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Activity levels in nature

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Abstract. The basic levels of activity are considered, according to the levels of complexity of nature objects. Current science is not enough to understand their essence and connections.

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In one way or another, it is clear to everyone that at the heart of the possibility of the world development lies its unifying property, acting at all its levels, a kind of world-forming principle. This thought passes through the whole history of European thought, from the mythical Eros through the pantheism of Xenophanes (the oldest contemporary of Pythagoras), through God, understood as activity, by Aristotle and the world tension by Cleanthes (early Stoic). The idea that the world exists and develops due to its own craving for movement and change, in the 20th century yielded to mechanism (its few supporters were branded as mystics) and only now is returning to the understanding of the world and the causes of world crisis.

You cannot give a definition of an effective start, since it is a primary concept, the same as space and time. But it can and should be discussed, expressed through other basic concepts (how words are explained in the explanatory dictionary), which all are given to us intuitively. Since it cannot be inferred logically, it should be introduced as a postulate that intuitively generalizes a single impression of nature and society. It was convenient for me to take for it a neutral word – **activity**¹.

¹From lat. *activus* - effective, active (from lat. *actio* - movement, action, action). Rus the word activity (like the English *activity*, and the French. *activité*) is ambiguous, meaning not only the abstract effective beginning, but also the working activity of people. Therefore, we need an explanation of the term introduced here, and the best I see the meaning of the German *Wirksamkeit*. It is formed from the adjective *wirksam* (effective) and (unlike the German *Aktivität* and *Tätigkeit*) means, first of all, activity as an acting force and active property (and not as activity itself). In this sense, the word activity is further used.

The neutral term emphasizes the generality of the phenomenon, its dominance at all levels of organization – from elementary particles, through physics and chemistry, through life and culture, to space.

But is there any benefit from such a general concept? Yes, in my opinion, the introduction of activity as a primary property allows us to represent any appearance of novelty as the appearance of a new form of activity, which is inevitable with any complications of the forms of matter and their interactions.

To begin with, physics as a science of inanimate nature took its classical form in the 18th century precisely when it recognized its own types of activity (force, field, energy), separating them from the phenomenon of living activity (from the future *vis vitalis*²). Chemistry also introduced its own types of activity (valency, chemical potential, etc.) although it seems that they can be deduced from physical types of activity. But the fact is that in fact the problem of such a conclusion can be solved only for the simplest examples, and in the general case it remains a good wish. It is easier to accept that with the cooling of matter to planetary temperatures, chemical types of activity arose. This is a special case of the so-called **anti-anthropic** principle: the conjugacy of the

²The concept *vis vitalis* (lat. Life force) was introduced into scientific circulation in 1802, taking the long-standing term, the German anatomist, physiologist and natural philosopher Gottfried Trevira-nus. He saw her as a “barrier against which the waves of the universe are breaking, so that wildlife does not get involved in a general whirlpool” [1, S. 51]. He belongs (as, at the same time, to Lamarck) the term biology.

properties of objects is not set initially, but is formed as the objects themselves appear [2; 3; 4].

The further is stated from the position of this principle. In our time, physics is based on the fact that all power is the result of the action of the corresponding field. So, gravity is the result of the action of the gravitational field, and the most noticeable mechanical force in everyday life is the total result of the action of electromagnetic fields. This force arose with macro-objects.

It is the same with the activity of living matter: the task of its derivation from physicochemical activity can be posed, however, in fact, almost all the properties of living activity have to be considered as independent. The belief that life was just a very complex physics and chemistry reigning in the twentieth century, is losing popularity, because for a hundred years the main questions (how the action of genes leads to the formation of three-dimensional working organs; how the chemical and electrical activity of nerves leads to the emergence of consciousness; etc.) did not move a single step. Moreover, the situation is the same for the idealist and materialist, for the believer and atheist.

Further activity is considered to be gravity, and the attraction of a magnet, and a chemical reaction, and the movement of bacteria to light, and human thinking. Such general concept is necessary for understanding global problems, but it will not be of any use if one does not distinguish between different activities. The distinction can be made in different ways, and for evolutionary tasks it is necessary to distinguish between *activity levels*.

As far as I know, the theme of activity levels was posed in general terms by the Dutch-American physicist and natural philosopher Jan Burgers, aka Johannes Burgers (Burgers, 1895-1981), and he posed immediately for all types of activity of inanimate and living nature [5; 6].

The initial type of activity, common at all levels of being, he called *conceptual activity - cognitive activity* (CA) and considered it to be the primary reality. (Even matter and the field are secondary for him [6, p. 197].) He understood CA very broadly, and expressed himself not everywhere clearly, but nevertheless one can reveal its basic properties in his understanding.

Firstly, about the term itself. English dictionaries give conceptual meanings that are not quite suitable for understanding Burgers' thoughts (conceptual, speculative, conceptual), and his reasoning in the introduction³ to understanding does not approximate enough. We have to come from other dictionaries. His native Dutch dictionary did not give anything, and of the dictionaries available to me, only French gives, among others, something suitable (conceptuel - cognitive), which I **Secondly**, according to Burgers, the CA begins and conducts any process that generates novelty, and I see this clearly in the following way, requiring starting with a retreat. Biologist and philosopher A.A. Lyubishchev, master of the paradox, clearly explained the difference between the main concepts of bioevolution in the language of buildings. For him, *Darwinism* is "a theoretical pigsty: ... everything in nature is moved by pure swine, the struggle for existence and reproduction". *Lamarckism* – "the palace of physical education", in which there is an "active evolution of organisms"; *nomogenesis* – "the temple of truth, beauty and law" (letter to B.S. Kuzin, 1949).

In such terms, the process of any evolution (not only biological) seems to me like climbing a ladder (possibly a Lyubischevsky palace or temple), each step (level) of which is overcome by a certain effort, and on many of them it also requires a choice – whether to climb further or choose one of the doors of this level. The presence of an active choice and symbolizes any CA.

Thirdly, shortly before Burgers, the virologist and geneticist Gerard Schramm (Germany) threw an aphorism into the everyday life of science: "Life

³For example: «In order to make the philosophical picture consistent and fruitful, we need the basic doctrine that conceptual activity is a fundamental feature of the Universe. Living matter is not just ordinary matter plus conceptual activity added to it. The functioning of the entire Universe is the outcome of conceptual activity; the presence of matter, the division between life and nonlife, and the emergence of material structures carrying life are results of its mode of operation» [5, p. V].

(To make the philosophical picture sound and fruitful, we need a basic doctrine according to which conceptual activity is a fundamental feature of the Universe. Living matter is not just ordinary matter plus conceptual activity added to it. The functioning of the whole Universe is the result of conceptual activity. Presence of matter, separation between life and non-life, as well as the emergence of material structures that carry life, are the result of its mode of action".)

begins at the moment when nature manages to start thinking” [7, S. 13]. This was already unexpected and heretical: it was supposed to be said that only a person thinks (and, in part, higher animals). However, Burgers seemed to answer Schramm across the ocean, he said something completely unthinkable for those years that nature “thinks” always, at all levels. For Burgers, the combination of nucleons and electrons into an atom is just as reasonable as logical reasoning. This is the so-called *panpsychism*, an old idea revived by Burgers.

The question is inevitable: if so, then how to fundamentally distinguish between living and nonliving? Here Burgers showed an enviable understanding of genetics for the physicist-hydrodynamics of the advanced years:

“Information or a multitude of instructions encoded in the DNA of a cell nucleus can be considered as a multitude of strategies rather than a multitude of fixed programs ... When they are implemented, discriminative or cognitive activity comes into play ... Strategies can come into play simultaneously or separately under the influence of senior (master) strategies. Therefore, there should be forms of cognitive activity at different levels” [5, p. 175-176]⁴.

Thus, for him, the living CA is discriminating (now they say – informational) and *multi-level*. **This is the fourth.**

Now that it has become known that there are hopelessly few genes to record building an organism, we have to admit that Burgers was right: only very general directions of development, or rather strategy codes (more precisely, see the book [8]) can be written in DNA. The first, as far as I know, understood the Burgers case. This is the fifth.

Where and how everything else is written, we do not know, but there is a clue for searches - the vastness of information reproduced where there should be no heredity. This, first of all, is the *variety of snowflakes*, almost endless and at the same time regular: each snowflake has all 6 rays the same, they reproduce the same unique structure, and there is no explanation for this in science. The choice of

⁴There, Burgers predicted gene conversion (self-assembly of genes), which was soon discovered by geneticists in the experiment.

option is the result of some obscure activity, which can also be considered cognitive, like any path to novelty. CA is most easily seen on living objects, but occurs everywhere, leading Burgers and many other scientists to panpsychism. **This is the sixth.**

Burgers himself saw an explanation of incomprehensible phenomena in violation of the principle of causality: “Each event includes both the effects of past situations and the prediction of future opportunities” [6, p. 197]. Such an assumption, albeit bold, does not explain everything (the appeal to the future does not explain the symmetry of snowflakes). Thus, Burgers (far from the only one) made an application for some new picture of the world, where the past and the future are in some sense equal. **This is the seventh.**

The first example of the fact that not everything is written in genes, that much in life creates itself (*autopoiesis*), like a snowflake, was *self-assembly of macromolecules*. In the protein, only the primary sequence of the chain of amino acid residues is inherited, for the rest it creates itself by fitting into the native structure in much the same way that atoms lie in a molecule, and electrons and nucleons - in an atom.

Beginning with compounds of atoms, we observe two rows of levels of complication – inanimate and living. They are somewhat parallel.

Self-assembly is also crystal growth. Here the most surprising example is the mentioned snowflake: self-assembly is the same in every ray, i.e. exactly 6 times, and more in this form is almost never repeated in nature. Six is given by the property of a water molecule, but what determines the sameness and its non-repeatability? What prevents other snowflakes from growing in the same way? Or, looking from the other side, which makes 6 rays grow the same, if this is not necessary for growth?

The answer suggests itself: there is a program, a burgers strategy. It, apparently, has not been recorded anywhere, it simply begins to be realized immediately in all the rays of the growing snowflake in the form of fractal growth, one in all the rays. (This simultaneity of self-assembly radically distinguishes it from a biological hereditary program, which is

implemented sequentially.) There are infinitely many options for a fractal growth program, and there are no restrictions in the form of genes, so the options are not repeated.

Is that simple? Not at all.

Two identical snowflakes do not exist, but occasionally it is possible to see two very similar ones nearby, as shown in the **Fig. 1**. Their author writes: “They fell next to the difference of several minutes and, quite obviously, traveled together in the clouds” [9, p. 13], but writes, unfortunately, nothing more.

A small difference while maintaining extremely complex symmetry clearly indicates a small change in the fractal-forming self-assembly rule. Involuntarily you think about biology, about the common origin and small variability. However, the snowflake inheritance apparatus is not visible, and if it is not there, then where is such a striking but inaccurate similarity? And if so, where is he?

I can only answer by asking: where is he alive, if the genes (and DNA in general) are negligible? The tentative answer to this question is precisely the main idea of the book [8]: the ontogenesis of the living (the formation of an individual, one of the forms of autopoiesis, during which genes serve only as suppliers of materials and limiters of options, but not engines) also includes self-assembly. Snowflakes,

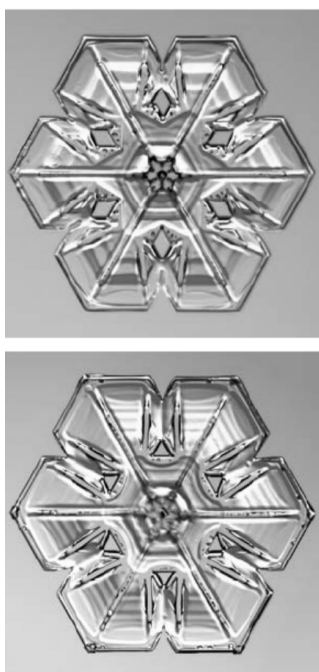


Fig. 1. *Two snowflakes* [9].

as said, have no limiters, and the variety of options for their self-assembly is unlimited.

Little is understood so far, but already it allows you to move on, after centuries of stomping on the spot, and closer look at self-assembly.

Self-assembly is a property of the activity of nature at all its levels. We saw this on the way down, deep into the microworld, but the same thing can be seen when moving upward, to higher *levels of activity*, into the expanses of the biosphere: just as molecules themselves fall into cellular structures, and cells assemble into tissues and organs, and they assemble into macroorganisms, so do organisms assemble into ecosystems, and those— into the biosphere. It is structured no less obvious (although less clearly) than the periodic table.

The structure and operation of each level of being is generally accepted to describe, without trying to derive its properties from the properties of the underlying levels – in natural science such are physics, chemistry, geology, biology, astronomy, etc. In the twentieth century, many intermediate disciplines were born (biophysics, geochemistry, etc.), which gave rise to confidence among many in the deduction of the laws of nature of the highest levels of complexity (later) from the lowest (that had arisen in the history of the world before). This confidence is not practically justified, and it remains for us, for the purposes of this article, to only trace the main levels of activity, not trying to derive one of the others, but noting their connections and, most importantly, common features.

Elementary particles already have their own activity (charge, spin, etc.), which seems to prevent them from connecting, but they are connected under the action of activity of a higher level (such, for example, the repulsion of protons, which, however, fit into an atom). Atoms are combined into a molecule both by virtue of their own activity (polar bond) and by virtue of the activity of the next level (covalent bond).

These are two levels of self-assembly, and the third is the self-assembly of macromolecules (in biology) and rocks (in geology) mentioned above.

The result of self-assembly at all the mentioned levels is ambiguous (there are isotopes, isomers,

conformations), i.e. diversity is already essential here at one level of complexity, and such diversity is rapidly growing in the future (at further levels of complexity). This circumstance would lead the Universe to complete chaos if it were not for the distinguishing (according to Burgers) role of cognitive activity.

At each level of complexity, the diversity of objects is arranged in rows of similarities, and they are in second-order rows (rows of rows), which S.V. Meyen, a paleobotanist and natural philosopher, called **refrains** in 1978. The refrained structure is found everywhere, both in material objects (objects and processes) and in ideal ones (judgments, language structures, and social phenomena). They are described in detail in the book [8].

A refrain can be a pair of rows (alkaline and alkaline earth metals in chemistry; Eurasian and American carnivores in zoology; contours of leaf blades of ferns and flowering in botany), or a larger number of rows: an independently formed nuclear structure of the cell in plants, fungi, and animals; case structure in languages with declension of nouns; laws of development of various societies from primitive to present statehood; and much more.

Understanding the ordering of the world as a result of the CA and, as I understand it, Burgers led to his idea of a unified CA with increasing levels of its complexity. The book [5], long conceived by Burgers and discussed with colleagues in his homeland in the Netherlands, was published much later in the USA. She did not have (and could not have) serious discussion (there were only a few brief lightweight responses), which, as his relatives recalled, became one of the main disappointments of his life.

Burgers' thoughts are gradually becoming relevant now, after half a century, in connection with the identification of new forms of CA. One of them permeates all levels of complexity of the living, and even on the verge of inanimate. If dark energy is mysterious for physics, the pure activity of the cosmos, which seems to be not related to matter, then *zombie parasitism* is also charged to biology.

In 1961-1962 in Germany and England, evidence has appeared that the larvae of some flatworms cause the insects (flies and ants) infected by them to behave in such a way that they are eaten by

animals, inside which the larvae develop. Soon this was confirmed by scientists from the USSR and other countries at various sites. It turned out that the parasite can induce the victim to take care not of his own, but of his offspring – see [8, p. 512]. In 1983, a parasitologist Simon Ellui (France, Canada) in the survey "Manipulation of the behavior of an intermediate host" [10] named 20 such examples.

This phenomenon is often more complicated than the hunting for higher animals (the parasite finds the exact ganglion of the victim, etc.), but is not related to the complexity of the parasite: it may not be an animal or even a larva, but a bacterium and even a virus. (A virus is not an organism, has neither behavior, nor nutrition, nor reproduction; he breeds by victim of the virus.)

Article [10] is surprising: the phenomenon is called "of course, the most impressive", the first chapter of Elli called "Insanity" (*La tête a l'envers*, literally: Head inside out), correctly assessing the action of brainless parasites as a loss of mind for their victims, but she ended article in the usual Lamarck-Darwinian move: it considered the explanation not the cause and mechanism of action, but the goal – the nutritional benefits of the parasite's behavior.

The error is hardly noticeable in the French text or in the English Summary, since in these languages the words *why* and *what* for are expressed in one word (*pourquoi; why*), in contrast, for example, from the German *warum* and *wozu*. Although every thought can be expressed in any language, the difference between the reason and the goal for the German or Russian is clear from the meaning of the words-questions, and the Englishman and Frenchman need clarification, which is rarely taken into account by the speaker or writer. This is partly why, I think, the Anglo-French debates about evolution traditionally revolve in the old-fashioned Lamarck-Darwin circle of concepts, with complete disregard for German-Russian ideas (nomogenesis, etc.).

The Russian language also has its own flaws: for example, there is no noun to the adjective bad (*no word badness*), which is in English (adj. Ill - n. The ill), French (adj. Mal - n. Le mal) and others. In particular, the exact translation of the title of Charles Baudelaire's book *Les Fleurs du Mal* is impossible, and they write inaccurate: *Flowers of Evil*.

There is a mixture of bad and evil in science: zombie parasitism has attracted some attention from society as a sophisticated evil, but there is no more evil in it than with any kind of eating. More importantly, the parasite searches for the right path, often complex and unique, without an organ of thought and even memory. But these are many instincts, and no one has an explanation (except for the wretched “so the Lord (Selection) wisely decided”).

To Elli’s honor, I’ll say that then she devoted a quarter of a century to the search for the “la tête a l’envers” mechanism. But she didn’t succeed: in a recent article, she called the violation of the victim’s immunity by a parasite. Those, instead of the current mechanism, a symptom is indicated, and nothing more. A particular immune fact did not clarify the search mechanism, and the mountain gave birth to a mouse.

For a future explanation of the essence of zombie parasitism, it is necessary to proceed from its universality, to seek a general explanation for this activity. It is natural to consider it as one of the forms of CA, and hardly the desired mechanism will be found before understanding the CA as such, before a new picture of the world.

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