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The Space-time of the Theory of Relativity

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1. The space-time relations are defined by the interaction of things and phenomena; they are neither defined nor do they exist by themselves. Respectively, the structure (geometry) of the space-time is defined by general laws of interaction and the theory of the space-time must deduce its properties from these laws. Being a theory of the space-time the theory of relativity was evolved just in this way, for A. EINSTEIN had set as its cornerstone the law of the propagation of light.

2. The theory of the space-time may be based upon the fundamental and general fact that each phenomenon acts upon some others.

If we define an event as a point-phenomenon, the space-time may be defined as the set of all the events, in which all the properties are abstracted with the only exception of those which are defined by the relation: one event acts upon another. Such an abstraction makes it more convenient to say that one event precedes another. The structure of the space-time is defined by this relation of precedence.

A construction of the theory based upon the concept of precedence was given by A. ROBB. His system is analogous to the axiomatic of the elementary geometry and includes 21 postulates.

3. The fundamental properties of the space-time of the special theory of relativity may be expressed by means of the following postulates, provided the above definition of the space-time is taken for granted.

(1) The space-time is a four-dimensional manifold (its topology being suitably defined by means of the relation of precedence).

(2) The space-time is homogeneous, i.e. any two pairs of events A, B and A′, B′ with the same relation of precedence being given, there exists a mapping of the space-time on itself, which preserves the precedence and juxtaposes A, B to A′, B′.

The first postulate includes the boundedness of the velocity of propagation of actions. The second one expresses the principle of relativity.

We can prove, though yet under some additional conditions of analytical character (as, e.g., differentiability of the manifold), that these two postulates define the space-time of the special theory of relativity. I.e.

there exist systems of coordinates by means of which the mappings preserving precedence are expressed as LORENTZ-transformations with an addition of proportional changes of all the scales.

4. The proposed approach to the theory of the space-time allows to enlighten some fundamental features of the special as well as the general theory of relativity. This theory is the theory of the space-time as a form of existence of matter. Not the relativity but the structure of the space-time defined by the matter, not the relative which is but an aspect of the absolute, but the absolute constitutes the true kernel of the theory.

Diskussion – Discussion

A. D. FOKKER: (After recalling ROBBS earlier axiomatic approach): Does the light-cone follow from your axioms?

A. ALEXANDROV: Yes, this is just my statement. However, one has to suppose the manifold to be differentiable.

S. N. BOSE: If you assume that you have a differentiable space and time, you are really borrowing from the ordinary concept of space and time and you are only translating in mathematical language and formulae the things which are familiar. You started with very abstract statements about events; now, if you want to locate these events, you are taking in a particular space; in fact, you define events in terms of concepts with which we are familiar, you are not really going behind these concepts.

A. ALEXANDROV: As soon as we are speaking of a manifold, of dimensions, of points and so forth we are borrowing from the ordinary concept of space. It is impossible to say anything concerning the space-time and not to borrow from the ordinary concepts. And nevertheless we can penetrate into the nature of space-time much deeper, than the ordinary concepts allow. Axiomatics of the elementary geometry is an example.

H. P. ROBERTSON: I agree with FOKKER, that it is good to revive the axiomatic attack, which has been much neglected since the early work of ROBB. What I should like to ask is what is it in your treatment which lead you to the Minkowski space-time, to the exclusion of the De Sitter space-time, which has the same degree of homogeneity.

A. ALEXANDROV: Among the spaces of constant curvature the space of zero-curvature has the highest degree of homogeneity, for it allows transformations of similitude. The possibility to transform a pair of points (events) into another pair, supposed in my third postulate, without any condition of equality of intervals, or any other similar condition, provides the possibility of transformations of similitude and thus ensures the space to be a flat one, i.e. Minkowskian one.