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At present, in spite of serious difficulties concerning strong interactions, theoretical physics is still in progress. But new physical ideas are badly needed, and « sufficiently mad » theories are more than ever expected. To develop a new theory one has, of course, to know how the old theories are built. But is our Knowledge of these really incomplete?

The conventional treatment of classical questions of physics is, in a sense, too utilitarian [1]. It is appropriate to explain and to describe different kinds of phenomena, but inappropriate for the search for elementary physical laws from which the whole picture of the world could be obtained by pure deduction.

Thus, we consider the following features of the conventional construction of physics as its weak points:

1. The intuitive character of basic physical notions, such as length, time, mass, charge and so on;
2. The superficial, purely external character of basic axioms arising from intuition and visual concepts;
3. The lack of a unified construction of physics as a whole.

One cannot exclude, of course, a possibility that the desired « sufficiently mad » theory would emerge somehow in a more straightforward and simple way, without laborious revision of physics from top to bottom, and especially of its foundations.

But it is quite possible that at the new stage of development of physics, where the physical picture of the world is to be radically transformed, a deeper analysis of general principles, a clarification of physical concepts and bringing them into agreement with the modern state of mathematics will be useful in creating a new physical outlook.

Usually, when the fundamental principles of a physical theory are

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1 Vide F. Spisani, *The Meaning and Structure of Time,* Bologna, 1972, p. 29 and pp. 59-61.

in question, some general postulates are meant from which the basic equations of this theory would follow, as Newton's equations in mechanics, Maxwell's in electrodynamics, Schroedinger's in quantum mechanics and so on. Doing so, the very fact of existence of such *physical quantities* as distance, coordinates, mass, tension of an electrical or a magnetic field etc. goes without saying, and everything is reduced to consideration of equations, which turn out to be invariant with respect to a group of transformations acting on variables entering these equations. We call this stage foundations of physics on the equations level.

In this report another formulation of physical theories is proposed departing from a deeper level — the level of *physical notions* and *quantities,* which precedes the equations level. We assume that all information concerning physical objects is to be obtained according to general rules from the corresponding collection of *experimental data,* the physical quantities (distance, time, coordinates, mass, temperature, entropy etc.) resulting as invariants of a new kind.

Our problem is to analyse on the contential level the elementary experimentally verifiable assumptions underlying physical theories. Consequently, we intend to formulate some very general laws reflecting specific relations between physical objects, in a *language of abstract relations independent of a concrete, empirical interpretation of sets and measuring procedures considered* [2].

We propose a new approach to the study of physical phenomena based on the possibility of dividing all physical systems in two principally distinct classes: phenomenological (homogeneous, continuous) and discrete.

It is supposed that systems consisting of discrete objects possess some kind of symmetry described by group theory. Phenomenological systems are those considered in geometry and chronometry, mechanics, relativity theory, electrodynamics, thermodynamics and, to a considerable degree, in *quantum mechanics.*

The description of phenomenological systems from our point of view requires a new mathematical apparatus adequately reflecting most general properties of physical objects and measuring procedures. The possibility of a general theory of phenomenological symmetry means that all theories mentioned above can be constructed in a unified way, with minimal arbitrariness [3].

[2] I. KULAKOV, *Elements of the Theory of Physical Structures,* « Lectures for the University Students », Novosibirsk, 1968, pp. 1-174. Therefore, any investigation « which once again takes into consideration the problem of micro-objectual structure, must consider new mathematical instruments suitable for formulating anew the problem of the micro-obpect » (SPISANI, *op. cit.,* p. 51).

[3] KULAKOV, *The One Principle Underlying Classical Physics,* « Proceedings of the Academy of Sciences of the USSR (Doklady Akademii Nauk SSSR), Vol. 193,

The phenomenological symmetry is expressed as follows:
Let $\mathfrak{M} = \{i, k, \ldots, l, \ldots\}$ and $\mathfrak{N} = \{\alpha, \beta, \ldots, \gamma, ..\}$ be two sets of physical objects (i, α) a number $\alpha^M{}_{i\alpha}$, so that eventually all the information about possible relations between sets$M$ and N is contained in the data matrix $\alpha^M{}_{i\alpha}$. There exists a rule allowing one to check the presence (or absence) of special symmetries in

Basic physical postulates underlying this rule are quite simple and natural:

1. The properties of physical objects are revealed in their mutual (binary) relations.

2. The primary (elementary) physical law is a restriction imposed on the form of the data matrix $\alpha^M{}_{i\alpha}$.

3. This restriction consists in a relation between matrix elements $\alpha^M{}_{i\alpha}$ corresponding to a finite number of physical objects (m from the set M and n from N).

4. The mn elements of matrix are subject to a functional relation $\varphi = 0$, where $\varphi(x_1, x_2, \ldots, x_{mn})$is a function of mn variables turning zero when x_j are substituted by corresponding .

5. An elementary physical law is universal in its character, i.e. it is true for any groups of physical objects belonging to a given class.

Very general assumptions cited above are condensed in a principle which we call the principle of phenomenological symmetry [4].

Let $\mathfrak{M}$ and $\mathfrak{N}$ be two sets of physical objects. We say that a physical structure of rank (m, n) is defined on the sets $\mathfrak{M}, \mathfrak{N}$ (m, n integers ≥ 2) if the mn number valued variables $\alpha^M{}_{i\alpha}$ standing in m rows $i, k, \ldots, l$ and n columns $\alpha, \beta, \ldots, \gamma$ of the matrix satisfy a functional relation $\varphi(\alpha^M{}_{i\alpha}, \alpha^M{}_{i\beta}, \ldots, \alpha^M{}_{e\gamma}) = 0$, the form of which is independent of the choice of m elements of and n elements of .

This principle is a most natural expression of the equality of physical objects with respect to the physical law. It looks somewhat too general, obvious and even trivial to be a source of useful information about structure and possible concrete form of physical laws. Nevertheless, it turns out that the very requirement of universality of the law (its truth for different objects belonging to a sufficiently wide class) implies, in reasonable limits of mathematical equivalence, the possible forms of the physical law and the essential restrictions on possible values of experimental data [5]. Let us note that the above principle of phenomenolo-

n. 1, July, 1970, pp. 72-75; « Soviet Physics Doklady », vol. 15, n. 7, January, 1971, pp. 666-668.

[4] KULAKOV, *The Geometry of Spaces of Constant Curvature as a Special Case of the Theory of Physical Structures*, « Proceedings of the Academy of Sciences of the USSR », vol. 193, n. 5, August 1970, pp. 985-987; « Soviet Mathematics Doklady », vol. 11, n. 4, 1970, pp. 1055-1057.

[5] MIHAILICHENKO, *Supplement to the Yu. I. Kulakov Book, Elements of the Theory of Physical Structures*, « Lectures for the University Students », Novosibirsk, 1968, pp. 175-226.

gical symmetry is apparently the only possible way to introduce the notion of physical quantity consequently and rigorously departing from the data matrix as a unique information source.

The thing is that any physical quantity (*distance, time, mass, temperature, electrical charge* etc.) is defined by the « inner » properties of a certain set of physical objects and cannot be introduced arbitrarily, « by definition ». For example, we are not allowed, strictly speaking, to identify *a priori* the readings of a concrete watch — the « quasi-time » τ^{M}_{iK} — with the « true » time interval t_{ik}, which does not depend on a concrete measuring procedure μ taken from a sufficiently large class, being defined by nothing but the « inner » properties of the set of events.

Thus, before introducing some physical quantity, we must check the existence of certain properties of sets considered. Usually, it is done intuitively. The principle of phenomenological symmetry allows an explicit formulation of these primary properties of physical objects in a somewhat unhabitual language of functional equations.