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REFLECTION IN SCIENTIFIC ACTIVITY AND HIERARCHICAL MODEL OF ARGUMENTATION

In this paper we consider an interaction between the reflection in the scientific activity and the scientific habitus. We claim that the ultimate goal of scientific activity consists in the desire to affect the scientific behavior of other scientists. As a rule, this means that scientific results are recognized more or less fundamental and depending on the fact that they determine scientific interests of the whole community of scientists. Accordingly, the scientific activity, which has entailed a serious discovery or invention, becomes a standard for the research behavior of the majority of members of scientific community. As a result, the given discovery or invention becomes the important part of scientific habitus (the embodied, interiorized social structure in scientific activity). The reflection in the scientific activity is a human ability that allows us to oppose the scientific habitus and not to subordinate the logical level of scientific argumentation to the dialectical level and the latter to the rhetorical level of scientific argumentation.

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1. Reflection in Science Activity and Its Role in Scientific Argumentation

The *reflection* is a human ability to go up over the standpoint of actor and go over to a new standpoint that is out both of the past (actions already executed) and of the future (actions only planned in the present). Such a standpoint to observe own or another's behavior helps to produce the reflective basis of own acts to improve the success of own activity. Therefore our ability to transmit the reflective basis for self-determination and the future activity to other people depends first of all on the complexity of our reflective system. Only due to transmission of the reflective basis the cooperation of individual acts is possible.

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Observing own and another's behavior allows us to have two kinds of activity instead of one: the *reflected activity* (activity as a whole) and the *reflecting activity* (reflection). The first kind is an action which may be observed, the second is an action of reflection which, evidently, can not be observed. The two given kinds of activity are not equal in rights, they are at different levels of hierarchy.

Let us consider more precisely how the reflection participates in the cooperation of acts of individual activity. Assume that there are two individual acts. At the same time, the actor A, making the first action, and the actor B, making the second action, aspire to understand adequately the sense of behavior of each other.

For this purpose, they should change the standpoint of the actor mentally: the actor A should go over to the point of view of the actor B, and the actor B to the point of view of the actor A. If both actors will have a common reflective basis, there will be the cooperative activity consisting of two elementary acts, i.e. of activity of the actor A and activity of the actor B. Note that the common reflective basis is possible just in the case there is a union of the reflected standpoint of A and the reflecting standpoint of B, on the one hand, and a union of the reflected standpoint of B and the reflecting standpoint of A, on the other hand. In other words, if the actors A and B have a *parity of the reflective relation to each other*.

To explain what this means, consider the following additive model. Let L and M be the variables; using them we will denote complex actions of two actors A, B, respectively. We assume that L and M have their values on the interval $[0, 1]$, where 0 means the full refusal to fulfil an action, and 1 the final decision to make an action. Introduce the parameters a_1, b_1, a_2, b_2, defined on the set of integers. The parameter a_1 characterizes the relation A to itself, the parameter b_1 his relation to B. In turn, the parameter a_2 characterizes the relation B to himself, the parameter b_2 his relation to A. As a result, the reflection of A can be defined as the expression $L + L \cdot a_1 + M \cdot b_1$, and the reflection of B as $M + M \cdot a_2 + L \cdot b_2$. The parity of the reflective relation to each other is explicated by the following equality:

$$L + L \cdot a_1 + M \cdot b_1 = M + M \cdot a_2 + L \cdot b_2.$$

The parity of the reflective relation of the actors A and B arises at two levels:

- at the level of their common pragmatical orientation (common motives, interests, aims, etc.),
- at the level of the common belief, similar cognitive standpoints.

At the first level, actors are cooperated unconsciously, without using some logical-and-cognitive procedures, therefore the common reflective standpoint, though it is developed by them, is not realized. It cannot be accurately formulated and logically inferred. At the given level, the actors A and B feel that they accept the performance of similar actions, therefore they aspire to carry out them in common. At the second level, actors are cooperated already on the basis of argumentation mechanisms in such a manner that the common reflective standpoint becomes to be quite realized and can be always verbally proved. At this level, actors agree to have a common action.

In practice, it is difficult to differentiate two kinds of parity of the reflective relation, but we can differentiate two levels of that: the level of the common belief is higher, than the level of the common pragmatical orientation. At the level of the common pragmatical orientation, the cooperation of actions is based on the *reflected standpoint*, whereas at the level of the common belief such a cooperation is based on the *reflecting standpoint*. Also, one can say, therefore, that the common belief allows us to create more difficult forms of cooperative activity. The cooperation on the basis of the common pragmatics refers to *communicative relations* and the cooperation on the basis of the common belief refers to *social relations*. In the society both kinds of relations are indissolubly bound. The main feature of social relations is that they assumes an agreement. Therefore the cooperation of people on the basis of social relations always has the form of a social institution, and the cooperation of people on the basis of communicative relations is fixed as a free association, i.e. association of people by means of common interests.

In Zinoviev's opinion[1], the ideal of communistic society consists in a dominant of communicative relations over social ones (see [11]). Social relations are built on agreements and are based on a social inequality. On the other hand, communicative relations are based on dialogs and reflect needs of human nature in the better way.

So, the activity is organized in a structure which is hierarchical and thanks to reflection mechanism has cooperative forms.

The cooperative activity of scientists is also performed on the basis of the parity of the reflective relation to each other, and this parity has the two levels of interaction too: the communicative relation and the social one. On the basis of communicative relations there are built scientific schools, initiative groups, informal communications (conversations) between

[1] Prof. Alexander Zinoviev is a well-known Russian logician and sociologist.

employees, etc., on the basis of social relations we have research laboratories, institutes, departments, etc. At the same time, there is no precise line of demarcation between cooperative forms of activity of scientists and cooperative forms of activity of other people (e.g., cooperative forms of activity of the same scientists, but already as agents of daily occurrence). Therefore, on the one hand, communicative relations in sciences may pursue absolutely unscientific purposes. On the other hand, social institutes of scientific community are not differed radically from the social institutes of other professional communities by principles of organization.

The main feature of science is a declaration that in science there is a special reflective basis for cooperative action (communicative and as well as social), namely scientific argumentation. The argumentation, corresponding to all norms of critical discussion, is regarded to be a unique reason for the decision to cooperate individual acts of scientists. For example, I accept scientific ideas, accordingly I belong to an appropriate scientific school, only on the basis of logical persuasiveness of those ideas. Unconditionally, the given request is executed not always, and if it is defaulted, it is possible to say that there is an infringement of the line of demarcation between cooperative forms of scientific activity and cooperative forms of unscientific activity.

The scientific argumentation is a mechanism of reflection for scientists. It can pursue the different purposes, including unscientific, but is the main basis of cooperation in scientific community.

Usually, unscientific motives of cooperative activity of scientists are expressed in using *argumentum ad hominem* and other fallacies of argumentation. As an example of *ad hominem* argument in scientific discussion we can examine the following episode of the Session of the All-Union Lenin Academy of Agricultural Sciences (its Russian abbreviation is VASKhNIL) in 1948, when genetics was finally branded with shame as a "bourgeois" direction in biology [3].

"T. D. Lysenko[2]. (...) *When true sons of Soviet people were victoriously finishing the struggle for honor, independence, and freedom of our Native*

[2] Trofim Denisovich Lysenko (1898–1976) rejected Mendelian genetics in favor of the hybridization theory of the Russian horticulturist Ivan Vladimirovich Michurin. Since 1940 he became director of the Institute of Genetics within the USSR's Academy of Sciences. Lysenko's works were considered canonical until 1960's, when the most prominent Soviet physicists proclaimed his works as false science. For example, in 1964, the well-known physicist Andrei Sakharov said about Lysenko at the General Assembly of the Academy of Sciences as follows: "He is responsible for the shameful backwardness of Soviet biology and of genetics in particular, for the dissemination of pseudo-scientific views, for adventurism, for the degradation of learning, and for the defamation, firing, arrest, even death, of many genuine scientists".

Land, there were researchers who have started to study an influence of war on flies!

Voice from place. *Fly-breeder*!" [9].

Let us remember that Walton (see [110]) differentiates the following kinds of *ad hominem* arguments:

1. the doubt in opponent's honesty;
2. the doubt in his ability to correct judgement (the doubt in his common sense);
3. the demonstration of opponent's ignorance of reality;
4. the doubt in his cognitive abilities (the demonstration of his illogicality, inconsistency);
5. the doubt in his morality.

All these arguments have been used by Lysenko's supporters at the Session VASKhNIL in order to discredit ideas of geneticists. Such forms of arguments in scientific argumentations set the cooperative forms of quasi-scientific activity.

Although geneticists tried to transfer the dispute of the Session to a framework of critical discussion, that attempt failed:

"P. P. Zhukovsky. *Concepts such as vitamins, hormones, viruses are never used by our opponents. I could advise not you, Trofim Denisovich [Lysenko], you are held in a good respect, but your followers to study, because the learning is light and the non-learning is darkness*[3]. (Laughter, applause.)

T. D. Lysenko. *And do you refer it to yourself*?

P. P. Zhukovsky. *I study all the time.*

T. D. Lysenko. *You study poorly*!" [9].

Prof. I. A. Rapoport, working at the Institute of Cytology, Histology and Embryology of the Academy of Sciences of the USSR, also tried to soften the attacks of academician Lysenko, but his attempts were ineffectual too, as well as Zhukovsky's attempts:

"I. A. Rapoport. *The necessity itself of mechanisms which would fix the achieved changes, independently of what caused them, requires a very exact research experiment. The genetics feasibly tries to solve this task, conducting experiments and calculating materials that are received in experiment under the corresponding control. It is natural that various hypotheses which are born in the head of experimenter and theories that we have in the wide field of science, contain often contradictions. The true is born in the struggle.*

[3] It is an aphorism of Saint John of Damascus (St. Johannes Damascenus), the Doctor of the Orthodox Church. This aphorism is a well-known proverb in Russia.

So, the modern theory of light is a fruit of struggle of two theories – the wave theory and the corpuscular theory. This struggle developed in the way that both beliefs won at the different time, therefore any suppression of opportunities and any application of too rigid attitude to the theory would harm science. We, in the Soviet theory, are far from suppressing any point of view being fruitful" [9].

The Session VASKhNIL sets a historical example of the scientific dispute containing the obvious violation of regulations and norms of the free critical discussion. But it was not a single instance in the history of the Soviet science, there were also other examples, one of them was Pavlov's Session of 1950 (see [6]) on which many Pavlov's followers were completely discredited. Notice that all scientific sessions of that period were finishing by drawing up the text of the salutatory letter to comrade I. V. Stalin. Also, as ideological components are not fixed in the structure of social institutes of science, they can influence the development of scientific ideas by means of communicative relations, taking roots in the system of informal communications of scientists and in the scientific public discussions.

2. Three Levels of Scientific Argumentation

By definition, *argumentation* is a procedure that is directed to the substantiation of an appropriate point of view in order to increase its acceptability for an individual or collective recipient which takes the role of rational referee. From the given definition it follows the double character of argumentation, namely presence of two aspects (logical and communicative). Indeed, on the one hand, argumentation is a *logical procedure* which essence consists in the use of substantiation forms (e.g. deduction), but on the other hand, it represents the *communicative process* providing, in the case of scientific argumentation, the perception, understanding, and acceptance of the novel idea, concept or theory.

This double character of argumentation comes to light if we differ three levels of the free critical discussion: logical, dialectical (dialogical), and rhetorical (communicative).

1. At the *logical level*, argumentation is considered as a product and is evaluated by means of using logical and semantic rules. At the given level of the analysis, the substantiation forms, which took place, are investigated and corresponding schema of argumentation are reconstructed. The criterion of success of argumentation is here the degree of observance of all logical norms of substantiation and proof.

2. At the *dialectical level*, we estimate argumentation as a communicative process. One of the problems of this analysis consists in defining necessary and sufficient conditions of communication (an example of one of such conditions is the request of absence of external factors to prevent from expressing the reasonable points of view).
3. At the *rhetorical level* of the analysis, argumentation is considered as a social activity which is directed to other people and evaluated within the framework of the ultimate goal to consent to do something cooperatively inside a communicative community. In scientific community such a goal is the consensus concerning the acceptance knowledge-claims.

Each style of theoretical thinking has the distinctive features. For example, *classical style* was characterized by the following. First of all, the classical thinking positioned itself as resisting to ideas of authoritativeness what in many respects has been connected to aspiration to overcome the conservatism of scholastic type of thinking. The given feature focused scientists on the program of innovation in tasks of natural sciences.

Secondly, and it should be emphasized especially, a theoretical fundamentalism was characteristic for the classical style, i.e. belief that any original knowledge can and should find the math-logical foundations in due course (attempt to mathematize scientific knowledge as a whole). This ideal of scientific truth has been stated, for example, by G. W. Leibniz: "It happens nothing without the sufficient basis." We can also recall there Galilei's well-known sentence: "The Book of the nature is written in the language of mathematics."

Thirdly, the classical style contains the idea of permanent progress of society. In relation to science, this idea was expressed in the reliance in the scientific knowledge capability to develop indefinitely (the idea of cumulative accumulation of scientific knowledge).

Fourthly, using the given style one reduces the foundation problem to the problem of the truth-verification. The given tendency asserted that true is the highest and a unique value in science. The reduction of logical validity to truth-values has been connected to the occurrence of a new treatment in the definition of logical deduction or proof. So, during becoming classical style of thinking the concept of deduction is already defined in terms of truth-values: from the set of premisses $\Gamma, \ldots, \Delta$ we infer the proposition Z if and only if the proposition Z is true for any interpretation, whenever all propositions from $\Gamma, \ldots, \Delta$ are true for the same interpretations. In this case we have the so-called semantic definition of the concept of logical deduction. On the other hand, ancient and medieval logic used the formal understanding of logical deduction: from the set of premisses $\Gamma, \ldots, \Delta$ we infer the

proposition Z if and only if the negation of Z is inconsistent with the set of premisses $\Gamma, \ldots, \Delta$. In this case the correctness of reasoning depends only on its deduction form and does not depend on something other, including the truth-validity of premisses. The semantic definition of the deductive relation between a proposition and its premisses resulted in the understanding that substantiation is a procedure mainly dependent upon truth-validity.

In the semantic definition of logical deduction one emphasizes two sides of deduction simultaneously: logical and semantic. On the one hand, the deduction is a mechanical procedure of inferring on the basis of step-by-step process of using logical inference rules and axioms or postulates of theory. On the other hand, the deduction reflects a stable dependence between the truth-validity of premisses and the truth-validity of the deduced proposition. So, if the premisses $\Gamma, \ldots, \Delta$ are true in the model $\mathfrak{M}$, then the deduced proposition Z is also true in $\mathfrak{M}$. The given parallelism of the logical and semantic sides of the deduction has allowed the logical level to dominate over two other levels (dialectical and rhetorical). Such an elimination of non-logical means from the scientific substantiation and its reduction to one of the logical forms of proof caused that the criterion of dialectical (communicative) substantiation began to rely within the framework of logical deduction.

The classical style of theoretical thinking was built on *Leibniz's ideal of the scientific substantiation* that all non-logical means should be removed from processes of substantiation and argumentation should be reduced to one of the logical forms of substantiation. The given ideal of substantiation was based to the classical (correspondent) theory of truth which started since Aristotle and which completely corresponds to the basic purpose of scientific knowledge – the expansion of knowledge about objects and the construction of statements with positive truth-values.

In the classical theory of truth, the truth-valuation corresponds to a correlation of knowledge with the cognizable reality. A proposition Z is considered true if its content consists of descriptions of factual state of affairs, otherwise the statement is considered false. The similar theory of truth is based on the following three postulates: first, there exists an objective reality outside human cognitive activity, secondly, a true knowledge of this reality is possible, thirdly, the basic and unique characteristic of knowledge is its truth-value.

The acceptance of this conception of truth and Leibniz's ideal of substantiation caused an opinion developed in scientific community that during the scientific argumentation, i.e. during the substantiation of new knowledge-claims, the application of any form of substantiation (proof, dis-

proof, confirmation, explanation, interpretation) should proceed with the use of descriptive statements as thesis and arguments. Recall that the descriptive statement is a statement which main function is the description of reality. If the description given by the descriptive statement corresponds to a real state of affairs, then this statement is considered true; if it does not correspond, then false. Examples of descriptive statements: "*Plutonium is a chemical element*", "*the Earth rotates around of the Sun*", etc. The content of similar statements is always comparable to reality, their truth-value can be always proved.

During the scientific argumentation we can use the descriptive statements with the proved truth-values and as well as the hypothetical descriptive statements. If the truth-value of the first is interpreted as either unit or zero, then the truth-value of the second will be distributed in the open interval of real numbers between zero and unit.

1. The first class of arguments, namely the true descriptive statements, consists of: firstly, the scientific facts and, secondly, the theoretical statements proved earlier. By means of the scientific facts the authentic knowledge of concrete events is fixed. For example, the scientific facts are expressed in the following statements: "*Water turns to steam at* 100°C", "*Madrid is a capital of Spain*", etc. The scientific facts have a huge significance for the scientific argumentation, as both the empirical disproof, and the empirical confirmation are constructed on their basis. Moreover, the scientific fact as a special form of argument is an entirely convincing basis which is not causing doubts and does not require an additional substantiation. Scientific laws, axioms, theorems, fundamental concepts and principles concern to the theoretical statements proved earlier.
2. The second group of arguments consists of the hypothetical descriptive statements. They can be both empirical, and theoretical.

The structure of a descriptive statement consists of the four parts: (1) an agent (a single person or a group of scientists), giving a description; (2) a subject (a described state of affairs); (3) a basis (a point of view according to which the description is given); (4) a feature (a truth-value of descriptive argument in the interval either true or false). The given structural elements are not always obviously expressed in a descriptive argument. So, the expression "*it is true that...*" usually is not used, but it is meant in arguments. Instead of the statement "*it is false that...*" one usually uses the simple grammatical form of the negative proposition.

From the viewpoint of the classical style of theoretical thinking it is necessary that the basis of descriptive arguments is one and the same – the

description of reality is always made from the same point of view. It means that standpoints of scientists in relation to descriptive knowledge should be identic, though, as it is known, it is not always so in fact. In the same measure it is necessary that there is no difference who the description would belong to (e.g. to the English physicists or to the German), it remains the same under any conditions. Thus, there is an identification, firstly, of the basis of description and, secondly, of agents of descriptive arguments. This entails the idea of total *intersubjectivity of scientific argumentation*, i.e. the idea of its independence of motives and intentions which are used in an appropriate scientific community. As a result, the idea of intersubjectivity of scientific argumentation (received development in the classical ideal of substantiation and according to which argumentation does not depend on the context of its application and on the audience) finally reduced the scientific argumentation to logical forms of substantiation.

Whether a pure descriptive statement is possible, in other words, a factual proposition, free from human values and referring to the idea of inter-subjectivity of scientific arguments? According to the development of modern logic and the modern communication theory, there exist no such statements in the conditions of real communications. So, the famous German logician R. Carnap after L. Wittgenstein asserts that any descriptive statement in speech practice actually looks like a propositional attitude ("an opinion statement"), namely it has the following logical-grammatical form: "*an individuum N + a performative verb + that + a descriptive statement*". The propositional attitude may be exemplified as follows: "*I think that it is so*", "*he believes that it is the good weather today*", "*she supposes that it will rain tomorrow*", etc. Hence, any descriptive knowledge in real communications comprises pragmatical elements (estimations, evaluations), which twist the logical meaning of a descriptive statement.

As an example of a curvature of logical structure in the descriptive knowledge by means of pragmatical elements, we can consider a possibility of construction of logical deduction, using propositional attitudes. So, from two statements "*I think that A*" and "*if A, then B*" we cannot infer in the general case that "*I think that B*", though under laws of logic from two statements "*A*" and "*if A, then B*" it follows that *B*. At the same time, if instead of 'think' we consider the verb 'hope', which has a more pronounced pragmatical component, then the infringement of the logical relation between premises and the conclusion will be even more obvious. Thus, the degree of pragmaticality in a propositional attitude corresponds to the degree of curvature of the logical meaning of an appropriate descriptive statement.

The pragmatical elements, used in the propositional attitude of descriptive statements, are *cognitive values*, which are embodied in the structure of logical substantiation. Consider an appropriate example. Assume that on a non-polluted territory one plans to construct and develop a large production. The firm-customer carries out an ecological examination through intermediaries and, according to its data, the construction of factory on the given place will not cause an appreciable harm to the environment. An independent ecological organization also carries out an ecological examination, but according to its data the production on this place will be accompanied by an appreciable deterioration of ecological conditions. Both examinations are carried out by scientists-ecologists duly and in accordance with the scientific norms of ecological monitoring, however results appear opposite. The explanation here can be only one that descriptive statements of ecologists-experts were not free from values initially.

The human values in descriptive statements transform the logical substantiation into a communicative procedure which already assumes opposite opinions and also takes into account behavioral aspect of these opinions, when descriptive statements affect, for example, performance of any acts (in case of ecological examination it is the positive or negative decision concerning the construction of large production). As a result, the descriptive statement is considered as the speech act, the judgement containing pragmatical elements and directed to the influence upon a behavior of other people.

Thus, the descriptive statement is not homogeneous and contents also some other levels besides of the level of logical dimension. The founders of the speech act theory, J. Austin and J. Searle [7], [8] numbered the following three levels in the descriptive statement: locutionary, illocutionary, and perlocutionary. According to them, the *locution* is a propositional content of the descriptive statement. The *illocution* includes the pragmatical evaluations of the given propositional content, formed on the basis of cognitive values, and this expressed by means of the use of corresponding performative verbs. The *perlocution* consists of non-verbal intentions, i.e. of latent behavioral purposes, which twist the logical meaning of the descriptive statement.

As we see, the modern treatment of the descriptive statement refers to Aristotle and Ch. Perelman's concept of 'topos' [5], as this statement is perceived as containing human values too.

According to the three levels of descriptive statements, it is possible to emphasize also three levels of descriptive (scientific) argumentation: logical, dialectical, and rhetorical. On the basis of the aforesaid the given levels

should be represented as various parts of a uniform structure of the scientific substantiation.

1. At the *logical level*, the scientific arguments are considered entirely as a semiotics product; exclusively, its logical and semantic component is there evaluated. At this level of analysis, the used forms of substantiation are investigated and argumentative schema are reconstructed (as those we apply here logical deductions and as well as deductions in which stable semantic relations (dependencies) are taken into account). Here argumentation has the following form: "*if there are arguments* $\Gamma, \ldots, \Delta$ *implying* Z*, then the thesis* Z *is true*"; we assume that from expressions $\Gamma, \ldots, \Delta$ the expression Z follows either under rules of formal logic or by virtue of a stable semantic relation between one of expressions $\Gamma, \ldots, \Delta$ and the expression Z. For example, the statement "A is a father of B" implies the statement "B is a child of A" only due to the semantic dependence (relation) existing between these expressions, therefore the argument "A is a father of B" nevertheless confirms the thesis "B is a child of A".

   The criterion of success of argumentation within the framework of the logical analysis is an observance of all logical norms of substantiation – argumentation should correspond to all laws of logic and truly reflect stable semantic relations between predicates realized in the actual world or in any other possible world in the case its range of values is fixed concerning the actual world.
2. At the *dialectical level*, the scientific argumentation is evaluated as a communicative process which can have an alternative outcome, because the procedure of substantiation necessarily assumes one or some opponents at this level. One of problems of the dialectical analysis is to bring the necessary and sufficient conditions of authentic communications to light. As a rule, the scientific community controls the dialectical level of argumentation by normative documents (according to those, for example, the format and the rules of scientific conferences are defined in advance). At this level, argumentation has the form: "*if there are arguments* $\Gamma, \ldots, \Delta$ *implying* Z *and opponents have no objections, then the thesis* Z *is true*." At the dialectical level, the dialogue and conservation of scientists are as much as possible formalized by the system of the complex mutual obligations started by the normative base of the corresponding scientific institution.
3. At the *rhetorical level* of analysis, the scientific argumentation is regarded as a social activity, whose interactive vector consists in obtaining valid scientific results (those, depending on the degree of their validity,

can affect scientific behavior of the majority of members of the given scientific community). The argumentation as activity is evaluated in the plan of its ultimate goal, i.e. within the framework of the consensus inside a communicative community concerning the claimed scientific principles, i.e. concerning the acceptance of these principles of scientific research by many scientists. In the scientific community such a purpose is, first of all, the final consensus concerning the acceptance of knowledge-claims. At this level, argumentation looks like: "*If there are arguments* $\Gamma, \ldots, \Delta$ *implying* Z *and opponents do not have any objections, then the thesis* Z *is true and it should be taken into account in any scientific research in the given area*".

Thus, the ultimate goal of scientific activity consists in the desire to affect the scientific behavior of other scientists. As a rule, this means that scientific results are recognized more or less fundamental and depending on that they determine scientific interests of the whole community of scientists. Accordingly, the scientific activity, which has entailed a serious discovery or invention, becomes a standard for the research behavior of the majority of members of scientific community. As a result, the given discovery or invention becomes the important part of *scientific habitus* (the embodied, interiorized social structure of scientific groups in scientific activity)[4]. For example, K. Gödel's incompleteness theorems have appeared so fundamental that all researches in the field of mathematical logic become to be carried out later either with application of recursive-theoretic methods, on the basis of which these theorems have been proved, or with taking them into account.

From this classification of levels of scientific argumentation it follows that the dialectical level includes the logical one, and the rhetorical level includes both the logical and dialectical ones. Thus, the scientific substantiation has a hierarchical structure in which the logical level of argumentation is subordinated to the dialectical level and the dialectical level is subordinated to the rhetorical one. The history of discovery of Copernicus, for example, confirms that the negative standpoint of opponents can bring

[4] The term 'habitus' is introduced in modern sociology by Pierre Bourdieu. This term is defined as follows. The habitus, being the product of history, produces individual and collective practices, and hence history, in accordance with the schemes engendered by history. Bourdieu defined 'habitus' as "the generative basis of structured, objectively unified practices" [1]. There are two kinds of habitus: 'class habitus' and 'subjective habitus'. The first is embodied in individuals and the second is understood as a collective and homogeneous phenomenon, mutually adjusted for and by a social group or class. The term 'habitus' underlines that social practices are not consciously organized. We agree with this thesis.

logical reasons to nothing. On the other hand, the one approval of opponents is not enough that results of scientific research become to be regarded as a fundamental discovery or invention. For this purpose also it is necessary that the given results have a determining influence on the scientific research activity of the large number of outstanding scientists.

As an example of hierarchical structure of the scientific substantiation, we can consider the following fragment from V. S. Nemchinov's speech at the Session VASKhNIL:

"V. S. Nemchinov. *Can somebody tell about N. N. Timofeev, the head of the Department of Selection of Fruit and Berry Cultures, that he is anti-Michurinist? Who can tell it about comrade Kolesnichenko?*

However, we have scientists of another direction, in particular, Prof. Zhebrak. Comrade Simonov has told that Nemchinov, as the director, has approved of the paper by Prof. Zhebrak published by him in the foreign journal. It is close to obvious slander, because it bears no relation to reality. It is necessary to say that the public knows that one of the first, who has written in newspapers concerning A. R. Zhebrak's article, was Nemchinov.

Voice from place. *Writers were the first.*

V. S. Nemchinov. *I say that I have written as one of the first; anyway, just after the article of writers.*

Voice from place. *Tell about your letter in 'The Leningrad Truth'*[5].

V. S. Nemchinov. *In 'The Leningrad Truth' I did not write any letter and I do not know what the matter is. It is obviously a legend.*

In my reports, speeches at the Party Assembly, at the Council of Academy, I have kept separate from the article of comrade Zhebrak and I have also stated for it a corresponding estimation. All comrades who speak here of this question, know it perfectly, but for some reason regard necessary to mislead the Soviet public.

Voice from place. *They feel the truth.*

V. S. Nemchinov. *The truth, certainly, will always remain the truth, and it will win.*

One can reproach me as director that I draw a distinction between the paper by Prof. Zhebrak, the Academician of the Belarusian Academy of Sciences, and his work. I have declared that one condemns, accuses the statement of Prof. Zhebrak in the American journal not as the fact what he sticks to, that he protects the chromosomal theory of heredity, but as the fact that he has made an antipatriotic action. So it was.

[5] In Russian "Leningradskaja Pravda", it is a well-known Soviet newspaper of that time.

Voice from place. *Is the chromosomal theory in the gold fund?*

V. S. Nemchinov. *Yes, I can repeat, yes, I think that the chromosomal theory of heredity was included in the gold fund of human science and I continue to keep such a point of view.*

Voice from place. *You are not the biologist how can you judge it?*

V. S. Nemchinov. *I am not the biologist, but I have an opportunity to check this theory up from the point of view of the science, in which I carry out my scientific research and, in particular, from the point of view of statistics.* (Noise in hall.)

It corresponds also to my ideas. But the matter is not with it. (Noise in hall)

Voice from place. *How is the matter not with it?*

V. S. Nemchinov. *Well, let the matter be with it. Then I should declare that I can not share the point of view of comrades who declare that chromosomes have no relation to mechanisms of heredity.* (Noise in hall.)

Voice from place. *Mechanisms are not present.*

V. S. Nemchinov. *It seems so to you that mechanisms are not present. These mechanisms are able not only to be seen, but also to be painted and defined.* (Noise in hall.)

Voice from place. *Yes, it is paints. And statistics.*

V. S. Nemchinov. *I do not share the point of view which has been stated also by our dear chairman [Lysenko] that the chromosomal theory of heredity and, in particular, some Mendel's laws are an idealistic point of view, a reactionary theory. Personally, I consider such a position wrong and it is my point of view, though it is interesting for nobody.* (Noise in hall. Laughter)" [9].

As we see, V. S. Nemchinov condemns the act of Prof. A. R. Zhebrak from the point of view of the Soviet scientific ethics, namely he negatively regards the fact of the publication of Zhebrak's paper in a foreign journal. Nemchinov tries to find common points with the opponents at the rhetorical level. However, it was unsuccessful for him, as opponents deny Nemchinov's ideas already at the dialectical level. Indeed, the scientific substantiation of ideas of genetics within the framework of mathematical statistics, i.e. that "the chromosomal theory is in the gold fund of biological science", encounters the radical denying of the scientific audience at this session. Nemchinov's logical arguments are regarded by the scientific audience as totally unacceptable. This emphasizes that argumentation has a hierarchical structure in which logical elements can be totally subordinated to pragmatical (valuable) elements.

The reflection in scientific activity is a human ability that allows us

to oppose the scientific habitus and not to subordinate the logical level to the dialectical level and the latter to the rhetorical level in the scientific argumentation. The Session VASKhNIL is an example, when the scientific habitus dominated over the reflection in scientific activity and, as a result, the rhetorical level of argumentation dominated over the logical one.

3. The Criterion of the Difference between Neopositivistic and Postpositivistic Models of Scientific Deduction

Depending on the definition, how the three levels of argumentation interact, it is possible to propose various models of the scientific substantiation. The following models are most known: neopositivistic and postpositivistic.

In the *neopositivistic model of scientific substantiation* (developed by R. Carnap, A. Tarski, and many other well-known logicians) one supposes that the logical, dialectical, and rhetorical levels of argumentation are connected among themselves in such a manner that the degree of logical validity of the thesis influences the degree of its dialectical validity, and the degree of the latter influences the degree of rhetorical validity of the discussed point of view. For example, according to this model, Copernicus' heliocentricism has had the negative response in the scientific community only because it has not obtained a comprehensive logical substantiation. Only after Galilei's principle of inertia and Kepler's laws it was possible to construct Newton's heavenly mechanics, having already the highest degree of logical validity. In the neopositivistic model, rules of definition of the degree of dialectical validity are set, thus, at the logical level of argumentation, whereas rules of definition of the degree of rhetorical validity are set at the dialectical level.

In the *postpositivistic model of scientific substantiation* (developed by Th. Cuhn, P. Feyerabend, and many other methodologists and science historians), in contrast with the neopositivistic model, one affirms that the criterion of definition of the degree of dialectical validity is set at the rhetorical level, and the criterion of defining the degree of logical validity is set at the dialectical level, therefore the rhetorical level of scientific argumentation can reflect an arbitrariness in decisions of scientific community as rational judge (we have demonstrated this by the fragment of V. S. Nemchinov's speech at the Session VASKhNIL).

The difference of two models of substantiation is stipulated by the historical typology of scientific argumentation. So, the neopositivistic model of the scientific substantiation assumes the classical type of scientific argu-

mentation (the classical style of thinking), while the postpositivistic model assumes the nonclassical or modern one. The *classical type of scientific argumentation* was characteristic mainly for natural sciences from the end of the 16th century to the beginning of the 20th century. The *modern type of scientific argumentation* develops by the middle of the 20th century, constructing nonclassical logics and as well as a variability of modern natural sciences were principal causes for this development.

The availability of competing research groups, equivalent in eyes of the whole scientific community and, at the same time, having mutually exclusive points of view, became probable only after the enormous differentiation of all scientific knowledge. The given social processes show that human values are an integral element of any activity. The scientific knowledge, being a special kind of activity, is through penetrated with human values and it is already impossible without them. Especially, it is necessary to emphasize that the human values, regulating process of scientific knowledge, as a rule, have a collective feature, instead of an individual one.

So, the main problem of modern postanalytical philosophy of science consists of the aspiration, firstly, to define, what form the human values have in scientific knowledge and, secondly, what influence on processes of scientific activity they have. The transformation of modern epistemology, its interest in the research of the role of human values in the scientific argumentation has affected the researches realized within the framework of the history of science. Many historic facts become to be interpreted in a new fashion. One began to reject the idea of reducing argumentation procedures only to logical forms of substantiation and as well as to consider the dialectical and rhetorical levels of substantiation as independent metalevels.

The dialectical and rhetorical levels are completely set by cognitive values. The values, shared by scientific community, and also forms of their expression (i.e. general principles, standards, samples, methodological norms) are definitely ordered and ranged according to a degree of their importance, forming a historically changeable hierarchy. The valuable factor has, therefore, a complex and comprehensive influence on process of the scientific communications and it is not separable from procedures of the scientific argumentation.

According to the classical type of substantiation, the method of solving scientific disagreements concerning a choice of one of theories is similar to a method of acceptance of the adjudication: all relevant facts, acting in a role of arguments, are regarded and the court gets their truth-validity by the precisely established legal rule, concerning a selection of facts. The finality of a verdict is guaranteed, because the question is considered on the

basis of rigid rules, instead of personal motives. At last, all parties agree to adhere to the born decision.

In scientific discussions, the scientific community acts in a role of the rational judge whose court concerns to the offered points of view. At the same time, the norm of the 'organized scepticism', accepted in scientific community, guarantees that a more empirically reasonable idea will be chosen from proposed variants. Thus, it is considered that the 'scientific jury of jurymen' will make a choice according to the rules shared by all scientists of the given scientific branch. Existing norms and the methodological rules being in neopositivistic model of the scientific substantiation assume that the born decision (for example, the consent) concerning a choice of one of the points of view, involved in discussion, will be, firstly, impartial and, secondly, acceptable for all parties: both for defenders and for opponents.

However, so simple mechanical (in Leibniz's style) sanction of arising disagreements is not always probably, as there is a situation in which two or more competing theories (concepts or theoretical schema), which are equally confirmed by empirical arguments, are discussed. In this case, according to argumentation theory, the proposed points of view are equivalently reasonable, this means impossibility of a determining choice between them on the basis of the empirical arguments. Thus, concerning such situations the classical model does not grant means of an explanation, what actually is the basis of choice and process of an exchange finishing by arguments, what basis for preferences of scientific community and what plays a role of decisive argument for occurrence of a final consensus.

According to the classical methodology of science, a 'calm' in scientific discussions should appear in the periods of existence of alternative theories so that the competing parties would be able to collect more differentiated empirical data and to put forward them later as the decisive arguments confirming the corresponding point of view and denying the point of view of opponents. However, the facts of the history of science testify to the opposite – in those periods heated arguments inflame especially and estimated judgements with much pragmatical component start to be put forward as substantiation.

The choice of theory cannot be made also on the basis of just logical means, because all rules of scientific deduction have the sense only inside a concrete theory, therefore out of those frameworks logical rules lose the sense. As a result, all rules of scientific (inductive or deductive) inference are indistinct so that they can be used by many mutually excluding methods. It is an opinion of P. Feyerabend proclaimed the thesis "anything goes".

Thus, the process of scientific argumentation cannot be completely reduced to one of types of the logical substantiation. This means that argumentation includes not only the set of statements connected among themselves by inference rules of scientific deduction, but also a "non-formalizable rest", namely arguments which we cannot analyze only by means of symbolic logic. The availability of such a non-formalizable rest allows P. Feyerabend to assert that "propaganda mechanisms and technique of washing of brains" have a crucial importance in the scientific argumentation. Notice that from the point of view of the logical level of the argumentation analysis we consider the *valuable components* as the non-formalizable rest that occurs in various forms of propositional attitudes ('topoi', as Aristotle would say). They also determine the dialectical and rhetorical dimensions of argumentative discussions. In the meantime, the form and content of valuable components are set within the framework of the hierarchy of values, shared by members of scientific community within the corresponding scientific *habitus*.

As representatives of postanalytical philosophy notice, the classical model of substantiation is a sufficient mean for an explanation only within the framework of the one theory, of the one paradigm or the one research program. In the case we survey a qualitative transition from one level of development of scientific knowledge to another (for example, the situation of Copernicus' revolution), explanatory means of neopositivistic model become obviously insufficient. This entails that in situations of scientific revolution we should use the hierarchical model of consensus. According to this model, the scientific theory should be logically correct and, in addition, should follow the hierarchy of values (habitus), which is shared by overwhelming majority of scientists.

So, the scientific consensus from the standpoint of hierarchical model is achieved only in the event that there was an acceptance of the scientific theory on the basis of the following parameters: (1) due to its logical validity; (2) on the basis of its conformity to key cognitive values of the certain informal scientific association, in particular to ideas of a scientific school; (3) in connection with an opportunity of its acceptance at the level of scientific habitus, i.e. due to an opportunity to embody results of this theory into the social activity of other scientists. The logical level of argumentation corresponds to the first level of consensus, the dialectical level to the second, and, at last, the rhetorical level to the third.

1. The *logical validity* guarantees that any changes of social frames, any cultural shocks will not cause a radical transformation of scientific activity. For example, the ideas of academician T. D. Lysenko were

not faultless from the standpoint of the logical level of substantiation, though they corresponded to the scientific habitus of the Stalin period. However, the scientific habitus began to transform after "Chruschev's thaw" in the Soviet science and Michurin's ideas have ceased to be entered in the social context. Later, it has resulted that they have ceased to be claimed generally.

As another example of necessity of the account of logical validity in the hierarchical model of consensus we can regard the recognition of Mendel's theory of heredity. From the moment of Mendel's discovery and until the moment of the public resonance of his ideas has passed more than 30 years. The recognition has come to Mendel only after his death, namely after his ideas become to correspond already to the scientific habitus of contemporaries. The logical validity of the theory of heredity guaranteed its safety in conditions of cultural transformations and an opportunity to be claimed. As we see, the logical validity is a necessary step in acceptance of results of research by the scientific community. This level remains constant at any historical event and in any cultural situation.

2. The acceptance of the scientific theory within the framework of *informal scientific association* (e.g. of scientific school) allows to use in the promotion of scientific ideas specific resource such as communicative relations. This resource is that the scientist obtains a very essential informal support in the subsequent promotion of results of his research. Without such a support the recognition of discovery can be delayed for long years, until the influential adherents will be ready to promote the given ideas.
3. The highest level of the recognition of the scientific theory is its acceptance at the level of the *scientific habitus*, entailed an embodiment of results of the scientific research into the social practice of scientific community as a whole. In this case the scientific theory enters into the general scientific thesaurus. Among conventional it is possible to name the following physical theories, for example: the Copernicus heliocentric system, Newton's mechanics, Maxwell's electrodynamics, etc. Now it is impossible to be the physicist and to not know all these theories. If the theory belongs to the scientific habitus, then it acquires the highest objectivation in eyes of all scientific community.

Consider an appropriate example. Yuri Matyasevich proved the insolvability of Hilbert's tenth problem. His result had purely author's character. From the point of view of logical validity, Matiyasevich's theorems were quite acceptable, because they were proved duly within the framework of

mathematical constructivism, the directions in mathematics which was very influential in that time. When Matyasevich obtained all necessary theorems for the proof of the result, leaders of Markov's school helped him to contact July Robinson, who studied the same problem, organized their meeting and agreed about possibility to publish their common paper concerning Hilbert's tenth problem.

It is necessary to remind that during times of the 70s years the USSR was isolated and this complicated professional contacts of the Soviet and western scientists. Therefore attempts to represent Matiyasevich's theorems in a common paper with the known American woman-mathematician allowed Matiyasevich's scientific results to be accepted in the world scientific community very soon. So, in 1974 the American Mathematical Society (AMS) decided to organize the Symposium "Development of Mathematics after Hilbert's problems". Matiyasevich was invited to give the report on Hilbert's 10th problem, but his participation was not supported by the government of the USSR, therefore Robinson alone was compelled to give the report on this problem.

Thus, the common publications of Robinson and Matiyasevich were well thought as strategic step which has played the positive role not only in Matiyasevich's destiny, but also they were useful to Markov's school. So, the hierarchical model of scientific consensus assumes the account of valuable components of the scientific argumentation as the special additional factors strengthening persuasiveness and acceptability of the scientific theory in the disciplinary community.

Thus, there exist two models of the scientific substantiation: neopositivistic and postpositivistic. In the first we assume that the reflection, as ability to be guided only by logical reasonings in the scientific activity, dominates over the scientific habitus, in the second that the scientific habitus dominates over the reflection.

4. Two Ways of Organizing Scientific Investigations: American and Soviet Systems

The social activity assumes special receptions of itself within the framework of the corresponding social system. Such receptions are called *reflection*. It is necessary to notice that the reflection is not the passive mechanism – it supervises the social activity in accordance with general instructions of social system. As an example of the reflection effect on the social activity we can consider two various relations to reckless driving. In the first case the

driver has the high self-estimation if he tries to concede other drivers free way. Assume that it is a norm for the social system A. In the second case, the driver has the low self-estimation if he concedes others the priority in traffic. Assume that it is a norm for the social system B. Evidently, traffic jam arises more often within the framework of the social system B. Thus, the various reflective estimation of the same social action causes various acts, and, as a result, various displays of a social system too.

The scientific activity is a version of social activity. So, it also assumes a reflection as the special mechanism of self-control. Accordingly, the scientific product is made in various way in different countries with the different reflective relation to scientific activity. It is possible to suppose that it is somewhere made with the big failures, and somewhere with smaller (by analogy to the example of traffic described above).

Creating the nuclear weapon (atomic bomb) in 1940s was the rather difficult scientific task. The USA and USSR have successfully realized the given purpose. Both were superstates of that time, however, having absolutely different public organizations of life. As a result, in both countries the scientific activity was organized very differently.

In America, appropriate investigations were started since September 1942 within the framework of the so-called 'Manhattan Project' which took place at over thirty different sites across the United States, Canada, and the United Kingdom. The scientific research was directed by the American physicist J. Robert Oppenheimer. The age bracket of most scientists was 30 years old. Most surprisingly that the Manhattan Project became the open area where the collective nature in discussion of general problems was welcomed. For that reason the project succeeded soon in developing and detonating three nuclear weapons in 1945: a test detonation of a plutonium implosion bomb code-named "Trinity" on July 16th near Alamogordo, New Mexico; an enriched uranium bomb code-named "Little Boy" on August 6th over Hiroshima, Japan; and a second plutonium bomb code-named "Fat Man" on August 9th over Nagasaki, Japan.

On the other hand, in the Soviet Union the development of the nuclear weapon was conducted under the strong administrative influence (the administrative head of the project was Stalin's former chief of security Lavrentii Beria) and the scientists, working at the given problem, were badly aware of common problems. Therefore Kurchatov's administrative role in the development of the nuclear weapon in the USSR was higher than the same role of Oppenheimer in the Manhattan Project. Also, as we see, the two completely various models of a reflective self-estimation of scientific activity have been involved for realization of the same problem. In the American case the open-

ness of scientific discussion, the collective nature in decision-making were welcomed, and in the Soviet case an isolation of local scientific groups and their external administration were observed. In other words, in the Manhattan Project the self-estimation of scientists and its translation produced an essential effect on social system as a whole (on all collective of employees of this project), and in the Soviet case the self-estimation of scientists played the subordinated role in relation to external factors (such as hierarchical management), and these two systems of self-estimation showed the features of two social systems.

To exemplify two ways of self-estimation consider Lefebvre's model of reflectivity [4]. In the language of mathematics the effect of reflection on scientific activity can be expressed as follows. Introduce three variables: a, b, c, defined on the two-element set $\{0, 1\}$, where 0 means the refusal of fulfilment of action, and 1 the decision to make action. Let the variable $a = 1$ ($a = 0$) express the pressure of the external world to do (or not to do) an act, the variable $c = 1$ ($c = 0$) the pressure of the external world, expected by the actor on the basis of his previous experience, to do (or not to do) an act, the variable $b = 1$ ($b = 0$) the self-estimation of the individuum seeing himself fulfilled (not fulfilled) action. Set now a Boolean function $A = f(a, b, c)$ such that $A = 0$ if an action is not accomplished, and $A = 1$ if an action is accomplished. For example, $f(1, b, c) = 1$ means that the external circumstances compel the individuum to make an action, and $f(a, 1, c) = 1$ – that the external circumstances, foreseen by the actor, compel him to act. The given function may be interpreted as $A = (b \supset a) \supset c = F(c, F(a, b))$.

As Lefebvre showed [4], the highest importance of reflection is expressed by the following Boolean function: $A = (b \supset a) \supset c = F(c, F(a, b)) = b$. In this case we have: $(b \supset 0) \supset 0 = b$, i.e. the fulfilment of an act is determined by an internal self-estimation. On the other hand, it is possible to continue Lefebvre's idea and to say that the lowest importance of reflection in the individual activity is described as follows: $A = (b \supset a) \supset c = F(c, F(a, b)) = c$. It is easily shown that the given equality holds just in the case: $(0 \supset 0) \supset c = c$, hence, the fulfilment of an act does not depend in any way on an internal self-estimation, and it is determined mainly by my life experience (instincts). There is one more interesting case, when we have $(1 \supset a) \supset 0 = \neg a$.

The formula $F(c, F(a, b)) = c$ shows that the individual activity is determined by external effects $\langle a, c \rangle$. Let us remind that the attempt to explain the individual activity by external effects was made only by behaviorism. However, as we see, the behavior depends not only on external effects, but also on internal mental properties, namely on self-estimations (on reflec-

tion). Therefore in many cases $F(c, F(a, b))$ is not equal c. Thus, the behavior is determined by reflection and reflectivity more often than by external pressure.

The self-estimation is variable. For instance, the emotional reaction of the same person to the same situation can be various at different time.

Let us remember that we had the two opposite models of reflection in the Manhattan Project and in Kurchatov's institute. The formula $F(c, F(a, b))$ should depend on the parameters differently in the first case and in the second. For the majority of representatives of the American scientific group the expression $F(c, F(a, b))$ has more often the value $F(c, F(0, b))$, but for representatives of the Soviet scientific group it has more often the value $F(c, F(a, 0))$.

We have explicated the elementary kind of behavior in which the choice is carried out only from two variants 0 or 1. At the same time, to interpret the behavior as the Boolean function $A = F(c, F(a, b))$ is not always convenient, because the parameters $\langle a, b, c\rangle$, determining the people behavior, have in actual fact probabilistic values. In this plan the probabilistic distribution of the function of reflective activity is more preferably:

$$A = F(c, F(a, b)) = c + (1 - c) \cdot (1 - a) \cdot b,$$

where values of a, b, c belong already to the interval of real numbers $[0, 1]$.

In the given formula the variable a describes the individual activity as probability to make choice of a positive decision under external pressure (i.e. the intensity of an external effect), the variable c shows a probable life experience of the actor (i.e. the average intensity of previous external effects), and, at last, the variable b describes a probable condition of individual mentality (i.e. the intensity of his internal self-estimations). So, a is a frequency of micropushing on a positive decision in the present, c is a frequency of micropushing on a positive decision on the basis of the life experience, b is a futurological function.

A probabilistic distribution of action A allows us to characterize the distinction of the American and Soviet methods of science management in the better way. So, in formula $F(c, F(a, b))$ the significance of the variable a for the behavior of a Soviet scientist should be higher than the significance of the same variable for behavior of an American scientist, and the significance of the variable b should be lower, respectively.

The example of two reflective patterns of organizing scientific activity is characteristic for the demonstration of general distinction in management of scientific knowledge and in its further socialization in conditions of the USA and USSR. The high level of reflection in the western science takes place up

until now, it is embodied thanks to the following principles introduced into the social system of scientific production all over the world:

- information resources are available that is shown in creating numerous platforms for the exchange of scientific experience within the framework of international conferences, international journals; at the same time, there exists a stimulation of interpersonal contacts of scientists from different countries thanks to programs of scholarships and to priority financing of the temporary research groups whose representatives are from different states,
- financial and technical supports for realization of research works are available (it is expressed in the dispersal of fund sources – for a long time, the state has ceased to be the basic sponsor of scientists),
- the unified estimation of scientific achievements by number of publications of an international level and by index of their citing, i.e. depending on an involvement of the scientist into scientific discussions within the framework of the international platforms mentioned above.

In the Soviet Union the given principles did not hold. Nevertheless, the Soviet science had some successes in the sphere of mathematical and technical knowledge. The matter is that various external circumstances had a much greater effect on the research work of the Soviet scientists than on the similar work of the western scientists. It was more difficult to publish scientific ideas, for example. Therefore in conditions of isolationism of the Soviet science the intensity in a competitive spirit of various research groups grew exponentially. On the one hand, this caused a scholasticism of mathematical knowledge (the Soviet mathematics and physics assumed more strict, exacting style of scientific work than it took place in the West). On the other hand, the Soviet humanities in many features transformed into a pseudoscientific knowledge.

Probably, Belarus is the only post-Soviet country that preserves the Soviet anti-reflective model of the science management.

In conditions of modern globalization, the isolationism of scientific knowledge and the low reflectivity of scientific behavior have a pernicious effect on the efficiency of scientific researches. Hence, by inheritance the Belarusian society received from the Soviet Union the science requiring the scale reforming. The sense of these reforms should consist in permanent embodying of the principle of high reflectivity.

In order to increase a degree of effect of internal self-estimations on the scientific activity, on the one hand, and in order to reduce a degree of effect of external circumstances, on the other hand, we should realize in practice the following principles of the science socialization:

- overcoming a dominant of the normative over the subjective – actors of scientific activity (scientists or research groups) of one and the same order should not have homogeneous, similar estimations of scientific activity of this order;
- overcoming a centralization in the science management – it is necessary to create conditions and to support all forms of activity in the science management;
- reduction in a risk level of organization decisions tanks to development of a network of administrative centers;
- organizing buffer platforms for the exchange of scientific experience.

In conditions of external normalization of scientific activity there exists a reduction in creative activity of scientists. Therefore for positive dynamics of the Belarusian science we need a rise in the effect of reflection on the scientific activity.

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