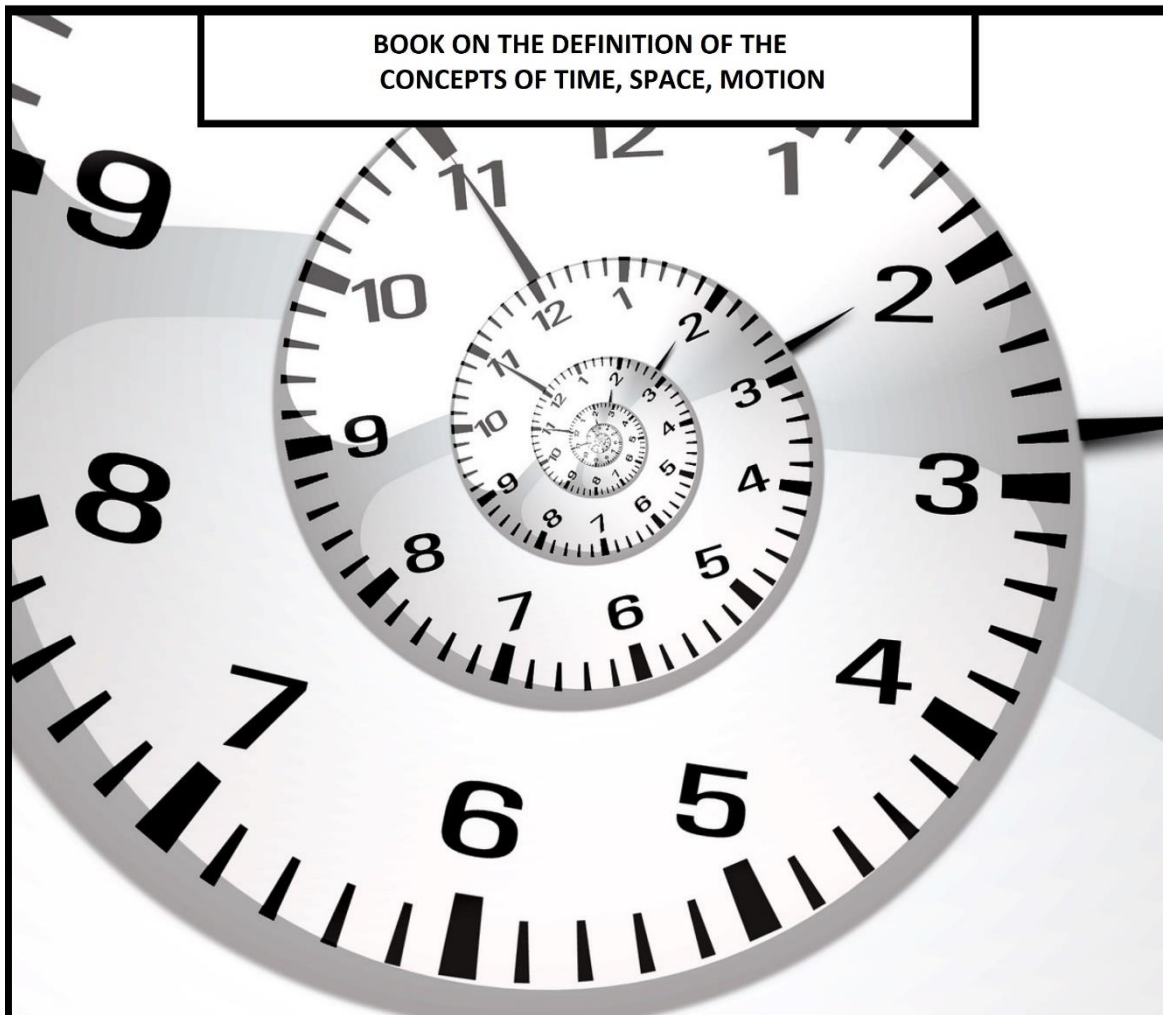


ALEXEI NENASHEV

T I M E

BOOK ON THE DEFINITION OF THE
CONCEPTS OF TIME, SPACE, MOTION



ALEXEI NENASHEV

T I M E

SECOND EDITION

*Book website: **nashev.net***

2024

The general concept of 'hierarchy of complexity' allows for mitigating the difference between the conceptions of natural laws for 'inert matter', biological and social relations. It opens up a possibility to account for the observer's influence on systems described by him. An apparent contradiction between objective and subjective aspects of time is resolved by its reformulation in the form of a relational rather than a postulated principle.

This book shows that the emergence and description of objects and laws is possible only through the realization of the hierarchy of relations. Any entity beyond relations is uncertain, universe beyond development does not exist.

Particular focus is made on interactions and paradoxes of the quantum world, contradictions of thermodynamic descriptions closely linked with concepts of time and the observer's influences.

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Important Introduction

In the 17th century, the efforts of prominent naturalists led to the division of one single natural philosophy into natural sciences and philosophy. There was no single theme for them that could be a criterion to both explain the results of individual experiments and try to explain the world as a whole. This paper attempts to use scientific and mathematical research as a basis for finding some general principles, which can be used to explain the phenomenon of time and the laws of nature, and, given the uniqueness of our world, to incorporate the influence of the observer, the human being, in the picture of the universe. It turned out possible to reassemble scientific and philosophical subjects under the unified concepts of natural philosophy owing to the findings of modern science.

I would like to note, that if it were possible to deal with complex topics in familiar everyday terms, the definition of time, the place of man in nature, and so on and so forth – all these concepts would have been clearly defined in ancient times, at the dawn of civilization, at least by philosophers of Ancient Greece, and if they had missed something, representatives of the German classical philosophy would have put them all in their proper places. However, there are as many different answers to the “accursed questions of existence” as there are people who ask them. Therefore, to design formulae, draw conclusions and give unambiguous, objective answers this paper does not use the preferences of one philosopher or philosophical school, but rather relies on the achievements of thousands of natural scientists, which have an important peculiarity – accumulation of new knowledge based of previous scientific thought and its verification by experiment. The paper also consistently builds a framework of notions that are common to all phenomena of our world.

Given the diversity of scientific disciplines addressed in the book, brief descriptions of chapter are given below to facilitate following of general the principles that lead to building physical, chemical, biological constructs.

Chapter 1 provides a few general examples of description of one and the same event from perspectives of different levels of complexity. From a higher level, an event may be assigned a free parameter that depends, e.g., on the observer. This principle is called TGS.

Further, Chapter 2 will present arithmetic relations based on the hierarchy of complexity. I would like to draw attention to the fact that the singularities of prime numbers are derived here (the issue of prime numbers is broadly covered in popular science literature).

The Annex to Chapter 2 contains a discussion of the use of mathematical axioms, which happen to be analogous to “observer influence” in physics. I would like to draw attention to the conclusion about the relative nature of the concept of “infinity”.

Chapter 3 presents constructs that lead to the definition of space, as complexity increases. Therefore, three-dimensional space is not a separate entity, but a consequence of relationships of a certain level of complexity.

The Annex to Chapter 3 gives a brief overview of some conclusions of Professor Kulakov’s Theory of Physical Structures used in this paper.

Chapter 4 shows how the condition of further complexity increase leads to the emergence of new parameters that consistently define the field, local physical points, and their interaction under Newton’s laws (which in this case are derived rather than postulated).

The Annex to Chapter 4 focuses on the implications of the logical non-closed nature of Newton’s second law.

Chapter 5 studies further increase in complexity, the effect of which on the “Newtonian” relations leads to emergence of a free parameter of entropy.

The Annex to this chapter shows that it is possible to derive, rather than postulate, the first and second laws of thermodynamics.

It is only in Chapter 6 that we approach the complexity in which the “time” parameter is defined. We introduce layers of time which are different for each level of complexity; so, for the “Newtonian” level there is a layer of reversible parameter of time, for the “entropic” level there is a layer of differentiating position of the system, and so on.

The Annex to Chapter 6 describes the causes of the formation of “arrows of time”, such as thermodynamic, light, and others.

In Chapter 7, the notions of increasing complexity that were used earlier are formulated in the form of a single condition, a kind of universal “Nash Law” *)¹. The TGS principle turns out to be a condition of its uniqueness.

Chapter 8 describes the formulation of physical, in the general case, natural laws, as a consequence of existence of different levels of complexity. The principle of symmetry appears when parameters of different levels of complexity are examined. The physical laws of conservation are derived from the concepts of space as a level of complexity and TGS principles.

¹ “Nash” is Our in Russian. Mean “Our Law”

Chapter 9 examines the impact of complex relations (above the level of space) on simpler, “pre-spatial” relations. This leads to the concepts of uncertainty of position in space, a fundamentally unavoidable probability in the description, quantization of low-level relations. Then, the unusual nature of parameters of the microcosm turns out to be a consequence of simpler relations rather than the concept of size.

The Annex to Chapter 9 is an attempt to describe the relationship that leads to gravity.

Chapter 10 shows the relativity of ideas about causality, determinism, and objectivity.

Chapter 11 focuses on further increase in complexity. It shows that the idea of information is the best match for the parameter at the next level, where the DNA/population system is defined.

In Chapter 12, further complexity is achieved through rapid inertia-free (electrochemical signals in the brain) search of low-level relationship options for further increase in complexity. This results in the formation of consciousness and society as an integral part of this level.

It is only natural for Chapter 13 to use previous findings about the personality as a parameter of the complexity level for studying the issue of individual freedom.

Chapter 14 explores the specific features and possible successes of the humanities and philosophy from the perspective of the complexity hierarchy.

Chapter 15 summarizes the earlier conclusions in order to provide a potential answer to the most common philosophical questions.

Finally, Chapter 16 makes a natural step toward considering hypothetical, more complex (for us) levels of personal, social organization, up to absolute complexity.

The Conclusion outlines the main points and key takeaways of the paper, pointing out the potential predictions that arise from this conceptualization of natural and social relations.

As can be seen, the subjects of the chapters repeat the hierarchical growth in complexity that forms the basis of this discussion, so that one or more of them, no matter how complex (or poorly written) they are, cannot be excluded. I hope that, in any case, reading the book will allow you to appreciate the basic idea that shows that a unified approach to the hierarchy of relations in our world is possible.

Chapter 1. Free Parameters

One of the most important tasks in the explanation of the time phenomenon is the consideration of either evident or implicit observer influences. Indeed, on the one hand, people use such entity as time to organize their activities, to work with technological devices, to describe processes including biological and social ones and to define periods of life. So, the idea appears that it is WE who introduces the concept of time, and it is only the observer influence. On the other hand, this concept permeates all exact sciences. It is used to describe all phenomena in the Universe such as star formation and nucleosynthesis, protein and chemical compounds synthesis, etc. The problem is that eliminating the observer influence is a basis for obtaining and processing objective information about nature. At the same time, without the observer self-sufficiency of time does not seem to manifest itself. Indispensably, either the starting point in time brought in from the outside or comparison of processes that do not influence each other, e.g., the clock running or the action under study, transpire “in the background”. There seems to be a dualism, where time is both subjective, and, therefore, dependent on the observer, and at the same time it is objective; and this constitutes an evident and insoluble paradox.

However, in physics, there are examples when the same process is described differently in different reference frames, so that in one case it appears to be subject to the influence of an observer, and in the other, it is a completely objective, single-solution problem. For example, the description of gravity assist, a technique often used by automatic interplanetary stations in flights to the Moon and planets. When a planetary orbiter passes near the planet, the celestial body changes the station’s orbit by gravity, significantly accelerating or slowing down its flight. In this case, there is no additional acceleration or energy consumption, there is no violation of weightlessness on board the spacecraft – it is, so to say, “out of touch on a matter”. In the gravity assist, there is a rule of velocities modulus equality before and after approaching the planet: an observer on the planet would not notice a change in the velocity of an approaching v_{in} and receding v_{out} apparatus, it would only notice a change in its direction (see Fig. 1.a.) Hence, it is a simple problem of two bodies. But if we turn to the heliocentric coordinates, taking into account **one more quantity**, the speed of the planet itself v_{pl} , then we will notice that the speed has changed (it can either be increased or decreased). Fig. 1.b shows a vector diagram of this exchange of angular moments. If the geometry of approach is correct (this is already a “human factor” – the angle at which the AMS approaches the Planet), the gravitational maneuver for different planets allows you to change the speed of the spacecraft from 3 times in the case of Mercury up to 42 (!) times in the case of Jupiter. Let me repeat: without any variations in weightlessness or acceleration on board. For the first case of the planetary-centric system there is no way to calculate the speed variation from the available data: this parameter is independent of the conditions previously introduced; it is, so to say, a “**free parameter**”. However, in the second case of the heliocentric coordinates, V_{SBL} and $V_{was\ removed}$ are unambiguously defined.

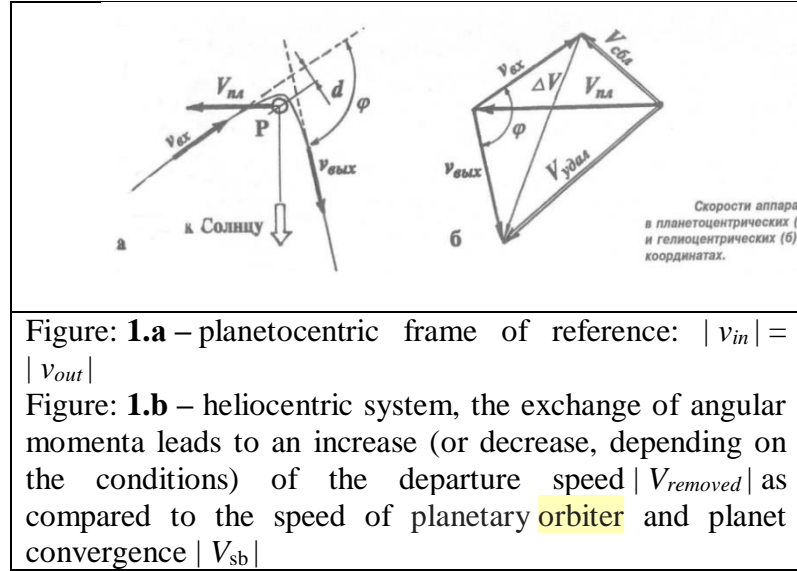


Figure: **1.a** – planetocentric frame of reference: $|v_{in}| = |v_{out}|$

Figure: **1.b** – heliocentric system, the exchange of angular momenta leads to an increase (or decrease, depending on the conditions) of the departure speed $|V_{removed}|$ as compared to the speed of planetary orbiter and planet convergence $|V_{sb}|$

One can see that such a difference is a consequence of the flight description from the standpoint of a more complex system (heliocentric system: spacecraft – planet – Sun) as compared to a more simple planetocentric system, where only spacecraft – planet interaction occurs.

The resulting “extra” speed $V_{is\ removed}$ is a characteristic feature of a more complex system (C_{helio}) in relation to the less complex ($C_{planets}$) one. We can put it as follows:

$$C_{helio}/C_{planets} \Rightarrow V_{remote}^2$$

I would like to emphasize once again that the $V_{distance}$ value can in no way be derived from the parameters of the planetary system $C_{planets}$, where this speed was introduced as a free parameter.³

But what if the described situation were not so obvious? Do we still have an example where a certain quantity appears due to different descriptions of the same system of interactions? The most well-known example, perhaps, is H in Boltzmann’s theorem. **With the transition** from the kinematic description of the system to the statistical one, the concept of entropy growth emerges, which makes the evolution of a dynamic system irreversible – even though the kinematic laws are reversible in time. This triggers a desire to search – similarly to the previous example – for a certain ‘complexity’, a more sophisticated system in respect of which the description of the interactions provides imperceptible presence of a ‘spare’ parameter that does not stem from the foregoing description (this is discussed in Chapter 5 Entropy), just like the value $V_{is\ removed}$ cannot be derived from the $C_{planets}$ conditions.

There is another a very similar problem, Maxwell’s demon paradox. According to the conditions of the mental experiment, a certain demon (control mechanism) is located between two vessels with an ideal gas and lets only fast molecules enter one of them, and only slow ones

² To avoid confusion with division and subtraction notations, the \oslash icons will hereinafter denote relations between two different levels of complexity, the \ominus - and \oplus icons will denote relations in the same level of complexity.

³ Of course, these descriptions cannot be reduced to each other, they have a different number of coordinates.

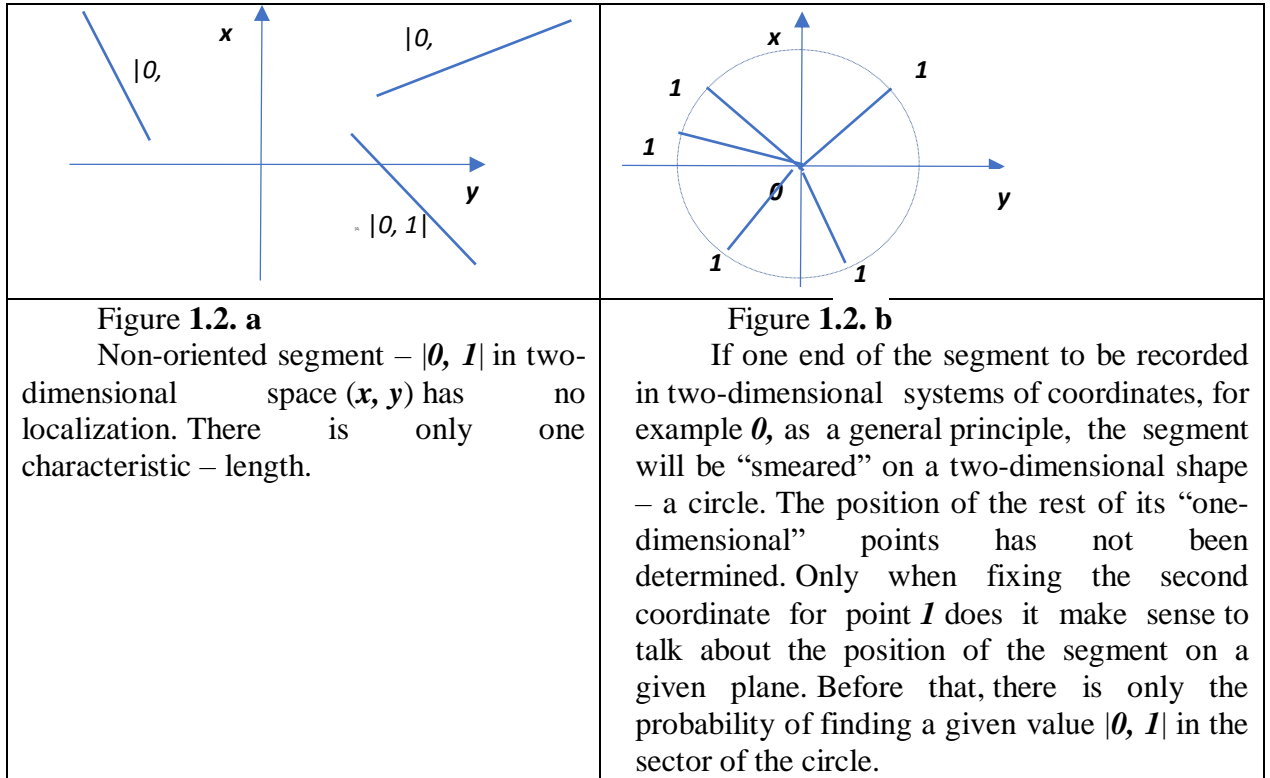
– the other. Since the temperature is determined precisely by the molecules' kinetic speed, the result of the demon's actions contradicts the 2nd law of thermodynamics, transferring heat from a colder body to a hotter one without energy consumption. Apparently, it is the demon's influence being taking into account that changes the system so that the entropy in the communicating vessels decreases, whereas without the demon everything goes in accordance with the laws of thermodynamics.

What exactly is its influence? When introducing internal energy, entropy and other functions, thermodynamics is not interested in their nature and does not connect them with the specific types of particles the body consists of and with the way of their interactions with each other.

It is the demon's actions that interfere with the system' "internal affairs". It would seem that the interactions between the molecules remained unchanged; in a simplified case, the molecules are represented merely by material points and the demon does not influence their movements. There is only one instance of intervention: the system with the demon distinguishes the gas molecules by highlighting them even with two different markers, fast/slow. The demon occurs as another "dimension", as in the previous example. It is the inclusion of its influence, additional to kinetic interactions, into consideration that leads to a paradox: a violation of the second law of thermodynamics. A paradox that does not exist for a system without a demon, so its influence can also be considered as a kind of free parameter.

Importantly, as soon as it is assumed that gas molecules are more complex formations than absolutely elastic colliding points and that there is still a degree of freedom in their behavior and they themselves will carry a property that **distinguishes** one molecule from another; no Maxwell's Demon will be needed for seemingly very improbable structures to appear. For example: when air cools down to the point of dew, water vapor condenses into mist. Indeed, in this case, the "demon" that separates the molecules of air and water has a well-known physicochemical property – the effect of hydrogen bonds joining H₂O molecules into vapor droplets, giant formations joining trillions of molecules. The likelihood of their accidental formation is negligible, and no demon can cope with it.

However, we are not surprised by this phenomenon, even though it seems worth it. This is habitual to us and we mentally separate the processes on the "physical" level from the 'chemical' level (associated with the structure of matter), forgetting that nature is one and the barriers separating it exist only in our minds.



Another simple example: let us take a line segment of a unit length $|0, 1|$ on a one-dimensional line. Its length is its only characteristic. If we “locate” it in a bidimensional space (consider this situation as it would be seen from the perspective of bidimensional space) – on a plane, its position will be ambiguous (see Fig. 1.2.a). An undirected segment is non-localized in a bidimensional space and it is meaningless to speak about its position before two coordinates are in some way assigned to it (its ends). We can even say that there is a probability to find it in any part of the plane. If the line segment is considered as an example of some processes of lesser complexity, one end of it would have an objective origin determined by the complexity represented by two coordinates (Fig. 1.2.b), the line segment would not exhibit an exact localization in two dimensions – not over the entire space in general, but along the figure of a circle. This line segment will appear as if smeared on the circle of its length radius, since this is its only characteristic. Its **position** in two dimensions is only a **probability** of being in a particular part of the circle. On the physical plane, physical characteristics will appear “smeared” on new interactions, as a kind of cloud, and will be viewed from the perspective of a relatively more complex structure of interactions.

It should be noted that the concept of “complexity”, which will often be used further, is not a quantitative assessment of a particular physical situation and does not coincide with the more popular Kolmogorov (algorithmic) complexity in the theory of complex systems. Furthermore, the concept of “free parameter” is very similar to the well-known value of “freedom degree”. However, the latter is a characteristic of a mechanical system, and the distinguishing of natural systems into physical, chemical and others is artificial. It is further shown that the

concept of free parameters can be used for different structures, including those that cannot be described mathematically.

For example, “superfluous” values that depend on a complex system of interaction are attributed to more simple relationships. This principle, the influence of a more complex system of interactions on a less complex one and, consequently, the appearance of additional characteristics, free parameters, such as the velocity V in the first example, will hereinafter be called the theory of **GS**, or **TGS** for short.

This is a very important difference from the common idea: it is not the laws that form relationships in natural systems, but the levels of complexity – according to TGS – establish certain laws (as well as relationships and interactions). Most chapters derive laws from the complexity level of relationships. This approach also enables another important step (the last chapters provide details on the subject): increasing complexity will be seen as an evolutionary process that also includes the observer.

To accomplish these tasks, first of all we will formalize the ideas about different levels of complexity, which, as we will show, determine the simplest arithmetic relations.

Chapter 2. Complexity Levels

During the creation of a rigorous basis for mathematics in the 19th century through the efforts of Bolzano, Cauchy, Weierstrass and a number of other scientists, a concept of motion and time was excluded from mathematics. The concept “a value runs through values...” has been replaced by an infinitely small approximation ε and “placing the mathematical points inside an interval”. Only relations, without any “movements” will be set in this respect, as long as it is possible to speak of the complexity sufficient to introduce such a concept. Further, it will be shown that the concept of complexity and relations between levels of complexity (which, in turn and at the same time, formulate these concepts) are quite sufficient to define mathematical operations. In the future, such an increase in complexity leads to an understanding of three-dimensional space and, further, a material point. As can be seen from examples of the previous chapter, the first step for this is the use of a hierarchical system of relations the lower elements of which constitute the basis for new ones, but do not boil down to them.

I would like to especially emphasize that no new mathematics is built here, which would require axioms and logic tools. It is shown here that a minimum set of concepts such as complexity growth is sufficient to determine the elements and relations that are usually given by postulates. Even the concept of an empty set (used below) is not given but is manifested as a consequence of the simplest relation.

Speaking about the complexity growth we have to introduce (alas, to postulate) at the very beginning the relation of 1a to level 1A , the lowest one in the hierarchy. This is the basic relation, the difference from nothing, from the empty set, \emptyset . The concept of “attitude” needs to be clarified from the very beginning: the relation of what to what? In this case, the relation of the existence of something to the empty set. It is also noteworthy that any object, in principle, is characterized by relationships. A thing-in-itself (not interacting with anything) does not exist, at least there is no reason to assume its existence.

In that case each new parameter⁴ is a characteristic of a more complex relationship, irreducible to the previous ones; a characteristic of a new level. Therefore, I will use the concept of “complexity level” a more accurate definition of which is formulated below.

The choice of parameters at the 1A level is small: either \emptyset or the only 1a . It can be written as ${}^1A \circ / \emptyset \rightarrow (\emptyset, {}^1a)$. It should be noted that at this level there are no different quantities 1a , no such things as 1a_1 and 1a_2 . This would require at least one other relationship in which they differ.

Therefore, a new parameter has to be introduced for further complication – a new relationship owing to which it makes sense to talk about the difference between elements of 1A from each other. So, the next 2B level of relations is defined that makes it possible to determine the difference of 1a , i.e., only from this “level of complexity” – I will hereinafter use this phrase without quotation marks – it makes sense to talk about a_1 and a_2 : (a_1, a_2, \emptyset) , or $(\bar{0}, a, \emptyset)$. However, so far only the inequality ${}^1a_1 \neq {}^1a_2$ has been defined, i.e., only the difference between the elements; other values have not yet been set: for example, there is no such thing as $3/4a$ or

⁴Parameter is a value to serve to distinguish the elements of a set from each other. This well-known definition is appropriate for the examples under consideration

πa . The only possible parameter that distinguishes 1a_1 from 1a_2 is 1a – there is no another parameter. Thus, according to the hierarchy, 2B level contains only relations $(\emptyset, a, a \circ a)$. All others, for example $(a+a+a+a)$ или $(10a)$, are merely different from 1a , but at this 2B level they are indistinguishable, or equal to each other.

Subtraction cannot be specified either, since subtraction is possible not only when two different numbers are determined as different: it is also necessary **to separate the value** from which another value is subtracted; so, it is necessary firstly **to cancel their equality** and to attribute to one value a possibility of an additional relation.

This is a key aspect. Subtraction is usually defined as the opposite of addition: the difference between the numbers 5 and 2 is the unknown from the equation $2 + ? = 5$. However, in the operation of subtraction, unlike addition (and multiplication), the numbers are not equal – **there is no commutativity**, no preservation of the result when changing the terms and factors: $5 - 2 \neq 2 - 5$. We need something to **distinguish** 5 from 2. So, it is necessary to define a new level of complexity – and this is an important difference from the axiomatics of arithmetic. Accordingly, the concept of “more/less” determined by the results of subtraction also exists only at a new level of complexity. It is necessary to set another ratio 3B where both relationships a and b (the upper index 1 ... 2 will sometimes be omitted for relationship symbols – for simplicity) already exist, and then, at the level of relations 3B its elements may already differ from one another: both b and the relation to the first base a .

Level 3B defines two different elements: \bar{b}_1 and \bar{b}_2 (each of them, in turn, distinguishes a from $a + a$ or from the empty set). So, if the relation of the level ${}^3B - {}^3b$ is given relatively to one of the previous levels \bar{b}_1 , it also sets \bar{b}_2 . On the contrary, it is still possible to speak only about the sum of two different relations $\bar{b}_1 \vee \bar{b}_2$, such that are defined for the value b .

It should be noted that the \bar{b} values refer to a more simple level, i.e. condition $\bar{b}_2: B \wedge \bar{b}_1$ puts the elements of \bar{b} in a subordinate position, defining the anti-commutation sought. In fact, one may set B using \bar{b} , and it may turn out that $B = b$; but the reverse operation is impossible. Also, if there are different \bar{b}_1 and \bar{b}_2 such that $\bar{b}_1 + \bar{b}_2 = B$, then this operation already implies the 3B level of complexity. This is what allows you to **set the relationship “more/less”**, and then to set the subtraction operation. Negative numbers have also been identified, which is natural: the relationship system has become more complex as new elements that are irreducible to the previous ones have appeared.

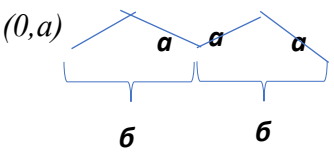
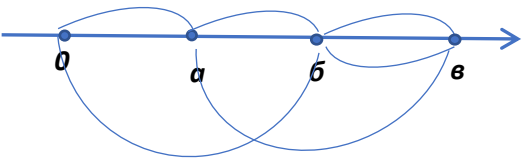
From that moment on, only the **ordered set** is defined. The concept of ordering is usually defined axiomatically, following by the definitions of subtraction, division, and other noncommutative operations. In the case under consideration, the order turns out to be a consequence of an obviously non-trivial system of relations.

Next, the relations level 3B can be divided into two classes: the one for which at least one \bar{b} value is used, and another one where this particular value does not exist; and this latter class forms a new “zero” relationship. Only at this level of complexity is it possible to define zero not as an empty set, but as the absence of this level of attitudes: $0 \neq \emptyset \vee B \in {}^3B$.

Further, if $\bar{b}_1 = a$, then there is a numerical element $b_2 = b - a$. In this case \bar{b}_3 could be determined in such a way that it differs from b_2 by a and simultaneously from \bar{b} by $2a$. These operations can be continued further until there are no differences, up to zero; and in this way **a natural series can be formed**. Note that the natural series is also not an intuitively fundamental thing, but a consequence of a system of relations between certain levels.

Interestingly, unlike the Peano axiom (“each number is followed by a larger number ...”), the natural series is not set by an operation of adding a unit, but, on the contrary, arises when a more complex numerical element is related to a less complex one (the TGS principle, as stated in the previous chapter) – by operation of subtraction. This is a consequence of obtaining non-commutativity required for linear ordering.

Since the relations \bar{b} are given by any possible search from \bar{b}_1 and \bar{b}_2 , we represent the natural series in the form of a line, where different line segments (multiples of a – for a time being there is no alternative) overlap each other – see Fig. 2.2. This line can be represented as a straight line (natural straight line), in contrast to Figure 2.1.

	
<p>Figure 2.1. For the 2B level there is no straight line at which the relationships are structured, they are independent of each other – there is no value for their order.</p>	<p>Figure 2.2. The $\setminus 0, b \setminus$ value may be presented as $(a+a)+a$ or $\bar{b}+a$, or $a=b-\bar{b}$. 3B relationships are dependent on each other. Then they are constructed as a line with zero and a general (basis) relation a.</p>

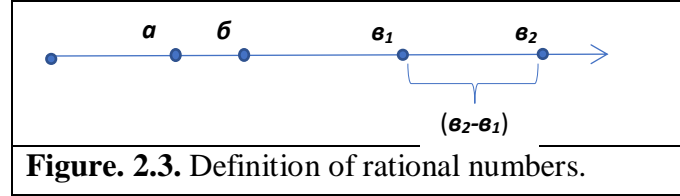
Only from the 3B level is it possible to put each relation between a , \bar{b} , b into straight lines, the difference in lengths of which visually expresses the difference between them. It is also possible to say that numbers or, more cautiously, numerical elements are given (at a given level of complexity).

So, a very important conclusion can be formulated at this point: each relation at the 3B level is set by all possible sets of different \bar{b} (for example, $4 = 14 - 10 = 3 + 1 = 136 - 132 \dots$). But the differences in the parameters of the 2B level were manifested due to the same new parameter \bar{b} . Thus, to clarify the definition of the level of complexity, it could be stated: each element of a higher complexity level establishes for the lower one the difference between its elements and can include all possible characteristic elements of the lower level. Another important point is that the overall hierarchical system implies that new and old relationships can **coexist**, as in the form of (\bar{b}, a, \emptyset) . Thus, the 2B level relationships include both – the basic a and empty set ratios.

We are used to that, as e.g., the number 15 differs by one simultaneously from 14 and 16, is natural, and is the sum of $13 + 2$ as well as a product of $3 * 5$. It turns out that these properties

are defined successively through the complexity of the relationship. To distinguish 15 per unit from 14 or 16, the level ${}^2\mathbf{B}$ is enough, while to meet the requirements of $16 > 15 > 14$, it is necessary to define two different relationships, and, thus, define level ${}^3\mathbf{B}$. Therefore, these properties are unequal.

Now there is a possibility to approach the definition of rational numbers: \mathbf{e}_1 and \mathbf{e}_2 being different from each other are determined for the level ${}^4\mathbf{T}$.



Not just their differences through two bases will be given (this could be determined at the previous level), but the characterization of this relation to one of the numbers \mathbf{B} , in fact, will add another basis \mathbf{e} to the basic \mathbf{a} and \mathbf{b} (which characterize the relations at the previous level ${}^3\mathbf{B}$). The selected value \mathbf{e}_1 acts as a new basis for comparing now natural numbers:

$$z = (\mathbf{e}_2 - \mathbf{e}_1) \oslash \mathbf{e}_1$$

Such a representation does not clearly contain the values \mathbf{b} and \mathbf{a} , and does not require a multiplicity between \mathbf{a} and $\mathbf{a} \oslash \mathbf{a}$ for new relationships, so on the numerical line the points of the new parameters may not coincide with natural numbers. The parameter z is the remainder of the division and is generally not reduced to any natural \mathbf{e} . If z coincides with a natural number, the relation is a product. At the same time, no mutual search for \mathbf{e} can result in z . It is similar to the situation in which the deduction for natural numbers was obtained – in the case under consideration a new level of complexity also sets the non-commutability of two values (z and \mathbf{e}), and only for this reason has a new division operation been defined.

If we set the rational numbers in that way, we can see that any numerical relation z can be determined by any given (infinite) number of sets $\mathbf{e}_1, \mathbf{e}_2, \mathbf{e}_3, \dots$ because $(\mathbf{e}_2 - \mathbf{e}_1)$ can be increased (multiplied) any number of times by the same amount as \mathbf{e}_1 which leaves their relations unchanged. For example, $\frac{1}{2} = \frac{2}{4} = \frac{3}{6} = \frac{17}{34} = \dots$

However, there is a uniqueness of the decomposition: $\mathbf{e}_2 / \mathbf{e}_1 = z$ clearly derives from $\mathbf{e}_2 / z = \mathbf{e}_1$. Uniqueness is postulated in arithmetic; here the postulation is also unavoidable, but a very important principle will be set and will be continuously applied for other levels of complexity – the principle of **uncertainty of complexity**: an element of the lower level of complexity does not contain an element of the higher one, or, otherwise, it is impossible to determine the elements of level ${}^{n+1}\mathbf{Y}$ and above from the level of relations ${}^n\mathbf{Y}$. Otherwise, for ${}^3\mathbf{B}$ level there is a difference between more complex values, z_1 and z_2 , but this means that there is no hierarchy and each level of complexity itself determines the higher one.

Another important consequence of the introduced level is the definition of **one**. The set of natural numbers defines zero, and here the relation $z = (e_1 - 0) / e_1$ gives the **one**.⁵ Of course, on a number line it **coincides** with a basic **a**, but, in contrast, is an element of complexity 4T , which is set by the relation of the infinite number of natural numbers to themselves.⁶

Importantly, at the level 3B all numbers are prime. Indeed, the complexity that determines multiplication operations is not yet defined for them. A number becomes fractional (and composite) if there is a complexity with which it can be decomposed into cores. And it only makes sense if there is a new relationship that defines, among other things, the multiplication procedure. For example, at the 3B complexity level number 4 is only a sum/difference of other integers, for example, $4 = 3 + 1 = 15 - 11 = \dots$. And only in complexity 4T it also becomes a product $4 = 2 * 2$. Thus, number four at the level 3B and number 4 at the level 4T are **different relationships**. They just coincide on the same number line.

Again, in the construction of numbers described above the important thing is a consistent and, so to say, “evolutionary approach” of the design of numbers’ hierarchy. There is no (and cannot be according to the principle of complexity uncertainty referred to above) a rule at the level 3B which somehow sets for each integer (**e**) a coinciding (“equivalent”) product (**z**). At the 4T level, however, it is possible to find the product numbers that coincide with the simpler ones at the level 3B , but there is no an imperative that all 3e relationships have to have matching 4z ones. Therefore, even in the complexity 4T there are remaining “pure” **prime** numbers, so when reviewing the line of their products there will be indivisible ones among them. They can only differ from neighboring composite numbers by a base of 1a – there is no other, more complex relationship for them. In addition, it means that inherently there is no algorithm to specify⁷ their positions on the number line. It is fundamentally impossible to assign a representation at the level 4T to elements of 3B through any mathematical operations, that is to say, to find a formula that defines prime numbers among others – they are too simple for this. This feature is totally random, and it is the result of influence of considering elements with fewer relations from the higher level, the “free parameter” of the TGS as it was mentioned in the previous chapter. This number line and its elements seem to be a model of determinism that should not be misleading.⁸

And then you can go on to design irrational – actually real – relationships, and the next level of complexity can be introduced – 5I .

For this purpose, several (numerical) lines are used, which are then reduced to one, with new bases where a new numerical relation will be marked.

⁵ It is easy to see that otherwise, returning in the hierarchy back to 1A , parameter 1a will be fractional, which is not possible.

⁶ Using the finished number – “one” for the simpler levels 2B and 3B , according to TGS, leads to the formation of elements of mixed complexity levels – ${}^{2,3}B$, ${}^{2,2}B$ – for which the indistinguishability of such ones from the higher levels is violated, so to speak, the symmetry is broken.

⁷ Through multiplication operations and all others, it is more difficult to add a unit to the numbers of a natural series.

⁸ According to the theory of the distribution of primes, a randomly chosen number from 1 to n , the chance of being prime is about $1/\ln(n)$. Exactly, a chance, a probability.

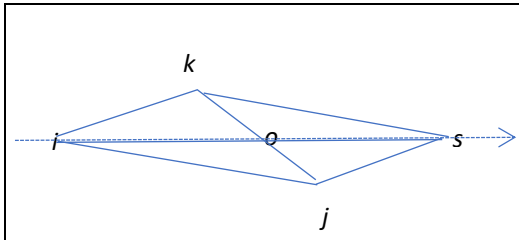


Figure 2.4. Definition of reals. It is assumed that the relations $z_1 = |ik|$, $z_2 = |ij|$ and $z_3 = |ks|$, $z_4 = |sj|$ are part of series limited by $|is|$

We can set four ${}^4\Gamma$ level relations: two pairs $z_1 = |ik|$, $z_2 = |ij|$ and $z_3 = |ks|$, $z_4 = |sj|$ – Figure. 2.4. While $|ik| + |ks| > |is|$ and also $|ij| + |sj| > |is|$; but $|ik| < |ij|$ and $|sj| < |ij|$. If they are positioned as shown in Figure 2.4, then $|is|$ is split into two parts io and os . It is possible to introduce another value, ε , independent of these relations, so that the condition has been fulfilled simultaneously $|ik - ij| < \varepsilon$ and $|ks - sj| < \varepsilon$. Considering that $|ik| + |ks|$ is not less than $|is|$ for small and infinitesimal ε , the value $|ik|$ becomes close to the point

o by any infinitesimal distance ε to the left while then the value $|js|$, to the right of o , also approaches it by an arbitrarily small ε . Thus, The Cauchy criterion has been met and the real value of the ${}^5\mathcal{A}$ level has been determined.

In other words, there are **two** reciprocal (converging) sequences. And, returning to the terms of complexity, this means that different relationships are given, which can distinguish between the existing sequences, separating them from each other. This increases the complexity level.

As in previous constructions, the higher complexity sets the difference between relations of lesser complexity between each other. In addition, it is only the magnitude of ε through which they form a new level ratio, so ε is a new basis. There is an important difference: in the past, new mathematical operations like subtraction, division, etc. were defined at the level of new complexity; in the present case, due to special introduction of the new basis ε through infinite series – there is no one-to-one set of actions that make it possible to obtain real numbers from rational numbers.⁹

Again, it is implicit in the principle of complexity uncertainty – the relationship ∂ cannot be defined from the level ${}^4\Gamma$. This principle causes uniqueness – the combined law of numbers at ${}^4\Gamma$ level. Indeed, if it were possible to define ∂ without introducing a new level of relationships, e.g., without infinitesimal differences in the combinations of z_1 , z_2 , z_3 and z_4 , as multiplication and division only, the uniqueness of these constructions would be in question.

The complex number – the parameter of the next level of complexity – cannot be located on a number line, because the set of real numbers is complete (in the standard metric).¹⁰ Then, it is given by two real numbers $(\partial_1, \partial_2) = \partial_1 + i\partial_2$. The view of the complex number itself demonstrates the concept of new complexity – a new type of difference between reciprocal

⁹ Let me recall that in the set theory the concept of power is introduced – the power of a set of integers, rational numbers (an infinite countable set), is denoted by aleph 0, the power of an infinite uncountable set, aka a set of real numbers, aka a **continuum** – aleph 1.

¹⁰ Strictly speaking, it is necessary to prove this – the theorem of replenishing the metric space, as well as the Frobenius theorem referred to hereinafter, to reprogram the terms of complexity used; but in any consideration, they must be true – they cannot be dependent on the way they are constructed (a kind of similarity principle comparable to that applied in quantum mechanics).

relations, the mutual irreducibility of two real numbers that compose it. It is understood that any real number is represented as ratios of other real numbers, such as sums. So, $10 = 2 + 3 + 5$. But the same is equal to the sum of $1 + 1 + 8$ or $22 - 12$... So, the numbers in the sets of 2, 3, 5 or 1, 1, 8, or 22, -12 are not detached from each other. While in a complex number (1, 9) or $1 + i9$ the components 1 and 9 cannot be added together, they are fundamentally different. The complex number in the hierarchy in question is more complicated than the real number, since it makes it possible to unequivocally **distinguish** the relations of a lower level of complexity from each other.¹¹ And, as a matter of fact, the use of the imaginary unit i as a “root of minus one” also implies a new relationship, irreducible to the relations of real numbers, where the “root of minus one” is meaningless. It is possible to say that “inside” a complex number, according to the hierarchy, there is just a real ∂_0 and ∂_1 which are fundamentally irreducible to ∂_0 , marked by the imaginary unit i . Of course, the complexities of the real ∂_0 and the complex (∂_0, ∂_1) are different.

As mentioned above, the relationship at the next level of complexity may contain all possible relationships of the previous one. Let me recall that $z_1, z_2, z_3, z_4 \dots$ implied an infinite number of members. There are only two numbers here (∂_0 and ∂_1). Therefore, although at this level the real numbers are distinguished between each other (from ∂_1 to ∂_2), this level will be considered as a variant of the real number level and be named as $^{5,1+1}\mathcal{J}$.

The next level of complexity should also be written as a variant of the level of complexity of the real numbers $^{5,1+3}\mathcal{J}$. It specifies quaternions. A quaternion represents a pair (∂_0, \vec{A}) where $\vec{A} = (\partial_1, \partial_2, \partial_3)$ is a vector represented as $i \partial_1 + j \partial_2 + k \partial_3$, and ∂_0 is a scalar, i.e., the real number, contrary to parts with complex $i j k$. Strictly speaking, the word “quaternion” should be used in quotes here. Quaternion is defined when quaternion algebra is given, thus, new relations have to be postulated, but in our case, there are no postulates. Even the concept of a vector cannot be strictly applied as the three-dimensional space has not been defined (yet), so, in the future simply the notation $I + 3\partial$ and the value of the level $^{5,1+3}\mathcal{J}$ will be used.

As a further step, especially in defining the space, the following point will be important: In the notation $I + 3\partial = (\partial_0, \partial_1, \partial_2, \partial_3)$, ∂_0 is a real number that differs in complexity from the rest of the formula. Similar to what we have mentioned about the complex number, the values ∂_1 , ∂_2 and ∂_3 cannot be considered separately, like ∂_0 . Of course, the “ordinary” real relation of ∂_0 and “quaternion” $^{1+3}\partial = (\partial_0, 0,0,0)$ are different from each other. However, I would like to point out once again that in the hierarchical construction for a higher level there necessarily are components of a lower level, and in this case, ∂_0 plays this particular role of simpler relations. As an inscription of a rational number in the form of an integer part can be considered an analogue of a fractional number ($3\mathbf{e} + 4\mathbf{z}$): e.g., 12,345 can be written as $12 + 0,345$, where 12 is “only” an integer number of $^3\mathbf{B}$ level, and 0,345 already has a higher complexity of $^4\mathbf{F}$ rational numbers. For details, see the Annex to this chapter.

¹¹ However, because of this independence of two parts of the same integer, the concepts of greater/smaller disappear for new numbers, it is possible to compare ∂_0 and ∂_1 on one line.

The $5,1+3\mathcal{A}$ complexity level given in this hierarchical way is the last for numbers. Frobenius' theorem established that there are only two bodies that are finite extensions of real numbers: the field of complex numbers and the body of quaternions. Thus, there is no relation $f_0 + if_1 + jf_2$, and the concept of numbers ends at the relation of level $f_0 + if_1 + jf_2 + kf_3$.¹² The larger complexity does not make sense in numerical ratios. But nothing prevents you from setting other, **no longer numerical**, more complex relationships. And, importantly, by the hierarchy principle considered, the relationships at these levels will have characteristics by numbers, but are not limited to numerical values. For example, the next chapter will deal with the common three-dimensional geometric space (and then with the physical space – time) as a certain level of complexity.

Going forward, a further increase in the number of relationships will set the elements and their movement in space, so-called physical relationships. However, nature is unified and the described **hierarchy of relationships forms a common core** for mathematical, physical, and natural sciences and, given the observer's problem, social research as well. The latter issue is discussed in detail in the last chapter.

The above constructions are not mathematical in the strict sense of the word. Mathematics requires the use of relations together with a set of axioms, this is how one introduces, for example, the natural series, the concept of ordering, the singularity of decomposition, the algebra of quaternions... It is noteworthy that, as physicists say, sometimes “manual” introduction of various axioms can lead to different results, which is natural. For example, it is the problem of cardinal numbers, or incommensurability of complexity scales of infinite sets.¹³

Importantly, in this paper the introduction of new axioms (rules, algebras) violates the proposed hierarchical increase of complexity, and they should not be used in the described constructions. But then is it permissible to use mathematics and its results for complexity constructions (for example, Frobenius' theorem, important for the construction of relations characterizing space, was mentioned above – in the next chapter)? I will provide a consideration that allows us to use the results of mathematical theories for such an “axiomatic” construction of relations.

A **correspondence principle of sorts** is assumed. In quantum mechanics it postulates that the description of quantum systems in the limit tends to classical laws. Here it is assumed that the described hierarchical constructions lead to the derivation of mathematical theorems. This means that mathematical theorems are applicable if used for appropriate levels of complexity.

¹² Of course, there are also hypercomplex numbers such as octonions (scalars and seven imaginary units), sedenions, and generally there is a Cayley-Dixon procedure that allows for the introduction of new imaginary units. But in these cases, the new imaginary units are combinations of the existing three quaternions. This is not a new level of complexity.

¹³ On the basis of transfinite numbers (ordinals and cardinals) and on the basis of the operation of transition from a set to the set of its subsets (Cohen's theorem, 1964).

Annex to Chapter 2

About infinity. Let me emphasize that only from the level $^{5,I+1}\mathcal{A}$, where the imaginary numbers are defined, do operations like inversion or conformal bijection (per unit circle) exist, and for these operations there is a concept of infinity as an independent entity. Whereas, at more simple levels the separate concept of **infinity** cannot be defined (through relations) and one should speak only about the number greater than any predetermined number. An important concept such as infinity (and hence, **singularity**) is relational and should be used with caution. Thus, the introduction of the characteristic of “power” for infinite number sets of different levels is not quite correct. It requires infinity as a special entity (in the set theory, it is introduced by a special axiom). This means that objects of lesser complexity like series of rational, real numbers, are described from a higher position, which also leads to the emergence of so-called free parameters, and, as a consequence, uncertainties and paradoxes. The known problem of the fractionality of cardinal numbers probably has exactly the same reason.¹⁴

Also, if the concept of complexity levels are used, it turns out that the relations of $^5\mathcal{A}$ (reals), $^{5,I+1}\mathcal{A}$ (complex numbers) and $^{5,I+3}\mathcal{A}$ (“quaternions”) differ qualitatively, although in the theory of sets all these constructions have the same power – the continuum – of the countless infinite set.

Finally, I would like to dwell once again on an important point. Usually, the numbers defined by more complex actions extend to less complex ones, e.g., the natural number 5 in the set of rational numbers is identically equal to the rational number 5.00000... This is not the case for the hierarchical construction, as mentioned above. These numbers coincide on a number line, but they differ in values. This difference is closely related to the principle of complexity uncertainty. Let me recall that according to this condition, elements of higher complexity cannot be deduced from a lower one – at the level of the lower complexity there can be no algorithm that would transform the relationships of this level into a higher-level relationship.¹⁵ But then it is impossible to “raise” the level of natural numbers to rational numbers and beyond. The relationships that define them remain extraneous to the more complex ones. True, they may coincide on a number line, but the number 5 ($^3\mathcal{B}$) is not the same as 5.00000... ($^4\mathcal{I}$) and is not the same as 4.9999... (it is obvious that 5.0000... is not identical to 4.9999... if the concept of infinity as a separate entity is not given. The creation of equality $5 = 4,999...$ is then the introduction of “complexity with infinity” by the observer). Thus, the relations of the lower levels are the basis for more complex ones, but they are not “dissolved” in them – there is no reverse process. This seemingly simple condition is very important and will be repeated in subsequent constructions.

Mentioning the influence of axioms, I will turn to the fact that, for example, continuity, which is defined above as a consequence of complexity constructions, can certainly be set by an axiom (and use it for the development of mathematical analysis), but any introduction of new conditions (including axioms) by a mathematician is – according to the TGS – an external influence on the pattern of

¹⁴ Probably, it can be shown that Gödel’s incompleteness theorems reflect the same fact. Resorting to arithmetic, for example, logic relationships that use inherently more complex relations, will lead to values that are not expressed through arithmetic relations, but exist for relationship systems (logic) of a higher level.

¹⁵ For example, proton, neutron, and electron have no information, hidden forces or parameters that set the rules for their protein molecules, although, of course, the protein is composed of protons, neutrons, and electrons.

interactions. This is the influence of the mathematician himself, “manually” introducing relationships that, in his view, are natural. Indeed, in arithmetic, it is believed that “... a set is partially ordered if it indicates which elements are followed by which (which elements are larger than which). One can say that the relation “follows” is a concept that formalizes intuitive ideas of ordering, placing elements in a certain “sequence.”¹⁶ Apparently, this formalism is based on intuition and the influence of the observer is very evident. In addition, “...the set of natural numbers has **natural** (!) ordering”. Again, this implies that there is a “natural” mathematician who introduces a “natural” ordering (probably, through intuition). The axiom sets a certain level of complexity; usually, the one that is most suitable for the problems which were set by the mathematician, the human. This is natural for applied science, but for the given problem it would be desirable for certain constructions created through the above-mentioned condition of continuous complexity of the interactions that the numerical elements be defined without intuition of the mathematician or the observer at all.

Thus, it turns out that in the above constructions, the natural series is not an elementary, natural and intuitive construction, but a system of certain levels of complexity determined by the quantity of relationships. In addition, when defining an ordered set, it turns out that it is neither a subtraction operation that sets the smaller number nor an operation of dividing two natural numbers by each other that sets the rational number. No, only after the higher complexity element is specified does it become possible to define the subtraction operation over the relationships – it is the bases that form it.¹⁷ This is exactly the opposite of the usual axiomatic way that determines the type of number through an input of mathematical operations. Again, the addition and subtraction operations, as well as multiplication and division, refer to different levels of complexity.

Chapter 3. Space 3+1

It was shown previously that the complexity of numerical relations according to Frobenius’ theorem cannot exceed the level of ${}^{5,I+3}\mathcal{A}$. Does the complication stop there? No, only the level is fixed at which numerical relationships still have a meaning – the most convenient and habitual for the observer.

In continuation of the construction of the hierarchical system, it will be shown that the existence and properties of what we call “a three-dimensional space” (and, in further complexity, time) are defined by the next 6E level of relationships, which determines the difference of ${}^{I+3}\partial = (\partial_0, \partial_1, \partial_2, \partial_3)$ values from each other according to the next level of the hierarchy. For illustration, the scalar part of ∂_0 will be denoted T , the vector part – x, y, z . The applicability of

¹⁶ *Mathematical Encyclopedia, 1975*

¹⁷ *This applies not only to numbers, but to sets as well. Kantor’s set theory assumes that any characteristic defines a set of elements matching this characteristic. The situation is opposite in the definition of numerical relations proposed above.*

the word “vector” for these values will be shown below (they will play the same role as the basis vectors in the theory of linear spaces).

It would appear that two values $^{1+3}\mathbf{d}$ can be distinguished if the values (T_1, x_1, y_1, z_1) and (T_2, x_2, y_2, z_2) are different. But for this they must be comparable: their components must belong to the same real lines – the line on which the values $(0, x_1, x_2, x_3, \dots)$ are placed, the line $(0, y_1, y_2, y_3, \dots)$, and the line $(0, z_1, z_2, \dots)$. However, the construction of such lines for the level $^{5,3+1}\mathcal{A}$ is undefined. It is true that just the simple exhaustion of x, y, z, T values gives any preset $^{1+3}\mathbf{d}$ number, but the absence of a common reference point, the common zero, makes it impossible to distinguish one set (T, x, y, z) from another.¹⁸ In order to distinguish them, an even greater complexity is needed: only in that case will it justify the three-dimensional reference point for the vector parts and zero for T .

The problem of defining a new level is to find relationships that give a new relation for four values, which gives three general coordinate lines for the vector parts, and independently of them the magnitudes of the scalar parts.

If the values of the vector part can be considered as coordinates, i.e., as numbers on three independent lines, then (according to them) $^{1+3}\mathbf{d}$ values can differ from each other. The scalar part is more complicated: it cannot be given as the fourth coordinate – otherwise it will not be different from the vector part. The scalar part T , as discussed in the previous chapter, has a lower complexity of $^5\mathcal{A}$ level. However, it is possible to present its square as the sum of the squares of three new values T_x, T_y, T_z :

$$T^2 = (T_x)^2 + (T_y)^2 + (T_z)^2. \quad (3.1)$$

Then, the input T_x, T_y, T_z are considered to be **coordinates on the same lines** as for the vector part, and the scalar T in this case is represented in coordinates (more precisely, the square of the scalar in the squares of coordinates).

Fortunately, a theory that defines space through general notions of relationships has already been developed, and we should just use its’ results. It refers to the theory of physical structures of Professor Yu. I. Kulakov and his group. Their results are convenient to use because the physical laws in their works are derived from the general notion of relationships, which is the closest to the concepts that we are developing here. Some aspects of the theory are summarized in the Annex to this chapter.

¹⁸ Of course, in the axiomatic definition of space, there is no problem of common zero. The given point of space is more complex than “quaternion”. Any number of lines including the coordinate axes can be drawn through any given point.

In particular, it shows that the equality to zero condition of the determinant of the matrix $\Phi_{10} = 0$, where Φ_{10} is the determinant of Keley-Menger (it can be interpreted as a bordered distance matrix)

$$\Phi_{10} = (-1)^4 \begin{vmatrix} 0 & 1 & 1 & 1 & 1 & 1 \\ -1 & 0 & \ell_{ik}^2 & \ell_{im}^2 & \ell_{in}^2 & \ell_{ip}^2 \\ -1 & \ell_{ik}^2 & 0 & \ell_{km}^2 & \ell_{kn}^2 & \ell_{kp}^2 \\ -1 & \ell_{im}^2 & \ell_{km}^2 & 0 & \ell_{mn}^2 & \ell_{mp}^2 \\ -1 & \ell_{in}^2 & \ell_{kn}^2 & \ell_{mn}^2 & 0 & \ell_{np}^2 \\ -1 & \ell_{ip}^2 & \ell_{kp}^2 & \ell_{mp}^2 & \ell_{np}^2 & 0 \end{vmatrix} = 0 \quad (3.2)$$

it is executed unambiguously when the squares of the ten real relations included in this record are represented as the sum of squares of the values x, y, z:

$$\ell_{ik}^2 = (x_i - x_k)^2 + (y_i - y_k)^2 + (z_i - z_k)^2, \quad (3.3)$$

which then appear to be the desired **coordinates**, i.e., the segments of three independent lines.

For the purpose of distinguishing “quaternary” values of $^{I+3}\mathcal{D}$ it is possible to “invert” the result obtained by Kulakov, and to assert that the level of complexity 6E , in which an infinite number of $^{I+3}\mathcal{D}$ relationships are different from each other, is given by condition (3.2). Thus, the Φ_{10} matrix of ten real relations $\mathbf{l} = l_{ik} \ l_{im} \ l_{ip} \ l_{km} \ l_{kn} \ l_{kp} \ l_{km} \ l_{kn} \ l_{np} \ l_{mp}$, which are the **bases** for a new complexity level, is equal to zero. It means that each of these values is independent and is not expressed through the others.

In other words, real relationships, fundamentally irreducible to each other, are defined – ten, and only ten of them, set any points comparable to each other by independent coordinates (lines having a common zero). Then, each point obtained in such a way has three independent characteristics (3.3), which establish a basis (that is why they can be considered as vectors as it was hypothesized at the beginning of the chapter), and the fourth separate scalar value, whose square is distributed on this basis according to the expression (3.1), since (3.2.) fortunately also presents the squared values of \mathbf{l} . Then, the infinite non-enumerable set of $^{5,I+3}\mathcal{D}$ relations is defined since they are comparable to each other for both – coordinates and the scalar value. So, the next level of complexity 6E is set.

Is it easier to say that, in the same way as the entries $^{I+3}\mathcal{D} = (\partial_0 \ \partial_1 \ \partial_2 \ \partial_3)$, we can put the value e of a new complexity as the number of ten constituents $e = (l_1 \ l_2 \ l_3 \ l_4 \ l_5 \ l_6 \ l_7 \ l_8 \ l_9 \ l_{10})$? Yes, but only under the condition (3.2), and it implies the relationships that are irreducible to the previous levels, namely ${}^6E \Rightarrow \Phi_{10} \ ^5\mathcal{D}$.

For the case of three-dimensional Cartesian coordinates (see Figures 3.1 and 3.2), the values x_0, y_0, z_0 – deferred from the common point “zero” of the coordinate origin – will be the vector components, and the values $(x-x_0), (y-y_0), (z-z_0)$ – the components of the scalar part. As can be seen, the vector part defines independent lines while the scalar part is decomposed along them according to the expression (3.1). The 6E complexity parameters will then be considered only as Cartesian coordinates.

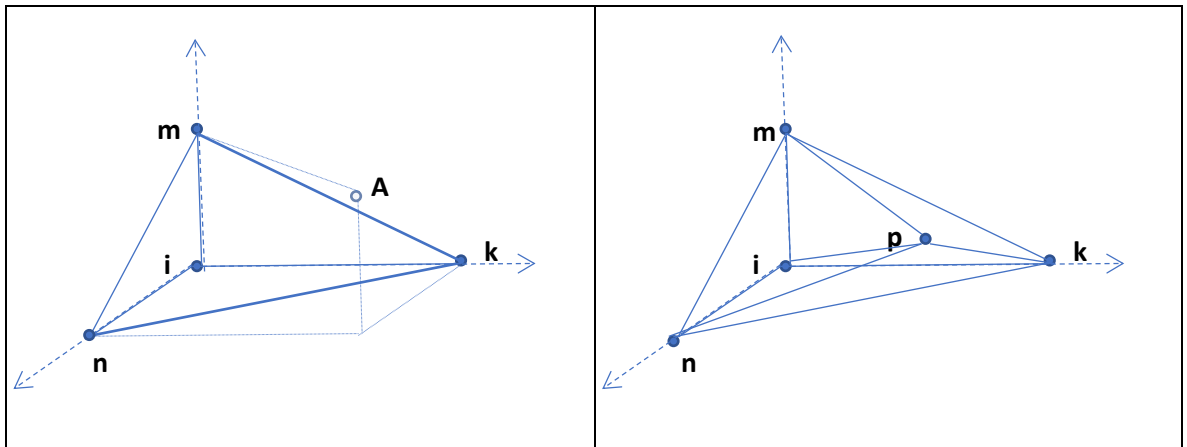
I will start with looking at a simple case where the scalar part equals zero: $T = 0$, then $l^2_{ik} = (x_0)^2 + (y_0)^2 + (z_0)^2$. In Figure 3.1 four points connecting six distances defining them are arranged to form the orthogonal axes. In this case, the rank of the Φ_{10} matrix must be preserved only when the $|ij|$ value is equal to zero, and the values $|jn| = |in|$, $|jk| = |ik|$, $|jm| = |im|$ are equal pairwise. Six real independent relationships remain. Six l^2_{ik} relationships define a **geometric** point A with three coordinates. So, this point is characterized by three real values that are fundamentally irreducible to each other.

Then we may say that the set of all ${}^{I+3}\theta$ values of the form $(0, x, y, z)$, defines a three-dimensional geometric space, where the infinite non-enumerable set of relations ordered by the condition $\Phi_{10} = 0$ – that is the three-dimensional (geometric) continuum. This level of complexity will then be labeled ${}^{6,1}E$.¹⁹

For a more general case it is necessary to add the parameter of scalar component T and further distinguish ${}^{I+3}\theta$ from it.

To do this, it is necessary to go to constructions with ten relations – see Fig. 3.2.

In this example, each point (e.g., P) is defined by four relations: $l_{ip} l_{kp} l_{np} l_{mp}$, for which the coordinates $(T_x T_y T_z)$ (scalar part) are defined on axes $0x, 0y, 0z$, and the axes define the other six relations $l_{ik} l_{im} l_{kn} l_{km} l_{kn} l_{kn}$, which represent the vector part.



¹⁹ It is important to note that the three-dimensional space, even the empty one, is the consequence of a rather high complexity level and not a kind of self-substance.

<p>Fig. 3.1 The $^{1+3}\partial$ relationship has no scalar component. Given six values im, ik, in, nm, mk, kn, ordered by the formula $\Phi_{10} = 0$, which gives a geometric point A with three dimensions. Given the infinite variety of these six values, it is possible to say that a three-dimensional continuum space is defined in such a way.</p>	<p>Fig. 3.2 The ten real values are ordered by the condition $\Phi_{10} = 0$, which is a condition for distinguishing these values from each other. Then the four interactions form “points” – i, p, k, m, n, the formations of the level of complexity corresponding to $^{1+3}\partial$, and the whole set of comparable values $^{1+3}\partial$ – the level 6E, and thus, the space $3+1$.</p>
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Since the point P is chosen at random, four relationships of **any** five points can play the role of the scalar component. For example, in Figure 3.2 it can be the point n , then the three-dimensional “vector” basis is determined by the relations $l : |im|, |ik|, |ip|, |pm|, |mk|, |kp|$, and the rest define T . Here, the distinction between vector and scalar parts is not uniquely determined; they can replace each other depending on the perspective.²⁰ So, the level of complexity 6E is defined by the coordinates (3.3) for any set of five points: for Cartesian $l^2 = (X - x_0)^2 + (Y - y_0)^2 + (Z - z_0)^2$ and in a form of $l^2 = (T_x)^2 + (T_y)^2 + (T_z)^2$.

By comparing the last two expressions, one can write:

$$X = x_0 + T_x$$

$$Y = y_0 + T_y$$

$$Z = z_0 + T_z$$

It should be constantly kept in mind that in this case the points are **no longer geometric** as in the example above: their characteristics – T, X, Y, Z – are not only four non-convergent real numbers, but a reflection of the condition (3.2); that is why the level of complexity is 6E and not ${}^{6,1}E$.

So, three independent lines are defined, on which it is possible to compare the vector components of the $^{1+3}\partial$ relations (and even their common zero for the case of Cartesian coordinates), but one more peculiarity occurs with the comparison of the T values. They have to be represented in the form (3.1), i.e., as **three** T_x, T_y, T_z values. But quaternion has only one scalar component, and therefore the zero must also be only one. Thus, the condition (3.1) must be integrated with the following representation: $T_x = v_x t, T_y = v_y t, T_z = v_z t$, that is, to formally allocate a certain **common** value t . In this case, at $t = 0$, all components $T (T_x, T_y, T_z)$ are reduced

²⁰ Such relativity should not be alarming, it is a consequence of considering $^{1+3}\partial$ from a higher level of the $3 + 1$ space, where it becomes possible to choose a dependent variable (unlike others). After this selection, the non-isotropic metric is fixed in space, which then emphasizes one of the axes as a special one.

to zero, so that the condition of a common zero is met; and the exhaustion of the triples of the v_x v_y v_z multipliers specifies all possible sets of T . Then the set of all t (with v constants) defines the real line by which all T are compared. This line is undirected and **does not form** a part of the geometric **space** given by the vector parts. Although the factors v_x v_y v_z form a three-dimensional vector, they are not a part of the $^{I+3}\partial$ vector values; the complexity level in this representation does not change.

Then:

$$\begin{aligned} X &= x_0 + v_x t \\ Y &= y_0 + v_y t \\ Z &= z_0 + v_z t \end{aligned} \tag{3.4}$$

These expressions²¹ cannot yet be called equations as the concept of a variable is not yet defined. These expressions are a new type of writing (3.2) and (3.3).

However, if we look at (3.4), we can see the difference between elements of new complexity and mathematical number elements. It could be said that at the geometric location (x_1, y_1, z_1) of the point $p_1 = (T_1, x_1, y_1, z_1)$ a point $p_2 = (T_2, x_1, y_1, z_1)$ can exist, and these points differ from each other if $T_1 \neq T_2$. A set (space) of points with the fourth scalar parameter T , in addition to geometric parameters, is formed which further distinguishes them from each other. Thus, the formed structure for the further complexity will be a basis of “space-time”. (Of course, I would like to set the value t from the very beginning – as “an arrow of time”, or at least in to distinguish some way the values $0, t_1, t_2, t_3$ from each other, but to this point it is still far away, otherwise T will have to be artificially preferred to other $^{I+3}\partial$ components. Positioning in space is meaningless for level 6E .) For a time being. The point at issue will be defining “3+1 space” or, what is the same, the level of complexity 6E . It is noteworthy that in the ordinary definition of physical space an incredibly sophisticated structure with infinite degrees of freedom is implied.²²

Another key consideration. Here, the value “zero” is not highlighted in principle: any point (vt, x, y, z) can be the origin of the coordinates, as well as, according to expressions (3.4), the origin of the coordinates can be moved from one point to any other, but there is no **selected** point $t = 0$. The latter conditions lead to tempting thoughts about deriving conservation laws, in particular, the law of energy conservation (which is a consequence of the homogeneity of time, that is, the possibility to arbitrarily shift the beginning of the timing). But it is yet early to speak about it as so far only the foundations for higher levels have been laid. Even in the present case, however, these conditions lead to very important consequences.

²¹ The theory of linear operators defines movement and similarity transformations, in particular, the isometry of space into itself (a special case of affine transformations). They are defined by expressions similar to (3.4). However, in this case these expressions are derived from the concepts of hierarchy of complexity levels, rather than being introduced from other considerations.

²² At the same time, each point of such a structure is probably dependent on others, otherwise how could it be possible to specify the curvature of this space...

If we fix the value t : $t = t_0$, then all expressions (3.4) become identical: the sum of the two real numbers $X = x_0 + v_x t_0 = X_0$ turns out to be on the right, the same happens for Y and Z . Thus, with this simplification, the particular law of energy conservation for the geometric point of complexity ${}^6\text{-}I\text{-}E$ is fixed. But these expressions are defined for each value of t . Then, by specifying an uncountable infinity of values of t (after all, it is a real number), we get a continuum of geometric points connected by t . For each fixed t , an infinite series of geometric points $(x, y, z)_{t1}, (x, y, z)_{t2}, (x, y, z)_{t3} \dots | v_1$ is formed that for further complexity levels become a trajectory (for this level the values of v are not selected). Each of this infinite trajectory defines one value ${}^{I+3}\partial$ which is different from the others. It is also necessary to consider all possible sets of $v_x v_y v_z$ and put the same series for $\dots | v_2, v_3, v_4$. By specifying all possible triples $v_x v_y v_z$ (and there is a non-enumerable infinity of them, too), let us present the 6E level (that is, space 3+1) as a set of all possible trajectories.

In any case, 3+1 space is a system of ten interconnected ($\Phi_{10} = 0$) relationships of the level 6E , so, **space is the essence of the complexity characteristic**. In the hierarchy of relations, the following levels will, in addition to their new differences, be characterized by 3+1 space relations. In other words, starting at this level, the relationship is sort of **immersed** in space and cannot be considered without it. Conditions arise for an entity to emerge with the properties we call space-time: duration, three and no more – according to Frobenius’ theorem,²³ geometric coordinates – different locations at different parameters of t , movement trajectories and so on. On the other hand, the interactions of the simpler levels – ${}^2E, {}^3B, {}^4I$ – will also be considered particularly from this spatial level of complexity, mainly because of the convenience of human perception, which leads to the introduction of free parameters and complex mathematical constructions, which make it possible, for example, to bring the descriptions of level relationships below 6E to the level of space (Chapter 9).

The above constructions were based on the use of squared values l_{ij} in the matrix of distances Φ_{10} in the expression (3.2). It is natural if the constructions came from postulating a three-dimensional space with the Euclidean metric, but in the proposed construction “by complexity” it will be necessary to justify this choice since there is nothing that would indicate the need to use this particular metric.

The requirement of having the Euclidean metric for the three-dimensional space: that distances have to be determined by the Pythagorean theorem

²³ Of course, one can write equations of multidimensional space and other objects that can be called spaces with any number of dimensions, but it would all be “manual” introduction of complexity.

$d(p, q) = \sqrt{(p_1 - q_1)^2 + (p_2 - q_2)^2 + \dots + (p_n - q_n)^2} = \sqrt{\sum_{k=1}^n (p_k - q_k)^2}$, strange as it may seem, is introduced solely by the researcher's preference. There is, for example, Minkowski distance, which generalizes the concept of metric, there is the Chebyshev metric, and others. And quite indicative is the modern definition of the selectness of Euclidean metric among all others: "*Euclidean metric is the most natural function of distance, reflecting intuitive properties of distance between points.*"²⁴ Intuition again, which in this case did not even take the form of an axiom, probably because it is so natural. From the relations hierarchy perspective, the Euclidean metric corresponds to ⁶E level and 3+1 space, respectively. This condition is necessary to represent the scalar *T* in the form of three coordinates (3.1), and this is only possible by presenting it in the form of squares, which transform the vector values into a scalar. Unfortunately, there is no proof that such a representation is unique. It is possible (and it has to be proved separately) that for the degrees of values *l* other than two – $l^3, l^{5/3}, \dots$, the functional equation of the form of (3.2) has no solution at all or that it has no solution in the form of three independent coordinates and scalar, which is required for complexity ⁶E.²⁵

Let us emphasize that the above reasoning refers to the construction of space as another hierarchical stage, where more simple elements are the basis for the construction of more complex ones and where it is not possible to enter relations (numbers, lengths, formulas) of arbitrary complexity without the right number of basic relationships.

Annex to Chapter 3

The findings of Professor Yu. I. Kulakov and his team were used above, and it would be appropriate to briefly present a part of this interesting theory.

Professor Yu. I. Kulakov in a series of works on the theory of physical structures (for example, *Kulakov Yu. I., Vladimirov Yu. S., Karnaukhov A. V. Introduction to the Theory of Physical Structures and Binary Geometrophysics. M. Archimedes 1992*) established that the elementary concept of *relation* is sufficient to define the space in general. Professor Kulakov suggested a simple condition for this: laws have the character of algebraic relations, binding elements, points, between each other. It turns out that in this kind of theory, we can talk about laws for three elements, four, five, etc. Let us call these numbers the rank *r* of law. Then each element of the law of rank $r = 3, 4, \dots$ binds as many pair relationships as there are combinations on *r* by two. By denoting the paired relationships between the elements *i* and *k* through a_{ik} , it is possible to write the law in the form of zero of some function from $r(r-1)/2$ pairs of a_{ik} type: $\Phi(a_{ik}, a_{ij}, a_{jk}, \dots) = 0$. Laws then differ primarily in rank. To find the type of function Φ , the symmetry property, i.e., the equality of all the elements of the given set, is used. Instead of one set of elements *i, k, j, ...* a set of any other *r* elements is selected: *p, m, n ...* It is this simple condition that

²⁴ *Mathematical Encyclopedia, 1975.*

²⁵ *To do this, it is necessary to prove the uniqueness of the representation of condition 3.2 through the sum of the squares of the distances l and, accordingly, the sum of the squares of the coordinates.*

allows to pass from the formula $\Phi(a_{ik}, a_{ij}, a_{jk} \dots) = 0$ to the system of functionally differential equations and to find specific types of laws. All these issues are detailed in the works of Yu. I. Kulakov and his group. Prof. Kulakov was named this theory of relations the theory of physical structures.

It turns out that the notion of rank r of a structure corresponds to the dimension n in geometry. There is an unambiguous link between them $r = n + 2$. The coordinates themselves are entered as follows. In the law $\Phi = 0$ (not only the $\Phi_{10} = 0$ used in this Chapter), $r - 2$ elements can be distinguished and considered as benchmarks. The ratios to the reference elements act as coordinates of elements i and k and all others.

Kulakov's group found all possible laws for systems of rank relations $r = 3, 4, 5$ from the solution of the corresponding functional-differential equations. As rank increases, the difficulty of finding laws increases significantly. There are several solutions for each rank r . It turns out that these solutions correspond to known geometries: Euclid, Lobachevsky, Riemann, etc.

As discussed above, three-dimensional Euclidean space is described by one of the laws of rank structure 5, which has the form

$$\forall i, k, m, n, p \in \mathbb{N}_3;$$

$$\Phi \begin{pmatrix} a_{ik}, a_{im}, a_{in}, a_{ip}, \\ a_{km}, a_{kn}, a_{kp}, \\ a_{mn}, a_{mp}, \\ a_{np} \end{pmatrix} = D_{ikmnp}^1 =$$

$$= (-1)^5 \begin{vmatrix} 0 & 1 & 1 & 1 & 1 & 1 \\ 1 & 0 & a_{ik} & a_{im} & a_{in} & a_{ip} \\ 1 & a_{ik} & 0 & a_{im} & a_{in} & a_{kp} \\ 1 & a_{im} & a_{km} & 0 & a_{mn} & a_{mp} \\ 1 & a_{in} & a_{kn} & a_{mn} & 0 & a_{np} \\ 1 & a_{ip} & a_{kp} & a_{mp} & a_{np} & 0 \end{vmatrix} = 0.$$

The law $\Phi = 0$ is identically fulfilled, if the a_{ik} pair ratio is characterized by triples of coordinates of the elements:

$$a_{ik} = l_{ik}^2 = (x_i - x_k)^2 + (y_i - y_k)^2 + (z_i - z_k)^2$$

This conclusion, like the distance matrix, was used in Chapter 3 above.

However, for the same rank Prof. Kulakov and his group found ten more and only ten other solutions of the equation $\Phi = 0$, which correspond strictly to ten types of 3-dimensional geometries. So, there is a pseudo-euclidean geometry

$$a_{ik} = l_{ik}^2 = (x_i - x_k)^2 + (y_i - y_k)^2 - (z_i - z_k)^2$$

Geometry of Lobachevski, Riemann and some others, as well as three almost unknown geometries.

Note that the theory of physical structures cannot be fully used to construct a hierarchy of complexity as it postulates an algebraic form of relations.

Chapter 4. Field, Locality, and Motion

At the next level ${}^7\mathcal{K}$, it is necessary to define the separability between some of the relations of the previous level and thus the possibility to compare them through a new parameter.

As stated above, 3+1 space is a reflection of the 6E level of complexity, where the level elements are characterized by ten interconnected real relationships (or five separate points). The solution of the corresponding functional equation (3.2) gives the form of a square of 6E values in the form of the sum of squares of coordinates. Given the expressions (3.4), this means that the ratios of 6E level are defined by four triples of interconnected real values (t, v_x, x) , (t, v_y, y) , (t, v_z, z) (with a common zero: $x=[0, x] \dots t=[0, t]$).

Then to **separate** these values, i.e., for a new complexity irreducible to the relations under consideration, we have to set a new parameter fixing the **difference** between the points x, y, z on each of the coordinate lines $[0, x]$ $[0, y]$ $[0, z]$ and the difference in the values of T attributed to them.

However, due to the independence of the zero reference point selection both for T and x, y, z , it can be represented as $x-0 = v(t-0)$. The interval in such representation is indistinguishable from those relationships that are set by the level 6E . That is why a characteristic of a new complexity should be presented in the form of difference – the difference of the coordinates X, Y, Z from those defined in 6E in expressions (3.4):

$$X_t - (x + v_x(t-0))$$

$$Y_t - (y + v_y(t-0))$$

$$Z_t - (z + v_z(t-0))$$

I will denote these differences as $S_x S_y S_z$ (there is no equality!). And in order to avoid confusion, we should call S not just an interval, but an offset.

The value S must not only distinguish the intervals from each other, but also be a numerical characteristic of the difference. However, distinguishing the real segment $[x_2 x_1]$ from, say, $[x_1 x_0]$ is a nontrivial problem. The fact is that a continuum, i.e., the power of real numbers, in its usual definition has logical problems in getting a physical scale – its points are countless and the allocation of any interval in it is impossible. The continuum has no inherent scale. The intuition that the whole is the sum of its parts does not work in this case.

What is meant here, e.g., by the construction of a “field” – for example, electromagnetic, filling three-dimensional space. The magnitude and the rate of change of the field at different points in space completely determine the behavior of the field, and the points of the field itself interact only with their nearest neighbors. But there are no points in the continuum that are closest to each other.²⁶ Therein, a countless infinity of “nearest” in any of its segments is defined. Therefore, it is difficult to talk about the concept of proximity for a force field if there are no adjacent points.

In the hierarchy of relations described above, this paradox does not exist. There are relationships in a hierarchical representation that naturally divide (giving scale and ordering) the continuum – these are the lower levels that necessarily exist in a hierarchical setting of relationships. Each new level, including ${}^7\mathcal{K}$, contains the relations of levels ${}^2\mathcal{B}$, ${}^3\mathcal{B}$, which are discrete, and the level ${}^4\mathcal{T}$, the relations in which are ordered, as discussed in Chapter 2. Considering the theorem that between two rational numbers there is at least one rational, it turns out that in any small segment of a number line (a continuum) there is an element of a countable infinity, even if surrounded by a countless infinity of irrational ones, which does “mark” it, making²⁷ any small segment of a continuum ordered. In other words, in any segment formed by two dissenting points of a real number line (level ${}^5\mathcal{D}$), one can find the relation ${}^4\mathcal{T}$, which, being ordered, also orders a given segment. Then any segment ΔX is reduced to the sum of smaller scale **ordered** segments – Δx_{1-2} , Δx_{2-3} ... At the same time, the segments can be arbitrarily small and their number arbitrarily large, and “one is located after the other”. Remarkably, the representation of a small increment described is very close to the definition of a differential form, which, though, still requires a marginal transition. And it is precisely the higher level of complexity ${}^7\mathcal{K}$ that singles out any chosen point as a special point (assigning each an offset), near which arbitrarily small converging segments are definable (there is an order!) at this point, and once selected, the convergence limit is determined. Then from this level it is possible (and convenient) to write the values in what we call the **differential** form, using the notation $\delta = \Delta \rightarrow 0$.

Given the form of the new parameter S which is $X_t - (x + v_x(t-0))$ offset, it is written as: $\delta^2 S / \delta x^2 = 0$ (by definition of differentiation the dependence S by x is linear; it cannot be nonlinear

²⁶ To recall the conclusions of the set theory: there is at least one rational between two rational numbers, there is an uncountable infinity of irrational numbers between two irrational points (real in the general case), i.e., points in the continuum.

²⁷ In a sense it is the conclusion of “the axiom of choice” of set theory.

and more complex at this level of complexity), and also $\delta^2 S / \delta (vt)^2 = 0$. Then $\delta^2 S / \delta x^2 = 0 = \delta^2 S / \delta (vt)^2$ or, in general form, given that S is independent of the coordinates x, y, z ,

$$\delta^2 S / \delta x^2 + \delta^2 S / \delta y^2 + \delta^2 S / \delta z^2 = (1/v^2) \delta^2 S / \delta t^2 \quad (4.1)$$

that is the known wave equation. Crucially, S then distinguishes the interdependent values x, y, z, t from all others at the previous level of complexity. The integral form of this equation will reflect the kind of differences of the parameters of the ${}^7\mathcal{K}$ level, their **irreducibility** to the expression (3.4) of the previous level. In addition to the coordinates and values of T , relations will appear related to the new displacement parameter: $X=X(x_0, v_x, t, S_x)$, $Y=Y(y_0, v_y, t, S_y)$, $Z=Z(z_0, v_z, t, S_z)$. Furthermore, the differences can be expressed in different forms: the solutions of the equation (4.1) lead to the appearance of a spherical wave, flat wave, etc.

It turns out that after the complexity defining the 3+1 space, the complexity of waves in this space is defined, meaning that it ceases to be unified and stable.

Academician Pontryagin noted that “*nature speaks to us in the language of differential equations*”. And the reason is that from the level of ${}^7\mathcal{K}$, relationships can be characterized by orderly, small – δ parameter changes. Only then differential calculus is defined and logical, where the integral form of expressions is a record of relations through the parameters characterizing both the previous levels (in particular the coordinates of 3+1 space) and the new values of S .

The question is, isn't the introduction of ordering of δ segments a reduction in complexity – from continuum to less complexity of ordered rationals? No, the complexity is increased because an **additional** displacement characteristic is attributed to each point characterized by a real relation (3.4) distinguishing it from the set of adjacent nearest points. This additional complexity is attributed exactly to a point from the continuum. The features of this new characteristic are most closely related to what in physics is called **a field**; in the present case, S is a field of displacement, torsion in a solid body. The concept of “displacement” can be replaced by the more usual “field value at a given point”. The main point is that the concept of a field is a relational value, a characteristic of the new complexity. Given the hierarchy theory, it is correct to say “field in the 3+1 space”, and it is possible to write the following conditional expressions:

$${}^7\mathcal{K} \Rightarrow S {}^6\mathcal{E} \Rightarrow S \Phi_{10} {}^5\mathcal{I} \Rightarrow \dots \quad (4.2)$$

that is, the field complexity implies the complexity of the 3+1 space as well as the continuity of the real series.

If we move from the familiar macroscopic parameters to the relatively **less** complex – to the 3+1 level (to the quantum physics relationships), the concept of a field, naturally, becomes redundant. For a small level of complexity, it is enough to use indivisible segments rather than a continuum, with no idea of infinitesimal changes. In this case it is necessary to introduce **discrete** values of ${}^2\mathbf{B}$ or ${}^3\mathbf{B}$ levels, so to say “field vectors”. Importantly, these values will also be relational, introduced relative to a certain level of complexity, rather than fundamental.

The field concept given through complexity levels naturally complies with the aspects of proximity recognized by all observers: first, each point of the field is a separate object and has its own characteristic; second, the higher-level relations can be defined by field displacements (I might say oscillations). In other words, the effects do not leap from one place in space to another, but pass through all intermediate points, each point being separated from the other, and, so to speak, has its own independent reality.

In foreign literature, the term “locality” is used more often, the analogue of “short-range” more common in Russian literature; accordingly, “non-locality” is a “long-range action”. Using a hierarchy of relationships entails its own adjustments. Here, you have to separate these concepts and use them for different levels of complexity. Short-range interaction should be used to distinguish the points of the field, and locality – to distinguish the material points, which will be discussed below.

The next level ${}^8\mathbf{3}$ should set the difference between S_1 and S_2 . Let w be the value that distinguishes two displacements. Its introduction into the described system produces two obviously different values, $w(S) : (S_1, S_2)$.

As stated above, S is expressed through the differential form. Then if S_1 and S_2 differ by an infinitesimal value, the characteristic that distinguishes them will also seem to differ infinitely marginally, and at the limit – disappear. So, how will the fields (displacements) differ from each other? It means that the new level of complexity should set a single parameter for both S_1 and $S_2 = S_1 + \delta S$, then if w is a new invariable parameter for S and for $S + \delta S$, then it can be attributed to the difference $\delta S = S_2 - S_1$, i.e., to the infinitesimal volume $\delta x, \delta y, \delta z, \delta(vt)$, and at the limit this volume does not grade to zero as for the previous level, but to w . Given that $S_x = X - (x_0 - vt)$..., only its second derivative in t : $\delta v / \delta t$ – will not depend on the choice of S^{28} and it is this expression, **the acceleration**, that can be written as a characteristic of w , distinguishing between S_1 and S_2 in the infinitely small volume $\delta x, \delta y, \delta z, \delta(vt)$. In other words, the selection in the new complexity of an infinitely small volume $\delta x, \delta y, \delta z, \delta T$ – which will hereafter be called **the material point** –

²⁸ It is impossible to differentiate the value of t , e.g., by v or x based on the conditions of introducing it as a part of T to provide a common zero with other parameters – see previous chapter.

in the difference of fields S_1 and S_2 will induce (communicate to it) the displacement difference parameter w , which is characterized by the value $\delta v / \delta t$ – acceleration. Figuratively speaking, the observer will see how under the action of **the difference in the magnitude of the fields** the material point acquires **acceleration**.

It is important that giving parameter w the characteristic $\delta v / \delta t$ separates the spatial part of displacement (δx , δy , δz) from the temporal part (velocity) for a point, and, according to expressions 3.4, then we can talk about the existence of a material point in space with coordinates varying in terms of t (it is too early to talk about time and the flow of time). Thus, at the new level it is impossible to pass from one material point to another, located however close, by enumerating the parameters of the previous levels (coordinates, displacement fields, etc.), it is necessary to set w – this is a higher level of complexity.

Now is the appropriate time to say that under the influence of different fields S_1 , S_2 , S_3 ... the relations between different material points are defined and there is a law connecting the parameters of these relations, but to do this we need a new level, where the difference of w values is defined.

So, the next level 9H should distinguish one parameter w from the others. Thus, for this level 9H there should be a special relationship distinguishing points from each other. This numerical relationship could be attributed to δx , δy , δz , T volumes distinguishable from each other. Let it be the values m_i . Then, taking into account the expressions (3.4), it is possible to simply speak about the point m_i (with a vanishingly small volume) in coordinates x , y , z , separately from other quantities $v_i t$ and about the $\delta v_i / \delta t$ change in the field. There are two emerging conditions that need to be taken into account: m cannot be dependent on characteristics of S (so, m should be a **scalar**), and the parameter t is general, otherwise it is impossible to compare and distinguish the volumes δx , δy , δz , δT of each material point. Also, there is no “non-field” interaction between material points.²⁹ True, $\delta v / \delta t$ represents the change in the field S , or acceleration, and therefore all the relations of material points are characteristics of the field.

To compare, or to establish the relationship of interactions between different w_i is possible in the following way: w_1 distinguishes m_1 for fields S_1 and S_2 ; w_2 distinguishes m_2 for the same conditions of fields S_2 and S_3 . That is, different m_1 and m_2 ended up in one point volume. We can say that a collision of material points occurred, or that they approached a sufficiently small distance.

²⁹ Which is only natural for the hierarchy of relationships. S is the “field” parameter of the previous level, so, new relationships are built on it.

The fields themselves can exchange with each other – displacement waves S (4.1) pass through each other, so to say – and can have coordinates before and after any point in space (they have a lower complexity than material points). But material points cannot “pass” as they distinguish the difference between the fields, in other words, they are “solid”. Then, $w_1 u w_2$ must change in a new complexity of values m_2 and m_1 in such a way so as not to violate the difference $S_2 - S_1$ and $S_3 - S_2$ either before or after the collision.

Since $(m_2, \delta S_2 / \delta t) + (m_1, \delta S_1 / \delta t) = 0$ or, considering that m is a scalar, and the quantities characterizing a vanishingly small volume $\delta x, \delta y, \delta z$ do not depend on time, we obtain

$$m_1 v_1 + m_2 v_2 = \text{const} \quad (4.2)$$

As we have already mentioned before, the fields do not distinguish the differences between themselves – they “pass” through each other; their complexity $^7\mathcal{K}$ does not contain this type of difference. In that case the **independence** of several fields influences the same material point – their influence on the parameter $(m, \delta v / \delta t)$ can be written as a sum, as in the case of **independent** field quantities. Then, for convenience, it is possible to introduce their single parameter F and apply it to a given point:

$$\sum F = m_i \delta v_i / \delta t \quad (4.3)$$

It does not matter whether the velocity has changed from the sum of collisions or from the actions of different fields.

In the expression derived for the second Newton law the condition appears for the separation of a material point in motion and space as well as **numerical** characteristics of all the others – **external** effects on it.

It should be noted that introducing F does not change the complexity of the relationships; as before, the independent field relationships distinguishable by m are described here, and the only difference is that F is no longer a scalar. The parameters F and m belong to the same level of complexity $^9\mathcal{H}$.

This gives rise to a paradox: an independent expression is impossible between F and m on the one hand and $w = \delta v / \delta t$ on the other, since acceleration is a characteristic of the previous level $^8\mathcal{J}$. If we postulate (derive from experience) F and m , then acceleration is a certain computable coefficient between them. If we say that different accelerations are measurable, then we have to postulate the existence of F and obtain the coefficient m – see the Annex to this chapter. From a logical standpoint, Newton’s second law is not complete. The reason for this paradox is simple: two parameters of one level of complexity and one of the previous level are used, which

naturally is associated with both, so they are expressed through each other. As a matter of fact, this is not very significant in practical terms: forces and masses always remain “behind the scenes” of measurements, and movements and trajectories are observed. This is discussed in more detail in Chapter 8.

However, it is necessary to make a backtrack and see how the locality of material points is taken into account in modern physics. In classical theoretical mechanics, the basic equations are given in two different ways. Either the second law of Newton is postulated, from which the Lagrange equation is deduced (*see, for example, the course for MFTI, Eizerman M.A. “Classical Mechanics” – M.: Science, 1980*). Or the least-action principle is postulated, as it is done in the famous course *Landau&Lifschitz “Theoretical Physics. Mechanics”*, and Newton’s second law is deduced from it. In the first case, **locality is implied** as individual forces acting on material points are specified. Without this, there can be no talk about changing the impulse of an individual body (i.e. a material point), its acceleration. In the second course, when deriving the Lagrange equation from the variation of the Lagrangian, the derived equations are supplemented by another **postulate**, the additivity of the Lagrangian. Thus, the principle of distinguishability of two material points is simply postulated, better to say, it follows from the experience. But for the hierarchy in question, the **distinctiveness** of elements in the 3+1 space is a necessary condition for defining a new level of complexity.

The dependence condition for **pair** collisions, which allowed us to write equation (4.2), can be interpreted in such a way that the equations of motion for **non**-interacting parts in 9H do **not** contain values related to other collisions. This is the principle of additivity mentioned above – irreducibility to each other of separate elements in space (independence of the Lagrangian function for non-interacting points). Thus, additivity, locality in general is a relational concept, which arises under the condition of complexity ${}^8\mathbf{3}$, which allows us to define a material point and to describe it with even higher complexity 9H , for which there are groups of points, i.e., when there is a difference that defines, in particular, **different** material points.

Only now we have a definition of what is usually postulated as local impenetrable material bodies – multiple interacting material points, to which a differential description (“inherited” from the differential level ${}^7\mathbf{K}$) of their relations (we can already say, motion) in the 3+1 space is applicable – and hence the concepts of equations of motion, and of the selected trajectory emerge.

It is noteworthy that Newton's third law could be derived as one of the consequences of the law of conservation of momentum (4.2), which in its turn is a consequence³⁰ of homogeneity of space. The latter is a direct consequence of derivation of the 3+1 space as a system of a certain complexity – the differences between separate points are indefinable from its level, which actually is homogeneity.

Annex to Chapter 4

I will refer once again to what I said above about the impossibility to derive the values of F , m , w in the classical form of Newton's 2nd Law independently of each other.

Let me quote Henri Poincaré: *"First of all, we face difficulties when we want to define basic concepts. What is mass?" "This, Newton says, is the product of volume by density." ... What is power?" "This, Lagrange would say, "is the cause which produces the motion of the body, or which tends to produce the motion." "This, Kirchhoff responds, is the product of mass by acceleration." But then why not say that mass is the amount of force per unit of acceleration? These difficulties are insurmountable... So, we go back to Kirchhof's definition: force equals mass multiplied by acceleration. This "Newton's law" ceases to be seen as an experimental law, it becomes merely a definition. But that definition is also insufficient, because we do not know what mass is... There is nothing left, and our efforts were fruitless – we find ourselves facing the need to resort to the following definition, which is essentially an acknowledgement of our powerlessness: masses are coefficients that are convenient to input into calculations... We must conclude that the classical system cannot produce a satisfactory idea of power and mass."*

There is an interesting corollary of the logical open-endedness of the law. In order to test whether Newton's 2nd Law is correct, strictly speaking, it is necessary to consider some 10^{80} forces acting on a particle in the universe, from all 10^{80} particles in it.

However, it is not necessary in the aforementioned case. I would like to emphasize once again that Newton's laws (or, what is the same, the principle of minimum action) are derived from the perceptions of the hierarchy of complexity and are a consequence of the existence of parameters of different levels. The concept of mass also appears as a consequence of relations allowing to separate one point from another, to cancel their indistinguishability. Then it is not necessary to investigate the behavior of 10^{80} points to strictly verify Newton's laws.

³⁰ According to Noether's theorem.

Chapter 5. Entropy

As shown in the previous chapter, the characteristics of one material point from the complexity level of 9H are separated from all others. The next ${}^{10}K$ level not only distinguishes the sets (systems)³¹ of material points, but also compares them to each other. The new level should have a parameter that is not limited to describing the relationships of individual points.

An important point needs to be made here. The designation ${}^{10}K$ implies the level of complexity of comparable systems, where there are parameters such as valences³² that take into account ionic and hydrogen bonds, etc. These “chemical” relations are different from the “physical” ones in principle and comparison of such systems produces different results. Therefore, the complexity of comparable sets (systems) of **material** points will then be denoted ${}^{10,-2}K$, the designation -2 shows that the considered relations are defined two levels below, at 8Z . They are the ones that will be discussed in detail. The “entropy” parameter, which will be introduced below for level ${}^{10,-2}K$, is applicable to level ${}^{10}K$ “chemical” systems only within limited models.

To work in the new complexity with a system consisting of individual material points, it would seem that we need to assign additional parameters for their coordinates, velocities, and their changes. And watch the system evolve? No. When we say “the system changes”, “the process”, we already imply consideration from the perspective of the complexity of an observer fixing different positions of the same system in time. In this consideration we cannot do so as the influence of the observer will inevitably be introduced. It is necessary to be able to compare the system of material points with another one having the same parameters of 8Z level: mass, type of interaction, number of points (mutual position). Then it would be possible to say that there is **one** system having **different states** or that there is a “**process** of changing the system” (in terms of the newly introduced parameter).

The new parameter can be introduced in two ways: by directly counting the positions (coordinates) of each material point in the system, and then using the new parameter to see the differences between them, I will call it “Boltzmann”; or, the second way, “Newtonian” – by studying all collisions of material points and remembering – also owing to the new parameter –

³¹ From this level we can talk about the concept of “system” in the sense of L. von Bertalanffy: A system is a set of elements in certain relations with each other and with the environment (*History and Status of the General Theory of Systems // System Studies*. – Moscow: Nauka, 1973).

³² Not limited, except for the simplest cases, to the type of relationship of the previous levels. So, theoretically, it is possible to describe molecules only in terms of the position of electrons in different quantum orbits, but even the most powerful computers allow to simulate the hydrogen molecule, but not heavier molecules.

the speed (to fix different states) and calculating the new positions after each interaction according to Newton's laws.

In the first case, it is necessary to determine the positions (coordinates) of all molecules and then record the changes. So, in the presence of a certain “memorizer” inside the system – a new complexity parameter, we can talk about the difference between one position of the material point system from another. For this “Boltzmann” case only the sets of coordinates $\langle X \rangle$ differ: $\langle X1 \rangle$, $\langle X2 \rangle$, $\langle X3 \rangle$, ... In statistical physics, the concept of statistical weight is used: W is the number of ways in which a given system state can be achieved.³³ Statistical weight is the appropriate **parameter** for describing the complexity level of ^{10-2}K , its introduction implies both the difference between the sets $\langle Xi \rangle$ and the memory of each. By the way, in this case, you can sort the sets, for example, in descending order of W .

In the “Newtonian” consideration, new velocities are defined by Newton's second law for each of the pairwise collisions. A new parameter is used to take into account the changes of velocities of points as a result of collisions. In that case, in order to distinguish the positions in the systems, it is necessary to record, i.e., “memorize” the accelerations and resulting speeds of all points, and then record and memorize the changes in velocity for the resulting new sets of interacting points (according to Newton's law). That is, to introduce a paradoxical parameter for the characteristics of the 83 system (not reducible to them), reflecting the differences between the sets of points with a numerical characteristic, I will designate it as \widehat{s} , by which the sets of accelerations differ.

Then, using the expressions of Newton's second law (2.4), an additional term \widehat{s} : $X=X(vt, m, F, \widehat{s})$ should appear for the new level, and the coordinates will depend on it as well. No, remember, \widehat{s} makes sense for the system of quantities X_i , because it is the states of the system of material points that are compared from the ^{10}K level. It is pointless to enter \widehat{s} in an expression, for example, for Newton's second law, and generally in an expression for the movement of individual points.

The value \widehat{s} has nothing to do with the previous level, it is a free parameter for it and, if only the relations of 9H are given, can assume any values. In reality, taking into account, for example, the mutual positions of points, there are limitations: e.g., the walls of the vessel limit the coordinates X , and then the value \widehat{s} cannot be arbitrarily large, so that with a large sampling of the values vt , w , F and with limited X_{max} , Y_{max} , Z_{max} coordinates, the value \widehat{s} approaches some value $\langle \widehat{s} \rangle$ - by the **law of large numbers**. And the more material points we have, the larger the

³³ If all material points are numbered and their coordinates are known, the statistical weight of such a system is equal to one – there is only one way to place different points at certain points.

sample. The last remark allows to link \widehat{s} and W – because it is the same characteristic of the level $^{10,-2}K$. True, the increase in the number of material points leads to a power growth in the possible permutations between them, and the number of mutual distances between the points changes linearly. Then dependence of \widehat{s} on W must be logarithmic, for certainty one can take natural logarithm,

$$\widehat{s} \sim \ln (W) \quad (5.1)$$

The coefficient between them must be constant, because, again, it is a kind of the same characteristic of greater complexity.

Interestingly, the known formula (5.1) here is the relation of entropy to the probability of a given state, derived from the treatment of relationships of different parameters, whereas in classical thermodynamics it is a postulate.

I would like to emphasize that, introduced in this way, the entropy \widehat{s} is a completely objective value obtained for level $^{10,-2}K$, relative to a lower level 9H . It can well be seen as a pseudo-force $F_{\Sigma}(\widehat{s})$, which alters (“pushing molecules apart” in the known example of gas distribution over a vessel) a system of material points, whose parts are connected by relationships non superior to the complexity level 83 . A pseudo-force that exists only for complexity levels from which it is possible to “remember” and compare the positions of the point interaction system.

At the same time, it should be repeated that **individual** interparticle interactions (at complexity level 9H) in the system occur strictly according to Newton’s laws – and are reversible, of course. An increase or decrease in the value of t does not change the form of the law. And it is only when the comparability of the system’s positions is taken into account (i.e. at the new level $^{10,-2}K$) that the disorder grows. Using the terms of thermodynamics, the multipoint distribution function which takes into account **all** correlations between 9H molecules, is reversible. Whereas the coarse-grained Ehrenfest structure (roughly, the partition of phase space into volumes of finite sizes that are **compared** $^{10,-2}K$) tends to equilibrium.³⁴ This is well demonstrated by a simple experiment with the dissolution of a drop of ink in water: at high magnification, it can be seen that the paint particles beat and shake under the Brownian motion, quite in accordance with the laws of mechanics; whereas the overall picture is a reduction of the ink concentration in water to a certain limit.

³⁴ It has been shown (L. Van Hove) that the irreversibility of statistical processes follows precisely from the coarse-grained structure.

There is a well-known saying that if thousands of monkeys tap the keys of typewriters, sooner or later, in centuries or millennia, they will print “War and Peace”. The problem is not the long run for the monkeys to randomly create a work of art, it is that in the described action, by default, there is an observer who distinguishes a meaningless set of letters from text. But the monkeys are not able to make that distinction, and from their level of complexity, the pages of nonsense are as good as the pages with intelligible text. A TGS appears, i.e. the impact of a higher level of complexity (reader) on a lower one. Thus, according to TGS, a free parameter appears that characterizes their difference. In this case, it is the probability that “War and Peace” will occur at a certain number of attempts or, which is the same, the time during which this work will be printed. At the same time from the monkeys’ “point of view”, any set of letters is a result, since (for them) it does not differ qualitatively from another set of letters. So, the probability of creating a text is equal to one, therefore, the search time for options in this sense does not exist.

The same is true for the formulation of an ergodic hypothesis justifying modern statistical physics. According to this hypothesis (all available microstates are equally probable over a long period of time), the condition that entropy generally tends to increase codifies a simple truth: the more likely it is that something will happen, the greater the probability that it will happen.

This statement also contains what might be called observer influence. Here, a priori, we mean the existence of something or someone that counts the possibilities and **distinguishes** the cases in which there are more possibilities from those in which there are fewer. This introduces an additional parameter by which the systems are compared. From the point of view of complexity concepts, it is the allocation of one state relative to others while calculating possibilities. But the systems themselves do not count! We need a higher-level interaction (for example, but not necessarily, an observer).

Such consideration also exists for the case of experience in mixing (ideal) gases in a single vessel – complexity of $10^{23}K$ level. The main problem is not that the probability of spontaneous separation of the molecules of one substance from another and their separation by volume is negligible. The peculiarity of this state makes sense if there is an observer or a relationship of a more complex level (processes in the atmosphere, for example), for which the situation where the molecules of gases are separated is different from any other situation where the molecules are mixed. The molecules themselves “do not care” about their collisions, if, of course, the chemical bonds that can resolve them are neglected. The same is true for the case of Maxwell’s demon in Chapter 1, separating faster molecules from hot ones and combining water

molecules into droplets when cooled, forming trillions of molecules, the probability of which is negligible except for “chemical complexity,” the effects of chemical bonds.

The condition of considering systems at different levels of complexity clarifies the influence of the observer in determining the parameter of entropy. For example, *L. D. Landau and E. M. Lifshitz* in their course “*Statistical Physics*” write: “....the linking of physical laws to the characteristics of the observer is, of course, totally unacceptable...”³⁵ Of course, an observer, as a system with a notoriously higher level of complexity, can consider the material point model from the conditions of $^{10,-2}K$ complexity. Its effect would be the **creation** (including in theory, in a thought experiment) of a similar system – by creating (finding) conditions when a substance is closest to the states of the material points, cutting off all the effects of complex relationships, setting initial conditions (including timing), that is, assigning one position of the system relative to the others, then giving a system of material points to itself, and receiving an increase in entropy to a certain value. But the same is true for **any complex system**. What is important is that the free parameter associated with the position of the interacting material points – according to the TGS – is formed for any system of relations where the difference of the groups of parameters $\langle F \rangle$ from each other makes sense.

The introduction of \hat{s} is perfectly valid for many natural systems. Hence, entropy enters the description of the evolution of a star. The influence of an observer is least to be expected. But a star itself is an object for which there is a difference between the initial position of gas molecules and the positions after certain processes. In this case: one stage of compression of the gas cloud (which actually forms the star) differs from another in terms of temperature and density, so there is a difference in stellar evolution. As a whole, the star is a more complex system than the 83 . So, to describe its processes, a free parameter distinguishing the position of individual molecules (ions in plasma) is entropy, which in principle does not exist for a system of level 9H (for a cold interstellar gas cloud, for example.)

The processes in a living cell that change during denaturation (increasing entropy in complex molecular formations) of the proteins in it also are real $^{10,-2}K$ relationships, which may include the concept of entropy.³⁶

³⁵ As a result: “The question of the physical grounds of the law of monotonic increase of entropy remains ... open.” Prigozhin also rejected the fundamental role of the observer in interpreting irreversibility.

³⁶ But when real interaction of high complexity is considered, rather than models from material points, the very necessity of introducing entropy becomes dependent on additional conditions. Thus, ubiquitin-dependent degradation of the protein allows the splitting of damaged proteins to amino acids, which are then used again to

Note the fact that the aforementioned $^{10},^{-2}\mathbf{K}$ models of interacting material points were considered, for which **only** the $^8\mathbf{3}$ relationships, i.e. Newton's laws, are determined. Entropy is also defined for such models. If within level $^{10}\mathbf{K}$ (without $^{-2}$) we consider additional relationships, assuming that material points can combine into molecules, that they have, for example, hydrogen (ion, metal, etc.) bonds, valence potentials, that they interact differently in their environment, entropy would no longer be the most important parameter compared to these new characteristics.

A hierarchical system of relationships implies that all objects in their structure have a less complex relationship. Then the selection (*in vivo* or *in vitro*) in any complex objects of **parts** characterized by level $^9\mathbf{H}$ will necessarily have the effect of forming a free parameter of such $\widehat{\mathbf{s}}$, and, consequently, the behavior of such a lower-level subsystem according to the principles of thermodynamics. For example, a **single** biological molecule will sooner or later denature, and the star, an **object** singled out in space, will sooner or later cease to exist.³⁷ If the observer perceives the surrounding world only as a collection of material points, neglecting higher-complexity interactions (or considering them as fluctuations of relations of lesser complexity), then he will receive both global entropy and the rule of augmenting it for any closed system. For the universe as a whole, as a system that borders on nothing a concept of thermal death of the universe will appear.

In such a “limited” description, any object is subject to disorganization. It will hereinafter be called an entropy trap – singling out of part of a high-level relationship by some or other process, experience, mental experience of, which leads to the definition of entropy for it. Interestingly, the introduction of entropy itself is a consequence of existence, by evolutionary hierarchy, of more complex relationships from which it can be introduced, which itself implies development (and denies thermal death). Therefore, the existence of entropy in any systems tacitly implies the existence of an “anti-entropic” state from which it is defined!

Unfortunately, in modern science, in physics in particular, relations are not divided according to hierarchy and the observer is not included in the system of relations that he researches, and hence, it is necessary to introduce postulates and “natural” values. This approach is quite applicable and led to success while researchers were studying the “physical world”, but in the study of increasingly complex chemical and biochemical systems, this separation and

synthesize useful compounds. Disruption in this case is part of a biochemical process that leads (without any observer influence) to increased complexity and, in general, reduced local entropy.

³⁷ *However, certain atoms can be used for other organic molecules, heavy elements after the death of a star form planets in the next generations of stars – in the general picture of the world the concept of entropy is meaningless.*

attempts to explain the complexity by fluctuations, i.e., random deviations from physical laws, leads to an accumulation of paradoxes and errors.

Thus, the well-known example of a broken cup is erroneous. They say: “A whole cup on the table is in a state of high order, while a broken cup lying on the floor is in a state of disorder” or, in other words, “the probability of formation of a whole cup from fragments is lesser than the formation of fragments when the cup breaks.” No, even this simple example should be considered from the perspective of the complexity hierarchy. Thus, the molecules of the cup are “unaware” whether they form a broken cup, a whole cup, or a piece of clay. What is hidden here is the influence of the **observer’s** greater complexity on a simpler system and – a priori – violation of the symmetry of states. The state of the whole cup required by the observer – order – is introduced, and all the positions of the fragments that can be formed are called disorder. However, what if the observer needed pieces of the cup of a certain shape, for example, square? Is a cup broken into even squares a more common thing than a whole cup? And, in general, pieces of any strictly defined (by something or someone) shape are as rare as the probability of the pieces to assemble into what we call a whole cup. To determine the magnitude of disorder, we need someone or something that marks or creates a difference of one position of the system from another, order from disorder, we need a higher level.

Annex to Chapter 5

Here we will discuss the principles of thermodynamics from the perspective of the presented relations hierarchy.

The first principle of thermodynamics is that there is no such thing as an eternal engine of the first kind. True, since there is no selected zero-point t at the 6E level of complexity (and this is the basis of the inertial system) through the condition $\Phi_{10} = 0$, which sets the space $3+1$, just as there is no origin, there is still nothing for which to create the initial conditions. They are not distinguished, either by hierarchy, or for material point ${}^8\mathcal{Z}$ or for its behavior in ${}^9\mathcal{H}$. Indeed, if relationships existed at ${}^8\mathcal{Z}$ level, through which it would be possible to compare and memorize the position of different material points, then a higher complexity ${}^{10}K$ would immediately emerge, which contradicts the principle of non-increase in complexity. But then the formulas of relationships do not depend on the choice of the reference value t (they are symmetric with respect to the time shift), which determines the law of conservation of energy according to Noether’s theorem and, accordingly, the first principle of thermodynamics.

An eternal engine of the second type does not exist, since **the second principle** of thermodynamics can only be modified by abolishing the principle of non-increasing complexity. In fact, in complexity ${}^9\mathcal{H}$ no set $\langle F_0 \rangle$ is selected, in relation to which differences $\langle F_1 \rangle$, $\langle F_2 \rangle$, $\langle F_3 \rangle$ and others would make sense. If that could be done, no matter how long it took, the right provision would have been obtained. As already noted, it is not uncommon to realize a state, but higher complexity would have to be used to isolate this state, however rare, from all possibilities. For example, a thermodynamic system with Maxwell’s demon will require additional influence,

external energy for its work,³⁸ Or, additional complexity will consist in the influence of an observer, a human (who watches, for example, the monkeys typing “War and Peace”), or accounting for chemical interactions that impact the inner energy of a substance.

The principles of thermodynamics reflect only the principles of hierarchy and TGS for the levels of complexity of material points. Entropy is meaningless for level ⁸3 and is rarely necessary for interactions above ¹⁰K. The notion of global thermodynamic equilibrium – thermal death of the universe – is an attempt to use relations of low hierarchical levels of matter for all levels of the universe.

³⁸ Feynman describes in detail the impossibility of using such a mechanical Maxwell demon in physics lectures, volume 2 Thermodynamics.

Chapter 6. The Time Flow

Finally, we can proceed to the definition of an important, in many ways quite peculiar parameter of time, so habitual and so difficult to explain, which has the distinctive feature of flow and universality. This is the parameter of irreversibility.

Like any new level, ^{11}J distinguishes some relations of previous complexity from those of a new one, comparing them through a new parameter. The relations of the previous level characterized changes in one system; in this case, it will be necessary to determine the difference between two or more systems. Until we come to a new level it will not make sense to talk about different systems as there is nothing that distinguishes them from one another. The distinguishing parameter will be the value t , augmented with new relations, which has already been used in determining the positions of the elements of one system. Let me remind you that t has already been determined at complexity level 6E (Chapter 3). It will be more convenient to select from the complexity parameters of the 3+1 space just the scalar value T and, in particular, t , since it is non-oriented and can be represented through expressions for different coordinates (3.4). Considering that the 3+1 space (coordinates, in particular) is somehow included in the hierarchy of relations of the next levels, the parameter t turns out to be convenient for attributing a higher complexity to it.

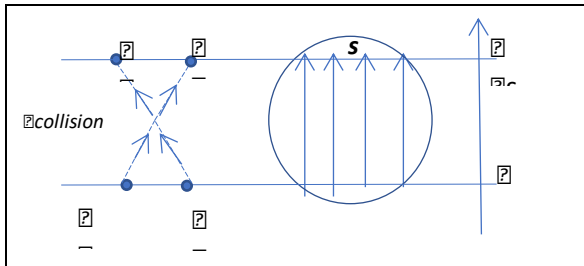


Fig. 6.1. The positions of interacting material points m_1 and m_2 (interactions of level $^8\mathbf{3}$) are marked according to positions of a more complex (level $^{10,-2}\mathbf{K}$) entropy system s that are irreducible to each other. Comparison occurs starting only from level ^{11}J !

Using a simple example, I will analyze the possibility of comparing the entropy system of relations $^{10,-2}\mathbf{K}$ and the “Newtonian” $^8\mathbf{3}$ through the t parameter. Fig. 6.1 on the left shows the collision and expansion of two material points according to Newton’s laws. Moreover, their positions can be collated with the entropy of the entire system, $^{10,-2}\mathbf{K}$, which is in no way connected with these laws. In the figure on the

left the positions of the two points are marked with an additional value \hat{s} . They can converge at the same distance from each other and even have the same velocities, but this will be a new position, still different from the original one – according to different \hat{s} . This difference can be attributed to the t value – one of the characteristics of the 3+1 space, common for the hierarchy of both levels – $^8\mathbf{3}$ and $^{10,-2}\mathbf{K}$. Let us put t in correspondence with the entropy values, and since t also appears in the description of the movement of material points in the 3+1 space, here it will

look like a universal value of some sort. As a matter of fact, this example shows why there is talk about some “mysterious connection” between entropy and time.

What then prevents us from introducing time in every system? If we consider the relations of $^{10,2}K$ models of interacting material points, then it will be easy to compare two systems of this level by selecting certain parameters like masses, velocities, number and relative positions of material points in certain volume including the predetermined values of \widehat{s} for one or both systems. It makes no sense to try to distinguish such systems at a level higher than $^{10,2}K$. We can talk about a new level if we consider more complex “chemical” relations ^{10}K ,³⁹ where the relationships of the parts are not reduced just to Newtonian ones, and where the introduction of entropy does not always make sense.

For example, the Krebs cycle (tricarboxylic acid cycle), which processes glucose into ATP in the cell, consists of nine subsequent stages – changes in chemical systems, the results of which being complex chemical compounds, will be used in parallel in other transformations; the cycle connects several metabolic pathways. Thus, a large number of changing chemical systems will be compared (with different interactions or relations) with each other according to the Krebs cycle. Only then does it make sense to attribute different durations to its individual stages.

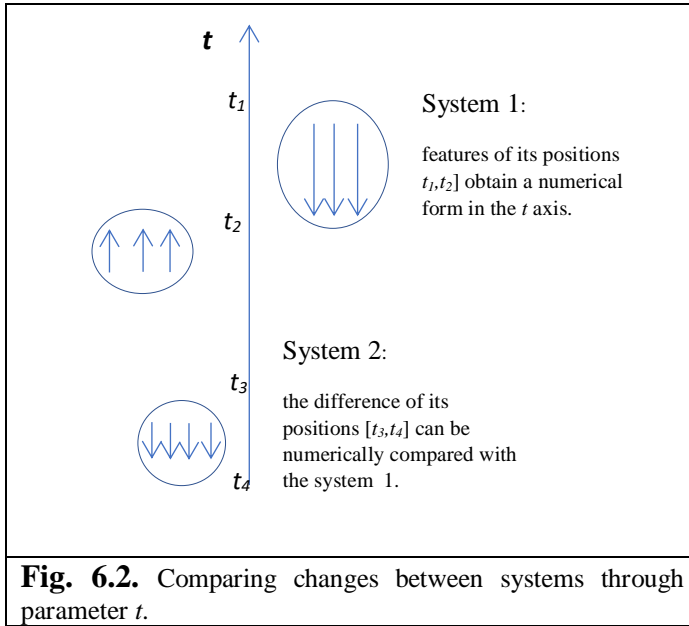
So, in a new capacity, with new features, t will be used to compare complex systems. For convenience, the new free parameter starting from complexity level ^{11}J up to ^{10}K will be denoted t_I .

$$^{11}J \text{ o } ^{10}K \Rightarrow t_I \quad (6.1)$$

If the system was in state $s \ I(0)$, to which **moment** t_0 is assigned (this is what the value of the new parameter will be called in the future; it should no longer be called it a point), its state $s_1(I)$ can be attributed to moment t_I . However, only the period $[t_0, t_I]$, albeit arbitrarily small, can be compared with a **change** in the state of another system $s_2 \ (0-I)$. In other words, for any moment t_I , a segment δt must be determined, albeit arbitrarily small, showing the irreducibility of one position of relations of the ^{11}J level to another. Otherwise, sets of identically interacting material points will be compared, that is, we will return to level $^{10,2}K$.

³⁹ Considering six chemical bonds: hydrogen, ionic, metallic, etc., and relations that are nonlinearly influenced by external factors.

In order for a new level to have different t_I values for different states of ^{10}K , they must have the nature of a **series** of values, because the changing state of one system (a change in the system determines the previous level) is matched with the changing state of another one (Fig.



6.2). Henceforth this will be called **flow**. This is very important since a new quantity is introduced being neither a constant, nor a “field” value, but a characteristic of **mutual** changes, including infinitesimal ones. Let me emphasize that any quantity in this complexity is meaningless without a set of other, nearby quantities (that is why the term “flow” is used). Indeed, even by fixing a set of relations in one system, we cannot “switch off” changes in others. Because of this, when comparing systems with each

other, there will be a constant drift – a change in parameters even for a fixed system at this particular level of complexity (it will not be the case for the previous level). Speaking about a point – a moment in time, it is necessary to consider the time **before and after** a given **moment**, to consider a flow through a given moment, a flow that determines the mutual changes in different systems. The introduction of t as a scalar or even a set of scalars leads to the loss of other complex parameters, for example, Zeno’s paradox will arise while describing motion.

The universal parameter “time” defined in such a way acquires interesting features. For the level 6E of the 3+1 space, the scalar T was presented in the form of $T=vt$. Further, the value t as a characteristic of the field – acceleration, was included in equation (4.2) of Newton’s law. Let me point out once again that the flow of time concept does not apply to a separate system (there is just a change in the system’s parameters), and vice versa, if it is defined, then complexity is implied in which it is possible to define and compare all systems of a given level (the entire material universe with its chemical or, more precisely, physical chemical relations). Thus, t_I time is “universal”.

According to the hierarchy, t is a real number from 5J level, it is also a scalar, different from the vector part in $^{5.4}J$. It should also be added that the independence of the laws of physics from the moment of time postulated in modern science (uniformity of time) is a simple consequence of the use of t starting from level 6E , where it is still impossible to distinguish any specific value of T from others (see Chapter 3). Further, at 7K level, countable and also material

(see Chapter 4) ordered segments are defined for it, making it an **ordered** value, which can be used in a differentiation operation. Finally, as shown above, at level ^{11}J it will be necessary to attribute the characteristic of flow to it. Strictly speaking, this parameter will carry a different load for each level, although having the same value, making it worth using the designations t_E , t_K , t_{II} , t_L . This allows us to say that time has different **layers**, manifesting themselves depending on the description of the relations between different complexity levels.⁴⁰

This opens the possibility to compare through time relations with a lower level of complexity, and not just “chemical” ^{10}K systems including, for example, the period of rotation of the clock hands and of the Earth (the change of day and night). It seems strange: what do systems have to do with it when two independent movements are compared? Their comparison is meaningless without the ^{11}J complexity level, since they do not directly affect each other and there are no common values through which they can be compared. Only from a higher level does it make sense to attribute free **common** parameters to elements of lower levels, which results in time “flowing through everything.” Time is not a self-sufficient entity, which permeates the entire universe, time, like space, is **relational**, it is a parameter of complexity (see Fig. 6.3). It is important that it is not time that determines the difference in the position of systems, but, on the contrary, the existence of their changes **beyond the complexity level** ^{11}J forms the flow of time.

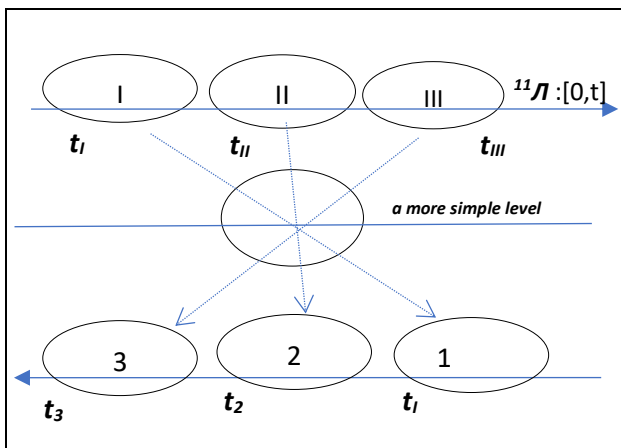


Fig. 6.3. Divided by time $[0, t]$, the process **I, II, III** of level ^{11}J (above) marks the relation of a simpler level, assigning to it (below) the value t_L , setting the flow of time for relations of lower complexity. For example, the Earth-Sun relation is assigned a certain starting point 1, relative to which the position of the Earth in orbit is measured, **comparable** (according to the **introduced** characteristic of time) with its other positions.

Let me analyze the features of time at different complexity levels (the case of applying the time parameter to levels up to space complexity 3+1 is discussed in Chapter 9). Thus, when using t for Newtonian relations 8B and 9H the expression (4.3) turns into a familiar formula with the ability to substitute any values for t_L . Such a second-order differential equation under given initial conditions has one solution. In this case, it will be possible to calculate the state of the systems at any moment. Laplace described it best of all: “We may regard the present state of the universe as the effect of its past and the cause of its future. An intellect

which at any given moment knew all of the forces that animate nature...; for such an intellect nothing could be uncertain and the future just like the past would be present before its eyes.”

⁴⁰ Similar to how a point on a number scale can be assigned a complexity value of 3B , 4F or 5J (see Chapter 2).

What is important is that for such an intellect (Laplace's demon) the future does not differ from the past. Some states are no different from others – everything is a result of shuffling the parameters of previous levels. Then the concept of time flow will be unnecessary: it will be enough to use the time of **layer** t_H due to its **reversibility** and equivalence of all its moments. Let me look into this in more detail.

Speaking about the concepts of the past and future and irreversibility in general, it is worth noting that it is not enough to specify the fact of the time flow, it is necessary to determine its beginning, the zero point, by which systems will be compared, that is, to highlight the relations that set the initial conditions. Once again, I will return to the level from which the value t was first determined. The homogeneity of time has already been mentioned in the Appendix to the previous Chapter 5 – the independence of the system's behavior from the point t_E chosen as the beginning. For level 6E all points will be equivalent; nothing will allow you to select the initial one, so to speak, to break the symmetry of the 3+1 space. The parameters of levels 9H and 83 do not contain a zero point either. You can set zero and compare systems only from level ${}^{11}I$.

For level ${}^{11}I$, while setting up systems at the moment t_1 , there will be no way in principle (they are irreducible to each other) to describe them at moment t_2 by 83 or 9H relations as they will always have differences. Thus, the flow of time – layer t_H , cannot turn back – it always goes from one state (the past) to another (the future), being undetermined **through** relations of **lower** levels. Based on these considerations, the vision of time as a continuous flow permeating the entire universe, directed from the future to the past, is a consequence of complex relations taking place at ${}^{11}I$ level and higher.

Just as an observer sitting in a moving train can imagine that he himself is motionless, and that the entire space surrounding the car is moving backwards, the same error arises with our perception of time: in fact, it is us being a system of high-level complexity who “travel” looking through the window at less complex objects moving backwards (see Fig. 6.3). This is what we can call the flow of time from the future to the past.

It is common for us that the time of any layer is “linked” to the system of space 3+1 and material bodies, since we need a description of the surrounding world precisely in terms of macroscopic relations. There is no doubt that ${}^{11}I$ level mostly corresponds to the complexities of relations between familiar inanimate macroscopic “things around us.” Processes like natural water cycle – evaporation, precipitation, run-off, as well as the associated washing out of riverbeds and sedimentation – all similar processes imply the flow of time, i.e. the derived time of layer t_H . Such processes, even under identical conditions, will always be different (rivers are

not similar to one another, the shedding of stones in different conditions cannot perfectly coincide). At the same time, the ^{II}J level is also manifested in all sorts of inorganic chemical processes, crystal growth, for example.⁴¹ This is what determines the time flow “before” and “after”.

It is worth pointing out once again that layers of time are a natural consequence of divisions of relations of varying complexity. So, at one level this is the result of separation of material points in space 3+1, at another – the appearance of a changing system. It is not the essence of “time” that separates material bodies, introducing their movement relative to each other, but the consequence of growing complexity that leads to the emergence of time as a free parameter.

The layers of informational (biological) and social time will be explored further on in Chapters 11 and 12.

Annex to Chapter 6

When talking about the concept of the current, or, alternatively, the arrow of time, it is worthwhile to dwell on modern perceptions of it, especially since there are several arrows of time.

Firstly, the arrow of entropy. It is a reflection of the asymmetry of time, its direction towards increasing disorder. This problem is described above and partly in the previous chapter. This particular topic, which is painfully important to us, individual (biological) objects, generates increased interest in trying to understand the phenomenon of time.

The model of the entropic system of material points works only within a certain framework: when, among all relations, we consider the relations of level 83 . Therefore, it would be a mistake to speak of the arrow of time leading to heat death of the universe. Nature itself, and with our actions as well, demonstrate the opposite process, and, interestingly, the very notion of growth of entropy, or roughly, disorder, can only be obtained by developing relationships to a high level of complexity. Indeed, in order to learn about the processes of entropy growth, one still needs a system of level ^{II}J (or higher – an observer, for example) with respect to which entropy is defined. One needs a sophisticated system against which to compare changes.

If we lived in the early universe, the disruption processes would be hard to find, the universe would evolve as a whole. Different parts that were **locally** susceptible to increased entropy could be isolated after the first stars burned and protoplanetary disks formed. In the past – in constant increase in the complexity of elementary particles, from quarks to molecules, in the nuclear synthesis of heavy

⁴¹ Evolutionary chemistry, which studies the processes of self-organization of matter, is precisely related to the principle of historicism and the concept of time included in chemical science.

elements – we would rather have derived a rule of reducing entropy, introduced new forces responsible for the constant synthesis of new interactions.

A less obvious but no less important arrow of time is the electromagnetic arrow. It is deduced from the assumptions that light “moves from the past to the future”. Hence, the light that reaches our eyes gives us an idea of the world’s past but not its future. Light waves occur when electrical charges move. As soon as an electric charge is shifted, light will start to spread, and always in the direction of the future... And under this condition, the hidden influence of the observer is clearly visible. A photon has no duration of propagation. In his frame of reference, there is no gap between the appearance of a photon and its absorption. It appears after consideration through a complexity no less than that of E of space $3+1$. It is also assumed here that someone has “moved” the charge or marked the moment of the photon’s movement and emission, which implicitly sets the complexity of the temporal layer t_{II} . For the charge itself “it does not matter” where and when it moves, and there is no time at its level. So, we have introduced the past – future by moving or marking movement of the charge, and then we are surprised to find out the results also lie on the line from the past to the future. But the charge did not move from the future and it was not in the past that we were looking for results – emission of light.

Then there is the empirical arrow of time. We feel the time running from the past to the future. We remember the past, not the future. Indeed, for the observer, the future and the past are different. There is no future yet, it would be, if it could be accurately modeled – see above on the Laplace’s demon. At the same time, the past is quite traceable. However, in this formulation of the Time Arrow, it is important to note the absolute influence of the observer as the person with memory distinguishing and collocating different events (states of systems) in time. “Memory”, or, to be more exact, the accumulated information is taken into account at the next level of complexity, which will be considered in Chapter 11.

Chapter 7. The Fundamental Law

In the previous chapters, especially in the chapter about time, a common thread is the requirement for a hierarchy of complexity levels. Starting from the very first, ¹**A**, level, simply encoding the condition of distinguishing existence from nonexistence, the complexity levels determine the occurrence of both three-dimensional geometric space and time, and material bodies (aggregations of material points). Looking ahead, I will say that the sequential setting of complexity levels determines both biological and social systems. The appearance of a certain type of carbon chains capable of replicating themselves (ribozymes) has created a new complexity for which this particular process and this particular arrangement of atoms in chains distinguishes them from all other chemical reactions and molecules. Let me emphasize: RNA molecules are distinguished by this new complexity. For individual atoms of carbon, oxygen, nitrogen, this compound is neither better nor worse than any other. At the same time, each new level of relations (and of the matter which they define) is based, according to the hierarchy, on relations of a lower level, e.g., ribozymes also consist of atoms of carbon, oxygen, nitrogen...

Furthermore, starting from Chapter 2, we will show the fundamental unity of what we call mathematical and natural objects, which prompts the perception of **our** unique world that is undividable into separate parts: the ideal world of mathematical structures, the world of physics, the world of biosocial relationships, etc.

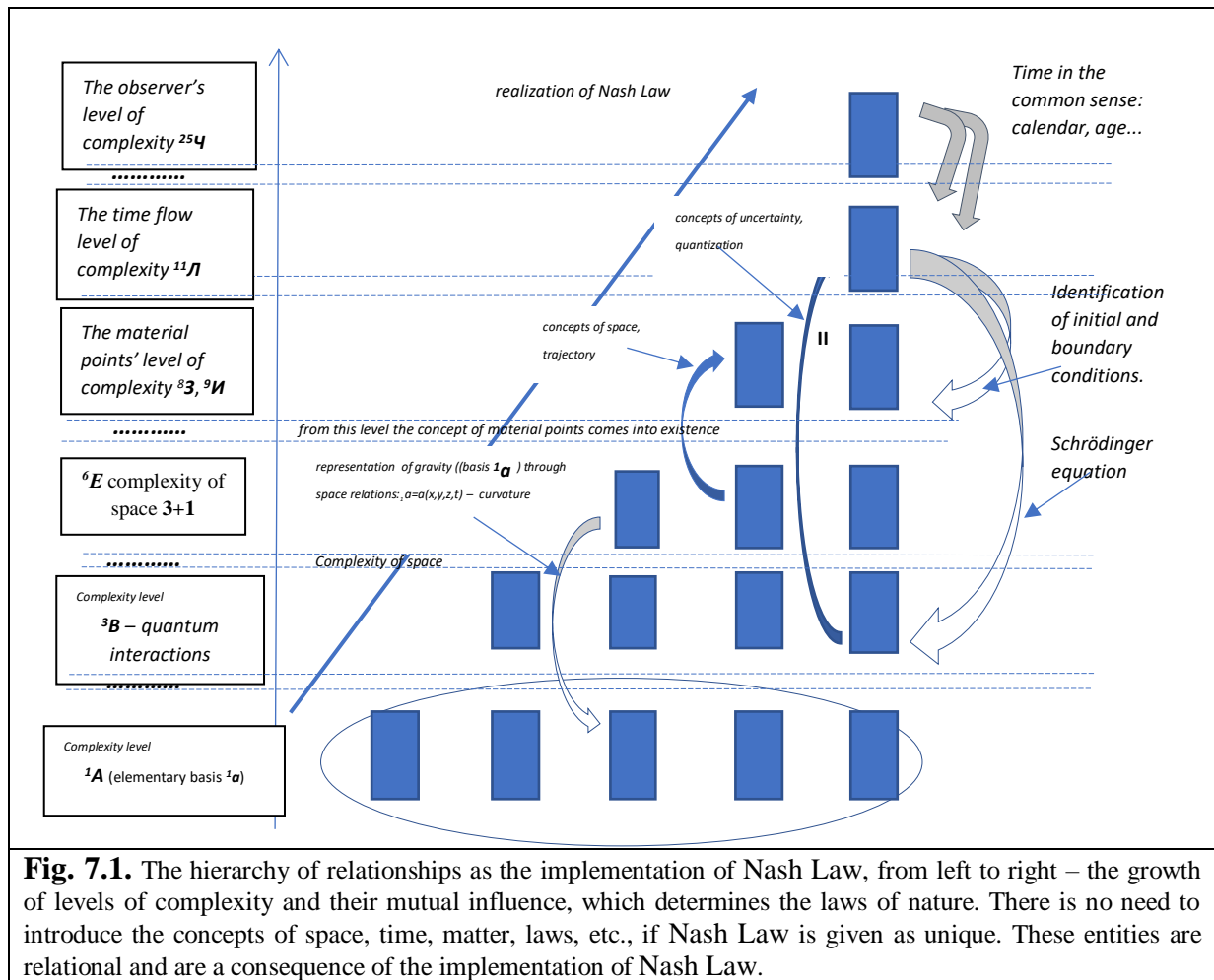
The empirical rule that all relationships are ranked by hierarchy can be made paramount – to designate it as the basic **law of Our World**, or “**Nash (Our) Law**” *)⁴². Then it will be possible to say that we as observers as well as the entire universe are subject to this super-law; moreover, both we and the universe are a reflection of Nash Law. At the same time, one must be extremely careful with its wording.

It seems that Nash Law should be another name for some universal world evolution. This seems to be confirmed by empirical facts about the emergence and expansion of the universe, nucleosynthesis, and so forth until the emergence of self-replicating molecules, living organisms... Not quite so. The concept of evolution is well developed for the conditions of speciation of living beings. But for Nash Law, biological relationships in general and biological evolution in particular are its consequences, and not concepts that exist only in biology (for more detail, see Chapter 11).

Further, the frequently encountered general statements regarding the universe where “everything is developing” will remain generalities unless you apply concepts of the hierarchy of

⁴² “Nash” is our in Russian. Means “Our Law”

complexity – developing from where and into what? Therefore, the definition must include **hierarchy**, when it is implied that all lower-level relations are included in higher-level relations. Also, the term “evolution” implies a certain movement, direction. Relations, however, are not going anywhere, there is no “vital force permeating inert matter” that people loved to talk about in the 18th century. Therefore, the definition of Nash Law should not contain words about some immanent (internal, originally inherent) essence for self-development, be it evolution or vital force.



How can the growth of complexity and the absence of concepts of constant development, evolution⁴³ or something similar be combined? The first step in defining Nash Law is that any essence implies a relation; without relations it is meaningless to talk about the existence of anything. Relations are built in such a way that one thing is the basis for another, the difference is characterized by an additional free parameter. It is by its presence or absence that relations are ranked being more or less complex α according to levels, levels of complexity. It turns out that the

⁴³ It is worth recalling mathematical analysis, from which, thanks to Cauchy's efforts, time was expelled (there are no longer phrases like “a point runs through values...” in modern mathematics, no one runs anywhere anymore), instead they use the following expressions: “there will be points lying in the area...” and so forth.

relations between different levels are not “aware” of the growing complexity since they do not exist outside of it.

In other words, **there are no natural, mathematical or other entities outside the hierarchy of relations.** There is no ideal world of mathematics or physics, there is only our world, the essence of the implementation of Nash Law (see Fig. 7.1.). Even more important is the point that the observer should also be included in the hierarchy of relations.

Now, in order not to leave the picture of the world unchanged, frozen at a certain level, even a very high one, we must talk about the implementation of Nash Law, implying precisely the existence (implementation) of **any** level of complexity. In other words, there is no **designated** special level of relations at which the complexity stops (otherwise there will be no continuity in the hierarchy of relations) – there will always be a free parameter that is not reducible to the relations of the previous level determining the next one. In fact, Nash Law is not a process that has initial conditions and develops in space and time; it is growing complexity which determines space and time. Nash Law cannot be limited by anything, since there cannot be external influence on it.

Then the **consequence** of the condition of its implementation, curiously enough, will be the concept of universal evolution, a certain universal vector aiming at complexity. Indeed, upon reaching a certain level, you can “look back” and see the (hierarchical) chain of complexity leading to it, and for any lower level the chain is increasingly shorter, which **looks like** some sort of **evolution** – there was a short chain of nested relations, which became longer and longer... Thus, organic molecules can be broken down into inorganic compounds, which consist of atoms, then subatomic, elementary particles... and form series of ever longer chains – “elementary particles”, “elementary and subatomic”, “elementary, subatomic, atoms” – and so on up to the selected level. What is most important, it is not evolution being set, but rather Nash Law being implemented along the hierarchy making it possible to separate the relations of simpler and more complex levels, in order to imagine a certain vector from the simple to the complex while looking back into simplicity. In Fig. 7.1, such a symbolic vector going up and to the right is labeled “implementation of Nash Law.” By the way, it is impossible to determine how this vector will go further using the relations at a given level, for example, at the “chemical” level, as soon as molecules are not “aware” of the origin of biological species – the principle of non-determination of complexity. The above idea of evolution will be further used in the book.

It is okay that Nash Law postulates the existence of a hierarchy of relations. But what if other similar super-laws exist, some for some entities, others for others? What about uniqueness?

We have already shown in the first chapter that relations of different levels are characterized by a free parameter (expression 1.1 of Chapter 1). It can be written as

$${}^{n+1}\text{Level}/{}^n\text{Level} = > {}^{n+1}y,$$

This condition was called TGS, but further it will be designated as **TGS 1**.

We also used the **principle of indeterminacy of complexity**, which was first formulated back in Chapter 2 when specifying rational numbers to introduce the uniqueness of the decomposition.⁴⁴ Without this condition, for relations of any ${}^n\text{Level}$, the difference between values of greater complexity of ${}^{n+1}\text{Level}$ is definable, but this means that there is **no hierarchy**, since each level of complexity itself fully determines the higher one.

It is obvious that the principle of complexity indetermination is similar to TGS 1, it is just a different formulation, and for brevity it will be called **TGS 2**.

TGS1 and TGS2 specify the **non-commutativity** of the ${}^{n+1}\text{Level}$ and ${}^n\text{Level}$ relations, providing a hierarchy of complexity (in particular, the irreducibility of relations from one level to another). Thus, for a biological cell, biochemical laws apply, making it an element of three-dimensional space, and consisting of elementary particles. At the same time, those elementary particles in a cell are “unaware” of the process of DNA reduplication, making such a description impossible at their level.

What is really important is that the TGS principle – in any formulation, points to the **uniqueness** of Nash Law – the growth of complexity necessarily forms a hierarchy of levels, from one of which it is impossible to “jump” over the others. It is impossible to find an algorithm that allows the values of one level to be combined on the spot so that larger values would be determined through them. And vice versa – the uniqueness of Nash Law implies TGS 1 and TGS 2. By the way, in defining evolution through a “look back”, it will look like a gradual continuous process. Indeed, there is no way to jump over a level – the hierarchy grows continuously.

The formulation of TGS2 as a principle of indeterminacy of complexity was also used in Chapter 5, on its basis the law of conservation of (mechanical) energy was formulated. Considering that the TGS is used at all levels of complexity, the law of conservation of energy (and all other conservation laws) can be used throughout the hierarchy of levels.

To summarize, Nash Law postulates a hierarchy of relations, its unlimitedness (the possibility of any level’s implementation), uniqueness. It is important to understand that the

⁴⁴ Let me recall that in Chapter 2 the axiom about the uniqueness of the decomposition – from $\mathfrak{e}_2 / 2 = \mathfrak{e}_1$ follows $\mathfrak{e}_2 / \mathfrak{e}_1 = 2$ – was replaced by “an element of a lower level of complexity does not contain an element of a higher level, or, otherwise, with the relations of levels ${}^n\text{L}$ it is impossible to determine the relations of levels ${}^{n+1}\text{L}$ and above.

world around us is not just characterized by this law, it **is** the law. Since any entity without relations is meaningless and it is impossible to talk about its existence, everything that determines the type of relationship (Nash Law) also determines everything that can exist.

One can see the fundamental difference between the use of Nash Law and the current construction of a system of knowledge, where some patterns being postulated are called natural (including “laws of nature based on experience”), and observable quantities being derived through them. In this case, the picture of the world is divided into parts: mathematics, physics, chemistry, biology, sociology; they are all based on different postulates. With the development of natural sciences, it is necessary to postulate fewer, but increasingly complex, interconnected interactions. Thus, when referring to objects of the microworld (of lower complexity in hierarchical terms), the equations that describe them acquire an increasingly sophisticated form. The number of free parameters grows when we turn from the observer’s level to increasingly simpler levels; in particular, we have to introduce more and more additional conservation laws.

In case of implementation of just Nash Law, the division between physics of the micro- and macroworld, mathematics, etc. disappears: all known interactions turn out to be hierarchically connected, and the study of increasingly higher levels of complexity (and the relations between them) leads, regardless of exact, natural, humanitarian sciences’ division, to the study of new interactions, including biological and biosocial ones. This will be discussed in more detail in Chapter 12.

Let me repeat that Nash Law and TGS encode the fact of hierarchy, its uniqueness, unlimitedness, and explain the genetic coherence of different natural constructs. The concepts of the firmament, existence, and the universe become meaningless without the concepts of relations and complexity levels.

Fig.7.1. will demonstrate that our world is kind of a “zoo” of various interactions: from the simplest to social ones (as has repeatedly been mentioned, relations of lower levels do not “dissolve” in higher ones), which form certain structures of the universe (at the end of Chapter 9 we will mention borders, distances, unity of the world). At the same time, for level 4T our world is still a set of elementary particles (even if some form atoms, molecules, etc.), again taking into account TGS 2 – the principle of non-increase in complexity, when the lower level is “unaware” of the higher ones. At level 9H the influence of both elementary particles and the collision of material bodies is determined, but it is “unaware” of entropy (though from the entropy level the characteristics of irreversibility can be attributed to the interactions of particles – see Chapter 5).

Only from our level the world is a space with material bodies, radiation, fields, where there is room for the development of both life and society.

Moreover, the observer is a part of the world and is also characterized by a level of complexity. According to TGS our description of any objective system cannot but contain free parameters. Yes, they are subjective, but since we are part of the universe, subjective relations fit completely into the hierarchy and also belong to absolutely objective relations of a certain level (for us, the highest that **we can understand**). We also create new relations that are irreducible to the previous ones, we form new levels of complexity, that is, we continue to increase complexity. This is discussed in more detail in Chapter 13.

Let me return to the example of the chains of complexity mentioned above – to the vector of universal evolution that appears when “looking back” from a certain selected level. The fact of appearance of any level (and difference from previous ones) sets the difference between “before” and “after” in the general process of evolution. The objective **past** exists as a reflection of relationships of lower complexity underlying a given level. Let this be level ^{II}J , then we can extend the idea to characteristics of the time layer t_{II} – from it to increasingly simpler levels (see Fig. 7.1). They will be ordered not only by the hierarchy of complexity, but also by time t_{II} , one after the other, resulting in the appearance of the concept of the beginning of time, which is the bedrock of the general development of relations. From this level, time becomes a characteristic of the preceding hierarchy. Then we can talk about, say, the Big Bang as a **moment** in time, the moment of the beginning of relations that shape the universe.

And vice versa, if we assume that all the laws of the universe were already predetermined at the moment (!) of the Big Bang, there will be no need to talk about the growth of complexity and time in particular. In this case, one must either consider time to be some kind of suprauniversal entity, or the influence of the observer makes it an entity staying beyond natural laws.

Chapter 8. Laws of Nature

The previous chapters have shown how the relationships of different levels took the form of three-dimensional space, equations of motion, Newton's laws, perceptions of the field, and the possibility of differential parameter description. According to the principle of TGS (1 or 2), discussed in the previous chapter, the comparison of relations of different complexity reveals the emergence of free parameters irreducible to values of less complex level. The interactions of such systems are **the laws of nature**. Therefore, it is not the laws of nature that define our world (our one world of mathematical, physical, biological, and other relations), but, on the contrary, existence of different levels of complexity under Nash Law is characterized by the interconnection of parameters, forming something that we call the laws of nature.

Let us take Newton's first law as an example. I will recall that the concept of the material point arises only at level ⁸3. If individual points are considered from level ⁶E, i.e., the 3+1 space, free parameters unusual for this level will appear – the coordinates of a separate material point – x, y, z, vt . Such a system will be **inertial**, because there are no other interactions, and therefore no changes in v . They appear, as shown in Chapter 4, at level ⁹H. If we add to such a system value t from a higher level, for example, t_K , we will get the movement of material points in the inertial frame, according to the equations that coincide (this is not one and the same thing, as the complexity is different!) with expressions (3.4). The motion is uniform – because in such a model the same time intervals Δt lead to the same changes in the position of the point ($\Delta x, \Delta y, \Delta z$) – simply because there are no differences between $\Delta x_1, \Delta x_2, \dots$ in terms of t , there are no changes in velocity v yet. Movement and the flow of time, the start of the countdown, the material point with specified coordinates for such a model turn out to be some introduced entities. We can write it this way:

$$^{11}J / (^9H / ^6E) \Rightarrow X = x_0 + v_x t ; Y = y_0 + v_y t ; Z = z_0 + v_z t$$

It is only by stipulating all the above conditions, the most apparently simple inertial mechanical system is defined, the **postulation** of which (Newton's first law) opens any course in mechanics.

The situation with ⁹H level models is more interesting. The concept of acceleration exists here and, by setting the time, that is, by considering such model from the ¹¹J level, we can also set the change in acceleration. If the material points in such a system are numerous and there is a possibility to track their movements, we will reach the level of complexity of ^{10,2}K with the parameter \widehat{s} . But if we stay at complexity ⁹H, the acceleration change in such a system is either zero, or equivalent to accelerated motion (including rotating body motion if it is considered to be

the sum of material points) or periodic motion and zero on average (for example, a mathematical pendulum in the field of gravity), or the accelerations of material points should be completely random, thus setting values of acceleration and displacement independent of t (fluctuations incalculable for complexity 9H), so the bodies have to move along fundamentally unpredictable trajectories. The latter two conditions are a conclusion of the study of the problem of three (and, as stated above, also more than three) bodies.

It is necessary to bear in mind that for our problems, for our familiar level of complexity of the world, it is necessary to describe it from the level not less than ^{11}J , where both the flow of time, three-dimensional space, and material bodies are defined, and where relationships can be represented in a differential form. Thus, to apply Newton's second law in our problems, existing as (4.3) for level 9H , it is necessary to set initial and boundary conditions, i.e., to **select** certain time points and coordinates relative to all possible ones, and also to represent t as a current. This is the consideration of relationships between levels 9H and ^{11}J , with the definition of the habitual macrophysical variables. Newton's second law represents only the connection between the parameters, but the introduction of initial and boundary conditions (e.g., t_0, x_0, y_0, z_0, v_0) for the use of the law are **supplementary** to 9H parameters at level ^{11}J , i.e., TGS1.

$$^{11}J \circ / ^{10}K = t_n (^{10}K \circ / ^9H) = t_n (t_0, x_0, y_0, z_0, v_0) \circ / ^9H = t_n (t_0, x_0, y_0, z_0, v_0) \circ / (\sum F_i = m_i \nabla^2 r)$$

In this description any position of the system established according to the 9H -level laws at times $t_1, t_2, t_3, \dots, t_n, \dots$ is also highlighted, i.e., completely defined in the phase space relative to the initial and any other moment before or after. Without the initial conditions, all numerical descriptions are meaningless.

Let me recall that the formulation of Newton's second law is not logically closed, as discussed in Chapter 4: the values of F , m and w are defined through each other in expression (4.3.). Only if initial conditions (highlighted values, which is level ^{11}J) are also included (see Picture. 7.1), F and m remain part of a mathematical construct required to produce the desired result. These trajectories are both defined and measured. There is no problem with the logic of Newton's Second Law from the ^{11}J level. So, as a matter of fact, teachers of mechanics try to proceed ASAP to examples and problems that demonstrate remarkable opportunities of applying this law.

Now let us look at the cases where the relationship system has complexity **lower** than space does. When transitioning from macroscopic levels the free parameters assume strange forms for habitual spatial relations. Indeed, the description of high-level relations defines the

parameters of time: $t_K, t_H...$ or coordinates. However, below 6E there is neither. An observer simply has no analogy for the relations of the microcosm. Indeed, it is impossible to obtain a “simple” result if we introduce our usual complex initial conditions for low complexity relations. Obviously, then free parameters remain for TGS1, depending on our high complexity, which looks like the influence of the observer. For mathematical representation of the microcosm we have to introduce strange quantities (instead of space, time, inherent in complex levels), hoping to link them through some or other mathematical constructs to the familiar ones, so to speak, artificially increasing the complexity of the microcosm, with additional parameters naturally depending on who introduced them.

From this perspective, I will consider some of the apparently strangest peculiarities of the microcosm, first of all, the quantization of values. Let me emphasize once again (see Chapter 2) that, according to the hierarchy any “higher” relationship can be represented through a series of inferior relations, first of all, through basis 1a of level 1A , which is fundamentally the same for all, because its level has nothing to be compared with. Moreover, for any higher level, the relations ${}^2\delta$ differ only by the value 1a , that is, such “primitive” relations will not only always be discrete, but they cannot differ by less than a certain indivisible value (which is natural): their differences will be the same and equal to the base 1a , constituting a natural series at the base. In general, if 1a is the same, meaning indistinguishable, for all relations, then the physical elements characterized only by the relations at level 2B and 3B will be fundamentally **discrete** and the difference between them should be described only by natural numbers.⁴⁵

We are used to operating with real, continuum quantities, forgetting that even to make a **measurement** we need a base value, a scale and the possibility to compare values with boundary (initial) values, i.e., a **complex system** is implied even in the simple fact of measurement. It is the difference in the level of relations, rather than the anthropocentric notion of size, that distinguishes the microcosm from the macrocosm.

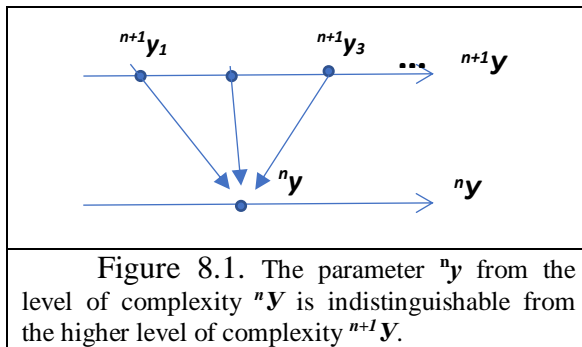
Further, the Pauli exclusion principle prohibiting fermions to have the same quantum state at the same time has no analogs in the macrocosm. The reason for this is also understandable in terms of the hierarchy of relations. Really, in the microcosm, there are no differences of the spatial continuum 6E , the particles “do not understand” that they exist in different points of the continuum of 3+1 space. They differ from each other in different 3B relationships, or in what we call quantum states, rather than in different spatial points, which are 6E relationships. At their

⁴⁵ *The only good thing about continuity is that it is more habitual to us, although, coming to think about it, it is not more understandable than the discreteness of the microcosm.*

level of complexity, having both the same energy and direction of the spin is like having the same position in space-time for different bodies in the macro-world.

Therefore, the tunnel effect is a consequence of the probability of finding a particle in any region of space, it implies a high-level influence, as the proton itself is “unaware” of extended space. Distance complexity makes sense, for example, for a star, in which case an energy barrier has been identified to prevent nuclei from fusing and a tunnel effect to allow particles to penetrate beyond the barrier. As a matter of fact, because of the tunnel effect, the thermonuclear reaction in stars occurs at a low temperature of about 15 million degrees, without which most stars would not exist. This is a good illustration that our world exists as an overlapping web of relationships of varying complexity.

We can now try to reduce the definitions of the laws of nature to a few basic concepts that defined both levels of complexity and free parameters. In Chapter 7 above, the conditions of TGS1 and TGS2 are formulated – different formulations of the singularity of Nash Law. TGS2 can be formulated differently: “relations of a lower level cannot be separated from each other with application of parameters of higher level of complexity” – see Figure 8.1. Indeed, higher-level parameters are free parameters for lower relations. This definition will be referred to as **TGS3**: from level $n+1Y$ (where the parameters l_1, l_2 are defined) the expressions ${}^{n+1}y_1 = {}^ny \circ l_1$, ${}^{n+1}y_2 = {}^ny \circ l_2 \dots$ will not change if ny is inverted in them or, in other words, the ny values are **symmetric** for the ${}^{n+1}Y$ level.



We can define the principle of supersymmetry⁴⁶ as the TGS principle that is common for all interactions (simultaneously 1, 2, and 3): according to the hierarchy, the relations of a lower level form the basis of a higher one, while the parameters distinguishing one level from another are undefined for the relations of a lower level, and the relations of a lower level cannot be distinguishable (symmetrical) for the next higher level.

As mathematical constructs are also ranked by the level of relations to which they are applicable, we can arrive at a well-known statement that symmetry lies exactly in the division of quantities by scalars, vectors, tensors, and spinors. Thus, if a relationship is represented by a mathematical construct of a tensor, it means that interaction of elements described by tensors is

⁴⁶ Not in terms of modern physical theory!

possible; if by a vector – by other vector relationships, by three-dimensional space – by other relationships that are defined for the three-dimensional space. If there is a symmetry, a change in the description of relationships at one level does not influence the description at another. In this case, each new level of complexity inherently **violates the symmetry** of relations of the previous level. Certain relationships, which were not visible before, are singled out in terms of a new parameter.

Symmetry is especially important for the microcosm because many parameters are not represented through the laws involving more complex relations than we are accustomed to. Therefore, the notion of symmetry is considered to represent the most fundamental relationships of the microcosm, and, subsequently, the laws of conservation, and the behavior of systems of the macrocosm.

Let me dwell on the derivation of conservation laws. According to Noether's theorem, they are a consequence of invariants. The law of conservation of energy stems from the homogeneity of time, the laws of conservation of momentum and angular momentum are a consequence of homogeneity and isotropy (the same properties in all areas) of space, respectively.

Newton's first law (law of inertia), derived earlier, is a consequence of homogeneity of space and time. When considering the 3+1 space as one of the complexity levels, such invariants are a direct consequence of TGS 3. The interaction points (x, y, z, T) of the 6E level represented in the formula (3.3) in Chapter 3 are not distinguishable for more complicated relationships. From the perspective of the complexity of material points, their systems, agglomerations, etc., it is impossible to prefer point x, y, z, T in the 3+1 space (formula 3.2) to any other point, neither when rotating, nor when displacing x, y, z , and T (vt). To put it another way: it is impossible to determine the selected areas based on the existence of the 3+1 space (according to TGS 2), much less the existence and motion of material points.

In general, laws, conservation, and symmetries express essentially the same thing: the uniqueness of existence and the hierarchical structure of the complexity levels. Symmetry is more suitable because conservation laws, for example, the law of conservation of energy, require recording through values that coincide with macroscopic ones, while symmetry uses a more abstract mathematical apparatus. Thus, TGS unites all three fundamental classes of principles of physics:⁴⁷ symmetry, conservation and extremality.

Thus, the construction of a complexity hierarchy comprises the fundamentals of modern physics.

⁴⁷ *By no means do all physicists share the view about these fundamental principles.*

Chapter 9. Relations of the Microcosm

Embarking on the study of the microcosm (or, what is the same, the world of relations of lesser complexity than level 6E – space 3+1), researchers had to look for and apply mathematical constructs that allowed them to operate with deliberately fewer interactions than is required to define space-time and material particles. The most well-known of such constructs are: the description of relations through wave functions and the use of probability.

In fact, frequency and amplitude are sufficient to describe a wave, for example, in terms of volume; if a wave comparison is required, the parameter of phase is also necessary – in total there are three parameters. This is in lieu of setting the time, mass, three coordinates, and three velocity projections needed to describe the motion of a material point. Due to the wave representation of microcosm relations the number of relations used can be reduced.

Indeed, probability is a numerical characteristic of an event, a measure on a set of events (with values between 0 and 1). The use of probability also **reduces** the complexity of ordered values, as it is impossible to separate the values of relationships “before” and “after”, probability always means “before”. And this measure is finite, it is countably additive. This means that the countless and infinite continuum of familiar macroscopic relationships is replaced by a mathematical technique that can work with a simpler – counting – system of relations, and this probability has the property of additivity and the possibility to use it in differential equations. The probability for a microcosm is a mathematical chimera whose introduction reduces complexity, but leaves open the possibility of applying known mathematical constructs.

Probability is usually introduced in the description of very complex systems in order to simplify their description. In this case, **on the contrary**, the relations of the microcosm are **too simple** for the usual complexity of 3+1 space needed for our purposes. Probability in the microcosm is a reflection of the complex influence on its relations.

Therefore, the familiar so-called “macroscopic” definition of probability cannot be used for a precise description of natural systems. For example, the phrase “the probability of finding a quantum particle ratio in a given volume” is meaningless, one cannot find something that does not exist, as particles are defined from the ${}^8\mathbf{3}$ level. The impact of a higher level must necessarily be implicit, for example ${}^{11}\mathbf{I}$, from which alone is it possible to register the change that the observer records using the mathematical construct of “probability”. In other words, the phrase “the probability of finding a relationship attributed to a quantum particle in a given volume if you **start looking** for it there” is correct.

In “*Quantum Mechanic*” L.D. Landau and E.M. Lifshitz noted: “*The absence of a certain trajectory in electrons deprives them of any other dynamic characteristics as well. It is clear, therefore, that for a system of quantum objects alone it was not possible to construct any logically closed mechanics at all*”. For these reasons, the following clarifications can be made. Electrons (outside the atom) are described by interactions that are not complex enough for the 6E three-dimensional space most suitable for researchers’ practical results. But if there is no space, does it not lead to the emergence of the concept of a trajectory as a continuous line in space, important for us? From the interactions that characterize quantum objects, it is impossible to construct a mechanic based on the relationships in a system of higher, macroscopic complexity.

Ambiguities in the description of the microcosm arise when researchers, without dividing nature into levels of complexity, transpose emerging features in the description of the lowest levels to the world as a whole. Then strange assertions arise, such as that “Classical world is one great effect of decoherence of wave functions” and so on. Apparently, quantum fluctuations are not something inherent to vacuum, but the influence of properties of relations of lower levels⁴⁸ which are hierarchically inherent to any more complex system.

I will focus on the concept of time (changes over time) for low-level relationships. The scalar value T and vector values x, y, z are distinct at the complexity level ${}^{5,3+1}D$, as discussed at the end of Chapter 2. For relations lower than the complexity of real numbers, the value T **cannot** be distinguished from the **vector** parts, so it is logical to use the system where T is not a scalar, but one of the vectors, with its own coordinate axis defined, and so, **quadrmetry**⁴⁹ arises. And all four components, given the above-mentioned use of probability, cannot have exact values. Such thing as the t_{II} moment does not principally exist for a relationship in the microcosm, there is a probability of an event at some period of time. For example, a neutron cannot disintegrate at a given time. There is a probability of its decay. The reason is the same as for the uncertainty of the position of a particle in space – we consider low complexity through space $3+1$.

Still, if we “manually” introduce the decomposition of values of the microcosm according to the usual three coordinates, the result will give the interdependence of (quantized) coordinate values. Indeed, a level ratio of up to ${}^{5,1+1}D$ level cannot be divided into two or three independent components (see Chapter 2), although at a habitual complexity level object has three projections.

⁴⁸ Including ${}^{2,3}B$, ${}^{2,2}B$ - see footnote 5 to Chapter 2

⁴⁹ Let me share a few thoughts on the reason for the (+---) space-time signature. For the level of space with Euclidean metric, the relations ${}^{5,3+1}D$ are expressed by squares in the matrix of distances Φ_{10} (Chapter 3). The square of the value ${}^{5,3+1}D$ is also a relation of level ${}^{5,3+1}D$, with the real part equal to $(T^2 - X^2 - Y^2 - Z^2)$, the square of the quaternion (see the Annex to Chapter 2 for the possibility of using the theory of quaternions). When considering from the level of space relations with complexity lesser than 5D , it is this scalar that remains – the values of the imaginary units are not to be used alone. In particular, for photons in three-dimensional space there is only such (+---) relationship of T, X, Y, Z values of the spatial level.

Values introduced from high levels of complexity, whether the angular momentum or the magnetic moment, will look like a **projection** onto one or another direction considered (from higher complexity). That is, a magnitude without **other** coordinates, without any other projection, as they cannot be determined at the same time.

One might object: a photon, for example, is characterized by energy, $h\nu$, which may have virtually any value, its values are not quantized. But it is this very example that demonstrates the effect of a complex system on a simple, so to speak, elementary interaction. Photon is an elementary transmission of action. It does not “know” any other interaction, it does not even have a time of existence, there is only a fact of existence. The photon frequency ν according to TGS1 is a characteristic of a more complex system that created this elementary interaction, it is **not its** characteristic, but a characteristic of the **process** that generated the photon. In the formula $Sist \circ / h \Rightarrow \nu$, *Sist* is a description of the system that radiated the photon, and h is the value that completely characterizes the “photon” elementary relation. It is a unit basis – see Chapter 2. It cannot be fractional or take another value. For a system of any more complex interactions, it is a constant.

Systems of greater complexity – atoms, for example, the hydrogen atom – are not just a proton plus an electron, but a new system characterized by a greater number of inter connections between each other than its parts. Just like the neutrino does not “sit” inside the neutron, although it is registered at the time of its decay, the hydrogen atom is a single system characterized by a system of energy levels that we can conveniently consider as a proton and an electron, the particles into which the atom decays under a certain external influence. So even the identification of an electron in an atom is already an observer’s assumption, the influence of a higher level “carving” the particle electron from system of the interactions of a single atom. The same applies to the photon beyond and (virtually) inside the atom.

An even higher level of complexity is the molecule. A chemical molecule is definable from a level of at least ^{10}K . It has three-dimensional coordinates and, specifically, the concept of color. When a photon or electron interacts with a complex system, for example by merging them with a molecule, the system changes, for it there is a **local** change of energy, a change of trajectory because of the interaction, etc. Only when interacting with such a system we can say that a particle (lower than 6E level) is registered in 3+1 space, or “we have found an elementary particle” in this place. The state “before” and “after” has become distinguishable, i.e. the concept of probability is no longer necessary, but then the representation of a simpler relationship in the form of wave function is not necessary either, as the concept of trajectory can already be used. This explains the decoherence process or the discontinuous transition from the probabilistic to

the classical system. Note that an observer is not necessary for this, but any relationship of a more complex level is needed (the eye of an observer, of course, is also appropriate).

However, for this higher-level relationship, constraints are imposed according to the TGS1 principle. Space is a free parameter for elementary particles, and there is no selected point in space where a photon or electron would **surely** be found.⁵⁰ This can be illustrated by Figure 1.2 in Chapter 1. In terms of probability, this means that some place is more likely for the interaction to occur, another less. So, if the probability is minimal, then a “reflection of the probability wave” or the “wave packet”) occurs.

Now we can try to explain the result of the famous experiment of electron diffraction on double slit, about which Feynman said that to understand this experiment was to understand the entire quantum theory.⁵¹ In fact, this experiment demonstrates the following fact: if paths are indistinguishable (a wave can pass through two slits at a time), quantum-mechanical amplitudes add up, and probability (as an amplitude square) contains a cross product – the interference member. If the paths are distinguishable (it is possible to find out where the event happened), then not the amplitudes, but the probabilities themselves add up, and interference does not occur (Feynman believed it was a fundamental law). I would like to draw your attention to the key word, which is **distinguishability**. It is obvious that like “decoherence” discussed above, this is a description of interactions of different levels. Distinguishability, or a violation of the symmetry of the lowest level of complexity, occurs when in an experiment with two slits the flight of different electrons is somehow fixed at a certain point or, in other words, a complex of relations is formed: an electron plus a macroscopic detector plus a screen. But such a complex is characterized by high, quite macroscopic, complexity, not lower than 6E . At the same time, in the experiment it is attributed to one electron, which in this case “acquires” complex spatial relations, certain coordinates (a certain slit), and there can be no interference term. The same happens for a second, third electron... the free parameter “3+1 space” in this case turns out turns out not to be free for electrons, but acquires specific values – coordinates (for some or other slot) for different electrons in the complex “electron – detector – screen”. Considering that the 3+1 space is the same (for observers and macroscopic detectors), the individual probabilities of “calculated” and hence separated electrons add up in it. Electrons are still described by

⁵⁰ To remind you, as already stated at the beginning of Chapter 4, the electromagnetic field can be considered as an auxiliary mathematical apparatus for calculating the maximum probability of “arrival” of the photon in a given place of space 3+1.

⁵¹ In short, the idea is that electrons fly, one after another, through an obstacle with two narrow parallel slits. On the screen behind them, in this case, many fringes form, an interference pattern of electrons – waves. However, if a detector is placed in front of the slits, which fixes through which particular slit the electron has passed, the interference pattern disappears, and two strips from hits of quite corpuscular electrons are formed.

probabilities, they still do not occupy a particular place in space (they do not even “know” what space is), but nevertheless their inclusion in a more complex system with a detector distinguishes them in space.⁵²

There is also an inverse relationship: the properties of the lower levels determine the appearance of the higher ones. Thus, the properties of “simplicity” of photons allow to form a light scale. Indeed, the interval defined for four dimensions should be zero for the photon complexity level in order to be independent of the positions and values of other more complex relationships (TGS3). Considering that $T = vt$ (see expression 3.4 from Chapter 3),

$$\Delta x \sim \Delta t \rightarrow v = \text{const}^{53}$$

i.e., measuring the distance Δx (from macroscopic source to macroscopic detector) covered by a photon, we **thereby** set the time for it to cover this distance Δt , since these parameters are indistinguishable at its level of complexity. If we have assigned the “flight” of a large distance to a photon (from radiation by a macro-object to a macro-detector), it means that we have also assigned to it a proportionally larger time of “flight”. The speed of light, the speed of photon propagation in terms of the complexity of 3+1 space is constant and more complex conditions cannot change it (according to TCS 3).

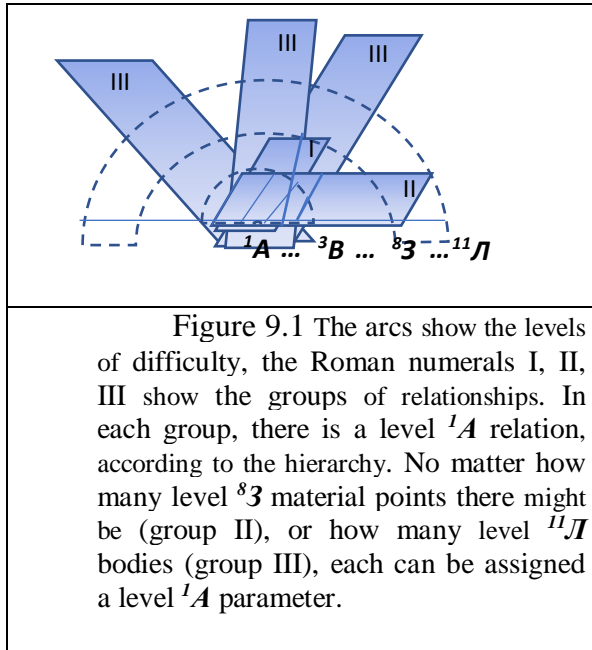
Also taking into account that simple, 3B level, relationships of quantum particles, in principle cannot be fractional, together this allows obtaining a **counting** (with discrete rather than real relationships) “solid” scale with a zero. In that case boundary and countability manifest at higher levels, by hierarchy, in higher levels, offering the possibility to count the selected macro-objects by the 3B arithmetic of natural numbers, although the objects themselves: areas, volumes, distances between them are described by real numbers (the continuum). Thus, our world takes its usual shape through directions, “distances from and to”, the certainty of boundaries of bodies, **comparable** speeds, and so on. These characteristics do not change and are unified for any other set of relations of the required level of complexity. Otherwise our world would resemble the ramblings of a madman. There would be no such thing as “near – far”, there would be no limits to the objects, directions or velocities.

Annex to Chapter 9

⁵² It can also be assumed that the complexity of the system is greater than that of electrons. It seems that the complexity of the system, which takes into account the influence of Maxwell’s demon and the vessels with the ideal gas, is greater than that of the vessels with the ideal gas alone (see Chapter 5).

⁵³ Mind that the values x , t are free parameters for the photon as they are undistinguishable at its level. Independence of the photon’s “velocity” from external conditions is the reflection in space 3+1 of its simplicity 2B .

I will also try to look at what's called gravity from the perspective of relationships. The thing about gravity is that, as experience has shown, gravity has the same effect on all objects, it is impossible to isolate any subsets of all the gravitational interactions in the world (three subsets are defined for electromagnetism: positive, negative, neutral). This fact can be used to find a relationship that exists for all levels of complexity to describe gravity. At the very beginning of Chapter 2, an elementary relationship was defined which, according to the hierarchy, will be common to all – see Figure 9.1 (see also Fig. 7.1. Chapter 7: the bottom level 1A , has only one element, which is included and **uniform** for any other level of complexity.)



Then, if any relationship is based on 1a , then in the expression (3.2) in Chapter 3 the determinant of the distance matrix is not zero: $\Phi_{10} \neq 0$, as the elements of the matrix have an additional component, and the rank of the matrix will be higher than considered. In this case, the difference will be very small: the value 1a is less than any given ratio, because the fractional parts of it are meaningless. The fact that the determinant of the distance matrix is not equal to zero (expression 3.2 of Chapter 3) can be interpreted as a curvature of space.⁵⁴

On the other hand, according to TGS1, the effect of the complexity of space 3+1 on the simple level of interactions 1a is described by the parameters of the space itself: $6^6E / {}^1A = {}^1a_{1-3} =$

$a(t, x, y, z)$. 1a cannot bring something else into the form of a free parameter, that is, the influence of the three-dimensional space-time level on 1a relationships will look like an absolute influence **of the 3+1 space alone**. Given that parameter 1a in the hierarchy exists for each relation of higher complexity, in particular, for each material point (it cannot be divided or added together, it is too simple to do so), the influence of $a(t, x, y, z)$ on any body (particle) will be proportional to the number of relationships (material points, or “particles” of the microcosm) in the specified volume. Then what has above been interpreted as the curvature of space – the difference from the zero of the determinant of the space matrix Φ_{10} in the expression (3.2) – will depend on the number of relations $\sum a(t, x, y, z)$ in each specified volume...⁵⁵ In summary, for all levels from 2B onwards, the relationships will be affected by the interaction 1a , which will look like an impact on the 3+1 space of a parameter proportional to the number of more complex relations or particles in the specified body or volume. It is easy to see that this parameter for complexity of material points is the mass – “the quantity of a substance.”⁵⁶

Then the expansion of the universe is a reflection of the fact of **difference** 1a for the next levels of complexity 2B , 3B , and so on, as discussed at the beginning of Chapter 2.

⁵⁴Detailed, for example, in the book by J. L. Sing “General Theory of Relativity”, chapter XI

⁵⁵ If we consider the “flight” of the photon in space 3+1, its “direction”, or the probability of getting to a certain place reduction) will also be affected by the curvature of space.

⁵⁶ It also means that quantum gravitation cannot exist in principle: something that is indistinguishable even through quanta cannot be described by quanta.

Moreover, if by gravitating masses we represent elements of level ${}^1A - {}^1a$, then the relation that distinguishes them, level 2E , will be constantly separating them from each other (beginning of Chapter 2). For the material points in space complexity level 3Z this means that material points will diverge from each other the stronger, the more material points there are in some particular volume of space. What occurs is something that is considered the effect of dark energy.

Let me note that the contradictions and mutual irreducibility of physical descriptions of the general theory of relativity and the quantum theory, the results of both are confirmed in practice, in this case have the nature of “contradictions” of different levels of complexity. Like, for example, the relationships between prime numbers and real numbers are not reducible to each other. Also, such an obscure notion, which some philosophers call the commonality of the world, acquires quite a real basis. That relation, the very first one at all levels is 1a (see Fig. 9.1). It is one for all and, by hierarchy, common to all more complex relationships, no matter how many of them are identified.

Chapter 10. Causality, Objectivity, Determinism

Speaking of **objectivity**, let us once again quote Albert Einstein: “*Physical concepts refer to the real outside world... to things that claim “real existence” independent of the observer... These objects claim to exist independently of each other as they are “in different parts of space”. Without such a supposition of the mutually independent existence... of spatially remote objects, assumptions that take root in ordinary thinking, physical thinking in the sense we know would be impossible.*” These words explain why Einstein could not accept probabilistic quantum mechanics, where, objectivity seems to have been replaced with “a game of dice”. But reading the statement more carefully, you can see that it mentions “ordinary thinking”, and at the same time independence from the observer and objectivity – “real existence”. In other words, different complexities are mixed.

Einstein goes on to mention space. The concepts of space and distinguishability (in the above quote, *mutually independent existence*) were discussed in Chapters 3 and 4. However, we should dwell in greater detail on the concept of objectivity of the scientific approach. In Chapter 4, a field is given as a characteristic of a certain level of complexity of relationships ${}^7\mathcal{K}$, thus making this concept both relational and quite objective. The field is very convenient as a means of calculating the relations at this and more complex levels; replacing it with simpler relations, exchange of bosons, has a meaning for levels of lower complexity.

The objectivity of the existence of time is also relational, as it is convenient to consider relationships from a certain level (in Einstein’s quote, *ordinary thinking*) from the position of the input parameter $t_{\mathcal{I}}$ **attributed** to all objects – see Fig. 6.3 in Chapter 6. The description of natural phenomena is so successful, primarily in physics, because the observer has the possibility of hierarchically isolating simple subsystems from “complex influence”. This is possible because the “physical” interactions that are important to us and that are investigated in the first place are quite simple and in principle cannot respond to other interactions in any way other than that specified by a more complex system – according to TGS 3. Once again, I will elaborate on this. According to the symmetry principle – SST 3, as lower relations of a lower level are indistinguishable from higher levels, they are **the same** for different configurations of higher-level parameters (this was discussed earlier in Chapter 8). This is what we mean by **objectivity** – **replication of results when viewed from higher levels**. E.g., the “spatial” relations of 6E are valid for levels ${}^7\mathcal{K}$, ${}^8\mathcal{K}$, and beyond. We can highlight different points, distinguish different lengths of 3+1 space from one another, but expressions like (3.4) in Chapter 3 will one way or another enter increasingly complex relations, and, in particular, they will all be subject to the Euclidean metric. We are, so to speak, immersed in space. The same can be said about the

fulfillment of Newton's second law. Starting from level 9II , its form is the same for relations of higher levels.

For example, as was discussed in the Annex to Chapter 4, to test whether Newton's second law is true, there is no need to take into account some 10^{80} forces acting on a particle from all other particles in the universe. This means that it is possible to model a system whose behavior can be formalized in principle in the description of a finite number of operations in the language of mathematics. Thus, the interaction of two bodies defined by relations of level 83 will be determined by Newton's second law, regardless of whether it is a human body or a stone. The apple falling from a tree will follow the same description as the apple that fell from Newton's apple tree.

This is the objectivity of both physical laws, space-time and material bodies, since, as you remember, material points are defined in 83 .

At that moment the possibility emerges to describe “**objective reality**” of the universe (to a certain level!) by a certain finite number of laws with a limited number of relationships, to which the relations of most objects of the “physical” material world react, and on which they depend. But this only applies to the world of simple interactions over which our influence can be unified. Our human differences, hopes and aspirations at this level of the world do not work – they are too complex for it. We influence such a “physical” world only as beings of a certain mass and with a certain energy, our descriptions allow to unify the development of simple systems with the same layer of time t_{II} and space $3+1$, that can be both synchronized and brought to a single reference point.

The hierarchy of relationships then suggests that mathematics is not some independent higher world that gives us an objective description of nature. Mathematics is part of the description of the universe and cannot stand above it. Its relationships are part of the hierarchy that defines our world, but only the relationships that lie (mostly) at its roots. They are therefore **the basis** of all the more complex systems (see Fig. 7.1) and are applicable to many relationships. Such fundamentality lays at the heart of the hierarchy, it also sets out what we call the objectivity of mathematical description, so the mood of a mathematician does not affect the truth of the Pythagorean theorem.

It becomes understandable that mathematics seems surprisingly maladapted for describing complex chemical and biochemical constructs, not to mention biological and social

ones.⁵⁷ Their description from the perspective of $^{11}\mathcal{I}$ or even $^{10}\mathcal{K}$ level should use such a large number of free parameters that trying to account for all of them (as it is possible with the input of the parameter of entropy for the $^{10.2}\mathcal{K}$ level) leads either to extremely complicated mathematical constructs, or to the mathematical description of simplified model interactions of complex systems.

Also, objective laws, independent of higher levels than $^{11}\mathcal{I}$, will describe the relations of the microcosm, a level lower than the spatial level $^6\mathcal{E}$. However, the question of the objectivity of microcosm relations gives rise to many uncertainties. As the authors of one of the most serious books on this subject⁵⁸ argue, it logically stems from the approaches of quantum field theory that “*there are no particles in the world*” or “*there is no time at the fundamental level*”. For the hierarchical structure of complexity to be reviewed, an important addition has to be made: it would be more accurate to say “at a simpler level” rather than “*at the fundamental level*”.

The microcosm is often called the fundamental level. Any level of complexity is **no less fundamental** (or, to put it differently, no less objective) than those that define the microcosm. Importantly, any laws that describe the relations of the world can be considered objective. We just have to take into account that they are relational, defined only for different levels of complexity. Only Nash Law is Absolutely primary and fundamental.

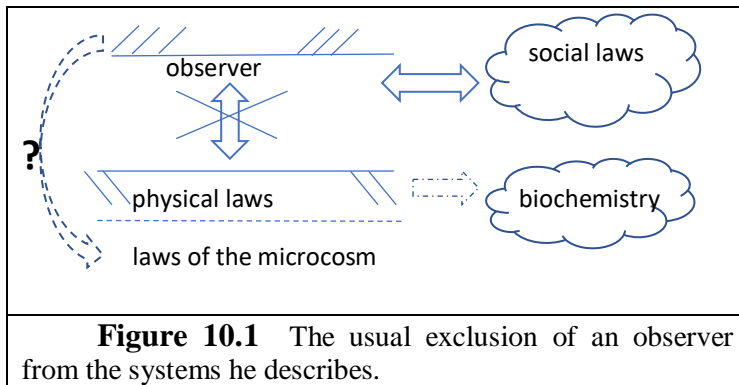
The highest achievements of researchers, representatives of the exact and natural sciences, were the discovery that all bodies have common interactions of lower levels; the fact that they succeeded in finding and making use of these relationships, common to structures, bodies, simple models, to solve the problems they face, cutting off more complex relationships in their models. Otherwise, neither science nor our civilization could move forward in its development if the features of the surrounding world were infinitely complex and distinct in all manifestations.

Nor is there any absolute in mathematics or physics: there is a **commonality** (universality) of natural and therefore mathematical constructs. Universality stemming from evolutionary hierarchical unity. We are also part of it, and, naturally, we reflect the hierarchy in our observations.

⁵⁷ The mathematician Israel Gelfand said: “There is only one thing that is even more incomprehensible than the incomprehensible effectiveness of mathematics in physics. And this thing is the incomprehensible inefficiency of mathematics in biology.”

⁵⁸ *Decoherence and the Appearance of a Classical World in Quantum Theory* Authors: Joos, E., Zeh, H.D., Kiefer, C., Giulini, D.J.W., Kupsch, J., Stamatescu, I.-O.

At this point it is necessary to dwell on the important issue of the relation of the observer, the subject to external objects. The existing views are simplified in Fig. 10.1.



On the contrary, in the representation of complexity levels of Nash Law, the observer is assumed to be the most complex system, for which the relations of lesser complexity are defined a priori, the relations of the “microcosm”, as well as three-

dimensional space-time and laws of nature... Then the observer himself is part of the world being described, so his position in the hierarchy is also defined, which will be discussed further. He is only one of the levels of complexity, and that constitutes the possibility of introducing the observer into the picture of the world. The opposite is also true – the values that he introduces when describing different levels determine the level of complexity of the observer himself, his place in the universe.

Let us look at some definitions of **causality** that are often used in mechanics. “*Newton’s second law formula expresses the causality principle of classical mechanics. The coordinates and velocities of the material point are continuously and unambiguously determined through their values at the time and the specified force acting on the material value.*”⁵⁹

Einstein said in more detail: “*The differential law is the form which alone entirely satisfies the modern physicist’s requirement of causality. The clear conception of differential law is one of Newton’s greatest spiritual achievements... Only the move to consider the phenomenon in infinitesimal time (i.e. e. to a differential law) allowed Newton to give a formulation suitable for describing any movement... So Newton came... to establish the famous motion law:*

The acceleration vector × The Mass = The Force vector.

This is the foundation of all mechanics and perhaps all theoretical physics.”⁶⁰

The notion of a hierarchy of relationships clarifies the concept of causation. As I have mentioned above, in Chapter 4... Newton’s second law in the form (4.2) is a consequence of the ⁹**H** level of complexity. In this case, Einstein’s words can be clarified as follows: given the hierarchy of the construction of the levels of relationship, a differential description and,

⁵⁹ Encyclopaedic Dictionary of Physics, 1987.

⁶⁰ Einstein A. Collection of Scientific Writings.

importantly, orderliness (from level ${}^7\mathcal{K}$, see Chapter 4) have been defined for ${}^{11}\mathcal{J}$. This allowed to divide the single value, as its parts still “know” about their position one after another. As defined in ${}^9\mathcal{H}$, Newton’s laws also give an expression for coordinates in 3+1 space: the interaction (the state of the system) at the time point t_0 is the basis (for the time layer $t_{\mathcal{J}}$) of the system state at the t_1 time point and, sequentially t_2 , t_3 and so on, and the relations ${}^{11}\mathcal{J}$ can be represented as the sum of consecutive, arbitrarily small, parts that are comparable in terms of t values. Then the description of a single process can be presented as consecutive parts, comparable to each other and, through $t_{\mathcal{J}}$, with other processes that are considered separately, calling the earlier ones the **cause** of the following ones. In this case only is what we call **causality** defined.

But what about the fact that observations suggest that causality permeates all relationships in the microworld? For example, if we consider the movement of the Moon and the Earth, then the force of gravity (or the curvature of space-time) can be considered as the cause, and the fact that the Moon revolves around the Earth is a consequence. Objects appear to have an inherent notion of causality. And causality then determines time, since the difference between cause and effect, one ahead of the other, seems to set the irreversible course of time... Let me dwell on this in greater detail. A man rolled a rock and covered the cave with it. The cause is a rock at the cave entrance, the effect is that a saber-toothed tiger could not get in. In this case there seems to be a clear distinction between cause and consequence. But, coming to think about it, the following happened: **selection** of one rock from among others (suitable to cover the entrance to the cave). Rolling it to a **certain** place distinguished from the others (the entrance to the cave). Therefore, both the size of the rock and its rolling acquire the characteristic of a new level of complexity – ${}^8\mathcal{J}$ and even ${}^{12}\mathcal{M}$ (see Chapters 3 and 11).

If the rock has rolled down by itself, then the reason seems to be its position on the mountain and, consequently, its falling down. But how many trillions of rocks have rolled down from the mountains or risen up in the process of mountain formation in the history of the Earth? These are just fluctuations in the process of existence of geologic shells. Whereas any **consideration** of certain rocks ascribes level ${}^{25}\mathcal{Q}$ to the stone-Earth system (see Chapter 12) – the beginning, the course of a process distinguished among others, perhaps its model of. In any case an observer **influences** the system he sees not only in the microworld, but **always**, as his description of the surrounding world is the essence of complexity level ${}^{25}\mathcal{Q}$ of Nash Law (Chapter 11) and therefore uses the relationships of this level, ascribes initial and boundary conditions to it. Anyway, it has been discussed in detail above.

Even a mental experience (an apple is gravitated to the Earth – this is the cause, it falls on Newton’s head – this is the effect) implies that a brain processes coded information about weight, the Earth, height of the tree, and so on. Moreover, in mental or real experiences (shaking of the tree – falling of the apple) there is a moment of beginning and duration. But neither the apple nor the rock are “aware” of the boundary conditions and not “acquainted” to Newton.

It should be emphasized once again that not only the human (an observer) transforms fluctuations of a lower level into relations of his own, higher level, dividing them into cause (earlier) and effect (later). For example, gravity gathers a gas and dust cloud into a star. This is the cause, because further there appears the notion of size and distances (which has no sense in a rarefied cloud). Hydrogen nuclei in the center of a young star closest to each other fuse causing energy release, and only heat up in the shells of the star. There is an objective difference in distances: in one place – for fusion, in another – for heating, and this complication is the effect.

Now let us go back to the interactions of levels below 6E , for which not only is there no time flow, but even three-dimensional space is not defined. The habitual notion of causality does not exist in this case, it is impossible to consistently decompose a very simple interaction into moments in time. It seems that this is not the case, for instance, when a neutron decays, there appears to be a reason: a nuclear reaction. The start and outcome of this process can be recorded in the form of a detectable proton, electron, and, if we are lucky, a neutrino. Isn’t this an obvious cause-and-effect relationship? Yes, but we have to take into account that the beginning occurred in a chemical substance where the neutron is located, and the decay was detected in a detector, which is also a macroscopic instrument. The complex system of the substance before and after radiation are compared with the detector before and after particles are recorded. These concepts, place and time, cause and effect, are higher-level characteristics upon which neutron decay conditions are projected. Both time and the causal order are the essence of the consequence of existence of different levels of complexity, meaning that they are relational by nature.

The concept of **determinism** becomes clearer. *“The world is governed by determinism (or is under the power of determinism), if and only if, under the precise state of affairs at time t, the state of affairs is further established by the laws of nature. The concept of determinism is closely related to causality. The form in which causality is realized in mechanics is called mechanistic or Laplace determinism.”*⁶¹

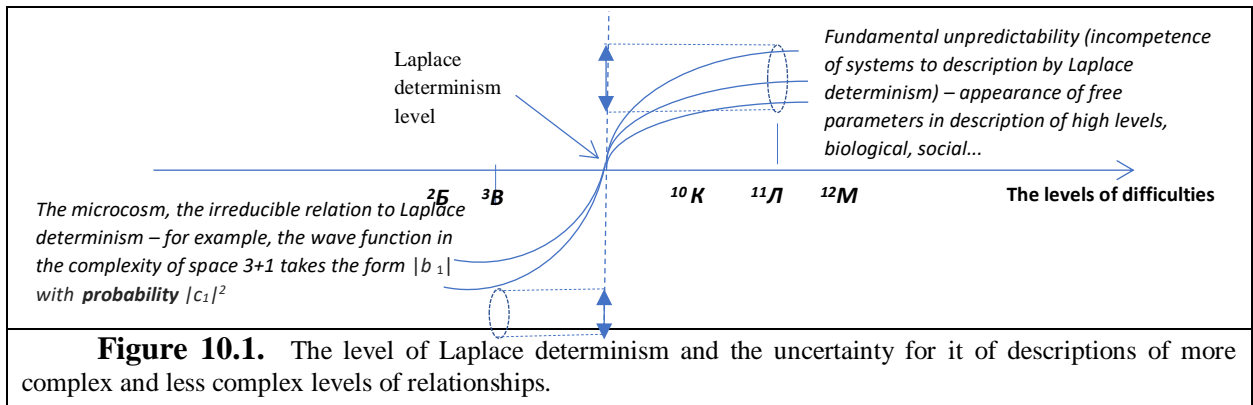
Laplace himself said: *“...we must consider the present state of the universe as a consequence of its previous state and as the cause of its subsequent state.”*

⁶¹ Encyclopaedic Dictionary of Physics, 1987.

Newton's second law is represented in the equation by simple derivatives of the second type, hence it has a unique solution under initial conditions. Thus, in our universe everything is predetermined (if described by laws of level 9H).

However, determinism is a consequence of certain levels: 9H , ${}^{10}K$, just like causality... Hence, determinism is also relational, depending on the problem from which we consider these levels – see Fig. 10.2.

We are used to the fact that the laws of nature are deterministic. As a consequence, there is no true new in the world. Another quote Laplace: “*comprehensive knowledge of the past causes comprehensive knowledge of the future*”. In this case, all that happens is regrouping in particle space, according to eternal laws. The future clearly reflects the past, there is no fundamental difference between the values of t , that is, there is no past or future.



If we abstract ourselves from the concepts of space-time, determinism is an unambiguous mathematical definition of a more complex system of relations through relations of a less complex one and the emerging free parameters. But then Schrödinger's quantum mechanical equation is a remarkable example of the deterministic description of interactions itself. And if its parameters and results are fundamentally not reducible to the spatio-temporal continuum we are accustomed to (being less complicated), these are the observer's problems soluble with the help of complex mathematical constructs and additional ideas about their parameters, as mentioned in the previous chapter.

The descriptions of different systems are represented by Figure 7.1, Chapter 7. The elements on the right are subject to interactions of different complexity, whereas on the left, even descriptions of a three-dimensional space level are meaningless. For each level of complexity, a completely deterministic description is possible in its parameters. At that, if the observer operates only with interactions of this level, he cannot obtain data in the habitual relationships of

higher levels – TGS2.⁶² When describing from a higher level, free parameters and fundamentally unpredictable (non-deterministic) descriptions emerge according to TGS, namely chaos.

Laplace's demon, tracking and calculating the interactions of macroscopic bodies as the sum of material points, will be surprised to see that the real position of particles will be described by **one more** parameter, entropy \widehat{s} . A demon with a complexity of no less than $^{10,2}K$ will see how the overall picture of the position of the particles changes, as if they are being pulled out by some additional "force". In doing so, focusing on the interactions of individual particles – level 9H – it will see strict implementation of Newton's laws.

If the demon is even more attentive (its level of complexity will exceed ^{10}K), a difference between individual parts of material bodies will exist for it, their asymmetry in different interactions will obtain differences in the results of different interactions under different initial conditions (temperature, mass, etc.). As a result, he will see the scraping of hydrogen clouds, the star formation, and the synthesis of heavy chemical elements. However, there is no way it can reduce this to the interactions of Newton's second law even with entropy. Let me add that in such case the different states of the systems under consideration are not equivalent to each other (as discussed in the previous chapter). The demon will know about the world up to a certain level of complexity – for example, to the formation of individual clouds of hydrogen (clumpiness) and a world with more complex relationships – when the star formation also goes on. This in particular determines the initial parameters for the further implementation of Nash Law or, alternatively, the reference point of time. The past and the future are not equivalent then.

Chapter 11. Information and Biology

The concept of biological evolution⁶³ as the main mechanism for the emergence of all the diversity of living systems dates back to the mid-19th century. The reason for its acceptance by the scientific community is a clear, empirically verifiable view of natural selection that explains both the existing diversity of life and the processes of changing earlier forms. It is the existence of natural selection that distinguishes biological evolution from attempts to justify the general evolution of "inert" matter. Indeed, the seemingly accumulated facts of the natural sciences, such as cosmology, attest to the gradual complication not only of living beings but also of the simpler forms of structure of matter. However, there is no such thing as the driving force of selection in

⁶² For example, it is fundamentally impossible to predict deterministic behaviors of biological or social systems from the complexity of $3+1$ space.

⁶³ The term *evolution* will hereinafter be used as the concept described in Chapter 7.

either physics or chemistry, unless, of course, you introduce vitalism, a favorite medieval concept of pervading life force. It even seems that there is a separate development of elementary particles into complex elements (embedded from the Big Bang), and from some point, separately, there is a known biological evolution. It will be shown that the idea of an evolutionary increase in complexity, implementation of Nash Law, is sufficient to explain not only the formation of lower-level relationships but also biological and social ones. The differences in the forms of evolution between them are explained by the features of the new relationships.

So, the system of the next level under consideration, ^{12}M , should distinguish and compare changes in the t_{II} time layer for entire complexes of systems. Its parameter, which should “remember” changes, is closest to what we call information. Let me point out right away that the form and content of the concept of “information” has changed so much over the last decades that it seems necessary to make a big digression, starting with the consideration of the attributive (characteristic of all systems) and functional (characteristic only of self-organizing systems) concepts of information. But we will not do it at this point, because in the previous chapter we dwelled in detail with the relative differences for physical and more complex relationships. Then the information itself is a characteristic of a certain level of complexity. The definition of Henry Quastler is the most suitable in this respect.⁶⁴ *“Information is a memorable choice of one of several possible and equal versions.”* This definition virtually repeats what was said earlier about complexity levels, only to add that a choice (from equal, so to speak, symmetric versions) is possible only when complexity increases when the symmetry of the versions is broken.

Returning to the description of the new information layer, it should be noted that obtaining data “selected from all possible data” always leads to the accumulation of information. And this new parameter increases in time t_{II} in any case: both when there are complications and simplifications. In ^{12}M complexity all processes, even unrelated to each other, or processes of disorganization (facts of biological death, for example), lead to accumulation of information (knowledge) and can be constructed in terms of “the past” – a less developed system (system with less information) and “the future” – a more developed system (that has accumulated information).

Moreover, for level ^{12}M (and above), the past exists for any moment of the corresponding time layer t_M . Indeed, in this case the results of information accumulation in different systems (objects) are to be compared. Even to the fluctuations (of macroscopic levels), it is possible in this case to assign the order in which they appear, to arrange certain values according to their

⁶⁴ from the book “The Emergence of a Biological Organization”, M. 1964

appearance with respect to each other. All this is **information** that **will remain**, even when the fluctuations themselves disappear without leaving a trace. The quantity of data ^{I2}M at different points in time is compared to each other, and this marks a relatively smaller or larger amount of information, or near past (or present) or distant past.

An important distinction of level ^{I2}M is that the accumulation of different distinctions corresponds to a certain value (finite set) – a code, such as a particular set of molecules. Then it is possible to change not the whole system of relations, but a part of it that is responsible for accumulation of information – the information code; the code becomes more complicated as information accumulates. In this case the (genetic) code is a new parameter, which gives a new value to organic molecules that have not been selected before, by which they can bind in a certain way (DNA-based protein synthesis), create proteins necessary for the cell without going through all possible amino acid connections, **without covering the entire evolutionary path**. Then the relations of the new level can be represented as a two-part system of two parts: the “new” part responsible for information as such, and the “old” part of the previous chemical level, which ensures its existence (protein molecules, their structures, albeit complex, but not existing without the DNA and RNA code). Due to the information parameter, the complexity is detached from the changes of all the relations of the previous levels, it is not connected with them and, so to speak, **has little inertia**.

Let me explain what is meant by little inertia. The enumeration of options from which more complex structures can be constructed requires a large number of interactions (takes time). For example, the conversion of hydrogen into heavy elements in the interior of stars is a long process that requires the collapse of the hydrogen cloud, the completion of the whole star birth and death cycle, etc. The formation of more complex chemical molecules under conditions such as earth-like planets also takes about a billion years. But if an information code (biochemical, DNA, RNA) emerges at a certain level of complexity, then the rate of changes increases. In this case, there is no need to wait for substances in all parts of outer space or a single planet to pass through the entire chain of transformations leading to complex carbon molecules. Moreover, new changes in living beings are merely a replacement or addition of a few atoms in a particular DNA molecule, rather than the creation of a new organism’s code “from scratch”.

This leads to the relatively rapid isolation of a greater number of different combinations of chemical elements, the possibility of obtaining a large number of carriers of the code, actually biological organisms whose existence, successful or not, in turn, brings the following changes of the code. As a result, even the most primitive organisms can very quickly – relative to geological timescales – alter the chemical composition of the entire planet, such as the emergence of the

Earth's oxygen atmosphere. DNA of an organism is a molecular embodiment of the notion of coded **information** accumulated and sorted by thousands and thousands of ancestors.

Relationships at this level also take on an unusual form. If before we were talking about the systems of material points, about their changes, now it is not just the molecules and not just a biological object. It is more proper to talk about the DNA/organism **system**. For more complex organisms it is necessary to refer to the system as DNA – “individuals of the population in the environment” or, in short, **the DNA/population system**. Then the complexity of DNA increases with the change and fixation of changes in organisms (in the general case, in the population) under the impact of the environment. The organism (the population) then is a form of realization of the ^{12}M level, and DNA is its content.⁶⁵

So, due to the low-inertia mechanism of variability and heredity, the complexity has accelerated. Consequently, an additional feature emerged that did not exist at the lower levels of complexity – the **redundancy** of higher-level relationships. At the same time, there appears a relative lack of adequate low-level relationships on which to build a DNA/population system, the lack of resources. A successful DNA/population system results in many individuals, their number increasing relatively rapidly (due to low inertia). Consequently, **competition** of biological objects for resources arises.

DNA as an information part of the system has no energy or resource problems at all: the cell, the metabolism of the individual ensure its existence. It is the other part of the system, the population, that encounters the resource problems. Feedback to the information part is provided by a mechanism related to the destruction of individuals and is called **natural selection**.

It is worth special mention that the usual explanation of the influence of selection is, so to say, reversed. It is not selection that causes biological evolution, but the evolutionary increase in complexity that leads to selection: $^{12}M \circ ^{11}J \Rightarrow selection$. There is no casuistry in this statement such as finding out what came first, the chicken or the egg, because Nash Law is implemented **for all other levels** of the hierarchy, in which case biological evolution is a **part** of universal evolution. They are not separated from each other, and their differences, as mentioned in the very beginning of the chapter, fit into the features of the ^{12}M level of complexity (inertia information codes, competition). **Nash Law: content – biological evolution – form.**

Seemingly, if the selection is a new parameter that distinguishes some organisms from others, it is the factor of increasing complexity, and this was the case at previous levels, why is

⁶⁵ From this level on, concepts of form and content are manifested, as well as “more developed – less developed system”. Only from this level it is possible to attribute these concepts to the simpler relationships of the “physical” world – according to TGS1.

this not enough here? If only one successful species of living beings (information systems), for example, unicellular organisms, had evolved and survived, then yes, the selection would have been its essential and sufficient characteristic to maintain the protein structures required for survival. For three and a half billion years, the Earth's biosphere was comprised of unicellular organisms only (with rare appearances and disappearances, fluctuations, so to speak, of multicellular organisms). One might think that for another thirty billion years, they might be the only group that successfully – through selection – resisted changes in the environment. What did occur in the Vendian that led to the emergence and growth of multicellular species? The infinity of Nash Law (see Chapter 7), which determined the information level, takes the form of a specific **pressure** (the existing notion of “evolutionary pressure” is the closest to it), i.e., an irreversible growth of the number and complexity of information codes. The very nature of information, as a new-level feature, implies its continuous increase, even with unsuccessful, dismissed (by selection) combinations of codes. This is what determines the biological evolution and its **irreversible nature**. It should be noted in this case that selection is an important action, albeit secondary to Nash Law, that ensures the selection of **one** successful information code among others in the context of limited resources and competition for them between populations, while the pressure ensures the continuous emergence of new codes.⁶⁶ Biological species are levels and sublevels of complexity. Selection, competition, speciation are its forms.

Evolution is generally thought to be driven by the variability in the surrounding context. Yes, of course, a change may sometimes result in increased resource hunger. Moreover, the history of the animal world shows that catastrophes that sometimes annihilate the majority of species actually lead to more successful development rather than simplification, i.e., to the transition of biological systems to a higher level of complexity. From the oxygen catastrophe of the ancient Earth, when cyanobacteria, switching from metanosynthesis to photosynthesis, poisoned and nearly destroyed the existing biosphere with the released oxygen, up to the well-known fourth great extinction, when the extinction of dinosaurs released the Earth's resources for birds and mammals – examples of catastrophes that eventually “helped” biological evolution, owing to its irreversibility under any conditions, can be found everywhere. So, are some disasters beneficial and others detrimental? Yes, if their results are considered from the perspective of level ¹²*M* in the implementation of Nash Law, then there appear the concepts of “beneficial” and “detrimental” disorganization, catastrophe and, in particular, the conclusion about the irreversible nature of evolution. Importantly, the irreversibility of both biological and general

⁶⁶ *We give little thought to the fact that each of our cells is over four billion years old. Every cell in the human body, any living being, was dividing, forming gametes, fusing, changing continuously for about 4.2 billion years, starting with the first protocell. This is the real reflection of the continuously increasing complexity, the infinite nature of Nash Law!*

evolution makes sense only from the perspective of different levels of complexity, hierarchy, i.e. Nash Law. Otherwise, relative to what can we determine whether development is reversible or not? Thus, for individual molecules, the life and death of a being that consists of them are indistinguishable (TGS 2).

The implementation of Nash Law and its infinity for biological systems takes the form of evolutionary pressure, consolidation (through selection) of successful changes and possibility of further complexity. Further details are set out in the Annex to this chapter.

Moreover, it follows from the idea of universality of the implementation of Nash Law, that the increase in the complexity of biological objects is not a consequence of the “principle of the pursuit of perfection” Lamarckism and not of vitalism. There is neither the maintenance of the acquired characteristics, nor the predetermined “subtle matter of life” that animates the stagnant matter. There is a statement of the fact of evolution: an increase in levels of complexity, which is true not only for organic, but also for other levels of complexity. Furthermore, according to the principle of uncertainty of complexity, TGS2, the growth of biological complexity cannot follow any given algorithm, only by search of a basis for a new one among all possibilities. This, incidentally, naturally explains the fact that the increase in biological diversity is based on known genetic codes and biochemical reactions, by recombining their parts and relationships. It also explains the fact that the more complex an organism is, the faster it evolves. It cannot be explained by natural selection as a major evolutionary force, but it is clear when we consider Nash Law: the higher the complexity, the more it accumulates ready code sets and conditions for their implementation, the more new proteins and biochemical reactions – everything for sorting, which can lead to the identification, among other things, of a protein suitable for further complications, the code, which is the fact of increasing complexity.

By the way, **the death** of a biological object is the emerging indistinguishability of its level of relations (functions of the organism) from the level of relations of the environment, the simpler environment (as they say, organic matter), the local reduction of complexity, from ^{12}M to ^{11}J and below.

The use of Nash Law provides a better explanation to some features of evolution of biological objects.⁶⁷ Thus, in classical (biological) evolution “the law of the jungle” is assumed –

⁶⁷ *In multicellular organisms, a higher complexity lies in cell differentiation. The differences in their functions are not random, as they may be in unicellular organisms, but are a necessity for the functioning of a whole complex multicellular organism. Gene shuffling in prokaryotes does not cause a permanent difference in biochemical reactions against which more or less successful combinations could be identified; even the most successful combinations remain fluctuations. Whereas through the complexity of a multicellular organism the difference of individual cells is informationally fixed.*

a reflection of natural selection where the strongest, more adapted one, is the winner. Recently, however, it has become increasingly clear that symbiosis is, on the contrary, a major path of evolution. It was a surprise to find out in the 19th century that moss was not a plant, but a symbiosis of fungi and algae. Now biologists have come to the conclusion that the vast majority of living organisms are complex symbiotic complexes, superorganisms. Even in the evolution of unicellular organisms – from prokaryotes (nuclei, more primitive cells) to eukaryotes (nuclear cells), symbiosis plays a crucial role. Mitochondria existing in eukaryotes are former free prokaryotes.

Even human beings are polynomials at the genetic level, and it is indicative that Nash Law explains this in a natural way. According to the hierarchy, new, more complex relationships are based on relationships of previous levels, not destroying them in competitive selection. Then the addition of the previous organism as a component is one of the main drivers of biological evolution.

Annex to Chapter 11

The role of selection in evolution needs to be further elaborated. Note that both critics and evolutionary advocates argue and present their evidence using different levels of complexity. Indeed, as many critics of evolutionary theory point out (not only creationists, but often technologists with knowledge of the probabilities of accidental events), it is easier for a tornado that has passed through a landfill to accidentally assemble a new airplane than for selection to accidentally form such complex objects as cells, multicellular organisms, and ultimately, the brain.⁶⁸ In terms of complexity hierarchy, this is the treatment of protein organisms at levels ⁸**3** or ⁹**H** where the interactions of material points are defined. For these levels, the probability of appearance of complex molecules is negligible.

On the other hand, the theory of natural selection assumes that particles combine into complex molecules and that these structures are self-sustaining (which is natural for us: we see them and are made of them) and that other complex biological structures are created from them. Thus, the relations of “organic matter” are adjusted to the known response of biological interactions. This is an implicit introduction of Nash Law – the distinction of relations of previous complexity to find among them those suitable for further development; a fact that is implicitly **underlies** the usual concepts of biological evolution. Biological evolution is tacitly considered by scientists from the level where its results are manifested at the level of complexity of protein molecules and DNA/population systems. It results in something similar to the anthropic principle of cosmology: if there is an observer, the laws must have led to its emergence, if there is an organism, nature has led to its emergence.

⁶⁸ *It should be noted that the probability for particles (molecules) to instantly assemble into a living being is greater than the probability for particles to form a chain: complex molecules, RNA, cells, DNA, cell aggregation, and then a complex biological being. And what we see is a gradual, step-by-step increase in complexity. What a huge quantity of intermediate steps must have been accidentally created, and in a specific order, on top of it! So, the assumption of a random, fluctuating genesis of life is meaningless.*

Biologists, speaking of random mutations leading to the survival of those better adapted, use their own, complex parameters to describe biological systems, obtaining (in accordance with TGS1) a free parameter unintended for the level of these systems – direction of evolutionary development.

So, since Darwin, scientists have pointed out that of the two basic tenets of evolutionary theory, the presence of random mutations and their fixation, the random character has only an idea of the mutations. Selection, on the other hand, is a strictly logical process that drives evolution when conditions change, and mutations that were previously neutral may prove beneficial or harmful. Harmful mutations are gradually discarded, while beneficial ones are fixed as they belong to a larger number of surviving organisms.

The principle of TGS 1 is visible: the influence of a higher level of development on description of a lower one. Are the notions “harmful” and “beneficial” chemical concepts? The concepts used in this case are those defined for levels more complicated than ¹²*M*. True, the surrounding environment can be harmful or beneficial to a more complex object. Even a molecule as complex as DNA is not affected by, e.g., the lighting conditions on a given area of land. Epithelium cells respond to illumination, but this already implies notions of cells and body with differentiation of cells. First, a complication arises, according to Nash Law, structures, and this more complex system faces previously unknown restrictions (not existing for the previous level) that it overcomes – the lack of illumination, for example – or does not overcome, which means the effect of natural selection. Informational complication goes on continuously and takes the form of evolutionary pressure. After that, selection leaves the complex structures selected from among others.

Chapter 12. Man-Society System

The subsequent complication of low-inertia systems is becoming increasingly problematic. The limitations on variability accumulate as the lengths of the molecular code chains increase, and the inflexibility of such constructions increases with complexity. Complex organisms cannot change more than the “roots” of genetic programs based on the codes of previous species can withstand: a superior organism, e.g., a mammal predator has the same cellular metabolism as a flatworm. Mammals cannot change their metabolism or grow a few more limbs, no matter how much they might need it. Epithelium cells cannot accumulate iron in their shells to create the iron shell needed for survival, even if there is excess iron in the environment. On the other hand, there are natural limits to the development of organisms: natural disasters, lack of resources. As a result, development must satisfy the conditions of a **compromise** between the new conditions to which the relations of new levels lead, and the hierarchical inflexibility of intracellular biochemistry.

Living organisms can change the terms of compromise, changing the environment: building nests, hives, ant houses. They can improve their bodily organs impacting the environment – the trunk as an additional limb in an elephant, the odorous anal glands of a skunk and others. The biological organism after transferring the genes to the offspring and, possibly, after growing the offspring, changing the space (building a nest, a lair, flight to places with better conditions) is no longer necessary although it continues to function, which is then a waste of resources.

It turned out that it is more advantageous to accumulate and compare information non-inertially, in representations reflecting the external world, without connection to the DNA/population system. It happens due to new relations – electrochemical codes (to be more precise, coded electrochemical agitations) in the brain of an individual, so then we can say, a personality. In this case, codes are a finite number of ordered electrochemical signals in the brain that reflect the influence of external stimuli without describing each step of their influence, e.g., a cat is a danger code for a mouse, regardless of its distance, activity, or coat color. There is similar brain work, of course, to some degree in evolved animals, in addition to their instincts. However, personality is also characterized by further work with codes, which gives them new parameters and characteristics. The general features of external relations, things, and whatever we call representation about them are encoded (by electrochemical signals of the brain), for example, the general idea of a stick as a part of a tree, as a narrow long object, etc. Then a person's awareness of the surrounding world is a process of singling out certain reflections in the brain, combining separate codes into chains of new relationships with new characteristics, new

parameters. For example, the idea of a stick (its code) plus the idea of a stone (its code) with the appropriate characteristics (the strength of the stick, the weight of the stone) means survival when being attacked by a predator. This allows us to determine the significance of these things (and other things with the same codes) for human beings, for survival, for life among other people. If we assign the property of “significance” to codes, then the chain of “stick plus stone” codes will increase greatly in significance among other codes. They **stand out** from other codes by this new relationship. This is a new complexity. Consciousness means the construction in the brain of new chains of relationships between codes of reflections of the surrounding world, constant attempts of the brain to inertially create chains with the greatest significance and use them for survival or life improvement. The reflection of the surrounding world through codes without process of awareness, for example, accumulating codes of some sticks and stones under feet, is not more than an attempt to find the “Self” of a photo camera, which also reflects and fixes reality (by electrochemical codes of emulsion or photomatrix). Assuming that “consciousness” equals “personality” and equals “the Self”, these actions, i.e., building of new relationships, define the essence of each person’s concept of the “Self”, or at least its main property.

Exchanging data about chains of codes and their significance with other people, memorizing and sharing this information, is the essence of society’s operation, the very thing that distinguishes it from an animal pack. “General” information for data sharing between a given person and other people should also be provided in the form of a code: these are, first and foremost, words, speech, and all other types of code sharing (gestures, facial expressions, and later, drawings and writing systems).

Since it is impossible to consolidate the received information and further use it without society, we should speak about the **Man-Society System**. Then a person through training and advice uses the memory of the clan and the material wealth of the clan, uses and accumulates the achievements of other people, including previous generations.

At the same time, the actual way of thinking (generating new relations, electrochemical codes in the brain) allows to accumulate and use information through an individual, personality, in comparison with the previous level of molecular codes, when the comparison of “more – less” information made sense only for the DNA/population system as a whole. But there are more individuals than populations, and the rate of non-inertial information processing is higher than the rate of selection. Therefore, the rate of social development is faster than biological development.

It is worth noting that codes, when received by a person, can be made more **complex** by him/her directly (new data, inventions, experience) **without** the influence of natural selection (death in case of unsuccessful complication) and, if the complication is successful, they can be passed on to other people, society and fixed in public memory through messages, texts, laws, education.⁶⁹ Options are being selected through personal experience and by comparing new data with the knowledge of society, rather than by destroying the carrier of failed information through selection.

The philosopher Karl Popper said a remarkable thing, though on a slightly different subject: *“Let our theories die instead of us.”* The death of a theory does not cause the death of its proponent, whereas in biological selection, a failed DNA code causes the death of an individual. Likewise, the implementation of a bad idea does not always lead to disastrous consequences. A bad stone axe is not a judgment on an individual if a good one can be made; at this level of complexity, a failure is also a piece of information, anyway, the accumulation of data results in more opportunities to find better data. As a result, quite a lot has been accomplished at this level: a non-inertial way of accumulating, sorting and utilizing information.

Of course, there is no clear transition from a molecular code to a non-inertial code, so the new level of complexity will be labeled ²⁵**Y**. Such a big difference – between the 25th **Y** level and the previous 12th **M** level – involves many important stages of biological and human evolution that are not considered here. It should also be noted that the notion of level becomes increasingly more blurred for a high level of complexity. A growing number of relationships are being defined, the numerous combinations of which are increasingly difficult to distinguish clearly in terms of their applicability for further development. Biological evolution shows many dead-end areas, where species that reach near perfection are found to be useless in further complication.

At the level of ²⁵**Y**, the process of higher brain activity allows to reflect interactions of the surrounding world and to carry out further development not only by trial and error, but through **comparison** of the received data codes, to realize the nature of these interactions, i.e. to immediately foresee, as far as possible, the results of one’s still planned influence on the surrounding world.⁷⁰ Thus, the work of the brain with non-inertial images – codes allows to

⁶⁹ *It should be noted that the idea of evolutionary hierarchy leads to the emergence of a DNA/population system, rather than a biological organism; to the formation of a man-society system, rather than a personality. It is only the conditions of further development that make it imperative to separate the “human” part from the Man-Society System.*

⁷⁰ *It opens up new potential for modifying the environment in ways that cannot be due to biochemistry: the use of fire, the advent of ceramics and machines....*

simplify and accelerate the search of options enabling the arrival at further, more complex relationships. Social evolution is a good illustration of this point. Codes (models) of other people's behavior, codes of certain innovations in the mind of an individual can be immediately compared with the available information in the memory of society, and can be immediately verified and implemented (or discarded). As a result, codes that describe relationships for any external objects are selected from the chains of codes, for example, the fall of any dense objects – animate and inanimate – to the Earth, or the displacement of water by any submerged body. In this case, it is possible to formulate the “laws of nature” describing the relationship between different parameters, such as Newton's laws and Mendeleev's table...

The concept of the law of nature appears specifically for the Man-Society System, i.e., it is a record that encodes information about the general character of external phenomena. For example, the hieroglyphs $F m w$ in recording Newton's second law are the codes that we have introduced for low-level relationships. That said, the very concept of “law” implies a lack of law or its erroneous application. The notion of “discovering the law” appears, but nature knows neither faults nor that it has been “discovered”. We are the only ones who can find and verify a particular code. In doing so, we may incorrectly describe certain interactions because, being a more sophisticated system, we introduce free (and sometimes incorrect) parameters to describe them. Continuous work with them resulted in the emergence of scientific research.

The existence of new relationships is also strongly affected by resource constraints, which mean so much at the biological level. At different stages, the struggle for them is translated into wars and exploitation, i.e., limited resources affect both inter-societal and interpersonal relations. At the same time, societies are self-organizing, structuring themselves under the influence of external pressures and internal forces. There is a continuous struggle for resources between individual global societies and civilizations. Western European, Eastern European, Arab, Chinese civilizations imposed their structures and social laws upon their neighbors in different periods by different means, often destroying those who resisted them. In some ways, this resembles the processes of natural selection and gene exchange in unicellular organisms in biology – but between state institutions. Within the latter, different groups of people are also engaged in struggles (riots, revolutions, strikes, civil wars) to optimize access to resources.⁷¹

When dealing with the topic of time for high levels, we should note that complexity and time in general are meaningless for a single biological individual. For example, the mammalian DNA contains information about the gills that former species had, i.e., about the past. The

⁷¹ *The class struggle, so influential in technologically advanced societies in the 19th century, has transformed through colonialism into a “rich North (“Golden Billion”) – poor South” confrontation by the end of the 20th century.*

information is accumulated through molecular codes, each of which cannot separately compare itself with others. The mechanism of comparison and selection of more advanced species, and thus of t_M time, exists for the DNA/population system, but not for a biological species.

Time is determined for an individual as a part of the Man-Society System. From the ^{25}Q level, the notion of age appears and, **when comparing** it with the age of other people, the knowledge of the processes of birth-adulthood-aging common for all people, the notion of death and the approximate time before it came into being. Society⁷² also sets a common reference point for chronological time frame: “from the creation of the world” or “from the Birth of Christ”. Thus, the Man-Society System adds one more layer of values to t that are beyond the previous ones, i.e. a new layer of time t_q . Thus, for the complexity level ^{25}Q , there exist, of course, a layer of reversible time t_H , and a layer t_N , through which, in particular, entropic systems of $^{10,-2}K$ can be compared. In addition, the process of low complexity, simple periodic motions, for example, rotation of the Earth, can be assigned numerical values, which will be a single basis for numerical unification of different processes: the t_q layer allows us to refer to “the universe at a given moment in time.” The time of layer t_q carries another important function of comparing the codes of relationships among different people. To accomplish a common task, it is necessary to distribute the actions among group members, and the more complex the society is, the more specialized perceptions each person has. In addition to a common language – common words – codes for communication, in addition to common laws, moral concepts, minimum level of education and understanding of the world around us, we also need a common time. Without comparing the actions of individuals according to these “coordinates,” communication and further joint work are meaningless. We are taught the notion of time by society, an individual person accepts it because he understands the essence of the relationships being introduced (the codes in the brain of a mentally healthy person are complex enough to add this relationship to them) and because our daily practice shows us that it is understandable and convenient for everyone, the notion of time complements the codes of social relationships.⁷³ In general, we can say that time exists for each human being because we possess the complexity of the level ^{25}Q . A special mention should be made of the fact that it is the time of the level t_q that will flow from the future to the past for all natural systems, as it is a parameter of comparing them with the most sophisticated system, i.e., society and personality, with direct implementation of Nash Law.

⁷² *In the modern world we can discuss the noosphere (as defined by Vernadsky) and the unified information space, rather than society as living conditions differ from nation to nation).*

⁷³ *Time is a considerable late notion for our civilization. The ancient Egyptians did not have it, and it appeared in the later parts of the Bible, in Ecclesiastes (1500 B.C.), of the ancient Hebrews. The ancient Greeks already had this notion: Chronos ate those he gave birth to.*

It has been constantly pointed out earlier that the identification of new relationships as compared to other relations of the same level is a step towards increasing complexity. Then the work of the mind, the results of its activity – new free parameters – provide for an unlimited number of new versions of relations (tested and fixed by society) beyond the previous ones. Our activity at this stage of complexity is something that is implemented by the law, the reflection of which is everything around us, the entire universe. This will be discussed in detail in the following chapters.

Chapter 13. Freedom and Predetermination

The concept of freedom through free parameters permeates the entire hierarchy of complexity, and is one of the key effects of Nash Law. Let me recall that the new parameters are free in terms of relations of the previous level: they are not reduced to them, they are genuinely free (the examples were discussed in Chapter 1). Relations of the lower level, which are part of more complex ones, limit them through the so-called laws of nature. For example, starting from level 6E , all subsequent relations are, so to speak, submersed in the 3+1 space; starting from the level ${}^8\mathfrak{Z}$, they are subject to Newton's second law, and so on. On the other hand, due to this free parameter, relations of each new level receive new properties that are not characteristic of the previous ones, increasingly more versions of complexity appear, although they are subject to laws. However, after a new complication, the previous parameters become deterministic (given the relativity of determinism: see Chapter 10).⁷⁴ All these aspects have been reviewed more than once in the previous chapters.

However, there are levels of complexity that are specific for us. This is the complexity of the level ${}^{25}\mathfrak{U}$, which we use as a starting point for defining human relations proper, as well as the new level associated with the consciousness of the individual, which is the most complex for us, and therefore there is no further certainty for us henceforth, as per the principle of indeterminacy of complexity TGS 2. This new level will be labeled ${}^{33}\mathfrak{Y}$, which suggests skipping many levels of social and personal development.

Again, both our consciousness and something we call matter have been determined by Nash Law (Chapter 7). Our consciousness is its highest reality (as far as our level is concerned), while the matter around it is simpler. Consciousness is affected (through the influence on brain function) by lower-level relations in the hierarchy.

According to TGS 1, being a relation of the highest level, it attributes free parameters to simpler relations, for example, for mechanical systems, it is the flow of time, initial and boundary conditions, which make it possible to track changes in parts of the systems.

According to TGS 2, consciousness cannot unambiguously define relations of more complex levels, even if they would be the outcome of our development. The future is uncertain for us, we can only predict it in simple models.

According to TGS 3, there is a symmetry of low-level relations for the relation of "consciousness". Each of these relations appears to be the same (symmetrical) for the consciousness of different individuals – see Fig. 8.1. (different people see plants, the Sun,

⁷⁴ Thus, in the example of Chapter 1, the escape velocity of an interplanetary station, which was previously a free parameter, becomes a certain value when the heliocentric coordinates and planet velocity are introduced.

houses, ticking clocks in the same way). This feature became known as an “**objective reality beyond human consciousness**” and gave rise to the subject of opposition between consciousness and matter.

Here it is important to explain why level ³³**Я** is higher than ²⁵**Ч**, as personal aspirations and achievements are not always higher than those that already exist in society. As we have discussed above, it is only through personality that information that codes are accumulated and become more complex, and a potential for new complexity is organized. Society cannot figure out what a particular human action will bring about. A huge quantity of social innovations, inventions, and creative products, which now form the foundation of our civilization, were rejected in due time. True, personal results can and most often do turn out to be fluctuations, but until they can be compared with subsequent changes, it is necessary to assume that each individual is above society in terms of complexity and to imply that level ³³**Я** is above ²⁵**Ч**. It is worth noting that the processes of personality formation altogether produce something similar to biological evolutionary pressure, as discussed in the previous chapter, but only for a new level. We may refer to this total constant **pressure** as **civilizational pressure**: new inventions, scientific discoveries, development of new territories and more profound space research, new innovations and a new way of life, constantly growing population with more and more opportunities in medicine and agriculture, and so on and so forth. Civilizational pressure is a reflection of the unlimited nature of Nash Law, just as it is for evolutionary pressure.

I would like to dwell on the issues of freedom and predetermination that arise for self-consciousness, for the individual, and primarily, on some important relations between the individual and society in the Human-Society System. The formation of the notion of personality, the notion of a separate “Self”, as **singled out** among others, is the formation of a new level of ³³**Я**. In the hierarchy, an element of this new level is associated with both a biological object and an individual in a population, and is also a material body that possesses (and is subject to) all the relations of the lower level. Moreover, the notion of “Self”, the awareness of a personality separate from the others, is the most possible kind of distinction between biological entities of the same species. There are no two identical personalities, destinies, there are no two individuals – two people – with the same self-awareness. The emergence of the “Self” is the emergence of the ultimate complexity in the universe that we know.

Obviously, the very definition of personality, of one’s “Self” implies a society that has taught a child (through relationships between people, through upbringing, due to the fact that parents were also brought up in society) to self-analyze and to separate one’s inner perceptions from those existing in the surrounding world, to learn to share the existing codes and words with other people. This gives rise to the conditions for one’s own delimitation of external relations on

the basis of one's own **perceived** sensations, separate from the others (see Chapter 12), i.e., to self-awareness. Therefore, without the conditions like these, personal consciousness in the form known to us could not exist at the dawn of humankind.⁷⁵ It is not important, as the boundary that separates a self-conscious person from a speaking fragment of his tribe could not be sharp – what is important is the very fact of gradual formation of the “Self”, the separation of an individual from other people around him.

The “Self” of a modern person, which appeared in the process of learning in society, starting from a certain point, can exist without teachers and even with a denial of these social relations. Then you can talk about self-development and independent existence of the personality in general – until death or mental illness. This has defined the conditions for the emergence of, so to say, transcendental “Self” that stands above the conditions of lower levels, even of society.⁷⁶

Considering personality as a system of a higher level of complexity leads to the fact that, according to TGS 1, level ³³**J** sets free parameters. If the thoughts of an individual (codes of relations in the outside world) are separated from the codes set by society and become “my thoughts”, then a new parameter appears to mark the separation of one's thoughts, one's decisions and actions from other external ones, and it is called **free will**:

$$^{33}\mathbf{J} \circ ^{25}\mathbf{Q} \Rightarrow \text{free will.}$$

Free will turns out to be a completely objective concept (bearing in mind the relative character of objectivity – Chapter 10) like, for example, time t_H , power or space, while moral laws and values of individual life, these new relations of the new level ³³**J** turn out to be conditions for further increase in complexity, for further development of the Human-Society System and for implementation of Nash Law. In general, we can say that freedom is not “only an idea”, as Hegel believed. It is one of the characteristics of the universe, like other free parameters. It is important to note that **free will cannot contradict determinism** (Chapter 10), they belong to different levels of complexity.

Free will, like the parameter of time, can be projected to relations of lower levels. We have different layers, just as we have in terms of time. It is the will that chooses a path in space: which road to take. It is the will of creativity, the will to create new links between people. And only later on, at the new level of a **complicated** system, one can determine whether the work of an individual is productive or unproductive, later on it will be possible to say whether the

⁷⁵ Here we will not deal with the evolution of relations of the level up to ³³**J**, but it is worth noting that the pursuance of autonomy was certainly justified in early societies. With few resources and a persistent threat of starvation, personal freedom of action, that resulted in a failure to comply with social rules, could cause his family and clan to perish.

⁷⁶ Jean Piaget, a Swiss psychologist and author of the theory of cognitive development, noted that according to experimental data, mental development makes it possible to form an attitude toward oneself from the outside.

realization of personal freedom was a fluctuation of the level ²⁵**У**, whether the invention was futile, creativity – unnecessary, or whether something contributed to the implementation of Nash Law: a useful thing was made, a book was written, children were raised ... Free will does not guarantee, but implies a possibility of personal freedom – new relationships that are not limited to what had been defined by society. It is an opportunity, as it depends on the person whether something new will be accomplished or whether his/her relations will remain the same as before (by the way, this is freedom as well, i.e. a choice to maintain the habitual relations or to strive for new ones).

The very fact that we describe and study other systems, in particular, setting time or initial conditions, indicates that information is being accumulated, this parameter grows, in which case we also change in the process of our meaningful activity: we become more sophisticated. The knowledge that is acquired through studies (and attempts to study) oneself and the surrounding world (including its simplified models) adds more complexity to the researcher, i.e., scientific knowledge + studies = more scientific knowledge (if the studies and their interpretation are correct and accepted by society, the scientific community and consolidated through the education process) – the Human-Society System **is not confined in terms of complexity**. Even the mistakes made, but those that we are aware of, signify the difference between the right and wrong statements, and the process of getting this information is also an increase in complexity.

At the same time, if an individual knows nothing or does not want to know anything beyond obligatory things, this has (almost) no effect on the general development. However, if a person has produced new information that society has accepted and thus has become more complex, has **changed**, then some new relations will appear and affect certain individuals: they will have to comply with the modified Human-Society System. New social laws, including criminal law, will affect other people by teaching and/or forcing them to comply with this new complexity.⁷⁷ Then we can present the increasing complexity by the following formula: Human → Society → Advanced Human, i.e. further development of level ³³**Я**. There seems to be a contradiction in the last statement with the idea that the level of personality is higher than the social one, but in the hierarchy, any level is based on the previous one, comprises its relations, and quite naturally, these social relations are used for realization of level ³³**Я**. And here the contradiction becomes apparent between individual freedom and social need, between society as an information bearer, the basis of education and the necessary rules that are **common for many people**, and the individual as a “transcendental”, **independent** part of the Human-Society System. This constitutes the contradiction and unity between free will and the laws of society.

⁷⁷ As Lenin put it briefly: “It is impossible to live in society and be free from society.”

Let me make a little digression. You may hear from child psychologists that children who begin to speak, do not actually learn to speak as much as they recall how to speak. This is not surprising, since the level of complexity ²⁵**U** has evolved, from which a personality can be formed. Uniting individuals into a society is a consequence of high frequency of contacts and feedback between all participants, when non-inertial codes arising in the brain are shared, as described in the previous chapter. This is communication, an exchange of words encoding surrounding things and relations. It is with its help that the Human-Society System was built, we can say that words are codes that are **common** both to the individual's brain and to the surrounding people, to the community. Thus, it is the ability to speak that unites these two parts of the Human + Society System. To form it, the core biochemical and physiological processes in the human brain and nervous system that determine human biochemistry and physiology would have to be used, so the development of conversational skills is an integral part of developing a child's body and mind.

Let us go back to our new parameters. Individuals may compare their relations and feelings with their previous experience and with what other people have communicated. In this case, we manage to **understand** the feelings by transferring them from the level of reflexes into new entities, **general codes**, so that the pain of a particular wound is defined as pain in general, a grief that can be communicated to other people. So other people will understand this notion, this code. It is man who can create "good" and "evil" since he is the one who divides relationships into good or bad ones. Animals cannot do this. I would like to note that all these new entities are related to the parameter of "free will" and are different for each individual, although, of course, at the level of society, they are more precisely defined and applicable for all (and, therefore, not suitable for all).

Individuals are unable to display their own level for themselves, to understand themselves, as, so to say, "Face to face, you cannot see the features", which means that can only understand the lower level ²⁵**U**, and these relations can still be presented in the form of certain parameters from level ³³**J**. In particular, we can still compare our behavior with those things that have developed in society in the form of behavior required for its existence and development along with its social morality. Whereas personal morality, personal rules of behavior and the reasons for following them are inexplicable to other people, and often the person himself cannot find the words to describe them. We simply cannot model (according to TGS 2) even more complex relations than those of level ³³**J**, reflect them in our consciousness in the form of codes to be compared with other codes, they will look like a miracle to us, a violation of the traditional cause-and-effect relations.

Annex to Chapter 13

As far as this issue is concerned, it is worth mentioning the failures of the megaprojects of reconstruction (!) of the human brain and consciousness: BRAIN in the USA and the Human Brain Project in the EU, announced in January 2013. Actually, these projects, which were supposed to surpass the results of the Human Genome Decoding Project, died quietly by 2018. The cost of these studies was worth about half a billion dollars (\$100 million in initial funding, state grants and donations) and the same amount in euros. Obviously, the deciphering of the brain and consciousness is still beyond our grasp.

There is a saying: If one does not know which port one is sailing to, no wind would be favorable. If you look at the materials about the failures of these projects, you can see that no one had any idea what exactly should be done what cannot be done in standard laboratories. (Although, hundreds of millions were absorbed successfully....) First, it is a good idea to define what consciousness is. And here we can add two-pence worth from this theory of increasing complexity. It should be emphasized that consciousness is not a self-substance, but a tool for achieving some or other goal, for carrying out certain actions to accomplish more ambitious goals. The tool itself – no matter how user-friendly and efficient it may be – does not mean anything. For example, the purpose of a planer is to make smooth boards for a fence, which we need for enclosing an area, which is essential for a comfortable life, etc. Therefore, when talking about consciousness, it is important to highlight the goal to be achieved and to understand why this goal is changing and becoming more and more challenging. Why not stop at the level of consciousness of chimpanzees scheming in a pack and planning their actions for hours ahead? Why not focus on the ideas of sweet bananas and the way to get them? But our minds are already occupied with the task of buying a new smartphone, getting the money for it, and we are looking for a job for the coming years, we undergo the training to get this job and do other things, we look for money to pay for the training...

As shown above, this goal can be defined. It is the supertask of constant and unlimited increase in the complexity of relations that led to the formation of space, the laws of mechanics, chemical bonds and other things that we call the universe. Then the **actions** of the tool “consciousness” that we have to carry out should be based on the analysis of the goals that we set for ourselves. We should study the challenges that society and individuals are constantly facing (by answering the questions of “how” and “in what way”) and study the activity of our “brain tool” through them only.

Chapter 14 Science, Truth, and Philosophy

It would be erroneous to believe that science seeks the truth. Science studies the relationships in natural and social systems. It is philosophy that studies truth and the meta concepts (being, consciousness, etc.) that correlate with it. Religion, based on revelation, has already got the main answer and is projecting it to more private concerns of human existence, society and, sometimes, nature.

Surprisingly, the study of relationships between feathers rubbed with amber, falling apples, and dream charts resulted in understanding many laws of the universe, as well as the hydrogen bomb, antibiotics, video files... Therefore, at one time, in the 1950s and 60s, science was thought to be the leader in the trinity of science-philosophy-religion and would soon replace it with itself alone. Everything seemed to be in favor of it: studies of the relationships between different natural systems, i.e. answers to the question “how”, began to unite with each other, surprisingly to the scientists themselves. The seemingly infinite variety of substances was reduced to some basic elements of Mendeleev’s Table. The movement of apples, the Moon, and stones, seemingly quite different things, turned out to be subject to one law. It is a kind of inverted cone with numerous familiar separate entities at the top, which merge below. Thus, the diversity of living beings happens to be an agglomeration of cells, the ones that contain DNA, which is made up of nucleotides, they are made up of atoms, the latter are made up of protons and electrons, and so on. It is the same with rocks, for example, they are conglomerates of silicates (usually), which are silicon-based molecules (usually), those are made up of molecules, and, further, protons, electrons...

The laws of nature also turn out to be embedded in each other like a matryoshka doll. For example, Archimedes’ law about a body in water is a special case of Pascal’s law about pressure. That one is a direct consequence of the molecular structure of water, a liquid. The latter is a direct consequence of the hydrogen bonds between water molecules, that are a consequence of proton and electron arrangement... The cone is also converging. Interestingly, these data are generated by studying the “how” questions (science) rather than by answering the “why” questions (philosophy).

When we search for answers to the “how” questions, we are surprised to see answers to the “why” questions about familiar entities (e.g., for a body immersed in a liquid: “why” – according to Pascal, the other one – according to molecules, etc.) and we have fewer and fewer entities to define.

Magnetism is another example. It turns out that there is no separate magnetism, that there is electromagnetism. When we study the “how” question, we come to the answer why magnetism (movement of charges) emanates. The question “why” stands for both of them, electro and magnetism. It is further revealed that there is a single interaction of weak and electromagnetic interactions. Both magnetism and radioactive decay are parts of some sort of single whole. Then, there are quarks, gluons... The cone has almost come together, the accumulated scientific knowledge covered the concepts of time and space, the problems of logic, the beginning of existence, the existence of the observable world and so on, just a little more left and... Alas, so far, the problem has not been solved. Apparently, the answer to the question “why” should be found for just a few concepts. And this is where the slippage occurs.⁷⁸

One of the contemporary prominent physicists said that by creating a “theory of everything,” the great unification of electrically weak, strong and gravitational interactions, we will get a description of the action, which will interfere to produce gluons, quarks, and those, in their turn – “elementary” particles, atoms, molecules, and so on. The inverted cone has at bottom the theory of everything, and above – the laws (rather, physical constants) of nature that drive the growth of that very cone up to the formation of us.

And the fallacy of expectations of everything from the “theory of everything” is apparent from the very beginning (albeit described here in a very simple way). In any case, no interference, even of gravitational fields with gluons, will result in additional increase in complexity. It turns out that either the observable and increasing complexity of the universe is a **random** result of all possible interferences, or the laws of nature are contained in each other as parts of a matryoshka doll at the moment of the Big Bang and come to existence one by one.

Also, one should not forget that we are considering the description of the cone of universal laws from the top, so to say, from the wide top of the inverted cone. The influence of an observer consisting of cells, molecules, atoms, quarks cannot be eliminated. We test all interactions that we discover to see how they correlate with experience, i.e., with the interactions of the existing world, which means that they carry an irremovable trace of surrounding complexity. Quite naturally, in the end we find ourselves, or at least our physical world, in the development from the beginning of the cone, with the precision of some constants.

One should constantly bear in mind that the very fact of our universe’s genesis, the fact of its development at any level is an absolute violation of all and any laws, and not only the

⁷⁸ *Now there is no fearful admiration experienced by an ordinary person before the omnipotence of science. Thank goodness there is no mocking and patronizing stereotypes about scientists as men with their heads in the clouds, fiddling with their instruments in the dusty attic of science....*

appearance of something out of nothing as a result of the Big Bang. The fact that the laws came into existence along with the universe only confirms this irregularity. We cannot break out from the circle of defining the incomprehensible through the unknown by simply postulating laws (or physical constants).

So (for now-?), let us go to the philosophers to get the truth. Or to the theologians. Or we can see how the implementation of Nash Law, which is getting space, time, laws from the ideas about the hierarchy of complexity, conforms to the principles and successes of science, philosophy, religion.

The problems of religion and Genesis will be addressed in the next two chapters, but here I will focus on how the humanities and philosophy approach the concept of Nash Law (almost all the previous chapters were devoted to natural science issues).

On the one hand, one can use the principle of Nash Law without any contradictions to build all relationships, as there is no distinction in the hierarchy between humanitarian and natural science relationships. We discussed this point in Chapter 10 when we defined the concepts of objectivity and cognizability. However, we are part of the ²⁵ Ψ level, the Man-Society System, and when studying these relations, we come up to a situation that can be described by the Russian saying “Face to face, you cannot see the features”. The relations of our level cannot describe us, i.e., we cannot use the familiar approach of excluding the influence of the observer. Nor can we use the principle of repeatability of experience: when we study ourselves, society, we get too many variable parameters of our own level, which leaves the object of study uncognizable.

However, we are able to set and tackle **individual** challenges of human associations, to predict social behavior, development within the limited timeframes (the shorter, the more accurate), and this is what the humanities do, because according to the hierarchy we are subordinate and respond to fairly simple laws, the laws of the lower levels. So, man is both a primate and a cellular as well as a mechanical structure. For these structures, we know the responses to external conditions and thus, we can predict our own and other people’s behavior in certain cases. Therefore, there is a possibility to successfully calculate the trajectory of society’s development (and individual behavior) under certain changes. For example, we can use statistics to explore the behavior of society as a mathematical structure, as a herd of biological entities, and so on. However, we have to remember that any forecasting of our own level by ourselves is “present continuous” and we cannot answer the questions about the future that life puts forward.

Studies in the humanities, particularly in law, public administration, and economics, have an inherent peculiarity that transforms the very object of research. A physicist cannot influence the law of energy conservation, but a lawyer in some cases may apply administrative or criminal laws differently, an economist should be able to influence the rules of human economic activity. This is the main difference between humanitarian research and laws from research in natural science. As a consequence, the sphere of human-society relations can be understood by us only partially, in models. The most famous model assumption is that society is evolving slowly enough to make its laws, as well as our behavior, stable and predictable. In this case, if we know the behavior of groups of people under certain conditions, we can, with the appropriate number of reservations, make the assumption that the same thing will happen when these conditions recur. This constitutes the basis, for example, of the Roman law: a certain punishment is to be imposed for a certain offense under the Code in the hope that the fault will thereby be punished in the most appropriate way possible.

The economic science (and other social sciences) differs from natural sciences in that it immediately studies the relations of the complexity level ^{25}Q , which is constantly changing, particularly due to the successes (or failures) of the economy. And from the definition of certain relations (consumption, payment, monetary circulation), the economist tries to establish parameters that characterize them, similar to the laws of natural science. In order to have a strict law/parameter, even to clearly define certain relationships, one has to build a very limited model that is far from reality, by throwing away from the social relationships too many things that influence them. Instead of introducing hard axioms based on lessons learned and replicated over time (something that does not exist in economics, does not exist at all), “reverse” actions are performed, i.e., certain **relations** are extracted from the systems simplified for this level of complexity and **assigned** axiomatic or “natural” characteristics (profit maximization, marginal utility, etc.). Any attempt to apply them under different conditions naturally produces poor results, since high-level models have to be very simplified and “trimmed” according to a certain schooling of economics (and often “in a lively way”, with some critical relationships being dropped). A system of level ^{25}Q cannot be modelled point-blank, for example, with the help of mathematical formulas or arrays of economic values, using relations of any simpler “mathematical” system because, basically, it is impossible to take into account the values that are changing along with society, and again, “Face to face, you cannot see the features”.

This kind of construction of axioms, which is **contrary** to that in natural science, is especially evident in jurisprudence. Laws (axioms) are built on the basis of the new-level relations, and then their applicability is investigated. Society is constantly changing, its laws and

axioms are also changing (for example, the infallibility of the monarch, class or racial inequality, etc.). If possible, new relations are reflected through known rules, defined by people before, for example, their scope of applicability, the meaning of laws and penalties are changing.

The background, attempts to explore and use historical knowledge, is based on the peculiar inertia of the society: the new free parameters that we create while evolving (as individuals, as a civilization) do not come into effect immediately. Thus, the invention of printing helped to accomplish universal literacy, but it took almost four centuries, even in Europe, to achieve literacy for more than half of the population, which in turn became one of the factors for accelerated social evolution (and a series of revolutions). Moreover, by presenting the implementation of Nash Law as a certain “process of development”, we can formulate (so to say, “retrospectively”, see Chapter 7) the laws of social development, or at least look for the key relations that influence society in the most serious way (in Marxism, these are production relations that form social structures). Then, again, we can make assumptions⁷⁹ about further changes in society.

Let me note the need for a neutral, extremely sensitive attitude of the researcher in humanitarian issues to the actions and results of human activities back in the old days. A scientist, a humanities scholar, should be an impartial observer. Indeed, even the universe of the 19th century and the universe of the 21st century have fundamental irreducible differences. The key characteristics of societies in different periods are defined by different attitudes, even if we name them in the same way, for example, the definition of freedom, revolution... Therefore, it makes no sense to talk about right or wrong, good or evil behavior of, for instance, members of the People’s Freedom Movement Volunteers (and their terror), from the positions of the modern social and historical analysis of the subjects of terror and willpower.

Now we can use the same premises to consider philosophy as a science. The 17th and 18th centuries saw the separation of the evidence-based science from the earlier natural philosophy. The difference between the scientific and, so to say, general philosophical view of the world was formalized, there was no longer any need for the attribute “natural”. At the same time, philosophical thought failed to move from explaining the world as a single whole to a precise (verifiable) description of its parts, from theorizing about existence and man to solving actual problems, from the general to the particular. These specific tasks became the prerogative of mathematics, physics, chemistry, biology, and later on, sociology... Actually, philosophers are not particularly concerned about that, since the basic beliefs introduced by each of them (or by a

⁷⁹ For example, “*The problem of different social structures is the problem of the childhood of mankind*,” Sergey Snegov, Soviet writer.

certain philosophical school) define concepts of being as a whole, and the whole is greater than the particular. Since we do not know other worlds to compare the results of the study of being with them, it is basically impossible to verify the truth of our philosophical concepts.

But science has come up with philosophical questions. The accumulated and structured natural scientific knowledge makes it possible to define philosophical concepts: from the particular to the whole. Scientific research turns to, or better said, returns to questions of natural philosophy: the search for general ideas about the world and man in that world, to the subjects that scholars separated from the evidence-based and math-based science earlier. Moreover, the fusion of these themes is going on a new level and is based on the knowledge accumulated and analyzed in exact sciences, rather than on general philosophical reasoning. This comeback takes place when scientific research has come close to describing the most general ideas about the universe and the place of a human observer in it.

The previous chapters dealt with the knowledge system based on Nash Law, the hierarchy of complexity that runs through and defines the universe, including the concepts of time, space, matter, the “Self”, and, most importantly, produces the experimentally verifiable postulates and laws of the natural sciences. So, we can bring back the term “natural philosophy” to discuss the levels of complexity. Verifiable answers to the questions of being, the origin of the universe, the essence of space and man appear to be the prerogative of science and the concept of natural philosophy.⁸⁰

It is worth mentioning that, unfortunately, the integration of knowledge about nature and man into a single concept, the **return** of natural philosophy turns out to be a boundary between modern science and philosophy, rather than their synergy. As we can see in the preceding chapters, since natural philosophy has its roots in natural sciences, there is no integration or even connection between natural and general philosophy: “ordinary” philosophy appears to be (in relation to the relevant ideas of complexity) a very special kind of cognition of the world, which is closer than anything else to art – the art of subtle spiritual and mental movements needed to create and consolidate our level of development, the Man-Society System, movements that are different and beyond anything that was done before. Just like works of art, philosophical concepts depend first of all on the identity of their author, then on the school and the ideas of their predecessors. But they do not afford any verification of their answers to the questions

⁸⁰ *By the way, a natural philosopher, who would like to be called so, should be able to solve a problem with at least the stationary Schrödinger equation, explain Friedman’s solution for Einstein’s equation, know about the difference between genetic and histaminic codes, be able to use the method of generalizing indices in sociology, etc., before starting to work on the levels of complexity of our world, its hierarchy and relationships of its components.*

posed, and do not need it at all. Therefore, the philosophy of Descartes and Mamardashvili, Marx and Kant joins the ranks with the works of Praxiteles and Malevich, Dante and Tolstoy.

To illustrate the cause of such a harsh conclusion for philosophy, it is worthwhile to show how far from each other are the findings of different approaches to the same issues from the perspectives of different philosophical schools and natural philosophy. To give an example, I will compare some well-known philosophical concepts with the natural philosophical conclusions made in the preceding chapters. I will compare them briefly and not quite professionally (which does not excuse me, of course).

Plato's vision of the world of ideas turns out to be remarkably opposite to that of Nash Law. According to Plato, the world of ideas is the pinnacle from which the other, so-called, lower levels stem. On the contrary, the world of ideal concepts (beauty) in natural philosophy comprising consistency, unity, indivisibility, independence from "things", human passions, etc., possesses the qualities of the simplest relationships, something inherent in the microcosm. The proton cannot be cut in half, electron orbitals are always discrete, Planck's constants, fine structure, gravitational constant and other phenomena do not change and are beautiful in their own way, but they are primitive as compared to the amazingly complex relationships that produce higher levels of the hierarchy. The things that seemed inferior to the philosopher, i.e., impermanence, passions, all these "shadows on the wall in a cave", turn out to be peculiarities, capabilities at more sophisticated levels. Even the very desire for the absolute (if we consider the absolute to be the highest level of complexity) originates from below, from the simple levels of indivisibility, permanence, etc., through hierarchical implementation, rather than descending from the absolute Good, which exists separately, outside the Platonic cave of passions and obscurity.

According to Kant, the thing-in-itself is uncognizable to us and is cognizable only in a phenomenon, in its manifestation, in its interaction with others. The latter is true, but certainly, Kant did not know that there are things that do not have many manifestations. So, the concept of the thing "electron" does not require an endless number of interactions. An electron is characterized by energy (including rest), charges (electric, color), the spin... basically, that is all. Even its position is undefined, every electron can be found anywhere in the universe (as shown earlier, its complexity is too small for the concept of three-dimensional space). So, some things are fully cognizable; of course, if there is a "cognizer" who defines a given thing (i.e., "cuts out"

the relations of a given level from all other things, and then wonders what kind of oddities occur).⁸¹

Kant believed that time is real but subjective, that is, it exists only in our imagination, in our understanding, and not in the real world. His basic theory suggests that our feelings emanate due to two things: first, it is something we see and think of as real; second, it is something we add to reality from ourselves. For example, if we wear red glasses, we see everything in red color. But it is just our individual perception. Space and time, which we consider to be attributes of the Universe, are regarded by Kant to be personal concepts because that is the way our brain is organized.

How does it happen that everyone has glasses of the same color? For otherwise, we would not be able to contact each other, to understand each other. So, at least from the fact that society exists, it follows that there are some common factors, which are external to the individual and allow us to consider space and time as an objective reality...

One should not overlook the concept of development, a kind of directed change, which is a reflection of the divine beginning or some immanent essence of being in many philosophical systems. Perhaps, Hegel was the only one who boldly assigned the cause of development to new entities, i.e., contradictions. The notion of thesis – antithesis – synthesis is an amazing attempt to describe any movement of the universe (which also has inherent contradictions) as a step forward, a step towards synthesis, i.e., the new (synthesizable).

Unfortunately, experience shows that combining the opposites usually results in their averaging or destruction, rather than in something new. Hot with cold gives warm, electron with positron gives annihilation. Naturally, a steam engine needs a heater and a refrigerator, so to say, the opposites, the use of which results in work, but nevertheless it is necessary to synthesize (create) the steam engine itself first, and only then to use the thesis and the antithesis of temperatures.

It is true that an observer can find the struggle of opposites in almost any action, but self-movement and development do not originate from it, but on the contrary, the (relative) opposites and their struggle also originate from development outcomes. If there were only the opposites, there would be no development: everything would go around in circles or would be reduced, like the Brownian motion, to random unpredictable deviations. Hegel's dialectical idealism puts the cart before the horse.

⁸¹ For example, Paul Dirac's idea that all electrons of the world comprise one electron.

Engels explains the general evolution of nature by immanence: *“Man is a manifestation of the immanent need for self-knowledge of nature in itself, ... and if he perishes, then it will give birth to the organ of self-knowledge it needs so much again at some other time, in some other form.”* Here the materialist Engels shifts to pure idealism, attributing some spiritual stimuli to nature, which, as he writes, are inherent in it from the beginning, for example, the urge for self-knowledge. In general, one can understand what drove Engels: it was the need to postulate the existence of the material world only in order to get such sophisticated entities as human society in general and the human being in particular. The absolute of God or Plato’s ideal world was replaced by the absolute of some kind of targeted development of nature as a whole. Basically, that seems close to the ideas of natural philosophy discussed in this book, where all entities are reduced to the complexity that gives rise to both the material world and human beings. However, the most important differences are that this work is based on ideas of natural science (including knowledge about the Big Bang, the emergence of chemical elements, the formation of stars, and biological evolution) regarding levels of various complexity whose relationships define what we call nature, the material world, and the laws of nature. In this case, the notion of immanence is a violation of TGS 2, the principle of non-increasing complexity, i.e., the element defined by relationships of one level of complexity does not contain any data, relationships, and basically, as a simpler one, cannot determine (strive for, self-identify) relationships of higher levels.

The fundamental question of philosophy. Marxism deals with the primacy of matter and consciousness. Both Marxism and the fundamental question have been ostracized in recent decades for well-known reasons. For example, it was argued that the fundamental question is: what is the meaning of life, or simply that philosophy does not have any fundamental questions.⁸² The meaning will be discussed in the next chapter; however, I would like to note here that Marx singled out the question about the relationship between consciousness and being, between thinking and matter, because different answers to this question resulted in different answers to the questions about being, human life, and, in particular, different answers to the question about the meaning of life.

According to the natural philosophy of complexity, the conditions of the hierarchy of relations and the implementation of Nash Law, it is impossible to separate thinking and matter from each other and to put either one or another notion in the forefront; it depends on the task at hand. If one has to consider physical, chemical, biological relations, so-called material relations, then, according to the hierarchy, they form the foundation for all more complicated things, and certainly, there is the primacy of matter. If we consider knowledge, steps toward further

⁸² *The question of suicide, whether life is worth living, was considered the fundamental question by Camus.*

increasing complexity, we should remember that it is through the level of ³³***J***, the most challenging level that we can imagine. At this point, the increase in complexity, the implementation of Nash Law, i.e., the action that defined the material universe is ongoing. These are the topics that require us to first of all explore consciousness, of course, and then all relationships down the hierarchy that are associated with it.

Schopenhauer believed that the entire world is the representation of a single will. Existence is aimed at the total subjugation of the will, where all phenomena manifesting it will be annihilated. This also includes time and space, which represent the universal form of manifestation of the will. Thus, they will cease to exist. No idea, no world. The only reality is no reality.

Well, perhaps these views are the best example of the need to separate scientific and natural philosophical studies of the mortal world and sinful humanity from philosophical ideas and to consider the latter as a special form of art.

Chapter 15. The Firmament and the Concept of Reason

In the previous chapter we discussed the possibility for natural philosophy, as a concept of the complexity's hierarchy, to provide answers concerning basic points of Being and Man. This has already been partially done: the concepts of space, time, laws of nature, free will, all being "philosophical" enough, turned out to be parameters in the construction of new levels of complexity (implementation of Nash Law). Nevertheless, by far more complex issues of being can also be considered from the perspective of this particular concept.

Dwelling on the purpose of life, our approach would be similar to what we think about the nature of time. If there were clear, logical formulas to designate the purpose of life and the essence of time they would surely have been found in ancient times by numerous Greek philosophers for certain. And if for some reason they would have failed, then German classical philosophers would have undoubtedly been able to formulate them. However, this never happened, and so far we can say that judging by the experience (numerous reasonings over many centuries) the purpose of life still cannot be determined through the known concepts.

Although it seems impossible to define them using philosophical and scientific concepts, the attempt to apply, so to say, natural philosophical concepts of complexity may turn out to be more successful. Indeed, "purpose" determines the place of an entity in its certain integrity, introduces a "part-whole" type of relations and makes it essential as a part of this integrity.⁸³ Such notions about distinguishing one thing from a common whole are quite close to concepts of increasing complexity perceived as the selection of certain relations among the rest. That is why attempts to explain the meaning of certain entities can shift from philosophical concepts to those of the complexity's hierarchy along with such parameters as prime numbers, space, laws of nature, which we discussed above.

It becomes quite possible to try to define the reason of life by continuing to introduce the concepts of consciousness in the surrounding world, functioning of society, and to look for the conditions under which the very concept of "purpose" would be defined. When these conditions are combined, perhaps, we will not get a clear answer about what the purpose is, but at least it will be possible to talk about it using the same ideas based on the relations common to all others that shape our world.

Now, it would be useful to briefly return to previous provisions considered in this study – from elementary relations and free parameters (Chapter 1) to the formulation of Nash Law. Thus, Fig.7.1. demonstrated that our world is kind of a "zoo" of various relations: from the simplest to

⁸³ *New philosophical encyclopedia. Moscow, 2000.*

social ones (as has been repeatedly mentioned, relations of lower levels do not “dissolve” in higher ones, being built in a hierarchic way), which form certain amazing structures that surround us. The emergence of individuality, of the concept of ego occupying its own specific place (and living during a certain period of time), possessing properties that distinguish it from another “I” or from “us” is the same process of growing complexity which has led to the dissociation of material points being separate in space and different in mass, which has led to the separation of molecules capable of replicating from all other sorts, and so on and so forth. At the same time, as was pointed out in the previous Chapter 14, studies of high-level relations which we call “humanitarian” have their own peculiarity, making it necessary to separate concepts of the material world from those of social interactions. Hence, the Universe turns out to be all relations (the entirety of the bodies and systems determined by them) of levels up to ¹²**M** inclusively. They can be defined through input parameters, reflected by codes in the brain, and, therefore, be explored. This will include everything what we call the material world, the material universe. Social and personal relationships correspond to levels ²⁵**Y** and ³³**J**. All levels up to ³³**J** combining the “material” and “humanitarian” ones will be further called the Firmament.

We should constantly bear in mind that complexity is not what has made the universe, but what it turns out to be. The universe – the material world, its relationships, laws, matter – all this is a consequence of the new emerging levels of complexity, the fulfillment of Nash Law. It is Nash Law that determines all the relations and since there is no essence beyond these it turns out to be the cause of everything that exists. Likewise, its uniqueness (discussed in detail in Chapter 7) is the reason why everything is happening exactly one way but not another way. Considering complexity as something that is being **developed** by us and through us, it looks quite natural that our position in the material universe and the firmament comes out of it. This position is truly quite special, distinguished not due to geometry (the Earth was previously considered to be the geometric center of the world), but to high value of levels ²⁵**Y** and ³³**J**. We are neither the mildew of planet Earth, nor the fluctuation of the boundless Universe. The Man-Society System is kind of an arrowhead for universal development, through which at this development stage Nash Law is being implemented, that is, we are not just a part, but the principal part of the Universum. An important conclusion follows: since we are included in creation, being currently its driving force, then we, our existence as such and our current actions are what can be called the reason of the firmament. And we will continue to be so as long as complexity occurs through us, as long as we are able to understand and distinguish the surrounding relations. At the same time, having received the opportunity to distinguish our “I” from all other relations we can become aware of them and our complexity in regard to lower relations. Furthermore, we can consistently discover interactions, laws, reflecting them in our consciousness and then presenting

them to society, and this knowledge, in turn, will make us more and more complex. The mere operation of Nash Law⁸⁴ raises us up in the hierarchy.

Conversely, there would be no reason for us to exist should we not increase or maintain complexity. What kind of actions are these? At least while complexity is maintained and increased by universal human actions – by creating, art, inventions, maintaining the Man-Society System, that is, by giving birth and upbringing children, purposeful work, construction and supporting others. At the same time, due to the principle of non-determination for TGS 2 complexity we will not be able to find out what kind of relations will form the basis of the next levels.

The issue of purpose, however, also refers to the level where the concept of personality is being defined. Purpose and justness are the relations corresponding to the level of Man-Society System. Also, it is worth noting that the issue of death must also be considered together with these concepts. If there were no death, the question of the purpose of life would not be so important. One would afford waiting for another 70, perhaps 700 or 7 thousand years until it would become clearer... but we do not have these centuries and millennia in store for us. The trouble is that the ³³**J** level, which corresponds to separate personalities implies, as mentioned above, the identification of one individual (personality) among others. But as soon as self-awareness **distinguishes** us from others, we inevitably fall into the **entropy trap** (see Chapter 5). In this case, entropy will apply for a separate biological body in exactly the same way how it generally applies for selected (artificially limited) high-level systems.

The death of one biological organism as a specific phenomenon can only be determined when this organism is isolated from the rest of the population, while the difference between organisms of the same species is a mere fluctuation at the “biological” ¹²**M** level. Thus, the difference in weight, strength, place within a pack, even in intelligence – all this matters only in the sense of the population’s survival. As for individual differences (needed for the understanding of one’s individual “I”), they will be averaged over the number of individuals and generations, thus making entropy as a parameter for the ^{10,-2}**K** level quite meaningless for this level. Figuratively speaking, there is no death in an anthill.⁸⁵

Animals, not capable of abstract thinking or reflecting codes’ external relations, which can be handled in an inertia-free way, just in one’s head, have no idea either of time or of their death. They act as if they were immortal, and their surrounding world is limited just to material

⁸⁴ *After all, even science cannot give us unambiguous certainty about what exactly will lead to an increase in complexity.*

⁸⁵ *Of course, we can mark one ant in an anthill or even renumber all of them and trace its (their) life and death. But this will involve our influence, the influence of the observer.*

actions consisting of directly cognizable elements. For example, the presence of food for a cat means pleasure, an approaching dog means danger. For cats, dogs or food as such do not exist, neither is there a mouse “in general”, instead there is just an instinct to prey on it. If a cat could envision a mouse being unrelated to a specific action it would be able to “relocate” this abstract mouse in the conditions of other interactions, say, imagine it being stuck in a mousetrap and not being able to get out, thus enabling the cat to use a mousetrap. But this means that the cat uses existing, previous ideas that cannot be confused with the present, that is, it is aware of the past. The past and time for a person appears when it is possible to compare a given action with previous ones being preserved as information (memory).

Epicurus once said that there is no death because while we live it does not yet exist, and when we die, we no longer exist. Indeed, this is quite true for animals. However, if consciousness comes to a cat, by observing other cats it would be able to draw conclusions about growing up, aging, and death. Consequently, it would be able to compare interactions of a specific moment, for example, decrepitude of the body, weakness, and fatigue to what it was before. Thus, time will emerge for it. Though its body as a complex system it would be able to accumulate data on biophysical interactions (age, for example), to compare it with previous feelings or with the appearance and actions of other cats, if it manages to perceive them as species of the same genus. Finally, the idea of personal death would visit it, it would become mortal and would start asking “what comes next” and “what is the purpose for everything”. Should this gloomy insight never visit it, it would keep bearing the burdens of life, old age, hunger, illness, living “here and now”, having no idea of death or what it was before it was born.

All this is somewhat similar to the biblical parable about the fruit of the tree of knowledge. People in paradise were immortal not because they lived for a long time, but due to their inability to comprehend death or lengthy processes (this will come after tasting its fruits), which means that to them they did not exist. Having understood this, that is, having reflected the actions and compared them, having divided them in their memory into what happened in the past and what would probably happen in the future, into what is bad and what is good, people ceased to be immortal, the concepts of good and evil, morality appeared being abstract notions unrelated to time, the future or the past.

To summarize the above, there are two mutually exclusive trends. The increasing complexity is the cause for understanding oneself as a separate entity. The very possibility for the individual’s further **development** separates him from ²⁵**У** (part of the Human-Society System) and brings him to the new level ³³**Я**; however, this same selection brings in addition the entropy trap, that is, the concept of **mortality**, thus obstructing the implementation of Nash Law.

That can be expressed as follows: $^{33}\mathbf{J} \propto 10^{-2}\mathbf{K} \rightarrow [t_0, t_k]$ where t_0 and t_k stand for the beginning and end of life. If we compare this entry with expression 1.1. in Chapter 1, with the expression for the entropy in Chapter 4, and so on, it would become clear that the limitation of life that is the definition of a time period important for the individual, will be less important for society and will have no meaning whatsoever for simpler levels and be quite similar to the way free parameters are formed according to TGS 1.

For level $^{33}\mathbf{J}$, a person's death is a direct threat to further implementation of Nash Law, which determines the universe itself. There is nothing terrible or irreparable in one's death for society, being part of the Man-Society System, especially if the person has managed to create useful conditions for those around him: a house, material assets, including special objects (art, technology) and/or has raised children. This might be relatively bad for an experienced person who wanted to continue living and could have done a lot more for future development. Anyway, for us, **individual** biological beings, death and the knowledge of approaching death is an absolute catastrophe.

Considering that we ourselves are a kind of complexity arrowhead⁸⁶ and that it continues through us, there will be no reason to doubt that sooner or later, the biological basis of the Man's part in the Man-Society System will change so that only personal desire will be the basis for death. And only then the so-called "mature" level $^{33}\mathbf{J}$ will appear. The fact that we now live much longer than, say, in the early Middle Ages is indicative of this. Our task is to extend our lives, and who can accomplish it except us? We must continue to implement Nash Law, we must continue to live, identify and change the mechanisms of protein denaturation, correct biochemical processes and finally download the electrical impulses of consciousness to the computer.

But this would probably happen later, and what about us, living here and now, who unfortunately are mortal? We are simply unlucky – we already distinguish and realize our "I", but we do not yet control the biological basis of this "I". We find ourselves in some sort of "intercomplexity", in between levels, and when mentioning "the purpose of life" should add "unfortunately" or "deplorably".

It is perhaps possible to formulate an "intermediate" purpose of life, with the intermediate goal of anchoring the $^{33}\mathbf{J}$ level, from which the implementation of Nash Law will continue... In particular, it will be necessary to eliminate contradictions in the Man-Society System, otherwise there will be no basis for the full development of the $^{33}\mathbf{J}$ level. Should contradictions continue

⁸⁶ The purpose of any level including $^{25}\mathbf{Q}$ and $^{33}\mathbf{J}$ with all previous and subsequent ones exists only in the complexity's unlimited realization.

and multiply, should society's pressure on the individual prevail or should individuals reject the need for social influence, then there surely will be no basis for further development.

Henceforth there still will remain hope, faith that somehow our bad luck and work for the benefit of the future will somehow be recompensed. By whom? Either by the absolute complexity, which will record and store all personal relationships of an individual (resurrect him), and thus falling under the religion department, or with the help of a certain high, but finite level of complexity, which will make it possible to restore the entire complex of relationships that forms every personality. This would also imply resurrection, let us call it a scientific one. And then, should such high level of complexity be found, the ideas of the Russian philosopher Nikolai Fedorovich Fedorov, who has set the general return to life, general resurrection of all our ancestors, all who have ever lived, as the basic goal of society, will turn out to be correct. Let me note once again that the possibility of implementing either of the two options cannot in principle be proven from our level.

Annex to Chapter 15

Let me dwell in more detail on the difficulties that one encounters even with a superficial view on the problem of the purpose of life. Firstly, attention should be paid to the unreasonable demands in respect of the results of its possible solution. By default, most people believe that having found the purpose of life (whatever that means), some positive changes would happen to them. Something hitherto closed up will be revealed to a person, life will improve, spiritual strength will appear including a new look at things and at oneself. Moreover, people think that if this very reason turns out to be shared by every one of us, then all people will form a new just society, become much closer to each other... Nothing but weird expectations. If someone has been churning out a component at a factory for years, and then they told him that it serves as part for, say, a refrigerator, and the purpose of his work is to better preserve food, it is unlikely that this will make the operator equal to the gods or make the work team friendlier. Same is here, one can find out the place and reasons for a person to appear in the universe, make serious assumptions about mankind's future fate, realize the essence of his "I", but this will not change a person, except for his moral and psychological terms, and even then, depressions should not be excluded.

On the other hand, the search for a purpose is often associated with the search for justification for the (apparent) meaninglessness of death. Here a contradiction arises between the cause-and-effect (see Chapter 10) nature of the relationships that make up our daily activities and the unclear (at least not clear for everyone) goal of our personal biological development from birth to aging and, alas, beyond. Evidently, the reason for farming is to maintain us well-fed, the reason for traveling by bus is to arrive at a given place. All these thoughtful actions support, increase or should increase our living standards, make life better or simply possible. The aimless actions of a drunk or crazy person apparently do not end well. Therefore, the knowledge about the inevitability of successive aging and death will irritate any person, forcing us to pose the question

regarding the final result of all our previous, seemingly purposeful actions, given the fact that passing away of other mortals normally brings us nothing good. Thus, a simple question arises about the purpose of all thought-out daily actions, since the visible result of all deeds and thoughts will stay six feet under.

The problem has several solutions. One common assumption is that in the end, after passing away, everything would be better than it was if everything was done correctly while living. This looks as if it were a kind of an extrapolation of our usual cause and effect actions regarding post-death existence. Another solution will be to find reason in a certain superstructure over our lives comprising our actions that were beneficial for the society rather than for the individual. In this case it will be quite logical to assume that after death there is just void. For example, the individual's righteous life as well as dignified death improving his children's and family life as well as that of the society and state would make a good reason for his actions. Close to that will be the notion of preserving one's dignity that surpasses death while honestly serving the master, God, etc. Some of these assumptions have already been discarded, for example, that the purpose of life is to serve the overlord (to give one's life for the king, the Japanese samurai's hara-kiri) while others are strengthening their positions taking into account the visible nature of social evolution even within the lifetime of one person. Indeed, although at every given moment the sum of social actions does not seem to be a conscious process (for some reason we say "the world has gone crazy"), over the course of centuries, and recently, with the acceleration of progress, and over decades, everything seems to be improving, at least if we consider a richer and more satisfying life to be better.

Consequently, it will be quite logical to assume that the purpose of our life is to fulfill part of the social plan, which has, if not a final clear idea, then at least an intermediate goal in the form of constantly successful development. One can give his life or live for his family, for his country..., the reason then would be serving other people, society and, if this service is purposeful, it will manifest itself through completely objective results and will be especially successful should this belief combine the idea of resurrection which is common for many religions.

However, the controversy of asymmetry in personal and social results persists. On the one hand, it seems that our daily private actions are 99% aimed at ourselves, at solving our problems: getting food, a roof over our heads, raising children, going to work, and so on. On the other hand, the purpose of an individual life turns out to be full-time work for some other people, for future generations, for society in general (about which a lot of people do not care at all) leaving nothing for themselves except for a possible "thank you" coming from their descendants. This really hurts.

As we can see from this Chapter, the notion of resentment turns out to be quite natural, since there is no solution to the issue of personal being at the stage of incomplete formation of the ³³**J** level; what we have is just understanding of such incompleteness and a desire to solve it. In case there is a chance to prolong our mental activity for an unlimited number of years (limited by a tragic accident, mental fatigue or personal desire), then the issue of purpose will be resolved precisely by human existence itself, by active life, leading to a further increase in complexity. Too many "ifs", sorry. For now, what we have is just a contradiction between the levels ²⁵**Q** and ³³**J** (see Chapter 13), and the entropy trap. At this level, we can only talk about an intermediate goal, which consists in creative existence, maintaining society and oneself, a person, at the highest level of development striving for the maximum possible

complexity rate from ³³**Я** level and higher through perhaps cumulative acceleration of personal and social development due to the increasing number of contacts. The pinnacle of such an understanding of the purpose of life at this stage of implementation of Nash Law is the maximum increase in the duration of active human life, ideally – unlimited extension of personal activity in time (full implementation of Nash Law at the ³³**Я** level).

There is one more topic, though, which I would like to separate from previous reasoning. If we assume that our actions are part of an hierarchy, does this mean that our current feelings and aspirations, thoughts, both smart and stupid, are all these 99% of mental and physical actions which define us separating from other people and “inert matter” will all disappear with our physical disappearance? Or is there still hope for them to remain as “past” in the hierarchy (see Chapter 6)?

I am not talking about the insights of geniuses and the painstaking work of non-geniuses or just talented people who implement Nash Law. I am talking about myriads of feelings and thoughts that accompany ordinary existence and are important only for a specific person being “swiftly mortal”, so to speak. Or are these just fluctuations of the complexity’s hierarchy, which mean nothing to it?

Perhaps they do mean something because, as it was mentioned before, even erroneous information is also important for higher levels. What will become the basis for further growth of complexity is beyond our comprehension. Neither can we realize how important is the time spent by a person for personal ends. We have no idea whether our often vulgar and empty acts, important to us, and not to Nash Law, our overall memory and information that allows us to realize ourselves, will remain necessary and reproducible in the universe in the future.

Chapter 16. Miracle: Relative and Absolute

In previous chapters we examined the division of knowledge into science, philosophy, and religion. In general, it is worth repeating that the division of the universe into parts described by separate postulates highlights lower levels where “objective, testable laws” outlined by natural sciences can be used. Here we can only say that if a statement is unverifiable, it is unscientific. It is the humanities that study, to the extent possible, our human levels from ²⁵**У** up to ³³**Я**. As for verification and objectivity, it is much more difficult here, but by modeling individual, limited relationships pertaining to our life, it is also possible to obtain verifiable data.

Further, we must take into account that from the perspective of TGS 2, for any level of complexity, interactions of a higher level will be incognizable, that is, they cannot be reduced to known relationships. Nevertheless, we can **try** to apply Nash Law further, going beyond our ³³**Я** level, carrying on with the hierarchy based on the principles of TGS and the concept of free parameters.

Referring to the next, hypothetical level of complexity ³⁴ Θ we can at once say that it should be based on the previous ³³ \mathcal{J} level. At the new level, parts of the previous one, these being individuals, will be highlighted, making this selection using a new parameter, which provides the individuals with a new complexity in order to be distinguished. We could call it the complexity of a superman should it not be for a negative historical connotation, so we would rather call this parameter “civilizational”, which arises in an individual in the process of development.⁸⁷ The ³⁴ Θ level adds importance to the relationships of the previous level because it is based on them, so that the death of an individual will disrupt them. I repeat that all personalities will be highlighted on a new level, so that it would be possible to overcome the entropy trap discussed in the previous chapter.

Does this new level apply only to our earthly future? Obviously, it does not as there cannot be just one place in space for the complexity greater than hydrogen plasma to emerge. Hence, we have to talk about other civilizations.

The scientific community does not like talking about “all sorts of other civilizations”. Only prominent scientists can afford it in their philosophical reasoning staying out of reach of their colleagues’ possible mockery. And this is correct, since the topic itself requires reasonings unrelated to real experience, ideas that everyone can introduce to the best of his imagination with a great deal of subjectivity. Therefore, the scientific community tends to ignore such issues possibly excepting certain astronomical assumptions about the possible density of earth-like planets in the universe, as well as general philosophical and moral reasoning.

Considering all this, it would become clear that there is no unified approach to the capabilities of someone else’s mind. It simply cannot exist since we, the observers, cannot be excluded from the picture under study, as discussed above. Without it there would be no scientific approach.

However, this topic becomes not at all abstract from the standpoint of natural philosophy and Nash Law, considering that we managed to take into account the influence of the observer in the picture of the world. In this case, by analogy, it would make sense to consider all **other living observers**, not necessarily the earthly community. Indeed, it was constantly pointed out above that the implementation of Nash Law reflects all levels of the firmament, and thus it would be completely impossible to neglect the unlimited hierarchy of complexity as well as the extraterrestrial projection of levels ¹² \mathcal{M} , ³³ \mathcal{J} and other even higher levels.

⁸⁷ However, the singularity of an individual can be conceptualized, for example, as a result of a successful attempt at self-knowledge. The concept of the self, the basis of the new complexity, then acquires a transcendental nature. This is an example of the precariousness of any modeling of the future – indeed, this is where TGS 2 works against us.

At the same time, the motives of possible representatives of a more developed civilization cannot differ much from ours, because in the figurative sense we have the same roots. It is also quite possible, as the famous paleontologist and writer Ivan Efremov was convinced, that representatives of another realization of the $^{25}\Psi$ level would be anthropomorphic. Even if it is a thinking ocean, the important thing is that we have been formed under the same universal conditions of levels from 1A up to $^{33}\mathcal{J}$ and beyond. Even though psychology or mental activity might be different, the **results** of mental processes cannot differ as Nash Law is unique. Although most people have no clue of quantum mechanics, they use devices that are based on its principles (such as cell phones), they know what they can get while using them and while exchanging impressions about their work. The results of communicating through radio waves or digital technology would be the same in case of any other civilization. It does not really matter what kind of psychophysiology we have, the results of our thinking and moral character should be similar, being based on the same levels of complexity.

However, if another civilization (let me put it this way) has turned out to pertain to levels higher than $^{25}\Psi$ or $^{33}\mathcal{J}$, then the relations that characterize them and the set of resulting actions would be incomprehensible for our level, being irreducible to those typical for $^{25}\Psi$ level and beyond individual people's comprehension (see Figure 14.1). Moreover, since for the $^{34}\Theta$ level our actions, behavior and their consequences are completely determined it would be possible, by introducing certain conditions that are a priori unknown to us, to determine the behavior of any individual. In other words, while our own and society's actions with their causes and consequences are quite predictable for a higher complexity, for us they are not. There is no way to predetermine your relationships while staying at your level. We can also say that for us, the actions of advanced extraterrestrial intelligence, whatever that means, would look like a miracle. That is why American Indians who lacked technologies to produce iron and firearms thought the invading Europeans were gods.

At the same time, I cannot agree with the assumption, shared by quite a number of serious scientists, including the famous Hawking, that more developed civilizations would necessarily bring us either enslavement or destruction. This is because we try to explore the unknown of another complexity using our past relationships that are well known to us. This reminds of the joke about a drunkard who was searching for his lost wallet under a street lamp at night because it was light there. Speaking of fears, people seek and find reflections of their own ancient instincts when a stronger, more aggressive group should seize more for itself, be it land, minerals, planets, star systems, together with enslaving or destroying the natives. Moreover, their great strength enforced by their advanced technologies (the possibility of star travel), is

considered to be a measure of greater development than ours. Note – not the strength of spirit or dignity, not the strength of helping the weak, which in the end brings more benefits than the destruction of the weak, neither of these. In fact, their high level of development is measured just by the ability to capture material resources. In the meantime, education, which we consider to be the most important resource even at our level, cannot be captured. A prosperous country should be rich in scientists, not in gold, rich in enthusiasts and volunteers, not in conquistadors, more complexity can be brought by people of good will, not by terrorists.

There is no doubt that we will understand representatives of a civilization that is currently on the same level $^{25}\mathcal{U}$ as we are, and perhaps we will even fight against it (we have a lot of terrorists of all stripes, including information ones). For better or worse, at this stage of development, physical contact is impossible due to the light barrier. Who knows, it may be quite beneficial for us that we have not met yet. But let me note once again that the light barrier only limits our level of complexity. For levels below 6E , for example, space and speed do not exist at all, while it is completely unimaginable what outer space is for higher levels, say, $^{34}\mathcal{O}$, and whether it will be necessary to overcome space constraints.⁸⁸ Most likely, the contact, whatever it is, will take place only when we become slightly different, more complex.

Until then we will be totally unable to understand and reflect in familiar terms what a more developed (complex) civilization will look like due to the principle of complexity's indeterminacy. Taking into consideration the $^{34}\mathcal{O}$ level, we will no longer be at the pinnacle of development, which means that TGS 2 will be working against us (see Figure 16.1.). This, in particular, explains the silence of space. We are expecting "interstellar ships" that would be familiar and **understandable to us** (for our level of complexity), considering them to be some kind of metal cans with air inside equipped with jet engines. Nevertheless, a simple school physics course tells us that such thing will be useless for interstellar flights. That is why we will never see such alien tins.

Protagoras once said that a person cannot climb higher in his thoughts than himself. What is meant, of course, is not the fact of mere thinking – no one can forbid it – but the meaninglessness of this activity. According to TGS 2, actions taken from higher levels of complexity will be completely inexplicable phenomena for us, a kind of miracle. But this miracle will be, so to speak, **relative** because these new parameters are based fundamentally on the same relationships as in our universe, and are in principle achievable and cognizable for us. Our

⁸⁸ For example, should modelling be possible with any predetermined accuracy, what will be the need for space travel unless we get exactly the same results?

gradual further development from ²⁵ Ψ to full ³³ \mathcal{R} level and beyond will allow us sooner or later to approach the required level, and, therefore, to contact and understand its representatives. So, the path to other civilizations lies not through space, but rather through us, through development

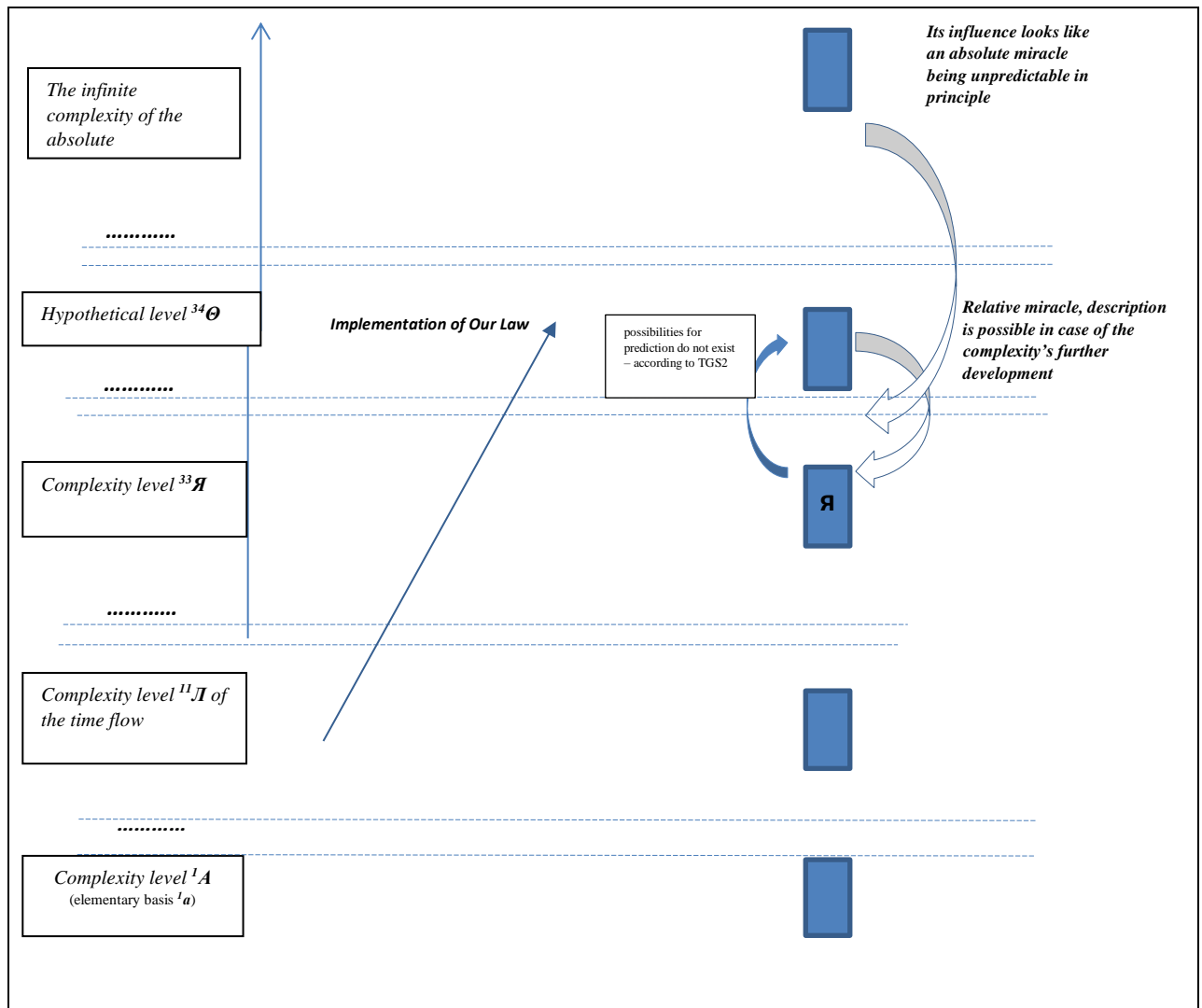


Figure 16.1 For the complexity level ³³ \mathcal{R} higher-levels relationships and parameters will be unpredictable in principle and their influence will seem miraculous. Nevertheless, by accumulating knowledge and implementing Nash Law, higher levels than the ³³ \mathcal{R} level can be reached. What is not achievable from the current perspective is the infinite complexity, the absolute.

of society and the personality.

It is difficult to say what these steps to a higher level would look like, just a few things may be discernible. The greatest progress is now taking place in the field of mass communications and interactions between people. The emergence of writing, printing, mass literacy, radio and television, mass media, the Internet, social networks allow everyone to communicate with a potentially unlimited number of other people, surpassing territorial boundaries. The number of interpersonal relationships increases exponentially, and is already limited by the biochemical capabilities of our brain. So contact is already underway, at the

moment we are still establishing contacts with each other, forming the maximum possible number of contacts (selecting, hopefully, the most useful ones) within our civilization, still only forming it into some potentially new level. When we reach the next level ³⁴**Θ** (prospects for the formation of a “mature” level ³³**Θ**, independent of an individual’s mortality were discussed earlier) we will have an opportunity to establish relations with other civilizations. In the light of these relations, problems of the light barrier and all these primitive spaceships we currently use will lose significance.

Another question arises when it comes to the existence of Nash Law. What is the cause for it (and consequently, for the firmament)? While this is just an experimental rule, we can only assume that it will continue to be implemented in the future, that people will not stop creating new things, and/or the increase in complexity in the universe will not stop altogether. The easiest way is to declare this law as an absolute in order to cut off such questions. But the very idea of unlimited complexity and further complications being underway prompts the question of an infinite level of complexity, or rather an **absolute** level, since numerical characteristics are not suitable in this case. What characterizes this complexity? From our point of view, it is an infinite number of parameters, each of which will then be completely defined and determined, since it can be considered from any, arbitrarily large number of levels. In particular, any relationship, any parameter, including in the Man-Society System or level ³³**Я**, no matter how many there are, will be completely defined for the absolutely great complexity. And what about free will? It remains a free parameter, but only for our level and, naturally, quite predictable for the absolute. Whatever effect this infinite complexity will produce on the lower levels will be perceived as an absolute miracle (Figure 16.1), simply because it is not reducible to relations of any finite level, be it either the “Newtonian” ⁹**И**, or ²⁵**У**, or the hypothetical ³⁴**Θ**.

This helps us to explain what Nash Law means: it can be a kind of free parameter for the absolute complexity. In this case, being a free parameter, it will be inexplicable (see TGS 2) from any other **finite** levels. At the same time, it turns out to be secondary in relation to absolute complexity, being completely determined by it. This is what determines our position, that of our firmament, the material universe, relative to the absolute.

Again, all reasoning concerning absolute complexity stem just from the notion of increasing complexity. The point is that, having set the growth of complexity from level **1A** onwards, we will be unable to stop considering it at any higher level, not even at the incognizable level ³⁴**Θ**. The question of the absolute arises not from faith, but from the existence of a hierarchy of an infinite number of levels, which enables us to talk about ever-higher complexities, going towards infinity.

Annex to Chapter 16

In order to comment on the subject of the absolute, I would like to look into the question of God's creation of the laws of nature, well known to philosophers, but often misinterpreted by ordinary people. We often hear that the formation of the universe as well as ourselves is due to the action of the laws of nature (by introducing fundamental constants, the Pauli principle, fine tuning, etc.). These laws are completely cognizable, their number is finite, and their fulfillment does not require additional influence of God. This logic falls apart, however, when we ask the question: "Who created these particular laws of nature"? The usual answer to this question will be "the Almighty", which seems to be proof of His existence.

Nevertheless, we can continue asking who created the Almighty, then who created the one who created Him... and so on. Such divine recursion can be interrupted by the comment that the Almighty does not need creation. He has Himself in His own power, life, creation, which are meaningless without Him. We can say that this is an absolute, in relation to which any concepts (laws, life, development) turn out to be secondary. This, however, is not a suitable explanation. If we introduce the concept of the absolute in this sense, then why do we need to refer exclusively to the Almighty? Let us call the laws of nature "absolute" and we will get a completely materialistic universe, where there will be no need for the concept of God. Nonetheless, in the latter case these laws will not work for public and personal relations... so we will have to turn to Divine powers again.

In general, this is a good illustration of the fact that it is impossible to determine the existence of God or His absence by logical constructs. This is not surprising: according to TGS 2 there is no way to determine higher complexity levels from the lower ones.

The unlimitedly increasing hierarchy of complexity considered in this study (I wonder what can limit it – see Chapter 7), is precisely the subject from which the concepts of laws and the absolute can be derived.

Firstly, the laws are not at all absolute, together with space, time, matter they are totally relational, as has at length been discussed previously. Secondly, for the unlimitedly increasing complexity, which can then be called "absolute", both time and all kinds of relationships and parameters turn out to be deterministic, predictable (for infinite/absolute complexity, each individual parameter is included in an infinite number of more complex parameters). At the same time, the absolute of complexity includes all possible levels of the hierarchy, but does not violate the parameters of any given complexity, in particular, for level ²³ Ψ it will be so called freedom of the future, for ³³ \mathcal{J} , free will. And vice versa, as shown at the end of this chapter, the very hierarchy of complexity, the universe being determined by Nash Law, becomes its parameter.

Conclusion

In modern natural sciences, it is believed that the conditions of origin (initial and boundary conditions for the genesis of the universe) as well as natural laws do provide answers to the questions of the existence of the universe. Historically, this position stems from ancient natural philosophy, which sought the basis and root cause of all things from common psychology, which implies responsibility for everything around us. It also comes from the successes of mechanics, which since the 17th century has been capable of predicting the behavior of material bodies at any moment in time since the initial conditions were set. What crowns this concept is the first push or first impulse notion. Previously it was attributed to the Creator, then to the Big Bang, or initial fluctuation. Figuratively speaking, someone pushed, and the universe rushed into development. The role of virtual rails – directions of development after the initial push, is attributed to the laws of physics, and of nature in general. To such rails the concept of “flowing” time is added (time in science is the “environment” of development). Evidently there is quite a number postulates that are to be introduced: the Big Bang containing all further development, the flow of time, space, laws... The usual scientific description assumes that by introducing certain quantities (obtained through experiments), one can obtain the characteristics of the related systems. Here we assume the opposite postulating the plurality of systemic relations that are a priori **different in complexity** and cannot be reduced to one another. They can only be arranged from the less complex to the more complex. A kind of **hierarchy** of complexity is formed. What is important is that it will be permeated with free parameters that determine the difference between systems.

The very (empirical) **fact** of the hierarchical increase in complexity is called Nash Law (see Chapter 7). Just as there is no stationary (material) universe, there is no firmament without growing complexity. While considering the firmament as a consequence of the hierarchy of complexity, the universe and we altogether are the essence of the implementation of Nash Law (Chapter 7), which forms the structures that we call nature, even the laws themselves being a consequence of the hierarchy. Then neither “inert matter” nor a “primary impulse” are needed.⁸⁹ The preceding chapters develop constructs that show the relevance of such a vision.

An important consequence then arises: with such a definition of relations, there will be no difference between the composition of “inert matter”, mathematical structures, or social connections. Therefore, it became possible to take into account the influence of the observer and generally determine the place of social relations in the picture of the world. This formation is shown schematically in Fig. 7.1, the extension of columns from left to right means an increase in

⁸⁹ Tranquility in any of its manifestations is the observer' artifice.

complexity. The interactions between different levels are determined by the laws of nature, axioms, and physical constants. At the same time, as noted at the end of Chapter 1, by setting postulates and constants being unrelated to certain levels, we get a **fragmented** picture of the world – a separate ideal world of mathematical constructs, separate physics for the microcosm and the macrocosm, separate biological and social laws.

It should be emphasized that any interactions at different levels lead to free parameters, to new interactions even without an observer. This notion allows us to understand why mathematics, a deductive science, was able to so miraculously explain and predict known natural phenomena. Indeed, what is the connection between formal logic and space? An explanation suggests itself (almost according to Plato): it is through the introduction into the world of mathematical ideal entities, the reflection of which is our sinful existence. Meanwhile, in accordance with Nash Law, and taking into account common “hierarchical roots” of all natural phenomena, these are mathematical constructs that compose the unified basis for more complex relationships (discussed at the end of Chapter 9). Mathematics then turns out to be part of natural science, part of our world, not just some ideal world.

The above formulations – physical, mathematical, and biological – do change the formalism. The tasks of studying natural relationships and using the results for our needs are better handled by existing mathematics, physics, biology, based on clear axioms and experimental data, even if they have limited application, beyond which they lead to paradoxes. The definition of time, the difference between the “beginning” point and the rest on the “arrow of time”, the naturalness of spatial three-dimensionality and in general the definition of the concepts of matter and space for now remain rather philosophical subjects, or more precisely, natural philosophical ones, being quite distant from the range of problems modern science is dealing with. Scientists can successfully cope with generic notions about these things, or even without having any clear perception about them.⁹⁰

What does “formalism” described in this paper explain? Let me mention some consequences. The Euclidean metric of our space, being currently introduced “manually” as “the most natural” one, is a consequence of emergence of spatial relations. The expansion of the universe is a reflection of the fact that relations 1a differ from each other – see Fig. 9.1, which brings us to level 2B (discussed at the beginning of Chapter 2). Considering that complexity is constantly growing (there is nothing to stop it since it is not a process in space and time, it is the

⁹⁰ I recall the notorious phrase “Shut up and count” as a response to attempts to clarify the essence of the features of the microcosm.

very manifestation of space, time...), starting from level 6E it looks like a constant division of each point, an increase in their number, that is, an expansion of space.

There cannot but be a curvature of space when specifying matter (a material point) through complications from 6E up to ${}^8\mathbf{3}$. Indeed, the distance matrix (expression 3.2) will not be equal to zero when its elements are interdependent. This is exactly what happens when some of its elements are distinguished in relation to others, which is the basis of level ${}^8\mathbf{3}$, when we can talk about material points. The difference from zero of the distance matrix is the curvature of space (discussed in the Annex to Chapter 9).

There cannot be a probabilistic description of the microcosm, since differences arise not due to size, but due to complexity. As we have already mentioned in Chapter 8, in order to describe relations of lower complexity it is necessary to use mathematical constructs that make it possible to reduce the number of relations, primarily wave functions, a probabilistic description. Everett's idea of the formation of more and more new universes to explain just one fact of a probabilistic description is similar to making mountains out of molehills or even sliding into the Everett abyss.

There cannot be a real space having four, eleven or more dimensions, which is what cosmologists love to operate with. Just like time is not a full-fledged coordinate. The space $3+1$, where one of the quantities is determined due to the other three, is part of the hierarchy, the level of its relationship is obtained from the previous one (from quaternions). Further complication does not lead to an increase in dimension (the concept of number ends at quaternions), but to waves, then to material bodies and so on.

Neither can time be a self-essence not only outside of space, but also outside of the general development of the universe. Consequently, time cannot be the only characteristic of our world's relations, since the development of the universe implies different levels, and, therefore, we must talk about different layers of time for each of them.

Also, the horizon problem obtains its natural explanation. Let me recall that the temperature of the cosmic microwave background radiation at very distant points of the universe is almost the same, though the horizons of these points do not intersect, so no signals could pass between them. A popular solution to the horizon problem has been proposed within the framework of the inflation theory. However, what follows from the notion of complexity's hierarchy is the resulting raggedness of matter (division into separate clouds of gas) being a consequence of growing complexity up to level 9H , meaning that there were no **separate** objects **before** the universe's complexity grew up to these levels (about several millennia after the Big

Bang). The resulting clumps in hydrogen (possibly under the influence of non-stationary fields – level ⁷**J**) could not in principle have had **different** initial conditions in different parts of the universe, no matter how far apart they were. Subsequently, the horizon problem simply does not exist. The previous level ⁶**E** does not imply a difference in its parts and parts as such.

Finally, the emergence of the mind is not at all an amazing or the rarest fluctuation of organic matter, being quite a logical **result** of the same law (Nash Law), the result of which is not just the human “Self”, but also, earlier, elementary interactions like space, chemical elements, and life. The “humanitarian” consequences of Nash Law are not worth repeating here – Chapters 13 through 16 describe them in great detail.

A few words about some physically testable predictions. Firstly, the description of quantum processes in the microcosm should look as if they develop in a geometric space with fewer than three dimensions, being fractional in particular. The theory of fractals operating with the space having a fractional number of dimensions, allows us to consider a smaller number of relationships (as well as the introduction of a probabilistic description) and notice more subtle effects in the microcosm. Again, this does not mean that the dimension of space is fractional, it can serve as a mathematically convenient description of interactions of the microcosm.

Secondly, processes in the early universe can also be described in terms of space having less than three dimensions. Thus, most likely, theories operating with two-dimensional space after the Big Bang may be quite useful.⁹¹

Also, ultra-small black holes could not have arisen in the first milliseconds after the Big Bang, since their presence means that space has split into parts. This could not have happened before the emergence of spatial relations. Namely, the search for such objects, or more precisely, the search for radiation as a result of their explosive destruction, is an important task for modern astrophysics.

It is worth revisiting the important entropy issue. The laws of nature currently in use imply the isolation of some interactions, including free parameters according to TGS. For example, the fall of a body in a gravitational field tacitly implies that the body was raised, has got potential energy, and, in general, has acquired certain **initial conditions** after being **distinguished** among others. Also, turning to the description of thermodynamics, the distribution of compressed gas molecules over a large vessel implies that the molecules were first brought into a special state (in mental or real experiments), and then left to their own devices, to the influence of simpler relations, where there is no specialness. What happens then is an

⁹¹ *The hypothesis of the holographic principle already exists.*

equalization (from a higher level!) of **one** initial state with all others, subsequent ones, the **difference** between which is **not defined**. Entropy can increase only in systems that are closed in the sense of increasing complexity. Then individual stars would burn out, individual apples would go rotten. The rule of increasing entropy only works if we (or natural conditions) “carve out” the relationships of simpler levels from the whole picture, creating an entropy trap (Chapter 5). All this, I repeat, is a consequence of the fact that the laws describe interactions from a higher level and attribute their own parameters to simpler ones. If we take into account the complexity of more general structures, of which the selected systems form parts, then there will be no entropic death: after a supernova, heavy elements would remain, forming planets with a complex geochemical composition in stars of subsequent generations, apple seeds would germinate, and so on in everything – the increase in complexity continues.

A few words about “Occam’s razor”, the rule that entities should not be multiplied unnecessarily, which is the methodological basis of modern natural science. The new ideas introduced here fit into a broader idea, which I can call not just a razor cutting off everything unnecessary, but also a “glue” combining customary entities into one, reducing their number when possible. Indeed, such “gluing” is pervading all modern science, where over the last century space and time have been united in GTR, electric, magnetic and weak interactions, into electroweak interaction, the difference between hundreds of chemical elements has been reduced (glued, so to speak) to different sets of protons, neutrons and electrons, elementary particles are being arranged in the SU 4 symmetry group. These constructs correspond well to this generalized “glue” principle of Occam’s razor. Nash Law remains generally the only entity that forms the remaining relationships.⁹²

When we attribute laws and parameters to surrounding relationships, we inadvertently introduce our high-level complexity into the description of much simpler relationships. It is worth giving examples, discussed in different chapters of how higher levels influence lower ones, that is, TGS 1.

With the introduction of increasingly complex numerical relations (Chapter 2), it turns out that the location of prime numbers on the numerical axis cannot in principle be predicted from a higher level (at level ³**B** there are no differences other than by the basic unit). In other words, there cannot be formulas in which prime numbers will be defined through composite or real numbers.

It is not surprising that by applying the laws we have formulated, we obtain a result that leads exactly to a description of the surrounding world after the Big Bang, to what is called the

⁹² As I have said earlier, without the concept of “relation”, matter is meaningless; it makes no sense to study a “thing in itself” or even to talk about its existence if it does not manifest itself in any way.

Anthropic principle. While setting physical constants and interactions in the systems under study, we, figuratively speaking, contaminate them with our influence and violate the purity of the experiment. If interactions and constants apply for levels 6E , 8Z , and ${}^{11}J$, then we introduce a ready-made answer into the problem under study according to the hierarchy. Then, the “fine tuning” of physical constants that are perfectly suited specifically for our universe is not at all surprising – we can only talk about “wrong” values of the constants from higher levels. At lower levels there is simply no difference in magnitude. Moving on to the provisions of the complexity’s hierarchy, neither the mysteries of fine tuning nor the Anthropic principle itself will emerge.

It is generally accepted that the Pauli principle does not allow elementary particles to merge into one. Therefore, they usually say: “The implementation of the Pauli principle created a world with separate particles.” We describe the **opposite** idea: initially the complexity increased so significantly that first different relations were determined (level 2B , 3C – Chapter 2), and then this fact of difference was defined as the Pauli principle. It seems that it does not make much difference whether the law (Pauli’s, for example) is more primary than the levels of complexity or vice versa. This reminds me of the chicken or the egg causality dilemma. Yes, we can by all means consider natural laws to be primary, but then we will have to introduce additional postulates in order to implement them: three-dimensional space, time, somehow set the pace for universal development, and so on. Otherwise, we can get by just considering the hierarchy of complexity.

Nor can we assume that the early universe “has expanded and become colder.” In actual fact the Universe became more complex, which means, according to the TGS, that new parameters of space and temperature appeared. This differs from the modern concept, postulating that in a hot universe, in the first seconds, photons had such high energy that due to colliding heavy particles and antiparticles were first born, and then annihilated. Later on, when the universe became colder, pairs of lighter particles were formed – electrons and positrons. From the perspectives of development of the hierarchy, that is, the implementation of Nash Law, a violation of symmetry has occurred, which looks like a predominance of particles over antiparticles. This is what we can call a complex symmetry breaking. In general, each **new** emerging **level** occurring after a new disposition was selected from previously equivalent ones will be the **symmetry breaking**.⁹³ Of all the possible relationships, only those remain that will

⁹³ The famous physicist Freeman Dyson once pointed to the fact that the development of the Universe starting from the very beginning looked like a continuous sequence of symmetry breaking. At the moment of its origin, the universe was absolutely symmetrical and homogeneous, but as it cooled down, one symmetry after another was broken, and an ever-increasing variety of structures emerged. The phenomenon of life naturally fits into this picture,

lead to creating a next level. For the early universe this would mean both cooling and the emergence of space 3+1. The result is self-sustaining complexity – through stable elements suitable for the next step.

In that case, while studying complexity why not get by the existing mathematical approaches, the theory of nonequilibrium structures, self-organized criticality, and, finally, synergetics? In systems that are far from equilibrium, such amazing structures will arise... But the flows of energy that sustain such dispositions will sooner or later disappear, complex structures will fall apart. What's next? They will remain in the form of fluctuations, and will be able to “stay” only if they themselves turn out to be the **basis** for further complications.

Thus, among carbon chains, only ribozymes can self-copy, and this will distinguish them from all others and form the basis of a new level, this time a biological one. The formation of other organic substances, even more complex ones, only makes sense if they are used in reactions to maintain the biological level. Given that this is true for any level, **existence** will imply creating relationships for further complexity, be it ribozymes, heavy chemical elements, physical laws, space, consciousness, etc. It becomes evident that the implementation of Nash Law, its infinity, symmetry-breakings while transiting to the next level is exactly what the universe is. This is not a characteristic of the world around us, this is what it is. There is no need for either primordial matter or the “first impulse” from which “everything began”; our universe in fact is development.

Importantly, we cannot use the known essences of time, space, matter, the laws of nature, putting them in just one row being separated by commas and expecting them to be a reflection of some deeper essence, the Big Bang, for example. This would be the case if the relations' systems in the world were finite and, therefore, unambiguously predetermined and also reducible to each other. However, the unlimited nature of the hierarchy means that if there is one level of relationship, then the next one is implied. Could there really be limitations? At this level of Nash Law, we, the Man-Society System is what is implementing it, it is from us and through us that a new level, new relationships arise.

There is no natural law which would make pixels on an LCD screen form these particular letter lines. What we really have is the law of universal gravitation, but there is no such influence that can make chemical elements integrated into printing ink to draw these letter lines on paper. Even so, our world is one. The world of physics and the world of human will should not exist

for life, too, is symmetry-breaking. The development of life itself is accompanied by further differentiation and growth of diversity. “To this process of growth and diversification”, Dyson “sees no end”.

separately. Then the formation of the Man-Society System and, subsequently, consciousness and, in particular, the emergence of the “I” who writes these lines and the “I” who reads them is not an accident, but a natural part of development.⁹⁴ This level makes it possible to consolidate information, search for new complexity, doing it quickly in an inertia-free way. It develops through the individual’s consciousness, so the formation of complexity level $^{25}\mathcal{U}$ is a necessary and sufficient condition for the emergence of the human brain. The existence of personality is, on the one hand, a consequence of the implementation of Nash Law, on the other hand, its implementation continues through personality. We are not just a part of the world, we are the universe at this stage. The firmament is meaningless without us, without new levels of relationships, just like us, our existence is impossible without a hierarchy of simpler relationships that formed the chemicals of our body, the biological organisms from which we descended, the biochemical processes in our brain.

Einstein was surprised to learn that the universe is cognizable: *“The eternal mystery of the world is its comprehensibility ... The fact that it is comprehensible is a miracle.”*

In terms of hierarchy, there is no miracle since any relationship has a common basis at lower levels. Therefore, the relations of simple levels can be represented as limited models at higher ones. You just need to take into account that the observer himself belongs to a high level of complexity – and when modeling you have to neglect more complex parameters, cut them off (for example, when the attraction of an apple and the Earth is regarded not as a fruit and a planet, but as two material points with one characteristic – mass).

From the $^{25}\mathcal{U}$ level, expressions (3.4) and (4.2) are written in the form of known laws of physics (accepted by the scientific community). In order to “descend” to a lower level of complexity, the observer builds a model of relationships at the required level, cutting off, to the extent possible, more and more complex relationships. And this can only be done owing to the hierarchy of relationships, the hierarchy of levels of complexity, the hierarchy being a direct consequence of the implementation of Nash Law and the TGS. Therefore, in the observer’s model of an apple falling down to Earth, the result does not depend on the soil where the apple falls, does not depend on the variety and ripeness of the apple – the levels of geology and biochemistry are definitely higher than $^8\mathcal{J}$ level. The observer describes the level from which material points are defined; they are replaced by an apple and the Earth. Science and description of the world in general is needed to find relationships at lower levels and, on this basis, predict the behavior of objects at the same low level. Kepler proved that the planets move around the Sun in an ellipse. But this fact is not what the need planets, it is us who need it. It is the observer

⁹⁴ *In this way a person (observer) becomes an integral part of the world picture.*

who may be mistaken and believe that the planets rotate strictly in a circle. The error does not affect the planet-star system, which cannot interact (for us, move in space) depending on our ideas. The type of laws (mathematical or descriptive) is our creativity; in our formulation they put the codes of relations (in the record of the law) in accordance with our level of complexity.

The researcher's influence on the object under study characterizes the researcher and, ultimately, his place in the universe. And if we have identified this influence, introduced the researcher into the described picture of the world, then we have taken a step towards understanding ourselves. Let me remind you that in Chapters 13 and 15 we talked about free will, about new moral relations as new parameters of the ³³*J* level, relations more complex than which cannot be determined for us (so these parameters turn out to be truly "free"). It is especially important that free will, morality, has the same nature as the parameters of other levels of complexity, for example, space, certain layers of time or material points. This means that Kant's famous statement that *"Two things fill the soul ... with strong surprise and awe, ... this is the starry sky above me and the moral law in me,"* can be commented on as follows: for all their dissimilarity, both the starry sky above us and the moral law within us are the essence of the manifestation of different levels of complexity. The growth of the hierarchy of complexity is not a characteristic of the universe, it is what the universe, including man, is.