the expression of difference belongs to a *law*; this difference is positive and negative electricity" (ibid., 82). In other words, it is necessary not only to cognize force as a category of being; it is important to cognize force as a concept that manifests itself in its regularities. Only then does the chance appear not only to predict being but in many cases to direct it.

Unlike space and time that designate the system of coordinates for the location of substance, force is inherent from the beginning in every instance of matter as an momentum; it changes or transforms along with matter as it determines the laws of the latter's activity. In this connection, the task of science is to discover the laws of force that determine the being of this or that material space. However, it is an even more difficult task to cognize the mechanism of the leap-transition from one system of the being-world to a qualitatively different one—for example, from the microworld to the organic world, and from the latter to the social world. This means discovering the laws of force in the interconnected chain F → Orb → P → C. Accomplishing this task would amount to the creation of a universal theory of the universe, which would be the theoretical premise for achieving the immortality of mankind and perhaps even of individual man, for man's ultimate goal is the attainment of unlimited life.

My formulation of the category of Force in the language of dialectical materialism is as follows:

Ontobia, or ontological force, is a philosophical category designating an attribute of being that reveals its essence through motion, space, and time. *Briefly stated*, ***ontobia is the property of being that reveals its existence.***

I deliberately used here the word *being* rather than *matter* since the former includes not only the objective world but also the subjective world, which is an integral part of the social world. In society, as we will later realize, the category of Force plays as much of an attributive role as it does in nature. However, in order to single it out and evaluate it, it is necessary to examine the real meaning of force in the organic and the inorganic worlds, in those links that Hegel called the *particular*.

CHAPTER II

FORCES IN THE UNIVERSE: ESSENCE AND MANIFESTATIONS

Force, like a woman, loves to make appearances.
The latter in society; the former in the light of laws.

Author

Wir müssen wissen. Wir werden wissen.

David Hilbert

The definition of the category of Ontobia could have been considered an act of purely speculative philosophizing had it not been a reflection of the natural being that exists independently of us, whether we want it or not. From the perspective of modern science, this all-encompassing being is our universe, which may be either expanding or contracting, but in any event is moving in some direction under the influence of force. The question is, what is this force or forces?

If we assume the correctness of the idea of the Big Bang—i.e., that our universe had such a beginning—then it is proper to postulate an original superforce, something that provoked the explosion. Even if we allow for the possibility of the existence of a megauniverse (a multitude of universes), that changes nothing; in this case, the respective universes must emerge as a result of their own superforces. Finally, we have a third option: to reject in principle the idea that universes have a beginning (and, accordingly, will have an end) and posit that they are eternal. In this last case, we would need to admit the absence of movement of the universe itself as a particular cosmic whole, which would entail its nonmateriality, contradicting the scientific data.

Another option, however, is open to us: we can rethink the concepts of *finiteness* and *infiniteness*. The latter is easily done once we realize that when we are discussing finiteness—i.e., a limit—we are already speaking of infiniteness since any definition of a limit involves overstepping it. In other words, the finite and the infinite are reciprocally defined. They are inseparable, each containing the *other* within itself. Finiteness is infinite and infiniteness is finite, or, in Hegel's expression, the finitized infinite or the infinitized finite.[1]

Returning to our universe in the context of the finite and the infinite, it must be admitted that, in the infinite world, there exist finite essence-phenomena. One of these is our universe, which we seek in vain to understand, primarily using the physical laws of force. It is these laws that uncover the deep essence of the universe. My objective here, as formulated in the preceding chapter, is to determine in what context the term *force* is used by physicists and astrophysicists in their exploration of the universe or, to be more precise, its inorganic part.

1

Force and/or Energy

Force in nature was studied by many scientists long before Newton (for example, Descartes, Galileo), but only he managed to show it so elegantly, in his laws that laid the foundation of classical mechanics. One should keep in mind that Newton did not try to uncover the essence of force but rather investigated force as a quantitative measure of interaction, or, in Engels's words, he treated it as "the carrier of motion" and nothing more. Such an approach has been characteristic of many physicists, for example, Henri Poincaré, whose pronouncement on this topic was presented in the introduction. It must be stressed that, unlike Newton, who admitted candidly that he was unable to identify the cause of gravity, Poincaré based his approach on philosophical presuppositions. He wrote, "That which it [science—*A.B.*] can cognize are not things in themselves, as some naïve dogmatics think, but merely relations between things; outside these relations there is no cognizable reality."[2] This ballad about the unknowability of "the essence of things in themselves" (cf. Kant's *Critique of Pure Reason*) was convincingly critiqued a long time ago by Hegel, and it is no less convincingly refuted constantly in practice. Cognition of interrelations between things

1 *Hegel's Science of Logic*, 145.
2 Poincaré, *On Science*, 8.

implies the simultaneous cognition of the things themselves. If we recall the formula of gravitational interaction expressed through Newton's law of universal gravitation— $F = G\frac{m_1 m_2}{r^2}$, where F is the force of pull between two masses and separated by the distance *r*, and *G* is the gravitational constant—then, abstracting from the mathematical formulation of a physical regularity, we discover that masses possess the property of being attracted to each other. This property, along with repulsion, as philosophers have written (Kant, for example), is embedded by force in matter itself. In other words, force made the transition from being-for-itself into being-for-other quantitatively defined by Newton's law for gravitational fields.

In this connection, the question that a well-meaning critic actually did pose to me may arise: what about Newton's first law of motion, which speaks of a thing in "a state of rest" inasmuch and as long it is not compelled by external forces to change that state? The answer is very simple: in this case, the discourse is about the laws of mechanics, which dictate a body's motion or rest in a certain system of velocities and space. Outside the framework of classical mechanics, this resting body conducts itself differently while, from the ontological perspective, it would be simply nonexistent if it did not possess the properties of motion and, accordingly, force.

After Newton, the word *force* continued to be popular among natural scientists. Even the law of conservation of energy, formulated in 1842 by the German physician Julius Meyer (and, independently of him, by the Englishman James Joule) was described by the word *force* (*Kraft*). In Helmholtz's words, this law says, "The quantity of force that can be brought in action in all of nature does not change; it can neither be increased nor decreased."[1] Meyer himself, in a number of works (for example, *On the Quantitative and Qualitative Definition of Forces* [1841] and *Comments on Forces of Inanimate Nature* [1842]), showed the polysemy of using the term *force*, believing that it is "not destroyable."

Another German scientist, Hermann von Helmholtz (likewise a physician by education), also used the word *force* (*Kraft*) to formulate the law of conservation of energy in his work *Über die Erhaltung der Kraft* (Berlin, 1847). In the above-mentioned report-lecture, he said, "Despite the differences between mechanical systems, they have one thing in

1 Helmholtz, *On the Conservation of Force*.

common: they all need a moving force to bring them in motion, same as the human arm needs muscle contractions to work" (ibid). He called this moving force *vis viva* (life force). Unfortunately, this explanation, being perhaps deliberately simplified for the sake of his audience (this quotation is from a lecture), distorts the idea of force. Force is not something separated from the thing/matter imbuing it with life-motion; motion is already the manifested force of the thing/matter.

In any case, in the second half of the 19th century, the word *force* started to be replaced with the word *energy*. Heated arguments took place over which term was better suited to describe the essence of the law. Engels attacked Helmholtz in this connection for his wrong choice of words. This argument has a diret bearing on the current topic; therefore, it makes sense to let Helmholtz say his piece first

> Force is only the objectivised law of action....The abstract idea of force introduced by us only makes the addition that we have not arbitrarily invented this law but that it is a compulsory law of phenomena. Hence our demand to *understand* the phenomena of nature, *i.e.,* to find out their laws, takes on another form of expression, viz. that we have to seek out the *forces* which are the causes of the phenomena.[1]

It might seem at first glance that I repeated Helmholtz in my definitions of force in the previous chapter. In fact, this is not so, and this "not so" is clearly explained by Engels. Helmholtz used the expressions *objectified law of action* and, a bit earlier, *objectified law of refraction of light*. Laws cannot possibly be "objectified" through subjective notions, not even through the category of Force since they are objective in their own right, independent of our ideas of them. This assumption on Helmholtz's part brought him close to Mach and Avenarius in the same conception of empirio-criticism that was criticized brilliantly in its time by Lenin in his work *Materialism and Empirio-Criticism*.

Engels, making ironic fun of the word *force*, preferred to speak of energy with regard to the law of energy conservation. He believed that the word *force* is better suited to terrestrial mechanics, the only science "in which they certainly do know what the word 'force' means" (ibid., 404). Engels was perhaps correct in favoring the word *energy* for the law of energy conservation since energy is, in fact, the sum of all

1 Quoted in ME, 20: 402–3.

attractions in the universe and equal to the sum of all repulsions; i.e., it is the quantitative manifestation of the cosmic force, or cosmobia. As a consequence of its manifestation, energy is already external with relation to force, and the dialectical interaction between the two is built on the principle of essence and phenomenon. Stated differently, when force begins to manifest itself as energy—i.e., in certain regularities of nature—it is more convenient to call it *energy*. Nonetheless, the term *force* proved to be so attractive that it acquired a key role in quantum physics.

It is known that modern science uses four fundamental interactions of four forces to describe inorganic nature. Two of these are long-range forces: the ultra-weak gravitational force that connects all particles possessing mass, and the electromagnetic force that connects all particles possessing an electric charge. The two short-range forces belong to the sphere of quantum physics; they are the forces of weak interaction between elementary particles (leptons, for example) and the forces of strong interaction (protons, neutrons, pions). The relative might of these four forces is defined by the following parameters: strong—1, electromagnetic—10^{-2}, weak—10^{-6}, and gravitational—10^{-39}. Scientists are continuing to try to unite all these forces in one Grand Unified Theory.[1] In other words, a unified theory needs to be created to unite all the forces that function in the chain cosmos–atom–nucleus–particle.

Certain progress has already been made in this area. In 1971, the American physicists S. Weinberg and Sh. Glashow, as well as the Pakistani A. Salam, managed to combine quantum electromechanics with the theory of weak interactive forces in the theory of electro-weak interaction. (For this, they were awarded the Nobel Prize.) In 1980, this theory received experimental confirmation at the European Organization for Nuclear Research (CERN, Geneva). The next step would be to link their theories with the forces of strong interaction. Scientists allow for this possibility but have doubts that it could be done in the case of gravitational forces.[2] I think that the creation of

1 By the way, attempts to create a Unified Theory of Everything based on a law of forces were pioneered by Roger Boskovic, a Jesuit of Serbo-Croatian origin. He presented this theory in his *Theoria Philosophiae Naturalis*, published in Vienna in 1758. Regarding him and his theory, see Barrow, *Theories of Everything: The Quest for Ultimate Explanation*, 17–19.

2 I do not touch here upon attempts to unify the first free forces with gravitational forces in 5- and 6-dimensional spaces.

such a theory is possible in principle if we proceed from the conception of the universe as an integral whole, entailing a certain orderliness that is possible only in the presence of established regularities in the interactions between all its parts.

2

The Big Bang, or the Theory of Everything

Back in its time, the theory of the Big Bang received a very mixed reception in the Soviet Union. The orthodox Marxists saw in it a threat to "eternally existing matter" since this theory presupposes the "birth and death of the universe."[1] It was likewise negatively received by a number of Western scientists, albeit for other reasons. As an alternative, Thomas Gold, Hermann Bondi, and Fred Hoyle[2] offered a theory of their own—the theory of "the steady state of the universe" (1948), which maintains that the universe has always been like it is now and will remain in "a steady state."[3] However, as factual evidence of the universe's expansion accumulated, the proponents of "steadiness" became a minority.

Today, the majority of physicists are adherents of the theory of the Big Bang in some variation or other, including in Russia (for example, the academicians V. L. Ginzburg and V. A. Rubakov). In the Soviet era, it was actively championed by I. S. Shklovsky, who even described in some detail how the universe will die and what forms its death will take.[4] Discussions on this topic, however, have not ceased to this day.

It should be emphasized that these are not just discussions of a particular scientific problem; the debaters aspire to theories that explain the emergence of being. Their books usually bear titles like *The Theory of*

1 This theory was subjected to criticism in a countless number of works, including those of Western Marxists. For example, see Hollitscher, *Nature in the Scientific Picture of the World*.

2 Curiously, it was Hoyle himself who introduced the expression *Big Bang* into the scientific lexicon in the early 1950s.

3 For more detail, see Parker, *Einstein's Dream,* 186–91.

4 Shklovsky, *Universe, Life, Reason*, 96–9.

Everything. It is not known who came up with this expression; perhaps it was Stephen Hawking, for 25 years ago he was saying that this kind of theory was about to be created. Even now he remains optimistic, saying that a theory of everything is destined to be developed ten years or so from now. I shall revisit the issue of the possibility or impossibility of the development of such a theory, but for the time being, let us examine, without going into microdetail, several models of the universe's formation.

The standard model of cosmology. The standard model was given a theoretical basis by the Soviet physicist Alexander Fridmann and confirmed in practice by the American Edwin Hubble, while the physicists Howard Robertson and Arthur Walker became systematizers of the idea. The standard model says that approximately 15 billion years ago (13.7 billion years, according to more exact data), some kind of singular state of matter came to an end in a great explosion that has since gone through several "epochs,"[1] or phases. The temperature of the universe—10^{-43} sec (the so-called Planck time)—after the explosion (hereafter, AE) reached 10^{32} K. After a while, the universe expanded and cooled down somewhat, with the result being the emergence of primary homogeneities, for example, the primary cosmic plasma, i.e., a chaotic movement of fundamental particles: quarks and gluons. Several hundred-thousandths of a second later, matter had cooled sufficiently (to about 10 trillion K) for the gluons to join quarks together in protons and neutrons (and their antiparticles as well). After several hundredths of a second, the conditions were already in place for the formation of nucleons of certain light elements. Then the boiling universe cooled down to 1 billion degrees; the nuclei of hydrogen and helium emerged, together with traces of deuterium ("heavy" hydrogen) and lithium. This process was given the name "primary nucleosynthesis."[2] When the temperature dropped to several thousand degrees, it became possible for the nuclei of hydrogen and helium to become joined with free-flowing electrons, forming the first electrically neutral atoms. This was a turning point; from that time on, the universe was in a transparent state.

Prior to the era of capture of the electron, the universe was filled

1 Parker designates them as the epoch of chaos, the epoch of hadrons (10^{-43} sec), the epoch of leptons (10^{-4} sec), the epoch of radiation (20 sec), and the epoch of galaxies (10^{6} years). Parker, 157.

2 For more detail, see: Weinberg, *The Three Minutes*.

with plasma of electrically charged particles—some, such as the nuclei, with a positive charge and some, such as the electron, with a negative charge. The photons, which only interact with electrically charged objects, were subjected to uninterrupted bombardment from a thick layer of charged particles, which changed their trajectories or forced them to become absorbed. A barrier of charged particles in the way of the photons' free movement could have made the universe almost opaque, resembling morning smog or the visibility that prevails in a snowstorm. However, when the negatively charged electrons moved into the orbit of positively charged nuclei, creating electrically neutral atoms, the charged interferences disappeared and the dense smog evaporated. From that time on, the photons that had emerged at the time of the Big Bang began traveling without obstacles, and the universe became visible. Approximately 1 billion years later (some believe that it took only several hundred million years), stars, planets, and galaxies appeared. Such is one of the versions of the standard model.[1] Naturally, it contains much that is unclear; for example, what is this singularity? And what was there before the Planck time?

The inflationary model. By the end of the 1970s, the first inflationary model (not yet using the word *inflation*) appeared created by the Soviet scientist Alexei Starobinsky. It was a very complex construction based on the quantum theory of gravity. This model did not make its way to the West, where a similar model was developed, albeit in a simplified form, by Alan Guth of the Massachusetts Institute of Technology. His model of the expanding universe concentrated on the period between 10^{-35} and 10^{-32} sec. In Guth's view, the universe in that time period was in a state of *pseudo vacuum*, in which its energy was remarkably high. In that instant, the universe expanded exceedingly rapidly (much faster than in the standard model). At 10^{-35} sec AE, the universe contained nothing but mini-black holes and islets of space. Therefore, with the sudden expansion in the form of "bubbles" or "froth," not just one universe emerged but a multitude of universes, with some of them possibly inserted into others. Each of the members of a "bubble" turned

1 There exist several variants of the Standard Model, but they differ only in detail. For example, see Delsemme, *Our cosmic origins. From the Big Bang to the Emergence of Life and Intelligence*, 289–91.

into a separate universe, in one of which we live.[1]

This conception is sometimes called the conception of *aneurysm* (in medicine, this is the term for a bulge on the side of a blood vessel), for it describes how, on a three-dimensional curved surface, space–time bulges like a tumor and eventually splits away from the "mother" universe, forming a new one.

This theory proved to be attractive. It began to be supplemented and to be refined, in particular by the Russian-American scientist Andrei Linde, currently at Stanford University. He maintains that the universe is endless in time and space (one senses his Marxist schooling here), and, therefore, inflationary expansion is not a one-off temporary action. The conditions for inflationary expansion may occur many times in isolated spaces in the cosmos that generate their own inflationary "bubblings," turning into new separate universes. In each of those universes, the process continues with new universes that germinate from old regions, generating a never-ending web of bubblings in the cosmic expanse. This theory could be called the idea of the multiverse consisting of a multitude of universes (in theory, an endless number of them). One may assume that, should this theory be confirmed, each of the universes may have its own laws differing from those of our own.[2]

The superstring model. The greatest popularity at present is enjoyed by the theory of superstrings,[3] which postulates that the fundamental components of nature are not zero-dimensional particles but thin one-dimensional filaments called strings. In the late 1980s, Robert Brandenberger of Brown University and Kumran Vafa of Harvard suggested examining this variant of the theory of the Big Bang.

Should we turn the clock back to the beginning, the temperature will keep rising until the universe contracts to the Planck length (10^{-33} cm) along every direction. The temperature will peak in that moment

1 See Guth, "The Inflationary Universe: A Possible Solution to the Horizon and Flatness Problems," *Physical Review* (1981), D 23 347; Guth and Steinhardt, "The Inflationary Universe," *Scientific American* (May 1984); Guth, *The Inflationary Universe*.

2 Linde, "The Universe: Inflation Out of Chaos," *New Scientist* (March 1985); "Particle Physics and Inflationary Cosmology" *Scientific American* (March 1992); Barrow, 168–9.

3 Not to be confused with the cosmic strings model, according to which there existed in the early universe extended objects—strings (10^{-29} cm thick and mass of 10^{22} grams per cm)—around which were wound, as it were, the substances that subsequently formed bodies of the galactic type. Due to new research on anisotropic relic radiation, this model is subject to major doubts.

and then start falling. For simplicity's sake, one should imagine that all spatial dimensions in the universe are circular. When we turn back time, the radii of these circles shrink while the temperature of the universe rises. However, in the vicinity of the Planck length, i.e., at the maximum temperature, all radius-dimensions disappear and then reappear, increasing in size. From this moment on, the temperature starts falling, and the universe starts expanding rapidly. In other words, "chaos" (in Parker's meaning of the term) transforms into the Planck coordinates (the Planck time and length), and this is the most critical moment in the development of the universe. Further development proceeds along the smooth lines of the standard model.

Moreover, in string theory, all spatial dimensions are tightly compacted into a multidimensional, Planck-sized Nugget that is approximately equal in size to the Planck length. The temperature and energy are enormous but not infinite since string theory avoids the brain-twisting singularity. When the universe starts going through its first phase of symmetry disintegration—at about the Planck time—three spatial dimensions separate out and start expanding while the rest keep their Planck sizes.[1] These three spatial dimensions then manifest themselves in inflationary cosmic scenarios.

It should be emphasized that this theory was in its time received very positively by Steven Weinberg, who believed that it might serve as the basis for "the final theory, and that this theory will have the predictive power to describe the qualities of all constants of nature, including the cosmological constant."[2] Weinberg may have been too hasty with this evaluation, for while this theory explains the emergence of three of the forces (strong, weak, and electromagnetic), it does not do so for the force of gravity. Attempts to explain the emergence of all four forces are currently being made based on a modified string theory that bears the name of the M-theory (with its 11 dimensions).[3] It is still in the embryonic stage, but already it is being referred to as the beginning of the second superstring revolution. Work on it started in 1995,[4] and after 2000, it branched into many unusual varieties, about one of which is

1 In the theory of Brandenberger and Vafa, the rest of the dimensions fold into the Calabi-Yau space. They also explain why only three dimensions managed to emerge.

2 Weinberg, *Dreams of a Final Theory*, 183.

3 In the name of the M-theory, *M* stands for mysticism, which hints at the multitude of unclear things in the studies of problems this theory encounters.

4 For more detail, see Greene, *The Elegant Universe*. For even more detail, see the same author's *The Fabric of the Cosmos: Space, Time and the Texture of Reality*.

needed to say a few words.

This theory was developed by a team of astrophysicists consisting of Justin Howry and Paul Steinhardt (both of Princeton University), Burt Ovrat of the University of Pennsylvania, and Neil Turok of Cambridge (England). Their version of the M-theory is the idea of the *ekpyrotic universe*, or the *cyclical model*, and it has no need of either an inflationary phase or a singularity. It is constructed on the postulation of the existence of a multidimensional universe that contains no substance or energy; all it has is three-dimensional "membranes" as particular topological objects that move in space and time. At some point, when one membrane collides with another, the "quasi-static state" is violated. The energy of the collision proves to be so enormous that the universe fills, or rather "is ignited," with hot substance, particles, and energy. The Big Bang was this sort of collision. Our universe acquired three spatial dimensions (since these dimensions are in a sense located on the surface of the membranes). Other membranes with the remaining measurements persist as long as the other two of them collide into each other, producing the next Big Bang, which happens once every several trillion years without end. Therefore, the universe has no beginning. This theory seems to remove not only the above-mentioned problems but also the problem of the universe's unique slant or the problem of isotropy of the relict radiation, etc.[1] This idea received a stormy counterreaction from the team of A. Linde,[2] although certain other no less respected cosmogonists are well disposed toward it. The disputing sides believe that around 2006 or a bit later, after the success of one of NASA's space exploration programs, the necessary data will be available to help determine the truth of the various conceptions.

I have presented here in brief several theories of the origin of the universe.[3] Thousands of books have been written about these theories and their variants. However, for all their variety, they all pose a handful

1 For more detail, see Khoury, Ovrut, Steinhardt, and Turok, "The Ekpyrotic Universe: Colliding Branes and the Origin of the Hot Big Bang," hep-th/0103239; A Brief Comment on "The Pyrotechnic Universe," arXiv:hep-th/0105212 v1 22 May 2001; *New Scientist* (20 March, 2004):37.

2 See Kallosh, Kofman, and Linde, *Pyrotechnic Universe*, arXiv:hep-th/0104073 v3 29 June 2001.

3 I cannot resist mentioning one more unusual theory: the theory of Loop quantum gravity. Its designers constructed a model of transition or, more exactly, a leap through some passage as if from one universe with negative time to ours with its positive time. Thus, they leaped over the singularity, inflation, and other problems of earlier theories. See *New Science*, 20 March 2004, 35–7.

of fundamental questions: what is the singularity, what is the cause of its explosion, and, which is of most interest to us, *were the laws of force embedded already in the superdense substance (or the Planck Nugget), or were they formed after the explosion?* Let us try to solve this.

3

Singularity vs. Vacuum

The term *singularity* means a state of substance in which infinitely great gravitational forces compress its mass to an infinite density. It is believed that this state exists in the centers of black holes. This was also the state of the universe prior to its explosion, i.e., in a state of infinite density in which "the properties of substance are not known." In other words, in this state there is no space or time. At the same time, it is assumed that this superdense substance consists of protons and neutrons. The proton is an elementary particle with a positive electrical charge of one unit and a spin of 1/2 (in units $\hbar$). It belongs to the class of hadrones and the group of baryons. Its estimated lifespan is 20 to 22 orders of magnitude greater than the age of the universe, i.e., 10^{30}–10^{32} years. The proponents of the standard theory of the Big Bang—for example, the famous astrophysicist S. Hawking—point out that "the laws of physics have to be violated in the vicinity of the singular state."[1] In his theory, developed together with R. Penrose, Hawking showed that the singularity is always presenting beyond the event horizon, where an "end" or "border" of space and time emerges. In one of his public presentations, Hawking said that a final theory of the universe may not ever exist. From a physicist's perspective, he may be correct. However, as John Barrow (another English astrophysicist from Cambridge) notes, it is possible, nonetheless, to reason out the structure of the initial condition of the universe, albeit "only on the level of philosophy or theology" (ibid., 52). Let us try.

The striking thing one sees in the quoted passages is that the

1 Hawking, *A Brief History of Time: From the Big Bang to Black Holes*, 8–9.

possibility is not excluded of substance/matter existing without space or time but with an internally inherent force. Is this indeed possible? I personally believe that this is impossible in principle, as substance, motion, space, time, and force are one. There is in fact no "end" to time and space, only an end to our understanding of that state of substance. The theories and laws known to us cannot explain this unique phenomenon; we have not yet penetrated into its essence.

Let us try an approach from a different angle. Academician V. Rubakov, the Russian astrophysicist, while defining the singularity as a state with infinitely great densities and an infinite spatial curvature, believes that such a singularity point never actually existed.[1] Where, then, did the universe come from? Rubakov brings up one of the more common variants of the answer: the universe was born out of nothing. "There were no universes at all; nonetheless, it was able to emerge in some way, be formed in the quantum manner." This could be explained through a theory of quantum gravity that does not exist yet. Rubakov, though, like many others, says that, within the framework of such a theory, one would have to drop *time* since in the time period shorter than seconds after the Big Bang, "many ideas cease to work." Perhaps this is correct, but time, at least, is still there since even if it is less than 10^{-43} sec, it is still time, no matter how infinitesimal it might be.

Let us return, however, to the subject of "nothing." Rubakov repeats, "It is called 'nothing' precisely because there was nothing there" (prior to the Big Bang). In connection with this nothing, another astrophysicist, the Englishman Martin Rees, notes that those who say, "The universe emerged out of nothing" should "watch their tongue, especially when they address philosophers."[2] That is because any philosopher would remark right away that since there is a "there," that means already that there is not a nothing since in a nothing there is no there. As long as physicists give no definition of the concept of Nothing, their claims about "the emergence of the universe out of nothing" lose scientific meaning. However, as has been known since the times of Anaxagoras and Empedocles, nothing can emerge out of nothing, and, nonetheless, the universe did emerge. How?

Let us switch to philosophical terms. When we say *nothing*, we counterpose it to *something*, which on the level of substances is being. In exactly the same fashion, when we think of being, our thinking about

1 *Nezavisimaya Gazeta (Nauka)*, 03. 06. 1998.

2 Rees, *Just Six Numbers: The Deep Forces That Shape the Universe*, 131.

it presupposes the presence of nonbeing, i.e., nothing. Although they differ in their nature, they are inseparably tied. Nothing exists, as does being, for we imagine it, and we think and talk about it. It exists; it has its being in thinking, in the idea, in speech, etc. The difference is this: while nothing belongs to being, being does not belong to nothing since the latter is a concept (notion), reflected in thinking or idea, which actually is none other than being. However, on the level of abstraction, pure being and pure nothing are the same since their discernment is done through inter-definitions, i.e., through concepts—in other words, through their subjective assumption. However, this abstract identity must fall apart, revealing a difference in a *third* something, which is *becoming*, i.e., the transition or movement of one into the other, which results in existing being.

Becoming is the inseparability of being and nothing, i.e., a unity in which both *being* and *nothing* immediately entail each other. The process of *becoming* manifests itself passing over into nothing and through emergence, when nothing passes over into being. Thus, becoming takes place due to difference, but its result is a unity in which being has disappeared into nothing, nothing has disappeared into being, and ultimately being and nothing have disappeared altogether. This sublation of becoming as the transition of being and nothing into a unity is existence, i.e., real being. It is with this real being that we are working when we understand the world around us.

Let us return to physical realities. At the time of the Soviet Union, a group of scientists (Ya. B. Zeldovich, L. P. Pitayevsky, V. Tz. Gurovich, A. A. Starobinsky, and A. Linde) promoted the idea that the universe had arisen from a vacuum, which enabled them to avoid the singularity. In other words, the count for the universe starts not at zero but at “minus infinity.” This approach encouraged the development of quantum gravitational theory, which leads to the possibility of the universe’s quantum fluctuation birth, its creation from a nothing that, in fact, is something, i.e., a vacuum.

This vacuum consists of virtual particles, which seemingly cannot be determined but nonetheless are capable of interacting with real particles and influencing their behavior. A vacuum is a material milieu; it is subject to the laws of physics; it interacts with ordinary substance and defines the qualities and also the qualities of space. Unlike elementary particles, vacuum particles exist for an infinitesimal amount of time as compared to their real doppelgangers and are, therefore, liberated from subjection, in the classical sense, to the law of conservation of mass–energy.

The Big Bang is usually described as having passed through a number of phases (see above). The proponents of vacuum believe that prior to the first phase transition, all energy was concentrated in a vacuum; only a tiny fraction of it belonged to substance as such. After the initial phase, the excess energy of the vacuum was transformed into the energy of substance, which emerged in the course of the phase transition itself in the form of the pair "particle–antiparticle" and quanta of radiation. That is, virtual particles acquired flesh and blood. Energy was pumped into substance.[1] This means that, at the time of the explosion, a difference of forces did not exist; the differences appeared later.

The vacuum theory is described in detail in many books and articles, including Rovinsky's book mentioned in the references. He believes, though, that "the single fundamental force uniting the weak and the strong interactions," plus gravity, existed in the milieu when the temperature was , i.e., not "in the very beginning."

The vacuum approach was sidelined for a while by the singularity theory. However, since the end of the 1990s, vacuum has been surfacing again in connection with studies of dark energy. It is, therefore, necessary to say a few prefatory words about dark matter.

The history of dark matter dates back to 1933 when the American scientist Fritz Zwicky suggested that the nucleus of a galactic cluster must contain more matter than follows from experimental observations. During the 1970s, different laboratories confirmed the phenomenon of dark matter, but the single most convincing proof was the observation of the cosmic microwave background radiation (CMBR), the leftover radiation from the Big Bang that fills the universe. (This discovery was made in 1965 by Arno Penzias and Robert Wilson.) These observations allowed the introduction of a new component—dark matter—to the theory of the universe's evolution and structure.

The question arises, what does dark matter consist of? Which particles form it? Many hypotheses have been offered. The candidates for the role of such particles have included particles from the family of supersymmetrical particles, the exotic "axion," or an even more exotic variant, black holes themselves. Be that as it may, when describing the universe, cosmologists started taking into consideration the density of

1 For more detail, see Podolny, 105–7; also Rovinsky, *The Evolving Universe*; Tchirkov, *The Quark Hunt*, 120–4.

dark matter.

Now a few words about dark energy, to which the cosmological constant λ (lambda) is connected. This energy has many names: vacuum energy, quantum void, quantum field, or often simply void. Discussions of it began in 1998 when Saul Perlmutter's team at the University of California, Berkeley drew the conclusion based on studies of a supernova that the universe is not simply expanding; its expansion is accelerating.

It was mentioned earlier in passing that "empty vacuum" does not exist in nature. This is due, among other reasons, to the fact that a void does not possess the entropy that fills the entire universe. Therefore, there can be no "empty" universe in principle. Moreover, if vacuum energy does exist in the universe—i.e., if it possesses spatiotemporal attributes—then it must have materiality, in which motion and force are inherent. Where there is no matter, there is no space or time. The question is essentially this: what is this matter that possesses the quality of repulsion?

Quantum field theory assumes that chaotic fluctuations of energy constantly create virtual subatomic particles, but their resulting vacuum energy would have to be so huge that the repulsing force would be 10^{120} greater than what we observe. We may postulate, though, that some particles have a negative energy that destroys the excess, leaving only a portion sufficient for explaining the acceleration of the universe's expansion. This variant of the theory is rejected by many physicists. Others theorize that the repulsing energy—sometimes called *quintessence*—has changed gradually over time but that nonetheless its negative gravitational force has remained sufficient to "push" the galaxies apart. This variant is rejected by the above-mentioned "membranists," energetically so by Sean Carroll in particular, a cosmogonist at the California Institute of Technology.[1]

Another unusual conception is being developed by an international team: Nima Arkani-Hamed, Hsin-Chia Cheng, Markus Luty, and Shinji Mukohyama. These researchers believe that dark matter, dark energy, and the inflationary forces are all one and the same; i.e., they are all governed by one super powerful fluid, which they have called *the ghost condensate*. This massless, invisible particle, possessed of antigravity qualities, spreads throughout the universe, increasing the pace of its expansion. In their opinion, this conception also solves the problem of

1 See Carroll, "Filling in the Background," *Nature* (6 March 2003).

quantum fluctuation at the moment of the Big Bang.[1] Their view adds little to the quintessence particles variant.

Nonetheless, despite the multitude of variants and conceptions of dark energy, its meaning, as well as the meaning of dark matter with its stated numerical parameters (relating to density), are taken into consideration by astrophysicists when modeling the structure of the universe. Thus, one of the variants of the universe's evolution is described by two equations (derived from Einstein's equation) that contain three free parameters: Hubble's constant H_0, characterizing the speed of the universe's expansion; and the density of mass ΩM and density of vacuum energy $\Omega\Lambda$, both of which are determined relative to the critical density (0.9×10^{-29} g cm^{-3}). These equations are designed to explain the reason for the universe's expansion after the Big Bang. This expansion is slowed by the gravitational attraction of masses in the universe, but at the same time, it is supported by the vacuum energy. Whether the universe continues expanding forever or experiences an ultimate collapse depends on the balance between mass and vacuum energy. This conclusion leads to the suggestion that the Big Bang itself took place as a result of a violation of the balance between infinitesimally small mass and the vacuum of the pre-explosion state.

Modern cosmogonists have drawn two important conclusions as a result of a number of experiments. The Japanese astrophysicist Masataka Fukugita writes:

> First, the total mass-energy density of the Universe is close to the critical value—that is, $\Omega M + \Omega\Lambda \approx 1$. The matter density (visible and dark) amounts for only 27% of the critical value, so the rest is attributed to the vacuum energy density, and thus to the cosmological constant. This is the most compelling argument for a non-zero cosmological constant, something that has for many years been anathema to physicists, especially Einstein (who introduced the constant, but later regretted it). The second conclusion from the CMB data is that in the Universe has of a dark-matter density, Ω_{DM} of 0.23 and that the density of ordinary (baryonic) matter $\Omega_{b,}$ is 0.04. These numbers tie in with the data from optical observations—a dramatic confirmation that the underlying models are correct. So it seems that the Universe is made up as

1 See Stephen Battersby, "The Ghost in the Cosmos," *New Scientist* (7 February 2004): 32–5.

> follows: 73% dark, or vacuum, energy, 23% dark matter and 4% ordinary matter (only 0.5% is visible using optical astronomy with another 0.5% visible at X-ray wavelengths). For some reason, most of the energy in the Universe is stored in invisible form.[1]

It should be emphasized that the above-mentioned calculations and research are directed toward determining whether or not the universe is finite. However, they all fail to answer the question of what transpired in the era "between 0 and 10^{-43} sec," during the Planck-time interval. And ultimately, what we have to ascertain is what took place before the moment t = 0. As was said before, the vacuum conception does give some food for thought on these matters, but such musings are too speculative and easily assailable.

Russian scientist F. A. Tsitsin poses the question of the origin of this 10^{-43} sec. He says:

> The answer is simple: we find (calculate) this moment (situated in the Planck epoch of the universe's evolution, when the GTR was not applicable), assuming tacitly that it was applicable there!... It is not necessary to argue that this "method" of localizing the singularity is touchingly naïve, though it is not all that rare in science.…Naturally, the quantitative estimate of the duration of "the Planck epoch" of the universe's evolution—that famous 10^{-43} sec—obtained in this clever fashion does not have the slightest bit of meaning (which, obviously, does not discredit this value as Planck's "quantum of time" obtained from the theory of dimensionality).[2]

Proceeding from this conclusion, Tsitsin casts doubt on singularity theories in general and, based on Linde's works, claims that "the notion of the finiteness of 'the age of the universe' is not justified." He quotes from a 1991 presentation by Linde: "The singularity theory is not applicable at zero. There was no single start of the world. Neither can there be one single end" (ibid.).

1 Masataka, "The Dark Side," *Nature* (3 April 2003): 490. At the same time, it should be mentioned that there are scientists (Europeans for the most part) who deny the existence of "dark matter." Cf. Marcus Chown, "Is Dark Energy a Mirage?" *New Scientist* (6 December 2003): 5–6.

2 Tsitsin, *Astronomical Picture of the World: New Aspects.*

From all this, the main conclusion is drawn that "in our day, after decades of dominance of the standard relativist cosmological model that asserted in its main variant precisely the finiteness of the universe's age, a return is taking place…to the classical notion of the infiniteness of the preceding (and the future) history of the universe," which is called in another place "the Greater universe" (ibid.).

This approach has a right to exist, of course, but several of its theses bother me. First, Linde writes of the infinity of the *world* and not of our universe, which in the framework of his conception of "chaotic blowing-out" is built into the universe, which consists of a multitude of universes. It follows that even "the end" of our universe will not mean the end of the megaworld. Second, and speaking now from the philosophical perspective, *infiniteness* can exist only alongside *finiteness* (as was discussed above). Third, Linde's conception is only one of several, and moreover, doubt has been cast on it. To the above-mentioned critics of his conception, I can add M. Rees, who believes that the calculations produced by "Linde and others" to prove their theory are "arbitrary in the highest degree."[1] Finally, judging by the works published in the West, the dominant theories of the universe's origin are those that postulate its beginning and end, even though in a somewhat different way from what was common in the 1980s–1990s. The above-mentioned dark matter and dark energy give it a different appearance.

Let me present here another example, the views of a group of American astrophysicists from Dartmouth College (New Hampshire, USA), led by Robert Caldwell. This group believes that the expansion of the universe will continue for about another 20–22 billion years at an accelerating pace under the influence of the mysterious dark energy. As a result, not only will all cosmic objects fly ever farther apart from each other, but also the forces of nuclear interaction will be overcome. Caldwell believes that "expansion will become so rapid that it will literally tear apart" the galaxies, the stars, the Solar System, and the planets. "Ultimately," he says, "it will tear apart matter itself. We do not know what will be after that. But it will appear as the end of time."[2] By the way, the Russian physicist Vitaly Ginzburg, a 2003 Nobel laureate, is also inclined to this view.

We shall revisit this topic, but for the time being, let us attempt to sort out the laws of the universe.

1 Rees, *Just Six Numbers. The Deep Forces that Shape the Universe*, 151.
2 See *Izvestiya-Nauka*, 13 June 2003.

4

The Universe and Its Laws

Were the laws of force embedded originally in the superdense substance prior to its explosion, or did they emerge afterward? There is still no definite answer to this question.

Several approaches to this problem exist, which have been presented and systemized by John D. Barrow:

(a) the laws preceded the emergence of the universe;

(b) the universe's original state preceded the emergence of laws;

(c) the laws and the universe emerged simultaneously;

(d) laws do not exist at all;

(e) the universe does not exist at all.[1]

Often the laws are identified with God (who, as it were, formulated and governs them). It is worth emphasizing that each of these approaches has its proponents, including the latter two. I personally stick to approach (b). But to begin, let us examine approach (a), which follows from the theory of supergravity as presented by Barry Parker.

First of all, Parker states that in the universe, there are two types of fundamental particles: particles of substance (for example, protons and electrons) and particles that are carriers of interaction called *calibration particles* (for example, photons and W particles).[2] The former belong to the class of fermions and the latter to the class of bosons. Under the influence of supergravity, fermions can turn into bosons and vice versa. In the very initial period, the graviton (spin = 2) was the boson, and

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1 Barrow, *Theories of Everything*, 24.

2 Calibration particles—bosons—have an integral spin while substance particles—fermions—a half-integral spin (1/2, 3/2, and so on).

the gravitino (spin = 3/2) was the fermion. (In the theory of expanded supergravity, which is closely tied to the theory of supersymmetry, other particles appear, each of them having a superpartner: the electron/ fermions corresponding to the selectron/boson, and the photino/ fermion corresponding to the photon/boson. Their interaction, or rather their mutual annihilation, produced the expansion of the universe. Barry Parker writes, "This means that at the very earliest times the universe must have been exceedingly simple—perhaps consisting of a single type of particle. This would have happened at a temperature of about 10^{19} GeV, approximately 10^{-43} second after the Big Bang. Before this time, all four forces of nature were together as one unified force—with only one type of particle."[1] In other words, there existed only one force—the *superforce* that gave birth to all the currently known forces and particles. Their separation from each other took place in a way similar to the freezing of water when temperature drops. Thus, in the interpretation of the astrophysicist Martin Rees, "The fundamental forces—gravitational, nuclear, and electromagnetic—all 'froze out' as temperature dropped, fixing the values of N and E in a manner that can be considered 'accidental,' just like the pattern of ice crystals when water freezes. The number Q imprinted by quantum fluctuations when a universe was of microscopic size, may also depend on how these transitions occur."[2]

In other works, a different sequence of events is given for the separation of forces. At 10^{-35} sec after the Big Bang, the strong interaction separated from the electroweak ones, which caused the isolation of separate quarks and leptons; by 10^{-10} sec, the electroweak interaction "split" into the weak nuclear and electromagnetic forces; and, as a result of this, particles, except for the photons and neutrinos, acquired their own mass.[3]

In short, at the moment of the Big Bang, all laws were, as it were, condensed in advance in one point, i.e., in the very superdense substance that gave rise to the Big Bang. Subsequently, the process of the universe's expansion followed the laws that were, as it were, "rolled up" inside the point of the explosion—roughly speaking, in a superdense cosmic DNA molecule.

These assumptions are possible if one supposes that the laws of

1 Parker, 264.
2 Rees, 153. N, E, and Q are cosmic numbers with clearly defined parameters.
3 See Tchirkov, 123–4.

these four forces' functioning were predetermined in the original single force. In this case, it is necessary to assume the predictability of the end of matter's motion, regardless of the infinite number of accidents it may meet in the process of its formation into this or that unit. Every material structure has a beginning and an end. But matter itself is endless with all its attributes (force, motion, space, and time). It existed prior to the explosion, and it will remain after the death of the universe. The question is, in which form? As a radiation? As a field? As black holes?

Nonetheless, this assumption about the possibility of all laws being condensed in the point of the explosion would have made sense if it could be confirmed by analogous events in other universes or universums. Theoretically, their existence is admissible in boundless space—in a mega- or metauniverse,[1] so to speak. As Rees writes, in this case one may assume that in some universes one set of laws may exist, and in others other sets. In our universe, it is the laws described by figures of the type Ω, Λ, and Q with precise quantitative parameters (ibid., 151–2). The "clot" itself from which our universe emerged could have existed for an indefinitely long time alongside other clots of dense matter with their own "single superforces." But even then it is quite evident that the "united forces" themselves, or rather their interactions, would have been based on other laws defined by the quality of these clots of matter. The laws of other universes, even if they emerged in a way similar to the Big Bang, certainly would have to be different from the laws of our "visible" universe since it is impossible to even speculate that explosions in other points of the metauniverse took place under the same conditions that obtained in the point of expansion of our own universe.[2]

I have made all these assumptions for the purpose of emphasizing that the laws of force that set matter in motion emerged not all at once, but gradually over time as differentiation of matter progressed and matter was joined into stable integrities.[3]

1 Although, as Shklovsky writes, the question of "whether other universes exist appears not at all an idle one," few are willing to tackle it. Shklovsky mentions only two American cosmogonists in this connection: Wheeler and Everett (Shklovsky, 101). Since the late 1990s, more scientists have been addressing this topic.

2 Hawking makes the same assumption, albeit in a somewhat different key. See Hawking, 125.

3 I am not addressing here the frequently discussed topic of whether the universe formed in time or together with time (space–time or space and time).

My approach is based on the idea that laws or regularities could not have existed from the very start—i.e., prior to the Big Bang—since they are realized over space and time. In the state of the singularity (if indeed such a state is possible), which also can be perceived as integrity, there was no interaction based on the laws of force known to us. I believe that interaction definitely existed, but it was subject to other regularities corresponding to the ultimate temperature (say, about 10^{32} K) and the density of substance. As mentioned above, to describe these regularities, a quantum theory of gravity is needed that is not yet available. In any case, only after the explosion with the expansion of the universe—as the "building blocks" of substance (protons and neutrons) form the nuclei of helium, deuterium, and other very simple elements—they overcome/break the plasma state, "finding themselves" in certain other integrities beginning with the microworld and ending with the macroworld.[1] The formation of this or that integrity proceeded simultaneously with the forming of the laws of conservation of these integrities as well as the laws of interaction between different integrities. Moreover, I do not deny that as the universe's expansion accelerates, the "old" laws may change, and even some constants, such as the gravitational constant. The formation of new structures of matter—for example, organic matter—was accompanied by the formation of new laws that were likely not programmed in the clot.

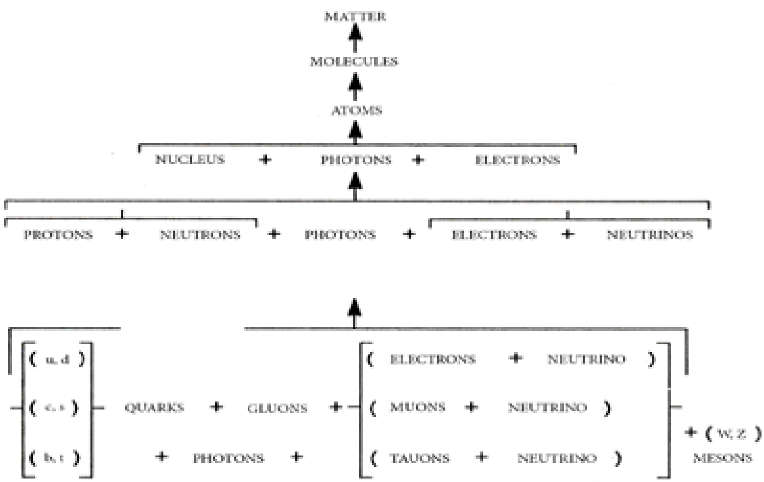
5

Cosmobia and the Cause of the Big Bang

In the preceding pages, the word *force* was used many times. It is now appropriate to discuss it in the context of its meaning in the inorganic part of the universe that encompasses the micro- and megaworlds. In the philosophical section of this work, I introduced a new word, *cosmobia*—C

1 See "Physics of the Cosmos," *The Small Encyclopedia*, 90–108.

(Greek for cosmic force)—meaning the force that drives the universe to expand. At that time of writing the preceding subchapters, I did not yet know about the cosmological constant introduced by Einstein and the debates that flared up around it after 1998 when the acceleration of the universe's expansion was determined to be a fact. This constant will be needed in the discussions of the Big Bang. But to begin, I want to reproduce a table-ladder borrowed from John Taylor. It will be a useful illustration for nonprofessionals in the area of physics, for it graphically shows the hierarchy of "interrelations" in the inorganic world.[1]



The quanta of natural forces can be presented in this form:

Force	Quanta
Electromagnetism	Photon
Nuclear Force	Gluon
Radioactivity	(W, Z) Mesons

This picture was envisioned by John Taylor at the time he was

1 Taylor, *When the Clock Struck Zero*, 82.

writing his book (1994). He stipulated, though, that by the end of the 20th century, new particles might be discovered that could be added to his ladder, which I will now proceed to do. This is how the table looks now:

Force	Quanta
Electromagnetism	Photon
Nuclear Force	Gluon
Radioactivity	(W, Z) Mesons
Gravity	Graviton
Cosmic (cosmobia)	Deion

I should remind the reader that while the first three quanta (photons, gluons, and mesons) and their physical parameters were experimentally confirmed a relatively long time ago (by 1984), certain doubts persist with regard to the graviton since it still has not been directly discovered. Its existence, however, was established indirectly back in 1984 on the basis of the discovery of a pulsar in a binary system, the American astronomers Russell Hulse and Joseph A. Taylor being awarded the Nobel Prize for physics for this in 1993.

I named a vacuum particle, which is connected with accelerated expansion of the universe and Big Explosion, as *Deion*. I will have more to say on this later.

Now a few words about Taylor's table. It illustrates graphically the world materiality, which consists of different structures of matter, substantial and field, with different forces inherent in each. Physics has succeeded in discovering the basic forces of nature, which are stated in laws, for example, those of Newton, Coulomb, and Maxwell. Others became known from empirical correlations in the form of cosmic numbers. Following are some of them.[1]

The cosmic number N measures the strength of the electrical forces that hold atoms together divided by the force of gravity between them. This number equals 10^{32}.

Another cosmic number is E (epsilon), equal to 0.007. It denotes the proportion of energy that is released when hydrogen fuses into helium. E defines the degree of strength of the ties in atomic nuclei and explains

1 I found the definition of the cosmic numbers and their meaning in Rees, 2–3.

the emergence of all atoms. This number allows it to be determined, for example, that each cubic meter of space contains 412 million quanta of radiation, or photons, and that the average density of atoms in the universe is only about 0.2 per cubic meter. Even though, as Rees writes, it is unclear exactly how many atoms there are in diffuse gas or in dark matter, approximate calculations suggest that each atom in the universe contains about 2 billion photons.[1]

The cosmic number Ω (omega) measures the amount of material in our universe—galaxies, diffuse gas, and dark matter. It tells us the relative importance of gravity and energy expansion in the universe.

The cosmic number Q gives us information about the entire cosmic structure: stars, galaxies, cluster galaxies, etc. It needs to be emphasized that even minimal deviations from these numerical parameters would have led to the formation of a fundamentally different universe, most likely without the appearance of man.

For this topic in the research, I am most interested in the number denoted by λ, which became an object of close attention after 1998, as I have already mentioned several times. This is the *cosmic constant* added by Einstein to his general theory of relativity in order to substantiate the static state of the universe. The definite characteristic of this constant as a force of repulsion balanced the forces of gravitation, and, as a result, the universe was thought infinite but not unbounded. When it was discovered that the universe is expanding, λ was forgotten for many decades. However, scientists returned to it when they assumed that the universe expanded by acceleration. This led to the conclusion that *some* repulsing cosmic force exists. It is indiscernible in the Solar System, and it evidently does not even have much importance within our galaxy, but it can have a substantial influence in the wide reaches of the universe. Despite its weakness, it is capable of overcoming weakened gravity in intergalactic space, which is often called the antigravitational force.

The cosmological constant is usually tied to the dark energy mentioned earlier.

In principle, I could have stopped here, having already shown how the material universe discloses itself through physical forces, acquiring in different structures of matter different force aspects and their numerical characteristics. However, in the above table, there figures one more force: cosmobia, in the form of vacuum forces with the deion quantum. Vacuum has been discussed in the preceding pages

1 Rees, 66.

but without connecting it to the *deion*. I suggest this quantum played a key role in the beginning of the universe and will play a culpable role in its end, which is customarily called the Big Crunch. It makes sense to revisit this beginning one more time.

Many people do not believe in such a quantum, but according to theory and many experiments, *it must be*. Nonetheless, before presenting my approach, I wish to speak first to the Big Bang skeptics, then to some optimists, and only then to myself. All of the participants in the debate are materialists, even if everyone does not admits it openly.

So let us return to the cause of the Big Bang. As mentioned already, many believe that this issue cannot be solved by physical regularities in principle because of the "quantifiability" of the space–time structure, which is discrete; i.e., there exists a minimum spatial size and a minimum time interval. According to these assumptions, the minimum linear size (the quantum of space) is $\sim 10^{-33}$ cm, while the minimum temporal interval (the quantum of time) is $\sim 10^{-43}$ sec. (The reader may have noticed by now that we keep spinning around the Planck parameters.) For comparison, the size of the atomic nucleus equals $\sim 10^{-13}$ cm, which is 20 orders of magnitude greater than the quantum of space; and light traverses a distance equal to the diameter of a hydrogen atom nucleus in $\sim 10^{-23}$ sec, which is an eternity compared to the quantum of time. R. E. Rovinsky writes in this connection, "If the quantum character of space–time is real, then, however, tiny these magnitudes are, it is impossible to bring particles of substance closer than the space quantum distance, and it is impossible to get closer to the start of the universe's expansion than 10^{-43} sec."[1]

However, should even this assumption about the quantifiability of space–time be confirmed, it will just mean only the experimental inaccessibility of the "beginning." There are, however, scientists who deny the knowability of the beginning of the universe in principle, for example, already-mentioned physicist and mathematician John G. Taylor, who does so on the basis of his theory of endless returns. Applied to the universe, it works in the following fashion: each level of the universe's energy state requires its own specific theory, and the "start" of this level coincides with the "end" of the previous one, or of the energy state of that previous level of the universe. Accordingly, the previous level as well as the following one requires its own theory, and so on without end for there exists an endless succession of levels of the

1 Rovinsky, *The Evolving Universe*.

universe.[1] (This reminds one strongly of Zeno's aporias about Achilles and the arrow.) In Taylor's opinion, even if we use the idea of the universe's quantum creation, which can facilitate the understanding of different levels, it still will not explain the universe's existence. He writes that the universe "can be viewed as not created (by someone), at least in our understanding, since it quite likely represents infinite complexity" (ibid., 116). That is, Taylor objects categorically to "divine" beginnings and, most importantly, to all variants of "the Theory of Everything" (ibid., VIII, 4, 13, 177–8). He believes that we will never be able to answer the question of "the beginning," as the universe "recedes into the infinite past; it is never accessible, although we should always be able to progress towards it" (ibid., 176).

Strangely enough, this is actually an exaggeration of the thesis of dialectical materialism that matter (not the universe) is endless in its manifestations and that the process of cognizing it is, therefore, likewise endless. Indeed, every section or level of the material world requires a theory of its own, but this does not mean that this or that form or manifestation of matter is not knowable in principle. Taylor himself confirms this, and we will have the chance to ascertain it ourselves when we get to the chapter about consciousness.

Be that as it may, on the theoretical level, more and more scientists have been coming up with their own versions of the universal beginning, especially since the end of the 1990s. Following is one.

Two Italians, Gabriele Veneziano and Maurizio Gasperini of the University of Turin, proceed from the assumption that the universe existed long before the explosion as a cold and infinite spatial extension. At some moment, there emerged an instability (why?), coinciding to a degree with the mathematical description of Guth's inflationary epoch, that forced all the parts of the universe to fly away from each other at great speed. For that reason, space started to curl up into itself, and as a result, the temperature and energy density shot up dramatically. After a while, a millimeter-sized three-dimensional region inside that vast space may have resembled the superhot, superdense lump that supposedly emerged from Guth's inflationary expansion. Further development followed a scenario corresponding to the standard model of the Big Bang. Moreover, since the period prior to the Big Bang has its own inflationary expansion, Guth's solution to the problem may be

1 Taylor, *When the Clock Struck Zero,* 114–5.

applicable to the period preceding 0.[1]

This approach may resolve the question of the "beginning-eternity" of the universe, but it leaves the old problems intact: why did *instability*, or fluctuation, emerge? These problems can be considered not only on the theoretical level but on the experimental plane as well. An avalanche of news coming from different space research laboratories around the world is confirming this supposition.

For instance, one report contains the following information: An international group of scientists obtained the first experimental confirmation of the theory of the Big Bang. The group of physicists from Japan, the United States, and a number of other countries succeeded, in a series of particle collision experiments at the Brookhaven National Laboratory (New York), in recreating the first moments of the birth of the universe. According to the theory, within several microseconds after the Big Bang a powerful temperature surge took place, with matter existing in the form of plasma, a chaotic motion of fundamental particles. These particles are called *quarks*, and they are considered the basic building blocks of the universe, along with gluons, neutral particles that glue the quarks to each other. After the temperature fell, the gluons glued the quarks together into protons and neutrons, which formed nuclei, and then atoms emerged.

In the course of experiments in the United States (January–March 2003), the specialists succeeded in recreating the plasma matter that supposedly formed after the explosion. In particular, they caused the nuclei of gold atoms to collide at speeds close to the speed of light. (To be precise, the ions of gold collided with lighter ions of deuterium. —*A.B.)* As a result, the temperature in the zone of the experiment rose to 2 trillion degrees, which is 300 million times higher than the temperature of the Sun's surface. They noted also the disappearance of one of the colliding streams of nuclei. The scientists believe that the nuclei disintegrated into invisible quarks that existed for fractions of a second.

I am not undertaking to describe these experiments in detail since they may be of interest only to specialists. It was important to me to emphasize here that, judging by the energy with which scientists have started attacking this *beginning*, one may assume that in the 21st century, this question will be answered on the basis of experimental data. Far more interesting to me is the question of how theoretical

1 For more detail, see Greene, 362–3.

physicists and even philosophers can arrive at statements about this or that phenomenon that are subsequently confirmed by experiments and practice.

A little over 30 years ago, the English philosopher George Melhuish, precisely in connection with the problem of the universe, reasoned about the category of Nothing and about the *pluriverse*. In the former case, he needed to prove "*mere nothing is a necessity to the ordinary rational view of things,*" without which we will not understand what *something* is.[1] To be sure, this topic was thoroughly chewed over by Hegel a long time ago, but considering that the Anglo-Saxons never cared much for dialectics, Melhuish's reasoning on this topic was quite beneficial to them. In the latter case, proceeding from "Multi-Universality" (a word introduced by J. Benardete), Melhuish needed to prove that our universe is not the entire universe. Following purely philosophical logic, he writes that as soon as we begin to define—or, in his terminology, to select—the universe and all the forces and things inherent to it, we are in fact making a selection from something greater than the universe itself (ibid., 79). "Hence whatever particular universe is selected, it will not be the universe as a whole" (ibid., 80). As a result, we have selected (chosen), or limited a *Selective Universe* (in the terminology of his theory), which is part of the *Non-Selective Universe*. The former is always limited, containing "only some things"; the latter is unlimited "because of there being nothing which it does not contain" (ibid., 81). Melhuish believed that "the acceptance of the Non-Selective Universe must represent *a basic revolution in cosmology*" (ibid., 82).

Even though time has shown that this approach in cosmogony did not develop into a revolution (perhaps cosmogonists do not read philosophical works; Weinberg, by the way, insists on this), it is in itself the theoretical premise for subsequent conceptions of the mega- and multiuniverses. This is all the more so as, in the late 1970s, the idea of a static, endless universe was still prevalent.

Another theoretical scheme of the universe's beginning may prove more interesting at present, one proposed by the Belgian physicist Edgard Gunzig of the Free University of Brussels. His conception of cosmogony is closely tied to the cosmological constant and the emptiness at the moment of the explosion. Gunzig's main thesis is, "This expanding universe is a strange character: in a classical fashion it can only be born as a result of the singular Big Bang, but the quantum fashion opens the

1 Melhuish, *The Paradoxical Nature of Reality*, 104.

possibility of a physically conceivable birth out of…practically nothing, out of the quantum void!"[1]

In Gunzig's view, the quantum void, or the quantum field, is the ontological essence of the quantum theory of fields (ibid., 41–2). This void gives birth to the cosmological constant in the process of the expansion of space–time. In this theory, either space–time or the void itself is not passive. Gunzig writes:

> On the contrary, the quantum field becomes the dramatic personage of an extraordinary phenomenon: the expansion of space–time causes the creation of material particles connected to this field. Within the framework of the quantum theory of fields, the particles express the quantum agitations of the field, while the quantum field is agitated in a quantum fashion because of the expansion of space–time in which it is immersed. This expansion of the geometric substratum produces an influence on the quantum field that is analogical to the influence of an external energy source: it forces it to give birth to matter in a quantum fashion. (ibid., 41)

That is, the cosmic fluid (the "quintessence," apparently) gives rise to itself out of the interaction of the quantum field and space–time. It is understood that the void is not absence of matter but rather a special, minimal-energy state of matter; i.e., it is the highly energetic vacuum discussed earlier. In this state, the uninterrupted creation of new energy (and therefore of material particles) is compensated for by the "spreading" of its density. As a result, the geometry (space–time) under these assumptions not only retains its dynamics but also becomes an energetic actor through interaction in the quantum field.

There is nothing strange in this approach. When I postulated in the philosophical section that motion, force, space, and time are inherent to matter, this was not merely a statement of the presence of passive attributes but that they are interdependent and inseparable; none of these attributes exists by itself (with the possible exception of such unusual phenomena as black holes or phenomena that exist outside the framework of the laws of our universe). Therefore, change in any one attribute automatically leads to changes in all the others. To make this clearer, let us recall that classical

1 Gunzig, *Story of the History of the Beginning*. In Prigozhin (Ed.). *Man Facing Indeterminancy,* 43.

dialectical pair, form and content. From the gnoseological point of view, we usually assert that a change of form leads to a change of content. This is perceived as if one phenomenon (change of form) precedes another (change of content) and vice versa. In fact, on the ontological level, this interaction takes place simultaneously with the active participation of two aspects that give rise to a third. In other words, Gunzig's claim about particles being born in the interaction of space–time (form) and the void (content) fits nicely into the dialectics of contradictions. The question is how well it fits into physical reality.

Naturally, the question also arises of what creates this interaction, what its cause is. Gunzig, being a follower of I. Prigozhin, speaks of resonance, fluctuations, and instability. His void and space–time enter into harmony, responding to each other through emerging fluctuations. It is perfectly clear that the universe emerges from an "instable void"! More precisely, "the universe emerges as the inevitable response of the quantum void to the ubiquitous presence of gravity" (ibid., 45). This means that there never was any singularity, nor was there any explosion. As for matter, it emerged along the lines of the just-mentioned principle. Let me repeat again: energy was transmitted from geometry to matter, and this on the whole ensured an energy balance algebraically equal to zero. "In other words," Gunzig writes, "the total energy of the universe equals the energy of the (prebeginning) void from which this universe emerged, and there is no difference between them from the perspective of energy. The universe and the void appear as two different energetically manifested phases of one and the same substratum" (ibid., 46). (Note: there was no explosion, but there was a prebeginning.)

Gunzig is not very convincing in his explanation of the quantum field's transition into a destructive state that gives rise to matter and, accordingly, to entropy. He arrives at this conclusion: "Thus, it is precisely the creation of entropy that distinguishes empty space–time from the material universe" (ibid., 48). Something is clearly amiss here, even if only for the reason that "empty space–time" does not exist even within the framework of his conception: it constantly interacts with the quantum field, and Gunzig often calls this latter *the void*, understanding it as "the minimal-energy state of matter" (ibid., 41). The idea of space–time's energy in interaction with the quantum field undoubtedly deserves attention, though it is very doubtful that it will ever be proven experimentally. I assert nothing for the time being, especially since in my understanding, time is always connected to heat, particularly in the English language (time/temperature). My feeling is that they are one and the same.

6

From the Big Bang to the Big Crunch

I proceed from the dialectical view that the ontological essences *finite* and *infinite* are mutually defining. In one of the finitenesses of the infinite space, there emerged our universe, with its beginning and inevitable end. Beyond our universe there exists the metaverse, consisting of different universes, or of at least *something*, if its laws and constants are cardinally different from ours. We are not likely to be able to understand this metaverse, at least in the next million years or two. Nonetheless, we must admit its existence, if only to avoid falling into the trap of space–time. This inseparable pair inevitably exists in the metaverse since, just like our universe, it *a priori* cannot be nonmaterial. This means that on the ontological level, there does not exist any zero in principle since the metaverse, which includes our universe, is eternal. By zero I mean a conditional point where the count starts from a certain event, which in our case is the birth of the universe. Although some theories assert that other universes may be located within our own—hence the term *mega-* or *multiverse* being applied to our universe—I believe that it is a single wholeness. I proceed also from the assumption that the universe is three-dimensional (plus time), while suggestions about the multidimensionality of certain sections of the universe are, though plausible, hypothetical for the time being. At least so far, neither microphysics nor cosmogony have presented convincing evidence in favor of multidimensionality.

Therefore, a tiny wholeness—let us call it *the cosmic Crumb*[1]—formed in some location in the metaverse and exploded for some reason. The fact of the explosion itself is no longer in doubt thanks to the practical research work of physicists and cosmogonists. But it is still unclear of what the Crumb consisted and the reasons for its explosion.

On the philosophical level, the answer presents no great difficulty.

1 Do not be confused with the theory of "Cosmic Egg to the Big Bang" suggested by Belgian priest and astronomer Georges Lemaître.

Whichever theory or model of the Big Bang one may follow, none deny the existence of an original (even if in the form of a quantum field) material substance, however superdense or energetically rich it may have been. In Chapter I, I defined force as an attribute of matter, and, therefore, force must be inherent in any initial state of the universe.

Now let us recall Hegel and other philosophers who wrote of force. In all matter, there exists an internal and an external force. Their contradictory interaction causes matter to move. That is, since "force is the self-repelling contradiction; it is *active*." Thus, the *external force* is active, aggressive, and seeks to close with another external force (in other words, it seeks to manifest itself externally), whereas the internal force, on the contrary, seeks to constrain the external one, i.e., preserve the whole. Hegel called this stage the "negative unity or essential being-in-itself." However, the development of the contradiction leads to immediate Existence, and "force, then, as the determination of the reflected unity of the whole, is posited as becoming existent external manifoldness *from out of itself*."[1]

The Big Bang occurred as a result of internal contradictions of forces inside protons or other particles, leading to an "external variety" of a sort that hardly could have occurred to any kind of Designer. Even though "the properties of substance" of that matter are unknown, this could not prevent *force* as an attribute of matter from functioning because force is the cause of the motion of matter. It appears that this is how the problem of the Big Bang can be resolved on the philosophical level.

It is perfectly clear that this is not likely to satisfy cosmogonists. Let me, therefore, attempt to fill in the above reasoning with "physics" content.

Cosmogonists claim that in the pre-explosion state (for example, in the singularity), the Crumb contained a certain physical substance—infinitesimal mass—for example, protons and/or energetic vacuum with some virtual particles, perhaps quintessences. It seems to me that protons should be excluded from the primary state since otherwise we would have to admit the presence of nuclear forces in them and the corresponding gluons and quarks. Astrophysicists themselves admit their formation only after the explosion beyond the Planck time limits. It is therefore more logical to postulate that this infinitesimal mass was represented by some other particle—let us call it the *initial (i)*. The virtual particle of the energetic vacuum we shall call the *deion (d)*. Compressed into the Crumb by events in the metaverse, the density of mass and vacuum reached

1 *Hegel's Science of Logic*, 520.

unimaginable magnitudes, say, the previously mentioned figure of 10^{120}.

Within this Crumb, motion took place, together with all its attributes: space, time, and the forces that corresponded to the spatio-temperature scale of that integrity. We cannot say anything about the laws of matter's motion in the pre-explosion state of the Crumb, but that does not mean that there were no such laws. Since the integrity was material—no matter what its size—all attributes of matter were inherent in it, including the laws to which it gives birth. Perhaps some things will become clearer once scientists manage to reproduce this state artificially, although that is a very doubtful proposition (considering the substance density); it would likely not be safe for our universe itself. Perhaps if we were to capture an initial (i) as a leftover particle in some other galaxy.

Gunzig's conception does without the initial; in it, vacuum itself gives rise to matter. However, as far as we know, the virtual particles of vacuum cannot come into being without interaction with real particles. The role of the latter in this conception is played by space–time. This is possible, in principle, from the perspective of dialectics, but I am not sure that it is possible from that of physics. Since Gunzig is a physicist, I leave this topic for them to discuss. My approach, after all, is different.

The virtual particle *d* interacted with the real particle *i*, increasing the latter's quantity and energy. This process led to the formation of fluctuations in the joint force field of initials and deions. However, the Crumb did not exist in "airless" space; it was surrounded on all sides by the metaverse and its force fields. At some moment, there occurred a violation of the "balance" of forces both within the Crumb and outside it, i.e., the balance between the total force of the Crumb (which was the rolled-tight cosmobia) and the external forces of the metaverse. This double violation of the balance of forces led to an explosion-jump, as a result of which the initial was either totally annihilated or some of it transformed into quanta—antiquarks (a quark–gluon soup)—with the ensuing chain of emergences—atoms, molecules, gravitational force, matter, and so on, all the way to galaxies and galactic clusters. It is conceivable that part of it remained in its original form, hidden in dark matter in the form of the above-mentioned axion.

As for the vacuum, its density fell abruptly almost to zero or at least below the current magnitude of the cosmological constant (0.7), which enabled gravity to form solid substances in the form of galaxies, stars, and planets. For a certain time period, until the abrupt expansion of the universe took place, the deion, as it were, "stepped aside," only to reproduce itself later in the form of the constant λ. It is C (cosmobia), the rolled-up cosmic force—of which the deion was the main component—that played the crucial role in the emergence of the universe, and it is C—when it untwists and occupies most of the universe—that will play a key role in the Big Crunch, the heat death of the universe. This approach should have satisfied John Taylor and his theory of endless returns since it borders on one side on the already known theories of the post-explosion period, and on the other side, it abuts the unknown metauniverse.

I do not claim that my purely logical version is flawless. It does not pretend to that distinction, but on the metaphysical level, at least, it "allows" matter to stay "eternally alive"; the death of the universe means only a change in the content and form of matter. This naturally will lead to changes in the laws of force that will correspond to the new state of matter. At the same time, ***my conception assumes that not four but five forces are inherent to our universe, the fifth being the cosmic force with its deion particle, which appears as the antagonist of the graviton.*** Its presence leads me to the conclusion that the creation of a theory of super-grand quantum unification of forces is impossible without taking into account this fifth force. It appears that it is the gravitational and cosmic forces that must be unified to begin with on account of the approximately equal order of magnitude of their manifestation. This fifth force, C, while itself being in need of physical–mathematical understanding, must play a roll in any all-encompassing theory of the quantum field.

7

God, the Anthropist Winnie-the-Pooh and Co.

God. It was mentioned earlier that some scientists hold to an approach according to which the laws (or the universal law) precede the emergence of the universe. In the same section, I said that to another category of scientists the universe, nature, and God are practically synonyms, or, more precisely, God in their writings often appears as a metaphorical name or a synonym for nature (Spinoza, Einstein). There are some, though, who believe that the universe itself is part of God or that it rests on

God, created by Him but not merging with Him. This approach is called *pantheism*, this term having been introduced in the early 19th century by the German philosopher Karl Krause. In its contemporary version, this idea is somewhat modified in the sense that the laws of the universe are a creation of God, or, in Hawking's expression, they are "the mind of God." "These laws," writes Hawking, "may have originally been directed by God, but it appears that He has since left the universe to evolve according to them and does not intervene in it."[1] This view was held by Newton, was more consistently developed by Leibniz, and is implied in Hegel's works.

A cardinally different approach was held by the Russian scientist Mikhail Lomonosov (1711–1765), whose weight in science was comparable to that of the above-mentioned luminaries. He believed that "it is easy to be a philosopher when you have learned four words by heart: *God created it thus*—and offer this as an answer in place of any other causes."[2] It is worth stressing that such famous thinkers as Hume and Kant likewise sharply objected to the idea that God is the creator of nature.

Among contemporary physicists and astrophysicists, few hold to the divine approach, though it is possible that there are somewhat more of those among evolutionary biologists. Steven Weinberg, the Nobel laureate, claims that whenever someone mentions the "creation" of the universe, the reaction of "most of my fellow physicists is a mild surprise and amusement that anyone still takes all that seriously."[3] Weinberg himself in one of his books, in a chapter titled "What About God?," proves convincingly the absurdity of this view against the backdrop of the process of the demystification first of the "Heavens" thanks to such scientific geniuses as Copernicus, Galileo, Bruno, and even the believer Newton; and then of life, starting with the works of Justus von Liebig, Charles Darwin, Alfred Wallace, et al.

Today God has become unnecessary, at least in the scientific community. Weinberg attests to this, quoting conversations with fellow physicists and astrophysicists. He mentions in this connection his 1977

1 Hawking, 122. I strongly doubt, though, that Hawking himself believes in God, even though he exploits the quoted phrase constantly. Apparently he needs it in order to give no offense to believers, but most importantly in order to do no harm to the sales of his books, which he has admitted candidly, albeit kind of jokingly, when talking of the success of his *A Brief History of Time*. See Hawking, *Black Holes and Baby Universes,* 37.

2 Lomonosov, *Selected Philosophical Works,* 397.

3 Weinberg, *Dreams of a Final Theory*, 205.

book *The First Three Minutes*, in which he "rashly" remarked, "The more the universe seems comprehensible, the more it seems pointless" (ibid., 204). Some scientists understood this remark as regret about the universe's pointlessness from a man nostalgic about a world in which the Heavens sing hosannas to God. A poll of 27 cosmogonists and physicists was even undertaken on this occasion. Ten of them unreservedly agreed that the universe is pointless. Thirteen did not agree, but three of them disagreed because they simply did not understand why anyone would expect the universe to have any kind of point. The Harvard astronomer Margaret Geller asked, "Why should it have a point? What point? It is just a physical system, what point is there? I've always been puzzled by that statement" (ibid.). The Princeton astrophysicist Jim Peebles remarked, "I'm willing to believe that we are flotsam and jetsam" (ibid.). Another Princeton astrophysicist, Edwin Turner, suspected that Weinberg had intended the remark to annoy the reader.[1]

Nonetheless, while agreeing entirely with the essence of the criticisms of the divine approach to the emergence of the universe, I do see in it a very fruitful phenomenon, however strange that may seem. The matter is not just that the ordinary habitant who is not well versed in things such as quanta finds it much easier to understand the six-day version of the world's origin described in the Bible than the three-minute version of the Big Bang theory, especially the initial period of a trillion-to-the-trillionth-degree fraction of a second. As I mentioned in passing in the previous chapter, the idea of God has always occurred to scientists whenever it was difficult, or sometimes even impossible, to ascertain the essence of things. This is especially true in the case of investigating the origin of the world or the universe, or even the contemporary ideas that center on the Big Bang. Almost everyone acknowledges that it is impossible to determine what transpired in the interval between $t = 0$ and $t = 10^{-43}$ sec. Some scientists simply say that since this time period cannot possibly be penetrated into, we should simply move on and discover laws and regularities. Others simplify the answer for themselves by saying that "only God knows" (or the equivalent "the Devil knows") what was "before" or "during" the above-mentioned time interval, and they likewise "move on" to uncover the regularities of the "afterward." As for those who have attempted to figure out what did transpire "in there," they became mired in the topic and never managed to extricate themselves from it. As a result, many

1 Among the surveyed members of the National Academy of Sciences of the USA (in 1998), only 7% admitted to being believers. See *Nature* (23 July 1998), 313.

phenomena of the "afterward" have remained unsolved. I do not exclude the possibility that without this "oh-so-useful God" science would have been left without many outstanding thinkers, such as Newton or Hegel.

It is necessary to keep in mind that *God*, *nothing*, and other abstractions and even myths are *concepts and categories of our being*. They consist of reflections of not only substantial being but also conceptual being, a large portion of which absorbs distorted, mythical, or irrational views about the surrounding world. By far the greater part of mankind's existence has fallen in periods in which irrational ideas about the surrounding world reigned. This was likely a natural period in mankind's formation. Fyodor Dostoevsky once said very fortunately, "If everything on Earth were rational nothing would happen."[1] (This phrase is an artistic expression of the correlation between regularity and chance.) It is imperative here not to forget one thing I mentioned in connection with the category of Nothing. God is a category of our being, but being itself is not a category of God. There is no God in *being*; "He" is present in our brains as an image or a concept—in everyone's brain, though, for different needs. Some need God in order to be "His" servants, others have use for "Him" in politics; still others need to understand why people need "Him" and why it is time to put "Him" to rest.

The anthropic principle. In spite of all this, God still has a presence in science, acquiring new appearances in the guise of "scientific" terminology. In this aspect, He is much more dangerous. I mean in this case the so-called anthropic principle, which in simplified form can be expressed thusly: we see the universe the way it is because we exist. Alternatively, if the universe were different, then we would not be in it. A somewhat more complex formulation of the principle is that the physical constants are what they are, for if they were different, life as we know it would not have existed. The most popular formulation belongs to Winnie-the-Pooh, who reasoned in a perfectly "anthropically" way, "That buzzing noise means something…if there is a buzzing noise, and the only reason for making a buzzing noise that I know of is because you are a bee.…And the only reason for being a bee that I know of is making honey.…And the only reason for making honey is so I can eat it."

In its contemporary form, the anthropic principle exists in two

1 I found this phrase by Dostoyevsky in Barrow's work. See Barrow, 149.

varieties.[1] The first one is called the weak anthropic principle. It says that which we propose to observe must satisfy the conditions necessary for man's presence as an observer.[2] The second variant is called the strong anthropic principle: the universe must be such that at some stage in its evolution there may exist an observer.[3] One has to admit this conception of the observer has been shared by such major figures in science as Niels Bohr, his colleague of many years John A. Wheeler, and the Nobel laureate Eugene Wigner.

At first sight, it would seem that the anthropic principle has nothing to do with God. The formulation of the problem appears to be almost scientific; moreover, its scientific character is "enhanced" by the theory of "delicate fine-tuning of the universe," supported by ideas of the "self-organization" of the universe. Ultimately, though, all these principles and theories amount to the "purposefulness" of the universe's evolution, with Man (capital M, of course) at its pinnacle—Man, who either merges with Omega-God (Chardin) or cooperates with Him. The most important, having accepted this approach, as suggested by its active adherent Reomar Rovinsky, "one should give recognition without protest to the hypothesis of the possible existence of an 'organizing principle' that determines the character of the directed development of the universe and its particular parts" (ibid). This organizing principle points in two directions: one is obviously toward God, and the other is toward self-organization of the universe.

The divine variant following from the anthropic principle coincides with the claim that God created the universe and its laws. It is no accident that Weinberg did not even bother to separate the "anthropists" from

1 This formulation of the principle belongs to Brandon Carter. I became acquainted with it from the works of other physicists.

2 In Hawking's formulation, the weak principle runs like this: "In a universe that is large or infinite in space and/or time, the conditions necessary for the development of intelligent life will be met only in certain regions that are limited in space and time" (ibid., 124). The reader should note that Hawking uses more cautious expressions in his formulation than nonphysicists do.

3 In his formulation of the strong principle, Hawking is once again extremely cautious: "There are either many different universes or many different regions of a single universe, each with its own initial configuration and, perhaps, with its own set of laws of science. In most of these universes, the conditions would not be right for the development of complicated organisms; only in the few universes that are like ours would intelligent beings develop" (ibid., 124–5). Hawking, in fact, rejects the anthropic principles, albeit in an ornate form. See Hawking, *Black Holes and Baby Universes*, 52–3.

the "diviners." By the way, he criticizes John Wheeler for his adherence to the well-known Copenhagen school, whose followers believe that quantitative magnitudes such as location, energy, or momentum have no value until such a time as they are measured by an observer. This view follows from positivism, which in Weinberg's interpretation expresses the idea of accepting only those things that can be observed. He says, "Other physicists including myself prefer another, realist, way of looking at quantum mechanics, in terms of a wave function that can describe laboratories and observers as well as atoms and molecules, governed by laws that do not materially depend on whether there are any observers or not" (ibid., 201).

Promoted within the framework of the anthropic principle is also the idea that the fundamental constants have the values they do because they fit the explanation of the emergence of intelligent life in the universe exceedingly well. However it is known, in some constructions of the modern theories of the universe, the theoretical possibility is assumed that the constants may change over long time periods (one of these possibly changing world constants is the *alpha*, the constant of the thin structure responsible for the interaction of light with substance). Should these suppositions be confirmed, the thesis about the constants being geared toward the emergence of an observer would naturally collapse. However, even should no such confirmation come, the science of physics continues to discover ever more fundamental particles and physical principles that have ever less relation to intelligence. The gluons, gravitons, quarks, virtual particles of the vacuum, dark matter, et al., which have "no idea themselves" what they will turn into, have no direct relation to man.

Here is where it comes to the rescue—the already mentioned theory of "delicate fine-tuning of the universe," proposed about twenty years ago by P. Davies[1] and picked up very enthusiastically in Russia. Its essence is this: yes, the observer did emerge substantially later than the universe, so he could not observe its birth and evolution, but nature itself has arranged everything so "delicately" that the observer simply have had to appear.

What are the arguments in favor of this theory? Rovinsky himself lists them in the book mentioned above. First, he suggests dispensing with the cliché that the natural processes in which man does not participate cannot proceed "purposefully"; otherwise, we would have to rely only on accidents, which can take us in the wrong direction. Second, nature is assumed not to possess infinite time for domination of chances. Third,

1 See Davies, *The Accidental Universe.*

any digression from these chance occurrences—for example, a change in one constant within the limits of 10–15%—would have prevented, say, the proton from joining with the neutron, and that would have made impossible nucleo-synthesis and the formation of composite nuclei. Instead, nature has "with great precision 'adjusted' a large number of micro-world parameters that *appear* to us to be independent, in order to make possible the existence of the evolving universe." In the final account, "the probability of each chance occurrence is very small, but their joint chance emergence is simply improbable." In order to avoid this improbability, matter, nature, or the universe took care to endow itself with *systemic character, dynamism,* and *self-organization*, and in particular, "self-organization appears as the moving force of the creation observed in our World."

In other words, inorganic matter in its substantial form (thing-in-itself) is endowed with intellectual properties on the level of human concepts. That is, the gluons that join quarks into protons and neutrons purposefully prepared these particles for their subsequent joining with electrons, which in their turn self-organized into nuclides in order to give rise to the *evolution* of the universe until it produced an observer. At this point, one finds it easier to believe in God with His ability to put the world together in six days than in thinking elementary particles. One also has to admit that it is this kind of logic that was characteristic of the empirio-criticists of the late 19th century, and it is characteristic to this day of some reductionist physicists who maintain that not all of matter thinks, though photons do. (The latter will be discussed in the section on thought and consciousness.)

Let us assume that I agree with this absurd theory: matter self-organized, continued to evolve, and finally gave rise to man. Whatever for? Let me remind you that our sun must eventually cool down in some way or another (no one argues against that); the Earth then turns into a lifeless cosmic object, and mankind naturally disappears. So where is the "delicate fine-tuning" here? And what good is this purposefulness of the universe if it gives birth to the observer and then destroys him?[1]

1 For more detail about the proponents and opponents of the anthropic principle, see Barrow, *The World Within the World*, 352–73. I want to note especially that the most active opponent of God and the anthropic principle is Steven Weinberg, who utterly demolished all this "mystical yada-yada" See Weinberg, "A Designer Universe?", *Skeptical Inquirer* (Sept. 2001). Among the contemporary Russian scientists known to me, the academicians Vitalyi L. Ginzburg and Yevgenyi L. Feinberg hold to similar positions and speak out forcefully against obscuritanism in science.

Never mind man. What about the universe itself, threatened by the heat death? The majority of astrophysicists continue to write and talk about it, and the second law of thermodynamics compels the universe to that end. The "fine-tuners" are silent on this matter. The anthropists, however, claim that the second law simply does not exist. Now we have arrived at a very important topic: the effects of the second law of thermodynamics.

8

The Second Law of Thermodynamics,[1] or The Law of Entropy

Physicists have formulated a number of postulates, or fundamental laws that extend over the entire universe. Held to be first among them is the law of conservation energy, which in its short form appears to be very simple: energy is conserved. That is, energy is conserved—remains constant—within an isolated or closed system (the universe) that cannot possibly be influenced from the outside by either heat or work.

More important in this research is the second law of thermodynamics (the law of entropy), discovered by Sadi Carnot and interpreted mathematically by Rudolph Clausius, who introduced the word *entropy*. (Major contributions to this law were also made by William Thomson [Lord Kelvin] and later by Ludwig Boltzmann.[2]) One of the law's formulations runs as follows: "Natural processes are accompanied by an increase in the entropy of the universe."[3] Different dictionaries and encyclopedias offer different definitions of entropy, but their essence is always the same: "Entropy in thermodynamics is a parameter representing the state of disorder of a system at the atomic, ionic, or molecular level; the greater the disorder, the higher the entropy.…In a closed system undergoing

1 This law is occasionally called by different names: the second basis of thermodynamics or the second principle of thermodynamics. All these names can be regarded as synonyms.

2 The history of the emergence of the concept of entropy receives a remarkably interesting presentation in the book by I. Prigozhin and I. Stengres. See Prigozhin, Stengres, *Order Out of Chaos: A New Dialog Between Man and Nature.*

3 Atkins, *The Second Law*, 32.

change, entropy is a measure of the amount of energy unavailable for useful work."[1] Another dictionary offers this definition: "Entropy is the degradation of the matter and energy in the universe to an ultimate state of inert uniformity."[2] (There are definitions of entropy that are tied to information, but we will pass on that topic for the time being.) One should keep in mind that these definitions apply to closed or so-called adiabatic and isolated systems (where there is no heat supply or removal).

There exists a certain chain of phenomena: entropy growth leads to chaos, chaos under certain conditions leads to structure, structure leads to equilibrium (maximum entropy), and equilibrium leads to death. It is implied that in the zone of maximum entropy, a system lacks the capacity to perform work or to transmit useful energy from one place to another—in other words, to generate order. All these things are described in rather fine detail in the scientific and popular literature, including what I reference here.[3]

It is worth remembering that this law, which appears to entail the death of the universe (i.e., the end of matter), provoked intense arguments and attacks from the side of the materialists. The latter's main counterargument was Engels's negative evaluation of this postulate in his rough drafts for *The Dialectics of Nature*. In fact, Engels did not provide an unequivocal evaluation. In that draft we read:

> The question of what happens to the supposedly lost heat has peen posed, so to say, *nettement* (openly, unequivocally. —*Ed.*) only since 1867....It is not surprising that it has not been solved yet; it is possible that considerable time will elapse until we manage to obtain the solution with our modest means. But it will be solved; this is as certain as the fact that there are no miracles in nature.[4]

Be that as it may, there emerged subsequently the so-called *thermodynamic paradox in cosmology*, which amounts to a seemingly inexplicable contradiction between the first and the second laws of thermodynamics.[5] That paradox is resolved in different ways, including by asserting that "entropy characterizes only the extent of our ignorance,

1 *The Hutchinson Dictionary of Science*, 232.

2 *Webster's Seventh New Collegiate Dictionary*, 277.

3 About the just-mentioned chain, see Atkins, 180–200.

4 ME, 20: 599.

5 For more detail, see Kazyutinsky, *The Thermodynamic Paradox in Cosmology: A New View*.

and not some objective characteristics of the objects' domain."[1]

The attack on entropy started almost from the moment it was first formulated as a principle of thermodynamics. In the late 19th century, E. Haeckel wrote in his book *The World Puzzles*:

> If the teaching about entropy were correct, then the 'end' of the world implied by it should have a corresponding "beginning," a minimum of entropy, when the temperature difference between isolated parts of the universe would have been greatest. In our opinion…both views appear equally groundless. There is no beginning of the world, and neither is there an end. Just as the world is boundless, it abides in eternal motion.[2]

Entropy was interpreted in the same tone by K. E. Tziolkovsky and N. A. Umov. However, the theory of the Big Bang and experimental confirmation of the universe's expansion have refuted these scientists' views.

Still, there exists another avenue of attack against the second law of thermodynamics: since it works only in closed systems, then if we assume that the universe is not closed, the issue of its heat death is removed. The postulate is not valid for open systems.

However, the logic of entropy in closed systems causes one to doubt the legitimacy of this approach. It is a known fact that, as a result of the spontaneous entropy process in a two-body system (the transition of heat from a higher-temperature body to a lower-temperature body), the amount of the entropy of the system is greater than the sum of the two bodies' entropies prior to the start of the process. That is, the entropy of the two-body system increases. In this case, when the closed system receives heat from the outside (which instantly makes the system open), its entropy will grow to an even greater degree since a body's entropy grows when it receives heat. There is nothing mystical about this because open systems are actually closed, only in a different system configuration. This means that our "closed" universe may be open in its interaction with other universes while forming a closed system jointly with each of them—for example, the megasystem in the megauniverse.

However, the Russian theoretical physicist V. B. Gubin approaches this topic from another direction. He believes that criteria for the concepts of

1 Prosvetov, *Information and Entropy*.

2 Haeckel, *Die Welträthsel*.

Equilibrium or Equilibrium Systems do not exist, and neither do criteria of a *system's orderliness*. Therefore, the law of entropy—i.e., the second law of thermodynamics as an objective law of nature (with no observer present)—likewise does not exist.[1]

Finally, there is one more argument against the second law of thermodynamics: that it has a limited sphere of application; i.e., it is not absolute.

I have no intention of refuting all these arguments since this has already been done many times by astrophysicists and theoretical physicists; it would take several pages just to give their bibliographies. The most important thing is that they have been refuted by practical research, especially by the work done in the last two decades.

Still, I am likewise opposed psychologically to the idea of the hopelessness of human evolution and the destruction of man as a unique phenomenon of nature. There was a time when I found inspiration in Engels's famous words:

> We have the certainty that matter remains eternally the same in all its transformations, that none of its attributes can ever be lost, and, therefore, also that with the same iron necessity that it will exterminate on the earth its highest creation, the thinking mind, it must somewhere else and at another time again produce it.[2]

The theory of the Big Bang and the idea of the heat death of the universe following from the second postulate of thermodynamics seem to offer no grounds for such optimism. Is there any chance of overcoming nature?

Of course, it is a bit silly to try to solve a problem that may emerge after several dozen billion years. As they say, we should live that long. Nonetheless, many people, some scientists included, are not deterred by this consideration, and some of them manage to find a way out in a very unusual suggestions. For example, Michio Kaku, an American physicist at the City College of New York and a codeveloper of the superstrings theory, proceeds from a conception that assumes the existence of parallel universes and suggests that some remote future generation of human beings (designated in his book as a "fourth-type generation") will succeed

1 See Gubin, *Physical Models and Reality. The Problem of Conformity Between Thermodynamics and Mechanics.*

2 ME, 20: 363.

in developing technologies for creating "wormholes"—a sort of tunnel between universes—and thus find escape routes.[1] This project might appear to be supremely fantastical, but Kaku reminds his readers that in Newton's time, the current mastering of the cosmos would have seemed no less ridiculous even to Newton himself.

I am rather fonder of Barrow's variant, which also contains hints as to how "not to disappear." Barrow believes that at the start of the universe's expansion, the level of entropy must have been vanishingly low, which testifies to the very specific conditions that obtained then. But those initial conditions existed in a minute interval in all the expanse of the universe. We still do not know the total entropy for all the universe. Nonetheless, the accelerated expansion of the universe continues, and it will lead to heat death in the distant future.

Can any form of life survive this event? That would appear to require some form of thermodynamic equilibrium if such a thing is possible in principle. In practice, this means that there must emerge information processing of the corresponding type, capable of processing information throughout all of future time; or, to put it more simply, it must process an infinite amount of information in an unlimited future. This is precisely what the content would be of the ultimate anthropic principle—or, more precisely, of the ultimate anthropic conjecture. In other words, the objective is for an information mechanism to emerge or to be created that would be capable of generating entropy and ultimately all the known laws of nature, turning them into a sort of "software" that could be managed as if in a computer.[2]

The transition from entropy to information truly is a leap not only in the understanding of the laws of nature but also in managing them. This means that negentropy processes are possible in principle as a result of human activity, i.e., the conscious preservation of those conditions—not yet known—that make possible the concentration and retention of dispersed energy.

* * *

1 Kaku, *Visions*, 355.

2 Barrow, 159–60. It seems that Hawking expressed this idea very simply: "Entropy can be regarded as a measure of the disorder of a system or, equivalently, as a lack of knowledge of its precise state." Hawking, *Black Holes and Baby Universes*, 104.

Be that as it may, I have no grounds to doubt the second law of thermodynamics. Moreover, I want to advance certain ideas that follow from it and are extremely important for the subsequent chapters. Moreover, I want to repeat that this law affects not only physical phenomena but also the phenomena of organic life, including that of man. In this I am not original; very many scientists share this position.

I proceed from the idea that structurally, the universe consists of three major blocks: the inorganic world, the organic world, and the social world. All three worlds are interconnected and mutually conditioned even though the being of each realizes itself through different specific laws. *The inorganic world manifests itself through the laws of physics, the organic world through the laws of biophysics and biochemistry, and the social world through social laws.* In each of the three worlds, there are certain forces at work in accordance with the structure of their matter in the context of space–time. These forces work differently because of the difference of their being (structures of matter).

The fundamental difference is that ***in physical processes, there is no original goal*** (the reader should have noticed by now that I am opposed to the teleological conception of inorganic nature, even in the form of Chardin's teleonomy). In those processes, there is only the incessant motion of matter following the laws of force inherent to them. In this area, the law of entropy works unconditionally. Every phenomenon of being has its life span; the birth and death of atoms and molecules, for example, are clearly defined by their nature. The entire universe has its life span, too. All events and phenomena are irreversible.

The biological world starts to distinguish itself from the physical world already in the fact that it has the capacity for reproducing itself, even though within the framework of the life span programmed in its genes. That is, each biota has its average life span. Therefore, ***the law of entropy works differently in the biosphere than it does in the physical world.*** Here it has to deal with ordered structures in which biochemical processes slow down the effects of the second law of thermodynamics, or at least force it to work at a different pace or at different speeds.

This work's next goal is to attempt to examine what goes on in the organic world, which forces determine its motion, and whether this motion is purposeful in character.

CHAPTER III

THE ORIGIN OF THE ORGANIC WORLD AS A MANIFESTATION OF THE ORGANIC FORCE

> Man appeared in the universe by chance,
> but mankind must survive by regularity.
>
> *Author*

It follows from the logic of my philosophical definition of ontobia that it must manifest itself in some fashion in the organic world—a part of being that is qualitatively different from inorganic being. This world is usually described using the word *life*, which has a conceptual content in biology. The term *biology* means *science of life*, or, according to dictionaries, "the totality of sciences about living nature." In other words, it is asserted *a priori* that everything that exists in the organic world is alive. Nevertheless, it is in fact not so simple to determine where dead nature ends and living nature starts. And what exactly is life?

Having at the time no idea of all these complexities, I believed before I commenced my research that the organic world truly is a world of living organisms whose emergence and existence are due to a specific manifestation of the second law of thermodynamics, i.e., the law of entropy. It appeared to me, as it does to many, that the organic world somehow finds a way around this law, "deceives it," as it were, thanks to the "clever" organic forces that are inherent only in that world—forces that I decided to call *orgabia* (Greek for *organic force*). Thus, I believed that the objective of this chapter would be to analyze how this "deception" takes place—that is, how the laws of orgabia put the brakes on the effects of the second law of thermodynamics, or at least get around it. In the initial stage of my investigations, I expected to have no difficulty in defining the term *life*, i.e., its difference from *nonlife*. However, as I penetrated deeper into the problem, my optimism started gradually evaporating, and the conclusions I reached at the end of my research are substantially different from my preliminary hypotheses and suppositions. The starting point of my research was the general knowledge that somehow remained in my head either since my school years or gleaned from reading popular literature.

* * *

At present, the organic world is known to be a reality only on our planet, where it began with the first deposits of organic carbon about 3.5 billion years ago, i.e., approximately 1 billion years after the Earth was formed. Another 1.5–2 billion years passed before there emerged the group of organisms from which arose the single-celled eukaryotes that 700–800 million years later evolved into multicellular organisms. Then, during the Cambrian Period (some 500–550 million years ago, according to estimates), a biological Big Bang of sorts occurred, and then over a period of 50 million years, practically all the known types of vertebrates emerged. In some scientists' opinions, the Cambrian explosion took place between 543 and 510 million years ago. If so, then over a period of just 30 million years, a huge variety of multicellular animals capable of swimming, flying, or crawling emerged. These organisms received the common name of *phyla*, a group of living beings from which plants and animals originated. And one of the animal species managed in just 3–5 million years to evolve into man.

I deemed this information sufficient until I addressed specialized scientific literature; this chapter is the product of my readings.

1

The Causes of the Emergence of Life on Earth

Creationism

There exist several differing models, or conceptions, of the origin of life on earth. The single most popular among the masses is the one described in the Bible, creationism, according to which the world and all its living things, including man, were created by the Heavenly Father either in six days or in just one (choose whichever variant you like, since both are presented in the Bible).[1] It is not only the masses of believers who adhere to the Biblical version; it has many champions among the antievolutionary "scientists." These people do not present a united group; rather, they are split into various schools that fight among themselves more vigorously at times than they fight together against the evolutionists. As a curiosity, I will mention the flat-earthers. However, there are also the schools of progressive creationism, evolutionary creationism, etc. In the opinion of Mark Isaak, a specialist on this topic, the single most influential one is the school of the young earth creationists, which has its own Institute for Creation Research and several corresponding societies. However, it is the school of intelligent design creationism that is believed to be the most advanced one in the scientific sense; it uses scientific terminology and methodology to attack the weaker or less-investigated aspects of the evolutionary theory. The main idea of all attacks by this school's representatives is their claim "that all beliefs about evolution equate to philosophical materialism."[2] In principle, this accusation alone suffices for many to reject science and make do with just the Bible.

In my opinion, it is perfectly useless to enter into polemics with proponents of this school, which would be like scientifically refuting children's fairy tales. To my surprise, though, I discovered that in the West, unlike in today's Russia, evolutionists continue to unmask the works of creationists, especially of those who masquerade as science.[3] On the whole, however, the scientific community does not take creationists seriously because they have practically no influence on the development of the science of evolution.

Neovitalism

The neovitalism theory is much more interesting than the preceding one. Although it does have some particulars in common with creationism, it has paradigms of its own. Its origin dates back to Aristotle (more about

1 See Genesis 1, 1:31; 2, 4:25.

2 Isaak, "What is Creationism?" [Article: May 30, 2000]. – www.talkorigins.org.

3 See, for example, the powerful anticreationist website: www.talkorigins.org.

him later). It evolved to some degree in the Middle Ages (for example, in the works of Galen the physician and, of course, Thomas Aquinas), but it finally acquired scientific form through the efforts of the chemist and physician Georg Ernst Stahl (1660–1734); his disciple, the well-known embryologist Caspar Friedrich Wolff (1735–1794) (not to be confused with the philosopher Christian Wolf); and the physician Johann Christian Reil (1759–1813), who preached vitalist ideas about the spirituality of all living things. The young Friedrich Schelling, though, in *On the World Soul*, subjected such views to caustic criticism, having in mind Reil first of all. He wrote, "It is the utmost nonsense in philosophy to assert that life is a *property* of matter, contraposing to the universal law of inertia that which we know after all as an exception to this rule—animate matter."[1] Having described rather convincingly the difficulties involved in defining life, he did himself ultimately tie the "beginning" of life to the world soul, sliding thus into classical idealism. Consequently, his criticism turned out to be better than his conclusions.

In the 19th century, the best-known vitalist was the chemist Justus von Liebig (1803–1873), who argued in 1844 that besides heat, chemical affinity, and the formative forces of cohesion and crystallization, "in living bodies there is added yet a fourth cause which dominates the force of cohesion and combines the elements in new forms so that they gain new qualities—forms and qualities which do not appear except in the organism."[2] This cause, or rather "formative principle," is none other than the "vital force" that is the core of the vitalism theory.

This theory has been criticized by many scientists, especially the Marxists of the Soviet Union. In my opinion, there was never any need to do this since in the 19th century vitalism, especially in Liebig's interpretation, was a counterbalance of sorts to the divine origins of various theories of life; i.e., it was clearly antireligious in character. Moreover, if we read Liebig's reasoning carefully, we will discover that his theory contains an enormous meaning that has not been refuted by the subsequent development of science. He writes, "This vital force, regarded as a property of matter, reveals itself, however…only under suitable conditions, which always existed in countless points of the endless world space, but in different periods of time they had to change places rather often."[3] No mysticism here whatsoever! No vital force exists outside

1 Schelling, 122.
2 Quoted in Sheldrake, *A New Science of Life*, 47.
3 Quoted in ME, 20: 613.

of matter; it is a property of matter—as Liebig himself subsequently specifies, specifically the matter of the organic world. Such reasoning was not only antireligious in inclination; they were clearly directed against the mechanistic theories that dominated in the first half of the 19th century.

Unlike Liebig's vitalism, the neovitalist ideas that made a splash at the start and in the first half of the 20th century had an obviously reactionary, antiscientific character. In them were now interlaced the mysticism, elusive essences, and other fantasies that abound, for example, in the works of Henri Bergson (with his "élan vital"), H. F. Osborn (aristogenesis—"the origin of the very best," a variety of neo-Lamarckism), L. S. Berg (nomogenesis), the German embryologist Hans Driesch (entelechy), et al.[1]

It should be borne in mind that vitalism and neovitalism opposed the mechanistic approach to the problems posed by the phenomenon of life, which, in their opinion, was shared by nearly all materialists. It is curious that Russian scientists were major and most consistent opponents of the neovitalists in the early 20th century, in particular K. A. Timiryazev, who wrote:

> Realizing perfectly the reactionary meaning of their teaching, which is a brake on science in the future just as it was in the past, the contemporary vitalists desire nonetheless to continue being counted as proponents of progress.…The hypothesis of vitalism never was, and cannot be in essence a *working hypothesis*. When setting out to explain some phenomenon, one cannot proceed from the notion that it is inexplicable. A vitalist as a *vitalist* is doomed to barrenness.[2]

Timiryazev had it exactly right: to this day, there exist "scientists" whose only occupation is to keep explaining to the commoners the "simple truth" that the world is inexplicable.

Nonetheless, even though agreeing with Timiryazev's above accusations directed at the neovitalists, I would like to present here, even if only schematically, the view held by Hans Driesch—for the simple reason that he uses the term *entelechy,* to which I am most partial.

Hans Driesch (1867–1941), proceeding from the discoveries he made in the area of embryonic regularities (the development of a whole organism

1 For more detail, see Hollitscher, 359–64.

2 Quoted in Hollitscher, 363.

from a part of its embryo), formulated the law according to which the developmental process of each part of the embryo is defined by its location in the whole organism and at the same time by the factor of entelechy. The reader has already encountered this term in the philosophical part of this book, in the sections dealing with Aristotle and Leibniz; the former used *entelechy* to mean *realized motion* and the latter to mean *moving force*. Driesch follows Leibniz in bestowing on entelechy the qualities of force, but he does so less directly than his predecessors. He believed, for example that the facts of regulation, regeneration, and reproduction appear to indicate that there is something in a living organism that keeps it whole even when several physical parts are removed; this "something" affects the physical system even though it is not part of it. It is this phenomenon that Driesch called entelechy. He postulated that entelechy organizes and controls physico-chemical processes through morphogenesis; the genes are responsible for the material means of morphogenesis—i.e., the regulation of the chemical substance—but the process of regulation itself is performed by the entelechy. In exactly the same fashion, entelechy organizes the activity of the brain, etc. It was not by chance that Driesch chose a Greek word to express *living force*. In Greek, *entelechy* literally means purposefulness or, in free translation, purposefully acting living force. This term enables Driesch to explain that whenever some normal mode of an organism's development is violated, through entelechy's guidance it will attain its goal—i.e., the formation of the organism—in one way or another. The organism's behavior and development are actually controlled by a whole hierarchy of entelechies, which are all subordinate to the particular general entelechy of the whole organism.

The question naturally arises, where is this entelechy hidden? In Rupert Sheldrake's interpretation, entelechy manifests itself as an "intensive multiplicity," a spaceless causal factor that nonetheless functions in space. In my opinion, the essence of Driesch's entelechy is formulated more precisely in the Soviet *Philosophical Dictionary*; namely, entelechy is "the intensive (spatial) variety that performs the selection from the number of all potential avenues of development."[1] Sheldrake emphasizes that this factor is natural (as opposed to metaphysical) and functions in physico-chemical processes. It is not a form of energy, and its effect does not contradict the first law of thermodynamics or the law of conservation of energy. So how does it function?

Even though Driesch wrote his work in a time of strict physical

1 *Philosophical Encyclopedic Dictionary*, 177.

determinism, he nonetheless allowed even then for deviation from the classics in the spirit of the subsequently discovered Heisenberg's uncertainty principle (1927). He believed that, at least in a living organism, microphysical processes are determined not entirely by physical causes, although, on average, the physico-chemical changes are governed by the laws of statistics. He suggested that entelechy functions in microphysical processes in a discontinuous fashion; i.e., it alternately holds back and releases these processes in accordance with the requirements of its purpose.

Still, the nature of entelechy remained unclear, and the search for its explanation started to address certain theories of physics and parapsychology. Sheldrake writes that, according to them, "a modern vitalist theory could be based on the hypothesis that entelechy, to use Driesch's terminology, orders physico-chemical systems by influencing physically indeterminate events within the statistical limits set by energetic causation. To do so, it must itself be patterned spatial-temporally."[1]

Nonetheless, the problem of its origin remains. This origin turns out to be *memory*, which is viewed mystically in the spirit of the French intuitionist Henri Bergson and the equally mystical psychologists H. A. Buchtel, G. Berlucchi, and H. A. Bursen. Sheldrake himself is quite fond of their ideas. He writes approvingly, "If memories are not stored physically within the brain, but somehow involve a direct action across time, then they need not be confined to individual brains; they could pass from person to person, or a sort of 'pooled' memory could be inherited from countless individuals in the past" (ibid.). This sort of explanation for the functioning of entelechy is shared, Sheldrake assures us, by the physicists and zoologists he mentions.

As a result, this type of vitalist theory amounts to the assertion that the genetic heredity in DNA determines all the possible proteins that an organism is capable of creating. But the organization of the cells, tissues, and organs and the coordination of the organism's development as a whole are determined by entelechy. The latter is nonmaterial and is inherited from the memory of the species; it is not a variety of matter or energy even though it does influence the physico-chemical systems of the organism that are controlled by them. This effect is possible for the reason that entelechy manifests itself as a multitude of hidden variables that influence probabilistic processes. In Sheldrake's opinion, this theory is by no means devoid of content, and it probably can be tested. Still, it is fundamentally

1 Sheldrake, 51.

unsatisfactory simply because it is vitalistic. Entelechy by definition is not a physical phenomenon even though it can hypothetically influence material systems, representing a multitude of variables that are, from the perspective of quantum theory, "hidden" in essences. This resembles the effects of improbabilities on improbability. That is, the physical world and the nonphysical entelechy can never be explained or understood in each other's terms; such is the sentence passed by Sheldrake on entelechy.

This sentence is unjust if only because two qualitatively different worlds (inorganic and organic) are in principle not explicable in each other's terms. Each requires its own terms since they work following different regularities, at different speeds, and, therefore, in a different spatial-temporal coordinate system. The problem is precisely that often we see attempts to use the laws of, say, quantum physics to explain the organic or even the social world. Equally counterproductive is the opposite approach, when the laws of society or psychology are used to explain the inorganic world.

For all the rejection of neovitalism, Driesch's entelechy does contain a very rational kernel; the important thing is to plant it in favorable soil, i.e., rethink entelechy in the context of biological force, inseparably from its material bosom. This will be done in the appropriate section; for now, let us address another idea that is favored by a certain circle of scientists.

Panspermia

In one of his works, Hermann von Helmholtz wrote:

> It appears to me to be a fully correct scientific procedure, if all our attempts fail to cause the production of organisms from non-living matter, to raise the question whether life has ever arisen, whether it is not just as old as matter itself, and whether seeds have not been carried from one planet to another and have developed everywhere where they have fallen on fertile soil.[1]

Somewhat earlier and in more detail, this topic was developed by

1 Quoted in ME, 20: 612.

Justus von Liebig in his *Familiar Letters on Chemistry*. Still earlier, in 1821, the Frenchman Sales-Guyon de Montlivault described how seeds were carried from the moon and were the source of early life on Earth. In the 1860s, the German H. E. Richter suggested the possibility that bacteria carried by meteorites from a different part of the universe gradually spread over the Earth. William Thomson also supported the idea of panspermia.

Engels seems to have been the first person to object to such ideas. He believed that protein (at that time held to be a sort of original clot of life), "the most unstable carbon compound known to us," would not survive the blazingly hot atmospheres of celestial bodies, especially nebulae.[1] Other scientists later responded in approximately the same vein, asserting that meteorites are not a very suitable means for transporting living matter because interstellar space is cold enough (-220° C) to destroy most microbes.

This argument was challenged in 1905 by the Swedish chemist Svante Arrhenius (1859–1927), who advanced a complex theory known as *panspermia*. He asserted that the cosmic travelers were actually bacterial spores, which could survive for long periods of time (for example, the bacterial spores discovered fairly recently in Carlsbad, New Mexico, in the United States are 250 million years old). Instead of traveling on meteorites that burned when they enter the atmosphere, the spores could travel across interstellar space independently, propelled by the physical pressure of starlight.

The main problem with this theory is that ultraviolet light would have been capable of destroying all spores long before they reached our planet's atmosphere; this was pointed out, incidentally, by K. A. Timiryazev in his time. However, there is a modification of this theory. The well-known scientist Francis Crick (who shared the 1962 Nobel Prize for the discovery of the structure of DNA with J. Watson and M. Wilkins) wrote an article with the biochemist Leslie Orgel titled "Directed Panspermia." The authors suggested that microorganisms, due to their unique tenacity, could be "packaged" and shipped on spacecraft with the intention of "infecting" distant planets. This, apparently, is the job performed by the various UFOs that keep harassing considerable numbers of observers on Earth, who themselves likely originated from cosmic spores or perhaps from bacteria. The only missing link in Crick's hypothesis is the *motive* behind such shipments.

It is quite admissible in principle that quite a few different components

1 ME, ibid., 616.

of prolife exist in the vast reaches of the universe. The research problem is in determining how simple the organic substance turns into a more complex organic substance, then into protein, then into genetic material, then into cells, and so on. The problem lies in identifying the chemical evolution that took place on Earth during its first billion years. Unfortunately, there is as yet insufficient information about that time period. Perhaps answers will come from other parts of the Solar System (the moon, the planets, the comets or asteroids). Still, some answers exist already.

Even though we will later address different views on the origin of life on Earth more than once, I want to present here a conception that, in my opinion, reflects natural phenomena scientifically.

The Conception of the Self-Generation of Life

Historians of science describe the self-generation of life in approximately the same fashion in biology textbooks and reference books. They only add new information to it. For centuries, leading thinkers spoke and wrote of the self-generation of life. Aristotle, for example, believed that insects and frogs originated from wet soil. This sort of perspective dominated until as late as 1668, when the Italian physician Francesco Redi discovered, as a result of a scientific experiment, that larvae originate not from rotting meat (i.e., not from living nature) but from eggs laid by flies. In the 18th century, microorganisms were discovered, and in the 19th century, Louis Pasteur in France and the physicist John Tyndall (1820–1893) in England proved with experiments that all living things originate from other living things, thus proving the theory of biogenesis. It is necessary to note that Pasteur drew the conclusion that not only spontaneous generation of currently existing microorganisms is impossible, but spontaneous generation of living things is also impossible in principle.

Engels's reaction to this is curious and noteworthy: "Pasteur's attempts in this direction are useless; for those who believe in this possibility [of spontaneous generation] he will never be able to prove their impossibility by these experiments alone."[1] Engels reacted in the same vein to Helmholtz's skepticism in connection with unsuccessful attempts to

1 ME, 20: 612.

create an organism from lifeless substance: "If success is ever attained in preparing protein bodies chemically, they will undoubtedly exhibit the phenomena of life and carry out metabolism, however weak and short-lived they may be" (ibid., 616). Engels was one of the first to believe in the possibility of abiogenesis, even though he thought that it would be accomplished experimentally no sooner than in a hundred years. He was off by 25, a successful experiment having taken place in 1953. Thus the idea of spontaneous generation of life surfaced in the 20th century as the theory of abiogenesis.

I will not bother here with a detailed description of the Earth's physical state in the first billion years of its existence: I will note only that the atmosphere in that era was much different from the one we have today. The most important difference is that some 3.5 billion years ago, the atmosphere contained a much higher proportion of hydrogen, and, most significantly, there was no oxygen in its pure form. In that atmosphere, nitrogen was combined with hydrogen in the form of ammonia (NH_3), oxygen was possibly already combined with hydrogen in the form of water vapor (H_2O), and carbon originally existed in combination with hydrogen as methane (CH_4). From the perspective of life's origin, it was important that free oxygen was absent (or else it would have burned the primary living structures), while the seas prior to life's emergence contained large quantities of methane. In the opinion of the proponents of abiogenesis, these conditions were quite sufficient for the conception of the primary vital structures.

At first, the Soviet scientist A. I. Oparin in 1924, then independently of him the Englishman John B. Haldane in 1928, and finally John D. Bernal, another outstanding English scientist, in 1947 proved theoretically the possibility of living things originating from nonliving ones. Bernal advanced the theory of *biopoesis*, a process that is divided into three stages: 1) the abiogenic emergence of biological monomers, 2) the formation of biological polymers, and 3) the formation of membrane structures and primary organisms (probionts).[1]

In 1951, the American scientist Harold S. Urey, winner of the Nobel Prize in chemistry in 1934 (for his discovery of deuterium), revisited Oparin's important idea that there could be no oxygen in the early Earth's primitive atmosphere, which should have facilitated the early chemical reactions that led to the conception of life. His disciple Stanley Miller proved this theory experimentally in 1953 by creating

1 For more detail, see Bernal, *The Problem of Stages in Biopoesis*, 24–39.

an imitation of the conditions that existed on Earth 4 billion years ago. His work proved that when electric discharges pass through a mixture of methane, molecular hydrogen, ammonia, and water vapor (a model of Earth's primary atmosphere), glycine, alanine, and other amino acids emerge, as well as a number of organic compounds. In the subsequent 30 years, Miller's experiment was repeated many times by, among others, the Soviet scientists T. E. Pavlovskaya and A. G. Pasynsky, as well as by Melvin Calvin and Sydney Fox. It should be stressed that they proved only the possibility of life's emergence from inanimate nature. This possibility was realized through the rarest of coincidences, for, as Teilhard de Chardin wrote correctly, "all organisms existing at present are descended from a single ancestral group (the case of the crystal falling into a supersaturated medium)."[1] This suggests that there must have been an improbable combination of coincidences that enabled a certain group of atoms to combine in molecules, then in macromolecules, then in cells, and so on in order to ultimately produce life. (We shall revisit the topic of "chance" later.) The force of substance (atoms) was transformed through many different chemical reactions into force of life, manifesting itself through proteins and nucleic acids. Let us examine some of the processes in greater detail.

Formally, all the chemical elements of a living organism are present both in space and on Earth. But only in the latter case, as a result of chemical transformations starting with, say, aldehyde are the end products protein (ferment), phospholipids (membrane), and DNA and RNA. For the necessary reactions to take place, liquid water is needed—something that is absent in space (even though water is present there in large quantities in the form of the three-atom molecule). Liquid water is needed for polycondensation on the lower stages of chemical reactions. But that is not all: there remains the question of *what* it is that ultimately turns these ferments, membranes, and DNA into a working mechanism. The American scientist Armand Delsemme believes that this question is answered by the conception of "the dissipative structure" advanced by Belgian scientist Ilya Prigozhin (Nobel Prize winner in chemistry in 1977).[2] Its essence is this: the dissipative structure is a chemical system organized outside thermodynamic development. It seemingly rejects the second law of thermodynamics, which asserts that entropy (which is a measure of unused energy—here is one more definition) cannot decrease

1 Teilhard de Chardin, 55.
2 See Delsemme, 146–9.

in closed systems. However, the dissipative structure is an open system that is constantly intersected by streams of matter and energy. (In fact, there is not a single structure in the universe that is not intersected by matter and/or energy.) This allows entropy to decrease, and the system becomes organized (structured).

The essence of Prigozhin's idea is that in dissipative structures, processes follow the principles of nonlinear bonds that maintain equilibrium. Such nonlinear bonds, or systems, can give rise to a series of forks that branch out into a more complex internal organization and, as a consequence, decrease entropy.

Nonlinear systems have feedback circuits. We are familiar, for example, with the circuit that controls a central heating system: a change in temperature changes the quantity of heat produced. This is a feedback circuit, for the change in action is the feedback that modifies its cause. In chemical systems, when the feedback circuit is clearly nonlinear—as in autocatalysis—the activation or slowing-down of reactions transforms the system into a hierarchical, ever more complex state.

This idea was expressed in its application to the origin of life by the German chemist Manfred Eigen, winner of the Nobel Prize in chemistry in 1967. He proceeded from Darwin's idea about the survival of the fittest applied to the level of prebiological chemical reactions. In this case, it means the survival of the molecules that proved to be the best fitted for reproduction on a matrix—possibly at first a matrix of a mineral kind. Eventually this matrix, progressing toward an organic molecule, could produce a ladder of ever-greater complexity.

Debated today is the topic of *what* these first molecules capable of reproduction were. The French biochemist André Brack believes that they were short strings of amino acids that managed to form peptides (a peptide is a very short protein consisting of a small number of amino acids) prior to the emergence of RNA. The discovery of the fact that RNA provokes autocatalysis led to the suggestion that "the RNA world" emerged earlier than "the DNA world." Autocatalysis means that RNA is capable of changing itself spontaneously. The Canadian Sidney Altman and the American Thomas R. Cech discovered that ribozymes (**ribo**nucleic acid en**zyme**) are capable of autocatalysis. For this discovery, they were awarded the Nobel Prize in 1989. This avenue of research was pursued further. Several years later, the Americans Deborah L. Robertson and Harold F. Joyce synthesized fragments of RNA and discovered that RNA emits organic material into its environment, which produces copies of itself. A while later, the copies start evolving and developing new, unexpected chemical properties. The researchers believe in this connection that the first molecules capable of reproducing themselves and maintaining catalysis were apparently nucleic acids.[1]

The conception of "the RNA world" has been described in rather fine detail and developed further in some parts by the Russian biologist academician A. S. Spirin, who traces the evolution of RNA all the way to the cell, following this scheme: abiogenic ribonucleotides–oligoribonucleotides–polyribonucleotides–catalytic activities (ribosomes) –self-processing and self-replicating RNA molecules–protein synthesis–coacervates–cells.[2] This version also appears to be favored by the British chemist L. Orgel.

However, the Belgian Christian de Duve, winner of the Nobel Prize in medicine in 1974 for his discovery of the lysosome (the digestive organoid in the cell), believed that the RNA catalysis is too limited and progresses too slowly to explain the rivalry, holding with Manfred Eigen's interpretation. The main problem for primitive RNA is the requirement that they attach the phosphate to the purine or the pyrimidine prior to polymerizing the nuclides so that they obtain an RNA string. Just as Brack does, de Duve believes that the course of theoretical reasoning and observation leads to the conclusion that proteins emerged as small polypeptides only 10, or at most 12, amino acids long and were assembled one after another in order to function, no matter whether through structure or catalysis. De Duve's central and original idea concerns the role of the sulfur–ether link (sometimes called the thioester link: tio = sulfur, ester = ether) on account of its high energy level and its water-oxidizing properties that are sufficient to dissolve the calcium phosphate that exists in rocks. Thus, "the sulfur-ether world" may be the missing link still hidden "at the dawn of time."

A different perspective on the missing link is held by the British biochemist A. G. Cairns-Smith of the University of Glasgow. In his opinion, evolution did not always depend, as is often claimed, on the close bonds of nucleic acids to proteins. He believes that the first organisms belonged to a class of colloidal mineral crystals that constantly formed in open systems, already following the laws of natural selection and evolution. Some of these primitive evolving organisms were already able to start creating organic molecules with the help of photosynthesis. Genetic control was eventually mastered only by amino acids. Life could

1 See "Once Upon 3.8 Billion," www.geocities.com.
2 Spirin, *The Biosynthesis of Proteins, the World of RNA and the Origin of Life*.

have started in claylike minerals,[1] and phosphates could have facilitated the transition to organic molecules.

I want to draw your attention to the idea of Clay, the importance of which has been pointed out by J. Bernal. Clay accumulates energy, transforms it, and releases it in the form of chemical energy, which can act in chemical reactions. Clay can also act as a buffer and even function as a matrix. Cairns-Smith experimented with microscopic crystals of metals of different types combined with clay and discovered that they replicate in the process of growth. He suggested that this might have something to do with the primary matrix in which certain molecules could reproduce themselves. As a result, he arrived at the conclusion that clay could have been the primary matrix for self-reproducing systems.[2] Some researchers believe, though, that as a result of mutations and selections of these simple and molecular systems, clay could have been eventually replaced in the capacity of matrix by other molecules.

Other scenarios exist that explain how simple molecules can produce large quantities of molecules. The above-mentioned Sydney Fox and his colleagues observed the spontaneous emergence of molecular borders between protein–nuclear systems. They heated amino acids in dry conditions and determined that in the course of this process, links of long polypeptides emerged. These polypeptides were then placed in a hot water solution, where they joined together in small spheres as they cooled down. Inside these spherical membranes, or microspheres, certain substances emerged. In addition, the lipids situated on the surface of the solution penetrated into membranes, thus creating lipoprotein membranes.

Some scientists suggest that another missing link in the prebacterial period can be identified as molecules of polycyclic aromatic hydrocarbons (PAHs), which are quite widespread in interstellar space. They account for up to one-half of the organic substances present in carbonate chondrites, the most common type of meteorites that have fallen onto the Earth along with other kinds of cosmic dust since the moment it formed. In the early 1980s, the chemist Everett Shock showed that PAHs can enter into

1 Recall the Bible: there is a reason why clay there means both the substance of earth and human flesh.

2 One Russian newspaper (*Izvestiya*, October 2003) in this connection burst out with an article in which it was announced that “the Biblical variant” of the emergence of life had been “proven scientifically,” meaning apparently that God fashioned Adam and Lilith (Adam’s first wife, according to legend and to the Talmud) out of clay. Later God seems to have changed his mind and manufactured Adam’s second wife, Eve, out of Adam’s rib. And all this took him just one day.

chemical reactions, forming amino acids. After a while, it was discovered that, under the influence of ultraviolet radiation, they can transform into spirits and quinones. And although PAHs are not found in living cells, these organic substances can easily transform into others without which life is not possible. At least the research of the chemist Richard N. Zare of Stanford University showed that they were contained in the original material from which the Solar System, including our planet, was formed.[1]

Another view exists, known as the *theory of local emergence of life* on Earth. This theory was advanced, in particular, by the Soviet scientist L. M. Mukhin, who believed that life could emerge in the area of underwater volcanoes, where simple combinations of molecules could take place that are necessary for the synthesis of organic substances, for example, hydrogen cyanide and formaldehyde. The mechanism of these substances' reactions is described in detail in the works of Oro and Cyril Ponnamperuma, to which Mukhin refers. Mukhin himself describes other reactions involved in the formation of complex molecules that do not require the presence of a methane–ammonia atmosphere.[2]

This theory has many adherents who believe that on the Earth's surface (in lagoons, water reservoirs, or rocks), the emerging organisms had little chance of survival, primarily on account of constant bombardment from outer space.[3] Only recently, William Martin of Heinrich Heine University in Düsseldorf and Michael Russell of the University of Scotland (Glasgow) advanced another version of the "underwater" theory, according to which the first living organisms on Earth could have appeared inside rocks that lined the bottom of the ocean. Over 4 billion years ago, tiny cavities inside minerals could have played the role of cells. The key part of this theory is deposits of iron sulfide (FeS). In hot springs on the sea bottom, this compound forms honeycombs with cells several hundredths of a millimeter wide. Martin and Russell believe that these cells are the ideal place for the emergence of life. Compared to other hypotheses of life's emergence on Earth, this theory is unique in that it assumes that the emergence of the cell preceded the emergence of proteins and self-replicating molecules. Hot water flow delivers to these cells ions of ammonia (NH_4) and carbon monoxide (CO), and the iron sulfide plays the role of one of the catalysts of the synthesis of organic substances from

1 See www.grani.ru for 27 August 2002.

2 See Shklovsky, 149.

3 Paul Davies holds a similar viewpoint. See Davies, *The Fifth Miracle: The Search for the Origin of Life*, chapter 7.

inorganic ones. Simple compounds became concentrated inside the iron sulfide cells, which could have led to the emergence of complex molecules: proteins and nucleic acids.

In scientific journals, there appear almost monthly reports of discoveries of various missing links in the long chain of the organic world's evolutionary development, especially on the level of viruses, bacteria, and cells. Some of these discoveries are confirmed by subsequent research; some are not. However, it is important in all this that the blank spots of the evolutionary process are filled in by scientific facts and not by conjectures of mystical content. In the area of applied organics, there also exist arguments about the origins of life, but these are mostly concerned with particular problems of evolution. I have not found any that cast doubt on evolution itself. There are quite a few doubters around, however, certainly among theoreticians in the area of organics. Let us take a look at some of the conceptions that are being discussed in the scientific literature.

2

Biogenesis and Entropy

In the preceding chapter, where the discussion was about the universe and the Big Bang, we addressed the second law of thermodynamics many times. This law, however, occupies an equally prominent place among the various theories of life's emergence on Earth. It suffices to remember the famous pronouncement L. Boltzmann made in 1886: "Thus, the general struggle for life is neither a fight for basic material…nor for energy… but for entropy becoming available by the transition from the hot sun to the cold earth."[1] This idea was researched by such major scientists as H. Helmholtz, A. Eddington, K. A. Timiryazev, E. S. Bauer, and many others who have been mentioned already or will be mentioned later. However, the interpretation of this idea among biologists is amazingly diverse, from reducing evolution to the second law to ignoring the law completely. In between these extremes are intermediate approaches based

1 Quoted in Davies, 26.

on the assertion that the effect of this law in the organic world is limited. Since the second law of thermodynamics, or the law of entropy, is very important in the context of this research, let us attempt to sort out the logic of the authors of each of these approaches.

Evolution = Entropy

The concept of the universalization of the second law of thermodynamics is represented here by the biologists Daniel R. Brooks of Canada and E. O. Wiley of the United States, who assert already in the title of their book *Evolution as Entropy* that "biological evolution is an entropic process."[1] In the foreword, having specified that their analysis is built based on the conception of entropy and information, the authors challenge many biologists and schools of thought as they advance three theses. I quote: "(1) they [entropy and information—*A. B.*] provide a connection between biological processes and natural physical laws showing that biological systems are not governed by special laws of biology, (2) they provide a means for demonstrating the plausibility of nonrandom, internally driven evolutionary change, and (3) they provide the conceptual link for the auxiliary hypotheses" (ibid.). The authors claim, in fact, that in biology there are no special laws and that the evolutionary process is not random. In order to prove this, they postulate two points: living systems must grow ever more complex, and they must be self-organizing.[2] Importantly, this process takes place not "at the expense of" but "as a result" of entropy growth (ibid., xii). Let us examine the logic of their reasoning.

The authors remind their readers that in the microworld, time is independent and reversible while in the macroworld, it is dependent and irreversible. Therefore, one of the attributes of matter manifests itself cardinally differently in these two worlds. Moreover, the irreversibility of time in the macroworld confers historicity on the second law of thermodynamics since history is likewise irreversible. The authors point out that a similar idea was advanced long before them—for example, by A. J. Lotka in 1924, who treated evolution and the second

1 Brooks, Wiley, *Evolution as Entropy*, x.

2 Evidently, these "two points" are nothing other than Lamarck's principle of gradation, according to which the organic world's development is headed in the direction of gradually increasing perfection and complexity of organisms.

law of thermodynamics (i.e., the law of entropy growth) as practically synonymous since they both assert the irreversibility of history (ibid., 5).

Here I have to repeat certain statements about entropy made in the previous chapter. The law postulates that every closed system moves in the direction of maximization of entropy until it reaches a state of equilibrium, which means death. However, since different systems can function in qualitatively different speed regimes, there appears a sort of asymmetry between them, a difference of speeds, temperatures, etc. The authors need to state this obvious fact in order to emphasize that "systems that are not in equilibrium may be moving toward equilibrium, or they may maintain themselves some distance from equilibrium by processing free energy" (ibid., 4–5), i.e., by decreasing entropy. "'The distance' from equilibrium is manifestation of the order and organization of a system" (ibid., 5).

Brooks and Wiley point out the apparent contradiction between the second law and evolution, meaning that directed change in the universe must lead to entropy growth—i.e., to disorder—while evolution leads to entropy decrease—i.e., to greater order. They quote Erwin Schrödinger, who explained this contradiction back in 1945 by the fact that the very existence of living systems depends on increasing the entropy of "their local surroundings." Thus, equilibrium could work out; the decreasing entropy of life was compensated for by the growing entropy of the universe as a whole. Therefore, the second law is not violated but merely circumvented in some localized areas at the expense of global entropy growth (ibid.).

This course of reasoning appears to me unjustified if only because the "balancing sides" are too inadequate to each other. The organic world is such a tiny quantity in the universe that the latter simply "does not notice it" (*almost* does not notice, to be precise). Most likely, this mutual bond is built in some other way.

The authors emphasize that many researchers connect the second law of thermodynamics to different attributes of organisms (for example, genes, cytoplasm, etc.) in order to find the dividing line between animate and inanimate nature. They also claim "evolution is an entropic phenomenon" (ibid.).

It is difficult to object to this thesis in principle, since not only evolution but absolutely everything that exists in the universe is subject to the second law of thermodynamics and is thus an entropic phenomenon. The problem is in figuring out how different kinds of being react to this physical law—in other words, which laws or regularities (if any) are their response to the second law of thermodynamics.

Brooks and Wiley point out, for example, that the living world is not chaotic; it is ordered, organized, and predictable (ibid., 34). Let us just take this note into consideration now. The authors suggest that the order manifests itself in the fact that, first, the living world consists of integrated working systems and subsystems; and second, these systems relate to each other in a hierarchical sequence. Also, "the orderliness and the variability of the natural world have their roots in reproduction, development and death. All three have one feature in common; they are irreversible processes" (ibid., 35). This is correct, but then almost all evolutionists wrote about these things while managing without entropy.

So what follows? "Living systems exchange matter and energy with their environment while maintaining their individuality" (ibid., 36). Well, naturally, they lose it only in death. Living organisms are open systems, which enables them to absorb energy. But this does not explain the structure of the living organism and the mechanism of its functioning that are determined by the organism's internal properties. At the expense of what does it happen? "Individual organisms are initially bounded, or partially closed, from the standpoint of 'epigenetic [secondary, accessory—*A. B.*] information,' that is, the sum total of genetic and cytoplasmic information specifying the structure of these organisms" (ibid., 38). In other words, this "epigenetic information" that did not emerge from without represents an internal limitation, or original condition, which makes the organism partially closed.

This is not exactly true. At a certain advanced stage, it may indeed be the case, but there surely was a period when the information carriers themselves—DNA, for example—preceded "the organism" historically and were also open or were integrity as the subsequent "organism" of the prokaryote or eukaryote type. Here, however, we see a description of fully formed, evidently more complex organisms. Brooks and Wiley further write that, on the strength of that same second law of thermodynamics, the organism must perish in one way or another, but "a genealogical lineage of organisms may escape thermodynamic equilibrium through reproduction" (ibid., 39).

This is correct. The most important thing worth noting here is that stochastic processes (streams of energy) intersect with deterministic dynamic phenomena; i.e., energy dissipates while matter transforms, or in other words, ontogenesis turns into phylogenesis—the organism turns into a species. The individual organism, subject to the second law of thermodynamics, perishes, but as it becomes an individual species, it lives on, as if "fooling" the second law of thermodynamics. The problem here is that the individual species themselves are dissipative structures with their own limitations that force them ultimately to perish and at the same time to survive through the genus, again as if circumventing the second law of thermodynamics. The next cycle, even more complex, goes through the same metamorphoses to the formation of human society.

The authors give a lot of consideration to information that influences the biosystem on its evolutionary path. They define it in this fashion: "Information, like energy or gravity, is a capacity. Energy is a capacity to do work. Information is the capacity to execute an ontogenetic program and/or maintain homeostasis (provide a continuous energy and matter exchange between the organism and the environment)" (ibid., 44). Also, "information is defined in all these cases as the difference between the maximum possible entropy and the entropy of the observed state of a system" (ibid., 64).

The authors remind us of the pronouncements by D. Layzer and S. Frautschi that:

> the expanding universe comprises a "causal" region in which entropy increases but progressively lags behind the maximum possible increase allowed by the expansion of the "causal" region due to the initial conditions constraints of gravity. The result of this growing disparity between the possible and the actual is the emergence of organized macroscopic structures. In terms of our model, the "causal region" is log A, and the growing disparity between log A and H_1 results in biological organization. Layzer predicted that there should be an "arrow of time" (log A), an "arrow of entropy" *(H),* and an "arrow of history" (/). Information is produced as an entropic phenomenon by any natural macroscopic system whose entropic tendencies are constrained at least partially by its initial conditions—that is its history. Our view of biological evolution is thus entirely consistent with cosmological evolution. (ibid., 66)

More precisely, the authors claim that biological evolution is entirely subordinate to the evolution of the cosmos. "We postulate that heredity and reproductive ties exert an analogous kind of influence on biological systems that gravity exerts on astronomical systems" (ibid., 69). Therefore, "there really is no fundamental difference between strictly thermodynamic and statistical mechanical views of entropy and of biological evolution. . . .

The second law is more than a law of thermodynamics—it is the natural law of history" (ibid., 70).

I get the impression that the authors misunderstand the meaning of the concept of Law, or else they are imbuing it with some meaning of their own they did not bother to specify. Otherwise, it turns out that thermodynamic processes proceed in the exact same fashion in the inorganic world as in the organic world. In that case, there is simply no difference between these worlds. Then it would be necessary to admit and prove that, say, Newton's laws or the laws of quantum mechanics are equally applicable on the molecular or the cellular level, and Mendel's laws can be used to describe the integration of electromagnetic forces. It turns out that the laws of mutations or heredity simply do not exist. This is the conclusion that follows from the authors' assertions.

Brooks and Wiley ask, "Why is there order and not chaos in the living world?" and answer, "Because living systems, organisms and species, are individualized dissipative structures (1) exhibiting finite information and cohesion, (2) maintaining themselves through irreversible dissipation of matter and energy, and (3) existing in an open energy system" (ibid., 70–1).

At this point, the question arises, what exactly is order, and what is chaos? I could claim that there is order in the nonliving world, too, since, for example, the Earth circles the Sun in an orderly fashion; the moon circles the Earth, etc. In his time, the prominent biologist J. Needham noted perfectly correctly that the words *organization* and *order* could be used in different senses. He particularly stressed the difference between the concepts of Order in thermodynamics and in biology, where order often means *scheme, drawing*, and *pattern*.[1] Therefore, the authors' answers do not particularly matter since the question was posed incorrectly.

Here is another assertion that follows from the authors' general conception. They write:

> Biological evolution is not a teleological process, nor is it a process that requires us to postulate that better adapted variants occur randomly and are "selected" because of their functional efficiency in a given environment. Rather, the most urgent property of living systems as entropy systems is historically constrained structural evolution regardless of the environment.

1 See Hollitscher, 369–71. By the way, Needham has a work titled *Evolution and Thermodynamics*, which is not listed in the bibliography of the book under discussion.

> Evolution is survival of the adequate, not of the most fit.[1]

One can agree that biological evolution has no purpose, but it is impossible to agree with the above pronouncements about adaptability to the environment. Interaction is absent in this conclusion. Otherwise, how would this adaptability or adequacy arise? There is something that forced it to be adequate; it did not emerge on its own. This “something” is the environment. In principle, adequacy is the same as adaptability developed in the process of natural selection; otherwise, we would have to cross out Darwin. Well, it turns out that the authors do cross out Darwin, but partially, not entirely. Brooks and Wiley write, “Our theory, based on this view [relativity theory—*A. B.*], uses established mechanisms of inheritance and is ‘non-Darwinian’ only to the extent of rejecting ecological determinism” (ibid., 297). This statement appears quite strange, coming as it does from authors who reduce evolution to the second law of thermodynamics—a law which in its essence is deterministic, if only insofar as it concerns the irreversibility of time, or history, as the authors say. History is not a set of chaotic events; it is a set of events produced by cause-and-effect phenomena that unfold in space and time. The emergence of life on Earth is one of these events.

In essence, by rejecting Darwin’s theory of evolution and reducing it to entropy (which is just a variety of reductionism), Brooks and Wiley were able to make a truly unexpected turn connected to the peaceful nature of their conception. I read with some surprise, “Our view of biological evolution suggests that it is an inherently nonviolent, accommodating process. We believe that the Darwinian and neo-Darwinian views, with their emphasis on external forces, promote a violent conception of the world. Under our theory, a biologist can note that two organisms are different without having to ask which one is better (fitter)” (ibid., 307). These peace-loving biologists evidently failed to notice that one organism does not bother to ask the other one which one is better but instead simply devours it, which in turn devours another, and so on without end, in spite of their, so to say, genetic “peacefulness.” Notwithstanding the seemingly obvious facts, the authors nevertheless continue

> In a general humanist sense, we believe it should be useful to seriously entertain the possibility that biological processes are inherently nonviolent. We have no strong metaphors to offer such

1 Brooks, Wiley, *Evolution as Entropy*, 71.

> as "survival of the fittest" or 'Nature red in tooth and claw," and that is just fine with us. We would like nothing better than to make sure that violent human behavior could no longer be justified and condoned as an unalterable consequence of an evolutionary legacy. (ibid.)

Altruism is commendable, of course, but how does one go about installing it in natural phenomena, which, in the authors' own words, are "not purposeful" but subject to the "brainless" second law of thermodynamics? I get the impression that Brooks and Wiley consciously reduced evolution to physical laws that do not "think" and, therefore, are not involved in the "struggle" for survival but interact peacefully following the principle of peaceful coexistence. Only one question remains: what does all this have to do with science?

Strangely enough, this question also applies to those who discard altogether the importance of entropy in the evolutionary process. Here we do encounter religion to a greater degree, though. However, let us proceed in order.

Evolution vs. Entropy

Many times, I have come across claims that entropy does not play the special role in biogenesis that is supposedly ascribed to it by some scientists (including the above-discussed Brooks and Wiley, who do it in a superexaggerated form). One has to admit that often such criticism is perfectly justified, and to a large degree, this is due to confusion in definitions of both entropy and evolution. Let us see how this happens.

The renowned Russian chemist L. A. Blumenfeld of Moscow State University writes, "All talk of antientropy tendencies of biological evolution is based on misunderstanding. According to physical criteria, any biological system is no more ordered than a piece of rock with the same weight."[1] To support this claim, he calculated "the degree of orderliness of the biological organization of the human body," which turns out to be "worth" 301.5 EU (EU stands for entropy unit, 1 EU = 1 cal/degree). For all that, he does not deny that there is a certain orderliness in biological

1 Blumenfeld, *Information, Thermodynamics and the Construction of Biological Systems*.

structures, but he ties it not to entropy but rather to the purpose, or meaning, of biological orderliness.

In its general sense, his idea amounts to the following: as a result of an accidental and improbable process, a certain organic structure is formed. In principle, there can be a great multitude of such structures, but only one is preserved—the one that acquired *meaning*. The meaning consists of the fact that the structure proved to be stable and capable of reduplication (reproduction). In the event of "memorization" of this chance choice, there emerges an orderliness that has meaning. In Blumenfeld's words, "a system emerged that is capable of creating meaningful information." (To demonstrate this idea, he uses the example of the two-string polymer.) It is doubtful that Blumenfeld seriously ascribed to molecules the property of thinking or pursuing a goal. But should we accept this assumption as a metaphor, it is indeed impossible to disagree with it; on the molecular level, as on every other organic level, a certain orderliness does indeed exist, and the organic structure grows more complex following practically the same scheme that Darwin described in his theory of evolution (selection, heredity, mutation). However, all that was said above does not deny the negentropic character of biological evolution since orderliness in an organism is different from orderliness in the inorganic world. This is what the entropist biologists insist on.

The already mentioned English biologist Rupert Sheldrake, who recognizes no ideas but his own, naturally attacks the second law of thermodynamics as well; in his opinion, its importance is groundlessly exaggerated. Here is the course of his reasoning: Entropy is usually regarded as a disorder. But first, this law applies to closed systems, whereas living organisms are open systems that exchange matter and energy with the environment. (In fact, hardly anyone argues against this statement; it is an ancient truth.) Second, this law applies to relations between heat and other forms of energy; it relates to energetic factors that affect chemical and biological structures but not the essence of these structures in the first place. Third, according to the third law of thermodynamics, at absolute zero temperature, the entropy of all pure crystals is equal to zero. That is, crystals are excellently "organized" from the thermodynamic perspective since there is no disorder whatsoever caused by heat action. Sheldrake writes, "There is no difference in entropy between a simple salt crystal and a crystal of an extremely complex organic macromolecule such as hemoglobin. It follows that the greater structural complexity of the latter is not measurable in terms of entropy."[1]

The fact is, no one actually attempts to describe the structure of, say, hemoglobin in terms of entropy. Moreover, the third law of thermodynamics applies not just to crystals; it relates to properties of substances at very low temperatures and states the impossibility of cooling a substance to the level of absolute zero through a finite number of iterations. Generally speaking, it relates rather to the atomic structure of substance, while the other two laws of thermodynamics are general and rule over a much wider class of natural phenomena.

Sheldrake's subsequent reasoning is of some interest, albeit from an entirely different perspective. He further writes:

> The contrast between "order" in the sense of chemical or biological structure and thermodynamic "order" owing to inequalities of temperature, etc. in a large system consisting of countless atoms and molecules is illustrated by the process of crystallization. If a solution of a salt is placed in a dish inside a cold enclosure, the salt crystallizes as the solution cools. Initially, its constituent ions are distributed at random within the solution, but as crystallization takes place they become ordered with great regularity within the crystals, and the crystals themselves develop into macroscopically symmetrical structures. From a morphological point of view, there has been a considerable increase in order; but from a thermodynamic point of view there has been a decrease in "order," an increase in entropy, owing to the equalization of temperature between the solution and its surroundings. (ibid.)

This is a good example for concentrating on the differences in the interpretation of order in the inorganic and the organic worlds while keeping in mind that the nature of this asymmetry is temporary, not absolute, since a crystal that is ordered for some stretch of time will eventually in one way or another be brought into disorder, i.e., perish. This applies also to the following example

> Similarly, when an animal embryo grows and develops, there is an increase in entropy of the thermodynamic system consisting of the embryo and the environment from which it takes its food and to which it releases heat and excretory products. The second law

1 Sheldrake, 66.

> of thermodynamics serves to emphasize this dependence of living organisms on external sources of energy, but it does nothing to explain their specific forms. (ibid., 67)

As Sheldrake reasons, in the most general of terms, form and energy are mutually related; energy is a "principle of change," but form or structure can exist for as long as it has a certain stability, or resistance to change. This contrariness is obvious in the relations between the state of matter and temperature. In sufficiently cold states, substances exist in crystalline forms in which the organization of molecules shows a high degree of regularity and order. As the temperature rises, heat energy forces the crystalline form to disintegrate at a certain point—the solid becomes a liquid—and so on until in the gaseous state the "molecules are isolated and behave more or less independently of each other" (ibid.). I might add that protons are even more independent than molecules. There is regularity at work here: the more complex the matter is, the fewer "degrees of freedom" it has.

Even though Sheldrake has no need of entropy for his own conception (which I shall revisit in the next section), he does not deny its effect in principle on organic systems. However, there are scientists who "fundamentally" deny the influence of the second law of thermodynamics in principle. Take, for example, the reasoning of the biologist Mae-Wan Ho (director of the Institute of Science in Society and Department of Biological Sciences, Open University, London). She remarks that when the discussion is about *negative entropy* (a term introduced by Schrödinger), it does not concern energy streams as such or their dissipation. The emphasis is on "the accumulation of energy." She writes, "Energy flow is of no consequence unless the energy is trapped and stored within the system where it circulates before being dissipated. A reproducing life cycle, i.e., an organism, arises when the loop of circulating energy closes. At that point, we have a life cycle within which the stored energy is mobilized, *remaining stored as it is mobilized,* and coupled to the energy flow."[1] The more such connected cycles exist within a system, the more energy is accumulated and the more time is required for its dissipation. As a result, Ho's conclusion is, "The average *residence time* of energy in the system is therefore a measure of the *organized complexity* of the system" (ibid.). This conclusion is more than a little debatable considering that viruses, for example, retain energy for very long periods of time, but do

1 Ho, *Are Economic Systems Like Organisms*?

not demonstrate "organized complexity."

Ho also advances the following thesis: "The organism is a superposition of non-dissipative cyclic processes, for which the net entropy production balances out to zero, i.e., $\sum\Delta S = 0$, and dissipative, irreversible processes, for which the entropy production is greater than zero, i.e., $\sum\Delta S > 0$" (ibid.).

On the basis of this postulate—which was advanced many times before Mae-Wan Ho by many scientists, in particular Manfred Eigen—Ho draws a very unexpected conclusion: "It frees the organism from the immediate constraints of energy conservation—the first law—as well as the second law of thermodynamics" (ibid.). As a result, we get a unique phenomenon: an everlasting, nonfading organism that circumvents two fundamental laws of nature. Apparently, this is the kind of scientist Blumenfeld had in mind when he criticized the antientropists. In fact, Ho's formulation only means that an organism's dissipativity is temporary and local, testifying to the relative openness of the organism that scoops energy from the outside while nondissipativity is inevitable since the organism is only a part of the general closed system—the universe—in which the second law of thermodynamics functions inexorably. But as it turns out, Ho needed this conclusion in order to reduce the organism to quantum coherence that starts to function in her writings alongside the laws of quantum mechanics. And even though quantum mechanics has laws of its own, in Ho's interpretation, the organism has become "perfectly free." "There is no choreographer orchestrating the dance of molecules in the living system. Ultimately, choreographer and dancer are one and the same" (ibid.).[1]

This variant is thus likewise a pure-as-they-come form of reductionism, albeit of the "sublimated" kind, for the organism, freed from all laws of thermodynamics, still must somehow exist and evolve. Naturally, this requires a certain creative agent, which can be none other than God. It is no accident that Ho gave a glowing review to a monograph by Christopher Alexander[2] in which he reduced all the vicissitudes of nature to God.

1 Also see Ho, *The Rainbow and the Worm: The Physics of Organisms*. World Scientific.

2 Ho, *The Architect of Life*.

Evolution Plus Entropy

I have already noted that most scientists hold intermediate views on the importance of entropy. As an example, I would like to refer once more to Arthur Young.

Young starts making a distinction between life and nonlife on the level of plants, whose lives, in his opinion, are directed against entropy growth; i.e., they violate the second law of thermodynamics in a localized area of the universe. In his interpretation, this law states that every distribution of states—such as heat and cold, orderliness and disorder—has a tendency toward averaging out. The plant, on the other hand, manages to accumulate energy within itself. Even though it is a local phenomenon, the plant does not create energy but instead absorbs it from sunrays and accumulates it in the form of dextrose (a combination of starch and sugar). Thus does negative entropy emerge in local spots as plants grow and accumulate more energy than they use up. Plants use this energy for their metabolism and growth. Moreover, we see that energy accumulates in a certain order, usable as fuel, in order to rouse a vital process, an exchange of substances that can be called *production*. Then the law of entropy could be formulated in this fashion: order tends toward disorder. Energy itself does not increase or decrease, but availability of energy does decrease. In other words, order is useful energy. A plant makes energy useful by extracting it from sunrays and accumulating its cells in the form of starch molecules. The plant also expends this energy. (This is very important since, without this ability, the plant could only accumulate energy, and this would mean the replacement of one type of determination with another; the plant would have no "freedom.") The plant has the power to accumulate and to expend, and as a result, it has freedom of a sort that liberates it to a certain degree from determinism. This liberation enables the plant to grow and reproduce itself. The plant's capacity for unlimited growth, which is not simply growth but its self (multiplication in seeds that grow up themselves), can be interpreted as an inversion of sorts of the given constraints. The plant acquires the power of self-dissemination. It inverts the original constraint and turns it into a force. This is not the same as the dropping of constraints as happens when a nuclear particle turns into a photon. The higher-level constraint remains; the plant, or cell, accepts the constraints of matter and operates with them in order to grow millions of times larger than their original size. In short, they circumvent the constraints of determinism. Such is, in brief, the course of Young's reasoning.

It is not clear why the plant, or cell, would avoid "determinism" and prefer "freedom," though it is quite clear why Young ascribes to them such "feelings." Like many of his colleagues in the West, he habitually links determinism with materialist conceptions that have a Marxist tinge, and they always cheer when they find some phenomenon that is not subject to determinism: "Look there; materialism fails again." The funniest thing about this is in Soviet textbooks on dialectical materialism; it was precisely plants that were used as an example for explaining all three laws of dialectics—the law of the unity (interpenetration) of opposites, the law of transformation of quantity into quality, and the law of the negation of the negation. These laws, however, do not belong to Marx and other materialists; they were discovered by Hegel, that idealist of genius. But this is just an aside.

If we discard Young's attacks on determinism, his idea that "the plant" can act against entropy does actually make a certain sense. At least, in his opinion, it accords formal recognition to negative entropy as a principle that is applicable in science.[1]

Proceeding from Young's logic, one has to admit that the above-described process of entropy accumulation in plants is reproduced to some degree in every living organism. Although it can be disputed at some intermediate levels—for example, between probionts and bacteria—in this case it is something else that is important. The organism's life first comes into conflict with the second law of thermodynamics and resolves it in its favor in a certain space of being designated as the biological world. The exchange of substances and energies in this world takes place qualitatively differently from the inorganic world. As soon as macromolecules of different structures (nucleotide acids, proteins, polysaccharides, etc.) emerged on Earth, the biosphere started its timid war against the second law of thermodynamics. In other words, the dividing line between the inorganic and the organic worlds should be that substance that starts the "struggle" against entropy. Such is the leading idea of Young's conception.

1 Young, *Which Way Out? And Other Essays*, 175–7.

The Second Law of Thermodynamics and Biological Information

I believe it is appropriate to present here the views of the English physicist Paul Davies after the publication of his book *The Fifth Miracle*. He can also be called a biophysicist. He is one of the few authors who approach the problem of entropy's importance in biology dialectically, developing the interconnections on the level of biological information. In support of his views, he uses some unexpected examples.

First, as does Young, Davies believes that "one of the principal ways in which life distinguishes itself from the rest of nature [nonlife—A. B.] is its remarkable ability to go 'against the tide'…and create order out of chaos. By contrast, inanimate forces tend to produce disorder."[1] And even though Davies repeats in this thesis the classics (Helmholtz, Boltzmann, Eddington), his views acquire urgency, considering the attacks leveled against him by some contemporary scientists who ignore the importance of entropy.

It is interesting how Davies goes about applying entropy to biological evolution. He believes that the emergence of new species means growth of order, evidently in the sense that phylogenesis increases the mass of organized organic matter. However, Darwin's theory indicates the price that has to be paid for this. In order for new species to emerge, multitudes of mutations are necessary, the vast majority of which turn out to be harmful and are subsequently destroyed in the course of natural selection. For every single successfully surviving mutant, there are thousands that perished (millions, actually). "The carnage of natural selection," Davies writes, "amounts to a huge increase in entropy, which more than compensates for the gain represented by a successful mutant" (ibid., 26). This appears to be logical, though it is precisely in connection with such reasoning that the temptation arises to apply the laws of biological evolution to society, which is often done. But let us leave society aside for the time being.

Unlike Brooks and Wiley, Davies has no intention of reducing evolution to the second law of thermodynamics. He understands perfectly that life is tied to entropy, but the latter does not explain yet

1 Davies, 22–3.

what life is. In this connection, he brings up an analogy to electricity and the refrigerator. It is clear that the refrigerator does not work without electricity, but electricity does not explain how the refrigerator works. In his explanation, Davies turns to information theory.

He reminds the reader that in Shannon's theory, "information is treated as the opposite of entropy." He also recollects that the organism is not a closed system. Therefore, "the information content of a living cell can rise if the information in its surroundings falls. Another way of expressing this is that information flows from the environment into the organism" (ibid., 29). According to Shannon, the entropy of the environment must increase proportionately to the decrease of the living cell's entropy. And that is indeed the case. Life avoids destruction thanks to the second law of thermodynamics—by importing, so to say, information or negative entropy from its environment. "The source of biological information, then, is the organism's environment" (ibid.).

In this connection, the question arises, what is the environment? Is it the organism's habitat? The biosphere, the Solar System, or the entire universe? In other words, from which source does the information, or energy, come that the organism consumes? On which level of the natural structure is the entropy gap created, which the biologists love to calculate in an organism? In his answer to this question, Davies leads his readers into the thickets of the Big Bang and the physical correlations between gravity and the second law of thermodynamics. His interpretation thereof appears to me unconvincing.

Evolution and Entropy

Even though I could not help inserting some comments as I was presenting the above ideas, I should state once again my position on this topic. To start, it makes sense to generalize the views of those authors who are negatively disposed to the idea that entropy influences living organisms. This approach is usually more common to creationists, but to varying degrees it is shared by almost all those who oppose "mechanistic determinism"—a pejorative term used against the materialists. The creationists' views in generalized form boil down to the following:

1. The second law of thermodynamics implies that all systems

> and parts of systems move from order to disorder. The second law prohibits order from emerging spontaneously from disorder since the essence of universal matter is disintegration.
>
> 2. In practice, however, the spontaneous emergence of order from disorder could be observed in many cases: seeds turn into trees, eggs turn into chicks, salt crystallizes as the solution evaporates, crystalline snowflakes form from the chaotic motion of water molecules. Therefore, there has to be a preprogrammed mechanism of energy conservation necessary for such changes.
>
> 3. It is this mechanism that overcomes the second law of thermodynamics, which prohibits order from emerging from disorder.
>
> 4. As to who or what created or controls this mechanism, creationists say *God*, vitalists say *life force*, pure reductionists say *the thinking elementary particle (atom, electron, quantum).*

As happens so often in science, a mutual misunderstanding results from arbitrary interpretation of certain terms. To illustrate, let us start again with that very important pair: order/disorder. Order implies the existence of some rule that can be followed to describe the location of parts in a system. For example, the distance between points in a closed system must have equal numerical parameters. Alternatively, the quantity of elements in some group has to be limited to a certain definite number or else their spatial location must form a certain figure—say, a square, a triangle, etc. In other words, order is determined by the rule used to describe the system's structure. When we have no rule of order for describing a system or its structure, we are therefore unable to predict its behavior, and we call the system disorderly.

The likelihood of disorder in any given system is much greater than the likelihood of an ordered system since the former has at its disposal an unlimited number of ways for (un)forming while order has constraints in the form of corresponding rules.

Furthermore, the level of thermodynamic disorder is measured by the phenomenon called entropy. There is a mathematical correlation between entropy growth and increasing disorder. The *total* entropy of an isolated system never decreases. However, the entropy of some part of the system can spontaneously decrease at the expense of even greater entropy growth in other parts of the system. When heat spontaneously moves from a system's hot part to its cold part, the hot part's entropy is spontaneously reduced. The anti-entropists, meanwhile, keep claiming that entropy never decreases in principle, for this contradicts the second law of thermodynamics. In closed systems, entropy can decrease in some parts, but the entropy of the system as a whole grows all the same.

However, in organic systems, which are considered open systems, energy arrives from the outside that allows the organism to reduce entropy. Or, in other words, in an organism, some energy is retained "in a comparatively *low*-entropy form, namely in the photons of visible light."[1] How does that retention work through the "mechanism of energy conservation"? (see point 2 above). These questions are not related to the second law of thermodynamics. When the proponents of the conception of Evolution vs. Entropy tie the organism's development to entropy, it is a common ruse intended to devalue a fundamental law of nature. The proponents of the conception of Evolution = Entropy do practically the same thing, only with the opposite sign; that is, the reduction of evolution to entropy means the destruction of evolution as an independent phenomenon. Thermodynamics does not deal with situations that require a mechanism, "thoughts," or "creative agent" to create order out of disorder.

It follows from the above that the second law of thermodynamics, on the strength of its fundamental nature, plays a huge role in the emergence of the organic world. The organic world became possible due to its capacity not only for conserving solar energy, but also for transforming it in ways that are different from those of the inorganic world. Nonetheless, this possibility does not amount to a violation of the law of entropy since ultimately every organism—in fact, the entire organic world—perishes or dissipates into the universe. However, this process operates here differently from the case of "inert" nature. In organic nature, new structures, new mechanisms, and new phenomena are created that operate along new laws and new rules. At the same time, change also affects the content of the terms and concepts used to describe the organic world. For example, the concept of Order acquires an entirely different meaning in the organic world; the above-mentioned John Needham wrote of this. These changes are now owing not to the law of entropy but to the mechanisms embedded

1 Penrose, *The Emperor's New Mind* (1990), 413. Generally speaking, a huge role is played in these processes by the "quality" of solar heat as a source of low entropy. The Earth then reradiates it in a high-entropy form. This happens because "the sky is in a state of temperature imbalance" (415). In detail, see Penrose, 411– 7.

in organisms. It is as if entropy says, "I gave birth to you, but your further evolution is no concern of mine."

Let us take a look at different views on this matter.

3

Other Conceptions of Evolution

Sheldrake's A New Science of Life

In the 1980s, Rupert Sheldrake published his book *A New Science of Life,* which has since been republished three times (the last time in 1995[1]) and has provoked a tumultuous response on account of the author's ultra-original ideas about life. Although the ideas themselves received no further development in the concrete research work of biologists, I have decided to repeat them here anyway, not just because the author himself continues to insist on his conceptions,[2] but also because his ideas are reproduced in different variations in quasiscientific literature, especially in Russia.

What are their essence and attractiveness?

Sheldrake is a professional biologist and an embryologist who made a point of taking classes in philosophy and the history of science at Harvard University. This is the scientist who casts doubt on all current and schools' approaches to the definition and origins of life. At first sight, especially to nonspecialists, his criticisms and his own theory may appear rather convincing.

Sheldrake is quite skeptical, for example, of the hypercycles of chemical processes in the "original broth," as well as of life's arrival from outer space in the spirit of the above-mentioned Crick and Orgel, or Hoyle and Wickramasinghe since "what happened in the distant past can

1 Sheldrake, *A New Science of Life*.

2 See, for example, his interview for *The Seattle Post-Intelligencer*, 1 April 2003.

never be known for certain," and, secondly, even if life's origin is learned, it "would shed no light on the nature of life" (ibid., 29).

He is equally skeptical of C. G. Jung's once-popular conception of *the collective unconscious*, which exists as the secondary psychic system of the collective, universal, or impersonal nature that is seemingly present in all individuals. The transfer of this *unconscious* proceeds through gamete nuclei (germplasm). Sheldrake offers reasonable objections to Jung, arguing with a number of logical justifications that this theory is essentially mechanistic, whereas "mental phenomena need not necessarily depend on physical laws, but rather follow laws of their own" (ibid., 31).

Also worthy of attention is his criticism of vitalism, especially the ideas of Hans Driesch, even though, as we shall see, it was precisely his ideas that Sheldrake took up. He is more sympathetic toward organicism, in particular the idea of morphogenetic fields presented in the works of A. Gurwitsch (1922) and P. Weiss (1926). It was further developed by C. H. Waddington within the framework of the concept of the *creod*—in literal translation from the Greek, the conception of the inevitable way or the structurally stable way of development of living systems. Its philosophical essence, briefly put, amounts to this: evolution is clearly defined in its ultimate goal.[1]

Sheldrake criticizes all the above-named conceptions and ideas; nonetheless, he makes use of their main premises (the conceptions of memory, morphological fields,[2] and the creod).

To begin, it makes sense to examine his approach to his own ideas. This is what Sheldrake writes of DNA, which is at the center of the theories of heredity transfer as a special kind of information: "But Information Theory is not relevant to biological morphogenesis: it applies only to the transmission of information within closed systems, and it cannot allow for an increase in the content of information during this process" (ibid., 61). The developing organism is not a closed system, and its development is epigenetic; i.e., the complexity of its form and organization increases. From this perspective, all talk of *genetic information*, *positional*

1 Soviet biologists perceived this idea as "the ability to preserve the typical course (or result) of development in the presence of substantial natural or artificial disturbances, for example, sharp fluctuations in environmental conditions, experimental interference, etc."—*Biological Encyclopedic Dictionary*, 293.

2 In this case, the discussion is first of all about one of the definitions of this term, namely, "vector fields in a phase space that have zones of structural stability (creod), separated by unstable structural 'interlayers.'"—*Biological Encyclopedic Dictionary*, 381.

information, etc.—of which mechanistic biology is often guilty—matters not at all, particularly since these terms are poorly defined, merely taken from the jargon of information theory. Thus, the application of this theory to biological processes is strained and artificial in character. Sheldrake speaks in approximately the same tone of the importance of entropy; his pronouncements on this topic were quoted above.

Thus, having disposed of all doctrines, trends, and laws, Sheldrake presents his own conception, or, rather, new science of life. For a start, he advances the hypothesis (his favorite word, by the way) of *formative causation*, based on which "morphogenetic fields play a causal role in the development and maintenance of the forms of system at all levels of complexity" (ibid., 74–5). In this context, the word *form* is used not only to designate the form of the system's outer surface or boundary but also to designate its internal structure. Moreover, Sheldrake specifies that one should keep in mind that formative causation is different from causality of the energetic type, which physics deals with.

He compares formative causation to a plan that supposedly can be viewed as the cause of, say, the specific form of a house while it is not the sole cause; it cannot be realized without building materials and builders' activities. Similarly, specific morphogenetic fields are the cause of the specific form of some system, though they cannot operate without the necessary building blocks and the necessary energy that pushes them into place. This does not amount to a claim about the causal role of morphogenetic fields that depend on a conscious plan. The idea is to emphasize that not all causation needs energetics, even when all changes are energetic in character.

Morphogenetic fields can be viewed as analogues of known physical fields in which they are capable of ordering physical changes, even when they cannot themselves be directly observed. Gravitational and electromagnetic fields have spatial structures that cannot be seen, touched, or heard, and they are devoid of taste and smell. They are revealed only through their gravitational and electromagnetic effects. In this sense, they are not material, but in another sense, they are aspects of matter due to the fact that they can be detected through their influence on material systems. "Similarly, morphogenetic fields are spatial structures detectable only through their morphogenetic effects on material systems; they too can be regarded as aspects of matter if the definition of matter is widened still further to include them" (ibid., 76).

Although the discussion here is only about the morphogenesis of biological and complex chemical systems, the hypothesis of formative causation can be transferred to biological and physical systems at all levels of complexity:

> Since each kind of system has its own characteristic form, each must have a specific kind of morphogenetic field: thus there must be one kind of morphogenetic field for protons; another for nitrogen atoms; another for water molecules; another for sodium chloride crystals; another for the muscle cells of earthworms; another for the kidneys of sheep; another for elephants; another for beech trees; and so on. (ibid.)

Thus we learn about the formative causation inherent to morphogenetic fields. Let us suppose that they really do exist. The logic further develops in the following fashion: According to the theory of the organism, systems or "organisms" are organized hierarchically on all levels of complexity. These systems can correlate to *morphic units*. The adjective *morphic* (from the Greek root meaning *of form*) stresses the aspect of structure while the word *unit* stresses the integrity of the system. However, morphogenesis does not exist in a vacuum. It can start only in already organized system, which can be considered as a morphogenetic germ. During morphogenesis, a new high-level morphic unit comes into contact with this germ under the influence of a specific morphogenetic field.

So how does this field unite with the morphogenetic germ? Just as a material system's linkage with gravitational fields depends on its mass, and its linkage with electromagnetic fields depends on their electric charge, the linkage of systems with morphogenetic fields depends on their form. Therefore, the morphogenetic germ is surrounded with a specific morphogenetic field due to its characteristic form:

> The morphogenetic germ is part of the system-to-be. Therefore, part of the system's morphogenetic field corresponds to it. However, the rest of the field is not yet "occupied" or "filled out"; it contains the *virtual form* of the final system, which is actualized only when all its material parts have taken up their appropriate places. (ibid., 79)

This is very curious: the morphogenetic field "manages" to contain itself in time while filling out the system, realizing itself part after part instead of all together, even though all of the system is "imprinted" in its virtual memory. It is unclear—what prevents it from coinciding with the system instantly?

Morphic resonance is one more term necessary to Sheldrake's conception. He reminds the reader of energy resonance in physics, which takes place between vibrating systems:

> But whereas energetic resonance depends only on specificity of response to particular frequencies, to "one-dimensional" stimuli, morphic resonance depends on three-dimensional patterns of vibration. . . .By morphic resonance the form of a system, including its characteristic internal structure and vibration frequencies, becomes *present* to a subsequent system with a similar form; the spatio-temporal pattern of the former *superimposes* itself on the latter. (ibid., 98–9)

In other words, morphogenetic fields penetrate into the system through the mechanism of morphic resonance.

Nonetheless, where do the fields themselves emerge?

> One possible answer is that morphogenetic fields are eternal. They are simply given, and are not explicable in terms of anything else. Thus even before this planet appeared, there already existed in a latent state the morphogenetic fields of all the chemicals, crystals, animals and plants that have ever occurred on the earth, or that will ever come into being in the future. (ibid., 95–6)

How do you like that? Isn't it just like Schelling's world soul? So this is what the "creativity" of the new science of life amounts to? Sheldrake, who previously criticized all and sundry, including mystics, slides himself very smoothly into mysticism—leaning on the great Greeks, though.

This answer, Sheldrake reasons further, corresponds to the spirit of Plato or even Aristotle in the sense that Aristotle believed in the eternal stability of specific forms. This approach differs from conventional physical theory in the sense that it would have been impossible to predict these forms in the terms of energetic causality; but the view presented here agrees with the view that the forms emerge or exist by themselves. That is, beyond the boundaries of empirical phenomena lie preexisting principles of order, i.e. principles that existed, apparently, prior the order itself. This is almost like the approach described in the Bible: create light first and only then the luminary.

The other possible "answer" of Sheldrake is radically different. Chemical and biological forms are repeated not because they are determined by changeless laws or eternal forms but because of a *causal influence from previous similar forms.* This influence would require an action across space *and time* unlike any known type of physical action (ibid., 96).

So where is that initial form that is later recreated so selectively? The answer: "The initial choice of a particular form could be ascribed to chance; or to creativity inherent in matter; or to a transcendent creative agency" (ibid.). And also

> The hypothesis of formative causation accounts for the repetition of forms but does not explain how the first example of any given form originally came into being. This unique event can be ascribed to chance, or to creativity inherent in matter, or to a transcendent creative agency. A decision between these alternatives can be made only by metaphysical grounds and lies outside the scope of the hypothesis. (ibid., 120)

Sheldrake admits honestly that his science cannot be proved experimentally. This admission is rather strange in the light of his frequent references to Karl Popper, who believed that only those ideas that can be proved experimentally can be called science. Proceeding from that postulate, one is obliged to conclude that Sheldrake's *New Science of Life* is not science at all. Sheldrake recognizes this himself to a degree, but he does not give up. He writes, "Although the hypothesis of formative causation proposes a new kind of trans-temporal, or diachronic, causal connection which has not so far been recognized by science, the possibility of 'action at a distance' in time has already been considered in general terms by several philosophers" (ibid., 97). At this point, he refers to the philosopher J. L. Mackie (1917–1981), who did write of "action at a distance" but actually meant perceptions of causation, not the nature of it.[1]

How does *morphic influence* function outside space and time? Sheldrake poses this question and answers, through other dimensions. It is possible that the spatial–temporal tunnel or the morphic influence of past systems simply exist everywhere. It is a different type of thinking, Sheldrake stresses one more time. If it is indeed a different type of phenomenon and thinking, it does not affect our world with its

1 See Mackie, *The Cement of the Universe*.

conventional type of thinking. This means that all this takes place in a transcendental world—one where the author of the conception dwells himself, probably.

I want to note that this transcendence of Sheldrake was not born out of nothingness. There are some physicists who champion equally radical conceptions. According to one of them, for example, elementary particles A and B that have interacted can no longer be regarded as separate objects even when they leave the boundaries of the conditional interaction zone. This *quantum inseparability* essentially means that all objects that ever interacted remain tied to each other in some sense. This strongly resembles Sheldrake's conception except that this theory has one peculiarity: the fixation of quantum ties is *nonlocal, nonspatial* in character. Unlike gravity and electromagnetism, it does not owe its emergence to any kind of fields; it emerges perfectly independently and simply jumps from A to B no matter where these objects are situated. That is, these bonds "ignore" space, and that means time is of no importance to them, either. This nonlocalized mutual influence of A and B takes place instantaneously, faster than light. As the English magazine *New Scientist* puts it, what is meant is not just mathematical images of the physics of subatomic particles: it is a component of the real world, as confirmed—supposedly—by J. S. Bell of CERN. However, this phenomenon does not exist within the limits of the statistically average quanta's behavior; it can be manifested by individual pairs of quanta as a special case.[1] This discovery by Bell does not seem to have been confirmed, but the idea is alive and exploited, and not just in physics.

Since Sheldrake's conception cannot be proved experimentally, it can only be believed or at least discussed on the level of metaphysics, which in Western scientists parlance is called philosophy. Strangely enough, Sheldrake believes that his innovations in the area of understanding life fit with many metaphysical schools, including materialism (!). Since I am quite partial to the latter school, I want to present here briefly the Englishman's views on materialism.

Sheldrake writes perfectly correctly, "The metaphysical denial of any creative agency or purpose in the evolutionary process follows from the philosophy of materialism, with which the mechanistic theory is so closely associated" (ibid., 142). If one takes *creative agent* to mean God and sees purpose in the evolution of inorganic and organic worlds in

1 "Photons Remember About Each Other?," *Za Rubezhom*, 1987, no. 30. Reprint of N. Herbert's article from *New Scientist*.

different variants of anthropic principles, then Sheldrake is indeed correct: materialism rejects such fables. He is also correct in writing, "Materialism starts from the assumption that only matter is real; hence everything that exists is either matter or entirely dependent upon matter for its existence" (ibid., 203). In this approach, Sheldrake sees the mechanistic shortcomings of materialism; at the same time, though, when explaining his categories in the metaphysical part, he reasons like a dyed-in-the-wool materialist.

For example, Sheldrake claims that all real morphic units can be viewed as forms of energy. On the one hand, their structures and the types of their activities depend on the morphogenetic fields with which they are associated and under whose influence they emerge. On the other hand, their existence and their capacity for interaction with other material systems are due to the energy inherent to them. However, even though these aspects of form and energy can be divorced conceptually, in reality they are always associated with each other. "No morphic unit can have energy without form, and no material form can exist without energy" (ibid., 117). This approximately resembles the so-called duality of the wave particle in quantum physics.

Even though the analogy in this case is strained, Sheldrake's assorted "morphs" nonetheless ultimately depend on matter as well, keeping in mind that energy is only one of the forms of matter. Conceivably, this coincidence took place because "some of the modern versions of the philosophy of dialectical materialism would probably provide a good starting point for the development of a modified materialism in this sense. They already include many aspects of the organism approach, and are based on the idea that reality is inherently evolutionary" (ibid., 210, notes). Sheldrake acquired this information from L. R. Graham's work on Soviet philosophers.[1] If he had read Engels's book *The Dialectics of Nature* or Lenin's work *Materialism and Empirio-criticism*, he could have discovered that dialectical materialism was born long before the Soviet philosophers, who, by the way, contributed little to this current. However, I want to emphasize something different here, namely the phrase "reality is inherently evolutionary." Paradoxically, Sheldrake rejects his own conclusion; to see this, it suffices to read once again his oft-repeated statement to accept this conclusion. He writes:

> The origin of new forms could be ascribed either to the creative activity of an agency pervading and transcending nature; or to a

1 Graham, *Science and Philosophy in the Soviet Union*.

> creative impetus immanent in nature; or to blind and purposeless chance. However, a choice between these metaphysical possibilities could never be made on the basis of any empirically testable scientific hypotheses. Therefore from the point of view of natural science, the question of evolutionary creativity can only be left open. (ibid., 153)

In other words, on the basis of Sheldrake's conception, "the reality of evolution" cannot be verified or confirmed; it can be only taken on faith. Dialectical materialism, on the contrary, insists on the reality of evolution and is based on experimental evidence of this reality. As a result, Sheldrake's conception and materialism belong on different sides of knowledge.

In approximately the same spirit, albeit with some nuances, Sheldrake's ideas "agree" with other metaphysical currents, which did not prevent him from becoming noisily popular with some exalted scientists in many countries as well as with *New Scientist*; the latter, apparently, keeps its ratings afloat mainly with the help of "ultra-original" scientists. The only publication that declined to join in the torrent of glowing reviews for Sheldrake's book was the American journal *Nature*, which dared say the following: "In reality, Sheldrake's argument is in no sense a scientific argument but is an exercise in pseudo-science."[1]

I repeat: the only reason I devoted so much attention to this scholar is that so many people with impressive scholarly degrees and titles only masquerade as scientists, and the naïve reader often believes them. In order to avoid being snared by their bait, it is necessary to know that some fundamental things exist that cannot be violated in principle, namely, the laws of thermodynamics.

Let us address now some real scientists.

The Origin of Life: Accident, Purpose, or Way?

Manfred Eigen and Ruthild Winkler wrote a work back in the 1970s that remains relevant to this day.[2] The authors specify right away that contemporary biologists most likely would not be able to delimit the living from the nonliving (ibid., 10). The criteria for doing this are

1 *Nature*, 24 Sept. 1981.

2 Eigen and Winkler, *The Game of Life*.

unclear—for example, the criteria for distinguishing a virus from particles capable of forming a crystalline grid.

To explain the conditions necessary for life, Eigen and Winkler fall back on the concept of Entropy, which obviously suggests itself in connection with metabolism. They write, "The dynamic order characteristic of life processes can be maintained at the expense of constant compensation of entropy production" (ibid., 11). In other words, metabolism is the process of transformation of free energy, which slows down the system's (organism's) slide into a state of dynamic equilibrium. Naturally, the authors also mention such necessary conditions as self-reproduction and mutability of organisms. They describe in detail the structures of nucleotides and proteins, as well as other biochemical components of "animate life." But at first it is necessary to deal with it from a philosophical aspect of biogenesis.

Eigen and Winkler claim that the macromolecular structures found in living organisms are unique (ibid., 22). To make their case, they present a system of reasoning dealing with information and entropy.

First of all, they repeat the well-known opinion of many biologists that stochastic laws correspond to unitary processes while deterministic theory corresponds to macroscopic increases (ibid., 49). This principle is related to natural selection in the sense that "the filtering process of selection chooses certain alternatives from among microscopic non-determinate elementary events, enhances them and reveals them in the macroscopic process of evolution" (ibid., 50–1). It is important how they pose the question: "Does it lay the road toward a certain goal? Or is the character of this process such that only the road determines the goal, and therefore none of the historical avenues of evolution are apriori necessary?" (ibid., 51). The authors are inclined toward the latter answer. They believe that "'The Beginning' is unambiguously determined by the interactions inherent to matter. The initial conditions pre-determine the course and the goal of evolution" (ibid., 52). Here again, the problem of "the beginning" crops up.

The authors write, "The beginning is a chance event. The probability of this event is practically equal to zero, but, on the other hand, one cannot claim with certainty that it cannot possibly not happen" (ibid.). Let us note that very many biologists are inclined toward believing in the first part of this statement, taking it to the point of absurdity, to "absolute" or "blind" chance. The fact that it is not so will be shown in the corresponding section of this chapter.

Eigen and Winkler are also extremely skeptical of the idea of such an occurrence being repeated. This, too, is important, since many scientists claim that the chance formation of living organisms is possible on many other planets of our universe. They write, "But the *precise* 'chance bull's-eye' in history, which would lead again to modern forms of life, is impossible. It is extremely improbable that for a second time there would assemble in some small element of volume at a favorable moment the exact same set of molecules, and the historic process of evolution would be reproduced" (ibid., 57).

The authors say, "Predecessors of living cells are not found in nature. Neither phylogenesis or ontogenesis seem to have stated these steps for us" (ibid., 70). This statement is essential for us. It means that, in the authors' opinion, the starting point of life is *living cells*, i.e., eukaryotes. Nonetheless, they do not deny the emergence of *living* from *nonliving*. Another factor indicated by the authors is the direction of the evolutionary process in time. "This property is closely tied to the temporal direction of entropy growth in irreversible processes" (ibid., 88). This directedness leads to self-organization, with a selection as its key or method.

Thus, Eigen and Winkler put forward and experimentally prove that the evolutionary process is launched by stochastic and deterministic causes and that life emerged by chance and is not likely to ever be repeated or to have ever been repeated. Entropy plays a huge role in this process and can be interpreted as the informational state of the vital system; the transition from *nonliving* to *living* matter is possible, and life begins with the cell (not with bacteria, as many others believe).

Darwin and Stephen J. Gould's Model of Punctuated Equilibrium

I had no intention to dwell in detail in this work on the different theories of evolution since I am interested primarily in the origin of life. Nonetheless, I believe that it is worthwhile to present here, if only in outline, certain theses from a theoretical conception that appeals to me in spirit and content. To begin, I would like to present evolutionary biologists' summary view of "their" science, mainly because I have often come across pronouncements, especially among some Russian sciolists, that, in the West, they have supposedly long ago rejected

Darwin and the contrived theory of evolution in general. However, I have to disappoint these skeptics. The theory of evolution is not only alive and well in Western science, it is actually dominant.[1] Or, in the words of Paul Davies, "Darwinism is the central principle around which our understanding of biology is constructed."[2] Darwinism explores the processes of life that has already emerged, and it is also necessary to bear in mind, how did life emerge in the first place? Finding an answer to this question is a task pursued by other sciences. However, scientists are with increasing frequency resorting to fragments of the theory of evolution in order to explain the formation of molecular structures, cells, etc. The issue of whether this is justified is another battlefield on which schools, positions, and views collide.

All evolutionary biologists proceed from the thesis that evolution is the process through which all living things developed from primitive organisms by way of changes in a certain sequence over billions of years. Although the question of how the evolutionary process itself emerged is still being debated, it is a scientific fact that evolution did take place. Biologists are in agreement that all living things underwent various changes in consequence of physical and chemical processes. There are few today who deny that the organic world emerged from nonliving matter.

The most direct proof of evolution is offered by the science of paleontology, research into the living beings of the past using fossilized remains or imprints, usually found in rocks. Additional evidence of evolution is derived from comparative studies of animals and plants, including their structures (comparative anatomy) and data from biochemistry, embryology, biogeography, and other branches of science.

The changes that take place in organisms serve to enhance their adaptability, that is, their potential for survival and reproduction in the face of a changing environment. I would like to stress in particular that Western biologists, with the exception of the neo-Lamarckians, believe that evolution does not possess purposefulness. A certain type of organism could emerge only when varieties of forms emerged that differed in hereditary characteristics or behaviors passed on from parents to offspring. Through sheer chance, certain varieties were

1 I discovered, to my surprise, that this theory of evolution has survived even in today's Russia. There, it has even acquired a special name: evolutionistics. See Iordansky, *The Evolution of Life.*

2 Davies, 18.

unable to adapt to their environment and perished while others proved to be adaptable and their numbers increased. The disappearance of the nonadapted, or "the survival of the best adapted," is called natural selection since it is nature that rejects or favors the survival of a certain species.

Nonetheless, even in our day, Darwin's theory of natural selection is still being subjected to attacks, not only from religious obscurantists but also from the so-called enlightened public. For some reason, many of them cannot reconcile themselves to the idea that man originated from apelike animals. Strangely enough, many of them accept much more readily the idea of the organic world—including man—having originated from bacteria. The only explanation I can find for such humility is the supposition that the reasoning of all anti-Darwinists is stuck at a pseudo-scientific level.[1] Unlike them, the modern evolutionists who dwell in the realm of science treat their predecessor of genius with enormous piety—perhaps for purely egoistic reasons. As Darwin's followers write, "Darwin established our profession not only by discovering a force—natural selection—that seems both powerful and true; he also, perhaps more importantly, made evolution accessible to science by granting to empiricists their most precious gift of tractability and testability."[2] This does not mean that Darwin's followers always accepted or accept without reservation all of their teacher's theses. Every evolutionary biologist has contributed additional information brought about by subsequent discoveries in the area of biogenesis. This is true of Stephen Jay Gould (1942–2002), a major figure in evolutionary biology and a paleontologist by profession, whom the US Library of Congress listed in 2001 as one of the 83 living legends of the United States.

To begin with, let us recollect the essence of Darwin's theory of natural selection in its modern form—in this case in the interpretation of Gould, who wrote a key book on this topic in which he thoroughly analyzed what appears to be almost every work that has had to do with evolutionary theory.[3] I note also that Darwin used "the organism" as a unit of organic integrity, since in his time, the field of research did not reach into the deeper layers of biogenesis.

1 I do not mean, of course, the founders of the science of genetics, who were opponents of Darwinism for reasons that are natural to an emerging science. Nonetheless, later, during the 1930s–1940s, mutual recognition took place between Darwinism and genetics in the form of "the synthetic theory of evolution."

2 Gould, *The Structure of Evolutionary Theory*, 98.

3 It suffices to say that this work has 1,434 pages in the largest edition.

Darwin's theory of evolution consisted of three major blocks:

> 1. Superfecundity: all organisms produce more offspring than can possibly survive.
>
> 2. Variability (mutability): all organisms vary from other conspecifics so that each individual bears distinguishing features.
>
> 3. Heredity: at least some of this variation will be inherited by offspring (ibid., 125).

To Darwin himself, by the way, this latter mechanism appeared to be mystical, even though he asserted its existence.

In the context of this theory, I have been interested Darwin's interpretation of *struggle* in the evolutionary process that was transposed by some of his followers onto society. Darwin wrote in his book *The Origin of Species*, "When we reflect on this struggle, we may console ourselves with the full belief that the war of nature is not incessant, that no fear is felt, that death is generally prompt, and that the vigorous, the healthy, and the happy survive and multiply."[1] In other words, the struggle, no matter how fierce, causes no pain to organisms. It is people who introduce their emotions and evaluations into nature, ascribing similar feelings to organic nature, for example, the world of plants or the animal world.

Moreover, by Darwin, "as natural selection works solely by and for the good of each being, all corporeal and mental endowments will tend to progress towards perfection" (ibid., 459). The struggle thus leads to the general perfection of species, even if it has a side effect, no matter what the price. Gould rephrases this: "But nature needs not to operate by the norms of human morality. If the adaptation of one requires the deaths of thousands in amoral nature, then so be it."[2]

What is it that Gould does not accept about Darwin and the neo-Darwinists? It is the conception of *gradualism* in evolutionary changes, which implies, first, the absence of leaps in development, and second, the related seeming inevitability of the evolution of the organic world—in other words, the absence of chance events.

This approach implies that all organisms must travel down an

1 Darwin, *The Origin of Species*, 129.
2 Gould, 122.

evolutionary path—in other words, gradually grow more complex. However, the history of the organic world does not support this postulate. The organic world began with viruses and bacteria sometime around 3.5 billion years ago and then 2 billion years later continued as the history of prokaryotes; of these latter, some branches for whatever reason did not develop in the direction of complexity. Moreover, the greater part of today's organic world, even if we take just the last 500–600 million years, also has failed to display a trend toward greater complexity. Gould as if responding to the proponents of the idea that Nature is purposeful, writes, "In a world where so many parasitic species usually exhibit less complexity than their free-living ancestors, and where no obvious argument exists for a contrary trend in any equally large guild, why should we target increasing complexity as a favored hypothesis for a general pattern in the history of life?" (ibid., 900). The figure is well known: there currently exist about 2 million different species of organisms (with insects accounting for about 75% of the total), which amounts to 0.1% of the 2 billion species that have ever existed.

In response to the views presented above, Gould advances his own conception, the model of *punctuated equilibrium*. The essence of this idea is that evolution, possessed undeniably of its own "creative force," creates new structures but only under certain conditions. Certain physical and chemical components are necessary to bring about "life" in certain organisms. This phenomenon is unique as demonstrated by certain details of abiogenesis. Successive steps toward increasing complexity are not automatically ensured; a species passes its "punctuations" (leaps) in order to reach equilibrium for a time, from which it emerges due to mutation to reach a new "punctuation." While Darwin placed the emphasis on "the organism" as the source of individual struggle, Gould insists that selection applies to species, groups, and even genes. In other words, life truly is a hierarchical structure, but selection (which is in essence a "struggle") takes place on every level of this hierarchy (ibid., 899–900). Peace does not pertain to it since peace means death. Gould also emphasizes an idea that deals with the role of chance in evolution and the role of leaps. And even though Gould's enormous bibliography makes no mention of the works of Hegel, one has to admit that the great naturalist, in obedience to logic and facts, was thinking dialectically.

4

The Triumph of Karl Popper

I have always disliked Karl Popper, a philosopher very popular in the West, for his work *The Open Society and Its Enemies*, in which he attempted to refute Marx. However, as I climbed deep into the thickets of orgagenesis, I kept remembering him in connection with his method of demarcating science from nonscience, the principle of falsification enclosed in refutability in principle of any scientific statement. Popper was well able to enjoy this principle's triumph since almost every scientific opinion or claim about this or that problem of orgagenesis meets with resistance in the form of refutations or alternative opinions, conjectures, and theories. This is especially true when the discussion concerns the theoretical aspects of the organic world, which are the essence of biology, namely, the key questions of what life and progress are and whether life is a necessary or a chance phenomenon. Let us start with the latter topic.

Life: Necessity or Accident?

Was the emergence of life inevitable? Was it the result of a process that had to happen eventually? In other words, was life a law of nature? Or was it the result of a coincidence of such improbable chance occurrences that it would take a much greater time than the age of the universe to explain its emergence through a random process? These questions have popped up in one way or another in the preceding pages; the time has come to systemize them.

Scientists divide into two camps in accordance with their answer to these questions; some believe that life emerged by chance while others maintain that its emergence was law-determined. It is a unique occurrence that under the same roof of regularity, there is room for entire currents with completely opposite ideological stances and scientific views. The idea of the regularity of the universe and, accordingly, of life is defended by creationists and by Marxist materialists, by proponents of panspermia, and by employees of NASA. Why the latter do it is perfectly understandable: they are always involved in squeezing out funds for their space exploration programs, including the search for "intelligent life" in the cosmos. The essence of this approach is that the universe is regular, life is likewise regular (not accidental), and therefore thought is also regular and eternal. This amounts to something like biological determinism, i.e., a theory of predestination.

The outstanding English naturalist Alfred Russel Wallace defended this idea in a theological key. He wrote in 1905, "The ultimate purpose [of evolution] is (as far as we discern) the development of mankind for an ultimate spiritual existence.…Our universe, in all its parts and during its whole existence, [is] slowly but surely marching onwards to a predestined end."[1] Robert Broom, the discoverer of the Australopithecines of Sterkfontein and Kromdraai, likewise believed "man is the final product" (ibid., 78) of evolution. In his book *Creative Evolution* (1944), Henri Bergson concluded, "Man might be considered the reason for the existence of the entire organization of life on our planet" (ibid.). Distinguished neurophysiologist Sir John Eccles is even more definite and theological. In his book *Evolution of the Brain: Creation of the Self* (1989), he confesses that while in the first nine chapters he stuck to a materialistic explanation of Darwinism, in the end of the book (some enlightenment having apparently dawned upon him), he felt compelled to add his idea of "a final goal in all vicissitudes of biological evolution," and he ascribed the uniqueness of the self or soul "to a supernatural spiritual creation" (ibid.).[2]

It is interesting that the idea that the universe evolved in the direction of life and man is also defended from the position of materialism. It was perhaps most clearly expressed by the Nobel Prize-winning biologist Christian de Duve: "'Life is the product of deterministic forces. Life was bound to arise under the prevailing conditions, and it will arise similarly wherever and whenever the same conditions obtain.…Life and mind emerge not as the result of freakish accidents, but as natural manifestations of matter, written into the fabric of the universe."[3] Though I doubt that de

1 Quoted in Wills, *The Runaway Brain: The Evolution of Human Uniqueness*, 77.

2 I want to note that a convincing criticism of anthropomorphism in biology is contained in Chapter 4 (written by V. Ya. Dalin) of the book *System, Symmetry, Harmony*, Tyukhtin and Urmantsev, eds.

3 Quoted in Davies, 208.

Duve is a Marxist, he did reproduce here almost word for word Engels's idea from his *Dialectics of Nature* or the definition of life from the Soviet *Philosophical Encyclopedic Dictionary*: "Life is a form of matter's existence that emerges with regularity under certain conditions in the process of its development."[1]

It should be noted that such thinking is normally characteristic of astronomers, chemists, and physicists, while it is extremely rare among biologists. Nonetheless, there are protagonists of "regularities" among them as well. Along with de Duve, we can list Gary Steinman and Marian N. Cole of Pennsylvania State University, who wrote in the 1960s, "Matter has an innate tendency to grope in the direction of life by virtue of the chemical affinities that act between atoms and molecules."[2] The idea of "affinities between atoms and molecules" is also close to those of Sydney Fox and Cyril Ponnamperuma.

Davies, in his capacity as a physicist this time, objects, "To claim that atomic processes include a built-in bias favoring organisms means that the laws of atomic physics effectively contain a blueprint for life" (ibid., 210). Since he is himself inclined toward the "informational" explanation of life, it is quite logical for him to assert, "A law of nature of the sort that we know and love will not create biological information or indeed any information at all. Ordinary laws just transform input data into output data. They can shuffle information about but they can't create it" (ibid.). And here comes a very important statement, the content of which I will discuss in the next paragraph. Davies writes, "The secret of life lies, not in its chemical basis, but in the logical and informational rules it exploits. Life succeeds precisely because it evades chemical imperatives" (ibid., 212). Please note the latter phrase.

Let us now examine the reasoning of the opponents of stochasticity, which is built on their doubts about the time needed for the first bacteria to arise. In particular, the renowned British astrophysicist Fred Hoyle and his colleague from Sri Lanka N. Chandra Wickramasinghe attempted to demonstrate this, claiming that it is practically impossible for bacteria to arise in such a short period of time. This was noted even earlier by Van Rensselaer Potter, who claimed that even the simplest form of life required hundreds of different types of molecules, perhaps a thousand, three thousand, ten thousand, or even more.

Dr. Duane T. Gish, former vice president of the Institute for Creation

1 *Philosophical Encyclopedic Dictionary*, 186.
2 Quoted in Davies, 209.

Research, refers to several geochemists in disputing the idea that Earth's atmosphere in its early age was much different from the current one. He maintains that even in those times, there was enough oxygen that could have prevented the origin of life along the schemes described above.[1] In the same vein, he disputes the claims that a methane–ammonia atmosphere—another precondition of the emergence of life—existed at that time. He refers to several prominent chemists who believe that the amount of ammonia in the atmosphere was much smaller that the volumes described by the proponents of abiogenesis.

Another important objection arises in connection with the "thermodynamic barrier" on the route of the polymerization process, or the spontaneous synthesis of chemical and physical processes. By this, Gish means the chains of chemical bonds between the amino acids that form proteins or the reactions between sugars, phosphorus acid, purine, and pyrimidine for the forming of nucleotides, as well as between nucleotides for the forming of DNA and RNA—i.e., all reactions that require energy. The severance of any of these links, on the contrary, frees energy. That is, it is the destruction of these bonds that comes naturally and spontaneously, not their formation. To illustrate this, Gish offers an analogy fit for children featuring an automobile. The automobile, he says, does not go uphill by itself; on its own, it can only roll downhill. In order to move uphill, it must expend energy, which must be taken from somewhere. Thus, Gish declares triumphantly, in the initial period of the Earth's existence, proteins, DNA, RNA, etc. would only have been able to spontaneously self-destruct.

How, then, would it have been possible for them to develop on their own? What mechanism existed at that time that could have forced the synthesis of molecules and in general the carrying-out of this entire chemical process? Such a mechanism clearly requires an agent and is not just some chance occurrence. In such cases, creationists credit the emergence of life to God, naturally, while scientists of Hoyle's type ascribe it to the cosmos in accordance with the theory of panspermia.

It is quite interesting that Friedrich Schelling, the unique philosopher, managed to unite God, cosmos, and chance in his conception of life. In his work *On the Soul of World*, to which I have referred several times already, he thoroughly analyzed the entire literature available at the time on the organic world and arrived at the conclusion that life is a chance phenomenon and is not a manifestation of purposefulness. He wrote:

1 Gish, *Origin of Life: Critique of Early Stage Chemical Evolution Theories*.

> That animal matter emerges at all, cannot appear to us as the *goal* of nature, since this emergence only takes place through the action of blind necessary laws. But the fact that this matter acquires in its forming a certain *form*, we can think only as a chance consequence of nature's action, and therefore only as a goal of personified nature, for nature's mechanism does not *with necessity* create a certain form.[1]

This was written in 1797! Schelling offered convincing criticism of the vitalists' *vital force*, but in the current context, his reasoning about the interaction between chance and law is more important. Schelling writes, "*Nature must be free in its blind regularity and, vice versa, regular in its complete freedom*"—and almost as by Hegel—"*in its regularity* [nature—*A. B.*] *is not subject to laws, and in its non-subjection to laws it is regular*" (ibid., 147). Thus, Schelling characterizes chance as a regularity lying behind life's emergence that created specifically organized structure out of dead matter.

But where are the cosmos and God? They will appear in a moment in Schelling's work. In his opinion, something else was necessary to bring life to organized matter. This something, of course, was the world soul—the cause of life, so to speak. Here they are both: the cosmos (world) and God (soul). However, if we forget about the soul of world, we will see that Schelling the idealist is much closer to the scientific truth than are the godless materialists and their inevitability of life.

French scientists, for some reason, tend to incline toward the randomness theory. Back in 1970, the French biochemist Jacques Monod, Nobel Prize winner in medicine of 1965, wrote in his book *Chance and Necessity* that the emergence of life was the result of an extremely improbable chance occurrence that is not likely to repeat anywhere ever again. Teilhard de Chardin wrote much the same thing sometime earlier.

Teilhard de Chardin gives no clear definition of life, though it follows from the context of his *The Phenomenon of Man* that it begins with the cell. However, he draws a number of important conclusions that cannot be ignored. He is convinced, for one thing, that "for the naturalist the conviction is growing that the explosion of life on Earth belongs to the category of events that are absolutely *unique*, events which once they are

1 Schelling, *Collected Works in 2 volumes,* I: 137–8.

accomplished are never repeated again."[1]

The chance approach usually coincides inevitably with the idea of a leap in evolution, and Teilhard de Chardin, naturally enough, recognizes the latter (ibid., 50). Another important thesis of his that cannot be ignored is that "life possesses a force of expansion as invincible as that of a body that dilates or vaporizes" (ibid., 62). Life manifests itself in expansion, conflict, and struggle "by reproducing itself beyond count." In this way, life ensures that it will have a chance to survive and a "chance to advance" (ibid., 66).

Teilhard de Chardin, however, advances some theses that accord poorly with each other. On the one hand, he believes that life realizes itself through a technique of *trial and error*; i.e., life advances on a wide front, preserving itself and continuing its advance only in those areas where the conditions prove suitable. On the other hand, he also speaks of *directed chance*, or directed complication (ibid.), and this idea even acquires the status of a law of life in his work. Teilhard de Chardin writes that the transformation of life "provides a direction—and consequently proves that the evolutionary movement has a direction" (ibid., 95). Elsewhere, he writes, "Life proceeds not only by strokes of luck, but strokes of luck that are recognized and grasped, that is, psychically selected" (ibid., 97, footnote).

The problem with this approach is that "chances" and "directed chance" or "directedness" in general are mutually exclusive. As for "psychically selected strokes of luck," they can be attributed—with a big stretch—to one of the late stages of life's evolution (when the nervous system emerged) but cannot be conceived of as governing the preceding stages—for example, biogenesis or, earlier still, geogenesis. Still, even Teilhard de Chardin's idea of the chance character of life's conception is qualitatively in contradiction with the conceptions of life predetermination in the form of hidden information, toward which the adepts of the anthropic principle, as well as those of all the variants of reductionism and their "thinking" atom, lean. In Teilhard de Chardin's conception, the main thing is the idea of *the leap* and of life's expansion that is ensured by certain fundamental laws, including the second law of thermodynamics.

Teilhard de Chardin had little interest in how much time was needed for the first bacteria to emerge since he was thinking on the philosophical level. Nevertheless, the problem of time is important indeed. To a certain degree, it resembles the problem of the Big Bang and the subsequent three

1 Teilhard de Chardin, 59.

minutes. The interval between the decline in the number of large comets and the time of the first fossilized bacteria cannot have been longer than 200 million years. Is that enough for the first self-reproducing cell to have arisen? The majority of biologists answer in the affirmative.

In the description of an American scientist we have encountered here before, A. Delsemme, it transpired in the following manner: Cellular life began with the three-dimensional form of the ferment, which gave them their specificity (for example, the ability to take on the form of another molecule, like a key in a lock). The opponents of randomness have calculated that there is only a 1 in chance of an amino acid that is needed to build the required geometric structure being formed accidentally. Furthermore, the chance is only 1 in 10of the active site (center) being located in the best part. Thus, the chance is only 1 in 10 = of obtaining the required ferment that would be capable of functioning. Three billion years would have been needed to form it by chance! However, this is not the essence of the problem since the process would have taken place in billions of places in the depths of the early seas. Three years would have sufficed for the needed ferment to form by chance in at least one of these spots. The problem is that, to form a basic bacterium, about 2000 ferments are needed, each with its specific forms and differing catalysis' actions. In order for them to emerge by chance, at least = attempts are necessary. Fred Hoyle was perfectly correct to compare this to the chances of "a hurricane assembling a Boeing-747 from debris in a junkyard." [1]

The enormous unlikelihood of a bacterium's accidentally forming in a time period of 100 million to 200 million years led Hoyle and Wickramasinghe to the hypothesis that bacteria existed in comets. But, on the whole, their argumentation has proved unconvincing. In Delsemme's opinion, this is because they based their calculations on pure randomness. They attached equal probabilities to all the possible chance occurrences involved in the assembly of a bacterium from scratch. Despite the bacterium's small size, it is indeed every bit as complex as a Boeing 747. However, there is no reason why a Boeing jet or a bacterium must be assembled in just one operation. There are difficulties, of course, that lie in the nature of the evolutionary process, in which all proteins involved must assist each other and act in concert for the sake of preserving the whole organism.

Some recent research has helped clarify this issue. It suggests that the emergence of life was due to the collective qualities of polymers as

1 See Delsemme, 150–1.

evidenced by their catalysis properties. This explains the interest in the fact that RNA are autocatalysts. M. Eigen resolved this problem through the idea of chemical hypercycles that are capable of evolution. The main essence of the hypercycle is that it provokes different chemical reactions that take place at the same time as various mutually interacting feedback schemes.

Here is an example of the simplest hypercycle as described by Delsemme: Three reaction products—*A*, *B*, and *C*—influence each other indirectly. *A* catalyzes the reaction that leads to *B, B* does the same for *C*, and *C* does it for *A*, closing the feedback circuit. Should some of the reactions produce $A_{1,}$ $A_{2,}$ $A_{3,}$ etc. that are less suitable for survival, they will bring about the disappearance of the whole cycle. The same applies to $B_{1,}$ $B_{2,}$ $B_{3,}$ $C_{1,}$ $C_{2,}$ $C_{3,}$ etc. If *A* survives, it is because it has selected the correct choice for *B* and *C*, and vice versa. Thus, a hypercycle is the machine for selecting and coding the correct information for survival with the fewest expenses and starting with zero information. In a word, the Darwinian mechanism for evolution on the level of the species and survival of the fittest are also perfectly valid on the level of purely chemical processes (ibid., 152).

Laboratory research shows that the brevity of the time period available for early life to form on Earth is not a problem. With the simplest ferment, which includes only a small group of amino acids and perhaps some RNA fragments, the hypercycle can produce the first protobionts in less than 100 million years, and thus the road would be opened for the first bacteria.

We can summarize all this as follows: Prigozhin's dissipative structure that is necessary for life can be brought about by a simple scratch without necessary primary information, while Eigen's hypercycle wedges itself into the evolution of species and the survival of the fittest on an extraordinary chemical level. Thus, genetic information is initially coded in the survival of the most suitable chemical process and accumulates in the small stages that are most probable at any given time. The objections raised by those who feel intuitively that life is too complex a phenomenon to emerge by accident are thus removed, and the quantitative calculations for this problem in the spirit of Hoyle and Wickramasinghe have proved their utter irrelevance. "We can in fact readily accept," Delsemme concludes, "that 'life' is a very probable physico-chemical phenomenon that will appear soon after the prerequisite conditions are met. On the Earth, it could easily have emerged in the time available after the biosphere emerged as a result of the cometary bombardment" (ibid., 153).

It follows from the above that the emergence of life is due to a chance occurrence that had a high degree of probability. This means that nature did not pursue a conscious goal of creating life. However, since it did emerge, its regularities formed following the same principles along which regularities developed in inorganic nature after the Big Bang. Scientists are continuing to discover the laws and regularities governing the organic world.

Progress and Complexity

Is progress inherent to the organic world? With rare exceptions, the majority of scientists, regardless of school or different ideology, answer this question affirmatively. Moreover, they are convinced that progress is not only present, but it is inevitable. If this is indeed the case, what exactly is progress?

This Latin word means *advancement forward*. What does *forward* mean? In one biological encyclopedia, we read, "Progress in animate nature is the perfection and growing complexity of organisms in the process of evolution."[1] Since this definition is too general, the Soviet biologist A. N. Severtsev suggested (in 1925) drawing a distinction between it and biological progress, which is "the result of the success of the given group of organisms in the struggle for survival, characterized by the growing number of individuals in this particular taxon, the expansion of its range and its splitting into subordinate systematic group, and morphophysiological progress, which is the evolution of organisms on the way of growing complexity and perfection of their organization" (ibid.).[2] Let us note that in all definitions of progress, we inevitably come across the word *complexity* in combination with *purposefulness*. The latter, naturally—in Julian Huxley's interpretation, for example—must lead evolution in the direction of a sentient being.[3] It follows that the only branch of evolution that is *progressive* leads to man.

Even if one agrees with this thesis or in general with the idea of

1 *Biological Encyclopedic Dictionary*, 507.

2 Iordansky gives a detailed analysis of Severtsev's views, along with those of other Russian scientists, on the concept of ""evolutionary progress."" See Iordansky, 359–84.

3 See Huxley, *Evolution,* chapter 10.

purposefulness, one has to keep in mind that "the progressive branch" could not emerge from nothing. In the course of the evolutionary struggle, it differentiated itself from a multitude of "nonprogressive branches," which means that all branches participated in the progress of man's emergence. Therefore, the entire evolution of the organic world is progress. Thus, we slide once again back to the theory of foreordainment, which is highly dubious at the very least.

Moreover, what is complexity in the biological world? Is it truly inevitable, and does it necessarily lead to progress? Pierre Teilhard de Chardin answered this question unequivocally: "From the beginning, matter has, in its own way, obeyed the great biological law of 'growing complexity.'"[1]

Many scientists from different schools and camps adhere to this position. However, a number of questions arise that the proponents of complexity do not answer for some reason. For example, what about the matter in the universe where no biological world exists? Even here, on our planet, the biological world emerged only 1.5 billion years after the Earth's formation. So where is this "from the very beginning"? In addition, there is no guarantee that a more complex organism is destined for progress, i.e., for advancement forward or, in other words, for survival. Dinosaurs are obviously more complex than bacteria (as is every organism that appeared after the latter), but bacteria are reigning to this day and will apparently continue to do so until the end of the universe while the former have departed. This applies also to billions of other organisms that have existed on Earth and have disappeared forever. Moreover, nature offers us examples in which "excess" complexity proves to be harmful while the simplest organism survives. (The same phenomenon exists in social development, but this will be discussed in the subsequent section.) All of this means that it is wrong to assert that complex organisms are better adapted to environment.

The renowned and popular English biologist Richard Dawkins defends this idea supremely doggedly. His term *the best adapting organism* has no meaning unless a concrete environment is specified. On this issue, I am entirely on the side of Gould, who emphasized constantly that the use of the term *complexity* is not justified. He perceived this term as a surrogate for *progress*, which he regarded as a harmful conception based on ideological prejudices. He writes, in particular, "I believe that the most knowledgeable students of life's history have always sensed the failure

1 Teilhard de Chardin, 18.

of the fossil record to supply the most desired ingredient of Western comfort: a clear signal of progress measured as some form of steadily (growing) complexity for life as a whole through time."[1] Elsewhere, he writes, "We are glorious accidents of an unpredictable process with no drive to complexity, not the expected results of evolutionary principles that yearn to produce a creature capable of understanding the mode of its own necessary construction" (ibid., 225). In his works, Gould demonstrates with thousands of examples how this or that complication was accidentally created in this or that link of the organic world's evolutionary process. Besides, these links occupy a minuscule part of the organic world against the background of the domination of "simple" organisms. He speaks out furiously against the thesis that progress governs the evolution process—not because he is opposed to progress, but because the notion of progress as growing complexity is in contradiction both "to conventional deterministic models of Western science and to the deepest social traditions and psychological hopes of Western culture for a history culminating in humans as life's highest expression and intended planetary steward."[2]

By the way, modern scientists are not as quick with answers to the questions "what is progress?" and "what is complexity?" The American Roger Levin, who writes of the theory of complexity (as a branch of science), tells of the difficulties he had in trying to extract definitions of *progress* and *complexity* from different scientists. Information specialists usually reduced the whole matter precisely to information. In particular, Norman Packard (from Prediction Company) said, "Biological complexity has to do with the ability to process information."[3] *Complexity* was defined in the same vein by the authors of a classic textbook on evolution (1977) by T. Dobzhansky, F. Ayala, G. L. Stebbins, and J. Valentine. The biologist Stuart Kauffman of the University of Pennsylvania declared that the concept of complexity is a rather complicated thing and advised Levin to contact Dan McShea, a biologist at the University of Michigan and an expert on this topic. McShea told Levin, "Complexity is a very slippery word. It can mean many things." Biologists are currently very uncomfortable with the idea of progress because of the connotations of an external guiding force. McShea said, "It's acceptable to talk about complexity, but not progress" (ibid., 133). Still, McShea failed to say anything distinct about complexity.

1 Quoted in Davies, 224.
2 Gould, www.geocities.com.
3 Levin, *Complexity: Life at the Edge of Chaos*, 137.

The problem is indeed not simple. Here, we again encounter the categories of Objectivity and Subjectivity, and the use thereof requires understanding of their spheres of applicability. The universe and the organic world exist objectively, outside our consciousness and will. The notions of progress or complexity are not inherent to them; they exist by themselves under the laws of nature. The task is to uncover these laws, not to force them on nature. When we attempt the latter, we only fool ourselves; objectivity remains hidden while subjectivity is deceived. One of these self-delusions is the urge to ascribe goal-setting to nature, an original purpose to the universe. Actually, we implement a postulate, an objectively existing deterministic sequence: complexity–life–thought, or progress: $\in$ (complexity, life, thought). It is to be noted that a lot of prominent scientists argue against such a construction. Apart from those mentioned above, they include the biologists J. Simpson and Ernst Mayr, the physicist-chemist P. Atkins, and others. It is curious that even I. S. Shklovsky, one of the fiercest proponents and organizers of the CETI (Communication with Extraterrestrial Intelligence) program for searching for extraterrestrial civilization, a man who believed deeply in the multiplicity of intelligent life in the universe, was compelled to admit eventually, “It is perfectly unnecessary that life, having emerged on some planet, would *become sentient* at some stage in its evolution.”[1]

But it did become sentient! And this is, among other things, due to the growing complexity of nature. No one even disputes this. The objections are caused by the idea that the growing complexity inevitably leads to sentient life, which is *not* true for a fact. Moreover, this hypothesis is refuted by a multitude of facts regarding the reality of evolution. As for complexity itself or the process of growing complexity, they exist as objective reality, inherent to the being of the universe. Some scientists even believe that laws of complexity exist that create information—or at least segregate it from the environment—and “weave” this information into material structures.[2] These laws can also manifest themselves through “informational forces.” Eigen leaned toward this approach.

However, one should keep in mind that in the process of growing complexity as such, there is no mysticism. For example, there are different mathematical games, some of which are even called Life, where the structure of a system grows more complex following certain given rules. These models reflect processes that take place in the real world. However,

1 Shklovsky, 158.
2 See Davies, 215.

it is necessary to keep in mind what Atkins wrote: "The point of these games is that each one shows that attributes of our present universe, such as complexity, stability, and apparent purposefulness, emerge as the consequence of simple events played out under a gentle rein of rules.… Nothing is more remarkable than consciousness, and nothing is more awesome than that its heart is simplicity."[1]

I would like to draw certain preliminary conclusions from the above. First, complexity does exist as a phenomenon of being as such, but its transformation into organic complexity is clearly limited to small islets in the universe. Second, it does not necessarily evolve into intelligence. The latter is possible under an extremely fortunate coincidence of circumstances having to do with the environment as well as the subject itself. Third, I proceed from the assumption that progress does not exist either in the organic world or the inorganic one. It exists only where reason is present, and reason is inherent only to man—the sole phenomenon in nature with which life begins.

What Is Life, or Where Is Its Beginning?

This question was posed point-blank by E. Schrödinger, though many scientists have struggled to answer it throughout the history of mankind. One cannot say that scientists have made a reply; the answers have been coming since the earliest human history, and they have satisfied society's needs in this or that time period. However, the development of science in the last two centuries has refuted the ancient and medieval scientists' ideas about life, and as a result, science is raising the question again: what life is? Once again, answers are coming in without delay. But the mere fact of their multiplicity indicates that the problem remains debatable. Engels, for example, believed that "life is a method of existence of protein bodies, the essential aspect of which is *constant exchange of substances with the surrounding external nature.*"[2] He admitted, however, that this definition is insufficient.

In the 20th century, naturally, knowledge about life became more profound, and the definition of life became modified. In one biology textbook, the main properties of living organisms are listed as follows: 1)

1 Atkins, 196–7.
2 ME, 20: 265–6.

unity of chemical composition, 2) exchange of substances and energies, 3) self-reproduction programmed in DNA, 4) capacity for growth and development, 5) irritability, and 6) discreteness.[1]

The prepared reader will object right away to several points in these listed properties that are supposedly inherent to living organisms. Take, for example, item one. It is clear that the same chemical elements make up the composition of living and nonliving nature; therefore, it is necessary to specify that in living organisms, the proportions are different (four elements comprise 98% of the bodies of living organisms: carbon, oxygen, nitrogen, and hydrogen). Item two also should be explained in more detail, which the authors of the textbook actually do. However, biosynthesis (or photosynthesis) makes it more difficult to weasel out of this point, since, for example, fungi, which are classified as plants, do not have this ability. As to item three, self-reproduction, we must remember viruses, which, according to other criteria, are more like molecules than life-forms. But perhaps life begins precisely with the molecule? As for capacity for growth, chemical polymers have it, too; irritability or sensitivity also applies to metals, which are prone to fatigue and decay. Moreover, these kinds of definitions are so broad that, in principle, practically any material structure can fit into the category of Life. Thus, the so-called cosmists, who are quite popular in Russia, manage to endow with life—and even consciousness—the electron[2] or plasma[3] (therefore, the Sun and every other flaming cosmic object not only lives, but it also thinks).

Not very far from them are some specialists in biology whose works are recommended as textbooks. For example, in one textbook, the organization of living systems on Earth begins at the molecular level.[4] It is possible that life begins at this level, but the question of why precisely this level is defined as the beginning of life has no answer. R. Rovinsky, who was already mentioned in the preceding chapter, believes that ever since the emergence of bacteria about 3.5 billion years ago, life has "controlled completely the terrestrial cycle of carbon."[5]

1 *General Biology*, 5–6.

2 One of these eccentrics writes, "There are no doubts that *the electron, possessed of its own fine-field structure, is capable of perceiving and transmitting elementary information*" (author's italics). Balyberdin, The Mystery of the Conception of the Universe, 84.

3 Berdyshev, *The Laws of the Cosmos*, 361–4.

4 See Bogdanova, *Biology: Problems and Exercises*, 11.

5 Rovincsky, *The Evolving Universe*.

Sometimes the definition of life is approached from another direction—certain qualities or properties are ascribed to it. For example, the Russian scientist S. H. Karpenkov claims (albeit with a large degree of caution), "The living thing is a material system endowed with the property of purposefulness."[1] We shall return to the topic of purposefulness later, yet now let us note this.

Academician V. Vernadsky, one of the most prominent Soviet scientists made a clear distinction between *inert* and *living* natural bodies; between the two there "exists a sharp impassable border."[2] The living substance he described as a living organism is characterized by qualities that are absent among inert bodies, namely, the ability to be born; to possess the spatial properties of right and left and irreversibility in time; and to increase the free energy of the biosphere; as well as a certain size range (between 10 and 10 cm, a range of 10) (ibid., 174, 180–182). Please pay particular attention to the last trait, for Vernadsky designated a system of coordinates for the functioning of the organic world. He was disposed negatively to ideas of existence in the living world of "special life forces" (the conception of vitalism) and argued decisively, "*There is no 'life' in the biosphere outside of the living organism*" (ibid., 194). He was also skeptical of the idea that life was blown in from outer space, even though he did not exclude it in principle. I shall revisit Vernadsky in connection with the topic of the noosphere, but right now, I want to note certain things of principle. First is the asymmetry of living organisms (rightness–leftness). Vernadsky believed that in the biosphere, only living organisms possess this property. Second, Vernadsky introduced the word *ectropy*, meaning the accumulation—or, more precisely, the increase of—free energy in the biosphere as a result of the radioactive decay of elements and biochemical energy, that is, a process opposite to entropy.

I want to draw attention to this property of leftness–rightness inherent to the organism, as stated by Vernadsky. This very important aspect was noted long ago by Louis Pasteur ("the asymmetrical principle"), J. Bernal, I. S. Shklovsky, and others. Pasteur in particular connected the asymmetry of living systems to a certain asymmetry of the universe. This idea received no further development. However, the problem of *chirality* (the arrangement of molecules in only one of the two possible spatial structures) continues to remain a very serious topic since sometimes it is precisely the transition from racemate (the chaotic location of molecules

1 Karpenkov, *Conceptions of Modern Natural Science*, 366.
2 Vernadsky, *Philosophical Thoughts of a Natural Scientist*, 177.

in space) to chirality that is called the criterion for separating the living from the nonliving. This transition did not take place in the course of evolutionary development; it was the result of a leap.[1]

Not long ago, it was reported that the team of Graham Cooks at Purdue University (West Lafayette, Indiana) discovered the cause of left-sided orientation of the first building blocks of biological molecules. The team determined that the left-sided serine molecules are easily capable of forming chains in which all links are strongly connected to each other. The left-sided serine clusters in turn connect to other left-sided amino acids by themselves. The right-sided serine, in the scientists' opinion, does not have the ability to form strong bonds and for that reason does not possess such manifest "constructor abilities."

Let us now address the views of the Soviet cosmogonist I. S. Shklovsky. Based on the cybernetic approach by A. A. Lyapunov, Shklovsky defines the living substance as:

> a complex molecular aggregate that has a "directing system" that includes a mechanism for passing on hereditary information that ensures the preservation of reactions for the succeeding generations. This is due to the inevitable "noise" in the transmission of such information our molecular complex ("the organism") is capable of mutating, and therefore of evolving.[2]

This definition allows Shklovsky to list bacteria and blue-green algae as organisms in which the main dividing line between molecules or their combinations (for example, amino acids) and the single-cell organisms is the mechanism of heredity—in other words, the mechanism of replication, or reproduction. Shklovsky writes, "Life only emerged when the mechanism of replication started functioning. Any combination of amino acids and other complex organic compounds, no matter how complex, is not yet a living organism" (ibid., 151). However, nucleic acids (unlike proteins) are capable of replication; i.e., the beginning of life can be seen in RNA (or DNA). Also capable of replication, by the way, are blue-green algae, which do not have a formed cellular nucleus and procreate in a "sexless" fashion. Viruses are nuclear-free cell-free formations, and they are also capable of reproduction. Walter Hollitscher believed, for example, that "the nuclear-free forms are the beginning of the existence

1 For more detail, see Karpenkov, 340–1.

2 Shklovsky, 143.

of organisms."[1] Still, something is missing here.

Let us now analyze the views of some Western scientists on this topic. Among them, we also observe a wide divergence of opinions about life: from "life is all of nature" to truly scientific conceptions of life. An example of the former is found in the views of Christopher Alexander, who writes in his work *The Nature of Order* that:

> all of what we loosely and traditionally call "nature"…is then characterized by just that actual life which I have identified in the better human artifacts. Within the terms of my definitions, nature as a whole—all of it—is made of living structure. Its forests, waterfalls, the Sahara desert and its sand dunes, the vortices in streams, the ice crystals, the icebergs, the oceans, all of it—inorganic as well as organic—has thousands of versions of living structure.…The living character of these structures is different from the character of other conceivable structures that could arise, and it is this character which we may call *the* living character of nature.[2]

This resembles very strongly the idea of Leonardo da Vinci of nature as a living organism, with the sole difference that Alexander ultimately moved to the idea of a God who breathed *life* into this nature.

This sort of definition of life, amounting to a return to the times of Aristotle, usually issues from people who are not professional biologists—that is, mathematicians, physicists, and "technology scientists." It seems to these people that since they have managed to decipher the fundamental phenomena of nature, they are capable of saying something about such "trifles" as life. Curiously, they are not so rash in their own professional spheres.

Professional biologists are less categorical in their views on life. For example, John Bernal even believed "there may have been no precise beginning of life."[3] He writes:

> In the active equilibrium brought about by the continuous transformations between one chemical and another, certain cycles

1 Hollitscher, 385.

2 See Alexander, *The Nature of Order: An Essay on the Art of Building* and *The Nature of the Universe*, Vol. 1. "The Phenomenon of Life," 292–3.

3 Bernal, *Science in History*, 640.

> may have become established which were self-perpetuating—molecule A making molecule B and so on till molecule Z makes molecule A again. At this stage, in the biochemical sense, the whole medium might be said to be alive, though no organisms existed. But such life would obviously always be liable to dissolution. Only when large polymer molecules were produced—proteins or their precursors—could these little worlds of chemical processes pull themselves together, cut themselves off from the surrounding water, and become the first organisms from one of which all later life is descended. This may have occurred in some of the ways indicated thirty years ago by Oparin and Haldane. (ibid.)

Proceeding from the above, one may suppose that Bernal recognized the "living medium" as a vital substance, for example, the original "broth" in which life congealed. However, such life is too fragile, and real life starts with the separation from the medium, i.e., from the moment a certain autonomous integrity was established that is capable of subsequent reproduction. If this is the case, then it follows from Bernal's definition that life begins with *bacteria*.

The topic of bacteria has been researched in detail by the American biochemist Carl R. Woese, who traced the genealogy of the bacterium, using as the basis of his analysis the unfolding sequence of RNA in ribosomes as a universal part of evolution. Woese suggested that organic life started with one universal progenitor that split into three subkingdoms: Archaebacteria (ancient bacteria), Eubacteria (true bacteria), and Eukaryotes. It was the latter that started the chain of organisms that led all the way to man. However, it is important here to note the following: from these eukaryotes arose over 2 million branches of "life" (that we know of today), and only one led to man. Researchers also argue to this day over what exactly the common hereditary traits of bacteria and eukaryotes were. Some scientists believe that it could have been just one trait. Organic life may have emerged many times in different parts of the biosphere, but very often it unraveled, due first to natural cataclysms and second to competition and the survival of the fittest. Be that as it may, the search for "the beginning of life" provides no answer to the question of WHAT LIFE IS.

Considering the failures of earlier attempts, and for that reason being careful in summarizing all the available definitions, C. Villee, the author of the widely known book *Biology*, defines life in the following fashion: "Inherent to all living organisms...are a certain size and form, metabolism, mobility, irritability, growth, reproduction and adaptability....Inanimate objects can possess one or several of the properties listed, but they never exhibit the whole lot of these properties at the same time."[1] It is easy to notice that this list can be supplemented with more properties, for example, heredity and changeability; that plants, viruses, and many bacteria are immobile, while amoebas have no form; and so on.

Armand Delsemme, as does Bernal, believes that life begins with the first bacteria that emerged 3.5 billion years ago. The 11 different kinds of bacteria discovered by the American paleobiologist J. William Schopf (of the University of California, Los Angeles) in the siliceous layers in West Australia go back at least that far. The diversity in these 11 groups is evidence that these microbes had already existed for a sufficiently long time to become different from each other. Their analogy to cyanobacteria (called *blue-green algae* in botany) is evidence that the microbes were already using sunlight for extracting carbon from it as a "food" (building material). As a result, half of the oxygen was released from the molecule into the atmosphere, just as cyanobacteria and plants do today. In the subsequent 3 billion years, an enormous quantity of stromatolites emerged. They formed rocks composed of colonies of bacteria that also used sunlight. Thus, Delsemme believes that life begins with the first bacteria, and the task is to determine their "fundamental difference" from "the mineral environment."

A group of scientists (Claus Emmeche, Aletta d'A. Gelin, and James Doyne Farmer) suggest a list of basic components that differentiate living organisms from nonliving bodies. The list includes 1) auto conservation (the trait of continuing preservation of the organism), 2) auto reproduction, 3) storage of information (DNA), 4) metabolism, 5) stability (in interaction with the environment), 6) control (enabling protection of the group's identity), 7) evolution (the mutation and natural selection), and 8) death.[2]

I have not yet reflected in these pages on the meaning of death, but it really is one of the most important components of life. Engels even offered the definition that life is death. Leaving aside the philosophical content of the concepts of Life and Death (which imply each other), death is inevitable from the perspective of passing on heredity and continuation of the genus. In other words, the immortality of ontogenesis would mean the absence of phylogenesis, without which ontogenesis does not exist

1 Villee, *Biology*, 24.
2 On the website of Eduardo Díaz, or see www.linkexchange.com

(after its launch, naturally). So it is a vicious circle. The death of the organism not only gives the opportunity for phylogenesis to emerge, but it also creates the possibility of increasing the duration of its "life" within the framework of the organic world (and at the stage of human society, it is theoretically conceivable to increase it to the end of the universe). But that is a separate topic that we shall revisit.

Paul Davies, who was quoted above, has some interesting ideas for the definition of life. He states 10 components that comprise life and provides curious commentaries on some of them. For example, almost all authors mention metabolism as one of the most important components of life. However, metabolism cannot be equated with life. "Some microorganisms can become completely dormant for long periods of time [for example, spores—*A. B.*] with their vital functions shut down. We would be reluctant to pronounce them dead if it is possible for them to revived."[1]

It was mentioned above already that many scientists include in the organism the ingredient called *complexity*. Davies includes it, too, but with a qualification. One of the components of complexity is the unpredictability of the object. For example, if we throw a live bird and a dead one up in the air, it is easy to predict that the dead one will drop to the ground while the living one will fly away in an unknown direction, even though gravity affects both of them. At the same time, it is easy to predict that a chick will hatch from a chicken's egg while it is impossible to predict the size and structure of the next snowflake or the behavior of a hurricane. In Davies's opinion, the explanation lies in the following: "The crucial difference is that the chicken is made according to specific genetic instructions, whereas lamp blobs, snowflakes and eddies form willy-nilly. There is no gene for a snowflake. Biological complexity is instructed complexity or, to use modern parlance, it is information-based complexity" (ibid., 6).

According to Davies, one important component is "organization," which could be called "organized complexity" or "bound complexity." (Let us recollect that Schelling wrote of "organization" as one of the crucial components of the organism.) This important component demonstrates that the parts are bound together in a certain integrity (when the part does not function without the whole and the whole does not function without the part). Davies also introduces the terminology of computer technology to the organism: hard- and software, with proteins being the former and nucleic acids being the latter. This analogy looks useful to me.

1 Davies, 9.

Based on all this, Davies draws a very important conclusion: in the organism, "there is no such thing as a living molecule, only a system of molecular processes that, taken collectively, may be considered alive" (ibid., 11). He emphasizes that of all the listed components of life, the most important are, after all, metabolism (breathing, eating, drinking, and excreting) and reproduction. Of these two, the latter apparently is more important since "the secret of life comes instead from its informational properties; a living organism is a complex information processing system" (ibid., xviii).

I would like to present here one more unusual definition of life that I found in a scientific dictionary: "Life is the ability to grow, reproduce, and respond to such stimuli as light, heat, and sound."[1] The word *sound* suddenly makes an appearance here. Generally speaking, all the other components listed can be applied to nonlife, but as for sound, the organic world really does react to it qualitatively differently from the inorganic world.

One can go on endlessly presenting other definitions of life, but it will add little to what was already said above since no one has managed to justify the dividing border between life and nonlife. Most importantly, what is the criterion of this border? Another possible variant of defining life is to justify certain laws inherent only to the *living*. Therefore, it makes sense to examine on the basis of which laws, if any, the organic world realizes itself or, to use Hegel's term, manifests its *being-for-other*.

Laws of the Organic World

It would have been logical to ask first of all the question, what laws of the organic world can be stated if we still do not understand what life is and where it begins? Strangely enough, this situation is not uncommon in science. It is possible to evaluate the essence of being in its manifestations even through laws without penetration into the causes of it. In physics, for example, quite a few laws have been discovered without understanding the causes of their emergence. No one knows what gravity is, but the law of universal gravitation has been formulated nonetheless. The same applies to *mass*: no one knows what it is, but it is present as a concept in

1 *The Hutchinson Dictionary of Science*, 371.

the formulations of many laws of physics. Chemistry has been developing as a science for over two hundred years, but until the 20th century, it did not become clear what it is that it studies. This is also true in the case of the organic world; it is unclear where it came from and what life is, but the laws are in place.[1]

Let us take a look at some of the organic world laws in simplified and schematic form since the details are described in special scientific literature.

Reproduction is the process of copying that enables an organism to produce another one identical to itself. This regularity is observed in the reproductive processes of bacteria, plants, and animals. However, the process of reproduction (in itself) is insufficient for singling out the organic world as integrity. For example, when a crystal is placed in a saturated solution, it grows and reproduces the crystalline structure of neighboring atoms. But the organic world requires one more process that is different from simple reproduction, namely, evolution.

Evolution reveals itself through the categories of duration or stretching over time necessary for transmitting information to new copies. Evolution resolves the famous paradox, which comes first, the chicken or the egg? The chicken was formed through lengthy evolution of the biological world over millions and millions of years, and thus its course of evolution can be traced all the way back to the original cell that emerged over 3.5 billion years ago.

However, in order for these two processes (reproduction and evolution) to work in the organic world, a structure that is capable of stabilizing the series is necessary. These processes must also be supplied with the energy and with certain substances required for the making of duplicates. This structure must code the copying of “instructions” and then “read” them in order to transmit them to another organism.

The cell is this principal structure, and the primitive form of the organism consists of one cell. The separation of the cell from its environment is ensured with a semipermeable membrane. It enables the cell to be relatively autonomous from the environment. The substance required for duplication arrives from the outside (nutrients), and the

1 I know well in how many ways the word *law* can be interpreted (for example, regularity, empirical generalization, rule, etc.). Though law will be discussed in more detail later, I will present my formulation here: *law is a concentrated manifestation of force that reveals the forms and methods of matter’s motion*. This is what this definition leads to in development: law is a type of knowledge that makes it possible to forecast the motion of matter in coordinate systems.

necessary energy is produced by the process of metabolism.

The genetic code. The discovery of DNA made it clear that the "instructions," or the chemical code, is coded in DNA, which is passed on to each next generation. RNA is the transmitter of the instructions.

The evolution of genetic message. The process of evolution is in fact rather simple since it rests on two principles: 1) mutation—errors in the copying of the genetic message and 2) survival of the fittest—those who adapt best to the environment.

The first principle is based on the impossibility of avoiding errors in the transfer of the genetic code. In one way or another, an error of some sort occurs. A typical error involves the incorrect reading of a "punctuation mark" or a "stop signal" (DNA consists of 20 different amino acids plus three "punctuation marks" needed for breaking the message at the appropriate spot). The genetic code can then be copied a second time until the "encounter" with the "stop signal." In this case, two identical codes can be transferred to different cells in the subsequent generations. In the future, the cells may differ even to a greater degree as errors are copied in two codes. It is amazing that the degree of the error copied stays constant, occurring once per billion pairs of basic copies. Such rarity is caused by the fact that a process of error correction exists that removes the errors or corrects the code. However, since the length of the molecular chain to be copied is enormous (for example, man's DNA contains over 10 billion pairs of bases), a few dozen errors are guaranteed for each copy in the duplication of a cell.

Delsemme noted an interesting regularity: the early forms of organic life started evolving with an extremely brief genetic code, which hints that the first organisms were simple, possibly even simpler than viruses. We know that viruses behave as parasites; they can survive and multiply within cells, but their system of reproduction is simpler than that of most primitive cells. Their genetic recipe is written down in either the DNA or the RNA, but the two are never combined. At the same time, the simultaneous existence of DNA, RNA, and ribosomes in the majority of elementary bacteria speaks of a big step on the road of growing complexity.

Moreover, the steep rise from viruses to bacteria and the slower progress from bacteria to plants and animals is due to the fact that RNA, which among other things destroys introns (bad or erroneous DNA), was not stabilized and, therefore, error rate was still enormously high. The evolution of simple organisms is exceedingly fast. To become convinced of this, it suffices to recall the common cold virus that changes every year and thus defeats efforts at creating an effective vaccine.

Survival of the fittest. A particular individual that possesses the characteristics, which give it an advantage over other individuals in the same species, may adapt better than others to the environment. However, the nature of this advantage means little from the perspective, say, of finding food, defending against predators, or protecting against climate change. But it means a lot when this advantage increases the relative quantity of offspring *in a geometric progression* compared to the preceding generations.

Darwin described the mechanism of natural selection. Later, in the 20th century, the neo-Darwinist geneticists showed how this natural selection proceeds on the level of molecular biology.

A phenomenon also worthy of research is, as I would call it, the law of acceleration. Academician Oparin also noted in this connection, "Nature's path from the initial protobiont systems to the most primitive bacteria… was at least as long and as difficult as the path from the amoeba to man." The actual picture is quite different, as made obvious by the method for calculating the speed of evolution suggested by Delsemme. Its essence is that the maximum quantity of information that can be contained in the genetic communication of different organisms should be viewed as a function of the time since their emergence, calculated in billions of years. The quantity of information is naturally tied to the organism's degree of complexity. It is obvious that at the moment of the protobionts' emergence on Earth, the genetic information must have been very brief: between one and ten "words" (for simplicity's sake, Delsemme uses *words* to calculate information; a five-letter word usually contains about 100 bits of information). Thus, these "ten words" correspond to approximately 4 billion years. The road from the protobiont to the primitive bacterium took about 1 billion years (between 4 and 3 billion years ago); the increase in information was from approximately 10^2 to 10^4. From bacteria to blue-green algae, information increased from 10^4 to 10^6, and this took about 2 billion years (between 3 billion and 800–600 million years ago). The remaining time period—from algae to animals—saw information quantity increase to 10^8.

Presented above are the main blocks of the organic world, which are the "legislative basis" of this world. In each of them, the fragmentation of organic matter takes place that subordinates its own particular laws or regularities. These are numerous; it suffices to browse through any biology textbook to become convinced of that. As an example, here is one of the laws of biogenetics formulated by E. Haeckel: "Ontogenesis is a brief and quick repetition of phylogenesis, conditioned by the physiological functions of heredity (reproduction) and adaptation (nourishment)."[1] In the field of genetics, which appears to be the most fruitful one from the perspective of the development of science, there also exist different particular laws, for example, the Hardy-Weinberg law of genetic equilibrium (1908) or the law of homologous series of hereditary mutability discovered by N. I. Vavilov.

The above refutes the position of those who deny the presence of laws in the organic world, who generally believe that this world does not exist as an independent integrity but is rather simply a part of the world "in general," implying in this "general" only the physical world. Such statements are caused to a degree by the failure of attempts to define life and, therefore, the failure to find a criterion for demarcating life from nonlife. Is there an exit from this apparent dead end? It seems to me that there is.

5

The Philosophy of Orgagenesis

We have encountered a seemingly insurmountable difficulty in defining life. Of course, we could stop struggling over such trifles and simply bestow the name of life on all existing being, as many in fact do. Especially since, in Mephistopheles's wise words, "All theory, my friend, is grey, but green is life's glad golden tree," even if this life's tree becomes red in the Sun or black in black holes. It is all life all the same, and one could put a full stop there.

The problem is in the conclusion *all is life*, which is an empty identity, which means the absence of development, i.e., death. Since life and death do not exist without each other, we have grounds to claim that all is death, and this contradicts our observations and practice. I only needed these philosophical tricks to emphasize once again that the definition of "everything" as life is not fruitful; it is a dead end both in form and content. Therefore, some other variants must be sought for resolving the problem

1 See *General Biology,* 306.

of life/nonlife. Most likely, they lie outside the sphere in which natural scientists attempt to solve it, and some of these scientists have come to suspect that there is something wrong with their definitions of life. For example, Schrödinger writes, "It seems to me that the opinion according to which the fundamental difference of the organic from the inorganic lies not in the object's properties, but in the subject's perspective, is quite deserving or reflection."[1] A century and a half earlier, Schelling, having thoroughly *thought* this problem, stated, "The concept of life *must be constructed*, i.e., it *must be explained* in the capacity of a phenomenon of nature."[2] Naturally, it can be constructed only by man.

Both the philosophizing physicist and the natural philosopher hint that the definition of life can be given only by man. Therefore, this concept is subjective by definition in the sense that it can reflect only man himself. To put it more simply: the universe and its laws exist objectively regardless of whether man exists or not, whether or not he defines it in concepts or in something else. The universe does not care about all this; it does not depend on man. But as for life, we have something else: if there is no man, there is no life. The mutual dependency is absolute. Is this really true? Let us examine several philosophers' views on this topic.

Life Begins with Man

The criterion of life according to Valeryi Gubin. Against the background of biologists' and physicists' approaches to the issue of the criteria of the definition of life, the views of the Soviet theoretical physicist Valeryi B. Gubin appear decidedly strange.

In the preceding chapter, I already mentioned Gubin's name in the context of entropy. He denies the second law of thermodynamics as objective reality but accepts it in the nature–observer relationship. He could certainly be listed among Berkeley's followers if it were not for the militant materialism that he manages to combine rather convincingly with thorough idealism, although he denies the latter. Nonetheless, his approach to the problem of life/nonlife makes a lot of sense, which will become evident once I present the views of other philosophers.

1 Schrödinger, *My World Outlook*.
2 Schelling, 122.

Since Gubin rejects the existence of entropy in general, it appears quite natural that he claims "one cannot separate the living objects from the nonliving based on their entropy readings as is often believed.…The entropy of a living organism is practically the same as the entropy of the same volume of ordinary water."[1]

Gubin is possibly unaware that when entropy is interfaced with the criteria of life, it does not relate to the temperature content of the organism-system; it concerns the orderliness of the system. This is what specialists in entropy talk and write about, in the West, at least. However, I am ready to agree with Gubin's criticism of *useful development*, which is a variant of the concept of Purposefulness. Since this criterion exists on the subjective level, it is inherent not simply in the living organism, as Gubin writes, but only to man, or the observer. If so, it is the observer who will determine what is living and what is not.

To begin, Gubin designates "the existing border," or the criterion, which is "the minimal threshold of non-indifference" of the observer toward the phenomenon. "Non-indifference" means that good may come from something and bad from something else:

> So the truly substantial, critical threshold is the presence or absence of the sense of the type "good–bad." The presence of this sense distinguishes the feeling object from its environment, puts it in a particular relation to it, different from the "relations" of microscopic interactions. Without this sense, the border between it and the environment does not emerge by itself, and it simply does not exist as a separate, independent (by itself) object.

However, only one substratum of matter possesses such sense—man. In other words, life begins with man. But what about bacteria, cells, proteins, plants, and animals, which are listed as living organisms by practically everyone? They simply do not qualify as living. How could this be? Gubin writes:

> What do they care what they are called! Inasmuch, as they do not have senses of the "good–bad" type, then they are indifferent not only as they are named, but to much stronger effects, up to a strength that destroys them completely—in perfect analogy to the attitude to all this of some senseless crystals. Hegel called

1 Gubin, *Physical Models and Reality*.

> sensation the specific difference, the absolute distinguishing trait of all that is animal. This criterion suffices for us here.

In this regard, all talk of "growing complexity of the organic world" and of the nonsocial in general is obvious nonsense. Gubin writes, again quite justly:

> But the notions of "complex" or "many" only appear with the living, with its relation to objects of activity and to the activity itself: the measure is directly linked to this. For the inanimate Nature, complexity does not exist (and neither does information): it does not torment itself, struggling to accomplish something, does not celebrate victories, does not worry if something does not work out.

Darwin described the struggle in the evolutionary world in approximately the same way. Gould also used almost the same words to describe this world. It was not by accident that Gubin remembered Hegel. What he described is directly related to Hegel, to his view of life. Nevertheless, to begin, let us here recollect the positions of Aristotle and Kant.

***Aristotle**'s soul.* To the great Greek, the dividing line between the living and the nonliving was the soul, which, in turn, is "the first actuality of a natural body which has life potentially."[1] In the spirit of materialist dialectics, Aristotle explains the interrelations between entelechy, soul, and body: "And since the product of the two is an ensouled thing, the body is not the actuality of soul, but the latter is the actuality of a certain kind of body. And for this reason those have the right conception who believe that the soul does not exist without a body and yet is not itself a kind of body" (ibid., 34).

In exactly the same tone, Gubin explains the "ideal sensations" in their relations to matter/body. In a similar fashion, dialectical materialism explains the interrelations between brain and thought (a detailed discussion of this will follow).

Considering these criteria, what does Aristotle regard as "living"? We read, "But life is so spoken of in many ways, and we say that a thing lives if but one of the following is present—intellect, perception of movement,

1 Aristotle, *On the Soul*. In John Heil, 31.

and rest in respect of place, and furthermore the movement involved in nutrition, and both decay and growth" (ibid., 33). The presence of the indicated traits enabled Aristotle to designate as "living" the entire organic world known in his time, i.e., plants and animals. One can agree with this or disagree, but it is worth noting that Aristotle introduces a truly qualitative category—Soul—for distinguishing between the living and the nonliving and interprets it quite materialistically. It is another matter that it was believed, in his time, that plants and animals have souls (even today, though, there are quite a few mystics who still believe in these archaic notions). However, if we stand on the position of science, which forces us to exclude the presence of soul in plants and animals, then we will be compelled to admit that life begins with man—the only creature who realizes the concept of the Soul through his own consciousness.

Life according to ***Kant***. One of Kant's works[1] contains a small but very important fragment dedicated to life. I quote it here in its entirety:

> Inertia of matter is and means nothing other than *lifelessness* of matter by itself. *Life* means the ability of the *substance* to determine itself for action, proceeding from an *internal principle*, the ability of the *ultimate substance* to determine itself for change, and the ability of *material substance* to determine itself for motion or rest as a change of its state. But we know no other internal principle of substance that would cause it to change its state except for *desire*, and in general no other internal activity except for *thinking*, tied to that which depends on it, [i.e.,] the *feeling* of pleasure or displeasure and *lust* (Begierde) or will. These defining foundations and activity do not belong, however, to perceptions of our external senses, and therefore they do not belong to definitions of matter as matter. Therefore every matter as such is *lifeless*. (ibid., 151–2)

This entire fragment consists of conceptual terms: Desire, Thinking, Sense, Longing, and Will. Ultimately, something has to possess these listed qualities to be classifiable as life. We return to self-awareness. It was no accident that Hegel developed this idea dialectically.

Life according to ***Hegel.*** In Hegel's writings, we fall once again into the

1 Kant, *The Metaphysical Principles of Natural Science.*

embrace of soul and body. Hegel insists on clear distinctions between Idea, Notion, and Reality. Otherwise:

> wholes like the state and the church cease to exist when the unity of their Notion and their reality is dissolved; man, the living being, is dead when soul and body are parted in him; dead nature, the mechanical and chemical world—taking, that is, the dead world to mean the inorganic world, otherwise it would have no positive meaning at all—dead nature, then, if it is separated into its Notion and its reality, is nothing but the subjective abstraction of a thought form and a formless matter. *Spirit* that was not Idea, was not the unity of the Notion with its own self, or the Notion that did not have the Notion itself for its reality would be dead, spiritless spirit, a material object.[1]

In addition, one should not only distinguish between Notion and Reality, but also understand the meaning of *subjective notion* and *objectivity*. Hegel needs all these ideas and the distinctions between them to avoid confusion over what the discourse is about: life as the idea of the notion of life, or life as a subjective notion that does not coincide with its internal being, and so on. If these distinctions are left out, scientific analysis turns into empty talk.

What is life? Hegel answers, "The Notion of life, or universal life, is the immediate Idea, the Notion whose objectivity corresponds to it" (ibid., 764). Inasmuch as life is an idea, or notion, the one who formulates this notion or idea can only define life. Therefore, there is a need for this observer, i.e., man—in Hegel's words, "*the living individual*":

> This is in the first place life as *soul*, as the Notion of itself that is completely determined within itself, the initiating, self-moving *principle*. The Notion in its simplicity contains determinate externality as a *simple* moment enclosed within it. But, further, this soul *in its immediacy* is immediately external and possesses an objective being of its own—a reality that is subjugated to the end, the immediate *means*, in the first instance, objectivity as *predicate* of the subject; but further, objectivity is also the *middle term* of the syllogism; the corporeality of the soul is that whereby the soul unites itself with external objectivity. The living being possesses

1 *Hegel's Science of Logic*, 757.

> corporeality in the first instance as reality that is immediately identical with the Notion; thus it has this corporeality in general by *nature*. (ibid., 765–6)

It follows from this puzzling passage that the concept of Life is objective and its source is Nature. However, to single himself out from the indifferent being of Nature, the living individual must possess the need to sense himself with the *indifferent objectivity*. This difference unfolds through contradictions of a different sort, in which such phenomena as *good, feeling, pain*, etc. emerge. By the way, "Pain is therefore the prerogative of living natures," or, rather, real existence reveals itself in the pain experienced by a living being.

In *The Phenomenology of Mind*, Hegel reflects, in a rather complicated manner, on life through the category of Self-consciousness. Namely, it "distinguishes as having a being distinct from itself, has in it too, so far as it is affirmed to be, not merely the aspect of sense-certainty and perception; it is a being reflected into itself, and the object of immediate desire is something living."[1]

Hegel is hard to explain; he can only be studied. Nonetheless, the following conclusions suggest themselves, following from his reflections.

Life is a concept, and a concept can be formulated only by a self-awareness, which is possessed only by a living individual. At the same time, life is objectivity, real being, but it is being that distinguishes itself from *indifferent objectivity* through reflection into the concept, which forms in the unity of soul and body that manifests itself through the sensations of "good–bad," pain, desire, etc. Together, all this is man. As a result, we see that life in its true meaning begins and ends in man, and its separating border is the soul/entelechy, according to Aristotle; self-awareness, according to Kant and Hegel; and the sensations of "good–bad," according to Gubin.

Thus, the simplest definition of life is—*life is man*. This definition can be reformulated more scientifically: *life is that form of organized matter that realizes its separateness from the surrounding world and is capable of consciously influencing this world*. This definition resolves many of the previously discussed problems: progress, complexity, purposefulness, etc. I did not object to Engels's expression "life is death" because Engels meant the nature that is unconditionally subordinated to its own laws, including the second law of thermodynamics. From my definition, a

1 Hegel, *The Phenomenology of Mind*, 221.

different consequence follows: *life is the constant struggle against death*, i.e., the struggle against the law of entropy. For the organic world, the word *struggle* has no meaning since this word is tied inseparably to such concepts as Will, Goal, and Means. It is not struggle in the organic world but adaptation, namely, natural, not artificial (i.e., meaningful) selection. Darwin came up with the perfectly correct name for his theory of evolution.

Man remains a part of nature, of course—at least in the part called the body, which is subject to the laws of the organic world. However, in his head—i.e., in his consciousness and thinking—man is already in another world, the social world. The joining of soul and body led to the emergence of man, a new integrity in the universe. Man was born of the organic world, but as integrity, he ceased to be a part of it, even though he consists of the elements of that world (proteins, chromosomes, etc.). Man created another world, the social one, qualitatively different from the organic world. In the same way, the organic world, which emerged from the inorganic world, is qualitatively different from it, even though it consists of its elements (elementary particles, atoms, molecules, etc.). All this means that there is no life in the organic world, and thus biology—the name of the science suggested by Jean Baptiste Lamarck in 1802—is incorrect considering the view presented above. It should be called *orgalogy*, the science of the organic world (not to be confused with organology, the science of organs, which already exists), hence the terms *orgagenesis* (the origin of the organic world) and *orgabia* (the organic force).

This does not remove several of the above-mentioned problems connected directly to the organic world. This includes the old questions of where does the organic world begin, what are its interrelations with the inorganic world, and is this world governed by laws? To answer these questions, we shall have to dip a little again into philosophy.

Orgagenesis as a Manifestation of Orgabia

It may appear to the reader that as I delved into the search for life, its evolution, etc., I forgot all about *force*, the main concern of this work; it seems to have disappeared somewhere. But this is not so; force was present at all times, everywhere: in viruses, bacteria, cells, i.e., in every structure of the organic world that has a material substratum. Let me remind you how I defined force in the philosophical part of this book: *force is that property of being that reveals its existence*. As a philosophical category, I called it Ontobia. In the organic world, it seems logical to call it Orgabia—the organic force. (Following the same logic, it can be called in the narrow sense, on the level of biogenesis, Biόbia—the biological force.) However, as it is the inevitable attribute of every organic structure, every force becomes visible in the laws of matter's motion, and the laws of orgabia are qualitatively different from the laws of force in the inorganic world. Now I want to formulate the fundamental principle:

Every integrity that is qualitatively different from the preceding stage of being manifests itself based on laws that are formed by precisely this integrity, while its parts are subject to the laws of the preceding integrity.

It was not by accident that I noted above the thesis that Davies dropped in passing: life begins at the moment it circumvents the laws of chemistry. Davies made a remarkable guess: the new stage in matter's development starts when its new quality as integrity ceases to be subject to the laws of the preceding integrity. Based on the just-given definition of life, we can rephrase this: life begins when it ceases to be subject to the laws of the organic world, and when the organic world ceases to be subject to the laws of the inorganic world. Thus, physics—or, more broadly, the inorganic world—has its own laws; the organic world has its own laws; and society has its own laws. They manifest themselves through the particular laws of force that reflect the specificity of each of the three worlds. At the same time, their dialectical interconnection is preserved through the subjection of the parts of every integrity to laws of the preceding integrity. When it is said that an organism is subject to the laws of chemistry or physics, which is perfectly correct, one has to keep in mind that these laws work on the level of the parts of the organism. The atoms and molecules of bacteria, plants, and animals function according to their own physical and chemical laws, but bacteria, plants, and animals as integrities enjoy other-being based on the laws of the organic world. Note that this principle does not have a reverse vector; i.e., the laws of the subsequent integrity are not applicable to the preceding ones, neither in their parts nor their aggregate. For this reason, it is impossible, for example, to apply the laws of social development to the animal world, or, say, the law of natural selection to the inorganic world, the laws of heredity to molecules or atoms, or the laws of physics to the analysis of society. The temptation does arise from time to time to use these laws going in the backward direction, but even here, the second law of thermodynamics works with its deterministic essence: time only moves forward.

I stress that the laws of one integrity differ from the laws of another integrity when there is a qualitative leap from one system of space–time and temperature coordinates to another system of coordinates. The leap itself is not foreordained; it is accidental. But once this leap takes place, a new system is formed with its own laws. Law and chance are tied to each other inseparably; one does not exist without the other—let us again recall Schelling. There is no order without chaos and vice versa. Determinism works on the level of laws, but the laws themselves are not absolute since laws are the ordered, and that means predictable, process of interaction between substances; once the substances disappear, the laws disappear. For example, the collapse of the Solar System (expected in 7.5 billion years) will mean the collapse of our planet (from the point of view of man, it should happen much sooner[1]), and, therefore, the collapse of all the laws of the organic and social worlds.

In the preceding chapter, it was said that even the fundamental laws of physics are not constant; they are formed in the process of matter's motion. For that reason, it would seem to be difficult to accept the absence of goal-setting in nature from the very beginning, which implies a strong deterministic regularity of life emergence. Chance is excluded, and so is struggle; what is left is the smooth ascension of the ladder of progress. The problem with this is not only that the history of evolution belies such an idyll, but also that regularity does not exist without a chance since the absence of the latter precludes the presence of the former. It is the same as in the series day—night, black—white, finiteness —infinity. In other words, being itself and ontology rebel against the purpose at this stage of matter's motion.

Evolutionary leaps are a different manifestation of quality and quantity. Quantity transforms into quality through a leap, which cannot be traced for the simple reason that once the leap is traced, it ceases to be a leap. This is what makes the search for "the beginning" in the inorganic or the organic worlds ineffectual, the efforts to determine where the world begins: with the atom, the electron, the proton, the

1 For more detail, see "Hell on Earth," *New Scientist* (6 December 2003): 36–9.

quark, etc.; with the cell, the bacterium, the virus, the molecule, etc. Such attempts are perfectly fruitless on account on the nature of the leap itself. It can be defined only through the law of force: if there is a new regularity (stability) that was absent in the preceding integrity, this means the emergence of a new phenomenon, a phenomenon of a new quality. Leaps also exist within the frameworks of the new integrities as the leaps in the course of the evolutionary process. However, these leaps lead only to structural changes; they do not change the integrity but do change its structure. (S. J. Gould mildly called such a leap *punctuation*.) For example, in orgagenesis, changes in the structure of the bacterium, the cell, etc. led to the forming of new integrities, but within the framework of one and the same world—the organic world. An example of a revolutionary leap is abiogenesis, which most likely will not be repeated, at least not on our planet. In other words, the transition to another world requires a systemic, or revolutionary, leap.

In the light of the above said, one has to admit that the beginning of the organic world was marked by the forming of organic molecules[1] at the stage of biopoesis, in accordance with J. Bernal. From then on, evolution followed the already-mentioned scheme: probionts, prokaryotes, eukaryotes, and so on all the way to the animal world. The single most important difference between the organic from the inorganic world is *self-development*, which some scientists connect to self-complication and others (Teilhard de Chardin) to expansion. Proceeding from this assumption, I would define the concept of the *organism* as a *form of matter capable of self-development*. In the process of the organic world evolution from the simple to the complex, various laws were formed corresponding to each stage of evolution. Some of these laws determine the course of development of the entire organic world; others work only in certain local areas (the worlds of bacteria, plants, or animals).

It should be noted that nature, bringing forth laws, begins to be subjected to them; i.e., the law comes to stand above nature itself. A long time ago, Schelling expressed this idea: "The origin of animal matter in the vital process is perfectly *accidental*....[It] is none other than the blind action of nature which flows from necessary laws that govern inorganic and organic nature, contrary to nature's real intent and seemingly

1 The attentive reader may remind me of my sarcasm when I expressed skepticism of a similar idea by an author of a biology textbook. However, the discourse there was on the level of organization of "living systems," which in my definitions of life are placed outside the limits of the organic world.

contrary to its will (invita natura) in the capacity of a consequence which it cannot prevent."[1] However, every law is constrained by a certain space and time (as mentioned already, the range of the organic world is between and cm) while nature has no bounds.

The above-said allows us to resolve easily the issue of the functioning of the fundamental law of entropy that is at the center of so many debates. It is fundamental because it encompasses the entire universe. The organic world cannot violate or circumvent this law, just as all other fundamental laws and constants, simply because they are fundamental, i.e., universal. However, the second law of thermodynamics does not exist for the purpose of "giving birth" to the organic world. If it had this ability, the entire universe would appear as one organic world. The latter, in fact, emerged on an islet in the universe due to chance events that subsequently became set in certain laws that formed a qualitative integrity. Subjection of the organic world's evolution to the second law of thermodynamics would amount to elementary reductionism. However, denial of its influence on the emergence and/or development of the organic world inevitably leads to some "agent," i.e., to religion.

It is obvious that the second law of thermodynamics affects all parts of the organic world, but the organic world itself moves, or develops, following its own laws of force. The word *force* is rarely used by biologists (with the exception of the vitalists). For example, Gould uses the expression "force of natural selection," while Davies uses "force of bioinformation." On the whole, the laws of organics are usually described with the use of other words, but force lies at their foundation. It seems only Schelling, like nonvitalists, applied the concept of force to the organic world. He allotted to force decisive importance in the sphere of material being, i.e., on the level of ontology. Naturally, being a fundamental category, force has to function in the sphere of organics as well. But how does it work? Schelling's answer is very persuasive: "*The essence of life* [to Schelling, the organic world is life—*A.B.*] generally consists not in force, but *in the free play of forces*, uninterruptedly supported by some external influence" (ibid., 179). To Schelling, the external influence is the world soul of nature. In this case, it does not concern the soul; it matters that the organic world really does exist and moves based on the simultaneous interaction of all forces—every sector of the organic world reproduces and prolongs itself with the participation of all organic substances. In the inorganic world, scientists

1 Schelling, 137.

face the challenge of uniting all the forces of Nature into some unified theory or conception. The "organists" need to cognize the forces in their disunity to reveal the specificity of different laws based on them and cognize their interaction.

Some Conclusions

Although in the preceding paragraph the essence of certain laws of the organic world was described, some scientists deny the existence of these laws since they see the organic world as an inseparable part of the physical world. This idea is defended in an extreme form by Brooks and Wiley. This is why biology (orgólogy, in my formulation) is not a science at all.[1] The other reason for not recognizing the laws of organics is the argument that nothing definite can be predicted in this world, while the laws of physics give clear predictions of the behavior of physical bodies. For example, the laws of physics allow us to predict the location of the planets around the Sun in, say, one year from now, or ten years, or even 10,000 years while the laws of evolution do not let us predict which organism or species will emerge or disappear a certain number of years from now. Similarly, we cannot use the laws of genetics to predict who will be born to a certain parent: a genius or a fool, a materialist or an idealist.

Strangely enough, the topic of laws is constantly discussed in the West precisely in connection with the problems of studying the organic world, and precisely in the tone I have just presented, using the work of John Wilkins.[2] For some reason, many refuse to understand that every law is a simplification of reality, and its predictive value cannot be absolute. There always exists a certain degree of relativity even in classical physics, not to mention quantum mechanics, and there is a mass of allowances, uncertainties, and degrees of precision.[3] Nonetheless, the laws of physics are objective; they work not only by themselves, but they also work for us when we make skilled use of them. Naturally, in the organic world, the

1 In sarcastically exaggerated form, this idea ascribed to many physicists: there exist only the science of physics and everything else. As Rutherford said, "All science can be divided into two groups—physics and stamp collecting."

2 Wilkins, *Evolution and Philosophy. 1997*. www.talkorigins.org/faqs/evolphil.html.

3 Lyubarsky (who reviewed this chapter) advised me to put it this way here: in biology there are laws, but the limits of their applicability are defined by the limits of taxa.

laws work differently since their initial conditions and the environment affect the results to a greater degree than in the inorganic world. It is precisely these differences that divide the two worlds. Otherwise, there would have been just one physical world. Moreover, a law is not the sole accumulator of knowledge about the phenomenon, and it should not be a fetish. In this connection, I would like to quote Lenin, who commented on a passage by Hegel: "The concept of the *Law* is *one* of the stages of the cognition by man of *unity* and *connection*, of the reciprocal dependence and totality of the world process."[1] Let us emphasize: *one* of the stages of cognition, though this stage is extremely important. Without entering into discussions of laws and regularities, the definition of law, which can be found in any work of Marxist literature, is "a law is a necessary, essential, stable, repeating relation between phenomena." It is also necessary to distinguish that there are the laws of functioning (for example, the law of gravity) and the laws of development (for example, the development of the universe, or of society). In organics, the law of complexity growth can be considered a law of functioning, and evolution is an example of a law of development.

* * *

The above analysis compels me to reject two assumptions stated in the beginning of this chapter, namely, that 1) the organic world is the world of living organisms, and that 2) this world "circumvents" the law of entropy growth. These ideas proved to be false since they did not coincide with the being-for-self and regularities of the organic world. It is difficult, of course, to let go of the belief that your favorite dog or cat is not a living creature. It is even more difficult to admit that the chimpanzee, so much resembling man, also proves to be nonliving. If we recognize them as living, then we also have to recognize not only bacteria and viruses as such, but also molecules, atoms, electrons, and other "quantum wildlife," as well as all cosmic objects, since all of them move, interact with each other, and "breathe." In brief, the entire universe turns out to be life. It is, as noted earlier, a dead-end variant for cognizing nature. I repeat: ***life begins with man***, *and what is before him and beside him are only the organic and the physical worlds.*

1 Lenin, *CW*, 29: 135.

There is no progress in these worlds. A law-conforming chance led to the emergence of man. But since man is part of the organic world, this world is the environment for him that he cannot exist without, at least in the current stage of historical development. This forces him to uncover the laws of the organic world, and not only the laws that enable him to predict the future of this world, but also the laws of his past development—something that is designated by the English word *retrodiction* (as different from prediction). There is still much that is unclear in research on the past and the future, and, as a result, the general regularities of the organic world are described more as trends than clearly interdependent variables, as in classical physics, for example.

From the perspective of the laws of force, the same regularity can be traced in the organic as in the inorganic world—the expansionism of force. Every material substance contains in itself an internal and an external force. The struggle between these forces is the source of the substance's motion, and, in this process, the substance encounters the force of the environment that now becomes external to its substance. In the organic world, the struggle between the force of an organic substance and the forces of the environment (which in turn consists of a multitude of substances of both the organic and the inorganic worlds) concludes either with the destruction of substance itself or with the "victory" that a substance manifests itself in the conquest of "living" space. As evidenced by the history of orgagenesis, huge quantities of organic substances perished; nonetheless, some not only survived but also managed to expand their space all the way to the formation of a whole world—the world of organics. This substrata developed, through trial and error, a mechanism for absorbing and retaining energy with decreased entropy, which enabled them, on the one hand, to conquer part of the space of the surrounding world, and on the other, to ensure for themselves relative independence from it. This is how expansion of force manifests itself. This expansion takes place based on objective laws that form as a result of the interaction of inert matter without interference from any "operators" or "agents."

We will see an entirely different picture after man's emergence into this world, when the concepts of Life, Progress, and Goal, "meaningless in the organic world, acquire their ontological being."

CHAPTER IV

MAN: FORCE AND PROGRESS

Knowledge of force equals force of knowledge.

Author

In the preceding chapter, I asserted that life begins with man, and man begins with the acquisition of consciousness. Therefore, the world of man forms a qualitatively different segment of the universe that reveals itself through particular laws and regularities. In this chapter, I intend to research how the ontological force, or ontobia, manifests itself in man; in other words, what determines the force of man as a new qualitative species of the organic world. Or, in a word, what makes man truly human?

Leaving out the exciting history of man's emergence on Earth in order to avoid the temptation of getting involved in the endless arguments between theologians and evolutionists (I am on the latter's side, naturally), I pass on to a no less complex topic of man as the thinking subject of nature.

This topic encompasses the problems of consciousness, thinking, thought, soul, spirit, etc. These problems have stirred mankind from the earliest days of its existence. In the philosophical sense, they date, most likely, to Buddha in the East and to Plato in the West. Plato believed that thought is located in the head, Aristotle was certain that it is in the heart, and others were convinced that it is in the liver. René Descartes, with his famous aphorism "cogito, ergo sum" (I am thinking, therefore I exist), transferred the problem to a different area: albeit thought is located inside the brain, it is not a physical object that has a definite place, and though it is located inside the brain, it has no definite place. It is known from practice that the destruction of any one part of the brain, while causing certain damage to thinking, does not destroy it entirely. Still, it will be shown later that Descartes was wrong in believing that "pure thinking," or soul, and the body are completely independent of each other.[1] From the philosophical point of view, this approach provides free rein for various idealists' interpretations in the spirit of

1 See Descartes, *Selected Works*, 283.

idealism, and it continues to inspire many modern philosophers and psychologists.

This problem has been discussed and debated in the scientific literature for about a century and a half in the context of the mind/body, or, less often, the mind/brain problem. With good reason, Schopenhauer designated this problem in his time as the "*Weltknoten*" (the world knot). Progress can be discussed only from the position of experimental research on the brain's functioning, the structure of the neurophysical and chemical bonds and functions of different parts of the cortex. The problem, however, has remained unresolved from the philosophical perspective: what are consciousness and thought ultimately? What is the connection between thought and consciousness, thinking, soul, and spirit? As Jaegwon Kim, professor of philosophy at Brown University (United States), writes, "Although our understanding of these problems has been deepened in many ways in recent years, the concept of personhood continues to challenge our philosophical ingenuity and imagination."[1]

In principle, there is nothing surprising about this evaluation since, in the opinion of the vast majority of scientists, including Nobel Prize winner James D. Watson, the human brain is "the most complex thing we have yet discovered in our universe."[2] And although some scientists are optimistic about the possibility of figuring out how the brain operates, others, the superpessimists, have lost all hope of solving this phenomenon. Already-mentioned English neurologist John Eccles, in his book *Evolution of the Brain: Creation of the Self,* draws this noteworthy conclusion: "Since materialist solutions fail to account for our uniqueness, I am constrained to attribute the uniqueness of the Self or Soul to a supernatural creation" which is "a miracle for ever beyond science" (ibid., 154). But this conclusion is also characteristic of materialists (in the Western sense of the word). One of them, Colin McGinn, a British philosopher working in the United States, believes "an understanding of consciousness is beyond the reach of the human mind" and that this is "biological realism" (ibid., 167). I shall revisit McGinn's views in the appropriate place.

At this point, I want to note that, despite all the difficulties involved in understanding the human psyche, a whole army of scientists is working in this area as evidenced by this figure: in just the last 10 years, about

1 Quoted in *The Oxford Companion to Philosophy*, 579.
2 Quoted in Levin, 153.

30,000 works on this topic were published in the West. Their authors are distributed among different schools and currents that in Western philosophy have been called behaviorism, positivism, functionalism, etc.[1] From the perspective of the science of psychology, scientists are divided into two major blocks: the dualists and the monists. The dualists, in turn, are divided into two major subgroups: the proponents of Cartesian dualism, according to which mind and matter are two different fundamental substances, and the property dualists, who see the mind as an aspect of matter that is not yet understood. Monism has further subgroups. Some scientists rally around the theory of identity (which asserts the identity of mind and matter), others champion the principles of functionalism (mind is a process), a third group holds to the theory of emergency (the mind emerges from a physical process, but is not identical to it), and the agnostics (consciousness and matter are one and the same thing, but its nature is unknown) are a fourth group. The dualists outnumber the monists while, among the latter, the smallest groups are comprised by the so-called functionalists and "identitists" (mind = matter). Rita Carter, the author of the above classification, calls the latter "hard" materialists.[2]

The American philosopher Ken Wilber offers a different classification. According to his calculations, psychology (in the West, naturally) is divided into 12 currents, and each of these is further divided into two or three subcurrents. They are all widely represented in the *Journal of Consciousness Studies*. It is clear already from the title of the journal that the problem of consciousness is the theme, not the problem of thought (or thinking). Almost all the writers are fixated on just one category—consciousness, sometimes in combination with body or brain—while ignoring all other aspects of the brain's reflection, including the very important one—thought.

It should be stressed that these Western authors (I browsed through the above-mentioned journal—all issues for 2001–2003, some selected issues from other years, plus a great deal of other literature) make no mention at all of materialist scientists, even such outstanding ones as I. M. Sechenov or I. P. Pavlov, not to mention Soviet scientists (L. S. Vygotsky, A. N. Leontiev, S. L. Rubinshtein, P. K. Anokhin, A. R. Luria

1 These are reflected, to a degree, in an anthology of the philosophy of thought put together by the philosopher John Heil. See Heil, *Philosophy of Mind: A Guide and Anthology*.

2 See Carter, *Consciousness*, 58.

et al.).[1] This is likely for one simple reason: they have never read these scientists' works. This is a common phenomenon among the scientists of the American/Western European area: they do not know what goes on outside their scope. (There are exceptions, of course.) Let us examine what goes on inside their own area.

1

Western Currents and Schools

One way or another, I will have to touch on various aspects of research of different Western currents; however, I intend to devote my main attention to one area that is close to me *pro forma* in its terminology (in Wilber's hierarchy, it occupies the 11th spot).[2] I am speaking of the various theories of quantum consciousness that ascribe to mind a capacity—inherent from the start—for interacting with and changing the physical world as a whole through quantum effects (i.e., changes in the molecular processes of the human body) and, more generally, that affect the physics of material reality. This approach includes numerous attempts to install consciousness in the physical world in accordance with different avant-garde theories of physics.[3]

It should be recalled that this current emerged in the years of the triumph of the quantum theory of physics (the 1930s), when certain principles of this theory (randomness, indeterminacy) appeared very attractive for explaining the processes of life. Niels Bohr played a large role in this current; he believed that life could be explained based on the regularities of quantum physics. To a more exaggerated degree, this

1 On the contribution of these scientists to the science of thought, see Slavskaya, *Thought in Action: Psychology of Thinking*.

2 The dominant school here is one of the subcurrents of cognitive science, emergent/connectionist, which means stages or gradation in the hierarchy of emergence (of something) that are generated in consciousness, or consciousness as an emerging hierarchically integrated system of connections. See Wilber, *An Integral Theory of Consciousness*.

3 The magazine *Scientific American* is the most consistent proponent of this approach.

idea was transformed into almost a theory of "quantum biology" by the outstanding physicist Pascual Jordan.[1] One of the main features of this theory was its opposition to materialism, which had supposedly been refuted under the influence of "natural scientific experiments." Although Jordan himself was subjected to harsh criticism by many biologists and psychologists (by Max Hartman, for example), he acquired many followers. It is most amazing that his disciples, known as physicalists, are classified as materialists since, in their interpretation, matter itself (photons and other elementary particles) began to think. What a peculiar turn of events!

So let us see what contemporary Western scientists write and say about consciousness and thought.

W. L. Miranker, a computer scientist, writes, "Yet consciousness cannot be observed or measured objectively. It is, for this reason, what we call an internal property of matter."[2] He goes on to analyze the interaction of photons on the physico-mathematical level, which adds absolutely nothing to this judgment.

Paul Livingston, a philosopher, giving an overview of the various schools, writes, "The idea that consciousness is 'subjective' expresses a different idea; perhaps the clearest formulation in the contemporary literature."[3] I could add that this "clear" formulation was confirmed many times by Socrates long ago in each of Plato's *Dialogues*. Livingston confirms this thought with a reference to John Searle, who defines the subjectivity of a conscious state as its property of existing *only* for a single person or from a single point of view (ibid., 16, footnote 1.)

John R. Searle, a professor of philosophy at the University of California, Berkeley, who belongs to a different school—introspectionism[4]—is in a certain sense a pioneer in the subject of consciousness. Within the framework of introspectionism, he developed the concept of Intentional

1 See Jordan, *Die Physik und das Geheimnis der organischen Leben*.

2 Miranker, "A Quantum State Model of Consciousness," 4; see also Hunt, "Some Perils of Quantum Consciousness: Epistemological Pan-experientialism and the Emergence-Submergence of Consciousness," 35–45.

3 Livingston, "Experience and Structure: Philosophical History and the Problem of Consciousness," 16.

4 Introspectionism is one of the leading currents in psychology; its basis is the methodof self-observation. Within the framework of this school, consciousness can be understood in terms of intentionality, meaning internal perception by a subject of its sensations, notions, feelings, and life experience. They cannot be understood or realized by a third person; neither can they be evaluated objectively. In philosophy, this school is known as "the philosophy of intention."

States, i.e., the directedness of consciousness.[1] For some reason, though, neither Searle nor Livingston explain why, despite the subjectivity of consciousness, all normal people recognize a table as a table and the Sun as the Sun. Out of this unanimity comes the frightening objectivity of consciousness. This does not agree with Searle, who believes "materialism is just as confused as dualism because it denies the existence of subjective consciousness as a thing in its own right."[2] Searle's "biological naturalism" rejects both dualism and materialism. From the philosophical point of view, it follows that "consciousness and other mental phenomena are caused by neurobiological processes in the brain.…In a word, the conscious mind is caused by brain processes and is itself a higher-level feature of the brain" (ibid.).

2

Physics of the Mind and the Mind of the Physicist: What Wins?

Rupert Sheldrake, who was introduced in the preceding chapter in the course of explaining morphogenesis (in connection with the influence of high-level morphogenetic fields on the probability of events in morphic formations), referred to the prominent American-English physicist and philosopher David Bohm (1917–1992), whose conception allegedly coincided with his own.[3] Bohm wrote not only of quantum physics but also of many other things as well. He is widely known and is quite an authority. Many would like to enlist him as an ally. The physicalists, for example, likewise believe that Bohm is on their side. In fact, there are no grounds for this claim, even though it may appear that he is.

Let us examine in brief Bohm's view of consciousness. Bohm and

1 Searle, *The Nature of Intentional States. In Prokhorov, ed., Philosophy, Logic, Language.*

2 Quoted in Carter, 70.

3 Sheldrake, 86, 93.

his coauthor, the English-Canadian physicist David Peat, believe that it is "reasonable to conclude that consciousness always has a material aspect or side that can in principle be studied scientifically."[1] But the problem is that in the process of studying it, there is always something stealthy present, something that is usually called "the mental aspect." "Consciousness can then be understood, at each stage, as the interweaving of these two sides. Hence it is possible to go beyond the usual approaches in which mind and matter are two separate but interacting streams, or in which consciousness is considered as just a material process" (ibid.).

Thus, it is difficult to conclude that Bohm is a physicalist. We can see here the pure dialectics, with no hint of mysticism. But that hint does appear—and some scientists seize on it—in the course of Bohm's reflections on life in general and even on inanimate matter in the context of the "totality of matter, life, and mind." "In this sense, therefore, even inanimate matter must have some kind of mental aspect" (ibid.). In another work, Bohm calls this mental aspect *protointelligence*. Thus, it turns out that matter starts thinking. But this is not so. If we were to revisit the work mentioned first and continue reading, we would discover that the authors go on to reason about the hierarchy of *implicate orders* (a term invented by Bohm), of which the higher one possesses more delicate mental aspects than the lower one. The authors emphasize:

> Of course, this does not imply that "consciousness" can be imputed to electrons or to other such "particles." This arises only at much deeper levels of the generative order. The essential point, however, is that there is no absolutely sharp "cut" or break between consciousness, life, and matter, whether animate or inanimate. Of course, each of these can be analyzed in thought as categories with a degree of relative independence upon each other. This makes it possible for each to be studied, up to a point, in its own right. (ibid.)

In Peat's words, the essence of Bohm's main idea is that his "implicate domain" can be called idealism, spirit, or consciousness. "The division of those into two—matter and spirit—is an abstraction. Matter is always one."[2]

Moreover, Bohm claims (in a dialogue with Sheldrake) that the

1 Bohm and Peat, *Science, Order, and Creativity*, 211.
2 Quoted in Talbot, *The Holographic Universe*, 271.

laws of nature, which are inherent to the universe, are themselves not eternal but "are constantly forming and developing."[1] Therefore, both consciousness itself and the laws of its functioning are not originally inherent to nature; they emerge as material substances are formed that give birth to the phenomena of mind and consciousness.

It is hard to offer any objections to Bohm, except for his position regarding "totality" and the "absolute" break. Bohm (with Peat) is correct to a degree: we are all parts of one integrity—the universe—and there is no "absolute" break between its parts. Nonetheless, there are qualitative things in nature itself, parts of which differ from each other *qualitatively*. Otherwise, we would have had no need to invent the words *living* and *nonliving* to describe nature; there would have been simply *nature*.

Roger Penrose is frequently referred to as a proponent of physicalism, i.e., the theory of the quantum origin of consciousness. Penrose is an outstanding mathematician, physicist, and cosmogonist who has made quite a few discoveries in those areas, including his joint work with S. Hawking on black holes. The problem of consciousness is most likely a by-product of his reflections on artificial intelligence, although it is worked through in rather fine detail.

Having read his books *The Emperor's New Mind* and the subsequent *Shadows of the Mind,* I did not find in them unambiguous confirmation of the views ascribed to Penrose, even though he really does analyze the influence of certain elements of quantum mechanics on the mechanisms of the brain. Moreover, in the introduction to the first book, he writes, "In particular, I assert that the phenomenon of *consciousness* cannot be described within the framework of modern physics theory."[2] Nevertheless, in the subsequent book (*Shadows of the Mind*), he suggested (not asserted) that "large-scale quantum coherence" can take place in the microtubules of the brain's neurons, the idea of which was suggested to him by the biochemist Stuart Hameroff of the University of Arizona Center for Consciousness Studies. The essence of the idea is as follows: In microtubules (tiny filaments of protein in neuronal cell walls), quantum processes take place. The microtubules themselves are very complex, and, possibly in the same way that individual neurons are information processors inside the more powerful information-processing system of the brain, they may prove to be microprocessors

1 Sheldrake, 253.
2 Penrose, *The Emperor's New Mind* (Russ.), 11.

inside the neuron.

The inner structure of a microtubule is substantially separated from the environment. Penrose and Hameroff suggest that a fine quantum state can survive in them for a half-second. In that time, particles would be in the state of a yes/no position, and they would be able to interact with other particles (including ones in different neurons), effectively ignoring their location. This interaction would be a form of quantum action. At a certain point, the system collapses (ceases to be) due to the physical process of decoherence under the influence of gravity. Then it (the system) is brought into a state of subjection to the laws of classical physics. Every collapse, in accordance with theory, would mean a signal (blip) of consciousness, i.e., a response to computation. This theory is known as *orchestrated objective reduction*.

This is indeed reduction of consciousness to the level of a machine count of yes/no, which is the basis of attempts to build artificial intelligence. I want to note that Penrose himself is a major skeptic with respect to the possibility of creating AI while defending at the same time the theory of simplifying consciousness to the level of a primitive machine. Even Stuart Hameroff, who inspired this idea, was forced to admit in conversation with the mathematician Alwyn Scott, "It is true that there is currently no hard evidence for quantum coherence and wave function collapse [above-mentioned collapse—*A. B.*] in microtubules."[1] Nonetheless, it makes great sense to dwell in more detail on the logic of Penrose's interpretation of the problems of consciousness since a similar approach, albeit expressed more vaguely, is shared by very many psychologists and neurologists.

Penrose clearly poses two questions within the framework of the mind–body pair: "How is it that a material object (a brain) can actually *evoke* consciousness? and, conversely; How is it that a consciousness, by the action of its will, can actually *influence* the (apparently physically determined) motion of material objects?" He continues, "It appears that we have, in 'mind' (or, rather, in 'consciousness'), a non-material 'thing' that is, on the one hand, evoked by the material world and, on the other, can influence it."[2]

These questions are raised in one form or another in almost all works on the subject. They cannot be answered scientifically since they are posed in a manner that separates mind and body from the "trifle"

1 Quoted in Carter, 302.

2 Penrose, *The Emperor's New Mind* (1990), 523.

that is man. The discourse here is not just about a material object, be it the brain or the body, but about the brain and body of man. Therefore, it is not a simple material object but man that evokes consciousness—something he has formed over a long period of evolution. It is precisely the consciousness of man, not simply consciousness of the brain, that influences, among other things, the material world; for example, when man sends rockets into outer space, to the moon, and to Mars.

Thus, mind–body cannot be torn from its carrier, man. Penrose seems to have sensed this when he deliberately reformulated his questions: "What *selective advantage* does a consciousness confer on those who actually possess it?" (ibid.) The answer is very simple: he who has consciousness can cognize, influence, and even rule to some degree at least part of the world.

But this answer contradicts Penrose's views that all "mammals" possess consciousness (ibid., 526–7), not to mention his beloved cats, dogs, and monkeys[1] (ibid., 494). When one ascribes to mammals consciousness or even just "simply feeling," then the temptation arises to ascribe consciousness to the entire universe, to all of the organic and the inorganic worlds. Although Penrose himself does not quite believe in the consciousness of the nonmammalian world, we shall see soon that he does arrive, anyway, at universal consciousness.

Prior to this, Penrose involuntarily reinforces his love for cats and dogs with reasoning about the absence of thought's close bond to word (or verbality). As proof, he quotes a letter by Einstein in which the great physicist writes, "The words or the language, as they are written or spoken, do not seem to play any role in my mechanism of thought."[2] The geneticist Francis Galton describes the character of his thinking in much the same vein.

In response, one can refer to many scientific works that analyze man's formation as a thinking creature in parallel with his speech skills, as well as psychologists' works that describe the internal, nonrealized speech.[3] But would not it have sufficed for Penrose to pose the simple question, why is it that the speechless monkeys and other mammals have

1 In his second book, Penrose already asserts unequivocally, "The phenomenon of consciousness, on the other hand, is ubiquitous, being likely to be present in much non-human as well as human mental activity." See Penrose, *Shadows of the Mind,* 51–2.

2 Quoted in Penrose, *The Emperor's New Mind* (1990), 548.

3 See, for example, the already mentioned work, Mithen, *The Prehistory of the Mind*; also Wills, *The Runaway Brain*; Alain, *The Self and Its Brain*.

not submitted to God's judgment not only the special and the general theory of relativity, but even just some third-rate tale about themselves? I believe that Einstein and Galton would not have given us the joy of their discoveries if they had not had speech. In this connection, many like to quote Schopenhauer's famous aphorism, "Thoughts die the moment they are embodied by words." This is elementary nonsense since thought emerges precisely when it is embodied by words. We could not have learned that Schopenhauer had a thought had it died when embodied by words. Word itself already is thought; the two are simply inseparable.

Penrose writes that words are useless in mathematical thinking. One could even strengthen this statement: words are equally useless for musical thinking, artistic thinking, etc. The point is not that these thinking processes use different codes of thought; the point is that nothing of the above-mentioned would have existed if man were not thinking in words. The entire animal world, including mammals, with the exception of man, gives us an expressive (or, rather, never expressed) example in proof of this statement.

Penrose, like many others who separated the problem of mind–body from man, slides involuntarily into anthropologism, even though he does not seem to agree with it. This is what he writes: "The weak anthropic principle…seems to me to be unexceptionable, provided that one is very careful about how it is used."[1] At the same time, "I cannot believe that the anthropic argument is the real reason (or the only reason) for the evolution of consciousness" (ibid., 562). But this duality, as could be expected, is ultimately resolved in favor of the former assertion. This is how Penrose concludes his treatise: "Consciousness seems to me to be such an important phenomenon that I simply cannot believe that it is something just 'accidentally' conjured up by a complicated computation" (ibid., 579–80). It follows from this that "it is only the phenomenon of consciousness that can conjure a putative 'theoretical' universe into actual existence!" (ibid., 580). Therefore, consciousness existed before the emergence of man. But on the other hand, it turns out that without the consciousness of man, without our "talk" about the universe, the latter simply does not exist. I do not want to repeat here the arguments against the anthropic principle presented in the preceding sections.

The chapter from which I have been quoting so abundantly is titled "Where Lies the Physics of Mind?" Judging by its content, the physicist's mind failed to answer the question posed in the title. It did prove

1 Penrose, *The Emperor's New Mind* (1990), 561.

itself rather effective, though, in describing the problems of quantum mechanics and cosmogony.

3

Neo-Berkeleyism, or Transcendental Consciousness

There exists a group of so-called scientists who reject the physicalists, or reductionists, not because their theories are not confirmed by practice, but mostly because they slide in one way or another into materialism. The one who writes about it most openly is Rita Carter, a popularizer of all sorts of ideas about consciousness, who in her latest book collected many interesting articles by specialists in this area. Against their backdrop, her own views do not appear scientific but very much engaged philosophically. I am compelled to dwell on them in order to show that not only in Russia but in the West as well there is no shortage of mystery plays flavored as "science." And Carter's logic is quite unique, as well.

To begin, Carter admits, almost regretfully, "scientific materialism" in the last two hundred years of its existence (?) really did acquire quite a few proponents in the understanding of the problems of consciousness. But 9 out of 10 Americans and 76% of Britons prefer to believe in *spiritual* dimensions that are more fundamental than the material universe. Not all of them call this spirituality God, but almost all of them believe in something unified, in some form of Mind that transcends consciousness. Once again, this is not necessarily connected to religion, but nonetheless, various polls show that between 40% and 80% of all people have experienced a certain transcendental sensation of "flight in the highest spheres," for example, during prayer or after taking narcotics. Carter experienced a similar sensation on three different occasions and subsequently came to believe apparently in clairvoyance, psychokinesis, telepathy, and other such psychic phenomena.[1] Briefly

1 Carter, 278.

put, transcendental consciousness exists.

Moreover, not all is so simple with this consciousness, either; there are problems here, too. Carter writes that, according to the quantum theory of the mind-brain, the universe is intelligent since quanta themselves possess minds. But if the universe is intelligent, there is no need to explain how the mind emerged or how it works. Question answered. Still, if the universe is intelligent for a different reason—namely, thanks to the transcendental mind—then how does matter emerge out of this mind? Is matter-out-of mind just as much an illusion as mind-out-of-matter? Here is where Carter returns to the Penrose–Hameroff conception and inverts it. Recall that those authors believe that the mind emerged from "quantum coherence." Carter has matter emerging from the mind.

This is how she reasons: A common opinion exists that a single bit, or quantum, can be described as an element of information in the form of yes/no. However, the identification of this information in the environment requires a *sensitive observer*, without whom we would never learn what is really going on. (Carter maintains a modest silence on this issue of where this observer emerges from prior to the formation of matter.) Here I am compelled to quote; otherwise, I will not be believed. Carter writes:

> A system like this (before it is observed) is known as coherent quantum superposition. The event that occurs on observation is called quantum decoherence or collapse. A collapsed state is a definite "answer" to the question of observation. And one theory is that that "answer" is the material universe—collapsed into concrete existence by the question posed by the observer. In other words, we create a part of the material universe every time we invoke the question of attention. (ibid., 305)

Should one proceed from such "scientific logic," no richness of the imagination will suffice to picture how many universes one child creates with its "whys?"

But this does not bother the scholar. Carter is concerned that quantum theory does not work on the level of man's scale. She is helped out by the existence of some schools that maintain that consciousness is not tied all that closely to the brain. She refers to a surgeon whose patient "saw" the operation performed on her own heart as she found herself seemingly outside her body while her brain was practically not functioning. In one hospital, 6% of patients in 63 cases experienced the same thing even when in a state of clinical death (ibid., 306). I may add that I have observed myself several times from “outside,” or rather “from the ceiling,” in my sleep without any operation being performed. I want to emphasize that many pseudoscientific writers, some of them decorated with scientific regalia, refer to these sorts of examples that seemingly confirm consciousness’s autonomy from the body. In fact, these examples only just confirm consciousness’s inseparable bond to the body and to matter. Even if we assume that consciousness has a certain independence of the body, it does, all the same, “fly out” of the body and “fly back” into it. (In reality, it is perfectly clear that nothing flies anywhere; all these visions take place in the brain.) For some reason, consciousness “flies back” to its own revived body. And where does the consciousness go when the body is dead? Apparently, it keeps asking questions, trying to effect “quantum decoherence.”

I repeat: I would not be describing all this if it were not being repeated in many books, journals, and magazines. And here is what this gibberish is needed for, as told by our learned writer in her ingenuous naiveté: Carter is even prepared to recognize Penrose’s theory, primarily for the reason that “consciousness may be incorporated into the scientific paradigm without recourse to hard materialism. Descartes’ *res cogitans,* the indivisible, infinite stuff of mind, may turn out to be, not just part of the natural world, but the very basis of it” (ibid., 307). She continues:

> It has become fashionable in recent years to speak of science reaching a dead end. In a sense that may indeed be true. Objective science may not be able to probe beyond the limits of the physical world because there may not be an objective world beyond—only a field of possibilities, which become facts by the very act of observation. To proceed past the concrete limits of materialism, then, scientists may have to abandon objectivity and place themselves within the scheme of things, recognizing themselves as creators as well as observers of the natural universe. From this subjective perspective, the hard problem of consciousness may simply dissolve. (ibid.)

Carter clearly has decided to outdo Berkeley himself. But Berkeley’s subjective idealism at least was justified to some degree, for he was fighting against mechanistic materialism, introducing elements of dialectics into his reasoning. Attacks on objective science from solipsists of Carter's type are particularly hypocritical because they themselves make use of the fruits of this very science, the fruits of the scientists who created computers, machines, airplanes, rockets—in short, achievements of science and technology that became possible not due to some mythic transcendental consciousness, but due to the creativity and scientific thought of flesh-and-blood scientists. At the same time, all the varieties of the transcendental consciousness theory and other such nonsense have their consumers since they are precisely the theoretical base for all those who soar in the spirit or imbibe "spirit" from alcohol and drugs, or for the plainly mentally ill people whose growing numbers are causing justified alarm in all advanced capitalist countries. Their theories have no relation whatsoever to science, but their social importance is still there. I intend to speak of this in my book on society.[1]

Now it is time to return to science.

4

The New Jersey Nihilists, Daniel Dennett, and John Taylor

Among the scholars and scientists—philosophers and psychologists—who work on the problem of consciousness, there is a small group who deny as a matter of principle the possibility of understanding consciousness. They are modern agnostics of a sort, or neo-Kantians of a very peculiar brand. They are negative about the possibility of understanding only consciousness while they work quite successfully in other areas of science.

I already mentioned one of them in the beginning of this chapter: Colin McGinn, an English philosopher currently working at Rutgers University (New Jersey, United States). In one of his first major works, *The Problem of Consciousness* (1991), he claimed that consciousness does not exist, or at the very least, it cannot be explained by the science of

1 Battler, *Society: Progress and Force: Criteria and First Principles.*

physics (only the physicalists disagree with the latter conclusion). In his subsequent works—for example, *The Character of Mind* (1997)—McGinn continued to defend his previous position.[1] His logic is that consciousness belongs to the sphere of "introspection" (remember Searle?), which is counterposed to the physical world, which is cognizable through ideas. The relations between the two resemble those between the brain and consciousness; i.e., they are "noumenal," or, in other words, impossible to understand.[2]

The informed reader will recall this term right away from Kant's works, where *noumenon* means objective reality that is not attainable by human experience—something practically synonymous with the uncognizable "thing-in-itself."[3] McGinn says the same thing: consciousness does not belong to the "cognitive possibilities" of the human organism. He specifies that, well, there is nothing wrong with the fact that a child is unable to understand social conceptions, or that he, the author, cannot share a farmer's fear of tornadoes. Or like this: "Armadillo minds cannot solve problems of elementary arithmetic, but human minds can."[4] We, too, are creatures of nature, and therefore there is no reason to rule out the possibility that we lack the abilities to understand something in nature. "Mind may just not be big enough to understand mind."

It is perfectly natural that this approach provokes opposition from many scientists, especially those in the natural sciences sometimes in a peculiar form. For example, Weinberg, whom I have mentioned several times, is very negatively disposed toward philosophers in general and those of the neopositivist persuasion in particular. Therefore, he advises students to read the history of science rather than the philosophy of science. But there are philosophers, and then there are philosophers. One of them—Daniel Dennett, professor of philosophy at the Tufts University Center for Cognitive Studies—wrote a book titled *Consciousness Explained* (1991) that was published in the same year as McGinn's, containing, however, entirely different conclusions. I will make use here not of Dennett's book but of his critical review of McGinn's book, especially since Dennett does not limit his review to just that author.[5]

1 See also his interview for *The Times* (13 January 2004): 8–9.
2 McGinn, "Can We Solve the Mind–Body Problem?" In Heil, *Philosophy of Mind*, 786.
3 See Kant, *Critique of Pure Reason*, 192–6.
4 McGinn, ibid., 792.
5 Dennett, "Review of McGinn, *The Problem of Consciousness*," *The Times Literary Supplement,* 10 (10 May 1991).

He mentions two other philosophers at Rutgers University—Thomas Nagel and Jerry Fodor—who are in agreement with McGinn about the uncognizability of consciousness.[1] These three can be regarded as a group that professes "New Jersey nihilism." Their philosophical bases are, for Fodor, "epistemic boundedness" and, for McGinn, "cognitive closure." The latter is defined in the following fashion: "A type of mind *M* is cognitively closed with respect to a property *P* (or theory *T*) if and only if the concept-forming procedures at *M*'s disposal cannot extend to a grasp of *P* (or an understanding of *T*)." McGinn then translates this ingenious phrase into the language of the simple folk: "What is closed to the mind of a rat may be open to the mind of a monkey, and what is open to us may be closed to the monkey." Monkeys, for instance, cannot grasp the concept of an electron, McGinn reminds us. Dennett comments on this wittily: "I think we should be unimpressed by the example of the monkey, to whom the electron is out of bounds, for not only can it not understand the answers; it can't understand the questions. The monkey isn't *baffled*, not even a little bit" (ibid., 5). But McGinn believes that the animal world possesses consciousness, which was installed by a sort of biological engineering at the dawn of evolutionary history (evidently following God's textbooks).[2] There is a reason that he keeps connecting the resolution of the problem of consciousness to animals' reactions. He manages, for example, to grieve because "even if we could solve it [the problem of consciousness—*A. B.*] for our own case, we could not solve it for bats and Martians" (ibid., 788).

I find it hard to believe that this was written by a serious philosopher. But if this is indeed so, he should have taken care that his philosophy would be understandable not only to monkeys, fish, and bats, but also by all "living organisms," starting with bacteria. I do believe, though, that there will be no problems with Martians.

One of the causes of such fantasies is the unwillingness to understand or accept one basic thing: all animals, to say nothing of the preceding stages of the organic world, are devoid of consciousness, of which one of the most important attributes is language. Unlike McGinn, Dennett accords an extremely high importance to language, a position that is opposed by some philosophers. In his own work *Consciousness Explained*, Dennett asserts that the mind is a physical phenomenon after all, or, briefly put, "the mind is the brain." On account of this phrase, the above-

1 Nagel presented this position in the article "What Is It Like to Be a Bat?" in *Philosophical Review* 83 (1974), which created quite a stir at that time.

2 McGinn, ibid., 795.

mentioned R. Carter numbers him among the "hard materialists"—a term that is apparently supposed to mean mechanistic materialists. In fact, to Dennett, the mind and the brain are not identical since between the predicate and the subject there is the link *is,* which means formation, i.e., a certain process of consciousness's emergence in the brain. The philosopher believes that many areas of the brain are involved in this process of emergence or appearance, and the brain itself, in his opinion, is a virtual machine of sorts.[1] It would appear that Dennett, who believes that the mind can be understood, leans toward the possibility of creating artificial intelligence—something that I personally have strong doubts about, as I mentioned already. There is a reason that Dennett is reckoned among the physicalists. However, the value of Dennett's works lies in the fact that they inspire further research while the approach of the agnostics, as McGinn suggests, is in fact "putting a lid" on the topic of consciousness. This latter idea is clearly destined to fail.

In the chapter devoted to physics, I mentioned the name of the English physicist and mathematician John Taylor and promised to return to his work in the part devoted to brains. His work on the mind–body problem is no less fruitful than his work on his main profession's topics. Since the early 1970s, he has been participating in various projects related to research on the brain.

So it is that Taylor, having rejected all idealistic and semi-idealistic approaches to the mind–body problem, advances his own relational theory of mind, according to which the mind is a pure product of matter's activity. He clearly designates his approach as "a materialist theory of Mind."[2] This approach, in his opinion, is "economical" since it removes the problem of two different forms of being (or essences) and at the same time resolves two supposedly "insoluble" problems: a) nature of the mind (in the spirit of Eccles's pronouncements) and b) the interaction between matter and the mind (ibid., 151). Taylor supports these claims with experimental data obtained by neurologists and by himself in the course of his practical activities involved in the realization of various projects.

In identifying the part of the brain responsible for consciousness, Taylor accords much attention to the layer of neuron cells called nucleus reticularis thalami, or NRT, which cover the front and side parts of the thalamus. All inputs and outputs of signals (information) in the thalamus and from there into the cortex are performed through NRT. They are,

1 See also Levin, 155–7.
2 Taylor, 184.

as it were, the gateway that controls the flow of information between the thalamus and the cerebral part of the brain's cortex. In the thalamus exist the so-called medio-dorsal nuclei that are connected to the front layer of the NRT. It is their interaction that creates a sort of "global working space" with a clear division of labor, with consciousness and self-consciousness being formed and controlled precisely in the NRT zone, although, naturally, all zones of the brain participate in this process. The established functional specialization of these zones explains, for example, such emotional phenomena as bursts of anger and lack of restraint. They take place because these sorts of irritants emerge in zones that are insufficiently close to the NRT and, as a result, are subject to almost zero control.

I have no intention of delving deep into the experimental psychophysiology of the brain within the framework of the outlined approach. I want only to note that it has a broad theoretical base in the form of the global workspace theory, developed by Allen Newell and Herbert A. Simon. Both the theory and experiments based on it are described in many works.[1] I mentioned Taylor and the theory itself mainly for the purpose of emphasizing once again that many scientists hold without embarrassment to the materialist approach and that their theories accord well with practice.

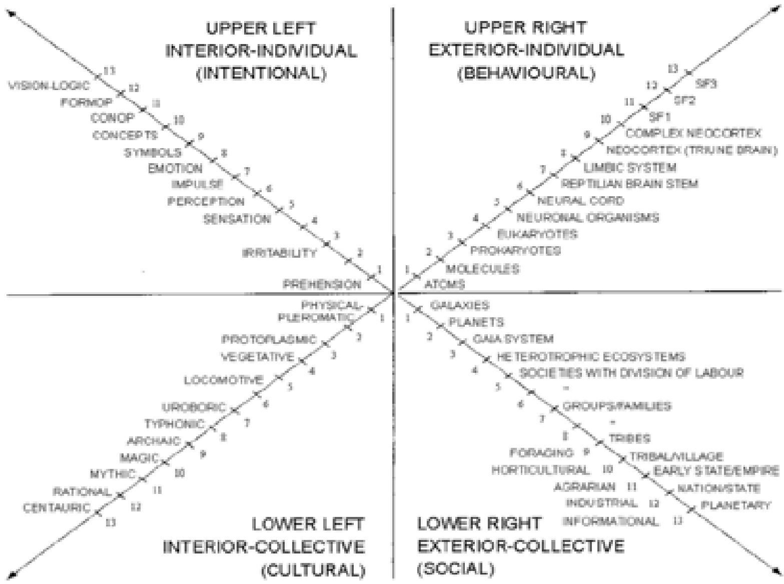
5. Ken Wilber's Conception of the Complex Approach

It appears to me that of the multitude of authors who study the problem of consciousness, the one who came closest to explaining the mechanism of its emergence was the already mentioned Ken Wilber, an American philosopher working in Denver (Colorado, United States).[2] He believes that each of the different approaches (once again, he counted 12 of them) contains grains of truth, since "nobody is smart enough to be wrong all the time." He unified these approaches in a peculiar four-

1 For example, see Baars, "The Global Brainweb: An Update on Global Workspace Theory."

2 Wilber, *An Integral Theory of Consciousness*.

quadrant scheme consisting of the 1) exterior–individual (behavioral), 2) exterior–collective (social), 3) interior–individual (intentional), and 4) interior–collective (cultural).



The first quadrant (upper right) reflects the course of evolution: atoms → molecules → cell of an organism → man's brain. The specificity of this block is that every subsequent stage of development includes the preceding one in an irreversible form. For example, the cell consists of molecules but not vice versa. Wilber designates each unit of development as integrity, borrowing from Koestler the word *holon*, i.e., integrity that is at the same time a part of another integrity (for example, the atom is a part of the integral molecule, which in turn is a part of the integral cell, and so on). However, the existence of the individual integrity itself depends on the community of other integrities in such a fashion that it gives the individual integrity the opportunity to exist. That is, every micro is built into the corresponding macro—specifically the corresponding one, not just some arbitrary macro.

The second quadrant (lower right) presents the line (exterior–collective) that starts with galaxies → planets → the Gaia system →and leads to states → planetary. Should one connect the two blocks with circles, then the atom would correlate with galaxies, the molecules with planets, man with states, etc. Eric Jantsch noted a very curious regularity in such correlations: while the individual integrities grow bigger (since they absorb the preceding integrities), the exterior–collective integrities become ever smaller (the planet is smaller than the galaxy, the Gaia system is smaller than the planet, the family is smaller than groups, etc.). The reason is apparently this: the individual integrities are growing increasingly more complex (i.e., they acquire greater depth) while the quantity of integrities capable of reaching this depth keeps decreasing; the collective integrities also grow smaller (for example, there will always be fewer molecules than atoms, and thus the set of molecules–planets will be smaller than the set of atoms–galaxies). This observation led Wilber to a very important conclusion: evolution unfolds in the direction of greater depth rather than greater span. (I think that this process characterizes the pre-man stage; from now on, the expanse will be growing as well since evolution is ultimately the expansion of force).

What the two blocks on the right have in common is that the integrities listed both on top and below have spatial locations that can be observed/studied empirically. They exist as objective and intrinsically objective realities.

As is proper, everything external has a corresponding internal. The upper left quadrant demonstrates interior individualities; there, located on the line in a certain hierarchy, are the organs of reflection: prehension, irritability, sensation, perception, impulse, emotion, symbols, concepts, conop (concrete operations), formop (formal operations), and vision–logic. Wilber realizes that this row can be described in different terms, and there are heated debates about these terms that are partially presented in the article in question. This is precisely the line, or hierarchy, of organs of reflection that the vast majority of neuropsychologists are working on (with no results). In Wilber's presentation, this row looks rather convincing since it is connected to the top right quadrant; every level of the upper left quadrant corresponds to a level of the upper right quadrant. For instance, the third level on the left—irritability—corresponds to the third level on the right, prokaryotes. Sensation (the fifth level on the left) corresponds to neuronal organisms (the fifth level on the right), and concepts correspond to the complex neocortex organism (man). As a whole, levels 10 to 13 (logical and other operations) correspond to the brain of advanced man, etc.

It is also very important that the interior–individual has meaning only in the presence of the interior–collective (culturological) —the lower left quadrant. In this case, though, the discussion mainly concerns human consciousness, which possesses not only a subjective but also an intersubjective space. The interior–collective integrities Wilber designates on this line are physical, pleromatic (a botanical term), protoplasmic, vegetative, locomotive, uroboric (reptile, or based already on the brain), typhonic (the limbic system), archaic, magic, mythic, rational, and centauric (corresponding to advanced man). Once again, each of these levels is correlated to the corresponding levels in the other blocks.

As a result, Wilber came up with a grid of sorts, comprising four blocks that simultaneously encompass the subjective, the objective, the intersubjective, and the interobjective. This scheme was not formed *a priori* as some metaphysical model; it was formed *a posteriori*, i.e., after researching several hundred branches of science, as Wilber says. He believes that, apart from its scientific value, his integrative model satisfies all currents of thought, including even the materialists, who agree, in his opinion, with his right-hand blocks (i.e., objective reality) but "pay no attention to the existence of the left-hand blocks and the direction of consciousness."

This remark means only that he is not familiar with contemporary materialists, many of whom deserve to this day the adjective *vulgar*. For example, the prominent Soviet scientist N. Amosov (undoubtedly a surgeon of major stature and a remarkable personality), being a materialist to the core, nonetheless manages in his book *My World Outlook* (Moscow, 2001, electronic version) to endow the entire animal world, and the entire universe in the bargain, with mind. But this is just an aside—to remind the Western scientists yet again that they simply do not know what they are talking about when they write about materialists.

So how do the contours of consciousness emerge from the square grid presented above? For simplicity's sake, Wilber translates his scheme into the language of linguistics. The upper left block would then be called *I*, the lower left block *us*, the two blocks on the right *this (it)*. These three worlds are much easier for philosophers to designate. Karl Popper calls them the *subjective*, the *cultural*, and the *objective*. Plato speaks of the *good* (as the ground of morals, the *we* of the lower left); the *truth* (objective truth or it-prepositions); and the *beauty* (the aesthetic beauty in the *I* of each beholder, the upper left). Kant likewise designates three main domains: *science*, or its; *morals*, or we; and *art* and self-expression of the I.

I leave out here Wilber's arguments against potential objections to his scheme. He refutes them all rather convincingly since all these objections come as if from one angle of vision. Something else is more important: he claims that all the named approaches are correct to some extent or other for some level or other of each of the four blocks. But this is not yet consciousness.

> Consciousness actually exists distributed across all four quadrants with all of their various levels and dimensions. There is no one quadrant (and certainly no one level) to which we can point and say, There is consciousness. Consciousness is in no way localized in that fashion. Thus, the first step toward a genuine theory of consciousness is the realization that consciousness is not located in the organism. Rather, consciousness is a four-quadrant affair, and it exists, if it exists at all, distributed across all four quadrants, and anchored equally in each. Neither consciousness, personality, individual agency, nor psychopathology can be located simply or solely in the individual organism. The subjective domain (Upper Left) is always already embedded in intersubjective (Lower Left), objective (Upper Right), and interobjective (Lower Right) realities, all of which are partly constitutive of subjective agency and its pathologies.

Should any one quadrant be removed, the whole grid will disappear since each of its blocks is necessary for the others' existence. Consciousness therefore cannot be purely subjective, private, personality-based, and individual, just as a "private language" cannot exist. Just the same, the brain, as the focus of a physical phenomenon, cannot possess consciousness if there is no environment, no intersubjective relations. Consciousness is not localized inside the brain, but neither is it localized outside the brain since the brain is just a physical region with a simple location. Besides, a substantial part of consciousness does not exist completely in physical space but also in emotional, mental, and spiritual spaces, of which none have definite locations. And yet all of them also possess reality (or are even more real than mere physical space).

Of course, Wilber did not really manage to unite all the approaches in one theory since each of these approaches is not merely reasoning about consciousness but a world outlook. Almost all of them imply a Creator, for which Wilber found no place. His entire construction amounts to dialectical materialism, no matter how strongly Wilber himself may disagree. He correctly described the interactions and interconnections of the phenomenon he calls consciousness. But the problem is that this is not enough since, first, no definition of consciousness was given (only a description of the structural bases for its emergence), and, second, no connections are shown between consciousness and thought, spirit and soul (if indeed they exist at all). So far, there are no answers.

6

Arthur Young's Conception

In all the literature I have read on this subject, only in Young's works did I find attempts to arrange the whole range of phenomena (mind, consciousness, soul, spirit, body) into a definite elegant theory. He is the developer of the universal theory of process, which I discussed earlier. Here I will note only that the quantum of action, or the photon, which is "the beginning of all things," lies at the foundation of his theory. In his interpretation, the entire evolution of the universe is built on this foundation, including the important part, the consciousness of man. In this sphere, he attempts to build a hierarchy of interdependencies for the entire chain that creates human thinking.

Young prefaces his analysis of the mind–body problem with an eloquent quotation from Arthur Eddington: "The analysis of consciousness into parts presents the same problem as the analysis of the physical universe into parts."[1] In principle, there is nothing wrong with this since it is one of the methods of scientific cognition—the ascent from the particular to the general (induction). Alongside and especially in combination with going from the general to the particular (deduction), it produces fruitful results in understanding the world. The main issue is not to forget in the former case that the particular is part of the whole, with which its analysis must constantly be linked. Otherwise, it would be impossible to understand what this part means, no matter how deep the analysis. This banal truth is often ignored by many scientists who actually deserve a different name: subspecialists, or specialists in navel-gazing.

Young makes use of both these methods, which enabled him to advance substantially further than the many subspecialists. But to begin, I would like to draw your attention to one peculiarity that I was not able understand until I read Young's work. The topic discussed in this chapter is formulated by different scientists as the problem of mind–matter,

1 Quoted in Young, *Which Way Out? And Other Essays*, 127.

mind–body, or mind–brain. Why was just one word combination not chosen out of these three?

In Young's presentation, the first variant requires constant explanation of how the mind induces matter if the matter is primary. In order to avoid answering these questions, many prefer the second option, mind–body. It seems to them that in this way, they steer away from philosophy, i.e., ontological problems. The mind–brain option seems to lead still further away from those problems and back into the realm of science. Considering the specializations of scientists, there is work to be found for everyone in the latter case: psychiatrists and psychologists study the mind, biologists and chemists study cells and neurons, and medics study the entire body.

Young believes that, in reality, these clever tricks do not remove the problem, which ultimately boils down to the analysis of the mind-as-subjective versus matter/body/brain-as-objective (ibid., 128). In dialectical materialism, this is called the problem of "the correlation between subjective and objective in the process of cognition." But to Western philosophy, objective phenomena of dialectical materialism, or objectivity, remain a problem. Many philosophers to this day are not sure that they exist in an objective world, and for proof of their own nonexistence, they refer sometimes to Plato's ideas or to transcendental phenomena.

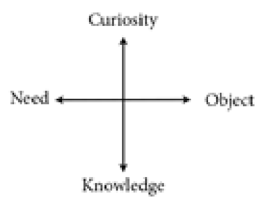
Playing along with them, Young asks, for example:

> What is force? According to the relativistic interpretation, it is a bending of the space–time matrix. Does this answer make force mental or physical (body-like)? Or, what is a square? Of course, it is a geometric figure made up of four points or four lines which are themselves physical and known through sensation. But the squareness of the points or lines resides in the relationship between them, which is a mental perception: the observer's projection of a concept of an object. (ibid., 129)

From this begins the old routine of the observer's subjectivity and the rest of the set of conceptual equipment from the arsenal of idealism. Although Young himself did not escape this idealism—as was shown in Chapter I, however with regard to the problem of consciousness—he advanced much farther than many of the other scholars mentioned.

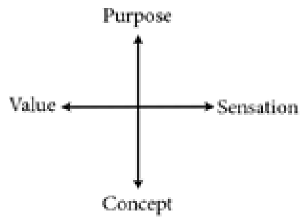
In order to understand Young's reasoning, we need to be certain of the meaning of the word *mind* in its usage here. Young includes two meanings of this word. One is derived, for example, from sentences of the following type: “Have you a mind to go to the opera?”; i.e., in this context, the word *mind* is used as *purpose*. Another meaning is present in the sentence “Visualize in your mind a figure in the form of a square.” In this case, it comes to mean something that forms an idea-forming—in short, *idea* or *concept*. (concept formation). Young includes both these meanings in the word *mind* (ibid., 131), which I understand as *reason*. Young uses the word *value* (which I understand as *quality*), to mean, for example, pain or pleasure, while *sensation* can mean color, sound, smell, or taste.

Starting his analysis of consciousness, Young notes right away that the problem of mind–body represents not one dichotomy but two. The body splits into emotions and sensations—in other words, into the need and its supply—and the mind accordingly splits into curiosity (the need for concept) and knowledge (the concept). Thus, the first dichotomy is demand and satisfaction—physical phenomena. The second dichotomy is the search and the answer to it—nonphysical phenomena (ibid., 127).



It follows from this that *consciousness* is the integration of these four aspects, which in their interaction either form a mutual equilibrium or destroy each other. The interconnected object and need require stability, whereas knowledge, expressed ultimately as purpose, is dynamic and begins to act immediately. Therefore, a contradiction exists between the two axes, which leads either to equilibrium or to mutual destruction.

Young refers to Jung, who also described consciousness using four aspects: intuition, emotions, intellect, and sensations. Young replaced these words with ones of his own choice, except for the last one. For *intuition*, he substitutes *purpose*; for *emotions*, *value*; and for *intellect*, *concept*. As a result, he obtains the following schema (ibid., 132):



The horizontal categories are functional; i.e., their properties are defined, naturally, by the physical body. A value—fear, for example—can emerge due to an interior stimulus with the involvement of gland secretions; sensation is due to external stimuli that react to external objects by nerve endings. The vertical categories—purposes and concept—are not physical phenomena. This abscissa axis is the mind while the ordinal axis is the body (ibid., 134). Their interaction is consciousness.

I would rather not repeat Young's ideas on consciousness here, if only because they are reminiscent of Wilber's conception that is deeper and more convincing. But Young did not stop there; he went further, as is shown in another, later work of his. He asserts there that for most actions, consciousness is not required; what is necessary is intention or purpose. They are formed in the process of learning within the framework of cycles of a recurring phenomenon (day–night, etc.). That is, consciousness cognizes cycles of actions in a learning cycle. Young writes that it is "important to point out that the learning cycle includes consciousness and action."[1]

By Young: consciousness ties to spirit and soul in the following fashion. The learning cycle, which makes consciousness possible, accumulates knowledge from the previous cycles in memory blocks that one ceases to be aware of. This knowledge is transferred from one life to another over successive stages through the soul, which is the necessary guide. (For animals, this guide is DNA, which accumulates the instincts of the "group soul" of creatures.) The realization of the accumulated knowledge is spiritual activity, i.e., the *spirit*, which moves and remodels people's souls. The difference between the spirit and the soul is that "the spirit is the supreme function." It expresses itself in intuition, purpose, in "the higher self," and in other ultimates. The soul is the first transmitter

1 Young, *Science, Spirit and the Soul.*

of the spirit, its access to experience, sensations, and values. Having emerged, it learns and, together with the mind, serves the spirit. This is the principle of the spirit and the soul's interpenetration, which prevents light, or consciousness, from disappearing after death. It is in the nature of light to illuminate, and without the soul, which preserves the values of experience, it (the spirit, or maybe the soul) would truly be the Cheshire Cat's smile. With an organic understanding of ultimate reality, the correlation of consciousness with light through the activity cycle does not explain the state after death. "I once thought," writes Young, "that since the photon was outside of time there was no problem with its endurance, but it could be said that because it is outside of time it does not endure" (ibid.).

In any case, the soul and the mind are necessary intermediate principles between the spirit—the active side of consciousness—and the body. Note that the thing that does not disappear is not thought in the sense of accumulated knowledge, i.e., the intellect or the awareness of one's own "I" (the ego). It is the soul that does not disappear.

As for memory, it is not, of course, some computer that retains information. Memory rests on experience and the senses; it evolves. The language of the soul is myths, poetry, drama, and other kinds of art. It is not information, either. A computer can be switched off. Without a power source, a computer ceases to function.

Motivation is one more function of the soul.

Illusions are something real, a necessary ingredient of the soul. Deception is an error in the interpretation of reality. The soul and the ego are means; the ego is temporary, and the soul is constant; and the ego is the container, and the soul is the content. Its content penetrates into the spirit, which is the true focus of human evolution.

Young writes, "The principal reason for my conviction of the reality of the soul and its persistence through time, its immortality, is that the theory of process requires that in any process there must be something that, like mass–energy in physics, is conserved" (ibid.).

If everything that was created can be destroyed, then why is the soul immortal? "The answer is that it is not constructed. Structure arises at Level III (the level of the concept: Mind/Form). The soul is simple substance, energy if you like, and if energy is conserved, so is the soul" (ibid.).

Thus, Young has a chain shaping itself: spirit–soul–mind–body.

7

From Materialism to Cosmism, or Soviet–Russian Approaches to the Problem of Consciousness and Thinking

As I am writing for the Russian reader, too, it would be unfair to devote no attention to Soviet scientists. Unfortunately, I do not have the opportunity to undertake a full survey of contemporary Russian scientists' views on the topics in question. In all the relevant journals that I have browsed over the past three years, I did not find a single article dedicated to the topic of mind–body. Moreover, judging by the themes of the roundtable discussion "The Brain, Neurosciences, Neurology, and Neurosurgery" that took place within the framework of the joint session of the Russian Academy of Sciences and the Russian Academy of Medical Sciences in February 2004, Russian scientists are occupied for the most part with purely applied research, not with philosophical comprehension of the categories of Consciousness or Thought.[1] This does not mean that this particular topic does not interest anyone. However, it is surprising that, for the most part, it is not brain specialists who are working on it but scientists of other sorts. In connection with this, we should remember that in the Soviet Union, serious debates used to rage over the mind–body problem, which are detailed in the book by the American philosopher Loren Graham, a specialist in the history of Soviet science.[2]

It turns out that in the 1950s, there already were different schools and currents in Marxist psychology. The main school was championed by V. M. Arkhipov and I. G. Yeroshkin. They considered mental activity to be material, meaning that consciousness is a neuronal process. F. F. Kalsin was associated with this school. This position was also defended, albeit in a softer form, by such scientists as N. V. Medvedev, B. M.

1 See Leonid Likhterman, "The Age of the Brain," *Literaturnaya Gazeta*, no. 6, 11 February 2004.

2 Graham, *Science and Philosophy in the Soviet Union.*

Kedrov, and A. N. Ryakin. The latter's "softness" consisted in the fact that they did not identify consciousness so unequivocally with matter, but spoke of psychic activity, including thought as a specific complex form of matter in motion, which means in fact that the moving thought is material (ibid., 403).

M. P. Lebedev spoke out against this "vulgar materialism" in his article "Matter and Consciousness" (*Voprosy Philosophii*, 1956, no. 5, 70–84). Scientists from the circle of S. L. Rubinstein at the Institute of Philosophy held that mental activity is physiological and psychological at the same time, asserting that the term *ideal* is perfectly suitable when used in the context of epistemology (the reflection is the ideal while the reflected is the material). Nonetheless, some other scientists (for example, F. I. Georgiev) were opposed categorically to the use of the term *material* in describing mental activity. V. V. Orlov wrote openly of the "spiritual activity" of the material brain.

A very curious position was held by the very prominent physiologist P. K. Anokhin (1898–1974). From his theory of "the organized chain," he drew the conclusion that "intentions and purposes" are attained because they already exist in advance in the organism in the form of nerve impulses. "These impulses must exist prior to the occurrence of the reflecting action" (ibid., 415). This conception has been called "the mechanism of advance reflection." It is perplexing that J. Scott Jordan, to whom I have referred already, fails to mention his predecessor while promoting a similar viewpoint.

Should one stick consistently to Anokhin's view, which has acquired a conceptual form among some contemporary Western scientists, one would ultimately slide to "the thinking atom." But while the American and European philosophers and psychologists fall into this absurdity as they use a broad arsenal of "cognitive" tools and interpret facts arbitrarily, the contemporary Russian "atomists" do not bother with such trifles; for arguments, they refer either to the follies of Madame H. Blavatsky or the "wisdom" of Agni Yoga. For example, the physician Victor Yagodinski, one of the Russian cosmists, quotes from Yoga: "The force that moves life is embedded in every atom as inherent to every atom."[1] The result of his reading this book seems to be his own thesis that "of all energies, thought is the finest one" (ibid., 333).

In order to understand thought, Yoga should have measured first the "thickness" of all other energies. However, in the West, this approach is

1 Yagodinski, *We Are Ruled by Cosmos*, 332.

likewise called the Fine Energy conception. Its proponents postulate the existence of a finest bioenergy (not related to the known four forces of physics) that plays an exceptional role in consciousness and its activity. The sources of this conception are the wisdom of the ancient writings of India, Japan, and China, from which is borrowed the key word *spirit*, pronounced *prana, qui,* or *tsi*. The Russians, though, prefer to call it *cosmic consciousness*, referring to such giants of cosmism as K. Tsiolkovsky, N. K. Roerich, and A. L. Tchijevsky. For some reason, they also list V. I. Vernadsky among their number, even though nowhere in his works does that author say that the cosmos breathes or thinks.

8

Consciousness–Thought–Force–Progress

A Few Words on Reductionism

To begin, I would like to recall that the above-discussed quantum theories of consciousness[1] are just one of the central research areas of a broader approach known as reductionism.[2] Back in the time of the Soviet Union, Soviet scientists rejected reductionism since at its foundation lies the idea "that the psychical has no independent causal meaning and thus can be reduced…to phenomena of a different order—molecular processes in the brain, reflexes, etc., or otherwise to 'collective ideas' and social stereotypes. This perspective amounts to treating mental phenomena as an epiphenomenon, i.e., a phenomenon whose real value is negligible."[3]

1 The quantum's thinking properties are "proved" in the most exaggerated form in the book *The Quantum Self: A Revolutionary View of Human Nature and Consciousness Rooted in the New Physics* by Danah Zohar.

2 For more detail, see Gulick, "Reduction, Emergence and Other Recent Options on the Mind/Body Problem: A Philosophic Overview."

3 Yaroshevsky, *Psychology in the 20th Century*, 10.

In principle, such criticism was justified, especially if one has in mind the modern variety of reductionism—the theory of quantum consciousness. Nonetheless, in modern capitalist Russia, the attitude toward reductionism has changed, at least among some Russian scientists. They have started defending this approach, regarding it as a method of cognition as well as a tool for fruitful interaction between neurophysiology and other sciences, in particular physics and chemistry. Thus, R. A. Tchizhenkova, justifiably reminding the reader of great achievements in the area of brain research, writes, "The experience of electrophysiologists accumulated over the last quarter century has shown convincingly that the principles of neuronal cells' activity and the principles of their interaction are amazingly alike on all levels of the nervous system in representatives of the entire variety of the animal world."[1] There is, however, just one problem: neurophysiologists to this day are unable to answer the question of what the *difference* is between the functioning of neural cells in the animal world and in man.

Scientists will never determine these differences based on reductionism. The reductionists, answering the question why "the brain thinks," involuntarily slide ever deeper into the depths of matter all the way to its primary building blocks—to protons or photons, for instance. It is on this level that they attempt to find, or hope to find, answers to their questions. However, this approach means that they do not understand the problem of correlation between the parts and the whole, between disorganized matter and organized matter, and, in this connection, the problem of growing complexity of matter. They give no thought to the fact that *the whole is not just the sum of its parts; it is a sum of parts that compels the whole to work according to the laws of the wholeness, not the laws of its components.* The English astrophysicist John Barrow offers the following example: a collection of protons, neutrons, and electrons may be adequate in power to the computer on your desk, but the manner in which this computer is put together, endowing it with a certain integrity, makes it different from a "crowd" of subatomic particles. Barrow demonstrates with this example the unproductivity of reductionism in the analysis of material structures outside of cosmic physics.[2]

There is no argument that the creative combination of biology and physics has clarified many aspects of the operation of the brain's core

1 Tchizhenkova, *The Problem of Reduction in Biology and Neurophysiology*.
2 Barrow, *Theories of Everything*, 140.

such as the functions of different brain structures or the ties between certain functions and morphological structures of neural tissue. But an additional problem, apart from the one outlined above, is that the Western structuralists regard their approach as not just a supplementary method for studying the human brain, but as a fundamental doctrine about consciousness and thinking, tying it to chemistry and physics, i.e., offering another variant of vitalism. As Tchizhenkova writes with irony, "It is precisely because of this attitude toward the problem of reduction that remarkably touching 'scientific theories' worthy of science fiction are sprouting up that are sometimes presented in the popular-science literature" (ibid.). In fact, however, some very famous scientists are engaging in this sort of science fiction, such views having been presented in the first section of this chapter.

Should one hold consistently to the physicalists' approach, one would have to admit that every photon, or any other elementary particle that participates in the biophysical and biochemical processes, carries consciousness in itself. In other words, matter, or energy, thinks. Let us take this as a given. We would then have to admit that a newborn baby possesses all the attributes of a thinking creature, considering that already at birth it contains about 100 billion neurons with trillions of bonds. Nonetheless, for quite some time, these neurons fail to reveal their "consciousness." (Outside of human contact, consciousness does not manifest itself at all as demonstrated by the oft-cited examples of children who grew up among animals.) In order for consciousness to manifest itself, there must be interaction with the social environment, which in practice takes on the form of the educational process. Ultimately, this process sets in order the morphologic structures of the brain and their functions in accordance with knowledge about the surrounding world. As Sechenov wrote, "Mental activity, like every earthly phenomenon, takes place in time and space."[1] What exactly takes place "in time and space" has been researched very thoroughly by scientists who specialize in children's neuropsychology. Evidently unacquainted with the physicalists' fantasies, they believe that most scientists are no longer interested in the topic of what is more important, nature or nurture. "The baby doesn't arrive in the world as a genetically preprogrammed automaton or a tabula rasa at nature's mercy; it arrives as something more interesting than that."[2]

1 Quoted in Yaroshenko, 31.
2 Quoted in Nash, "Fertile Minds," *Time* (3 February 3 1997).

This is interesting in the sense that the child's brain starts functioning in such a way that by the age of 10, all the unnecessary synapses (links) that are not needed or are rarely stimulated are gone (destroyed). Moreover, in the opinion of the pediatrician-neurologist Dr. Peter Huttenlocher of the University of Chicago, "the number of synapses in one layer of the visual part of the cortex increases from 2500 neurons at birth to 18 000 by the age of seven months....Though these microscopic bonds between neural tissues are formed throughout life, they reach their highest intensity (15 000 synapses per neuron) by the age of two and remain at this level until the age of 10 or 11" (ibid.).

Note that the child's behavior and its development in general depends as American scientists emphasize, on "correct education," in other words, on knowledge that corresponds to the necessity of existing in this or that physical and social environment. In other words, the brain develops. There is no consciousness in it originally, but there is a material base in the form of the genes that form the human being's nervous system in simultaneous interaction with the surrounding world.

The Philosophical Aspects of Consciousness and Thought

Life starts with man, because it is man that is the sole phenomenon in the universe that began to think, i.e., distinguished itself from the environment. It is thinking that is man's definiteness that distinguishes him from the rest of the world, including the animal world. Man is thinking *in-himself*—i.e., in his body—since thinking is different from his being as a physical body and his natural sensuality, which are his ties to the surrounding world. But there is thinking *in-him*, too, since man himself is thinking. It is an attribute of man in the same way as motion and force are attributes of matter. Where there is no thinking, there is no man. In other words, thinking is present in his available being, while his available being is present in thinking. This is the essence of the definition of man. As Hegel said, "The *determination* of man is thinking reason."[1]

The views of the scientists who analyze consciousness within the

1 *Hegel's Science of Logic*, 123.

framework of the mind–body dichotomy, broadly presented in my *Dialectics of Force*, lead them inevitably into a dead end. They will never be able to solve the enigma of consciousness outside of its carrier, man, or, more exactly, thinking man (though *nonthinking* man does not exist, the creature resembling him having been only a biological *Australopithecus* species). Thought is the line that separates the world of man from the rest of the world. Pierre Teilhard de Chardin was correct to a certain degree when he wrote, "Access to thought represents a threshold—a threshold that must be crossed with one step.…We find ourselves transported to an entirely new biological level."[1]

I wrote "to a certain degree" to mean that the emergence of thought did not occur "in one step." The size of this step was about 14 billion years within the framework of the universe; 4.4 billion years within the framework of the Earth; 3.4 billion years after the emergence of the organic world; about 800 million years after the emergence of the animal world; and finally, about 2–3 million years for the transition from apelike creatures to man. No one has described the latter stage better than Darwin in the framework of his theory of evolution and Engels in his work *The Role of Labor in the Process of the Ape's Transformation into Man*. They explained how this process took place and why man "became thoughtful" ("fell into thinking").[2]

One of the reasons why contemporary Western scientists keep circling the topic of mind–body is, in my opinion, that they never applied the *theory of reflection*, an extraordinarily important component of dialectical materialism. This ignorance manifests itself, for example, in their opinion that materialists ignore or even deny altogether thought and consciousness as objective reality. This is not so. It suffices to refer to Lenin, who wrote, "It is indeed correct that thought and matter are 'real,' i.e., they exist. But to call thought material would mean making an erroneous step toward confusing materialism with idealism."[3]

Dialectic materialism does not deny the reality of thought, consciousness, and other ideal notions, but it understands reality as something that exists subjectively, not objectively; i.e., it is reflected in man's thinking. Thinking is the process of reflecting objective reality in conclusions, concepts, theories, etc. This reflection is not the identification of, say, matter and spirit or the body with the mind, which

1 Teilhard de Chardin, 116.

2 On the same topic, see Mithen, *The Prehistory of the Mind*.

3 Lenin, *Materialism and Empirio-criticism*, 231.

leads to the *objectification* of the ideal and its substantiation. The latter amounts to the vulgar materialism that is represented so broadly today in physicalism, and the classics of Marxism waged a battle against it.

The phenomena of consciousness and thought are subjective realities that are reflected in objective realities. In the language of philosophy, the definition of consciousness would be the capacity for subjective reflection of the objective world, which is inherent only to man. And *thinking* is the capacity for cognizing and transforming the surrounding world in accordance with one's objectives and purposes, which is inherent only to man.

The problem usually lies in identifying how this reflection of objective reality takes place. Many philosophers have described the mechanism of reflection in the process of human cognition, but none went as deeply as Hegel did. I had planned to adumbrate Hegel's views here, but fortunately I had a book at hand in which authors of one of the chapters needed less than one page to say what took me over five. To save "time and space," I will make use of those authors' explanation, especially since they use examples from information theory that we will have need of later. The authors of the chapter are D. I. Dubrovsky and A. D. Ursul.

Dubrovsky and Ursul clearly specify the differences between the concepts of Information and Signal; the latter includes material–energetic characteristics while the former is free of them. It is obvious that information does not exist separately from the signal; it is embodied in its material structure. At the same time, it does not depend on the concrete physical properties of the carrier, and, therefore, it is to a certain degree invariant with respect to the form of the signal. This is extremely important for understanding the nature of the ideal. Now let us allow the authors to speak:

> Let us examine a comparatively simple case of psychic reflection. Suppose that the individual visually perceives over a relatively short stretch of time some object A; this means that the individual experiences the image of object A (let us designate that subjective image as *a*). In that stretch of time, there emerges in the individual's brain a certain aerodynamic process (a certain neurodynamic structure), born from the influence of object *A* and responsible for the image of *A* experienced by the individual (let us designate this neurodynamic equivalent of the image as *x*). It is natural to think that the subjective image and

> its neurodynamic carrier (*a* and *x*) are *simultaneous* and *same-causal* phenomena. Nonetheless, these phenomena should be distinguished: *a* is an ideal phenomenon, i.e., subjective reality (it cannot be called material since it does not exist in the form of objective reality accessible to an external observer); *x* is a material process that takes place in the brain. *x* is not a psychic, ideal image of the object *A*; *a* is a *code* reflection of object *A*. This neurodynamic code, existing in the individual's brain, is *experienced* by him precisely as an image: it is subjected to mental decoding, so to speak.
>
> The relationship between *a* and *x* can be considered a particular case of the relationship between information as content and the signal as its form; *a* is the information received by the person about object *A*; *x* is the material, neurodynamic carrier of this information, the signal. However, the person, as an integral self-organizing system, has only the information "given" directly in its interior world, while its neurodynamic carrier (the signal) is deeply hidden from it (I do not know what takes place in my brain when I see object *A* or experience the image of object *A*).[1]

This passage explains accessibly, in my opinion, the mechanism of reflection of the objective (signal) in the subjective (information). The question may arise, why is it that a certain signal is reflected informationally in the form of, say, the image of a man or a table, or in the form of some quality—red, warm, or round—that is, through neurodynamic codes with different contents?

This question is related to the evolution of man, to the last two to three million years of his past. When one says that man is a thinking mind, one must remember, naturally, that man became what he is due to the development of social relations, with the indispensable attribute of speech. Without speech, there is no thought; without thought, there is no man; and none of these are possible without society. Everything is united, but this unity is achieved over a lengthy evolutionary/revolutionary period. It was during this period that various signals formed gradually as certain physico-chemical structures in the depths of the brain fixed themselves in memory. I cannot exclude the possibility that each word might have taken several thousand years to develop. Thus

1 Berg et al., eds., *Management, Information, Intellect,* 234–5.

it went—word by word, sentence by sentence, and concept by concept.

Now it is time to proceed from general philosophical reasoning to the analysis of the formation of the functioning structure of man as a thinking creature.

Consciousness + Thought = Mind

It is known from the work of neuropsychologists that in the brain of every animal species, areas exist that are responsible for the biological preservation of the species. For example, in the brains of monkey and man, certain centers (groups of neural cells, or neurons) exist that are responsible for the execution of the functions of reproduction, movement, blood circulation, feeding, vision, etc. They function unconsciously, following their own biophysical and biochemical laws. But in the human brain, there is something peculiar: alongside the regions that work below the threshold of consciousness are regions (or one region) of consciousness. In the general balance of the brain's information processes, the unconscious plays an extremely substantial role: 10^9 bits of information per second are processed at this level, whereas on the conscious level it is only 10^2 bits (ibid., 237, footnote).

The human cognitive process begins with sensations that reflect objective reality as images. How, however, does the subsequent transformation of these sensations–images take place? How does "the transformation of the energy of the external irritant into a fact of consciousness" proceed?

Let us attempt to understand the psychophysical and neurodynamic processes of the operation of the human brain using the concepts of psychology.

The first stage of interaction with the outside world produces sensations. Sensations are realized through reflection. It is essential to note here that the process of reflection is not instantaneous; it requires a certain time that depends on the quality of the irritant (on average, between 1/5 and 1 second).[1] *Consciousness* is a psychological category that expresses the human brain's ability to perceive an external impulse (irritant) and code it in neural cells as special physico-chemical

1 For more detail, see Carter, 25–9; also Penrose, *The Emperor's New Mind* (1990), 568–72.

structures.[1] This scheme can be written as impulse–image–structure, or material-1–ideal–material-2 (since the structure is a physico-chemical combination in the nerve). None of these three members are identical to each other; they are different forms of the same object of reality, be it physical or ideal. With this one might wonder, even if we assume that this is true with relation to a physical object or irritant (light, warmth, color, or shape), about the case of nonphysical objects, for example, the word (which can kill or inspire). This question causes many scientists who tackle the problem of consciousness to fail. The answer is simple enough: every word (like every other abstraction), before it became an abstraction with a clear meaning, passed countless times through the head (brain) of man, through the above-described tripartite transformation, until it acquired meaningful reality for him. All initial abstractions, including the concepts of Numbers, Geometric Points, Lines, and Figures, as well as Language, were given rise to by concrete things. Every word, concept, or thesis started its "life" with the primary material phenomena that they came to designate and then came to be reflected in the brain. It suffices to recall how children are brought up.[2]

Thus, consciousness has coded certain information in its neuron microschemes. However, this is not just information of the yes/no type; it is information proceeding from concrete sources, i.e., from some part or other of the reality of being. ***I call this information knowledge.*** There is merely a sensation when one jerks his hand away from a hot object, but it becomes knowledge emerging as a result of processing a sensation when the idea of temperature is connected to a concrete object. This information is knowledge, coded in consciousness.[3] In other words, the external impulse, having undergone a certain transformation, has acquired the form of knowledge. This knowledge is transferred into memory blocks, with the current information being deposited, as physioneurologists have determined, in the thalamus, whereas long-term information is deposited in that part of the cortex called the

1 I would like to draw the reader's attention to the fact that mathematicians and cyberneticists, with rare exceptions, draw no distinction between the concepts of Consciousness and Thinking, which they regard as synonyms.

2 Based on a large amount of factual material, the French ethnologist Lévy-Bruhl has shown the evolution of the thinking-development process in surviving primitive peoples. See Lévy-Bruhl, *Primitive Mentality.*

3 Note: The etymology itself of the word *consciousness* (co + knowledge, from the Latin: con [to join] + scire [to know]) demands that knowledge be "stored" in consciousness.

hippocampus. In other words, memory is the depository of knowledge coded in the nuclei of neural cells.

Human memory is often compared to a computer's memory blocks. Despite a certain similarity, there is a colossal difference between them. Human memory retains not just information—say, the formula $E = mc^2$ in the form of simple bits—but information tied either to its source or to its content. Artificial intelligence comparable to the human brain can be created only if someone succeeds in recreating an artificial man with all his biosocial attributes. An artificial intelligence comparable to the human one would need to possess not only sensations (smell, taste, sight, etc.) but also the uniqueness of thought.

Next comes an extraordinarily important stage: the ascent of consciousness to thinking. Historically, consciousness precedes thinking:[1] the transition to the latter must have been a leap (in the philosophical sense). This leap was carried out thanks to speech. It seems to have taken place during the period of transition from *Homo erectus* (about 1 million years ago) to *Homo sapiens* (about 200 thousand years ago), i.e., at the time when the human brain increased by almost 50% in size with a simultaneous sharp increase in neurons and dendrites.[2] The "thinking mind" emerged. True man began with this stage.

Consciousness is passive; it reflects and accumulates coded knowledge. Thinking is active; it concerns itself with decoding knowledge for subsequent action. Thinking transfers knowledge into a particular logical chain consisting of words (symbols), theories, conceptions, concepts, and categories. In other words, it needs to transform the third member of the three-link chain (the structure coded in the neural cell) back into the ideal, which then is transformed into action.

What does this mean? Thinking is the process of translation of a physical structure into the ideal. Accordingly, this process must be discrete. This discreteness is embodied in thought, which in a rough approximation can be said to function similarly to light (waviness and discreteness). Thought is a quantum of action that characterizes the discreteness of thinking. The mechanism of its operation lies in thought extracting coded information–knowledge and decoding it as an ideal abstraction (it is apparently at this stage that speech comes into its

1 Penrose, too, notes this. "In my own way of looking at things, the question of intelligence is a subsidiary one to that of consciousness." Penrose, *The Emperor's New Mind* (1990), 526.

2 For more detail, see Delsemme, 201.

own), which, as a new quality, returns to its material structure (some special neural cell) programmed for action. Formally, thought is not subject to the law of conservation of energy, unlike, say, the photon or "energy quantum" in the second stage, i.e., the stage of the ideal. However, since the ideal is a reflection of the material (in this case, the material physico-chemical structures in neurons), thought does not exist without a material carrier, or, in other words, a "reflector," which is why it is subject to all the fundamental laws of nature as everything it reflects. To make this clear, thought can be compared to a certain degree to fireworks. Like fireworks, thought must be "ignited" from some source. In burning, fireworks can show not only shapes but also words. However, after fireworks have burst, any word they have formed disintegrates into burned-out particles while thought has memorized it in its concrete meaning as it returns to a certain neural microscheme.

The discrete flow of thoughts is the process of thinking, i.e., a multitude of quanta of action that constantly leap from the material to the ideal and vice versa, and which provoke interactions between nuclear neural cells that create electrochemical reactions in the brain.

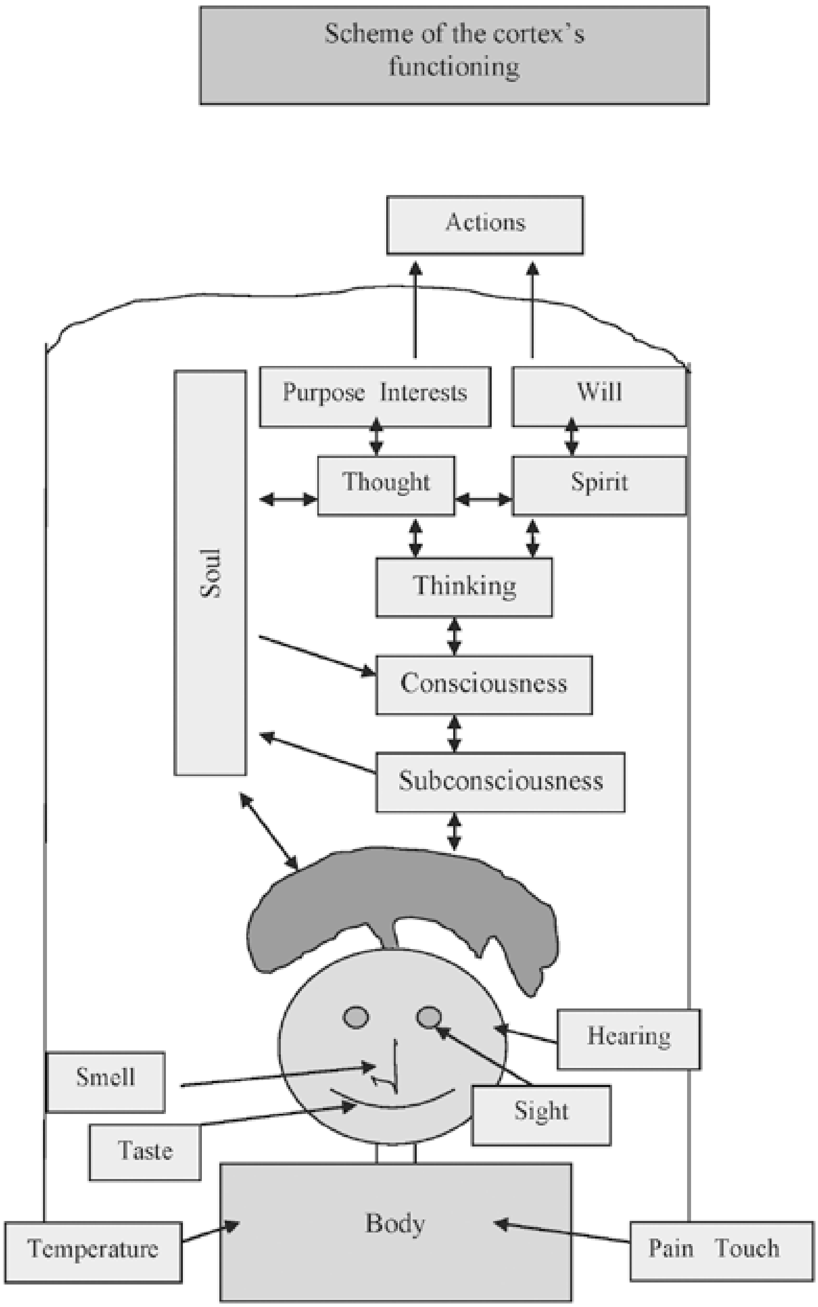
Given this interpretation of the mechanism of the brain's functioning, it is not difficult to answer the constantly reemerging question: how can immaterial thought influence the body? This effect certainly exists, and it can be experienced by anyone. It suffices to read half of any page in Hegel's *Science of Logic* to feel your brain "hum" and your body perspire. I repeat: thought is concentrated thinking that creates an ideal image that returns to its material shell (some neural cell, or perhaps even deeper) in the form of a memorized structure of meaning, which is what forces the body to operate according to a program bearing new content. The ideal becomes material. On the neurophysiological level, this new structure of meaning changes the spatiotemporal activity of the neural links, apparently in the cerebral area of the brain, and, as a result, we have the sensation that "our brains are humming." Figuratively speaking, thought speaks and gives orders.

Transfer of thought from person to person over a distance is impossible in principle for many reasons. Among them, first, thought does not exist as a reproducible combination of certain physico-chemical structures. Second, thought per se is an abstraction and is not identical to the object reflected in it. One might as well attempt to transmit a smile or mathematical formula over a distance. Should you succeed, we can revisit this issue.

Once again, the function of consciousness is to reflect the external world while the function of thought is to influence that external world based on consciousness. The combination of consciousness and thought is the mind, which none has but man.

Let us now proceed to the next stage of the unfolding of thinking, which leads to *spirit*. If we reject all the mystical interpretations of spirit, it can be designated as the energy of man directed at the attainment of a particular objective. When this happens, spirit is transformed into *will*. The two terms are nearly synonymous, but there are some differences. Spirit corresponds more closely to the idea of purposeful action, nearly coinciding with the word *determination*. The will is spirit in action, with the action being—I stress—intentional and purposeful. As Leibniz wrote, "A volition [*volunatas*] is an endeavor [*conatus*] for acting of which we are conscious."[1] In other words, will or volition is transformed into purposeful action.

1 Leibniz, *Philosophical Essays*, 19.


Scheme of the cortex's
functioning
Actions
Purpose Interests
Will
Thought
Spirit
Soul
Thinking
Consciousness
Subconsciousness
Hearing
Smell
Sight
Taste
Body
Temperature
Pain Touch

Spirit and will are mental states, meaning that mental and emotional processes play a much greater role in their organization than rational processes do. From the physiological point of view, this means that different parts of the brain's cortex participate in these processes. However, I do not rule out the possibility that the interaction of will and spirit may take place in a certain "willpower" region of the cortex that exerts a reverse neurophysiological influence on the thinking process. One also has to keep in mind that spirit and will do not emerge in every person but only in those who set goals and objectives that transcend simple survival or biological reproduction.

The *soul* certainly does exist as a manifestation of the subconscious's interaction with those parts of the brain responsible for the uncontrolled functioning of the human organism (growth and development hormones, hearing, sight, etc.). The general state of the operation of the whole organism produces the state of the soul, which is also a mental phenomenon. Let me put it this way: the goal is a dot, while the spirit (will) is a line and the soul is a plane (hyperplane). Movement of the dot produces the line, while movement of the line produces the plane.

The spirit depends, to a greater degree than the soul, directly on thinking and is more closely tied to thought, while the soul depends to a greater degree on those parts of the brain that are not consciously controlled and are responsible, for example, for the functioning of the heart, the liver, etc. It is the state of the soul that forms human types as sorted by its psychological properties (choleric, sanguinic, phlegmatic, melancholic).

Long ago, Baruch Spinoza pointed out the soul's inseparability from the body when he wrote in *Ethics*, "The Mind can imagine nothing nor recollect past things save while in the body."[1] He also argued, just as correctly, that the body's disintegration (death) causes the soul to disappear as well, whereas the spirit is eternal.[2] In this meaning of spirit, knowledge is transferred through the string of above-mentioned notions—*consciousness, thinking, thought*—and, due to human activity, is stored in the repositories of humanity's common memory.

It is necessary to keep in mind that identifying the different stages of the movement of consciousness and thought means stating the

1 Spinoza, *Ethics,* 213. Here the word mind is identical in meaning to the word soul.

2 In a somewhat different vein, La Mettrie, fearless materialist and atheist of the 18th century, in *Treatise on the Soul,* as formed precisely in "the brain," gave an interpretation of the soul. He is regarded today as a pioneer of scientific psychology

brain's operation in abstract concepts that reflect the real world. Both on the level of concepts (things-outside) and on the level of being (things-in-themselves), they are all interconnected and intercausal on both the horizontal and vertical axes. On the level of being, all links in the presented chain have a spatiotemporal extent except for thought, to which time and space do not pertain. Thought is a quantum, an impulse. Thought, despite the historic duration of its development, appeared ultimately by way of a Hegelian leap—a transformation of quantity into quality. It is not yet known which concrete material structure (biochemical reaction) created it, but the important thing is that it did. This was the transition from biogenesis to psychogenesis, i.e., the leap from the animal world to the world of man. I think, therefore I am human!

Knowledge = Force

We have finally gotten to the main point—to force. What is the force of man? Differently stated, how does the force of man differ from other forces of nature? How is the force of man measured?

It could be inferred from the above passages that thought is the force of man since it sets him apart from the rest of the world. But thought is an abstraction—a property, or function, of human thinking. Although in the philosophical section of this book I defined force as an attribute of being that consists, among other things, of ideal reality, the motion of force itself by nature must have material substance. Apart from its attributiveness and its implicitness, force "loves" to manifest itself through laws. Thought by itself, as reflection, is insufficient for defining the force of man.

It was asserted earlier that thought is a quantum of action, an impulse. But in the preceding context, these designations were metaphorical in character; otherwise, we would have fallen into the clutches of physics or, worse still, "quantum consciousness," which I oppose unequivocally. Thought, as reflection, is something ideal; therefore, it has to be reflected from something. This "something" is information, which flows into the conscious and subconscious. Primary information—that which is perceived through sensations—can be regarded as a statistical group of signs in Shannon's sense, i.e., without semantic content. This is the information that flows to the block of the subconscious (10^9 bits), with only a small part going to the block of consciousness (10^2 bits). This is a warehouse of sorts for unprocessed raw materials. The processing of this information in the first block on the subconscious level services biophysiology. The second block—consciousness—is closely tied to thinking, where thought comes into its own. Its function is to identify, select, decode, and ultimately translate statistical information into knowledge (this procedure means joining the syntactic, semantic, and sygmatic aspects in the synthesis of knowledge).[1] By the way, experimental psychologists claim that a certain region in the cortex exists where the processes of thinking for processing "abstract information" take place. Dr. John Skoyles calls this place "the prefrontal cortex," and it differs from all other parts of the brain in that, on the one hand, it is cut off from direct external influence, and, on the other hand, it is connected to all internal sources of information storage. Most importantly, this zone developed historically later than the other parts of the brain.[2] In any case, this zone can be considered a warehouse for storing finished goods.

However, in order for the function of processing information into knowledge to be realized by thinking, a condition is necessary that is embedded in the existence of being that reflects itself outward into other-being, i.e., emits impulses of information in different forms. The "capture" by the neurons of the brain of information is the flash of thought that transforms information into knowledge. This meeting (of the material and the ideal, roughly speaking) leads to their merging, and a new quality appears—thought—which is born instantaneously in the act of information identification and transformed directly into knowledge. Therefore, thought is dissolved in knowledge. As a result, we have made a transition from the material world to the reflected one, the world of goals and concepts, the domain of thinking. This world has its own laws and regularities, the truth of which are determined not just by the blind reflection of the external aspects of the material world, but precisely by that kind of reflection that penetrates into the depths of the material world, including man himself. In Hegel's words, the accuracy of the correspondence of the reflected world with the real world depends on the degree of concurrence between cerebral intelligence or intelligent mind and the object of cognition.

Thinking commands the sum of knowledge, constructs concepts,

1 For more detail, see Klaus, *The Power of the Word*, 13–22.
2 See Carter, 167.

and formulates laws. Ultimately, the knowledge and its accumulation thereof are the *force*, the foundation, of human development. The famous aphorism "knowledge is power" is not quite correct, for knowledge is not the subject of the predicate of power. *Knowledge and force are an identity*. When we measure knowledge, we measure force, and hence we measure the force of human thinking.

Information and Knowledge

The meaning of the word *information*, used many times above already, needs to be specified. Information as a concept aspires to a position at the same level as the concepts of Matter and Energy. In spite of this, scientists do not interpret information unequivocally; at any rate, it has many different definitions and interpretations. For example, the French mathematician Louis Couffignal defines information as "a physical influence that provokes a physiological response."[1] After some clarifications, he defines information as "a physical action that influences thinking" (ibid.) Therefore, Couffignal says, information has two aspects: semantics, which is contained in the influence of this information on thinking, and the carrier of information, a physical phenomenon that allows semantics to influence thinking.

Cyberneticists, mathematicians, and in general everyone involved in trying to construct a "thinking machine" cannot help but translate all the processes of man's functioning into the language of information, the example having been set long ago by Norbert Wiener, "the father of cybernetics." He wrote, in particular, "The third fundamental phenomenon of life that is irritability belongs to the domain of communication theory."[2] In principle, absolutely everything can be attributed to "the area of communications," including "social relations," which can be viewed as "a special form of information transfer" (Louis Couffignal). What, then, is information?

All is not as simple as it at first appears. For example, the Russian scientist and polymath Yuri M. Baturin maintains that information "does not exist in *Nature* [emphasis mine]; it was required to fill in the 'blank spots' in the scientific picture of the world, as previously invisible

1 Quoted in *Cybernetics: Results of Development*, 111.
2 Wiener, *Cybernetics,* 11.

essences."[1] Strangely enough, Baturin is correct; information does not exist in nature as a material substance in the form of matter or energy. N. Wiener wrote, anticipating attempts to reduce information to matter, that "information is information, not matter or energy" (ibid., 132). This means that information is not an ontological category, and thus it belongs to the realm of concepts, to the sphere of reflection. If it does not exist in "Nature," i.e., not as an independent essence, it exists in being as something ideally reflected. (The reader is perhaps already starting to guess that the mechanism of understanding information is the same as in the understanding of consciousness–thought.) Baturin expressed this with the very precise word *relation*: "Information is the relation of conformity between two systems." Thought in the process of thinking does precisely this: it brings two systems in conformity as it transforms information signals into knowledge. The German scientist G. Klaus writes of the same thing in a different form: "Information is not something independent, it is not something absolute; it has an informational character only in relation to systems that perceive information."[2]

However, there is only one "system" that can perceive information as information: man. This is because the concept of Relation itself is gnosiological; it is inherent to man alone. Even animals are not "related" to anything since an animal's relation toward others or toward signals does not exist as a relation, for it has no consciousness, only mind (psyche) and invertebrate organisms do not even have a mind at all. This is even truer concerning the inorganic world. Two interconnected machine systems do not perceive information, which, in Wiener's words, means "designated content"; they receive only electrical signals. Therefore, I repeat: it is man alone that perceives information.

This is one aspect: the perception and reflection of information. The other is its corporeality, its energy–momentum (impulses, signals). Again, as with thinking, speech, words, concepts, etc. are all abstractions derived from concrete things and originate from their physical carriers. They are preserved not in some transcendental airspace, but in books, on disks, and inside man.

Even so, as was asserted above, the force of man lies not in information but in knowledge. Here, further clarification is required. Knowledge can often be regarded as information and vice versa. Where

1 Baturin, *Political Information and Its Perception*, 111–2.
2 Klaus, *Cybernetics and Society*, 60.

is the border that demarcates one from the other? For example, what is it that is stored in libraries, knowledge, or information? The answer comes to mind easily. Imagine that all the libraries in the world were given as a gift to some jungle tribe of Mumbo-Jumbo that has only just learned to read. To them, these libraries will be some variety of information, at best. Similarly, to a child, the formula a + b = c would amount to informational signs that he could possibly memorize on the subconscious level.

Knowledge is the possibility of using information in practice. For this possibility to be realized, the information must first be systemized and put in order; i.e., it must acquire meaning for practical activity. Without subsequent action, there is no point in giving meaning to information—i.e., the status of knowledge. This is why the largest part of the information we absorb dissipates, disappears due to being unneeded, and never becomes knowledge. Therefore, information is tied to knowledge as "input" and "output" in the process of thinking, in which purposeful action (or utilization) is embedded. It is in knowledge that the category of Force operates at full capacity since the former internally accumulates ontology (and its physics and chemistry) and psychology (the process of reflection in the brain), as well as behavior in the environment (behaviorism, if you will).

One might ask what man needs *knowledge* for, which would ultimately lead us to the main question: what is the meaning, or purpose, of human life? Answers to this are plentiful: from making a pile of money to dedicating one's life to the liberation of mankind. These answers are all of a social nature. We, however, are interested in the purpose of human life as a unique phenomenon of nature.

Goethe answered this question by saying, "The meaning of life is in life itself." He is correct, for life is the essence of man, and only man realizes who he is. Therefore, the longer the life, the longer man remains man. Briefly put, the meaning of life is in its extension. But how, or at the expense of what?

Information–Entropy–Knowledge

Let us begin to sort out the interrelations between information and entropy. In *The Dialectics of Force* (in the chapter dealing with physics), entropy, or the second principle of thermodynamics, was discussed in the context of the inevitable heat death of the universe. In the chapter on orgabia (in the same book), a particular manifestation of the second principle was emphasized—the generative chaos that to a certain degree puts in order the organic world according to its laws. Many researches connect this process of ordering to information. This is what we read, for example, in Wiener's work: "Just as the amount of information in a system is a measure of its degree of disorganization, so the entropy of a system is a measure of its degree of disorganization; and one is simply the negative of the other" (ibid., 11). Wiener is here asserting a relationship of direct proportionality between information and entropy: the more information, the less entropy, and vice versa. Subsequently, these ideas were developed and clarified, and information came to be defined as data that reduce or remove the uncertainty that existed before their arrival. As a result, in the thermodynamic interpretation of the statistical concept of Information, it came to be viewed as negative entropy (negentropy) that is drawn by the system (for example, a living organism) from the environment for organizing its internal processes. "This gives grounds for distinguishing between information being *free*, viewed regardless of its physical embodiment, and information being tied, which correlated with the microstates of some system."[1]

Free information is its invariance, as I noted above. *Tied* information is directly subject to the second law of thermodynamics. This was discovered long ago thanks to the work of Szillard, who sought to solve Maxwell's paradox that information cannot be obtained for free. It has to be paid for with energy, and, as a result, the system's entropy increases by at least an amount equal to its decrease at the expense of the information obtained. In this sense, *tied* information does not possess negentropic properties that would cancel, for example, the entropy of a biological system. Blumenfeld was correct when he wrote, "Any biological system is no more ordered than a slab of rock of the same weight."[2] For any biological system, only new, created information has meaning, something that became possible because of the increased complexity of the organic world's structures. This process emerged by chance and on an objective level. The emergence of man signified a leap into the realm of the mind, in which the subjective world started to play an enormous role.

1 Berg et al., eds., *Management, Information, Intellect,* 183.
2 See Blumenfeld, *Information*.

As mentioned already, cyberneticists do not see much difference between information and knowledge. Wiener can talk about information and then, in the same context, about "the battle for knowledge." For the purpose of the present investigation, this distinction is extremely important since I regard information as the primary raw material (even in the context of *free* information), which only subsequently is processed by thinking into knowledge. More precisely, knowledge is ordered information, or negentropy. The negentropicness of knowledge manifests itself in the fact that man—and man alone—*influences Being consciously in accordance with different purposes, of which the most important is the* ***extension of life****—and I underline* ***not simply life, but the extension of life***. Simple life is determined by the laws of the organic and the inorganic worlds and is completely subject to the second law of thermodynamics. The extension of life, however, is a struggle waged by knowledge against the second law of thermodynamics to expand its living area in time and space. While not canceling that fundamental law, knowledge wrestles from it certain islets in the universe where it either works at a different pace or shuts down altogether for some particular time. Therefore, *it is not information but knowledge that is the measure of organization for the system into which man is built*—man, who opposes disorganization of the environment and heightened entropy.

Life and Progress

Norbert Wiener wrote, "To live effectively is to live with adequate information."[1] I have noted already that the goal is not just to live but also to live a long time, and the need is to possess knowledge rather than information. However, the important term here is *correct*. Many may say that false information and false knowledge exist. That is correct. However, the very existence of man and mankind is evidence that only correct information and correct knowledge prevail over incorrect information and knowledge. This is because correct knowledge adequately reflects the objective reality man is constantly encountering. The criterion of correctness is practice, however banal that may sound. The laws of reality, which are constantly put to the test by practice as

1 Wiener, *The Human Use of Human Beings*, 18.

well, are formulated on the basis of correct knowledge.

In this regard, a question about progress arises. In the preceding chapters, I took a look at anthropists of all stripes. For them, progress means the ascent of the universe toward man. Other scholars—Gould, for example—believe that progress does not exist at all. With the former claim I disagree in principle, but with the latter only with respect to the organic world. The world of man is another matter. Man is not the goal of evolution. However, evolution having taken place, man is now able to formulate the purpose of life, which is its prolongation. We can therefore refer to the positive difference between the life span allotted to man by nature (the laws of the inorganic and the organic worlds) and his real (actual) life span achieved thanks to his knowledge, or negentropy, as progress. It is this delta—the *delta of life*—that is progress. The simplest formula for expressing it is this: $\Delta L = L_A - L_N$, where L is lifespan; A is actual, or real average, life span; and N is natural, or biological, lifespan.

This delta is the quantitative characteristic of the force of man. It depends, I repeat, not just on knowledge but on knowledge of the laws that govern the universe, i.e., the laws of all three worlds: the inorganic, the organic, and the human worlds. The deeper and more fully man uncovers these laws, the higher his negentropic potential is and the higher his capacity for influencing the universe is in his self-interested extension of life.

This logic can be applied both to society and to mankind as a whole. The longer the average life span in a particular society or state, the greater its total force is and the more progressive it is. It is no accident that in those societies where knowledge is not yet developed and obscurantism reigns—for example, in the form of religion—the average life span does not increase. Let me remind you that the average life span during Greece's Golden Age of Pericles held steady at the 20-year mark. Throughout the Middle Ages, when Christianity held sway over Europe, for almost a millennium and a half the average life span in Europe stayed at the same level, and it was only by the 18th century (the start of the Enlightenment) that it increased to 25 years. In the 19th century, it reached 35 years and even surpassed 40 in some places.[1] The same can be said of Third World countries in our day.

In other words, when man arrived, there emerged a force that challenges the law of entropy. Over the past 10,000 years, man has increased his average life span by a factor of almost four times (from

1 See Bobrov, *Let Us Talk About Demographics*, 72, 74.

approximately 20 to 75–80 years),[1] though originally nature allotted to him as a biological organism only about 20 years on average. This means that man, remaining a part of nature and accordingly being subject to the law of entropy, managed nonetheless to create a structure of his being that enables him to resist nature and all of its laws. Therefore, the force of man, reflected from his being, changes the being not only of man himself but also that of nature, of which he still remains a part. Only man creates things that did not exist in nature before his arrival. Man has proven to be able to change the volumes or rates of dissipation of energy, i.e., decelerate the action of the second law of thermodynamics. Although man does slide toward equilibrium and die due to this law, he manages at the same time to extend his existence as a species. On the level of mankind as a whole, he already aspires to immortality. This is his ultimate goal as representative and carrier of the noosphere. Even though this goal is not attainable in principle, according to the law of entropy, the struggle for its attainment—struggle rather than a passive belief in progress—is the essence of human existence. The progress of human development is nothing other than the extension of the life of mankind and individual man as its nucleus. Thus, man appeared by chance, but mankind must survive by regularity.

* * *

After I finished writing this chapter, I came across a book that puts my entire optimistic ending in doubt with two claims to which I absolutely must react. The first one is the claim that man has already reached the optimum average life span, or that at most his life span can be increased to about 120 years. Thus, J. S. Jones of University College London wrote in one of his sensational articles that human evolution is complete, meaning that the brain has stopped increasing in size and its morphology has not changed over the past 100,000 years. The life span growth that is due to medicine, sanitation, etc. has exhausted itself, and in the future these things are not likely to change the situation qualitatively.[2]

Jones and certain others who advance such arguments fail to notice the obvious. Yes, the brain has stopped growing, the genes have not

1 See Bromley, *The History of Primitive Society,* 312.
2 See Wills, 303.

changed, and neither has the morphology. And yet over just the last 100 years, man increased his average life span from 40 years—the average life span in Western Europe in the middle of the 19th century—to approximately 80 years today in the advanced countries, i.e., by a factor of almost two. Note that there is no such leap in the Third World. To what is this due? It is due to knowledge. It is in the First World that the science-and-technology revolution has been taking place over the past hundred years. The laws of nature were not only discovered in this world, but they were also put to skillful use. The results are there for all to see. It is not necessary to wait for the brain to increase and for the skull's morphology to reach the volume of a pumpkin. The brain's present size has sufficed for the knowledge needed to increase man's life span by a factor of two over a short period of time. This, by the way, is a response to all those who are skeptical of science and claim that it is of little use. Can you imagine what will be after 100 years, or 200, or 1,000 years? The pace of life span's progress may change, but the trend will stay the same: man's life span will keep increasing.

The other claim is more serious. It is advanced—although as a doubt—by Christopher Wills: is greater life span really an advantage from the point of view of the preservation of the species? Could it be that a shorter life span is more profitable for this purpose? (ibid.). In fact, can mankind survive if the average life span of individuals were to increase to 200 or 400 years? The current increased life span in the First World is already causing all sorts of economic and social problems. These questions can even be put in an exaggerated form—what would be better for mankind, to have a population of 1 billion with an average life span of 200 years or 15 billion at 70 years?

This reminds me of Malthus and the various neo-Malthusians who fear that the means of production (or foodstuffs, as Malthus wrote) will prove insufficient for a growing population, much less for an aging population. In the contemporary situation, these fears are groundless, and all the existing problems are of a social or religious character.

The correspondence between orgagenesis and phylogenesis is determined by the laws of evolution and in society by the laws of socioeconomic relations rule. Force reigns in both realms, but in the former case they are blind, objective forces of nature while in society they are forces of knowledge—knowledge of the laws of nature and society. Knowledge and practice will determine which correspondence between life span and population size is or will prove to be optimal, both on the level of states/societies and that of mankind as a whole. Let me remind you of the example of China, where a deliberate policy of birth control is implemented.

Life span is only a reflection of knowledge of laws of nature and society. Mankind's goal is to turn its knowledge of laws into a law of knowledge growth—or a law of growth of force, which is the same thing. Its fundamentality will be determined by the successes in the struggle against the law of entropy for time and space in the universe. The results of the struggle between these two laws are the essence of progress and regress.

CONCLUSION

For over 2,500 years, philosophers have been trying to determine what force in nature is and its connection to matter, motion, spirit, space, and time. Each has offered his own ideas on the interrelations of force and the indicated phenomena, but most arrived ultimately at the conclusion that force exists within matter as its motive basis. Some began to speak of the self-motion of matter, meaning the presence of two forces (with different names) within a material integrity, with their contradiction causing matter (or sometimes the spirit) to move. In my opinion, Hegel's reasoning could be considered the pinnacle of this interpretation of these interrelations if these ties had not turned out to be merely a reflection of Absolute Spirit. This idea did not suit the subsequent naturalists C. Vogt and L. Büchner, who joined force and matter back together again, asserting that they are the same thing while forgetting about motion, which Hegel always kept in mind.

By the early 20th century, the debate about force as a philosophical category had died down. However, force retained its actuality as an empirical category in physics and cosmogony and as a concept relating to the organic world. But what is particularly notable is that the category of Force took center stage in political and social science as well as in the theory of international relations. In the domain of politics, force first came to be discussed in the works of Engels (for example, in the chapter "On Violence" in *Anti-Duhring*) and especially Lenin (in the context of the correlation of class forces). In sociology, it started with a major work by Bertrand Russell explicitly dedicated to power. And in the theory of international relations, force first appeared as a concept after World War II thanks to the works of Hans Morgenthau within the framework of his theory of the balance of powers.

I specified in the preface that the existing interpretations of force in the social sciences do not suit me, which is why I was compelled to undertake this labor. The conclusions of this book will enable me to return to politics and international relations armed with a different weapon. This is why:

From my definition of *ontological force—ontobia—as an attribute* *of being that defines its existence*, it follows that all material space possesses force. In principle, there is nothing particular in this thesis. The characteristic of Force as ontological category appears in the assertion that *while space and time indicate the direction of matter's motion, force defines the form and states of matter through motion in the multiform structure of the universe*. These states of matter are uncovered through diverse forces that reveal themselves in the laws of force. In the micro- and macroworld, force manifests itself as the four known physical forces; in the megaworld (the universe), the force is cosmobia; in the organic world, orgabia; in consciousness, force-knowledge; and in the social world, it would possibly be called force-power (I will delay the clarification of this force until the special research to be undertaken in my next book is finished). This means that force is multifaceted and that identifying a given facet entails determination of the law of its functioning in this or that structure of material and ideal being.

My definition of the law of force, tied to the new definition of the concept of Progress, provides the methodological basis for formulating the laws or regularities (possibly as tendencies) of the development of society and the human community. The interconnection between force and progress in my formulations at least may facilitate obtaining answers to such questions as why have hundreds of states disappeared from the world arena while others survive to this day? Why did the American Indian civilizations (the Incas, the Mayans) fail to develop for a thousand years and fall under the blows of insignificant forces while younger states managed in a very short time to achieve great might and demonstrate their aggressiveness and expansionism? Why did the Arab world fall so substantially behind the European world, and why is it currently under attack from the United States? Why did Russia remain a marginal state in Europe for a thousand years and then turn into a superpower in fewer than 70, and why did it slide back to the pre-Peter I era in the last 15? Why is it that the Western world is currently dominant, and why will this domination inevitably end unless the West changes the vector of its development? Why is it that the words from the famous revolutionary song—"We shall raze the world of violence to the ground, and then we shall build our new world; he who was nothing will be everything!"—correspond to the law of progress, not that of entropy growth, although it should have been the other way around? Giving answers to these questions will not be difficult proceeding from the conclusions and formulations that have been suggested by me in this work.

GLOSSARY OF SCIENTIFIC TERMS

Abiogenesis. Emergence of the living from the nonliving in the process of evolution. Abiogenesis is currently impossible due to the absence of its physico-chemical premises and the inevitable destruction of the emerging forms by contemporary living organisms.

Absolute zero. The lowest possible temperature, about -273 degrees Celsius, or 0 on the Kelvin scale.

Adaptation. The adjustments of an organism's functions and structure to the conditions of its existence.

Adenine. A purine base contained in all living organisms in the composition of nucleic acids (one of the four "letters" of the genetic code) and of other biological substances.

Amino acid. Organic molecule with a radical—NH_2—and an acid function—COOH; the proteins are built up from 20 different types of amino acid.

Amygdala. A subcortical brain nucleus adjacent to the hippocampus, which appears to be crucial for emotional memory.

Anisotropy. The dependence of a milieu's properties on direction. It is characteristic, for example, of the mechanical, optical, magnetic, electrical, and other properties of crystals.

Antimatter. Matter consisting of *antiparticles*.

Antiparticles. Elementary particles that have the same mass, spin, life span, and certain other internal characteristics as their "doubles," but differing from them in the sign of electrical charge, magnetic moment, baryon charge, lepton charge, strangeness, etc.

Arrow of time, cosmological. Direction of time in the universe, tied to its visible expansion.

Arrow of time, thermodynamic (heat). Direction of time in the universe, tied to the growth of *entropy*, which makes it impossible to reverse processes in the macroworld. The growth of disorder and the devaluation of energy determine the content of the physical law of energy preservation and stipulate the cause-and-consequence order of events.

Axon. The fiberlike extension of a neuron by which the cell sends information to target cells.

B meson. Heavy meson made of a bottom *quark* with any antiquark.

Baryons. Heavy elementary particles with a half-integral spin and a mass no lower than the mass of a proton.

Bifurcation. Separation, forking, splitting of the trajectory of motion, etc.

Biopoesis. A teaching that recognizes the forming of living things only from living things. One variety of biopoesis is the version about the cosmic origin of life.

Biote. A historically formed aggregate of plant, animal, and microorganism species united by the common area of their distribution; unlike the biocenosis, it can be characterized by an absence of connections between the species.

Black hole. Region of space–time that remains invisible to distant observers because its gravity is so strong that nothing, not even light, can escape from it.

Boson. A particle, or pattern of string vibration, with a whole number amount of spin; typically a messenger particle.

Boson string theory. First known string theory; contains vibrational patterns that are all bosons.

Brain stem. Evolutionarily, the most ancient part of the brain, consisting of the midbrain, the hindbrain (excluding the cerebellum), and the medulla oblongata.

Brane. Any of the extended objects that arise in string theory. A one-brane is a string, a two-brane is a membrane, a three-brane has three extended dimensions, etc. More generally, a p-brane has p spatial dimensions.

Calaby-Yay space, Calaby-Yau shape. A space (shape) into which the extra spatial dimensions required by string theory can be curled up, consistent with the equations of the theory.

Catalysis. Acceleration of a chemical reaction in the presence of catalyst substances that interact with the reagent but are not used up in the reaction and are not included in the end product.

Cell. Structural unit of living beings. The *prokaryotic* (without a nucleus) cells are the most primitive; they are found only in bacteria. *Eukaryotic* cells (with a nucleus) display a much more complex structure; they form unicellular microbes, which are not bacteria (like the protists), and all the multicellular organisms (animals, plants and fungi).

Cerebellum. The "little brain" at the back of the brain stem involved in fine control of movement.

Cerebral cortex. The outermost layer of the cerebral hemispheres of the brain. It is responsible for all forms of conscious experience, including perception, emotion, thought, and planning.

Cerebral hemispheres. The two specialized halves of the brain. The left hemisphere is specialized for speech, writing, language, and calculation; the right hemisphere is specialized for spatial abilities, face recognition in vision, and some aspects of music perception and production.

Chirality. Feature of fundamental particle physics that distinguishes left- from right-handed, showing that the universe is not fully left–right symmetric.

Chondrite. Stony meteorite coming from the asteroid belt (between Mars and Jupiter).

Chromosomes. Structural elements of a cell's nucleus, containing DNA in which the sequential information of the organism is contained; in the chromosomes, genes are located in linear order.

Citokinines. A group of plant hormones, derivatives of nitric bases of purine; they increase the speed (rate) of cell division.

Citoplasm. Extranuclear part of the protoplasm of animal and plant cells.

Citosine. A pyrimidine base contained in all living organisms in the composition of nucleic acids; one of the four "letters" of the genetic code.

Cortex. The surface of the brain, divided into two halves, composed of almost the same architecture of six layers of cells throughout. It may be subdivided into primary regions where inputs arrive (visual, auditory, sensory, olfactory), or outputs leave (motor), or associative, where those inputs are analyzed and related together or motor programmes are stored.

Cosmic microwave background radiation. Microwave radiation suffusing the universe, produced during the Big Bang and subsequently thinned and cooled as the universe expanded.

Cosmogony. The branch of science that studies the origins of the universe and of separate cosmic objects, including the Solar System and our planet in particular. Cosmogony is a division of astrophysics.

Cosmological constant. Supplementary member of Einstein's equation of the general theory of relativity, which physically presents the possibility of vacuum having energetic density. The formula is $\Lambda = \frac{8\pi G}{3c^2}\rho$, where p—vacuum, G—gravitational constant, c—speed of light.

Cosmology. Study of origin and evolution of the universe.

Critical density. Mean density of the universe that would be just right to prevent it from falling back upon itself under its own weight. If the universe had just the critical density, it would continue to expand indefinitely, although at a slower and slower pace.

Dark energy. A hypothetical energy and pressure uniformly filling space; more general notion than a cosmological constant as its energy/pressure can vary with time.

Dark matter. Matter suffused through space, exerting gravity but not emitting light.

Dendrite. A treelike extension of the neuron cell body. Along with the cell body, it receives information from other neurons.

Dissociation. Disintegration of a particle (molecule, radical, ion) into several simpler particles.

DNA (desoxyribonucleic acid). A high-polymer natural compound contained in the nuclei of cells of living organisms. The DNA is the carrier of genetic information; its particular segments correspond to certain genes.

Electroweak. The electroweak force results from the merging of the electromagnetic force and the weak nuclear force, which become indistinguishable for energies around 100 GeV and at distances less than 1 fm (10^{-15} m); this corresponds to the size of the atomic nucleus.

Empty space (or "vacuum"). Because of the existence of quantum fluctuations, the nature of empty space is not as simple as was thought before. The average energy of the quantum fluctuations in the vacuum is not nil. This energy seems to confer a transient (virtual) mass to all particles that transport nuclear forces, which constrains them to distances less than 1 fm (size of the atomic nucleus). These particles polarize space, which does not remain symmetrical in all directions. A totally symmetrical space ("false vacuum") exists only at high temperature.

Enzyme. Protein used as a catalyst for a biochemical reaction.

Eugenics. Francis Calton's term for the betterment of the human species through controlled or regulated breeding.

Eukaryotes. All organisms whose cells contain a formed nucleus, separated by a shell from the cytoplasm. Eukaryotes are divided into three kingdoms: fungi, plants, and animals.

Event. A point in space–time defined by its date in time and its location in space.

Event horizon. Imaginary sphere surrounding a black hole delineating the points of no return; anything crossing the event horizon cannot escape the black hole's gravity.

Evolution. One of the forms of motion in nature and society; uninterrupted, gradual quantitative change, as opposed to revolution.

Exon. Part of the genome that is expressed in a particular living being, as opposed to *intron,* a part that is not used, and often contains an incoherent message. The intron is not expressed in the individual but is, however, transferred by heredity and remains present in the genome.

Ferments. Biological catalysts that are present in all living cells; they perform the transformation of substances in the organism, thus directing and regulating its metabolism. By their chemical nature, they are proteins.

Fermion. A particle or pattern of string vibration with half a whole odd number amount of spin; typically a matter particle.

Flat space. Possible shape of the spatial universe having no curvature.

Flatness problem. Challenge for cosmological theories to explain observed flatness of space.

Fluctuation. Chance deviation of a physical magnitude from its average value.

Formaldehyde (formic aldehyde). Colorless gas with a sharp odor; its chemical formula is HCHO; it is the raw material in production of phenolformaldehyde resins, isoprene, etc.

Frontal lobe. One of the four divisions (parietal, temporal, occipital) of each hemisphere of the cerebral cortex. It has a role in controlling movement and associating the functions of other cortical areas.

Galaxy. A system of several billion to hundreds of billions of stars; galaxies vary considerably in size and structure; most of them are not distributed uniformly in space but arranged in clusters containing from a few up to 10,000 members. Most galaxies fall into two varieties: spiral and elliptical. Our Milky Way galaxy is a giant spiral. There are about

100 billion galaxies in the observable universe.

Ganglia. Nerve knots.

Gene. Unit of hereditary material that is responsible for the formation of some elementary trait.

General relativity. Einstein's theory of gravity; invokes curvature of space and time.

Genome. The whole of genetic information carried by DNA or RNA; in evolved organisms, the DNA is coiled around proteins to form chromosomes.

Glia. Specialized cells that nourish and support neurons.

Gluons. Smallest bundle of the strong force field; messenger particle of the strong force; the particle "glue" (particle or quantum of energy) analogous to the photon, whose exchange between protons, neutrons, or their constituent quarks can lead to the very strong binding known as the nuclear force and to the binding of the quarks together to make the neutron and proton and their heavier companions.

Grand unification. Class of theories that merge all three nongravitational forces into a single theoretical framework.

Gravitational force. The weakest of the four fundamental forces of nature. Described by Newton's universal theory of gravity and subsequently by Einstein's general relativity.

Graviton. The quantum of a gravity field that has a zero rest mass, zero electrical charge, and zero spin (not yet discovered experimentally).

Gravity. Attraction (pull); the universal interaction between any forms of physical matter.

Guanine. A purine base contained in the cells of all organisms in the composition of nuclein acids; one of the four "letters" of the genetic code.

Hadrons. Collective name for particles such as the neutron and the proton.

Hippocampus. This organ is at the edge of the cortex and is essential for laying down long-term memory.

Hormones. Chemical messengers secreted by endocrine glands to regulate the activity of target cells. They play a role in sexual development, calcium and bone metabolism, growth, and many other activities.

Hypothalamus. A set of subcortical nuclei involved crucially in the perception of pleasure or pain, and more generally in the transfer of body-drive levels (thirst, hunger, etc.) into associated neural motivational states.

Intron. Segment of the genetic message that is cut out at the time DNA is copied by RNA in complex living beings; the intron contains many errors and incoherent passages, owing to the hazard of mutations; see also *exon.*

Invariance. The invariability of some value (magnitude) when physical conditions change or with respect to certain transformations.

Invariant. Value (magnitude) that remains unchanged in this or that transformation.

Ionization. Transformation of atoms and molecules into ions.

Ions. Electrically charged particles formed from atoms (molecules) as a result of the loss or capture of one or several electrons.

Isomers. Chemical compounds that are identical in molar mass and composition but differ in structure or spatial location of atoms and, therefore, in properties.

Isotopes. A variety of chemical elements whereof the nuclei of atoms differ in the number of neutrons but contain the same number of protons and therefore occupy the same place in the periodic table of elements.

Isotropy. Identity of properties of objects (space, substance, etc.) along all directions.

Kelvin. Temperature scale beginning at the absolute zero (-273 °C in the Centigrade scale); Kelvin degrees are identified by the symbol K (in honor of William Thomson, Lord Kelvin); example: 300 K = +27 °C. At very high temperatures, the difference between the two scales becomes insignificant.

Leptons. Elementary particles with ½ spin that do not participate in the strong interaction.

Limbic brain. The rear section of the forebrain, lying directly under the cerebrum hemispheres and consisting of a multitude of interconnected nuclei, concentrated around the third ventricle. The rear and side nuclei of the limbic brain form the thalamus; the front part is the hypothalamus. The limbic brain participates in the performance of vegetative functions as well as sleep, memory, psychic reactions.

Lipides. A vast group of natural organic compounds that includes fats and fatlike substances.

Magneto-resonance tomography. Tomographic exploration of the brain based on the phenomenon of nuclear magnetic resonance.

Matter, diffuse. Rarified matter in the cosmic space that groups into gaseous nebulas. These are distinguished into gaseous (diffuse) nebulas proper, consisting of atoms and molecules; intermediate gas-dust nebulas that include dust particles and are embryos of stars and planets; gaseous planetary nebulas that form from decomposing cast-off shells of stars.

Mesons. Unstable elementary particles with zero or integral spin that belong to the class of *hadrons*.

Metabolism. The sum of all physical and chemical changes that take place within an organism and all energy transformations that occur within living cells.

Metagalaxy. The part of the universe that is accessible to modern methods of astronomic research; it contains several billion galaxies.

Methane. Colorless gas (CH_4); the principal component of natural gas (97–99%), (incidental) oil gases (31–90%), mine and marsh gases; it serves as the raw material for many valuable chemical industry products: formaldehyde, acetylene, carbon bisulphide, etc.; it is also used as fuel.

Midbrain. Section of the brain's stem located between the limbic brain (in front), and the Varoly bridge and the cerebellum in the back.

Mitochondreon. Organelle ("little organ") of the eukaryotic cell, which transforms nutrients into energy, generally by oxidation; it is believed that it is an ancient bacterium, introduced first as a parasite, then forming a symbiotic relationship with the infected cell. In particular, it possesses a different DNA that reproduces independently.

Mitosis. Division of the cell nucleus into two equal parts in which all the chromosomes divide equally, leading finally to two cells identical to the first one. It is different from *meiosis,* in which the chromosomes do not divide but are equally shared by the two new cells, which are then sex cells.

M-Theory. Currently incomplete theory unifying all five versions of string theory; a fully quantum mechanical theory of all forces and all matter.

Multiverse. Hypothetical enlargement of the cosmos in which our universe is but one of an enormous number of separate and distinct universes.

Muon. Elementary particle that is a heavier electron.

Mutations. Naturally emerging or artificially caused changes in an organism's hereditary properties as a result of reconstructions and violations of the organism's genetic material—chromosomes and genes; mutations are the basis of changeability in living nature.

Natural selection. The process of survival and reproduction of organisms that are best adapted to the conditions of the environment and of death of the nonadapted in the course of evolution; the consequence of the struggle for survival.

Neuron. Nerve cell. It is specialized for the transmission of information and characterized by long fibrous projections called *axons* and shorter, branchlike projections called *dendrites*.

Neutrino. Stable noncharged elementary particle with ½ spin belonging to the leptons.

Neutron. Neutral particle made of three quarks. It is one of the two components of the atomic nucleus, the other being the *proton*, which is positively charged. Almost identical in mass and other properties to the proton except for being electrically neutral; it is the other fundamental constituent of all nuclei besides the proton.

Nova. Latin for *new*; a nova is a star that suddenly becomes 100,000 times brighter so that it looks like a *new* star in the sky.

Nucleic acids. Complex organic molecules composed of long chains of structural units called *nucleotides*; they comprise the genome of living cells. They are of two different types: DNA (deoxyribonucleic acid) and RNA (ribonucleic acid), which differ only in the nature of one of the four types of nucleic acid bases present in the nucleotides (uracil in RNA, thymine in DNA) and in the sugar present in the chain (ribose for RNA, deoxyribose for DNA). The DNA of human chromosomes occurs in the form of two twisted strands; the mRNA (messenger RNA) appears in only one strand. The rRNA (ribosomal RNA) is a structural part of the ribosome. Finally, the tRNA (transfer RNA) transports the amino acids for assembly into a protein.

Nucleon. Common name for the proton and the neutron that are component parts of atomic nuclei.

Nucleotides. Phosphorous ethers of nucleosides; consist of a nitrous base purine or pyrimidine, iodine carbohydrate, or several radicals of phosphorous acid.

Nucleus reticularis thalami. A sheet of inhibitory cells draped over each thalamus and acting as a gate to control relayed information between thalamus and cerebral cortex.

Nuclide. Common name for atomic nuclei (and atoms), characterized by the number of neutrons in the nucleus, the number of protons, and the total number of nucleons, called the *mass number*. Radioactive nuclei and atoms are called *radionuclides*.

Observer. Idealized person or piece of equipment, often hypothetical, that measures relevant properties of a physical system.

Ontogenesis. The individual development of an organism, the totality of the organism's transformations from its conception to the end of its life.

Organelles. "Organs" of protozoa that perform different functions: motion, contraction, reception, digestion, etc.

Organogenes. The main chemical elements in the composition of organic substances: carbon, oxygen, hydrogen, nitrogen, phosphorous, sulphur.

Organoids. Permanent specialized structures in animal and plant cells; these include chromosomes, mitochondrias, etc. Organoids are often called *organellas*.

Parietal lobe. One of the four subdivisions of the cerebral cortex. It plays a role in sensory processes, attention, and language.

Particles, elementary. All tiniest structural particles of substance and matter. They are subdivided into several groups. Most important are the heavy *hadrons* and the light *leptons*. The former include protons and neutrons, the latter, neutrinos and electrons. Every elementary particle has a corresponding *antiparticle* with the opposite-sign charge.

Peptides. Organic substances consisting of amino acid radicals connected with peptide bonds; in living cells, peptides are synthesized from amino acids or else they are products of protein exchange.

Photons. Quanta, elementary particles of light. The speed of photons' motion in a vacuum is the maximum possible in nature; it equals approximately 300,000 (299792.5) km/sec. This is the so-called speed of light, the main physical constant in the theory of relativity.

Photosynthesis. The forming of organic substances in plants and blue-green algae utilizing the energy of solar radiation. It is the process that sustains the existence of life on our planet; it gives us organics, biochemical energy, and oxygen.

Planck constant ($h = 6.62 \times 10^{-34}$ Joule-sec). Fundamental value in quantum physics; it is the indivisible minimum of *action* called a *quantum.* Action is energy multiplied by time. For rotations, the Planck constant *h/27ris* is often preferred.

Planck length. This is a natural unit of length derived from the existence of the Planck constant. It is equal to about 10~^{35} in, which is extraordinarily small. If the Planck constant is h, the gravitational constant G, and the speed of light c, then the square root of hG/c^3 is a length which does not depend on the units chosen; this is the Planck length.

Polynucleotides. Polymer organic compounds formed by radicals of mononucleotides; nucleic acids are natural polynucleotides.

Population. The aggregate of individuals of one species that populate some territory, relatively isolated from others and possessed of a certain gene fund; it is viewed as an elementary unit of evolution.

Positron emission tomography. A way of measuring activity in the brain by monitoring blood flow. **A** highly effective method for tracking extremely small concentrations of ultra-short-lived radionuclides that mark physiologically meaningful compounds in the brain. It is used for studying the exchange of substances that participate in the realization of the brain's functions.

Primates. Highest order of mammals, with two suborders: semi-apes and apes; includes over 200 species, from lemurs to man.

Prokaryote. Earliest single-cell organisms that still survive as bacteria; prokaryotes do not possess a nucleus enclosed in a membrane, nor organelles, nor chromosomes with proteins and DNA. The blue-green algae are also prokaryotes. For this reason, they are not really algae but are more properly described as cyanobacteria.

Proteins. Natural high-molecular organic compounds built of the radicals of 20 amino acids, linked by peptide bonds into long chains.

Proton. Particle made of three quarks and charged positively; it is one of the two constituents of the atomic nucleus, the other being the *neutron*. The hydrogen nucleus is a single proton.

Protoplasm. The content of a living cell—its cytoplasm and nucleus; the term is very rarely used in contemporary scientific literature.

Purine. Prebiotic organic molecule; its basic form contains two joined rings, one hexagonal and the other pentagonal. Its formula is $C_5N_4H_4$. It combines with a pyrimidine to make each rung of the double helix that makes DNA or RNA. Adenine and guanine are the two nucleic bases that are purines.

Quantum fluctuation. Spontaneous variation of the properties of empty space at extremely short distances invoked to explain the origin of the "haziness" proper to quantum phenomena; in particular, a quantum fluctuation would explain the spontaneous emission of light by an atom or the spontaneous decay of a radioactive nucleus (see also *empty space).*

Quantum gravity. A theory that successfully merges *quantum mechanics* and *general relativity,* possibly involving modifications of one or both. *String theory* is an example of a theory of quantum gravity.

Quantum mechanics. Framework of laws governing the universe whose unfamiliar features such as *uncertainty, quantum fluctuations,* and *wave-particle duality* become most apparent on the microscopic scales *of atoms* and subnuclear particles.

Quarks. Fundamental elementary particles of the atomic nucleus, which is bound by the strong force; three quarks make either a *proton* or a *neutron,* whose combinations in varying numbers make the atomic nuclei. One quark plus one antiquark make one *meson.* Single quarks cannot exist outside the atomic nucleus because the strong nuclear force confines them in a region of about 1 fm. Quarks exist in six varieties (up, down, charm, strange, top, bottom) and three "colors" (red, green, blue).

Racemases. Ferments of the isomer class that catalyze in living cells the reversible transformation of stereoisomers; for example, amino acids.

Relict radiation. Background space radiation; its spectrum is close to the spectrum of an absolutely black body with a temperature of 2.7 °K. The origin of the relict radiation is considered to be tied to the evolution of the universe, which in the past had a very high temperature and density of radiation (the hot universe).

RNA (ribonucleic acid). High-molecular organic compounds, a type of nucleic acids; they are formed by *nucleotides*, which include adenine, guanine, citozine and urazil, as well as the sugar ribose (in DNA, it is timine instead or urozil, and desoxyribose instead of ribose); they participate in the realization of genetic information in cells of all living organisms.

Serotonine. A derivative of the amino acid triptophane. Serotonine is synthesized in the central nervous system and in the chromaffine cells of the alimentary canal. Serotonine is the mediator of the transmission of nerve impulses through the synapsis.

Shift, red. Shift of the spectrum's lines into its red part, characteristic of the optical radiation of objects that are moving away from the observer. It is explained by the Doppler effect. It proves that galaxies are moving away from each other, and it proves the fact of the universe's expansion.

Special relativity. Einstein's theory in which space and time are not individually absolute but instead depend upon the relative motion between distinct observers.

Stochastic. Chance, probabilistic.

Strangeness. A quantum number that characterizes *hadrons.*

Strong nuclear force. Force of nature that influences quarks; holds quarks together inside protons and neutrons.

Supernova. Final explosion of a massive star that, in a few days, becomes hundreds of billions of times brighter so that it outshines a whole galaxy for several months before fading away; the explosion remnants remain visible in telescopes for millennia (example: the Crab Nebula).

Symmetry. A transformation on a physical system that leaves the system's appearance unchanged (e.g., a rotation of a perfect sphere about its center leaves the sphere unchanged); a transformation of a physical system that has no effect on the laws describing the system.

Synapse. A gap between two neurons that functions as the site of information transfer from one neuron to another.

Tauon. Elementary particle; the heaviest of the electrons.

Temporal lobe. Cerebral cortical region between visual input and long-term memory storage in the hippocampus; is in medial and lateral posterior positions on the cortical surface.

Thalamus. A structure consisting of two egg-shaped masses of nerve tissue, each about the size of a walnut, deep within the brain. It is the key relay station for sensory information flowing into the brain, filtering out only information of particular importance from the mass of signals entering the brain.

Thioester. Class of chemical compounds analogous to the esters but where oxygen is replaced by sulfur. The esters are formed by the reaction of a carboxylic acid with an alcohol, thus freeing a molecule of water.

Tymine. A pyrimidine base; it is contained in all living organisms and in the DNA; it is one of the four "letters" of the genetic code.

United theory. Any theory that describes all four forces and all of matter within a single, all-encompassing framework.

Urkaryote. One of the three ancestral branches of bacteria that may have been the starting point of the symbiotic forms leading to the *eukaryotes*. The two other ancestral branches are the Archaeobacteria and the Eubacteria (or true bacteria).

Virtual. Used in physics to speak about a transient particle or property (such as energy) that appears and disappears by virtue of a quantum fluctuation; for example, a virtual mass can appear only during the very short time allowed by the Heisenberg uncertainty principle. For very short distances, empty space shows the constant emergence and disappearance of virtual particles.

Viruses. Stimulants of infectious diseases of plants, animals, and man that propagate only inside living cells.

W^+, W~, and Z°. The three elementary particles that *carry* the weak nuclear force; this is the force that explains radioactive beta decay as opposed to the strong nuclear force that is responsible for the stability of the atomic nucleus; the strong force is carried by eight different ("colored") gluons.

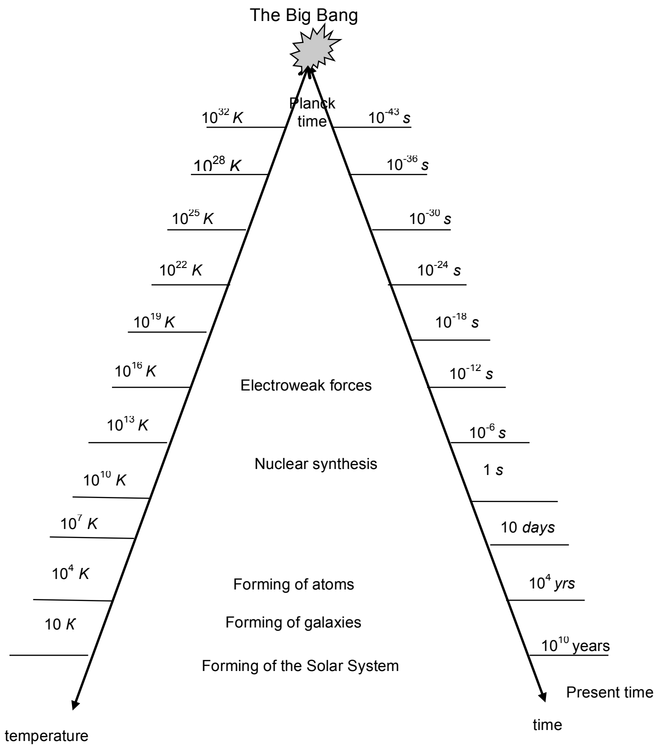
Waves, electromagnetic. Oscillations of an electromagnetic field. Different kinds of radiation, including visible light, are forms of electromagnetic waves differing in length and frequency.

Weak nuclear force. Force of nature acting on subatomic scales and responsible for phenomena such as radioactive decay.

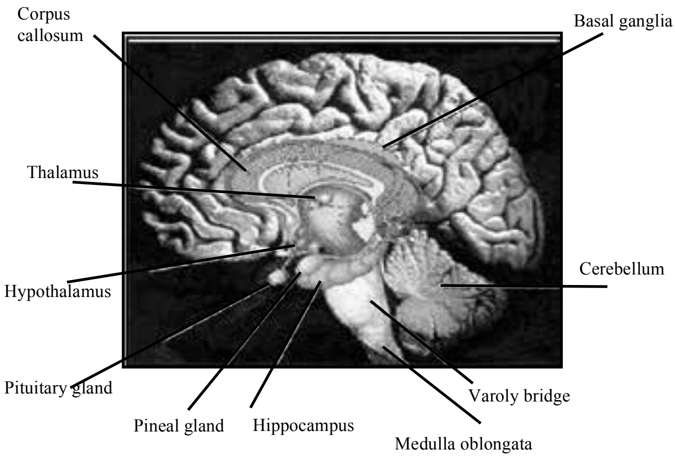
APPENDICES

Big Bang

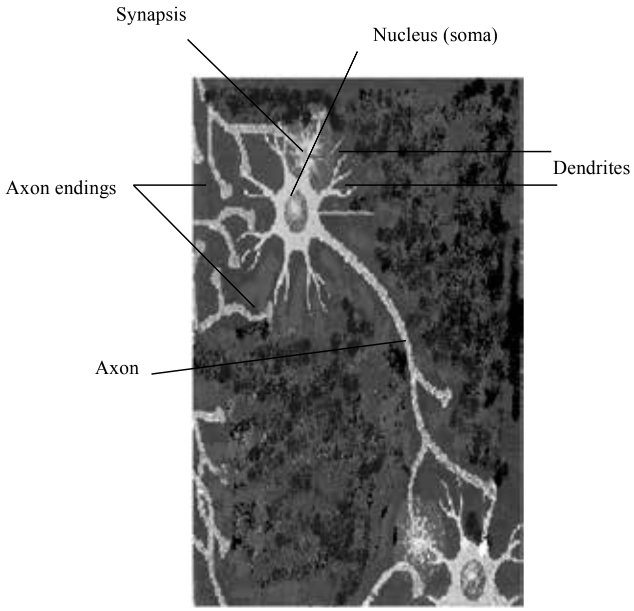
This figure depicts one of the inflationary versions of the Big Bang, showing several key moments in the history of the universe.



Structure of the Brain



Structure of the Neural Cell



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