Publ. Astron. Obs. Belgrade No. 85 (2008), 51 - 61 *Contributed paper*

COSMOLOGY AND ONTOLOGY

PETAR V. GRUJIĆ
Institute of Physics, Zemun, Serbia
E–mail: grujic@phy.bg.ac.yu

Abstract. Cosmos poses unique problems to its investigations, both from the epistemological and ontological aspects. We analyze modern cosmology as science of the totality of the material reality, with emphasis on the physical content of the principal entities involved in describing the Universe as we perceive. In particular we examine the concept of creation and anihilation and argue that these notions, if relevant, are devoid of meaningful content. If applicable, the notion of evolution refers to transition from physical field entities towards inert matter components. We discuss the meaning of the existentional quantificator and show that the cosmology is essentially a historical science. Finally, we consider an interplay between the epistemological and phenomenological aspects, arguing that in cosmology it is the former one may rely on.

1. INTRODUCTION

The question of physical cosmological ontology transcends (or should transcend) any particular cosmological paradigm. The latter assumption, however, will turn out very difficult to fulfill as we shall see later on.

Further, it has often been argued that any methodology may be reduced to two principal categories: tautology and analogy. In the case of cosmology the latter approach becomes senseless and one is left with the absolute entities. Cosmology, thus, appears to fall within Newtonian paradigm, rather than Leibnizian relativistic one.

We have no Archimedes' point to stand on and much one states about Universe has a hypothetic value, or may be taken as a postulate at best. The first consequence of this unique ontological situation is that almost everything one considers about Universe must be done *ab initio*. This brings forth a number of consequences which one must bear in mind when dealing with the concept of the ultimate reality in the cosmological sense.

One is that many statements about the universe can not be falsified and thus are not scientific assertions in Popperian sense. What makes cosmology proper as something of the kind "take or leave it". It is this status of the modern cosmology which enables the enormous proliferation of cosmological models we witness today Grujic (2007).

2. NOTHINGNESS

Common mind can not fathom the term ”nothing”, that is it is unable to attach a proper ”notion” to the term. It was this aporetic aspect of nothingness which prevented Greeks from inventing zero, as a sign for nothing. The closest that Hellens came to nothingness was te notion of êåíïí, the void deprived of air, the next thin substance. In the absence of the notion of universal (Newtonian) gravitational force, kenon would correspond to our concept of empty space. In the Abderian atomistic hypotesis kenon was filled with materil corpuscules, atoms, which moved freely in the void. It is interesting to note here that it was India who invented zero as an aritmetic figure, denoting nothingness. Buddhistic concept of *nirvana* surely played a role in recognizing nothingness as a part of reality. Moreover, since nirvana was supposed to be the ultimate resort of the physical reality, this kind of the universal attractor, as we might call it according to modern parlance, was the seat of the total material reality. Hence, nothing appears equivalent to everything, confirming the old French dictum that *les extremes se touchent.*

But can nothing be part of the physical reality? It depends, of course, on the definition, or better the prescription how we determine an existence of an entity. What, in its turn, implies a choice of a presumably fundamental physical theory one makes use of. At present we possess two of these - Quantum mechanics (QM) and Generalt (theory of) relativity (GR). We start with QM.

According to this theoretical paradigm, all entities are divided into two categories: *observables* and the rest. To each of the former there exists a Hermitian (self-adjoint) operator, whose eigenvalues are real numbers and are thus measurable quantities. Nothing has no its (Hermitian) operator and thus can not be recognized as a part of reality. This seems clear enough, but things are not that simple in reality. Time has its Hermitian operator neither, but can we dismiss it as nonexistant? In the mathematical formalism of (nonrelativistic) QM time appears just as a parameter. This exclusive position of time is reflected further in the very nature of this quantity, which appears as elusive as nothingness. Hence, relying solely on the QM formalism does not seem to provide a definite answer as for the nature of nothing.

The central construct of any cosmology is the concept of evolution. Whatever the cosmological paradigm accepted, universe evolves from simpler to more complex form. Thus, rewinding the cosmological time one ultimately arrives at the single entity, whatever its nature may be. In Greek antiquity this entity was called áñ÷Ý. But what was the nature of ”pre-entity”? More precisely, are we to understand it in ontological or epistemological (logical) terms? If we adopt any of the alternatives, are we not betraying the very problem we try to solve? If we ask for the most fundamental entity, it should not be split into other ones, otherwise it is not the ultimate thing we are looking for. Hence, true *arhe* must be of both kinds, ontological and logical.

The above digression is intended to help us to consider the proper meaning of the most ancient of European cosmologies, those of archaic Greece. As we mentioned above, Greek mind abhorred the notion of nothingness.[1] It is our task, therefore, to searching the archaic pre-Socratic (philosophical) cosmology the nearest construct to

[1]It was for this reason that Aristotle rejected Abderian concept of void, as empty space.

our modern concept of "nothing". In the so-called Orphic Theology (see, e.g. Kirk et al. (1995)), we find the following "scheme"

$$\mathrm{X}\acute{\alpha}o\varsigma \quad \leftarrow \quad \mathrm{X}\rho\acute{o}\nu o\varsigma \quad \rightarrow \quad \mathrm{A}i\theta\acute{\eta}\rho$$

Now, we have to interpret the possible meaning of the terms involved. But first of all, one has to choose the nature of the very scheme, locating the latter either in the ontological or epistemological (logical) space. Prima facie it belongs to both, what is tantamount to none. It appears both the logical order and temporal sequence of evolution. Time is supposed to be prerequisite to the ontological changes, but at the same time it appears present as such, without any further determination. It is *arhe* in absolute terms, the *first principle*. At first sight this solution of the "absolute beginning" is opposite from that accepted by St. Augustine, who argued for a dependent existence of time, that is no time before the Creation. Orphic solution was more in the Newtonian spirit, whereas St Augustine's points to the Einsteinian cosmology. In view of Kant's solution, however, both choices turn out superflues, if one accepts the time as an inner sense of mind. But it is the second layer of entities in the above scheme we are mostly interested in here.

The notion of aether is (and presumably was for Greeks too) a vague concept, as something maximally thin and subtle, structureless and fluid (that is shapeless in space and time). The modern, pre-relativistic concept of aether, as conceived in the 19^{th} century electrodynamics is first what comes to our mind, but it is always risky to read modern concepts in the ancient minds. We may, never-the-less conceive it as the entity the closest to "nothing" in an ontological sense. We shall postpone discussion about the relationship between Aether and of Chaos to later chapters, but here we just note that these notions appear to be treated on equal footing here. In Hesiodic *Theogony* Chaos is true *arhe*, which first of all came into being. Much discussion has been devoted as to the real meaning of the term. Aristotle took it for *place*, whereas Stoics followed Zeno of Citium in interpreting Haos as liquid, i.e. water. One of the first interpretation in modern terms as disorder can be found in Lucian's A*meres 32*, where it was taken for shapeless matter.

Etymologically, this noun is derived from v ÷á, - gape, gap, and yawn. If we interpret these terms as synonyms for *abyss*, chaos would be understood as emptiness, and thus as nothing. According to some secondary sources, first of all literary ones, chaos was understood occasionally as the gap between primordial sky and earth. If this sense is accepted, then it would run directly against our modern usage, as disorder. For separating primordial matter into two distinct entities introduces order into the world.

Before we pass to GR we note that there is within QM a formalism, instead of Schrödinger's, which deals with creation and annihilation operators. But here these operators deals with specific entities, like particles, and annihilation of one particular kind automatically generates another sort of particle.[2] Thus, it concerns transformations, rather than creation (annihilation) in an absolute sense.

As for the GR, situation is as much different as vague as well. Einstein conceived his Universe as a selfcontained entity, where matter, space and time are intrinsically

[2] This formalism is called second quantization.

linked to each other, that it makes no sense to consider either of them separately. His cosmos was not imbeded into "empty space", that is into "nothing", for there is no way to define the latter without presence of matter. By empty space we have to take really emptiness, deprived not only of matter, but any physical field, even the universal gravity.[3] Hence, there is no "nothingness" around, for there is no "around". Nothingness appears tightly bound to something and is thus deprived of the existence on its own.

3. FROM CHAOS TO COSMOS

If "unknown" is not "nothing", it must possess some atributes, otherwise we can not speak of its existence. This requirement makes the notion "unknown" dubious at least. Obviously, it can have a relative meaning only, for the totally unknown is tantamount to nonexisting. We pass, then, from "totally unknown" to a milder notion of "maximally unknown". This passage means going from proper physics (öéóéò) to mathematical physics, more precisely to the *information theory.* In doing this, we come to the central construct of order/disorder contrepunct, the notion of *chaos.*

The prototype of chaos is a gas, which is in fact an eponym of the former. It came into usage of physics in 17th century, du to Flamish J. B. van Helmont (1577-1644).[4] Chaos appears disguised under many terms in modern science, physics in particular, like disorder, randomness, nonlinear dynamics, white noise, unpredictability etc, just as it had numereous meanings in ancient times. Here it is interesting to note that it is mathematics which decides what *random* is, but only nature (physical processes) is able to generate randomness. The best example is the generation of "random numbers" on the computer, which, in fact, are not random and are therefore designated as "quasirandom". Only microphysical processes, like the radioactive decay, may be regarded as random, what in this case is tantamount to saying it is unpredictable. It is for this reson that QM is considered the paradigm of nondeterministic theory.

4. MODERN COSMOLOGIES

As noted before various contemporary cosmological paradigms are based on different basic concepts and many of them have no meaning in alternative models. Before entering discusion on the role of creation as a concept in various cosmoogical paradigms and models, we first classify these models according to some underlying principles. These principles appear, in fact, postulates and thus acquire similar role to the above mentioned philosophical and theologicl constructs.

We divide all modern cosmologies into two broad classes: (i) static and (ii) dynamic models. They are defined according to the mathematical attributes, so-called *cosmological principles* (see, e.g. Peebles (1993).

(i) The simplest, and thus most general, is the so-called *perfect cosmological principle.* This states that our Universe is homogeneous in space and time. The first

[3]The stress here is on the "universal", for Newtonian universal attraction may be supplemented by repulsive force, as it has been argued by some modern cosmologists.

[4]Who used Flemish phonetic equivalent "g" for Greek "?".

asserts that the cosmic matter is (quasi) uniformly distributed in space. The latter asumes that the structure of the universe remains the same as the (global) cosmic time evolves (time homogeneity). (We shall discuss this paradigm in some details later on). The first truly scientific cosmic model due to Einstein belongs to this static picture of our Universe, as well as the original variant of the Steady-state cosmology, due to Bondi, Herman and Hoyle (Peebles 1993).

(ii) If the static attribut is lifted, we have a dynamic, homogeneous universe. To this model belongs the so-called Friedman-Lemettre model, which was the forunner of the modern Big Bang model, which lies at the core of the Standard cosmological paradigm. But besides these two paradigms lie two "eclectic" models, which mix the features of both principal classes.

(iii) The modified Steady-state model, (see, e.g. Narlikar 1977), which took into account the observational fact that the universe undergoes the global expansion, after observations of Hubble in 1929. The authors of the original model had to abandon either the homogeneity assumption, or to abandon the model altogether. Both alternatives were all but satisfying and the authors chose to save the phenomenon and allow the Universe to expand and at the same time to remain with the constant density of matter. We will discuss this model in the following.

(iv) Inhomogeneous Cosmos. Unlike the standard assumption of any cosmology that universe is inhomogeneous at small and medium-size parts, but passes into homogeneous at the large cosmic size. By an essentially inhomogeneous Universe we mean inhomogeneity to persist up to arbitrary cosmic distances. One of possible realizations of such a paradigm is the so-called *hierarchical cosmos*, Grujić (2001), conceived as early as in the pre-Socratic era, by Anaxagoras (see, e.g. Kirk et al. 1995). We shall consider this model later on.

4.a Static cosmos

It is clear that by adhering to the perfect cosmological principle static models circumvent the issue of creation and external factors altogether. Moreover, the notion of cosmic (global) time loses its meaning and any global change, including the coming into existence is *a priori* ruled out. This paradigm appears the easiest to tackle, as it introduces everything *ad hoc*. We may say this paradigm is epistemologically homogeneous. The ancient principle of *isonomy* has been applied here to its fullest extent.[5] But even such a paradigm is not devoid of complexity, despite its maximum symmetry. The question arises as to the compatibility of the attribute of spatial uniformity and the presence of structure. To put it in this way: can a uniform universe be ordered in anyway, that is be a cosmos?

To save the phenomenon Einstein introduced his, now famous/infamous so-called cosmological constant Ë.[6] By doing it he spoiled the original elegance of the theory, better to say approach from the first principles. By putting Ë "by hand", Einstein introduced an obscure entity, whose nature appears still the matter of debate among

[5] Copernican principle appears a special case of this general notion, conceived by Greeks.

[6] The fact that he renounced it later is of little importance now, both from the ontological and epistemological viewpoints.

cosmologists. As for the uniformity assumption the matter appears even more problematic. The only rationale for assuming even distribution of the cosmic matter was the mathematical convenience – such a model is solvable, at least to a good approximation. Thus, epistemology overrides here ontology, prescribing to Nature what is more convenient to us technically.

4.b Dynamical models

By introducing the global cosmic dynamics, first for the sake of stabilizing the system, and then to account the observational evidence of the overall expansion (Hubble flow), the stability problem has not be solved, but the issue transfered to a more general formal space. Introducing kinematics and thus the global cosmic time, one passes from the pure geometry (or physical statics) to the phase-space, in which velocity dimension has been added to the spatial ones. The universe remains still unstable, but now from a global perspective. It is the force of inertia which now prevents local and global collapses of the all-gravitating matter. The Universe is now essentially unstable, but locally stable - no galaxies collide.[7] The global cosmic dynamics brings into the game another issue - that of the (physical) cosmic eshatology (Adams and Laughlin 1997, Cirkovic 2003), which we shall address later on. Within this picture the final state of ever expanding Universe will consist of the infinitely diluted collection of truly elementry particles, electrons, positrons and photons. This state thus appears the reverse of that described by Weinberg (1977) as the "initial" state within the Big Bang paradigm, which was conceived as a plasma of arbitrary high density.

5. CREATION OR TRANSFORMATION, THE QUESTION IS NOW

Big-Bang Cosmology (BBC)

[The] answer to the question why there is something rather than nothing is that nothing is unstable.
H. Georgi

When dealing with time-dependent, evolutionary models, we are faced with the choice of approach to the assumed history of the Universe. One choice would be methodological one. We trace the evolution of the cosmic system backwards in time, as the very model has been developed historically. This approach corresponds, in a sense, to the inductive method. The other choice starts from the assumed initial state and let the system evolves in (cosmic) time, up to the present. This approach resembles formally the deductive method, and surely has stronger pedagogical merits.

We shall, for the start, consider the classical BBC, as derived from Einstein General Relativity (GR). The Universe begins its life from the "primordial singularity", point-like concentration of matter (material point in term of secondary-school physics), but with the infinitely big density. This initial state plays the role of "nothing" here, for it assumes the state we have no experience of. Moreover, we can not have it, since the very attribute of "infinity" can not belong to any observable. These

[7] This statement is only partially true, but it preserves never-the-less the essential difference between the static and dynamic paradigms.

attributes appear purely mathematical constructs. In fact, it was this singularity which prompted cosmologists to abandon Friedmann's and Lemaitre's classical models and introduce the Quantum Field Theory (QFT) into the early stage of the Universe. We note, however, that although QFT appears a remarkable development of the original Quantum Mechanics, one should bear in mind that it is not a definitive Theory, like the Quantum Electrodynamics, but rather designates one particular field of research in theoretical physics.

The concept of a physical field, as a further abstraction of the ultimate physical reality, has been already present in the Faraday-Maxwell electrodynamics. But the electrodynamic field appears highly regular, with the dynamics governed by the periodic conversion of the electric into magnetic field and vice versa. It is this regularity which enabled Einstein to imagine the light as a collection of particle-like photons (as they will be dubbed later on) It is the concept of irregularity, even spontaneity, which will bring the notion of physical field closer to out ultimate goal of "creation ex nihilo", that is to the ultimate creation process. Historically, however, an interlude was made, that of cosmic inflation Linde (2002).

It is less known that the limitation of the maximum speed rests on a more fundamental constraint, that of the principle of causality. If this principle is not violated, any speed of information transfer would be allowed. If the universe is subjected to an overall expansion, no paradox concerning cause and consequence appears.[8] The inflation hypothesis has not yet been confirmed, though it has been accepted by the majority researchers as the best alternative to solve the principal problems of the Standard model. The ansatz of this supposed phase in the universe evolution was the so-called de Sitter model, proposed as early as 1917, (see, e.g. Peebles 1993), which dealt with arbitrarily thin cosmic matter (empty Universe), which underwent an exponential expansion. In the limit of zero-scaling parameter (t ? - 8) the particle horizon vanishes and all matter constituent come into causal connections. The dominant constituent during inflation is a physical (scalar) field, as the driving force of the inflationary expansion. The inflation hypothesis brings in two assumptions: (i) new physical field(s), (ii) "condensation of the field(s) at the end of inflation into "ordinary matter". It is an old wisdom that many hypotheses can prove anything and if a new model should be convincing, it should start with a single novel proposition. It is, therefore, for this reason mainly, that the whole mechanism is termed "inflation scenario". In a sense, it appears a subtle substitution for the originally proposed HBB. The "nothing" appears now in clothes of (still unknown) physical fields, which engender inert matter at the end of the inflation. We note here that the proposed inflation lasts exceedingly short, Ät $\sim 10^{-31}$ s,[9] so that one may speak of an "instantaneous creation" of the present-day Universe. Since after the inflation the Universe has been undergoing further evolution, much slower , of course, by the present-day universe we mean the typical observed Cosmos. The central idea behind the inflatory scenario appears the construct of the metastable physical field (whose exact nature is still the matter of conjectures), which has been dubbed the false vacuum. Vacuum should invoke our feeling of the evacuated air, something close to our notion of empty

[8] As for the opposite direction, contraction, this "alibi" does not help.

[9] By which time the universe expands by the factor 10^{30}.

space, whereas the attribute false is contrived as to enable a spontaneous bringing about inert matter, as we experience it now.

The assumption of the instability of the primordial physical field is essential, for it eliminates the need for an external agent, like a divinity. Or, better to say, it moves that agent further from the ordinary image of the unique Universe, as an idea of the totality of reality. The metastable states are supposed to be unstable, in the sense that a slightest perturbation would destroy it and the "system" collapses into something radically different. The origin of these perturbations is left undetermined. The tacit assumption behind such an approach is that the very "meager strength" of the perturbation, which causes colossal consequences, never-the-less, will pass the appearance of an extraneous agent (almost) unnoticed [10] Hence, we have a false vacuum, which collapses into a set of inert particles and other physical fields, like the electromagnetic one, "spontaneously'. As the theoretical physicist H. Georgi put it, nothingness is simply unstable.

This response to the Leibnitzian question of the logical preference of nothing to anything, could be regarded as an atheistic reaction to the "logical proof" of the existence of Demiurg, like God in the biblical tradition. As elaborated at lengths by Grünbaum (2000) nothing prefers anything, neither from the logical nor ontological viewpoints. In fact, the very question which Leibniz posed was illegitimate one, for it tacitly assumed there was a third possibility, a state between existence and nonexistence. What amounts to the observation that there can be no Archimedian point for this primordial dichotomy. The existence is a brute fact, nonexistence a brute idea (which has support neither in epistemology nor in ontology).

The inflatory scenario was suggested in order to reconcile two apparent inconsistencies – the observed universe properties and the Standard model (Collins et al. 1989). According to the new Standard model (NSM) our Universe was created twice: once by Hot Big Bang, then by the inflation. The latter set the initial condition for further, less rapid evolution, starting with two distinct components of the material content. One was the purely chaotic electromagnetic field, whose remnants we observe today as the so-called Cosmic Background Radiation (CBR), in the thermodynamic equilibrium and present-day temperature of 2.73 K. The other component consisted of electrons, positrons, protons and neutrinos. After sufficient cooling of the Universe (including both electromagnetic and inertial components), massive particles started to form closed systems, like Hydrogen atoms. It was then that the radiation and matter decoupled and the latter became transparent for the former. From this cosmic moment we are entitled to speak of Cosmos, the ordered phase of the development of the Universe. From this time on, we have a coexistence of two distinct components of the content of our Universe: ordered set of subsystems like atoms, stars, galaxies etc and chaotic sectors of CBR and the neutrino "sea", into which everything has been imbedded. Hence, there is no pure Cosmos and no pure Chaos in the present-day universe. The former has arisen from the latter, but the latter still persists. The fact that we do not feel the existence of the chaotic components, that is not in a direct way, makes us unaware of the existence of the chaos, but the latter is present all the

[10] That is, enter through the back door.

time. But the two chaotic components appear distinct in two essential ways. While CBR interacts with "ordinary mater", albeit weakly, the neutrinos can be regarded as decoupled from the inert matter for all practical purposes. They appear a kind of the semi-existing sector, somewhat between matter and pure space. Never-the-less, these elusive "particles" may possess nonzero mass (though extremely small) and thus play a noticeable role in the structure and evolution of the Universe.

6. COSMIC REALITY

Though not aware of it in the everyday life, we live not in the three-dimensional world, but rather in an abstract four-dimensional manifold. When we say "There exists O", we mean that at a specified place and at a particular time instance, we may experience the existence of the object O. But we infer this existence from our senses, one or a few together. The most frequently and usually the most reliable way of colleting information from the outside world is by registering light signals. Since in the ordinary, earthly situations, light propagates practically infinitely fast, the time instance is usually ignored. What we see is existing now, and we use the present tense to acknowledge this observation. To the contrary, when we hear a remote blast, the event is already mater of past. Our reaction to the event must account for this time delay.

We do not hear "events" from the deep space, but watch them via electromagnetic (eventually gravitational) radiations. In order to locate the event in space-time, one must resort to a theoretical model, which helps him to account for the finite speed of light. In some situations one must even account for the deviations of the light signals due to the gravitational bending of light (gravitational lenses), etc. In all these cases theory must be applied for extracting real elements from the observed phenomena, Ribeiro (2005). But our principal concern here is the application of the existential quantificator, or simply the meaning of an assertion "There exists O". In the realm of deep cosmos there is no such an assertion, except in a metaphorical sense. Better to say, no present tense may be employed in describing cosmic events and objects. Instead of the last statement, we may state only "There existed O". Cosmology is essentially historic science, what is tantamount to saying that there is no such a science as cosmography.[11]

But the feeling of an instantaneous inference into the physical reality has been so deeply entrenched in our mental structure, that when Minkowski geometrized the (relativistic) kinematics it was accepted with a great relief. Photons coming from the deep cosmic space carry information from the remote time. The more distance of the source object is, the fewer .photons arrive into our retina and less visible the source appears. By making use of powerful telescopes, we are able to collect more photons and direct them into our eye and thus see the image of an object which existed millions of years ago.

But what does it mean for our empirical evidence of the cosmic reality? If a remote cosmic object suddenly vanishes from existence (whatever it may mean) and at the

[11] In this sense the proper language of cosmologists should be that of Hopi Indians, rather than our Indo-European paradigm.

instance we perceive it is nonexistent, our false knowledge of its actual existence would not affect anything in the practical sense. In other words, it is the image we have of the cosmos which matters, not the actual state of the universe, which may have changed meanwhile. As long as there is the ultimate upper limit of the information transmission (be it the speed of light or otherwise), there is no danger that we suffer from the lack of information about out physical surroundings. It is for this reason that the world *is* what we *see* (or sense in general sense)

7. CONCLUDING REMARKS

In the above analysis we have considered ontological aspects which various cosmological paradigms and models imply. From the whole span of these paradigms, from the everlasting, deterministic static universe to the eternally self-reproducing chaotic inflationary scenario, principal ontological questions provide different answers. Where issues of the type "coming into being" make sense we have followed the gradual transition from the standard inert matter as the representative of "something", via elusive elementary particles, like neutrinos, to the ultimate "ethereal" entities, like the fluctuating physical field, as the closest approach to what maybe denote as "nothing". But the ultimate "nothing" evades our inference, both ontologically and epistemologically, as we have argued above.

We have argued that there are two principal aspects of the issue "coming into being", ontological and epistemological. The first concerns the notion of "creation of matter", as conceived by the proponents of *creatio ex nihilo*, the second transformations of one state of the universe into another. If the later means the formation of the ordered universe, the cosmos, the issue remains in the informational plane, and thus acquires essentially epistemological character.

We have not dwelled on the important aspects of a comparison between these two aspects, in particular the issue of the creation of the substance versus formation of a structure. In both cases the questions of the external agent comes to mind. The answer to the first, ontological aspect relies on the absence of the Archimedean point, whereas the concept of self-organizing complexity is offered by the theoreticians as the response to the concept of the cosmic *Nous*, in the Anaxagoras' sense, Mugler (1956). But both solutions are still vulnerable to the requirements of self-sufficiency, or completeness in Gödelian sense. What makes the epistemological approach more fundamental than the ontological one.

Acknowledgements

This work has been supported by the Ministry of Science and Environment Protection of Serbia, under the contract No 146022.

References

Adams, F. C. and. Laughlin, G.: 1997, 'A dying universe: the long-term fate and evolution of astrophysical objects', *Reviews of Modern Physics*, **69**, pp. 337-372.

Ćirković, M. M.: 2003, 'Physical Eschatology', American *Journal of Physics*, **71**, pp. 122-133.
Collins, P. D. B., Martin, A. D. and Squires, E. J.: 1989, *Particle Physics and Cosmology*, New York, Wiley.
Grujić, P.: 2001, 'The Concept of Fractal Cosmos: I. Anaxagoras' Cosmology', *Serb. Astron. J.*, **163**, 21.
Grujic, P.: 2007, 'Some Epistemic Questions of Cosmology', *Foundations of Science*, **12**, No 1, pp. 39-83.
Grünbaum, A.: 2000, 'A New Critique of Theological Interpretations of Physical Cosmology', *British. Journal for the Philosophy of Science*, **51**, pp. 1-43.
Kirk, G., Raven, J. and Schofield, M.: 1983, *Presocratic Philosophers*, Cambridge.
Linde, A.: 2002, 'Inflationary theory *versus* Ekpyrotic/Cyclic Scenario', arXiv:hep-th/0205259 v1 26 May 2002.
Mugler, Ch.: 1956, 'Le probleme d' Anaxagore', *Rev. etud. grec.*, **69**, pp. 314-376.
Narlikar, J.: 1977, *The Structure of the Universe*, Oxford, Oxford University Press.
Peebles, P. J. E.: 1993, *Principles of Physical Cosmology*, Princeton University Press.
Ribeiro, M.: 2005, 'Cosmological Distances and Fractal Statistics of Galaxy Distribution', *Astron. Astrophys.* **429**, pp. 65-74.
Weinberg, S.: 1977, *The first three minutes*, Basic Book Comp.