Discrete space-time

One conceivable hypothesis on the structure of space in the microcosmos, conceived as a collection of disconnected elements in space (points) which cannot be distinguished by observations. An acceptable formalization of discrete space-time can be given in terms of topological spaces Y in which the connected component of a point $y \in Y$ is its closure $\overline{y}$, and, in a Hausdorff space Y, is this point itself (totally disconnected spaces). Examples of Y include a discrete topological space, a rational straight line, analytic manifolds, and Lie groups over fields with ultra-metric absolute values.

The discrete space-time hypothesis was originally developed as a variation of a finite totally-disconnected space, in models of finite geometries on Galois fields V.A. Ambartsumyan and D.D. Ivanenko (1930) were the first to treat it in the framework of field theory (as a cubic lattice in space). In quantum theory the hypothesis of discrete space-time appeared in models in which the coordinate (momentum, etc.) space, like the spectrum of the C^*-algebra of corresponding operators, is totally disconnected (e.g. like the spectrum of the C^*-algebra of probability measures). It received a serious foundation in the concept of "fundamental lengths" in non-linear generalizations of electrodynamics, mesondynamics and Dirac's spinor theory, in which the constants of field action have the dimension of length, and in quantum field theory, where it is necessary to introduce all kinds of "cut-off" factors. These ideas, later in conjunction with non-local models, served as the base for the formulation of the concept of minimal domains in space in which it appears no longer possible to adopt the quantum-theoretical description of micro-objects in terms of their interaction with a macro-instrument. As a result, the space-time continuum is inacceptable for the parametrization of spatial-evolutionary relations in these domains (e.g. the Hamilton formalism in non-local theories), and their points cannot be distinguished by observation (in spaces Y this may be represented as the presence of a non-Hausdorff uniform structure). The discrete space-time hypothesis was developed in the conception of the non-linear vacuum. According to this concept — under extreme conditions inside particles, and possibly also in astrophysical and cosmological singularities — the spatial characteristics may manifest themselves as dynamic characteristics of a physical system, in the models of which the spatial elements are provided with non-commutative binary operations.

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