MEASURING METHOD AND ITS GNOSIOLOGICAL ASPECTS IN MODERN PHYSICAL COGNITION

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In the article the experimental method which is one of the empiric methods of the scientific research, its specific features, characteristics, gnosiological opportunities and cognitive functions being applied in the empiric level of knowledge are investigated. It is shown that the main difference of the experimental method from other methods of empiric research is of its synthetic character. Thus during the experiment not only the conditions of the research are changed, but the methods of observation, measuring, comparison of the empiric cognition are in organic way synthesized as well. At the same time in the article the kinds of the natural scientific experiment are discussed too.

It is known that all phenomena of reality which are studied by practical way have objective quantitative and qualitative determination. Qualitative determination of material systems which is increased by apparatus and by organs of sense of the observer is expressed in different numbers (speed, mass, electric charge, energy, pressure, volume etc.). But quantitave peculiarities of process and phenomena are described by figure price determining in measuring operation of physical numbers. Usage of measuring operation first of all is connected with such matter as correctness of realizing of ratio of quantitative and qualitative aspects of the object of cognition [10]. So measuring method is not limited only by marking quantitative description of the object of cognition, it enables to study its qualitative determination as well. And adequate cognition of quantitative aspect of the object is conditioned by cognition of its qualitative aspect in measuring operation.

Taking into consideration of specifity we may define description of measuring in the following way: measuring is an operation of determining figure price of any quality by means of measuring unit or standard. Measuring being based on operating of organs of sense and material – sensual activity of a man is an active cognitive process. Though measuring is based on organs of sense of a man his intellect, knowledge and practice participate in its course as well: the aim and direction of purposeful perception of the object by means of measuring depends on a man‘s knowledge and interest, intellectual experience, outlook, his attitude towards reality directly. Finding out figure price of measurable quantity it is expressed in international system of units by measuring units such as kilogram, newton, coul, veber, mol, candle-power, meter, second etc.

Measuring process is not amorphous, but it has compound structure [7]. First of all measuring is a figure comparison of quantities describing the same quality. For example, while measuring the mass of any thing, in reality we compare two different masses – the mass of the thing and the standard.

Measuring being an empiric investigating method is carried out only within strict conditions and comprise the following elements: 1) object of measuring; 2) measuring unit or object of standard; 3) apparatus being used in measuring process; 4) way of measuring; 5) observer or subject who carries out measuring [1].

Application of measuring method causes some methodological problems among of which the ratio between sensual cognition and abstract thought is of great importance. Measuring unlike observation is connected with logic analysis as well.

Sensual perception goes into measuring as a necessary component. According to sensual perception of readings of apparatus a long of reasonable results are placed between the results of measuring. And that is why sensual perception is the only beginning stage of study of quantity. In such cases independent measuring is applied not only for “net” empiric observation of the phenomena, but it becomes a complicated cognitive operation where intellect is of great importance. Logic intellect is of special great importance in measuring quantities and determining the results of measuring.

Measuring operation in physics is closely connected with the principle of observation. The essence of the principal which appeared in connection with founding theory of relativity and quantum mechanics in physics may be commented so: only those notions and quantities which can be practically tested or measured in the structure of physics may be used; quantities which cannot be measured must be rejected. Let us address to the history of physics. As a result of impossibility of observing of absolute simultaneity on principal A.Einstein came to space – time conception in his theory of relativity. One can tell the same thoughts about Heysenberg’s activity that had abolished difficulties of Bor’s atom model. Heysenberg has created matrix mechanics which explains modern quantum mechanics for the first time.

From the point of view of methodology or general methods which enable to get measuring results, measuring – can be carried out directly and indirectly [12; 13]. Independent measuring, the sought for the result of which is obtained from measuring process directly is based on sensual – visual comparison of measurable quantity with special standard. For example, if we measure the mass, temperature, speed etc. of the thing according to the readings of apparatus – it is a direct measuring. But in indirect measuring the sought for the quantity is taken out mathematically from comparison of other quantities which are obtained by independent way and that is why in indirect measuring a logic comparison of the measurable quantity and standard occurs. For example, determining density of a spheric thing by the formula $\rho = \frac{m}{V}$ is an indirect measuring. Here m - is a mass and V-is a volume of the thing. In this case the mass of the thing is determined by the scales. At first in order to determine the volume of a spheric thing by the formula

$V = \frac{4}{3}\pi r^3$, its radius r is measured by the means of pair of compasses independently. On the basis of this direct measuring the volume of the thing is discovered indirectly. This example proves that the logic analysis of the quantitable descriptions which is obtained in indirect measuring is based on the data of measuring which is implemented on the base of the readings of measuring apparatus. And that's why it is wrong to oppose direct and indirect measurings or isolate one of them metaphysically. Unity of direct and indirect measurings is conditioned by the unity of sensual and logic cognition.

But within this unity both measurings obtain a relative independence. As far as possible each of them is used independently. Indirect measuring is especially extensively used in study of micro-world and society.

At the same time we must underline restriction of direct measuring which is conditioned by the following reasons.

Firstly, the number of measuring standards which are used in direct measuring must be equal common symptoms of measurable thing and other things on the whole. But this is impossible in practice.

Secondly, in direct measuring measurable thing is not associated with standard inside, that is measurable quantity and measuring unit appear as external factors.

Thirdly, in direct measuring it is impossible to determine figure price of quantities which characterize of cosmic objects and micro-objects being beyond our organs of sense.

Measuring method is of great importance in scientific research, especially in study of nature [1]. Measuring, first of all is a way leading towards discovery of laws. Great Russian scientist D.I.Mendeleyev noted more than once that "measuring and weight is everything for study of nature". Measuring is important not only from practical point of view. It is of great importance in formation of scientific theories as well. History of science, especially study of nature is rich with such examples. For example, Tikho Bragen's numerous measurings over the movement of planets enabled I.Kepler to theoretic generalizations in the form of empiric laws; on the base of measuring of atomic weight of chemical elements D.I.Mendeleyev could discover the periodical system of elements; Faradey discovered electrolyze laws according to measuring of number of quantity of material which emanated from electrodes.

In connection with investigating cognitive importance of measuring method such a question comes up: how to explain discovery of objective laws by means of measuring? To our mind the explanation must be in the following way.

In the process of measuring determining quantitative relations of phenomena at the same time we discover their some common relations as well; according to F.Engelse we discover "external determination of things". Every time we measure qualitative determination of things by means of physical quantities (mass, charge, current etc.) which express their important peculiarities. So measuring enables us to study and discover both relations of phenomena – common and important aspects. And it is known that a law is an expression of common and important aspects of relations. This shows evidently that we can define measuring as a true way of discovery of empiric laws [16]. Academician B.M.Kedrov notes that though empiric discoveries don't make revolution in the science, they cause to live latent embrions of future revolution [9].

For example, american scientist A.Maykelson's measuring the speed of light is one of such unical measurings that enriched the history of science. Russian scientist, academician S.L.Vavilov appreciating Maykelson's scientific heroism as "a record of experiment" wrote: "On the base of his experimental discoveries and measurings theory of relativity was founded, wave optics and spectroscopy increased and theoretical astrophysics firmly established" [6].

In modern physical cognition the question of gnosiological basing of the measuring method is in organic way connected with the question of exactness of measuring. Exactness is an important index of qualitative and scientific price of measuring. I.Kepler highly appreciating Tikho Bragen's measurings which are notable for their exactness (the error of them was 8 minutes) wrote: "The eight minutes that is impossible to take no heed will enable us to overturn in astronomy" [17]. I.Kepler had made a mistake: namely Bragen at the expense of combining a very high exactness of his measurings with his extraordinary diligence (he repeated his measurings 70 times) could discover laws of movement of the planets.

And what objective factors is exactness of measuring conditioned by? Exactness of measuring depends on objective and subjective factors and determining their correct ratio. Exactness of measuring requires take into account a number of objective factors which have some influence on measuring process. These factors include qualitative peculiarities of measuring object, conditions under what measuring process is carried out, peculiarities of space and time coordinates of measuring object, its speed of movement and others.

One of the main ways that improves exactness of measuring operation is increasing of quality of operating measuring apparatus based on maintaining principals and making newest measuring apparatus basing on latest achievements of science and engineering. For example, at present changing of frequency is measured by means of Messbauer effect with exactness of 10^{-16} hertz, but time on molecular generators with 10^{-11} second.

Subjective factors that measuring process include are organization of process, choice of measuring way, personal quality of a scientist, his persistency, level of preparation, scientific competence, ability of using of apparatus etc. Though all these subjective factors have an important influence on exactness of results of measuring, in any case not them, but objective factors have decisive role in measuring. That's why in order to get exact and objective result from measuring we must determine correct ratio of factors: not to distort results of measuring by exaggerating the role of subjective factors or reducing importance of objective ones.

The question of role of measuring in modern scientific cognition has been idealized by operationalism which is one of the fields of positivism and pragmatism.

American physicist P.Brijman (1882-1961) came out following thesis in order to ground his position: a) measuring is an absolute arbitrary operation being realized by a subject; b) measuring is the only foundation of scientific cognition [4]. Under these considerations Brijman regarded the object of scientific research as a totality of measuring operations and arbitrary scientific notion as determination of measuring way

of corresponding physical quantity. Thus he was changing the physical world that accepted as a totality of research object into results of measuring operations and the science itself into the system of notions determining by these operations. But by the using of scientific terminology and grounding evristical importance of measuring for scientific research Brijman tried to form operationalism in a scientific shape. But when we consider the contents of primary thesis of operationalism Brijman‘s scientific form of this conception is easily frustrated.

Firstly, one does not need to attribute measuring to absolute arbitrary activity of a subject. No doubt, it is possible to have some freedom in choosing of measuring unit and system of units in measuring operation. But this freedom itself must be founded on objective basis and subordinate to objective requirements. But the trend of operationalism putting aside objectiveness, evaluate relativity of freedom which may be in choosing of scale and system of units as absolute arbitrariness in determining of measuring.

Secondly, though all scientific merits and methodological values which measuring has it is not true to consider it as the only foundation of empiric basis and theoretical contents of scientific cognition. In this context groundless thesis of operationalism are specially shown in Brijman‘s attempt to apply some notions of theory of relativity and quantum mechanics to measuring. In order to prove our thought we remind such a fact that the notions - the curve of “space-time continuum” and “wave function” have been determined not only by the way of measuring. We should remember that the real contents of theoretical notions of physics are not conditioned by concrete measuring operations, but first of all by scientific panorama of the world [15].

Summing up the brief description of measuring method in an article it is necessary the underline that the position of measuring among empiric methods is about like observation and comparison. Measuring is a component of more compound method – experiment as well as observation and comparison.

[1] *E.P. Andreyev.* Questions of philosophy, 1982, №9.
[2] *M. Born.* Achievements of physical sciences, v. LXVI, issue 3. 1958.
[3] *M. Born.* Phusicalische Blatter. 1956, 2, s. 57-58 (in German).
[4] *B.E. Bukhovskiy.* Questions of philosophy, 1958, №2.
[5] *V.V. Bikov.* Methods of science. “Nauka”, M., 1974.
[6] *S.I. Vavilov.* Collection of works. v.3. M., Pub. House “Academy of Sciences of USSR”, 1956.
[7] *Z.M. Goutner.* Philosophical aspects of measuring in modern physics. Pub. House PGU, L., 1978.
[8] *V.A. Kanke.* Principal philosophical directions and conceptions of science. M., “Logos”, 2000, pp. 266-272.
[9] *B.M. Kedrov.* Questions of philosophy, 1966, №12.
[10] *V.A. Masko.* Gnosiological aspects of measuring. Pub. House “Naukova Dumka”, K., 1969.
[11] *O.A. Melnikov.* About the role of measuring in the process of cognition. “Nauka”, 1968.
[12] Methodological problems of measuring theory. “Naukova Dumka”, K., 1966.
[13] *M.E. Omelyanovskiy*. Philosophical aspects of measuring theory. In the book: Materialistic dialectics and methods of natural sciences “Nauka”, M., 1984.
[14] *M.E. Omelyanovskiy.* Development of basis of physics in XX century “Nauka”, M., 1984.
[15] *A.I. Panchenko.* Questions of philosophy, 1982, №3.

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MÜASİR FİZİKİ İDRAKDA ÖLÇMƏ METODU VƏ ONUN QNOSEOLOJİ ASPEKTLƏRİ

Məqalədə eksperimental elmi tədqiqatın empirik metodlarından olub, biliyin empirik səviyyəsində tətbiq olunan eksperimental metod, onun səciyyəvi cəhətləri, xarakteristikası, qnoseoloji imkanları və idrak funksiyaları tədqiq olunur. Məqalədə göstərilir ki, eksperimental metodun empirik tədqiqatın digər metodlarından başlıca fərqi onun sintez xarakteri daşımasıdır. Belə ki, eksperimentin gedişində nəinki tədqiqat şəraiti dəyişdirilir, həm də empirik idrakın müşahidə, ölçmə, müqayisə metodları üzvi halda sintez olunur. Məqalədə, habelə təbii elmi eksperimentin növləri də nəzərdən keçirilir.

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МЕТОД ИЗМЕРЕНИЯ И ЕГО ГНОСЕОЛОГИЧЕСКИЕ АСПЕКТЫ В СОВРЕМЕННОМ ФИЗИЧЕСКОМ ПОЗНАНИИ

V statğe rassmatrivaetsə gksperimentalğnıy metod, kotorıy, əvləəsğ odnim iz gmpiriçeskix metodov nauçnoqo issledovaniə, primenəetsə na gmpiriçeskom urovne znaniə. İssleduetsə eqo osobennosti, xarakteristiki, qnoseoloqiçeskie vozmojnosti i funküii v nauçnom poznanii. Ukazıvaetsə, çto osnovnım otliçiem gtoqo metoda ot druqix metodov gmpiriçeskoqo issledovaniə, əvlətsə eqo sinteziruöhiy xarakter, tak kak narədu s izmeneniem usloviy gksperimenta metodı gmpiriçeskoqo poznaniə, takie kak nablödenie, izmerenie i sravnenie orqaniçeski sinteziruötsə. V statğe tak je rassmatrivaötsə vidı estestvennoqo nauçnoqo gksperimenta.

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