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SUBSTRATUM, GRANULARITY, CHANGEBILITY AND EVOLUTION IN THE UNIVERSE

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Abstract

A new structuralistic approach concerning cosmic evolution is proposed. The concept of akantos is introduced. The local evolution would imitate the evolution of the Universe. The notion of akanton is understood as a superactive cell, astrogennic cell which would exist from the very beginning. The cosmic evolution is considered in terms of biogenetic scheme which is intimate with the Hegel's idea of organism.

Keywords: cosmology, stars, galaxies, cosmogony, local, global, Mach's view.

1. Toward the Sources of this Work. On a Certain Open Programme in Contemporary Physics and Cosmology

1.1. An Outstanding So-called Large Number

> 'Summing up it can be said that taking duly into account the large dimensionless numbers of Nature identified in our diagrams we may hope to have improved some details of Dirac's cosmology together with our understanding of the cosmic hierarchy and its evolution with the cosmic time ... '
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> (G. PAÁL, 'Large Number Coincidences and the Cosmic Evolution', *Acta Geologica Academiae Scientiarum Hungaricae* 23, 1980, pp. 129-138)

Holistic, structuralistic approach is usually connected with the philosophy of Ernst Mach. This trend is known in cosmology and it is based both on the speculations of philosophical nature and on some anomalies, numerical coincidences. Namely, as a result of the Universe expansion, the scale factor characterizing the matter in 'mega' scale has increased considerably and now it is 10^{40} times bigger than the proton radius. This

particular number, which cannot be compared with ordinary factors of the order of unity appearing in physics and in the application of the methods of dimensional and similarity analyses, occurs in many relations between microcosmic constants and constants which characterize the Universe as a whole (PAÁL, 1980; GRABIŃSKA and ZABIEROWSKI, 1979, 1980, 1981; ZABIEROWSKI, 1990).

1.2. The Relationship between Distant Matter, Elementary Particle and Fundamental Constants

The effort of philosophers, cosmologists and natural historians is concentrated on the attempts to present hypotheses and theories in which the relationship between Planck's constant h, light velocity c, proton mass m_p, gravitational constant G, electron mass m_e, electrical charge e, characteristic radius of the Universe R, Universe lifetime T, and Hubble's constant H are interpreted in the categories of the interactions between distant matter and elementary particles ergo local manifestation and forms of matter ('micro' scale). This trend of thinking is connected with the classical form of Mach's principle and with its different generalizations (PAÁL, 1980).

1.3. The Hypothesis of Variability of Physical Constants and the Problem of Mechanism of the Variation

Thus, a new physics is required. The logical order of categories and structures which serve the interpretations of cosmological coincidences is significant in all these exotic theories. The time order of transition process of Universe properties to proton properties (or the physical nature of such a synchronization of proton properties with the Universe properties) is usually omitted. In the face of the above, such theories, which do not warrant constancy of fundamental 'constants' e. g. m_e or e, or even introduce this variability, cannot squirm free from the reproach that they introduce this changeability to some extent automatically and not without the features of arbitrariness, with violation of the beliefs of modern physicists going by the fundamental principles. What follows it, the relation between electron mass and the Universe radius R as well as similar relations known from the ideas based on the Machian versions reflect a rather formal ratio.

1.4. The Essence of Physics according to Berkeley, Toland, Leibniz, Boskovic. Toward Mach's Vision and the Principle that Nothing Happens Without a Cause

We have no doubts that theories satisfying the Machian principle should play more important role in the analyses referring to the problems of matter evolution in the Universe than we propose here. By Machism we understand the general trend in the philosophy of natural sciences binding local matter properties with the properties of the whole Universe. And Berkeley so was the first who criticized the principles of Newton's theory on the basis of his own philosophical analyses. As it is generally known, that Newton's theory does not subject the properties of bodies and local physics to the Universe matter (e. g. its distribution). Berkeley rejected Newton's thesis, which stated that rotation was absolute, basing partly on the works by English philosopher J. Toland.

The tradition of structuralistic approach to the nature can be found in the works of Leibniz and in the work of the Croatian philosopher and mathematician R. Boskovic, who was also known for his astronomical works. The questions indicated by Berkeley were raised to the standing of the basic problems in philosophy of empirical science due to Ernst Mach's works: there has appeared a stream of works referring directly or indirectly to the Machian conceptualization of nature. This conceptualization remains in interesting connection with problems of closing of cause–result in nature.

1.5. Mach's Conceptualization of the Universe. From the Self-consistent Universe to Einstein's Field Equations

Mach claimed that 'locality' ought to be considered in physics as related to large scale, 'globality'. Philosophical analyses performed by Mach inspired Einstein, who was so much convinced of the rightness of Mach's views that he was willing to modify his original field equations, if this had complied with the conditions (postulates) imposed on Machian theories. In fact, such a case took place in relativity. This somewhat dramatic step of Einstein can be easily justified (and it is usually done so) by his philosophical views which he borrowed at least partly from Spinoza. There is no doubt that this opinion was expressed by the scientists of such a calibre as Mach or Einstein, and also today many scientists include Machian theory to the heuristics of science on the Universe, fields, matter, time and space.

2. The Meaning and Role of Wholeness in my Work

> 'In the standard cosmology it is assumed that the large-scale structure of the Universe appears to be extremely smooth. It means that the homogeneous matter is distributed isotropically over all the space volume. This assumption called the cosmological principle plays the role of initial condition for the solutions of general relativity equations which give then the uniform expansion of the radius of the Universe (the global scale factor). Such an initial condition enables to obtain very simple solutions but completely ignores the real grainlike structure of cosmic matter.'
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> (T. GRABIŃSKA, 'The Hierarchical Structure of the Universe', in: Cosmos — an Educational Challenge, ESA SP-253, Paris 1986)

2.1. Cosmology — The Megalevel

The proposed approach accentuates the structural properties of the Universe and it contradicts the standard cosmology. We adopt the expanding Universe although we know that the idea of globally evolutionary Universe irritated not only Einstein but also many philosophers and natural historians, e. g. working in the framework of Marxian system or 'Apeiron' dialectics. The possibility of global evolution was considered laughable by the latters who declared that the theory of expanding Universe suited an 'idealistic order'.

In a single paper it is not possible to analyse the whole of the problems connected with relationships among different levels of matter organization in the Universe. However, we shall try to present the principles of non-Kantian scheme of matter evolution. 'Universe' is here understood as a certain wholeness of specific type, elements of which have not got their own prehistory.

2.2. Cosmogony — The Macrolevel

Our notion of wholeness components of which have not got their own prehistory is fundamental here. Thus, the Universe, a prototype of such a wholeness is a measure of evolution and origin of stars, clusters of stars, galaxies, quasars, etc. We propose the similarities between two modes of matter existence — the cosmological and astronomical modes. The origin of stars implies that we must adopt the origin of the Universe, i. e. the

evolution on the global scale. It contradicts the idea of general balance proposed by Marxian and 'Apeiron' dialecticians.

We put forward as a suggestion that the notion of wholeness, understood in this way, is adequate to the cosmogonic question aiming at the explanation of the origin of galaxies and objects which do not belong to the physical levels of 'micro' or 'mega' but to the 'macro' level. The explanation of problems as a whole requires more extensive study referring also to the vast scientific production of perfecting the Kantian matter evolution scheme.

In the standard picture the Universe is smooth, it takes no notice of gains (astrophysical objects). Stars and galaxies appear as auxiliary objects, they do not exist on the level of the cosmological principle. The cosmological principle in standard cosmology points out the homogeneous 'matter', i. e. matter devoid of grains.

3. Galaxy Origin and Cosmology

3.1. The Kantian Mode of Galaxy Origin

By cosmogonic schemes of Kantian type are meant those modes of explanation of galaxy origin and formation of structural levels of matter (called here 'macro') which take rarefied matter, generally not occurring in the superdense state, as their initial state: in the cosmogonic schemes of this type, bodies already having their own prehistory enter certain mutual relationships. Although the work of I. Kant dealt with the cosmogony of planetary system but due to its generality it was esteemed by the modern science: this model of matter evolution has been accepted as obligatory in the contemporary cosmogony. Kant's general hypothesis can be verified on the basis of observational data, among others of the extra galactic astronomy (GRABIŃSKA, 1988, 1989).

3.2. The Diversity of Cosmological Models in the Light of Kantian Cosmogony

The problem of matter evolution can be analysed on the groundwork of different cosmological models; the cosmology of stationary state in the classical form with its specific creation of individual atoms favours the Kantian scheme of galaxy system origin, while the model of the Universe evolving from the superdense states suggests that the formation of galaxy

and star systems can be described conversely to the Kantian scheme, and at the same time the hydrogen atoms and diffuse matter can be formed (not created ex nihilo) in the subsequent evolutional stages of initial 'embryos'. We believe that this non-Kantian point of view also seems to be interesting and noteworthy.

We have used the world 'conversely'. It means that the elements of an astronomical object have not their own prehistory, so an individual astrophysical body (star, galaxy, galaxy cluster) appears as a realisation of the model of wholeness known from cosmology (fitting the Universe), not from astronomy. 'Embryos' can be called akantons — notion which is empty in Kantian cosmogony.

4. The Bootstrap of a Local and the Global

4.1. The Nature of Akantons

Besides the holistic thesis expressing that the Universe evolution takes place similarly to the evolution of stellar systems (galaxies) it is possible, on the basis of modern astronomy, to maintain the thesis that embryos (akantons), pre-stellar and pre-galactic bodies could be of cosmological origin; this trend of investigations is not inconsistent, despite the conventional opinion, with the modern extra galactic astronomy and empirical data. With the heuristics formulated in this way, in the non-Kantian research programme systems of stars and galaxies which are observed nowadays, would constitute, to some extent, a prototype of the properties of discussed akantons.

To avoid confusions, let us note that such a claim is not explicitly formulated in astronomy, i. e. it is not a claim taken from astronomical textbooks. In modern astronomy, matter is exchangeable as money, thus no akantons are required.

4.2. The Hegel's Idea. From Developed Astronomical Object to Akantons

Our method entirely accepts all the collected empirical material and does not contradict the existing evidence. This method is intimate, as we suppose, with the Hegel's idea on organisms, expressed as follows: ' ... it (developed organism) constitutes thus the standard and prototype for less

developed organisms; since everything in it attained its final form ... from it is possible to start acquainting something what is undeveloped'.

The developed galaxy systems such as extensive halo system, spiral arms, disk, population II, etc. are enough for recognition that new evolutionary scheme is possible. There is no hiatus between developed and undeveloped, developed stars and early stages of star evolution (akanton).

4.3. From Astronomy to the Philogenetic Evolution of Matter Totality

Thus, the detailed and thorough analysis of astronomical data would, according to the above principle, provide a clue to the cosmological question whether the Universe existed in the superdense state in the past; on the basis of the observations of 'mature' (developed) astronomical objects, it is possible to formulate the general outline of superdense embryos. Thorough of analysing the phenomena from the ontogenesis sphere would provide, in this way, the method for understanding the problems touching on a phylogenetic sphere of evolution (phylogenesis).

We wish to make two comments. Firstly, genuineness of the reverse relation is also permitted in this method, this approach. Secondly, it should be clearly mentioned here that we do not want by any means to demonstrate that Hegel is an authority in the methodology of astronomy, natural history and empirical science. Yet, this statement does not confine us in the presentation of non-Kantian matter evolution scheme.

4.4. The Cosmic Workshop of Destiny

We search whether in modern science it is possible to formulate the hypothesis of galactic structure origination from the galaxy embryos or pregalaxies called here akantons, the evolution of which would imitate to some extent the evolution of the Universe.

4.5. Ontogenesis and Phylogenesis

The star is a process. It contains an exchangeable part and an unexchangeable part. The last one imitates the Universe. The notion of akanton, i.e. pregalaxy or embryo-stage of galaxy is understood as superactive, superenergetic, superdense 'cell', kind of superpotency, a sort of superheavy elementary part, superdense fireball which would exist from the very beginning. Whereas phylogenesis can be understood as process to which all possible imaginable population of galaxy world (and also their respective

embryos) constituting the Universe is subjected. It can also be presumed that Universe evolution is most likely the necessary condition of formation of galaxy aggregates. The formation of galactic structure in these or those times and places can be treated as equivalent to the categories of processes taking place in ontogenesis. Accepting the non-Kantian scheme of matter evolution, one can find similarities between evolution in ontogenesis, defined in this way, and evolution in phylogenesis; between the evolution of the Universe and the evolution of the star system, galaxy, group (aggregate or cluster) of galaxies. This approach can be regarded as intimate to the recapitulation law, formulated by a German philosopher ERNST HAECKEL (1905), according to which the principal properties of phylogenesis are duplicated in the ontogenetic evolution.

We do not ask about the origin of the akantons, i. e. a superactive cell. It is a matter of cosmology, of the whole Universe, not of astronomy. In the modern cosmology we do not ask about the origin of Big Bang, singularity. They are from the very beginning, it is an essence of the Big Bang. We do not ask about the origin of expansion energy in modern cosmology.

4.6. Genotype in Biogenetic Scheme

In the anti-Kantian cosmogonic scheme of biogenetic (Haeckelian) type, the notion of genotype can be defined. Each embryo would transport mass m which in the simplest way can be expressed in the category of energy E ($E = mc^2$). This energy could be organized in various ways. If the manner of matter organization in the succeeding embryos — irrespective of the generation — is preserved, it can be said that the genotype of all the embryos (yet, which differ in mass) is the same. If any of the embryos, belonging to this multigeneration chain had different structure and his energy has been 'organized' in different way than of the 'mother embryo', then we would not be able to speak about the genotype consistence in all the generation originated by undoubtedly spontaneous fragmentation of embryos. Thus, we can say about the transfer of the basic organizational structure of the conveyed mass in the subsequent generations; possibly embryos would be of the same spatial dimensions, of the same inner temperature, etc. So the organization scheme of superdense matter of mass E/c^2 would be decisive for the 'genotype'.

Genotype, understood in biological sense, which is transferred from one generation to the other, can be changed by mutations. In the embryos in hand some changes could be caused by the possible dependence of fundamental constants, models (patterns) and standards upon the time-spatial co-ordinates. The law of universal gravity as well as the quantity

of Planck's constant can be different depending on the linear scale of the tested region, concentration of mass and fields, etc.

4.7. Phenotype — Macroscopic Manifestation of the Beginning Astro-object-gennic Cell

In the non-Kantian scheme of matter evolution, the development of embryos would be realized and finally this process would lead to the origin of phenotype. Astronomers distinguish its properties in the form of phenomena called systems of stellar and extra galactic matter. Phenotype understood as macroscopic manifestation of the superdense 'cell' would consist of the series of these cells, having, yet, different masses and spins; each of these lighter cells would be a mini-copy of the first and extremely dense cell.

4.8. The Astro-gennic Activity of the Akantons

The notion of 'cosmogonic activity' can be introduced into the research programme of non-Kantian scheme of the cosmic matter evolution. Thus, it is understood that embryos are able to create systems of galaxies, stars, rarefied matter 'seas' of neutrinos, photons, gravitons, and other light elementary particles (often round its geometric centre). Displacement of the lighter elementary particles from the superdense area to the peripheral regions being apart — as in the case of the 'cell' discovered by the Estonian School — several tens of mega light years would have to lead to the displacement of luminous matter and 'seas' of heavier neutrinos and other particles. The redistribution of the mass comparable with the mass of released light particles should lead to transformation of the relatively denser regions (distributed according to random or island-like pattern) into the regions of unusual topology: 'empty' spaces surrounded by more or less regular layer of luminous matter.

4.9. The Problem of Cosmological Expansion — Local and Global Expansion

In the non-Kantian scheme of matter evolution the observed structures of stars and diffuse matter can be treated completely in different way if compared to the Kantian evolution of matter, namely as the manifestation of (pre-matter) embryo disintegration. It is possible to link these processes with the question of unexplained sources of energy which can be found

in phylogenetic evolution. Explanation of energy sources of cosmological expansion is raised in modern monographs. The proposed biogenetic approach is just that raises the possibility of explaining the Universe evolution by studying phenomena being at the border of different sciences of 'space science' type — astrophysics, stellar astronomy, etc.

In this work ontogenesis would be a repetition in the shortened form of the phylogenetic evolution. As we said, phylogenetic evolution is understood here as the process to which all the set of galaxies, galaxy aggregate embryos, diffuse matter (gaseous and dust matter) and seas of light particles (shortly the matter of the Universe) are subjected. New embryos of stars, stellar aggregates (e. g. associations), galaxies etc., could originate in the course of this phylogenetic evolution. Their evolution from the embryo, for instance, to stellar aggregate would repeat the evolutional stages known in cosmology (not cosmogony). The conception of 'pre-atom' was introduced at first just in cosmology; the evolution of fireball type was 'demonstrated' most credibly in cosmology, although the model of the Universe discussed here departs a lot from the so-called standard model. It would seem at once that the formation process of stars aggregates and Universe evolution have little in common. However, it need not be so, even though the scale of energy is in both cases incomparable.

4.10. The Cosmological Substratum or the Universe with the Granularity. Changeability and Heredity in the Universe

Thus, the cosmic matter evolution can be expressed in the categories of changeability and heredity. The inheriting would condition, among others, the ability to form the macroscopic formations from the akantons (prematter, astro-gennic cell) by means of the division. Thus, we postulate qualitative (catastrophic) transformations analogous to the phase transitions which are able to form systems of stellar matter and galaxies out of themselves. During the Universe expansion the property of matter granularity would be inherited. This basic atomistic property of matter bothered many cosmologists (e. g. Bondi), especially in the treatment of cosmological matter in the categories of so-called 'substratum'. This model completely ignores the atomistic property of matter; matter would be practically scattered, deprived of its atomistic properties. Cosmologists verbally acknowledge the atomistic property of matter while granular property of matter is rather employed in cosmogony.

5. Concluding Remarks

The Kantian scheme of matter evolution can be hardly overestimated; the basic ideas of this scheme found their expression in definite theories e. g. of Weizsaecker at the time of the II World War, Schmidt (1944), Kuiper (1949), Urey, Alfven, Hoyle and many other physicists and astronomers working in the last decades of our century. At the beginning of the 19th century, Wilczynski[1] investigated the Kantian scheme of matter evolution as regards problems connected with the galactic spiral arms. Today his works are though to be classical. They were the basis for the theories of Weizsaecker and Heisenberg[2]. In the course of years, Kant's cosmogonic scheme not only became naturalized in the problems of Solar System origin but also was raised to standing of canon, obligatory 'style' of interpretation of empirical data. It was done mainly by astronomers as they were competent to verify this hypothesis. Presenting the views on the similarities between Universe evolution and the formation of the systems of galaxies and stars, we must be of utterly different opinion on the matter evolution scheme than the view put forward by Kant.

In this approach matter granularity is promoted to the basic groundwork of cosmological evolution and cosmogonic processes, it allows to throw a platform between the cosmological evolution and the evolution in a smaller scale — the scale of galaxy systems, very galaxies, galaxy clusters, star clusters and stars — even the lightest ones (of the mass not exceeding $1\,M_{\odot}$ — the mass of the Sun). In the cosmological concept suggested by Marxism and Einstein's pantheism there is no possibility of formulating the thesis about the phylogenetic evolution repeated on the level of the individual evolution — on the level which is comparatively simpler and which is marked by the 'lowest' star. Although the 'lowest' stars are imitation of reality (the Universe), I do not claim that the 'lowest' plane of existence mode is removed — for example, by two grades (RIPINSKY-NAXON, 1993) — from the ideal pattern (essential nature of things). Wojtyla's 'Workshop of Destiny' gives us no appropriate key to solve this question.

[1] In the last decade of the 19th century E. Z. Wilczynski studied the questions connected with the rotation of galaxies and galactic spiral arms, Cf. *Astrophysical Journal*, Vol. 4, 1896, p. 97, Vol. 20, 1899, p. 67. Later on these questions were developed the others, e. g. by C. F. Weizsaecker and W.Heisenberg.

[2] At the time of this highest scientific ability, during the II World War, they aimed at different goals ('To remove reckless resolutions, quoting a character 'In the depths of wrath' from Wojtyla's drama 'The Brother of Our God') — they did not publish any more works dealing with cosmogony.

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