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# PHENOMENOLOGY AND MODEL CONSTRUCTION IN THE HISTORY OF PHYSICS

"Physics always must strive after a direct description instead of an indirect one" says E. Mach, proclaiming a program of "physical phenomenology, free from hypotheses", at the turn of the 19th and 20th centuries.[1] Although the problems of this Machian physical phenomenology are linked with Kant's contrasting of phenomenon and noumenon, the concept of phenomenology, however, entering physical literature after Mach, is not identical at all with Kant's or Hegel's phenomenology, and is still less identical with that of Husserl. The essence of Mach's physical phenomenology, being free from hypotheses, means that the task of physics is solely to sum up and to describe (this being the phenomenology) the results of experimental research, while every interpretation, explanation, formation of hypothetic models belongs to metaphysics, to a penetration behind the domain of physics.

The establishing of the Machian phenomenological conception was not independent of social and ideological interactions, while on the other hand Mach's positivism affected several later tendencies of neopositivism, such as the logical positivism, the Vienna Circle or Reichenbach's school.

Machism or rather neopositivism are very impressive in the interpretation of disciplines of modern physics. This can not be simply explained by the ideological attractiveness of these trends. The possibility of positivist effects should be founded on the characteristics of physics itself, on the history of its progress. And as a matter of fact, certain prepositivist trends may be found in the history of physics, long before philosophic positivism and Mach's physical phenomenology appeared, and this not in form of secondary tendencies, but now and again as prevailing trends.

[1] E. Mach: *Die Prinzipen der Wärmelehre*. Leipzig 1896, pp. 401 and 403.

Examination of the historical roots and the later consequences of neopositivism demonstrates, that essentially the problem can always be reduced to a sharp, contrasting distinction between phenomenology and model.

The object of our paper is:

(a) to demonstrate that the contrasting of phenomenology and model is not correct at all, neither from the historical, nor from the logical point of view.[2]

(b) to reveal the roots of this contrasting, inherent to the historical development of physics.[3]

(c) to furnish data in order to prove, that in the last analysis physical idealism of recent times is also based on the wrong comprehension of the relation of "phenomenology" and model, in spite of many essential new features.[4]

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a) Experiment and mathematics are inseparable means of physical research. Their relation within physics can be compared to the inseparable connection of induction and deduction.

The inseparability of the descriptive and explanatory character of scientific theory corresponds to the inseparability of experimental and mathematical methods. Certain laws of physics may be rather of a descriptive than of an explanatory character, but a scientific theory always means the logical interpretation of perceptible (experimental) data, thus being always explanatory to a certain degree. Thus theory is always also explanatory and not only descriptive.

But certain so-called descriptive laws, also reveal regular relations between certain phenomena and groups of phenomena, furnishing also hereby certain explanations concerning given groups of phenomena, since the revelation of necessary connections a penetration behind the surface. Although the laws of Boyle-Mariotte and Gay-Lussac, for instance, only describe the relations between volume, pressure and temperature of gases (ideal gases), they furnish herewith more about the nature of phenomena and thus also supply some explanation about the essential character of the gas itself.

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[2] Details of this point are presented in: G. Biró: *Phenomenology and Model.* „Magyar Filozófiai Szemle" 1965, 7.

[3] The history itself is the best denial of the alleged divergence of phenomenological and model theory. The author investigated the history of development of the principle of energy, of the concept of entropy and of the first physical atomic theory, from this point of view. See: „Fizikai Szemle" 1960, 6; 1962, 1; 1963, 3.

[4] About the latest tendencies of physical idealism see: G. Biró: *Historical Periodisation of Physical Idealism.* See: „Építöipari és Közlekedési Müszaki Egyetem Tudományos Közlemények" 1965, 1.

The epistemological fact, that the laws of science reflect reality only approximately indicates, that laws apply to an idealized reality, to a model which is not identical with reality (only in the approach given by the level of science).

In this sense every theory represents a model theory.

Thus, there is no epistemological difference between a theory based definitely on models and a so-called "phenomenological" theory. Not only the fundamental ideas of the phenomenological theory contain abstraction and generalization as compared with the directly observable phenomena, but even models are abstractions originating in observed phenomena (*e.g.* the conceptions of atoms or molecules in the kinetic theory of gases are abstractions which serve to describe the observable phenomena, just as the conceptions of temperature, pressure, *etc.* of the "phenomenological theory").

b) The contrasting of phenomenological and model theories is wrong in view of logic and epistemology. All the same this opinion has been voiced again and again since centuries in the course of the history of physics. This indicates that the roots of such opinion must lie in the historical course of physics. Indeed, the outstanding role of positivism in answering the epistemological questions of physics, is connected fundamentally with the experimental method pertaining to the very essence of physics. As a consequence, positivist tendencies appeared in connection with physics almost immediately after physics had become independent in modern times.

The recent independence of physics runs parallel with the development of the particular experimental methods of physics. The greatest obstacle for the emancipation of physics is scholasticism and its natural philosophy. The experimental method constitutes a decisive factor in the fight against scholastic authority and mystification. Physics opposes experimental facts to the concealed properties (*qualitates occultae*) of scholasticism. Any absolutisation or overestimation of the experimental method is the first historical and epistemological source of positivism related to physics. This is the source of the establishment of the phenomenological standpoint.

At the time when physics became independent, it was in search for materials, thus experimentation has been the most important problem; this has been the new method of research; however even at this epoch physics was not characterized by mere "phenomenology". Namely, the mathematical formulation of experimental results means already to go beyond experimental results.

In various periods of the history of physics the task of experimentation or that of theoretical summarizing may come into prominence, experimentating, however, and establishing a theory (phenomenologic description and model) do not diverge, not even in certain transitory periods.

It was the logic of fight against scholasticism which led to Newton's *hypotheses non fingo,* which had not been recognized by Newton himself but directly led to the one-sided empiricism of the Newtonians of the 18th century, indicating the strengthening of phenomenological concept.

It may be revealed by means of a more detailed historical study, that even this period, the 18th century, was not a phenomenological one in the sense of the word used by the phenomenologists. Weightless materials and action at distance are certainly not mere descriptions of experimental results, but their particular explanations, and models for their interpretation. These models reflect beyond doubt the phenomenological conception, since they require special kinds of material for every group of phenomena, attainable at that time by way of experiment. This metaphysical conception, imperative in the situation of history of science in the 18th century, brought about idealistic tendencies overstraining its own range (action at distance is an effect without material).

The multiplication of experimental results exceeded the methaphysical conception; the phenomenological consideration was overshadowed by the success of mechanical model formation. From the middle of the 19th century physical research was possessed by the idea of the universal connection of phenomena, considering, however, mechanics as a basis of connections. (It is an interesting fact of the history of science that although dialectical and historical materialism were established in the middle of the 19th century, physics developed up to the end of the 19th century on the platform of mechanical materialism). Physics of the 19th century met with success in the domain of mechanical model formation even in such fields where discoveries objectively pointed already beyond the range of mechanical effects (optics, electricity, *etc.*).

The next stage of the history of physics where phenomenological tendencies were prevailing again, was the turn of the 20th century. When physics became independent, the necessity to overcome scholastic dogma, led to biassed apology of phenomenology. At the turn of the 20th century, however, it was been the break-through of the almost dogmatic system of classical physics which led to the same result.

In the years of the turn of the 20-th century it was discovered that the models of classical physics, constructed and highly respected in the 19th century, are not absolute at all. This led to the negation of models in general, and further, not only to the negation of models, but also to the negation of the objective existence of the world. The trend, standing against model formation, relying only on phenomenology at the turn of the century, produced an almost subjective idealistic tendency, *i.e.* Machism. Experimental facts at the turn of the century, breaking through the generalizing level of classical physics, inspired the establishment of new theories. The theory of relativity, and particularly the quantum theory, signify a decisive break with classical physics. The quantum theory arises as a mathematical generalization (Schrödinger, Heisenberg) of *ad hoc* premises (quanta — Planck, Einstein, Bohr) and of hazardous analogies (de Broglie). The way, leading from Bohr's successful, though incomprehensible quantum-conditions to the more successful, but still less comprehensible operator and matrix-calculus, stipulates a continuous experimental control of the mathematical apparatus of great efficacy, but of uncleared physical content.

In this period of the history of physics — not at last on the influence of Machism — phenomenology prevails more than ever before. It becomes almost a motto of physical research that "there exists only what is measurable". This proposition, however, seems to be right only at first sight. If it is interpreted consistently, it leads to complete negation of forming hypotheses. Hypothetic models may not be formed, since if something is not measurable, it may not be assumed that it exists.

c) The way, leading to the development of the quantum theory, was not free at all from model construction (considering Planck, or the classical quantum theory of Bohr or also de Broglie's wave theory of matter), model building came nevertheless into the limbo of classical physics as obsolete inheritance, — according to public opinion.

Speaking more exactly, this phenomenological trend, — at present already as a neopositivist trend, — disapproves only of m a t e r i a l models, but not of mathematical ones, although for phenomenology even mathematical models represent a *transcensus,* a penetration behind sensory experiences as mathematical models do, and thus even mathematical models should be inadmissible. The admission of mathematical models must necessarily lead, beside the negation of material models, to an epistemologically false concept of mathematics. It must lead to an objective idealism of such type, which considers mathematical apparatus, mathematics itself as the final essence of the world. The logic of history has brought about this concept. Certain problems of divergence of the quantum theory, as well as the accumulated new material of facts (several times ten elementary particles and their mutual transformations into the another) urged on the establishment of a new synthesis. This new synthesis has not yet taken place. But the mathematical apparatus of research, striving after this theoretical level has been conceived by many authors (beeing still under the phenomenological influence one or two decades ago) in an objective idealistic manner, mentioned already. To mention only the most eminent one: Heisenberg considers his material equation as a proof of the Platonic philosophy. Also objective idealistic interpretations relating to recent progress of development of physics are based upon the problem of the relation between phenomenology and model formation, which is epistemologically not properly cleared.

Summarizing: The phenomenological concept came about when physics were becoming independent in modern times, in connection with the development of experimental methods at the height of the fight against scholasticism; it was flamed up again with a new effort in the turn of the 20th century at the birth of modern physics, in course of polemics against classical physics. In the first period the phenomenologic "overswinging" of the fight against scholasticism led to a restricted empiricism as well as to an idealistic model formation (action without material) in the course of the 18th century. In the turn of the 19th and 20th centuries polemics against mechanical models of classical physics from the general negation of model formation to a subjective idealistic negation of objective reality. The lack of elucidation of the relation between mathematical and material models in the last decades emphasized the objective idealistic interpretation of physical laws. The new level of generalization overpassing classical physics, — about half a century ago — was established in such a social and ideological situation in the history of physics, that it was combined with subjective idealistic tendencies already since its birth. Today there exists already a social and ideological, as well as a physical and historical possibility for the latest physical level of generalization not to be charged with negative ideological ballasts. In this respect, the lessons drawn from the history of science could play an important role indeed.