Irreversibility, Time in Philosophical Aspect

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The problem of time is connected with a whole complex of scientific and philosophical notions. Among them there are pairs of antinomical, complementary conceptions deeply rooted almost in all philosophical schools and in the history of natural science. Besides substantial and relational, static and dynamic conceptions of time [1], the characteristics of time themselves such as continuity-discreteness or reversibility-irreversibility are complementary. It's difficult to treat the problem of irreversibility apart from this conceptual system for all of its constituents are closely related to each other.

According Newton "time in itself and by its own nature, without relation to anything beyond it, flows uniformly". In the world-picture of a classical theory time is substantial and reveal itself as a self-sufficient entity, it is absolute and continuous. All natural bodies and physical phenomena are subject to the passage of time, and so absolute synchronism is realized, but these bodies and phenomena do not themselves exert influence on time. A modern substantial conception of time deals with substantial flows that generate change; the universe is open to these flows [2].

Leibniz held a relational conception of time and polemized with substantial treatment of it. He insisted that "space as well as time is something purely relational: space is an order of coexistences and time is an order of sequences. For space in terms of possibility means an order of simultaneous things because they exist together" [3]. He didn't consider time as separate entity but saw it as a law of change in a set of states.

The modern relational conception of time is based on the special theory of relativity that considers time as a system of relations between physical events and bodies. Space-time is defined as a set of all events in the universe connected by common structure of relations of effects of events to each other and nothing else. In this structure the limiting speed of transmission of signals is of crucial importance. Question of temporal sequence of events becomes meaningless if there is no possibility for them to interact. It is argued in "Physical Encyclopedia", that "space and time are generally defined in physics as fundamental structures of coordination of material objects and their states" [4].

Another antinomical pair is constituted by static and dynamic conceptions. In static model all events are considered as existent. Nothing emerges by itself and nothing disappears by itself; the consciousness meets various events and records them as the moments of the present. Temporal relations are not denied by this conception but reduced to the relation "before-after" as given in the universal space-time manifold that has its metric and topology. There is no arrow of time in static model. This conception acquired the unexpected physical meaning in the work of J. Barbour [5]. He eliminated the difference between past and present by invoking the Wheeler-DeWitt equation. The equation describes quantum evolution of 3-geometry of space in superspace of such geometries with different metrics and contains explicitly neither time nor spatial coordinates. For each "universe" with its specific topology and metrics the Wheeler-DeWitt equation allows to find its corresponding probability. This configuration of matter ("universe") may be represented by a quantum particle moving in the superspace. J. Barbour draw the analogy between them and the tracks of subatomic particles in the Wilson camera assuming that appearance of the past is created in such a way.

A dynamic conception ranges all events in a temporal scale as past, present and future. Events come from the future into the present, so acquiring true being, and go into the past but not without leaving a trace. A dynamic conception allows to speak about general direction of development of the Universe from the more likely states to the increasingly less probable ones: from Big Bang to the present day. Development implies emergence of new and also continual influence of the past upon the future, the maintenance of wholeness, or unchangeable identity, with a presence of changes. The principle of becoming implies tendency to believe that process (and function) is more fundamental than matter and space. The dynamic model is in conformity with a grammar of tenses whose logic establishes order on the scale of precedence between a moment of speech, a moment of event and a reference point. Dynamic conception, therefore, lay time into Procrustean bed of lineal structure.

Conceptions of irreversibility and reversibility of time also form an opposition. In physics reversibility is associated with Poincaré's theorem on return. It has a general character and asserts that in the closed system any moving point returns repeatedly in any vicinity of its initial conditions. But irreversible processes are realized, that is such sequences of states whose order is unchangeable. With these sequences the direction of time represented by statistical, electrodynamic and cosmological "arrows" of time is associated. Apart from physics an idea of

irreversibility of time has evolved from the empirically observable irreversibility of all processes related to human life activity and social development. “Life passes forever without any hope to return” (G. Bruno). The principal measure of time is a human life in its wholeness and unity. A person exists until it maintains continuity of its inner state and is able “to produce the self out of itself” (M. Mamardashvili).

It seems that the basis of almost all of such pair-oppositions is the difference between viewing a time as a process or as a result of process.

Two realities are intelligible within quantum mechanics. One is “reality of dispositions, not of actually inherent characters of objects always having a place but of preferences of their behavior” [6]. Symmetry of quantum mechanics in respect of reversal of time refers only to the evolution of vector of state, not to the process of measuring that is irreversible in its nature. Process is reversible; irreversible is its result; but, as Hegel noted, “that is not result that is the actual whole but the result together with its becoming” [7].

The empirical regularities of evolution were stated on the basis of currently available data of paleontology. The emergence of new characters in a structure goes not without loss of some of its present properties, and with a partial disturbance of stability and decrease in the level of heritability. A structure retains the new by remembering it. “As a quantity of novelty available for a system to acquire is in proportion with a quantity of that has been forgotten by it, the more a system gets the novel, the more irreversible is the process of development that led to this, other things being equal” [8]. The law of irreversibility of evolution has been stated variously. According to one statement, namely by L. Dollo, this law asserts that organism can’t return, even partially, to the preceding condition that has been realized in the series of its predecessors.

Paleontology, geology as a history of Earth, and history proper have results of processes as their objects, and reversibility doesn’t exist for them. For geologist a river is alluvial plain, for hydrologist it is a process with a variable run-off. A geologist and a hydrologist have seen a river in the different time perspectives.

A global evolution of complex systems exhibits a certain directedness and irreversibility, accompanied by chaotic phenomena. Slow processes of a relative stability, of a cyclic development alternate with jump-like changes. In paleontology there is a known rule of “alternating equilibrium” (or punctualism) stated by S. Gould and N. Eldredge [9]. In the evolution of species long periods of stasis, when the main structural traits of a species remain unaltered, alternate with brief periods of transformation of one form into another. Speciation depends on the process of adaptation described by Ch. Darwin as well as on the more specific accidental factors. If a development is a stochastic process then the trajectory of development as it has been realized is unique.

In physics also the irreversibility is associated with chaotic phenomena. It has been demonstrated [10, 11] that the time of the reversible behavior in the system of colliding bodies is so small that the Poincaré theorem breaks down for such system cannot be held as closed. Considering also quantum effects of spontaneous radiation which accompanies collision of particles, it turns out that already after the first collisions laws of motion, symmetric in respect to reversal of time, are replaced by irreversible equations of statistical physics. “The only object which may put in a claim for to be governed by Poincaré theorem is the Universe as a whole. In this case it would be natural to treat a time of return as a life-time of the closed Universe” [10]. In Marchal’s report irreversibility is deduced from a chaotic character of motions, a sensitivity of system to initial conditions and a hierarchy of scales of natural phenomena [12].

Structure of time is related with a character of processes reflecting its nature. We may speak about cyclic, lineal, ramifying and fractal time.

The cyclic structure of time does not allow irreversibility. The idea of cycle as a basic foundation of the universe is known from the period of antiquity and ancient China. Life on Earth is organized as a closed, causally determined cyclic process that allows the evolutionary changes in character of cycle maintenance but not the loss of a cycling itself. The cyclic processes of life include metabolism with its emission of energy, and also growth and replication of molecules. The components that specify a living system (albumens, nucleic acids, lipids, polysaccharides) are the same components whose synthesis and stability are provided by the cyclic organization itself. Furthermore, a living system is the unity of interactions owing to such an organization, and must retain this cycling for to remain a living system as the unique entity [13]. Cycle is the mode of retaining stability, homeostasis of all existent, from celestial bodies to social structures. Contemporary social sciences know more than 1380 types of cycles.

In the cyclic model a function prevails; this is the world of functioning; nothing emerges or disappears in it; time here is a duration measured by multiplicity of cycles, and it is discrete. Repetitions impose a doctrine of determinism *a la* Laplace.

The idea of cycle is processual one, the process of existence is reduced to a repetition, to identity of thing to itself. But a process in open system is not determined only by its inner properties, and an introduction of elements from outside into such system gives a character of linearity to its motion. The outside elements interacting with the main

structures widen a range of developmental possibilities and reduce predictability. According to epigenetic conception of organic evolution the system of development of organism under the action of extreme environmental conditions upon their population is destabilized with the effect of increasing variability of individual states. The system comes to the new balance through selection of those variants which realize livable fluctuations, the selection shows up as a sequence of correction cycles that converge to the new equilibrium point. This stable norm is the accidental choice retained in memory, that is the result of a such process. Whether a steady organization is achieved or the phylum becomes extinct, various efforts of stabilization are typical for the preceding period of evolution and they are reflected in paleontological data as sequential or parallel morphological variants. The time represented by them has a structure of tree.

The ramified structure of time has also roots in quantum mechanics. According to the "many-worlds interpretation" of H. Everett the wave function describes all possible types of universes together with various observers living in them. By making measurements observer comes to know who is he and what a world he does live in. The world's history is split into various possible ways and these variants are realized without interacting with each other. In calculating the probability of the combined system of particle and measuring apparatus being in any one configuration we are implicitly dragging in an observer who reads the dial.

Parallel worlds not only have to be split after each act of observation or interaction between subatomic particles but also, in accordance to the nature of things, have to reveal a development of ramifications back in time. Therefore not only future is probabilistic but also past is. "With a passage of time meanings of things change", Lucretius said. This view is close to one of historians who possess a current past. The historian "cannot look at the past otherwise than from a standpoint of the present. In fathers' destiny we look largely the explanation of our own" [14].

The directedness of process testifies that some result is attained when presented as a thing or event, that is as a form of time whose natural referent is this process. There is a law of embryonic similarity. The embryos both of mouse and elephant follow similar programs of development being fitted into the definite sequence of stages but intervals between them are passed with a different speed. On all scale-levels of nature some preferential forms are realized. The trajectories of dissipative dynamic systems show tendency to converge to a relatively small number of states or attractors. In mechanisms of selection there is irreversibility providing stability of these states.

Among the sets which attract trajectories of dynamic systems there are strange attractors, sets with extremely irregular fractal structure which are characterized by scaling or self-similarity. Leibniz says in "Monadology" that "any part of matter may be represented as a kind of garden full of plants or pond full of fish. But every branch of a plant, every member of an animal, every drop of its body-liquids is a garden or a pond of the same kind". The idea of the fractal character of space-time leads to irreversible universe. Fractal organization of time is pertinent to systems with a dynamic chaos. Example is provided by discrete fractal structure of biorhythms. Kobelev's paper in the present collection shows the possibility of the world with a space-time of fractal dimensions without constants [15].

Brief conclusions

In natural science and philosophy there are pairs of antinomical models of time, and this set cannot be reduced to one fundamental model. Each of available models of time find its correspondence in some physical theory.

Conclusions concerning irreversibility or reversibility of time are determined by time horizon of a judgement about the directedness of changes which passage of time is associated with. The reified, shaped time as a result of process is irreversible.

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