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ABSTRACT

The collective monograph is devoted to the study of trends in the development of modern Ukrainian society. The research uses an interdisciplinary approach, which allows analyzing various aspects of the development of social processes in Ukraine and obtaining socially significant scientific results.

Kostyantyn Levchuk's research is aimed at the analysis of public organizations of Ukraine (1985-1996). Ukraine's democratic progress is aimed at creating conditions for the development of civil society, which is defined as a set of non-state relations and institutions. This society should provide citizens with the opportunity to protect their rights, satisfy needs and realize life and social values. The viability of democracy depends on an active dialogue between citizens and state structures, as well as between voters and their representatives in the legislative and executive powers. Such interaction is the basis for the development of democratic principles and ensuring stability in society.

The subject of Yuri Boyko's scientific interests is the consideration of aspects of the demographic manifestation of the regional system of the Forest-Steppe of Ukraine. Its main parametric characteristics (number, density, movement, dynamics of population growth) were reconstructed with the help of cluster analysis methods. For the first time, the explosive administrative "growth" of the population between 1856 and 1858, associated with the beginning of the liquidation of military settlements, was revealed. The main result of the study was a generalized statistical model of the demographic situation in the Ukrainian Forest-Steppe in the middle of the 19th century at the level of not only 6 provinces, but also each of 77 administrative districts.

Svitlana and Vasyl Bogatchuk characterize the Peculiarities of the development of education in Ukraine in the 1950s and 1980s. Issues of education development in Ukraine in the 1950s and 1980s. were associated with the leadership activities of the Communist Party, publications were most often dedicated to public holidays. Today, there is a growing interest in the development of education as an integral part of our society. The school played a significant role in the training of future personnel and

ideological education. In 1984, a new education reform was carried out, according to which the transition to education from the age of six was carried out, secondary schools were transferred to the eleven-year term of education. The greatest impact on the development of pedagogical theory and practice was made by the work of the world-famous teacher V.O. Sukhomlynskyi. In the 60s and 80s of the XX century. the government pursued a policy of Russification of education and suppression of the Ukrainian language.

In his chapter, Ihor Bielkin emphasizes that language etiquette in modern education is an important aspect of communication between students, teachers and administration. It includes rules of politeness, respect and correctness in communication, which contribute to the creation of a positive learning environment. Appropriate language etiquette helps avoid conflicts, improves mutual understanding and forms a culture of communication. The use of adequate forms of communication, the ability to listen to others and compliance with the rules of communication are key elements for a successful educational process. Today, in the conditions of digitalization, it is also important to consider language etiquette in a virtual environment, which opens up new challenges and opportunities.

In the work of Zorislav Makarov, a philosophical and methodological analysis of the problem of disciplinary relations in science is carried out, starting with the revolutionary situation of the formation of non-classics and ending with integrative trends in modern post-non-classical science. Initially, against the background of the crisis of mechanistic determinism in the science of the 19th century. alternatives to positivist, pragmatic and neo-Kantian approaches to the relationship between philosophical and scientific rationality and determinism are revealed, with a conclusion about probabilistic means of scientific description in the role of an interdisciplinary mediator between them. Then the dissemination of probabilistic categories, models and means of description in modern science is investigated based on the mastery and convergence of dynamic and chaotic parameters in the picture of the world with conclusions about the prospect of creating an interdisciplinary theory of nonlinear dynamic description and the meaningful potential of the idea of stochasticity to

overcome methodological dichotomies in the consciousness of the modern scientific community.

The work of Alla Zhuravlyova determines the influence of railway transport on the processes of urbanization and economic development of the south of Ukraine. Railway transport is one of the most important branches of the national economy of Ukraine, a catalyst for economic growth and improving the quality of life of citizens. It provides the needs of production and the population in all types of transport. Railway transport plays a leading role in the implementation of internal and occupies a significant place in the establishment of foreign economic relations of Ukraine. Comprehensive coverage and generalization of the historical process of the formation of the railway transport network on the territory of Ukraine, taking into account the interrelationships of the legislative framework of the state with the construction of railways, makes it possible to identify and analyze the impact of railway transport on urbanization. processes in the South of Ukraine in the second half of the 19th and early 20th centuries.

The content of the collective monograph corresponds to the scientific direction of the Department of History of Ukraine and Philosophy of Vinnytsia National Agrarian University. The monograph is the result of the initiative topic "Investigation of the trends of socio-economic development and consolidation of Ukrainian society in the recent history of Ukraine". State registration number 0122U001425. Head of the topic, Doctor of Science, Professor K. I. Levchuk). The monograph uses: socio-philosophical approach, historical-genetic method, statistical analysis, sociological and economic research methods.

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5. Disciplinary relations in modern science: prerequisites for formation and substantive perspectives

5.1 Introduction

Given the dominant and fundamental status of classical metaphysics, which it took over in theology of the New Age, disciplinary relations in classical science should not be a methodological problem. It is only about the competition of alternative programs of mechanism represented by R. Descartes, H. Galileo, T. Hobbes, T. Hooke, I. Newton or G.W. Leibniz. The disciplinary ice of mechanism broke when doubts arose about universal determinism and the means of its interpretation in certain fields. Already in the 19th century, even before conventionalist reflections, the instrumentalist approach, with which mechanics concealed itself from the traditional goals of studying the goals of the universe, gained expression in the transfer of all attention to alternative mathematical formalisms with the interpretation of ontological determinism as transcendent and irrational. Therefore, the undoubted successes of scientific determinism could be explained only as artificial theoretical hypotheses and convenient practical devices.

In this context, the representatives of pragmatism are noticeably different in their efforts to translate the «practical» advantage of artificial scientific determinism into a respectable «scientific» rationale, extending it to the level of philosophical determinism. The «tychism» that arose in this way is an interesting and understudied mechanism of pragmatic mediation of the irrational and random ontology of non-classical science by the rational-normative and material conditions of scientific society in the form of objective «laws of probability».

Considering that the more massive reaction in the scientific community to the indeterministic conclusions of empirical research consisted in the atomistic tradition of eliminating all signs of transcendence in knowledge in favor of «positive» evidence and «neutral» mathematical interpretations, the historical and scientific problem consists of the reasons for the adoption of probabilistic methodology. In our opinion,

they should be sought in the interdisciplinary exchange of the late classics: if the influence of psychology with its mechanisms of symbolization on non-classical logic, mathematics and theoretical physics is well known thanks to the works of G. Holton, then the influence of determination schemes from idiographic disciplines on the general non-classical culture of thought remains in the shade. In contrast to the flat positivism in these areas, neo-Kantianism with its distinction between the levels of rationality and determination, although partially reduced by probabilistic means of description, which caused also the non-classical mixing of theoretical and empirical knowledge in the form of the phenomenon of «theoretical load of facts», was more successful.

Philosophical reflection of interdisciplinary processes in science establishes a resonance of expansion of ontological ideas of global evolutionism from natural science and criticism of the static image of scientific knowledge from postpositivism. However, legitimization in this way of a dynamic beginning in the methodological consciousness of scientists, in addition to establishing a common platform for interdisciplinary communication, requires, at a minimum, overcoming stable dichotomies, such as externalism – internalism or «context of discovery» – «context of justification».

One of the promising means of reconstructing such a dialectic of the cognitive and the value, the psychological and the logical seems to be the introduction of stochastic categories into the apparatus of scientific rationality and self-reflection. The beginning of this process was laid by the classical theory of probability in relation to the quantities of scientific description, and in the times of post-non-classics the dominance of the constructivist approach in the scientific representation of chance, infinity, relativity, and formation becomes noticeable.

At least, taking into account epistemological randomness in the structure of general scientific methods promises to improve probabilistic models of the growth of scientific knowledge, actively developed by evolutionary epistemology and the post-non-classical project of nonlinear science. On this basis, a historical and scientific review of the relations between the natural and human sciences is proposed in the

perspective of the methodological principles of monism, constructivism and evolutionism.

The prospect of an interdisciplinary theory of dynamic description is associated with new nonlinear theories («sciences of complexity») – synergetics, nonequilibrium thermodynamics, chaosology, nonlinear dynamics, theory of dissipative systems, catastrophe theory, theory of singularities and bifurcations, fractal theory, qualitative theory of nonequilibrium phase transitions, etc. – which are distinguished by the development of a model representation of evolutionary processes by means of updated characteristics of chaos. The epistemological justification of chaos is associated with recent progress in calculus and measurement accuracy, when the discovery of the nonintegrability (A. Poincaré) of elementary causality and, in general, the heterogeneity of connections (levels) of determination, as well as the limits of accuracy (B. Mandelbrot) turned against the ideal of completeness of description.

The non-classical concept of chaos, transferred from the predicate (property) to the subject (state, object), presupposes the complication of the causal field to the «probabilistic-statistical» (statistics of «ensembles» plus probabilistic dynamics of «atoms»), and the structure of the system to the chaotic proper (in the sense of instability of random variables). The strategy of representing chaos changes in the transition from the classical study of closed systems to fundamentally open ones: from the concept of «dynamic chaos» with its emancipation of complexity (from the idealizations of classical science) to the concept of «deterministic chaos» with its reduction of random events in constructive stochastic dynamics based on a simple (deterministic) basic equation.

Based on the fact that the regularities of scientific laws are derivatives of cosmological singularities, and they fit into the project of universal stochastic models (nonlinear science), stochasticity gains the prospect of entering the *worldview* plan of modern science in a role similar to the *subjective* factor of a non-classical observer. However, the axiological and methodological potential of the stochastic image of the world depends on the implementation of its interdisciplinarity – the meaningful entry of non-linear stochastic models into all levels of scientific representation of reality

according to the scheme of «mathematical idealizations». Philosophical and methodological analysis of the emerging synergetic picture should establish its compliance with such a «virtual» criterion of post-non-classical rationality.

5.2 Irrationality into Probability: Dialogue of Philosophy and Non-Classical Science

A very widespread point of view regarding the non-classical theory of knowledge connects its beginning with the combination of Kant's denial of the correspondent («spectator») concept of truth with Hegel's epistemological processualism (progressivism), undertaken by F. Nietzsche. In this way, F. Nietzsche created a model of an extremely deterministic semblance of subjectivism. Another outstanding version of the German synthesis was proposed, according to the Canadian philosopher of science J. Hacking, by C.S. Peirce, who tried to compensate for the collapse of the possibility of truth with guarantees of a self-correcting method [1].

Correction is provided by a certain feedback that prevents the formalization of scientific knowledge into fundamental foundations (relations), from which it would only remain to deduce all sorts of consequences, without resorting to experiments. To prevent such speculations, C.S. Peirce puts forward the requirement of the *relativity* of truth, that is, the indication of specific conditions of its meaning. It is they that make it possible to move on to tangible consequences (effects) of the initial premises and thereby obtain convincing experimental objections against both. Then it will be possible to carry out correction to an updated configuration of conditions, logically not deducible from the original, in the hope of approaching the desired artifacts, which will simultaneously be consequences of more adequate knowledge.

Based on the statistical argument, one can claim that the results of such «trial and error» regarding hypotheses, conclusions and tests tend to converge to a stable *meaning*, which is dictated by the (co-)community of experimental experience in all its variability. But in contrast to the dialectical understanding of the *process* of truth, Peirce's relativity never passes into absoluteness, since the latter is either metaphysical, or unknowable, or irrational in itself (and these disjunctions are very weak). «Try to

verify any law of nature, and you will find that the more precise your observations, the more certain they will be to show irregular departures from the law. We are accustomed to ascribe these, and I do not say wrongly, to errors of observation; yet we cannot usually account for such errors in any antecedently probable way. Trace their causes back far enough and you will be forced to admit they are always due to arbitrary determination, or chance» [2, p. 47].

As can be seen, here are summarized the successes of C.S. Peirce in the theory of measurement, compensating for the disappointment of the scientific community of the 19th century in the possibility of *fundamental* positions of science (Euclidean axiomatics, principles of mechanics, etc.). «The paradox of the situation is that, although we know about the possible erroneousness of our judgments, yet as long as we have no real grounds to doubt them, as long as we believe in them, we cannot help but consider them true, for us they will be the absolute truth» [3, p. 321].

The most famous *fallibilist* version of understanding this situation is that of C.S. Peirce. Reality slipping into uncertainty forces the scientist to put forward ever new theoretical assumptions, the sophistication of the fallacy of which consists in strengthening the certainty of *internal* connections – affectibility, reducing sensibility (effectibility) – as well as in increasing the perimeter of referential connections («corroboration» in the terminology of K.R. Popper, «coherence» – N. Rescher, «self-organization» – W.R. Ashby). Therefore, the *probability* of the same scientific knowledge will change depending on its logical-psychological progress, regardless of reality, especially since the latter is nothing more than a pragmatic (expedient) hypothesis, a «correction of illusion». «And if Peirce had lived in the 20th century, he would have fully agreed with the neopositivists in their assertion that the problem of reality is a pseudo-problem that has no meaning in science» [4, p. 45].

This is a bolder step compared to the first positivist solution to the problem of reality. While A. Comte was struggling with «reasons in law» and «metaphysics in methodology», that is, the cultural-value dimensions of hypotheses about reality, to the extent that they are deprived of «positivity» (that is, the exit to the experimentum crucis regarding their truth value), C.S. Peirce was already imbued with irrationalist

philosophical (metaphysical) indeterminism («tychism»). As a non-classical philosopher, the American denies [mechanist] connections of phenomena repeatability and regularity, which could exhaust fallibilism, and with it freedom of spirit. At the same time, he still gives preference to the «aristocratic» explanatory function of theory, while positivism, qualifying it as metaphysical, brings to the limit the Newtonian «hypotheses non fingo» in the exclusive function of description [1].

Thanks to these premises, the founder of American philosophy comes to a derivative paradoxical statement about the *explanatory* status of the laws of probability, which forces us to interpret the objectively random world as deterministic. Like Kant's «pragmatic faith», from which academic pragmatism traces its ancestry, this is about the opposition of reliable (authentic, apodictic) and conjectural (possible, problematic) knowledge. Traditionally, in order to make an assertoric judgment about reality, either the first – necessary, or the second – random was used. However, in a situation of moral responsibility for a judgment, a random opinion becomes a *random belief* (Unternehmung), «as if» it were certain, and then only practical success [of the action] can become a justification for this epistemological adventure [5, p. 466].

In the more applied pragmatism of W. James, the implicit connotations of scientific pragmatic belief with the sphere of the transcendent were deployed in the most frank manner - by identifying this reduction of discouraging accidents with a strictly religious function [6]. Scientific epistemology is given, instead, the *full* articulation of its own premises in accordance with the epistemological formula of «adaptation of internal relations to external ones», which W. James traces back to the evolutionism of G. Spencer. Moreover, reflection on external relations should not be limited to immediate individual experience (as was the case with the English founder of positivism), but it should not turn into an independent variable that «by free will» reduces external relations (as is practiced in the moral and religious sphere). Otherwise, the study of expedient orientations (actions), for example, the *meaning* of theoretical concepts (terms), would be drowned in probabilistic epistemological pluralism: «for a psychologist who views phenomena from a strictly deterministic point of view,

manifestations of free will can be classified among the infinitely small factors that modern science can afford to ignore» [7, p. 354].

However, James's «radical empiricism» will differ from «flat empiricism» in the way it handles elementary regularities – the unlimited variability and combinability of these intersubjective positions in relation to the goals of a given subject. And the projections of such empiricism, as far as possible, to the ideological level give James's image of a «pluralistic Universe», in which neopragmatists see a premonition of post-classical scientific systems – stochastic and unfinished, open to spontaneous changes, fluctuations, catastrophes, bifurcations [8].

Finally, D. Dewey's «instrumentalism» finally breaks with the «spectator» concept of truth, excluding from scientific methodology what would later be called the «context of discovery» of theoretical knowledge, leaving it to either religious consciousness (P. Duhem) or idle speculation (E. Mach), but moderating epistemological pluralism (in addition to the pragmatic criterion itself) by the function of conventional coherence of elementary knowledge by the efforts of scientific experts. Nietzschean idea of truth as an «expedient error» finally found a prospect of justification in science. Thus, pragmatism, based on the material of qualitative areas and parameters of being, ignored by the idealizations of classical mathematical natural science, consistently discredits the explanatory and descriptive functions of theory, obviously in continuation of Kant's ontological isolation of the subject.

One of the main ideas of post-medieval science was the proclamation of a «ladder» of (semi-)transcendent «beings» that control earthly bodies. At the level of scientific programs, this meant that the moving material points of the revived atomism since the time of I. Newton are supplemented by [still only implied in Democritus] forces of change, tension (and direction). «It is true, of course, that changes in Newtonian forces can be explained as being due to motion, i.e., changes in the positions of particles. However, they are not identical to changes in the positions of particles, and the quadratic law is not even linear» [9, p. 139]. According to A.N. Whitehead, «Newton's forces are nothing more than the conditions of such constraint established by God, no matter in what mathematical form they might be finally expressed» [10, p. 521]. In the

course of the exhaustive mathematical articulation of the first scientific revolution, all the essential internal properties of *bodies* were transferred to these forces, representing the latter as equivalent unificates, the explanation of which can be reduced to functional (re-)movement: «the atomic material entities studied by physical science are merely individual stable entities, considered in isolation from everything except their interactions, which determine the life history of each of them» [11, p. 167]. In the terminology of J. Boehme, played with by F. Engels in his historical review of materialism, this transformation is designated as the loss of the affix of spontaneity: «qualitas» → «qual» [12, p. 87]. Obviously, it reflects mental processes, when rational ideas are formed by the negation of the sensory form of knowledge and exist, in the words of T. Hobbes, as «ghosts of the corporeal world», for which science selects generalized names.

Being a derivative of the Peripatetic thesis «everything that moves is moved by something else» [13], in the New Age these idealized objects-constructs were expressed in visual and convenient models: «‹…› the scientist can "see as if" those processes that are not actually given to sensory perception, but which at the same time are thought of as the causes of sensory-perceived phenomena» [14, p. 197]. Such idealizations were not limited to the physical sphere, as is vividly confirmed by Hobbes's scheme of the social contract. However, the prevailing methodological reflection comes down to the fact that the new European reincarnation of atomism turned out to be only the most vivid example of the mathematical measure of rationality, explicated philosophically precisely by the creators of mechanics (G. Galileo, R. Descartes). The main intra-scientific reason for the affirmation of this ideal, according to St. Toulmin, was that «geometrical knowledge provides an exhaustive standard, requiring no corrections to the accuracy by which one can judge all other requirements for knowledge» [15, p. 35].

Mathematical determinism dictated to A.M. Ampere, W. Weber, F. Neumann, G. Grassmann the static principle of long-range action of forces on bodies even after J.K. Maxwell's no less rational revival of short-range action with the dynamics of change of «forces» (electromagnetic field) without a mathematical indication of «atomistic

material entities» – so much did the new images contradict the original new European worldview intuition of the atom as a natural or social invariant of «economic determinism». «The internal, spiritual, which remained in neglect and inattention by classical mechanics and bourgeois legal consciousness (convictions, conscience, beliefs are, according to this law, a subjective, private matter of persons and do not concern society: in it the individual acts as a sealed, dressed in a tailcoat, impenetrable legal entity. object and thing, i.e. here is the principle of alienation), was considered that infinitely small thing that can be neglected in calculations (differential and integral calculus are precisely the pendant, correspondence and analogue of classical mechanics and civil society) ‹…›» [16, p. 184-185].

Therefore, the randomnesses that arose in non-mechanical physics, failures in description and prediction, not eliminated by means of measurement, began to be attributed, first of all, to «forces», leaving the unification of individuals and turning metaphysical determinism into indeterminism. The latter, combined with romanticism in the study of man and in the understanding of society and history, turned out to be a complete disclosure of the anti-rationalistic tendency that arose during the historical upheaval of the Reformation period, but balanced until then in German idealism by Leibniz-Wolf neo-Scholasticism [10, p. 490].

The irrational principle found its intellectual hypostasis in scientific (semi-)transcendental forces, which could justify the contrasts with the recent successes of mechanistic science, since it turned out to be truly unknowable both in the unsuccessful indeterministic and in the arbitrary deterministic versions of scientific description. The resulting prospect of occupying a place not only in life but also in scientific practice similar to Spinoza's «between God and chimera» forced one to seek refuge, most often, in inductive methodology as a «positive» approach to the incomprehensible necessity of the irrational principle. Moreover, by the middle of the 19th century, the romantic discourse of creative activity, nourished by the *transcendental* dimension of experience, dries up in the development of disagreements about the legacy of German idealism. As a reaction to its «highly rising wave», scientific thought focuses on an abstract-rational consideration of external sensory nature. Beginning with the rejection

of the natural philosophical method of transferring spiritual principles to nature, it moves on to a materialistic interpretation and the «inner life of the spirit»: «the recognition of the general regularity of everything that exists, the study of the simplest elements and forms of being, the search for the necessity underlying every change of phenomena – all this influenced theoretical research, and at the same time, the individual's assessment of everything individual, in which the "valuable" was identified with the natural» [17, p. 34].

In continuation of the Democritus tradition of contrasting natural cause with supernatural arbitrariness, in response to the excess of speculative or irrational explanations in the scientific community, the desire to endow cause with necessity, up to their identification, is intensified. Therefore, philosophical penetration into the worldview and content-categorical side of the knowledge of reality is replaced by a «positivistic» functional-methodological introduction to mathematics and natural science [18]. For example, J.S. Mill, who rejected natural philosophical speculations, in his project of a «system of science», where general principles, particulars and *individual experimental facts* were seen as ordered deductively, endowed only the latter with the status of «knowledge». And their guidance (induction) in regularity and uniformity forms only the *tools* for preserving, explaining and predicting an elementary set of facts. So scientific laws in the infinite perspective of the hypothetico-deductive method can only play the intermediate role of «memory knots»: the objective predisposition of the subject essence for a certain set of conditions is replaced by subjective hypotheticality. At the other – neo-Kantian – pole of European metascientific thought, W. Whewell, impressed by non-Euclidean geometry, also proposes an inductive (experimental) method – for the assimilation of a priori transcendental laws of thought, or «ideas», which are the only ones capable of giving the determination of phenomena a scientific status.

At the same time, the *avoidance* of metaphysics by most scientists and many philosophers simply returned methodological thought to the context of Hume's skepticism. That is, having initiated the objectification of «obsolete» methodologies using the procedure of atomizing knowledge into observable facts, it ended with their

subjectivization according to the *psychological* principle of association with past experience. In terms of determinism, this meant a rollback to the textbook Holbachian example of probabilistic as incompatible with scientific nomological description, which constitutes the condition of objective truth. ««…›Chance is a meaningless word that we oppose to reason, without, however, being able to connect a specific idea with it ‹…› by attributing natural phenomena to chance, we simply do not know its forces and laws» [19, p. 112]. Observed random facts, in the spirit of D. Hume, should again be interpreted as the price paid for the subordination of causal sequence (description) to logical prescription. Hegelian dialectic, which reduced chance and necessity to the categories of the real, began to look even more absurd in this context.

However, the need to «save phenomena», both in the well-known aesthetic spirit of the σοξειν τα φαινόμενα of the Alexandrian astronomers, and for pragmatic reasons, forces us to the most «without imagery» means of description, as J.C. Maxwell expressed it about his «soft gears». Bearing in mind that his working model has no other goal than to obtain a rigorous mathematical formulation of the laws of electromagnetism, he was one of the first to accept the distinction between the «mathematical» and the «physical» [20]. Thus, the explanatory and descriptive functions in the scientific community are already consciously turning into artifacts and cease to claim to depict the essence of phenomena, which in the old tradition had to either directly coincide with sensory human characteristics, or be mediated by sensory images, that is, be *visual*.

As the Enlightenment showed, despite the acceptance of the instrumental status of mathematized descriptions, they gradually took over the epistemological advantage (predictive power) of essential transcendental forces, which was fundamental in the new physical ideal of scientificity, making them unnecessary. «Science is the art of foresight. Its entire value, in the words of W. Ostwald, a contemporary of those changes, is in the extent to which and with what certainty it can foresee future events. Any knowledge that says nothing about the future is dead, and such knowledge should be denied the honorary title of science» [21, p. 16]. Not without the influence of Kantian ethics («transcendent immanence of the subject»), the tilt toward

epistemological agnosticism began to diminish in parallel with the return of internal «qualities» to bodies in addition to those that remained with them, but as invariant and (or) «secondary». And this means «dilution», problematization of invariant individual characteristics with transcendent moments of power (more broadly — problematization of the empirical with the theoretical).

«After the work of Faraday and Maxwell, changes in force fields become as important as changes in material atomic particles» [9, p. 139]. The recognition of their scientific significance gradually led to the loss of the property of clarity by theoretical objects, which legitimized the classical principles of handling idealized objects (reductionism, analyticity, precision, comprehensiveness, combinatoriality, integrativity), that is, it discredited the validity of scientific articulation as such, right up to its (non-)objectivity. A similar solution in non-scientific culture is embodied by M. Duchamp's Dadaism. According to this aesthetic trend, the emancipation of a work of art from normative-artistic objects, so that it becomes a life event, is realized as the free intention of the subject-artist is transformed in a playful way into the random characteristics of his work.

Thus, the solution was found in the immanentization of transcendental forces (theoretical loading of facts) at the cost of abstracting the explanatory function: it was necessary to be satisfied with causality as a holistic (non-analyzable) area of possible meanings, concentrated and emanating from the individual object itself - on the model of Leibniz's monads. The extent to which this solution seemed speculative is evidenced by the controversy surrounding radioactivity. The older generation explained the facts of radioactivity and «transmutation» by the retransmission of external («cosmic») radiation or flows of matter by atoms. In particular, D.I. Mendeleyev declared the interpretation of radiation by the internal properties of the atoms themselves («the atom's own responsibility for what is happening») an attempt to involve science in a «semi-mystical state» [22, p. 252].

In this sense, objects became independent, but agreed upon in the actualization of their capabilities by the general conditions of the state of the system to which they belong. «The main thing here is the rejection of continuity-necessity, of a series in

general; but there is a multitude not as a series, but as a sum of individuals, events. The cause of each individual event (quantum), the event itself, its outcome are considered free-willed: it can happen, or it can not, it can happen this way, or it can happen differently – there is no (for a quantum of a special case) predetermined necessity. But if we take the sum of these units, the multitude, then it happens this way and in such a ratio, in such a proportion» [16, p. 205]. Thus, non-classical science was groping for its new language – probabilistic-statistical, and scientific determinism, for its part, was separated from philosophical. External forceful causal determination began to be contrasted with internal connection of states (L. Boltzmann), logical relation – with functional correlation (J. Cuvier), the study of adaptations - with the law of growth ratio (C. Darwin), speculative consistency of categories – with reliability of prediction (E. Mach).

With all the desire to compensate for the metaphysical revision of qualitates occultae, which can be seen in these «newspeaks», in the development of methods for calculating empirical interactions, the spontaneous affiliation of many scientists with «hardcore» *idealism* can also be seen. Their methods of calculation are so irrelevant to their material content that non-force (connection of states, system-structural or informational connection) determination is paradoxically assigned the opposition to the material connections of «mechanics» as invented and at the same time – the name as natural «physical». And this is not accidental.

It is known that in the structure of the classical scientific picture of the world, determinism was firmly associated with the despiritualization of matter and the principles of «mechanistic» description. Under the impression of their successes, even «the philosophy of the era was oriented toward physics to such an extent that it became an exposition of ideas inherent in this and then a later level of development of physical knowledge, with the help of general concepts» [11, p. 97]. But in order to resolve intra-scientific inconsistencies, as well as to combine scientific mechanism with social, moral and epistemological applications, the worldview of scientists and philosophers of the modern era constantly attracted idealistic sources and arguments (usually of theological origin).

Thus, with the development of non-mechanistic physics and non-classical natural science in general, non-causal types of determination are established, causing first (I. Kant, G. Hegel) a rupture between scientific and philosophical ontologies as deterministic and indeterministic, and then the emergence of an alternative – irrationalistic – philosophy (terminology), compatible with the new scientific determinism. This philosophy developed the concept of levels of determination – non-causal and causal – and provided it to science, which for a long time could not (G. Helmholtz, W. Thomson) perceive the first (supreme) of them as objective, material and deterministic, and then in the foreign tradition began to call it physical, and in the domestic – purely scientific causality (variable in the forms of interaction – from Laplace to teleonomic). The extent to which the concept of levels has been successfully assimilated in science is demonstrated by the ordeals of N. Bohr's complementarity principle. In many ways, they can be explained by the elimination of clarity, in contrast, say, to Leibniz's isomorphic causal-teleological complementarity of natural phenomena.

In unsuccessful attempts to maintain classical methodological principles in describing *levels* of causality, as well as under the influence of the emerging culturalist style of thinking, the Kantian formulation of the question of determinism was revived. It became the norm to perceive determining connections as constructivist *projects*, among which scientific ones ensure their reliability through mathematization and (or) verification, and philosophical ones acquire *objectivity* by introducing categories and methods that explicate development in accordance with the procedural characteristics of non-classical objects. Both options, in contrast to the period of their syncretic nature, rehabilitate the status of *chance*.

Instead of the «insufficient» characteristic, subjectivizing knowledge and its results, chance is first introduced into scientific description through the «positive» method of calculation and prediction in thermodynamics and non-classical applications of probability theory. In this connection, a purely scientific meaning of «chance» was isolated, implicitly created already in classical probability theory, but for the time being incompatible with the norms of theoretical description. «From a modern point of view,

attributing certain quite definite values to the characteristics of objects and their environment is an extreme idealization, approximately justified only for objects with a huge mass (or number of atoms). In all more or less real situations, one has to take into account the fact that any physical characteristics are random quantities described by certain probability distributions in the space of the corresponding parameters. The most important characteristics of such distributions are their moments of zero and second orders, i.e. average values, dispersions and correlators» [23, p. 189].

However, universal epistemological attributes (generalization, explicitness, evidence), as demonstrated, for example, by the Einstein-Bohr dispute, will always be ready to assign this meaning an *epistemological* niche – among the temporary pragmatic flaws of epistemological constructions. A full-fledged ontological interpretation of it, referring to the deep levels of the structure of matter and the *in*tangible evolutionary processes, rests on the *problem* of developing and perceiving sophisticated mathematical models [24]. As this problem is overcome, the worldview significance of the scientific (mathematical) concept of randomness loses its purely negative connotations (uncertainty, non-obligation, irregularity, instability, insignificance, destructiveness), bringing some alternative types of randomness out of the shadows of the history of philosophy. Their dissemination turned out to be especially in demand by marginal scientific disciplines, and later also by interdisciplinary concepts that must satisfy both classical idealizations applicable to simple stationary objects, and at the same time constitute a perspective for non-classical and post-non-classical modeling.

5.3 Humanitarian prerequisites of the probabilistic style of thinking of non-classical science

In contrast to F. Brentano's program of *reducing* methodology from philosophy to the organon of natural science, in the second half of the 19th century, Kant's dualism of the spheres of morality (freedom) and nature (necessity) passed into the neo-Kantian division of the sciences of the spirit (idiographic, individualizing) and nature (nomothetic, generalizing). In the view of the latter, no special innovations were

expected: W. Windelband, G. Rickert or I.G. Droysen propose to generalize and (or) explain mechanical conglomerates of atoms in relation to the universal laws of their motion. But in the new humanitarian method of "understanding" (das Verstehen) one can recognize one of the scientific applications of irrationalistic philosophy. In an attempt to grasp its meanings from I.G. Herder before the Badenians should begin with the general position on the *incomprehensibility* of the transcendental, historical reality, which otherwise could constitute that universal explanans which in nomothetic disciplines ensures the possibility of complete determinism.

The beginning of this incomprehensibility in the humanities was laid by the reaction to the Enlightenment concepts of universal rational human nature and «natural law». Further confirmation was found in the historiographical incommensurability of the spirit (Geist), that is, the Subjects of time and peoples with the empirical (small) subjects belonging to them. There is absolutely no talk of an empirical generalization of large or small subjects due to the impossibility of a research scientist to belong to several spirits at once, in other words, due to the danger of «reading» the same «facts» by means of different hermeneutics. Therefore, in the procedure of understanding, *interpretation* as a particular (-historical, -own) explanation of a «historical fact» must be supported by its *empathy*, that is, (in-, re-)experiencing the subjective context being studied. But the main thing is that empathy promises to reproduce the integral internal state («totality») of the subject, producing *each* of the actions as an act of will causa sui. Although these «facts» are initiated by natural or economic conditions, and then «fit» into their «horizontal» causal series, however, they are nothing more than the whole in relation to the particular, necessary to the accidental, invariant to the variable. In this sense, subjective («total», «vertical») *determination*, given that it does not develop, as in G. Hegel, into a progressive self-articulated dialectic, is called «individual causality» and is subject not to «explanation», but to «description».

The *ontological* possibility of empathy, finally purified from pietistic mysteries, will be found already in phenomenology and existentialism (and natural science accepts it thanks to postpositivism). According to J.P. Sartre, being is accessible to the *subject* (consciousness) only in unique phenomena immanent to it. In them, it

recognizes itself, so that, in contrast to natural or objectified being (être-en-soi), it appears as a «dependent variable» in relation to its own existence (existence), chosen «on behalf of *each*» and therefore open to the scientific researcher [25]. «All that a philosopher can do, and indeed all that one person can do for another, is to illuminate the possibilities of action and the meaning of freedom in terms of providing genuine choice or self-sacrifice as opposed to decision-making under the pressure of social conformity » [26, p. 225]. The existence acquired in this way provides the subject with a horizon of personal meanings and goals («the assumption of essence»), free (de trop) from «external» causal series, until some of the (con)sequences of actions, *random* for the personal context, force one to discover in them a qualitatively new phenomenon of being, etc. [27].

Thus, the sphere of the spirit became limited to the internal (individual, historical) dimension, and the external natural world, given over to natural and technical disciplines, found itself outside the framework of cultural meanings and definitions [28]. Humanitarian knowledge, being a dialectical way of thinking, which presupposes the unity of the «silent» thing and the active subject in the scientific object, continued to operate with feedback, which not only limited the arbitrariness of the researcher, but was also culturally motivated and value-measurable. True, the cultural process and personal enterprise of the humanitarian object were invariably reflected in the epistemological merits of the corresponding positive knowledge.

As a result, limited explicitness, accuracy, predictability and non-mathematical probability as the reverse side of freedom assigned to the «sciences of the spirit» the characteristic of alternativeness, or (in epistemological terms) formal inconsistency. And vice versa, in monologically oriented disciplines, knowledge was presented as a linear movement toward the point of the ultimate development of theory, in the process of which all provisions contradicting the central idea are transformed into those compatible with it or rejected as erroneous. From here, the actual dialogue of different statements turned into a consistent monologue, which acted as a guarantor of the unambiguity and, ultimately, the pragmatic value of the theory [29].

On the other hand, «in the 60 years since the Battle of Waterloo» the historical worldview advanced by natural philosophy and continued by ideography has influenced the methodology of experimental natural science. The first sign was the tychism of C.S. Peirce, which obliged the scientist not to objectively depict the random world, but to (co-)create its highly probable image. Later, however, the issue is about introducing objective probability into nomological (formal) determinism not at all as a degree of reliability. Indeed, statistical physics (D.W. Gibbs, L. Boltzmann), which was emerging at the same time, began to operate with scientific and cognitive forms, where the immediate *series of causation* of microparticles were omitted as random, and their *final* statistical outcomes were included in nomology. There appeared a reason for non-classically minded thinkers to perceive these forms (entropy, the connection of states) as appealing to a holistic irrational determination, entirely in the spirit of romantic ideas about "mysterious affinity" and thereby smoothing over the opposition of the natural and the humanitarian (and in general, the «kingdoms of nature», delimited by the Thomistic-Aristotelian «hierarchy of entities»).

On this path, science occupies another traditional niche of philosophy's competence, moving with the help of Darwin's theory of evolution to a «positive» description of human nature. By depicting man as the result of a random experiment of nature, which has neither a providential plan nor a general lawful direction, Darwin's theory reinforces the ideological claims of science (although it raises the question of the foundations of human reason, which until then guaranteed the possibility of scientific truth). But the main thing is that «this biological hypothesis immediately acquired a more general meaning, since it promised to give a purely mechanical explanation of expediencies» [30, p. 469], making do with a causal (phenomenological) description and not asking the question «why?» or taking it for epiphenomenal. We are talking about expedient behavior that was observed in organic life, psychology, ethics, sociology, history, but did not find a convincing scientific explanation free of clerical associations.

But at the turn of the 19th and 20th centuries, the revival of «speculative» thinking (I. Kant and G. Hegel) was already becoming actual, which would help scientific

thinking, faced with non-mechanical reality, to critically reflect on its own categories and definitions to the extent that they determine this «empirical». True, a contemporary of this situation, N. Hartmann, notes a peculiar historical aporetic in that both the bare methodology of positive sciences and the compromised natural philosophical systems became unacceptable. In many ways, this aporetic was made up of the law of conservation and transformation of energy, according to which the fundamental status (the concept of «mass») should be transferred from qualitative matter to quantitative energy, which gave rise to an irrational background of the boundary between the substrate and the mathematical in *natural* science.

«The problematic situation in it is extremely unique: the basic definitions show the nature of the substrate (space, time, force, causal connection, energy), but on the contrary, the accuracy of special definitions (laws, relations) is rooted in something else, in the quantitative ‹…› A substrate of quantity is always assumed, which as such is not quantitatively knowable» [31, p. 239]. In particular, from the theory of relativity, which «going beyond the boundaries of unambiguous measurement relativizes the substrate of measurement», one should draw a conclusion about the heterogeneity (layeredness) of being, as well as about the continuing fundamental excess of its powers by the quantitative layer (mathematical thinking) due to its former captivating transparency and unambiguity. When the successes of mathematized natural science give rise to the oblivion of matter, only equations remain, which reason, in a Kantian manner, attributes to nature.

In the sense of the transcendental Subject, reason does prescribe laws to nature. It provides cognitive means (forms and methods) that, depending on their relevance and prospects, can set *certain* guidelines (causa finalis), discredit the sphere of *im*possible scientific experience (transcendental dialectic), or demarcate the standards of substantiation of scientific knowledge *from* the empirical experimental and socio-cultural conditions of its formation (instrumentalism). These basic methods of mediating the individual subject of cognitive practice in the latter case achieve such cognitive remoteness and delay that for an inexperienced researcher they seem

independent of external reality. Thus, one can say, the series of «corrections of induction» initiated by F. Bacon is completed.

That is why in the domestic and partly «continental» philosophical tradition the concept of determinism became subordinated to a more general *dialectical* doctrine. All the comments in it refer to the private, natural-scientific reason, which at that time shunned non-mathematized dialectic and reduced the entire arsenal of determination, explicated by philosophy before and after mechanism, to an unambiguous linear cause-and-effect relationship (Laplace determinism). As a consequence - unjustified extrapolations of classical dynamism, leveling internal individual differences in favor of the nomology of an abstract class (type) of cases, to qualitatively unique mega- and, especially, micro-worlds. It becomes obvious to everyone that the definition of the «final nature of things» entails a decrease in the certainty of the «individual features of individual organisms». However, the scientific community is in no hurry to make a concession to the classical principle of comprehensive description and to assert, following A.N. Whitehead, that «the specific laws of inorganic matter are basically statistically averaged, obtained as a result of the interaction of aggregates» [11, p. 171].

Compensation for this crisis of natural science is rather sought in the other extreme – the extrapolation of spiritual or vitalist layers of being (forms of matter movement), with their inherent expediency of the irrational, to the problematic characteristics of non-classical objects (in the organicist anti-reductionism of O. Spengler and A. Toynbee, we are talking about rethinking the *entire* content of «naturalness»). An additional argument was introduced by evolutionary epistemology, which problematized *conceptual* determinism in nature (C.S. Peirce, A. Bergson). For example, A. Bergson contrasts instinct (intuition) and intellect by the ability to «sympathize», that is, to penetrate the inner essence of an object. Scientific intellect, dealing with dead spatial matter, *analyzes* the primary duration of «élan vital» into separate freeze frames. Linking them with any determination, such as «past-present-future», is doomed to be an artificial juxtaposition of the non-spatial in space, the free (spontaneous) in the external, development in statics, the qualitative in quantitative, the individual in concept.

In view of the consistent deconstruction of the idea of rigid determinism, when the substantial cosmos began to be replaced by the substantial chaos par excellence, the certification of knowledge lost the guarantees of conformity with the self-identical ontology. «Objects continue to exist only as "convenient intermediaries", as "cultural postulates". The density and impenetrability of things evaporates: the objective world loses its "resistive" (objectionable) character, its opposition to the subject. Lacking interpretation in terms of Pythagorean-Platonic metaphysics, mathematized Nature, scientific reality, becomes, apparently, an ideational reality» [32, p. 196]. In the flawed equation being = thinking, being thus becomes the domain of meaning, while in relation to thinking they try to fix ontological structures that could serve as the basis for a new determinism.

The epistemologically similar situation of quantum mechanics is already based on *physical* indeterminism, which managed to acquire many supporters in science at the turn of the 19th and 20th centuries, since it was subordinated to the determinism of instrumental mathematical description. In the context of studies of the microworld, it is justified in «methodological principles», which in themselves, as scientific means, turned out to be heuristic factors mediating the expression of disciplinary patterns. The methodological principle of «complementarity» acquired special significance, according to which the expressive means (abilities) of science (scientist) are limited in such a way that they require alternation of incompatible methods of description. Thus, not only the need for a permanent combination of alternative theoretical languages is affirmed, but also their inevitable equality, randomness, and play.

Of course, this game required rational understanding (taming), and, ultimately, it began to be found in probabilistic-statistical means of description. But now they related not so much to scientific objects – purely «theoretical» in non-classical science – as to logical constructions, indirectly correlated with the data of experience. If earlier, in accordance with the «geometric» ideal of scientificity, the scientific method and the criteria of scientific truth assumed the derivation of the *theoretical* and the *empirical* from each other, then with the recognition of the scientific status of the unobservable object, they began to be perceived as ontologically heterogeneous. After the exhaustion

of the neopositivist project of their equation exclusively in logical-linguistic status, the arsenal of scientific means was concentrated on logical constructions («descriptions»), relatively detached (probabilistically related) from reality itself. In the perspective of different levels of conceptualization and coherence, assessing the *appropriateness* of transformative actions with such descriptions has become a general problem for scientific rationality and probability, culminating in the post-industrial era.

5.4 Post-non-classical integration in science: the status of humanities and natural sciences

With all the advantages of unification of the problematic, methodology and categorical-conceptual apparatus, the prospect of integration of scientific disciplines also means a sharp reduction in the normative guarantees of the success of the cognitive process. In particular, dubious projects of methodological *monism* arise in the form of an extremely broad extrapolation of popular nonlinear theories, the anthropic principle, discourse analysis, the hermeneutic approach, etc. In the conditions of modern scientific and methodological diversity, consistent normatization of knowledge has turned out to be to a certain extent doomed to comments regarding this or that reductionism.

At first glance, the generally accepted interdisciplinarity as a general specificity of post-non-classical science realizes in the respectable natural science field (and its technological applications) the aspirations of the anti-scientific social tradition, partly realized in the socio-humanitarian methodology.

We are talking about a compromise between universal scientific rationality and extra-scientific forms of spiritual activity, according to which ideas about reason as such are subject to revision and enrichment from criterial-instrumentalist to cultural and anthropological (presupposing a close correlation of mental procedures with the social and individual-psychological context). The new interpretation of the relationship between natural sciences and human sciences corresponds to the de-universalization of the goals and means of human pragmatics, recorded as a «postmodernist condition», and the model of concessions here is considered to be precisely the humanities, known

for its immanent «anarchy».

If the natural referent is seen as indifferent and constant «like a die thrown a large number of times», then the human one «is at the same time a partner and develops in conversation, along with the scientific one, another strategy (including a mixed one): the chance that it encounters does not relate to an object or indifference, but to behavior or strategy, that is, it is agnostic» [33, p. 138].

Continuing this thought, we should pay attention to the fundamental problem of model representation, which is updated during the development of developing objects: who should be «suspected» when faced with chance in the course of scientific knowledge – the limitations of the initial theory that is taken to cover the new phenomenal diversity (the law of motion in the simplest case), or the empirical lack of initial data (initial and boundary conditions)?

It is enough to compare, for example, the consequences of the deviations in the trajectories of Uranus and Mercury discovered in the 19th century: in the first case, a new planet was discovered, in the second, the principles of Newtonian mechanics were revised. Considering the evolutionary characteristics of both the theory and the initial data, the situation seems insoluble from the point of view of traditional rationality and determinism.

Today, in natural science, the designated test of the canon of scientific rationality is a simpler task, since its «first nature» is not complicated, as in the «second nature» of socio-humanitarian knowledge, by a subjective source of chance as an additional variable. In other words, in natural science it is easier to separate the values derived from ontology and the values introduced into ontology by historical socio-cultural traditions and innovations: «the image of what should be does not precede the image of what is» [34].

Indeed, the method of knowledge integration usually occurs due to the translation of natural-disciplinary methods by right of their extremely broad heuristics: it is enough to give an example of a natural-scientific classification of scientific rationality, which is actively used today by domestic methodologists. A similar judgment can be made regarding probabilistic means, which have long been recognized as interdisciplinary –

with the formation of appropriate approaches. It is known that theoretical-probability ideas received resonance in science after they influenced the principles of the structural organization of matter within the limits of mathematized natural science [35].

Thus, with the main watershed between natural science and humanities on the (non-)constitutivity of the object of knowledge by the subjective context, the above-mentioned nonlinear «grafts» successfully provide rational means of prognostication for the now common for all disciplinary departments «human-dimension» («ontological activity», «hermeneutics»), «evolutionism», relativity of objects of knowledge («modes of being»). At the same time, genuine scientific integration here also presupposes the simultaneous diversification of subject areas according to the circumstances of the specification and *limitation* of the methods being transmitted.

Modern interdisciplinarity, as methodologists unanimously note, has long surpassed the textbook examples of interdisciplinary (building bridges and filling in ditches) new formations – «at the junction» of objects, problems and methods, accountable to related scientific disciplines. Together with them, the quasi-rational idea of the «disciplinary matrix» as the historical hegemony of a certain prescription of a common method of scientific activity is also becoming a thing of the past. Today we are talking about large-scale (inter)disciplinary complexes, essentially oriented towards industrial-applied and social-civil tasks.

However, the proclamation of basic natural science models as a priority source of scientific «puzzles» does not necessarily indicate a reductionist approach, because modeling itself has recently been based on hermeneutic procedures. In particular, in the modern conditions of the collapse of the ideal of completeness of description of a dynamic self-developing system, we are talking about a noticeable weakening of the universal scheme of scientific modeling «from the construction and study of the model to its extrapolation» [36].

The sophistication of models so that they represent more and more real randomness must be compensated by increasingly abstract and alternative criteria of reliability. The distance between a model and its initial (empirical models) or final (theoretical models) original for modern scientific objects increases so much that one

can speak of a tendency to theorize scientific modeling with the transition of the representative function from the «model – original» scheme to the «model – fundamental model» scheme. This tendency especially affects the verification criterion, and hence the extrapolation potential of models, or their *trans*disciplinarity. This was vividly demonstrated by V. Kazyutinsky on the Metagalaxy object [37].

Thus, the tendency of mediation of ontology develops into its peculiar «bureaucratization», giving rise to a new unit of scientific and methodological analysis – particular language games (discourses), in which epistemological control (legitimation) is transferred from logical and empirical verifications to operational ones, and reflection – from the goals of knowledge to the *means* [33, p. 92, 99-114]. The problem of their alternativeness (and, accordingly, the criteria of rationality) in ontological terms corresponds to the problem of *reducing* the alternative possibilities of the «natural essence» into the reality of its law, which became more acute after the non-classical negation of the figure of the *subject* as an absolute «External Observer» in favor of a relative «cognitive agent».

For the methodological consciousness, which has long been under the hegemony of the positivist ideal of science, unnatural chance means a new syncretism of objective and subjective premises, and with it, alternativeness, redundancy and uncertainty of the canon of rationality. Today, the humanitarian scientific ideal and, in particular, the first schemes of the neo-Kantian and Diltheyian *Verstehen* are put forward as balancing guidelines.

At one time, this method, as an application of Kant's apology for subjective freedom, was intended to *overcome* accidents and inconsistencies in various methodologically immature disciplines (from «natural» to «social» history) [29], since it proceeded from a priori goals (integers) appropriateness. The latter, being«universal» historical values (meanings), taken at that time as a personalistic transcendent, ensured the achievement of the final validity of scientific knowledge through the correlation and dissolution of empirical historical values (meanings) in them.

Later, «understanding» already expresses the opposition of the unique subject of

comprehension to the generalized (typified) object of explanation, since they are produced by determinations of different levels. Then *each* of the subject's actions should be considered a self-sufficient act of self-causing, otherwise these «facts» will be spontaneously «read» by means of the opposite of different hermeneutics of «horizontal» causal series.

A similar *antinomy* of meaning and cause is recorded in the Frankfurt and Lacanian versions of neo-Freudianism. In the first case, it is resolved through the «withdrawal» of alienated cultural meanings in an abstract quasi-natural cause, in order to oppose this natura secunda to actual cultural meanings as «self-other». In the second case – through the «seduction» of the symbolic universe of the subject by the formal chain of the social Law according to the principle als ob [38]. Although both variants of communication of meaning and cause leave their rational commensurability in an asymptotic perspective, they are equally unanimous in denying spontaneity (I. Kant's «free causality») theoretical and methodological significance, perceiving this kind of randomness in an applied «therapeutic» context as «pathology» (an internally forced reaction). And vice versa, causal «normality» must be ensured by a complete explication of the entire hierarchy of subjective meanings (languages) – from individual to socio-cultural.

T. Kuhn, having adopted from the holistic concepts of psychophysiology, gestalt psychology and cognitive psychology the respectable experimental confirmation of the «understanding» determination, put forward the *idea* of combining the direct internalist and mediated by it externalist (re)structuring of experience, supported by postpositivism, poststructuralism, sociology of knowledge in the form of a fundamental pluralism of methodological standards of natural science. Thus, the price for the democratization of the «logic of scientific research» turned out to be the discrediting of intra-scientific methods of certifying the resulting knowledge – due to the impossibility of distinguishing in them the academic and political («corporate») components.

Being therefore equally susceptible to moral argumentation, which is oriented towards a certain image of the status quo, the criteria of rationality are prone to periodic

revolutionary renewal in favor of a new one-sided status quo. The prevailing *epistemological* solution to the problem of the discouraging multifacetedness of methodological standards leads to the fact that the original cultural-value dimension of rational norms of the «logic of scientific research» is «removed» in a *dynamic* dimension [39, p. 55-56].

The same scheme of probabilistic *addition* of levels of determination is observed in M. Foucault with the difference that he denies any *evolutionary* direction in the variability caused by the «superposition of sequences in the context of a certain discourse». The latter is considered only a methodological mask of determination causa sui, which in Foucault's (a)historicism is subject to eradication along with the continuous (teleo)logic of ideas. However, the real randomness of the non-substantial system of transformations is not easy to discern in the institutional orderings (in technology, language, organizations) of the original element of power [40].

One way or another, the problem of intuitive-psychological interpretation of the unique loses its urgency, and the subjective («total», «vertical») determination of value is called «individual causality» and is subject not to «explanation» or «understanding», but to the procedure of «*description*». Like the statistical description of non-classical physics, it rejects the classical dichotomy of «natural force» and «changeable conditions» of the structure of scientific law in favor of an undifferentiated interrelation of determining factors – abstract causal in one case and visual teleological in the other.

Leaving the actual relations of the transformative and life-meaning functions (object and value; means and goals) in the perspective of «growing refinements» [41], probabilistic-statistical (stochastic) methods of description thus turn out to be the discursive basis, if not of methodological monism, then at least of interdisciplinary communication.

A convincing proof of this is the change in ideas about scientific causality in medicine, the most conservative field in this regard. The fact is that at the intersection of the natural and the humanitarian, the «law» traditionally expressed not a *class* of causes – the distribution of the law in a certain set of conditions – but rather a *type* of set of individual causes.

This is precisely why the statisticization of medicine, initiated by P. Louis in the first half of the 19th century (simultaneously with the statisticization of leading experimental scientific disciplines) did not develop for a long time. The classical theory of Paracelsus' disease, when a certain etiology corresponds to certain symptoms and anamnesis, was revised only in the second half of the 20th century in connection with the rapid development of synthetic pharmacology. The latter forced the replacement of the "etiological cause" with a new working concept of a statistical «risk factor», which received a wide interdisciplinary resonance [42].

The real value determination, dictating alternative idealizations, and with them *corrections* for boundary conditions, the configuration of the phenomenal field, the accuracy of measurement, etc., turns out to be outside the competence of the falsification criterion. This reduces its sensitivity to sociological and individual-psychological factors, which are not simply filtered by the «membrane» of ideals and norms of scientific knowledge, but also perform at least a deductive-restrictive function in relation to them.

Perceiving these factors as *extra*-scientific, evolutionists allow their dispositional predicates into the «body» of scientific knowledge only in the inductive-probabilistic perspective of the verification criterion. And here nonlinear science came in handy, in which, finally, the subjective factor is convincingly interpreted for natural scientific methodology as an ineradicable factor of the objective process and subject description.

Thus, the outline of the solution is visible in the specified stochastic method of description, where both uncertainties are *combined* (added), but disciplined by model samples. Despite the fact that models are only a preliminary means of obtaining a law, in the context of today's conceptual diversity in the foundations of science, they have an attractive advantage of operational access to scientific rationality. Corresponding to the law only statistically, they are protected from sociological and axiological speculations accompanying the emerging paradigm. There are grounds for this opinion in the original nature of the law, which presupposes the consequence of distinguishing the structure of reality and its ideal model, the procedural-historical convergence of conceptual reconstructions and ontology [43]. Therefore, model «methods of

description» are put forward as prototypes of a new *meaning* of the category of law, which removes the contradictions of form and content, description and explanation in the dialectic of scientific representation of reality, thereby increasing the integrative and methodological viability of science.

In addition, the choice of the idea of stochasticity as an integrating link, with all the alternativeness of such a solution, reflects the real increase in the specific weight of stochastic phenomena in science itself and at different levels of its reflection. Among the advantages of this idea are both its belonging to a solid historical-philosophical tradition of the category of chance, and a detailed explication in the cognitive forms and methods of natural sciences and their applications. Thus, methodological generalizations based on stochasticity can be protected from speculations associated with a certain emancipation of the image of science, which opens up to chance.

Considering the all-pervasiveness of the «projective-constructive attitude» of modern European science with its psychology of manipulation of reality [44], it is difficult to avoid such a method of description even for socio-humanitarian knowledge, where there is an open problem of coordination:

– the relatively independent levels of determination of the *subject*, included both in the world of freedom and in the natural world of necessity;

– the relatively independent *bodies* of social science and the humanities (Geisteswissenschaften) — with the corresponding *uncertainties* regarding the potential of the individual in statistics and sociocultural dynamics in hermeneutics.

However, along with the natural sciences, a new paradigm of socio-humanitarian research is being implemented, largely initiated by the emergence of a new subject of research – the «information society». Increasing recognition is being given to methods of introspection, empathy, dialogue, transpersonal psychology, unique forms of projective methods in the game and other resources of the humanitarian component in addition to the highly scientific sociological one – all this in the impulse of expanding intra-scientific reflection on subject-object *inter*dependence.

As a result, *cognitive* relations, to which the classical subject-object model of scientific knowledge is reduced, in an interdisciplinary perspective appear to be only a

part of a more fundamental integrity of subject-subject cognitive relations, personified by goal-setting rationality. This «withdrawal» can already be observed within the socio-humanitarian polygon – in relation to humanities and social methodology as a dialectic of internal and external causation, when the external serves as a resource and criterion for the self-development of the internal (by analogy with the mechanical and organic expediency of I. Kant). The latter implies the transformation of the classical subject of self-consciousness towards unification with the object of knowledge in a single hermeneutic cycle through the means of knowledge [45].

A less categorical conclusion would leave the problem open and would record the split of science into «referential» and «fictitious» («simulation») according to their strategy of handling qualitative *matter*: revealing its possibilities *or* liberating possibilities from it. Then, in a broader context, they are continued in the current dispute about spiritual interpretation and technical formalization of social life: should each «alienation» of spiritual goals in the «body» of an object be subject to socio-cultural interpretation, restoring the *community* of its experience as a product of goal-setting of the social whole, *or* should we limit ourselves to a probabilistic-statistical accounting of goal-setting as «goal-rationality», without extending subject-subject relations beyond the limits of social communication? [46].

At the same time, the commitment to «individual causality» as a «quality mark» of the humanities and compensation for their «inaccuracy» phenomenally brings idiographic methodology closer to the empiricist methodology, which constitutes the «birthmark» of the entire Enlightenment project [47]. It is precisely the elimination of «metaphysical speculations» in favor of «natural» singular facts that natural scientific methodology cannot get rid of, seeing in this case a threat to the experimental verification criterion. «Social scientists, having rejected social atomism and individualism, today mainly proceed from the concept of society as a whole, which is greater than the sum of its parts. Such a concept of society can be used as an explanans in explaining particular social phenomena (practical actions, speech acts, economic structures, religious beliefs): each of them is constructed from the totality of the social functions or roles they perform» [48, p. 377].

It is noteworthy that already W. Dilthey in his programmatic «Introduction to the Sciences of the Spirit» supplements the criticism of *metaphysics* as a generalized idea of reality as a whole with a search for such a *humanitarian* method that would introduce the hidden basis of the «social-historical world» into the knowledge objectified by hermeneutics. Otherwise, the empirical reduction of empiricism dooms the humanities to the same consequences that constitute the anti-human appendage of natural scientific knowledge. We are talking about official value neutrality, which is usually considered a conquest of science as a rational and democratic social institution [49].

«Scientific technique requires the cooperation of a large number of people under one tool – therefore, it is directed against anarchy and even against individualism, requiring a well-consolidated social structure. Unlike religion, it is ethically neutral: it assures people that they can perform miracles, but does not say what those miracles should be. That is why it is incomplete. In practice, the purpose served by these or those scientific achievements depends very much on the case ‹…› No one focuses on the goal anymore, only the skill of the performance itself counts » [50, p. 591-592]. With such an attitude, the actual expediencies, inevitably realized in scientific practice according to one or another social order, appear to be entirely subordinate to purely scientific logic, that is, the random opportunistic coherence of «facts» is portrayed as necessary and therefore legitimized. «Here a fraud is committed: decisions that directly concern a person and are connected with moral values are made under the influence of the authority of science, which in principle is incapable of even distinguishing between these values» [51, p. 67].

This was the case until the dominant empiricist methodology was supplanted by non-classical constructivist approaches and methodological principles dictating a selective model perception of reality. After their ontological status was established, the course toward value neutrality could be maintained at the cost of *pluralization* of methodology, and the latter is considered a logical end to the educational project of mutually conditioning Reason and Progress. But few people note that in such a «state of postmodernism», alternative scientific methodologies are burdened with a new dimension – the need for consistent and epistemologically correct correspondence to

the subjective context.

Until the humanities become interested in the «conditions of possibility» of their «single» subject, the philosophy of postmodernism equates its humanitarian values as cognitive with other «foundations» that rationalize values into scientific ideals (systematicity, intersubjectivity, cognitive truth), which perform not so much an innovative-regulatory function as an administrative one (operational goals, enshrined in the values of formal hierarchy and exhaustive controllability). In conditions where the subject has ceased to be universal, and his thought – total, these scientific norms are today more effective than explicit ideologies. «All areas of scientific research are characterized by situations in which science allows the formulation of several reasonable alternatives, and it is impossible to show convincingly that only one of them is correct. It is in making choices between such alternatives, whether they are made at the level of general definitions of the problem or at the level of detailed analysis, that the political attitudes of scientists and the pressure from the political environment are most clearly used» [52, p. 205].

In this regard, the educational course on the elimination of the [spontaneous or metaphysical] *subjective* factor should turn to its consideration and «education», obviously, according to the criterion of its creative capacity both in the internal (epistemological) and external (sociocultural and technological) aspects. Such «humanization» of science in a certain sense has an independent tradition in the humanities, established, obviously, by the Augustinian-Neoplatonic cognitive scheme of «caritas», and in scientific practice means intentional-phenomenological and hermeneutic interpretation as a condition of objective-truthful cognition in the conditions of communication of alternative scientific research programs.

Of course, here a great adventure of measuring intra-scientific and socio-cultural values arises [53], since taking into account the subjective factor will require a certain methodological toolkit of self-representation of the subject of knowledge in meaningful agreement with other levels of representation of this object of knowledge. It is precisely this emerging strategy of «building virtual worlds» [54], which continues the non-classical philosophizing of science since the time when it began to master the sign-

mediated micro- and mega-reality, that is ignored by the supporters of the «human-dimensional» synthesis of sciences by right of sovereignty of the socio-humanitarian methodology.

The latter is rather doubtfully perceived as predominantly empiricist on two contradictory grounds: 1) the «historical» («individual») self-sufficiency of each «fact» and 2) the speculative unreliability of the theoretical level of knowledge with its high social relevance in the humanities. This looks as if in the natural science methodology preference was given to facts because each of them is «theoretically loaded», and at the same time theory was relegated to the status of a creative hypothesis because of its «axiological loading».

The indicated problem of coordinating heterogeneous determinants and levels of knowledge constitutes a heuristic perspective for overcoming disciplinary disunity. This conclusion is supported by the history of «disunity» itself, initiated by the famous «Hume's law». It is usually presented as a prohibition on the transition from description (a statement of «what is») to prescription (the modality of «what should be»), which constitutes one of the first explications of the ideology of the value neutrality of science.

In the terminology of A. Poincaré, the original difference between science and morality, by which they will always remain sovereign, is «grammatical», since one of them is always in the indicative mood, and the other is imperative. However, their coordination as mechanical reason and driving feeling is logically expressible.

«Feeling ‹…› gives the main premise of our syllogism, which, as it should be, will be in the imperative mood. Science, on its part, gives the minor premise, which will be in the indicative mood, and will deduce from them the conclusion, which can be in the imperative mood» [55, p. 657].

However, taking into account the well-known limitation of the scope of application of the «only reliable», according to D. Hume, mathematical scientific means, with equal justification one can see in this «law» the principle of protecting «moral philosophy» (ethics, law and aesthetics) from the error of naturalism. The fact is that although in the sphere of morality the necessity of cause-and-effect relationships

is the only genuine and pre-rational, its inevitable elevation from the rank of a sensual motive (moral santiment) to the rank of a scientific idea presupposes abstraction from individual-affective properties, and with it the transition to the category of a posteriori.

Therefore, a more general meaning after distinguishing between the mathematized and moral types of ideas is their equation on the basis of probabilistic epistemology, which does not distinguish in their final instrumental status between random-inductive and causal genealogies [56, p. 228]. All the same, in the perspective of expediency of a reasonably necessary, but unknowable Cause that opens up to knowledge, the possibility of non-trivial – theoretical – predictions of new phenomena is called into question.

However, having destroyed the essentialist basis of determinism, D. Hume prepared a new criterion of scientificity – the *constructivist* potential of accepted phenomena – which was assessed much later, under the conditions of actual total falsifiability. «‹…›We can say that we encounter essentially engineering, design activity in all areas of knowledge. We create and implement projects of production and experimental activity, construct numbers and many other mathematical objects, construct coordinate systems necessary for recording certain phenomena. Finally, any theory and even the facts on which it is based are products of design» [57, p. 206].

Recognition of the constructivist approach as an interdisciplinary methodological perspective will allow, in our opinion, to reconsider the main epistemological divergence between the natural and humanitarian departments, connected with the distinction between the subject and the object of knowledge. As long as humanitarian objects are reduced to the statement of value «facts», respectable humanities will be under the threat of artifacts – a mixture of cognitive relations of the described and describing systems.

The course towards increasing the constructivist potential will orient the humanities towards expanding the predictive field from elementary facts to behavioral, value-regulatory or paradigmatic levels, coordinated with the subjective context of the scientist. In a correct strategy for constructing virtual worlds, this will allow not only to bring both systems of cognitive relations closer together, but also to project

subjective values into life, thus confirming the practical and predictive validity of the humanities in producing relevant value objects.

5.5 Chaotic randomness in modern scientific concepts

In the course of studying the diversity of system objects by means of cybernetics, specific methods of theoretical description were outlined, which are not limited to purely *statistical* distributions. The random dynamics discovered in them, in addition to the "external chaos", are also constituted by structural changes responsible for *qualitative* transformations. On this path, new problems of nonlinear description arose, related to the representation of complex irreversible forms of self-organization (W.R. Ashby), or *evolution*, which were previously reduced to a speculative (G. Hegel) or phenomenological (C. Darwin) approach. In addition to the traditional dialectical statement in the sequence of the development process of a «leap» or «transition to a new quality», this stage is now becoming the subject of structural analysis and mathematical modeling. The starting point of evolutionary stochasticity is often called meteorology, in which, as early as the middle of the twentieth century, progress in forecasting methods (E. Lorenz, N. Wiener) soon led to the formation of new scientific concepts.

The baton in developing a general theory of dynamic description from cybernetics and systems theory is taken over by synergetics, chaos theory and other theories that develop the concept of nonlinearity in connection with the inclusion of the behavior of complex systems in a more general context of their transformation and new formation through *chaos*. Many authors even identify modern *post-non-classical* science with the so-called «synergetic» methodology and picture of the world, since and to what extent they rethink the categories of «reality», «development», «truth», etc. in connection with the concept of «chaos». «If, for example, chaos was traditionally considered to lie outside the bounds of science and therefore, at best, played only the role of a mystical origin in philosophy, then in the synergetic picture chaos is an unstructured or very complex structured existence that does not obey deterministic laws» [58, p. 113]. Some authors reinforce a similar thesis by saying that «since chaotic randomness does not

obey any unambiguous law, this means that the synergetic methodology includes the principles of pluralism and relativism» [59, p. 24]. Others specify it by the active role of the subject, capable of synchronizing and bringing into resonance its external disturbing chaos with the internal one so that the stability restored by the system continues according to the genetic scenarios (type of trajectories) that correspond to the *interests* of the given subject. The latter circumstance forces us to integrate truth and morality, «goal-rational and value-rational actions» within the limits of science itself, following the example of Eastern organicism [60, p. 24].

It should be noted that «chaos» has been brought to such a function relatively recently. The beginning of its application as a scientific concept was laid by J.B. van Helmont and A.L. Lavoisier to designate the main property of the non-combustible part of air: unlike oxygen, the remaining «gas» was not subject to fixation and calculations in certain chemical compounds. Despite the subsequent development of gas objects, for example, in the theory of molecular chaos, this property was assigned to a collective characteristic of various phenomena that do not fit into the current mathematical formalism and scientific language in general («algorithmic randomness» in the language of AIC A. Kolmogorov, G. Chaitin, R. Solomonov).

Objects of statistical physics are no exception, since the «average» and «random» quantities describing the mass coordinated behavior of microparticles were suspected of containing functions of too high an order. At first, chaos was allowed in them, that is, the *ambiguity* of elementary («short») cause-and-effect relationships simply by abstracting from the supposed «hidden parameters» due to the irrationality of the latter in the perspective of taking into account all elements and the hierarchy of external «noises» going to infinity. And only the extreme difficulty in fixing and calculating elementary cause-and-effect relationships in a deterministic process gave rise to the «physical» idealization of the motion of particles, independent («arbitrary») of these relationships, but subject to a generalizing law of change («long») of states.

Within its framework, the occurrence of one of the random events does not depend on and is not determined by other events; there are no permanent connections between the elements of a mass phenomenon, or they are of an insignificant nature. Thanks to

the Newtonians, the *dilemma* of the self-sufficiency of atoms (their «first» or «final» cause) and their rigid causality («proximal» cause) began to be recognized, leading to the idea of the relationship between atomism and stochasticity. Later, thanks to L. Boltzmann, the acceptance of the atomistic hypothesis necessarily required the use of probabilistic-statistical concepts to describe the structure of a physical system as a mass phenomenon. And the formation of an image of the world with features of stochasticity in methodological consciousness is carried out through the concept of chance, expressing a certain type of connection between equivalent *elements* of the system of classical statistical mechanics. Thus, «short» direct causality (in the sense of external elementary, «generative» causation) was subordinated to mediating *statistical* causality, but not because of integrability or indistinguishability, but because the latter were more comprehensive and sufficiently «long».

Thus, laws of state change were introduced as an alternative to the classical dynamic description of absolutely deterministic processes. However, in the interval between the Newtonians and L. Boltzmann, in the Laplace concept of determinism, according to the ideal of completeness of description of states of a mechanical system, the connection of states was identified with the causal connection, which today satisfies the description of only closed stationary systems. Limited methodological reflection of this feature up to the emergence of the concept of a non-classical object of science largely fueled the controversy regarding the status of probability in statistical physics under the conditions of unanimous recognition of its property of irreversibility. The prospects for resolving this problem receive real clarification only in connection with the establishment of the limits of application of the idealization of the isolation of elements of statistical ensembles, the isolation of the object as a whole from the infinity of additional factors of the external environment, as well as with the discretion and adequate mathematical expression of the constantly acting interrelations of its components.

The discovery by A. Poincaré in 1892 of a new class of unstable systems in which short causality cannot be integrated (and equations cannot be solved analytically) led to the first revision of the idealization of free particle motion, calculable in the form of

explicit functions of time for elementary coordinates and velocities. In addition to eliminating the absolute isolation of the system for *external* excitations (1), this also meant the possibility of significant deviations from the statistical law of state change on the part of *internal* non-articulated interactions (2). When superimposed, these uncertainties increase exponentially and can reach macroscopic dimensions.

Therefore, the strengthening of the random factor in the hierarchical structure of integral systems does not deprive the scientific description of all the accumulated advantages of rationality. «Being an indeterministic concept in general, synergetics nevertheless remains entirely within the boundaries of rationalism, since it believes that the entire set of states and structures that a system will have in the course of its evolution is potentially already contained within it» [61, p. 19]. The concession to objective indeterminism turns out to be an advantage for the *predictive* function, which now benefits from the articulation of the chaotic properties of causality. The complication instead of averaging of representation is resorted to in order to master the «outrageous» aspect of short causations, when they accumulate and are repeatedly amplified («nonlinear effect, or jump»), and the trajectories of particles, initially arbitrarily close, diverge exponentially over time [62]. As a result, the non-classical concept of chaos, for example, for a gas in a state of thermodynamic equilibrium, began to presuppose both a holistic, massed description of the inconsistent – without feedback – dynamics of elements and a probabilistic representation of their «short causations».

Thus, as the accuracy of measurements and, accordingly, the causal scale increased, heterogeneous and differently weighted connections (levels) began to be involved in the description, complicating the structure of the described system from random (in the sense of random variables of probability theory) to chaotic proper. If for stable dynamic systems, depending on their scale, determination was abstracted to dynamic or statistical, then for labile unstable systems the causal field is formalized into the opposition of statistical/probabilistic-statistical, and the description of the chaotic structure is formalized into stochastic.

In the development of *stochastic modeling* tools (degrees of chaos, «partial determinism», «dynamic chaos», «deterministic chaos»), first of all, the qualitative

theory of differential equations of A. Poincaré and A.M. Lyapunov, differential geometry, and then [not without rediscoveries in natural science material] the *theory* of dynamic systems with the final separation of the latter theory of dynamic chaos were used. In turn, the applications of chaos dynamics already cover a wide variety of areas – from chemical kinetics and neurodynamics to quantum cosmology and cosmomicrophysics [63]. In most of the examples given (works by A.N. Kolmogorov, D.V. Anosov, Ya.G. Sinai, G.M. Zaslavsky, B.V. Chirikov) we are talking about «*dynamic chaos*», understood as the stochasticity of closed (conservative) non-integrable dynamic systems. The fact is that even in the scientific community, chaotic behavior continues to be associated with complex non-dynamic systems, to the extent that they are burdened with external noise and internal fluctuations.

Meanwhile, *instability* of parameters is also characteristic of the simplest or algorithmized dynamic systems. Their characteristics of the movement of trajectories in phase space reveal a constant combination of regular and mixing distributions, that is, in fact, corresponds to the resonant-oscillatory dynamics of self-regulation. Therefore, dynamic characteristics can change over time completely randomly ("chaotically"), and the later «local» states of the system turn out to be unpredictable even with full knowledge of the law of its movement. «Chaos (as an internal property of a system) occurs almost always and almost everywhere! And if we do not always detect it, it is only because it either occurs in a very narrow range of parameters, or manifests itself over very long periods of time, or is veiled by other, stronger processes» [64, p. 6]. Similar conclusions were made regarding measurement procedures as a result of the study of fractal phenomena by B. Maldenbrot.

On the other hand, in response to the long process of emancipation of complexity and chaos from the idealizations of classical modern European science, the idea of *limiting the arbitrariness* of random processes by the objective context of irreversibility of self-development of open (non-conservative) systems is asserted. Thus, in connection with the study of turbulence, attractors, dissipative systems and the generalization of E. Lorenz's models, «Sinai billiards» since the 1970s, the concept of «*deterministic chaos*» with a stochastic representation of dynamics, but a simple

deterministic basic equation is formed. Simplification of the description here is usually carried out by methods of decreasing (reducing) the number of degrees of freedom (independent dynamic variables) of the system or aggregating simulation modeling with respect to essential parameters reflecting a wide range of disturbing effects. For example, the study of nonlinear dynamic climate models showed that its dynamics are mainly determined by only four fundamental parameters, on which the effect of the internal chaos of the climate process is «superimposed» [65].

In this case, there is no return from the arbitrariness (incidens) of local causality to the arbitrariness of nomology, since the random variables of statistical description are also deprived of independence, imparting to them a certain partial internal connection of «endentiousness», dynamics. In these parameters of restructuring, permanent organization of the new macro-order, the inevitable and irremovably chaotic consequences of micro-movements are realized and expressed. The main mechanism of such behavior lies in the interaction of macro- and microscopic movements, when the latter, due to the periodic accumulation of micro-perturbations and random deviations from average values (unstable modes), is capable of redefining the main variables (stable modes) in the movement of the entire system. That is, the description of short uncoordinated causations is not simply reconciled in general statistics with the holistic description of the dynamics of elements, but also periodically passes («is extended») into it.

In this way, the paradox of self-development that existed in the linear paradigm until the mid-19th century is overcome, according to which «…from one's own means non-development; and … from the external means not-one's own». After all, the first acquaintance of young mathematical natural science with its objects required their extreme simplification, their isolation from the infinite hierarchy and dynamics of connections. «The usual paradigm of becoming looked like this: becoming can be carried out only between firmly established milestones of knowledge, since otherwise it will be unknown what exactly is becoming, in what direction and to what results becoming leads ‹…› In other words, the starting point of becoming was identified by

classical science only with being, only with the self-identical state of the object of thought» [66, p. 127].

In nonlinear theories, «the main form of being is not what has become, but what is becoming, not rest, but movement, not complete, eternal, stable-integral forms, but transitional, intermediate, temporary, ephemeral-fractional formations» [67, p. 143]. The state of an object is established by means of non-fading (neg)entropic flows of matter and energy, containing it in a state of nonequilibrium, and the balance of the main variables (stationarity) is constantly tested by periodic correlations (coherences, cooperation, synergy) of disturbing effects of varying intensity. Being is an actual formation in which chaos and order, complexity and irreducibility occur and are expressed through each other. Accordingly, the degree of chaos will be determined by the degree of distance from the value of macroscopic stable modes that control numerous parameters of the state of self-organization, that is, from the informational «order parameter» to which the degrees of freedom of the system as a whole and its individual parts are reduced. «We can observe a certain phenomenon of cyclicity: on the one hand, the elements are "enslaved" by the order parameters, and on the other hand, the elements determine the behavior of the order parameters. Or we can draw an anthropomorphic picture: the order parameters represent the finding of a consensus between the elements of the system» [68, p. 140].

As a result, the trajectories form branching structures: stable reversible behavior corresponding to the classical «physics of the existing» falls on the segment *between* branches, and the periodic wandering of the initial conditions falls on the deviations themselves, which make up the individual history of the self-organization of the system as a whole. The combination of external and internal, local and global aspects of evolution in such a description allows us to speak about the identification of a new epistemological approach – «physics of the emerging», representing the dynamics of transition processes – from a stable order to unstable chaos and, conversely, to a new order (level) of self-regulation of the system and a new profile of random variables.

Depending on their nature, self-developing systems can differ in the ratio (specific weight) of micro- and macroscopic movements, (non-)equilibrium and (non-

)stationarity, internal deviations and external disturbances. For example, R. Thom in his studies of morphogenesis notes a decrease in the role of the material substrate in external flows (disturbances) capable of initiating new formations in autonomous living systems [69]. «Usually in such cases it is said that the cause was instability, and not a small initial impact ‹…› the cause is an internal property of the system, and not an external impact» [70, p. 14]. But in general, such conclusions still remain controversial and express the rivalry between traditional physical and biological intuitions of the category of *cause*: ««…› after all, in physics, either the moments of the "starting impulse" (in mechanics) or the "material carrier" of processes (in field physics) are still brought to the forefront. Biologists, however, speaking about causes in the philosophical, methodological, plane, have in mind first of all the aspects of the form-generating and even teleonomic plane» [71, p. 40]. Although in the perspective of the «topological revolution» I.A. Akchurin predicts the «isomorphization» of mathematical and conceptual structures with biological images.

5.6 Fluctuations and stochasticity

The theory of dynamic chaos itself reproduces mathematical models of destructive or constructive chaos, while *ontological* interpretations and generalizations of self-organization phenomena are increasingly united in the term «synergetics» today. In its original meaning by G. Haken, it indicated the coherence of the behavior of a large number of particles during structure formation in lasers. Typologies of structures of deterministic chaos are developed in line with the theory of catastrophes (bifurcations), and exchange processes (energy dissipation, entropy dynamics) are represented in the thermodynamic approach to self-organization, from the point of view of dissipative [closed or open] structures and systems.

In a generalized description of these models, I. Prigogine and I. Stengers (the authors of the thermodynamic pedigree of synergetics) highlight the permanent antagonism of special bifurcation and adaptation processes (mechanisms) in open nonlinear systems [72]. The first of them, *stochastic*, providing structural variability of the system, are included in response to sharp environmental changes and the crisis of

its internal existence. In contrast to the *adaptation* mechanisms, they lead to uncertainty and unpredictability of the system's future choices in order to resolve old contradictions (external and internal) with new ones, but with a higher integration of elements into the whole and giving development a new impulse. At the beginning of a typologized cycle of spontaneous development, one of the random events-information produces a leap in development in the system and is remembered by it. Then, as it adapts and increases in value, the system becomes so complex that it is shaken by a multitude of random events-information from within and without to a chaotic state, from which the system again makes a leap thanks to one of these new «provocations».

Since the interpenetration of the material-energy (power) and information (control) subsystems is significantly enhanced here, the problem of stochastic dynamics as a synthesis of the corresponding regularities of rigid and probabilistic determination acquires new perspectives and terminological nuances. Thus, in addition to the description of the predominantly statistical aspect of self-organization in artificial and living systems, *universal* (global) models of self-organization are developed in synergetics, applied to natural inanimate and social objects with the involvement of this *singular* initiating randomness. «In the problematic field of research into evolutionary processes, for a long time there was no common ground that unites the evolution of the laser system, the development of the embryo and socio-cultural evolution, namely, there was no information, generation, reception ‹…› From the standpoint of the information approach ‹…› the entire unified process of the formation of a nonequilibrium Universe can be imagined as a chain of successive events. It has branches, dead ends, returns, loops, but its general tendency is progress, i.e. an increase in complexity, orderliness and diversity» [73, p. 227-228].

If statistical «averages» and probability «distributions» still had an outlet for rigid determinism, then the irregularity of such randomness does not dissolve in the rhythm of generalized quantities and is registered on the periphery of the statistical flow. Moreover, in the conditions of a homeostatic crisis, when the system comes to an unstable state, an event falling out of all types of nomology can, as a minor cause, cause an unpredictable (from previous data of unstable equilibrium) and, most importantly,

qualitatively new result. Even J. Maxwell was one of the first to point out the existence of situations («special points») in which the behavior of a mechanical system becomes unstable (like, for example, a stone on the top of a mountain, which can suddenly fall, causing an avalanche). Warning his colleagues against underestimating the role of such situations, he believed that if the study of special points replaces the pruis of continuity and stability of things, then the corresponding successes of natural science will eliminate the predisposition to rigid determinism and its quite common absolutization [74, p. 268].

Starting with the theory of catastrophes, where a universal method for representing sudden jump-like transitions is developed, the term «fluctuation» or initiating stochasticity (V.I. Arnold, R. Tom) is assigned to such constructive events. This is how the conceptual interpretation of M. Smoluchowski's «fluctuations» was obtained, which served as mathematical models of the phenomena of instantaneous deviation of a system from an equilibrium state, discovered at that time, for example, strong scattering of light in a liquid near a critical point. And in the most general form, fluctuations are called random deviations of observed physical quantities from average values in the statistical description of the object under consideration as a complex system. Therefore, quantitative characteristics of fluctuations are based on the methods of probability theory and mathematical statistics, for example, in the form of dispersion relations.

Until recently, physicists associated fluctuations with the consideration of chaos at the *micro*scopic level; today, the possibility of the formation of *macro*scopic fluctuations, as well as their significant influence on the dynamics of the system, has been proven. In general, in a macrosystem, the very existence of many degrees of freedom often presupposes the occurrence of fluctuations, that is, deviations of macroscopic variables from certain «standard» values. However, in closed systems, they are usually negligibly small on the scale of the entire volume (phase space) of the system, are uncorrelated with each other, and are damped by a deterministic balancing reaction.

Another situation is in transitional, nonequilibrium processes of open systems, where fluctuations become macroscopic in the course of cooperation. In the critical region near instability, the behavior of the system takes on a coherent character, which is often accompanied by the emergence of new (so-called «long-wave») fluctuations. These losses of spatial symmetry through structuring and the formation of attractors, i.e., target programs that subordinate elementary trajectories in the phase transition, constitute a new stable regime – until the next branching.

It should be noted that it was precisely the progress in the study of fluctuations and transient processes that showed the need to use nonlinear methods of description. «Previously, in the case of "linear models," randomness was mainly responsible for the presence of constant irregular fluctuations in the values of some properties of systems around average values. In the analysis of nonlinear processes, randomness becomes responsible for changes on a global scale» [75, p. 191]. The description of changes in the qualitative certainty of a system, for example, phase transitions in nonequilibrium states, even with the help of probability theory and mathematical statistics, turns out to be inadequate, since the recognition and absolutization of the latter in the form of exponential («statistical») scientific laws «‹…› relied on the idea of continuity, that is, on a one-sided analysis within the framework of one quality» [76, p. 3].

G. Nicolis and I. Prigogine created a theory of fluctuations near strongly nonequilibrium states, defining the *evolutionary* role of fluctuations in the spontaneous formation of distributions of the type of dissipative structures, compensating for the increase in entropy by its outflow into the environment. In conceptual terms, they emphasize the evolutionary paradigm, giving it an expansive, including cosmological, interpretation. In the evolutionary cosmological interpretation, fluctuations are a *random factor* that determines the transition of the system to one of the stable trajectories (branches) at bifurcation points and a new type of self-regulation, corresponding to the macroscopic equations of the new type of self-regulation, but not representable in these equations [77].

Then the relation of trajectories and fluctuations is seen as the relation of «averages» (i.e. the most probable values) and unlikely deviations from them. At the

same time, interactions (physical and chemical) do not obey the logical and methodological principle of reducing random independent events to more or less rigid dynamic variables. According to G. Haken, this property distinguishes chaos founded by fluctuations from the two previous methods of overcoming Laplace determinism – «statistical mechanics» and «quantum fluctuations». And the formal similarity of physical and chemical fluctuations to cosmological singularities (the Big Bang and black holes) contributed to the entry of random ideas into the doctrine of the Universe, at the level of which philosophical criticism of mechanistic determinism (the linearity paradigm) had long been carried out [78].

5.7 Stochastic image of the world and the interdisciplinary status of stochasticity

In the prospect of mastering complex evolving objects, it was discovered that the regularities of scientific laws, even taking into account their statistical forms, are ontological derivatives of cosmological premises («orders of the Universe», constants). Due to the limited spatio-temporal scale of observations and the accuracy of measurements for a certain class of objects, this derivativeness of laws can be omitted, but other classes require the presentation of scientific laws as hierarchically intermediate systems. For example, in relation to a person, the determination procedures are derivatives of organizational orders (processes) in the social and personal plane, from the spectrum of possible forms of his existence. Moreover, the material and technical moments of determination (compare with the instrumental subjectivism of quantum mechanics or transfer and countertransference in psychoanalysis), as well as self-awareness, self-reflection can serve as factors that form organizational orders, since each state of the human system is bifurcational.

Taking into account the non-classical ideas of A. Eddington and P. Dirac about cosmological premises as initially random, multifaceted and changeable, such an approach is justified in relation to *any* object – due to the inexhaustibility of its components. If a system, consistently containing the components of the system, is derived from fluctuating characteristics, then with each transition from one level to

another there is a significant loss of information. «In fact, in Nature the very environment of an object acts as a kind of device, an indicator of the characteristics of the object ‹…› the concept of an observer acquires a generalized meaning, and the anthropomorphic context of measurement as a procedure of human activity is erased. Thus, the subjective factor ceases to be significant and the objectivity of the occurrence of fluctuations becomes obvious» [79, p. 174].

Since the world constants also play the role of an experimental criterion, the ultimate realization and triumph of the competing images of science must be given to Newton's «*hypotheses non fingo*», which led to the rejection of a qualitative explanation of phenomena and subsequently of a sensory-visual worldview (Galilean idealizations still claimed to reflect invisible but unchanging essential connections). In his new edition, «any scientific idea, put under fire from the demands of verification in the new European sense, is an idea that not only changes in fact, but is also obliged to change. It is unscientific if it lasts too long» [80, p. 339].

The culmination of this tendency can be observed in the discussions on the interpretation of the formalism of quantum theory – around the question of rational means of (verification, falsification) – where the recognition of the immanent gap between the results of discursive cognitive procedures and the events of objective reality has even served as the basis for modern irrationalist positions. In combination with the problematization of the concept of «time» (based on Heisenberg's uncertainty principle and the theory of relativity), the incompleteness (gap, break) of the empirical-analytical activity of thinking is transferred to the conditional form of nomological implicative constructions, known in mathematical terms as a probabilistic description. The popular idea, as a rule, ignores the result of a compromise between the rigidly deterministic intentions of logic and the uncertainty of its projections onto the surrounding world.

However, science will still be a method of research, including the *definition* (including linguistic and material-technical) of invariant structural properties of objects (for which their initial definitions are problematized) and the conditions of their existence, but with the requirement to produce a permanent final (re-)formalization and

(re-)calculation of the parameters of the object (I. Kant's «advancement of experience»), and most importantly – to clearly distinguish between the sought-after reality and the procedure for obtaining it. True, adaptations in the form of non-linear concepts of this attributive strategy are still quite one-sided and declarative, which is confirmed, in particular, by the predominantly *negative* and metaphorical formulation of the properties of the new image of the world.

The negative reaction to classical and non-classical science is expressed in the promotion of the priority of the prescriptive over the descriptive, the axiological over the naturalistic, the anthropic over the epistemological, hierarchy over homo- and heterogeneity, emergence over additivity and holism, probabilistic determinism over mechanistic and teleological [81]. Based on the fact that reality appears in this case in an immanent interconnection (analogy, assimilation) with man, its value-target qualities are brought to the forefront: instead of individual truth projects of the world, *value-possible* world tendencies.

On the other hand, the postmodernist one, any fundamental assumptions are derivatives of the «structures of discourse», in this case philosophical and scientific, which relativizes all rational and value-based attitudes of human existence into an ironic game or political claims. However, in any case, the growing contradictions in the factors of change of material systems and their communication develop into a certain oscillatory processuality, coming into ideological resonance with respectable scientific cosmological intuitions of uncertainty and evolution. Just as *in their time* the historical laws of scientific and theoretical knowledge ensured the functioning of mechanism, energism, organicism, the characteristics of unstable nonequilibrium systems served in interaction with the already established philosophy of life, existentialism, personalism as the basis of the *post-nonclassical* picture of the world. The world of dynamic parity of stochasticity (chaos) and structural order in the ontological context, fundamental pluralism, multi-(equivalence) and metaphoricality in the socio-cultural context and the world of bifurcation and dialogicity in the anthropological context.

Although the ideas of non-stationarity and evolution of the Universe were accepted by the scientific community back in the 1930s, when A. Eddington and P. Dirac discussed the problem of fundamental constants and physical laws, few scientists are yet ready to rethink the picture of global stability. As in the context of quantum mechanics, they rather expect the discovery of Second Order regularities that would govern the existing physical laws, and evolution will still strictly obey the laws of Nature in their traditional understanding. Oddly enough, such a priority of stability and equilibrium means the absolutization of chaos in its most authoritative – thermodynamic – interpretation. Some authors see in this a relapse of the mythological postulates of Hesiod or, in any case, the deistic identification of natural chaos with moral and cognitive imperfection. «As for the modern vision of the world, it is interesting to note that cosmology now views the entire universe as a largely disordered – and I would say, as essentially disordered – environment in which order crystallizes ‹…› order and disorder exist as two aspects of one whole and give us a different vision of the world» [82, p. 48].

In relation to their relationship, not only is «interconvertibility» increasingly recognized, the possibility of one occurring after (instead of) the other, but also mechanisms of *structure formation* of one by *means* of the other, of order through chaos, are being discovered. In this context, universal means of mathematical description for systems of diverse nature are being developed based on the idea of evolution under the general name of «synergetic». Synergetics assumes that uniform nomological properties of nature in the course of its long evolution have led to the formation of all types of systems – from mechanical to organic and social. In addition to the fact that in these models the principle of determinism is enriched by the concept of nonlinearity, according to which the variability of the development of structures is determined by the priority of internal connections («autonomy»), here the *specific* features of nature and the language of description of diverse structures are also overcome in favor of a general evolutionary isomorphism – «hylomorphism of the 20th century». Thus, models of nonlinear theories in the future will allow removing

disciplinary barriers, opening access to understanding and extrapolation of the acquisitions of some sciences in the context of others.

According to S.P. Kurdyumov and E.N. Knyazeva [83], synergetics is gaining ground as a new *paradigm* of scientific representation of reality, generating a revolution that is deeper and more extensive than the scientific revolution of the early 20th century, which began with the theory of relativity and quantum mechanics. In contrast to the Platonic paradigm with its dogma of the superiority of the universal over the individual and singular, the new paradigm revises the concept of the hierarchy of levels of being. «Whereas it was previously considered unacceptable to reduce the equal organizations of nature to the lowest or to place them on the same level of assessment, now on the basis of synergetics and non-classical thermodynamics, it is clearly I mean, the structure of the organization» [84, p. 23]. They lead such universal laws as the principles of extremity (variation analysis), combining causal analysis with target functions, the principle of covariance, the spatio-temporal structure of events, the principles of conservation, symmetry (harmony), causality, etc.

Synergetics is based on the ideas of systemicity, the integrity of the world and scientific knowledge about it, the common patterns of development of objects of all levels of material and spiritual organization, nonlinearity (multivariance and irreversibility) of development, the deep interconnection of chaos and order (chance and necessity). It also claims to overcome Kuhn's historical relativism through the establishment of universal communications within and between «disciplinary matrices». On this path, compromises are established between reductionism and holism in the methodological approach to the study of complex systemic objects, axiological, criterion and language vectors of the natural, technical and humanitarian are synchronized.

However, this method as a universal formal language of synergetics, in our opinion, is still quite vague: it includes both the apparatus of nonlinear differential equations, phase portraits, attractors, principles like the «three non-» (nonlinearity, non-closure, instability), and, for example, the fractal or holographic paradigm. Their ontological status is still a problem, since it must be mediated by the still only emerging post-non-

classical scientific picture of the world based on global evolutionism. Thus, the «philosophy of instability» of I. Prigogine is often contrasted with the biosphere-noosphere concept of V.I. Vernadsky, «‹…›because it is impossible to explain the transition from inorganic nature to biological and further to social systems by "thermodynamic evolution"; doubts are expressed about the adequacy of the program of unifying dynamics and thermodynamics into a single science, attention is focused on the fact that the derivation of the properties of the whole from the properties of its elementary states does not take into account the reverse effect (feedback) of new levels of organization on those formed earlier, and this, in the meantime, gives rise to new possibilities for development in the Universe, etc.» [85, p. 143].

The main obstacle here is the *conditions for extrapolating* all these generalizations of *nonlinear physics* to the level of a universal scientific picture of the world and worldview. For example, the prospects for the inclusion of probabilistic ideas of quantum mechanics (the uncertainty principle) in the theory of gravity (GTR) are not enough [86]. In general, the abstraction of special scientific cognitive structures to the level of universal worldview categories, epistemological guidelines for other natural scientific concepts and methods may require a huge amount of work on their rethinking, as happened, for example, with the categories of «causality» or «structure».

Otherwise, tendentious and unheuristic aspects begin to dominate in the methodological guidance for mastering new classes of phenomena – *explanatory* power is separated from *predictive* power (heuristics), that is, their logical symmetry is violated. Unlike the categories and schemes inherited from the general theory of systems, the concepts of «chaos» (with all its mythological richness) [87, p. 367–376], «order», «instability», etc. still require a logical definition in many ways, and most importantly – a definition of their ideological and methodological status. It is in this context of extrapolation of current scientific and cognitive constructs – ideas, methods, disciplines – from their own emerging subject area to the status of interdisciplinary ones that the significance of the idea of stochasticity is revealed.

The interdisciplinary approach, which has received significant development and tradition in domestic methodology, in general terms (interdisciplinary) assumes:

1) joint consideration of the problem by different scientific disciplines with their subsequent enrichment with interdisciplinary developments – multidisciplinarity;

2) the complexity of the object under study, understood as its systemic nature and the complexity of structural interactions, as well as its holistic redefinability in the dynamics of contextual factors.

In the first *extensive* aspect, the immanent problem of coherence, integrity of the object is periodically resolved with the help of an integrating link, which is set by new scientific paradigms coming to dominance. The second requires an *intensive* synthesis of knowledge and methods of certain sciences, a search in this series for the most extrapolated link for these conditions and tasks with a current revision of methodological prerequisites in the process of studying a given object, subject matter. «The problematic that threatens a theoretical flood must be "lightened" so that its individual aspects fall into their own "envelope" addressed to the appropriate discipline in the usual way ‹…› It turns out that with the help of our rational premises we have, of course, freed ourselves on the whole from all the Gordian knots of this problematic, but with the return mail we receive results that are not very suitable. We ourselves have abandoned our own criteria, and as a result the ground on which we stand is nothing but patches taken from well-wishing scientists who managed to come to our aid» [88, p. 10-11].

While in the interdisciplinary approach it is possible to distinguish «stages of maturity» — from trans-border zones of disciplinary convergence to the allocation of a new area of scientific knowledge – the leading role is played by the reflection of the *structural connections* of reality in the form of relatively autonomous hierarchical objects-systems in cognitive and practical problems. Against this background, it is possible to organize (restructure) the scientific field with the potential for the formation of new metascientific complexes «subject — problem — method — theory». In the course of such formation, alternative – in terms of the degree of subject breadth and generalization, set of aspects, means of formalization – interdisciplinary complexes are possible, as, for example, happened with the «cognitive sciences» [89]. General systems theory, informatics, cybernetics, etc. complement traditional logical-

mathematical means in this regard, offering their cognitive and practical methods, principles, idealizations, and categories as universal ones. They allow dynamizing the general methods of reproducing an object in thinking, signs, and activity, heuristically mediating the philosophical and special scientific levels of methodology.

A certain result of these developments is seen today in synergetics, which shifts the methodology of the systemic approach to «dynamic rails» and establishes universal inter-industry communication. In this regard, it is proposed to reduce the essence of the interdisciplinary approach to «transdisciplinarity», which is opposed, first of all, to «subject», «causal» disciplinary methodologies. Instead of them, for example, E. Laszlo defends the «horizontal» metaphorical transfer, similar to the method of «mathematical hypothesis» of S.I. Vavilov, when problems are sought under this universal method, effectively solved by it in the most diverse areas of human activity [90].

On the other hand, such a transfer should be based on the preliminary *meaningful* inclusion of nonlinear means of description in the foundations of scientific knowledge, especially in the structure of methods for studying natural processes. Considering that in the socio-cultural dimension metaphor is combined with pluralism, the reflexive norms of modern science require legitimation from the most relevant and convincing ideological preferences at the level of fundamental scientific discoveries, applied phenomena, and interdisciplinary concepts. This difficult task can be facilitated by the criterion-exploratory function of the idea of stochasticity. Having reached the level of general scientific transdisciplinary concepts in the *mathematical models* of nonlinear theories reflecting the spontaneous emergence, formation, and development of «spatially heterogeneous stable structures», «stochasticity», however, thanks to its own history, is also representable in other scales of interdisciplinarity.

Following the example of the structure of mathematical knowledge, complex studies, regardless of the subject matter, should present a holistic representation of the object being studied at various *levels* of abstract structures (representation levels): a) subject-scientific, b) substantive-abstract general scientific, c) formal-abstract philosophical-methodological.

a) Subject-scientific idealizations are usually limited to probabilistic-statistical *methods of processing* empirical data and decision-making. Although at this level randomness has long been known as an interdisciplinary tool – a methodological technique used in calculating mass objects, the scientific community has long operated with theories of chance (probability theory, statistics, stochastics), and also based on it the fundamental laws of statistical physics and quantum mechanics. This topic is of greatest interest and relevance in the modern methodological context at the general scientific level of substantive-abstract structures: «if interdisciplinary research and projects are a well-established form of interaction between scientists, then the process of developing general scientific knowledge, which has as its foundation the general concepts of cybernetics, information theory, systems theory, synergetics, etc., and general scientific cooperation is only getting on the rails of implementing one of the general programs of modern science – the synthesis of scientific knowledge» [91, p. 83].

b) Substantial-abstract general scientific structures, expressing in an explicit form the relationships of a structural order, constitute the *essence* of the interdisciplinary approach itself (F. Engels, M. Planck, A. Einstein), the main goal of which is to recreate an internally unified chain of forms of motion of matter, separated by the standards of individual scientific disciplines. In general, being general scientific categories, effective in different sciences, *general scientific subjects* have the advantages of high abstractness and generality in combination with mathematical explicability, sufficient for the exact sciences.

The latter distinguishes them from philosophical categories and allows them to be used as an intermediary between the philosophical and special scientific levels of knowledge in the mainstream of the non-classical problem of explanation (interpretation), but most importantly, to be used to expand the base of heuristic formalization of scientific knowledge [92, p. 102-116]. In this case, conceptual-categorical and subject analogies develop into heuristic conceptual and methodological extrapolations – approaches («structural», «systemic», «modeling», «cybernetic», etc.). Their relevance is justified by the need to solve complex interdisciplinary

problems such as automation, informatization, social prognostics or global problems that were taking shape in the 1940s as independent areas. Thus, the systems approach at one time stood out from a number of integrative disciplines (similarity theory, general modeling theory, operations theory, etc.) in that it assumed systemic and structural characteristics as the most universal. The categories of the systems approach were seen as comparable with philosophical categories, but contained the possibility of concretization by the degree of generality and subject specificity.

Along with «structure», «system», «model», «information», etc., scientific correlates of the philosophical category of «chance» also acquire the status of general scientific objects (idealizations) in connection with the integrative processes of science. In this vein, starting from the 1960-70s, the cognitive means of various sciences and social practices find their subject correspondence in various aspects of the concept of «*probability*», which found its expression in the formation of the probabilistic approach. Probability in it is not reduced to the properties of material objects, logical assessment or mathematical calculus in the corresponding models, rather, «a certain *universal abstract probabilistic object* is formed, which has countless implementations in the material and spiritual spheres» [93, p. 65]. Being a quantitative continuation of the structural approach, the probabilistic approach reveals the holistic properties of systems in their relationship with the properties of elements.

Another scientific correlate of the philosophical category of «randomness» is the idea of «*stochasticity*». Its substantive novelty and merit consists in enriching the language of scientific methodology with the concept of *instability* – in addition to stable, average or dominant properties of probability. Conceptual and quantitative means of the idea of stochasticity can synthesize problems associated with the description of complex self-developing systems and thus set a methodological and value vector for generally accepted approaches. Thus, in the language of the *probabilistic approach*, «stochasticity» expresses the *degree* of probability of events, taken depending on the movement of non-causal forms of determination (conditional, inspiring, etc.). In the *systemic approach*, «stochasticity» allows expressing the dynamics of the values of the mutual transition of elements between subsystems, and

in the *structural* approach – the dynamics of structures, that is, the law changing over time and the result of the interaction of the elements of the structure.

c) In addition to the mathematical apparatus, designed to give quantitative expression to qualitative processes on the material of complex systems and to ensure communication of disciplinary bodies of scientific knowledge, general scientific abstract structures can also include methodological principles that allow them to carry out a transdisciplinary function, as well as ideological ideas. Then they take the status of formal-abstract philosophical-methodological ones, which perform the functions of identifying semantic boundaries and establishing interdisciplinary structural connections.

This transition of scientific discourse to a broader context is accompanied by the universalization of stochastic subject descriptions: when the functioning of any *sub*systems (micro level) appears to their control structures as chaos, which at certain moments (alienation of control structures) manifests itself at the *macro* level, which requires the replacement or evolution of control structures. (All-)general forms of being, which act as a derivative of the categorical relationships of self-organization theories [94], are interpreted accordingly, adopting in this sense the functions of philosophical categories («potentiality/actuality» – «possibilities/actualities», «homogeneity/heterogeneity» – «whole and part», «bifurcation» – «leap», «transition» – «becoming», etc.). In this regard, «stochasticity» and its paired opposition «determinacy» are general scientific correlates of the philosophical categories of «chance» and «necessity» in the interpretation of change and development of the world. Since these new ideas find correspondences in the functioning of social institutions, culture, personal processes, and not only in the modeling of physical and chemical systems, there is reason to assert the formation of a new methodological culture. Depending on the interpretation of the context, it is called post-non-classical, postmodern, synergetic.

In general, philosophical and worldview categories, representing a holistic system, are called upon to express a certain integrative model of the world, in the formation of which one (pair) of the main categories acts as a system-forming factor.

Hence, opinions arise about the implementation along this path of the unused potential of *dialectics* as a methodological regulator of physical theories, in particular, their conceptual structures reflecting the processes of development. Indeed, even at intermediate levels of abstraction, such as, for example, a picture of the world, a style of thinking or a formal methodology, the representation of development is carried out «on the fine line of convergence of opposites». The example that was formed in the generalization of the mathematical expression of the states of unstable and nonequilibrium systems is no exception. Here, the coordination of non-stationarity of dynamics or transient phenomena is determined through chaos – the primacy of short-range, generally *un*coordinated phenomena, form-building – through catastrophes, coherence – through fluctuations, etc.

However, the difficulty lies in assimilating the features of determinism and rationality of the new paradigm, since the above antagonism is persistently perceived not as a dialectical contradiction between the rationally ordering function (systemicity) and the function of creative chaos (evolutionary), which is removed in the development and self-management of the system, but as the old Kantian methodological dualism of the free and the necessary, the irrational and the rational.

5.8 Conclusions

The pre-revolutionary state of minds at the end of the 19th century, when there was a need to balance the idealistic scope of German classics and the empirical effectiveness of positivism, is characterized by attempts to reconcile ideological irrationality and scientific probabilistic means of calculation. In particular, the «tychism» of C.S. Peirce suggests a revision of the absolute ontology of Laplace's determinism based on the guarantees of a self-correcting scientific method. At first glance, as in the classical mechanistic hypothetico-deductive method, communication between generalized initial premises and «tangible» experimental consequences is envisaged here. However, the resonance of metaphysical *in*determinism with the disappointment in the possibility of fundamental scientific provisions (Euclidean axiomatics, principles of mechanics, etc.) that occurred in the scientific community of

the 19th century dictates to the founder of American philosophy a *relative-teleological* concept of the progress of true knowledge.

Although the discursive expression of reality in conjunction with mechanistic determinism in this conception, entirely in the spirit of an irrationalist worldview, is assessed as nothing more than an illusion, scientists believe that it is within their power to reduce experiential quantities to intersubjective stable *meanings*. They can be justified by the pragmatic – expedient in the sense of orientation toward a «scientific» explanation – (co-)community of experimental experience in all its variability and certified by the degree of coherence (affectibility) of premises («illusions») generalized under the influence of «trial and error». Then the logical-psychological probability of scientific knowledge can be interpreted as the *laws of probability* of an objectively random world in which disciplinary boundaries are highly conditional. The non-classical pathos of pragmatism is reminiscent of the Epicurean «clinamen», in which anthropological accents are replaced by epistemological ones. However, the external forceful individual «causal» determination was contrasted with «*non-causal*» ones, such as the internal connection of states developed in the statistical theory of heat.

Another Hellenistic precedent that re-actualized pragmatism on a common inductivist and instrumentalist basis with positivism is the priority of the *predictive* function of scientific and cognitive forms. In specific sciences, in this connection, qualitatively heterogeneous functional correlations of the area of possible values in the role of a non-classical form of truth instead of homogeneous multi-level logical relations have become widespread. Having been ignored by strong mathematical idealizations of the program of experimental-mathematical natural science due to the low analyticity, integrativity, combinatoriality of the corresponding empirical quantities, these properties of being have now provided the subject differentiation of non-mechanistic science.

However, it would be a hasty generalization to claim that only the instrumental-pragmatic approach to the study of a qualitatively new determination of objects of non-mechanistic natural science ensured the general methodological acceptance of the probabilistic method of description, since together with the latter many classical

guarantees of truth were sharply weakened. In order to accept probabilism, *ontological* registration and coordination of these heterogeneous factors of determination, natural science had to use the concept of levels of determination from philosophical irrationalism, but after neo-Kantian humanities – already as entirely scientific (rational). The neo-Kantian scheme of determination, when a «*historical fact*» is both defined and understood (Verstehen) «vertically» («totally», hermeneutically), although it exists in variable random «horizontal» causal series of the material substrate, resolved in the best possible way the «irrational background of the border» of the experimental substrate and the pragmatic mathematical in *natural* science.

Moreover, in connection with the discrediting of the transcendental (subjective), the non-causal factor began to be attributed to the internal *spontaneous* properties (the «first» cause) of atomic objects, now truly *independent*, but coordinated in the actualization of their capabilities by the general conditions of the system to which they belong. At first, this *tendency* consisted in the extrapolation of spiritual or vitalist layers of being (forms of matter motion), with their inherent «expediency of the irrational» to the problematic characteristics of *non-classical* objects (A. Bergson, W. Ostwald, etc.). Then, thanks to quantum mechanics, it was transferred to the category of methodological principles regulating the non-classical relationship of the theoretical and the empirical as ontologically heterogeneous, and scientific rationality in general.

Correlation of processes of differentiation and integration, which are end-to-end for the history of science, at the post-nonclassical stage of the development of science is tilted in favor of *integrative* processes. In addition to the search for a common paradigm of such an interaction of sciences – linguistic, disciplinary, methodological, communicative or institutional – the functional task of philosophical reflection becomes the study of alternative consequences of one or another model of the sought-after paradigm. On the part of the anti-scientist community, the first decisive consequence is the general overcoming of the mentality of monism and universalism, since they were dictated by the classical exaggeration of the importance of the natural ontology of «class» to the detriment of humanitarian «individuality». Instead, instead of a concession to pluralism, scientists see in both ontologies a common fundamental

characteristic of random variability, which is more successfully and rationally represented by updated means of natural science.

The position of complex situationism will be truly modern, when the practical needs of the social order dictate to science the formation of temporary interdisciplinary complexes from the components of not only natural sciences or humanities, but also technical, formal and social sciences. And here, the methodological experience of modeling can act as a meta-scientific guide to the implementation of this instruction, in which the urgent problem of ordering excessive verification criteria finds expression in the involvement of humanitarian methods of «understanding» – from the neo-Kantian «Verstehen» to the post-positivist «epistema» – with the final affirmation of both dynamic and atropic parameters metascientific modeling. Based on the phenomena of the information society, such modeling expands its possibilities by involving empathy, introspection, dialogue, transpersonal psychology, projective methods in the heuristic game, and other resources of humanitarian methodology to supplement the actual sociological one.

Another discursive basis of interdisciplinarity is probabilistic and statistical means of non-classical natural science, which are better suited to the final description of reality through the asymptotic perspective of eliminating the difference between form and content, knowledge and ontology, subject and object. In the latter case, it is about the explication of the value prerequisites of knowledge in order to predict and agree on its results in the heterogeneous communicative environment of the scientific society.

In the course of mastering the diversity of system objects, specific methods of theoretical description were outlined, which are not limited to purely statistical distributions. The random dynamics found in them can be constituted not only by the assimilation of «external» chaos, but also by structural changes responsible for qualitative transformations. In contrast to the speculative (G. Hegel) or phenomenological (C. Darwin) approach to the representation of evolution, new nonlinear theories (synergetics, chaos theory, etc.) are aimed at developing a general theory of dynamic description, capable of producing models of new formation and

transformation by means of updated characteristics of chaos. From mathematical, or «stochastic», models, they are transferred to methodological and axiological regulations addressed to the post-nonclassical paradigm of scientific rationality.

This «positive» understanding of chaos is in many ways opposed to its traditional etymology of «gas», which goes back to the designation by J.B. van Helmont and A.L. Lavoisier of the incalculable non-combustible part of air in chemical compounds. Recent progress in calculations and measurement accuracy, having revealed the non-integrability (A. Poincaré) of «short» elementary causality and the general heterogeneity of connections (levels) of determination, as well as the limits of accuracy (B. Mandelbrot), turned against the ideal of completeness of description. As it turned out in studies on «dynamic chaos» (A.N. Kolmogorov, D.V. Anosov, Ya.G. Sinai, G.M. Zaslavsky, B.V. Chirikov), the strategy of eliminating «gas chaos» in relation to atomistic structures of matter was justified only for a class of phenomena when they form an absolutely closed system. The non-classical concept of chaos, transferred from the predicate (property) to the subject (state), presupposes the complication of the causal field to a probabilistic-statistical one (the statistics of ensembles plus the probabilistic dynamics of «atoms»), and the structure of the system to a purely chaotic one (in the sense of the instability of statistical random variables).

In the development of fundamentally open systems (with turbulence, dissipation, attractors, etc.), the course towards the emancipation of complexity and chaos from the idealizations of classical science already faces the task of reducing substantialized chaos. In the concept of «deterministic chaos» that has been forming since the 1970s, the idea of limiting the arbitrariness of random events is expressed in the representation of stochastic dynamics with a simple deterministic basic equation. In objective reality, they correspond to the properties of irreversibility and partial determinacy by the history of self-development, which are reduction properties for atomistic independence and determine the dynamic structure of the system. It consists of the interaction of macro- and microscopic movements, when the latter, due to the periodic accumulation of micro-perturbations and random deviations from unstable average values, is capable of redefining the main variables in the movement of the entire system. As a result, the

trajectories form branching structures: stable reversible behavior falls on the segment between branches, and periodic wandering of the initial conditions falls on the deviations themselves, which make up the individual history of self-organization of the system as a whole. The combination of external and internal, local and global aspects of evolution in such a description allows us to speak about the allocation of a new epistemological approach – «physics of the emerging», representing the dynamics of transition processes – from stable order to instability and chaos and vice versa.

An example of such a transitional contrast is considered to be fluctuations as a singular random factor, capable of initiating new attractors from a microscopic event by means of adaptation mechanisms and bypassing exponential forecasting – target programs for elementary trajectories in a phase transition. The formal similarity of physical and chemical fluctuations with cosmological singularities contributed to the entry of random ideas into the doctrine of the Universe and the worldview plan of modern science, based on the fact that the regularities of scientific laws are derivatives of cosmological premises. With the assertion of the ideas of A. Eddington and P. Dirac about the original randomness, versatility and variability of cosmological premises in themselves, the system hierarchy becomes comparable with the non-classical role of the subjective factor of the observer. For now, it is perceived at the level of negative principles: the priority of the prescriptive over the descriptive, the axiological over the naturalistic, the anthropic over the epistemological, hierarchy over homo- and heterogeneity, emergence over additivity and holism, probabilistic determinism over mechanistic and teleological.

However, in order to form a new (post-non-classical) universal scientific picture of the world, the conditions for extrapolating non-linear development models must be supported by a meaningful entry into the foundations of scientific knowledge. Based on the pluralistic priorities of the stochastic image of the world, the claims of synergetics and alternative paradigms to ideological and methodological dominance can be justified mainly by the internal consistency of all levels of representation according to the scheme of «mathematical idealizations». So far, synergetics can only correspond to these reflexive standards of modern post-non-classical science indirectly

(preliminary) – through the idea of stochasticity, which, in addition to transdisciplinarity as part of synergetics, also has its own pedigree. It is presented at subject-scientific, substantive-abstract, and philosophical-methodological levels of representation.

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