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The Universe as a Construct: Epistemic Beliefs and Coherence of Justification in Modern Cosmology

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In this paper we continue to study the epistemic nature of cosmological claims, in particular the status of the notion of the universe as a whole. It is demonstrated that this notion has a status of a construct with some epistemic links with empirical reality. However, it is argued that the effective methodology of contemporary mathematical cosmology related to the modelling of the very early stages of the evolutionary universes, consists not in the principle of correspondence of its theoretical constructs with empirical reality, but in the coherence of epistemic justification which relates to belief-like commitments of the community of cosmologists. As a case study, the inflationary model of the early universe is analysed and it is demonstrated that the coherence of justification leads to the transcendental problems in the style of Kant.

Keywords: beliefs, cosmology, coherence, correspondence principle, epistemology, extrapolation, universe.

> The real world is not a thing founded in itself, that can in a significant manner be established as an independent existence. Recognition of the world as it comes from God cannot … be achieved by cognitions crystallising into separate judgements that have an independent meaning and assert definite facts. It can be gained only by symbolic construction.
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> Hermann Weyl, *Mind and Nature*, p. 50

In this paper we explicate a simple truth that the standard cosmological model entirely depends upon the belief in the uniformity of the universe thus making the whole cosmological enterprise as having sense in rubrics of a certain faith-commitment which, as we have explicated previously (Nesteruk 2012[2]), has teleological overtones related to human activity in general. The strength of our argument is to come from a particular observation that modern cosmology functions not only through the conditions of correspondence with empirical reality, but also through the principle of epistemic coherence of justification of its constructs.

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The universe in the image of the human history

Our intention now is to provide a concise and symbolic (graphical) description of the universe as a whole in order to explicate an epistemological meaning of such a description, in particular its dependence upon some irreducible beliefs making this description possible. To do this we need to give a brief overview of the major methodological presumption in cosmology, namely the cosmological principle (Nesteruk 2012[1]). Since we cannot empirically verify the statistics of distribution of matter from other locations in space we have to speculate on the overall distribution of matter in the universe, appealing to philosophical and hence physically untestable assumptions. The universe seems to be isotropic on the scales corresponding to clusters of galaxies. This local isotropy, being an empirical observation, is a contingent fact and it does not entail that the universe should look isotropic from every possible location in it. However the idea of our indifferent position in space was a prevalent trend after the scientific revolutions of the 17th century, so that modern cosmologists felt obliged to apply the observable isotropy to all locations in the universe. This principle of indifference, the cosmological principle, postulates the uniform distribution of matter in the universe and the uniformity of space[1]. It is not difficult to understand that only under this assumption is any scientific methodology of studying the universe as a whole in cosmology possible. Indeed, the uniformity of the universe is needed in order to predicate its properties in terms of the same physical laws in locations which are fundamentally inaccessible to our reach. The integrity of our intelligence must correspond to the integrity of the cosmos, and this integrity is best expressed in terms of its uniformity. The global picture of the universe would not be possible if, in every corner of it, physical laws would be different and objects and phenomena would be infinitely varied. The cosmological principle reduces the description of "cosmic matter" (with the constituting element of this matter to be a cluster of galaxies) to two macroscopic parameters – density and pressure[2]. Indeed, theory cannot deal with the variety of specific and concrete objects which are astronomically observed. The contingent facticity of these objects is transferred to the contingent facticity of the generic symmetry, that is to the uniformity of their distribution in space. However the introduction of the cosmological principle does not explain away the contingent facticity of this principle itself: as such it does not explain *why* the universe is uniform. The postulate of cosmic spatial uniformity introduces a fundamental *construct of cosmic matter* which makes it possible to talk reasonably about the universe as a whole including its spatial structure.

The "cosmological principle" changes our perception of the contingency of our spatial position in the universe. If the universe is uniform a potential observer travelling across the universe would observe statistically one and the same picture of the universe. This evidently diminishes any drama related to the spatial contingency of humanity in the universe associated with its large-scale structure: we could be anywhere and would observe the same. This means that that fragment of the universe which is visible to us, while being limited in its particular image from the vantage point, gives a fair representation of that all which is possible.

The situation is more complex in terms of that particular temporal era when we are present in the universe if the universe is subject to change (evolution). If, hypothetically, the universe as a whole were to be static, that is without any large-scale change in time, its description would be very simple and correspond to a couple of contingent numbers (its density and pressure) which characterise the large-scale structure and

dny change and becoming would amount to the evolution of specific objects, such as galaxies and stars. The novelty in the universe would emerge from the local physical processes whereas the overall large-scale universe would remain the same. On the large scale the displayed uniformity would remain and no hope for its "explanation" would exist. This is the reason why the idea of the evolution of the universe as a whole becomes so important: it gives a chance to transfer the problem of its contingent facticity as observed here and now to the problem of its origin from some unknown initial state which would exhibit, either in terms of known physical laws or some mathematical argument, apodictic features, so that the annoying question about the facticity of its display could be removed if the initial conditions leading to this display are explained.

Cosmology received this chance when the experimentally observed red shift in spectra of galaxies was interpreted as their mutual recession due to a universal kinematic expansion of the universe[3]. The link between expansion of matter and expansion of space is asserted by general relativity theory through the relationality between them. This expansion, observed through luminous objects such as galaxies, seems to be isotropic. In combination with the "cosmological principle" the observed expansion in the universe is presented as taking place uniformly in all locations in the universe. This means that our image of the expanding universe can be transferred to any other location in which the picture of expansion would be the same. In this sense there is no geometrical centre of this expansion: one can talk of the expansion of the universe about every particular point. This is a counterintuitive result which refines the cosmological principle as related not only to spatial locations, but also to how the evolution of the universe looks from these locations, namely that it looks the same. In combination with the fact that the received signals come from remote parts of the universe one can state that the past of the universe looks the same from different locations. And this leads to another counterintuitive result that the universe is seen as the frozen past[4]. The past of the universe is made manifest through its present image. Thus the distinction between the universe's past and present, which is usually made by analogy with human history (some events in the past of the human history are not definitely in the present), is problematic: one cannot understand and interpret the universe as we see it here and now without referring to its past: when one pronounces the word "universe" one affirms the totality of its temporal spans. In this sense the subject matter of cosmology, that is the universe in the entirety of its spatial and temporal spans represents the unity of all its locations and eras, unifying all differentiated happenings in the universe in a kind of *event*[5]. As we will see later this is related not only to the visible universe, but to the universe as a whole.

The cosmological principle applied to geometry predicts three possible models of the spatial structure of the universe (closed, flat and open) all of which now must be linked to the universal expansion of space corresponding observationally to the mutual recession of galaxies and their clusters. The three models of space can easily be generalised in order to accommodate this expansion through introducing a notion of the universal scale factor *a(t)* as a growing function of "cosmic time" which stretches the spatial metric corresponding to all three models. There are two points that must be noted about this new cosmological *construct*, first of all "cosmic time". This notion is a construction obtained through imagination that one can place clocks everywhere in the universe, for example in all galaxies so that they move along their world lines together with the overall kinematic expansion, and somehow synchronised at its

beginning understood here simply as a reversal of expansion to its initial point. After introducing the construct of time it becomes possible to describe the overall geometrical becoming in the universe, its evolution in terms of the scale factor $a(t)$ as a function of time t. The dynamics of this scale factor as well as the dynamics of cosmic perfect fluid is subjected to Einstein's equations. These are differential equations with respect to time t reversible in time, that is they can be used either to predict the solution in the "future" given the conditions posed now, or, alternatively to formulate the solution in the "past"[6]. In this sense they just describe the reversible transition of the universe from one state to another: they do not describe the real becoming as emergence of novelty in the universe. Then this implies that the contingent empirical values of the cosmological functions, for example $a(t_0)$ at present time t_0 do not stop being contingent if the cosmological expansion were to be reversed backward in time: their values are just recalculated through the solutions of the Einstein equations at the initial conditions. It is in this sense that one must be aware that the cosmological expansion cannot be associated with the arrow of time which is observed empirically[7], so that it seems to be that the "t" variable of the cosmic time has little to do with the time of human experience which is intrinsically irreversible. The dynamics of the universe at large scales is reversible and thus does not account for the second law of thermodynamics which, as it is believed is linked to the special initial conditions[8]. From a philosophical point of view the geometrical model of the evolving universe provides simply a description of certain changes which happened at large scales, but real becoming as creation and transformation of new forms of matter at smaller scales requires for their description an appeal to physics which has a rather "local", earthly origin.

The solving of the Einstein equations for $a(t)$ requires one to start with a particular equation of state for matter. If the point of departure is the present universe in which free propagation of light takes place, its matter content can be treated as "dust" with no pressure. In this case the density of matter decreases as the universe expands in inverse proportion to the so called commoving volume which grows in time as $a^3(t)$, so that $\rho(t) \sim a^{-3}(t)$. If time is reversed, so that the expansion becomes contraction, $a(t)$ decreases and, as result, the density of matter grows. Theory predicts that it grows to such an extent that the evolution of the universe divides roughly into two completely different stages: the present stage where matter is decoupled from radiation; and the early stage when the spatial size of the universe was less than a thousand times than it is at present, and the universe was opaque. Before the transition to the dust-dominated era, according to theory, the universe represented a mixture of radiation and hot matter.

From the very inception of this non-stationary model it was a great temptation among cosmologists to extrapolate the contraction of the universe in the reversed time order to a limit, when the spatial size of the universe tends to zero. This mathematical limit represented a problem of interpretation, since all physical parameters such as density, pressure, curvature etc. acquired non-physical infinite values. The limit $t=0$ together with $a(t)=0$ was treated as the temporal beginning of the visible universe. The construct of this beginning seems to be contentious because one can hardly understand whether t=0 indicates the beginning of the visible universe only (and all other potentially physical universes admitted by the cosmological principle), or the beginning of the overall spatial structure if it is taken as pre-existent (similar to the Newtonian absolute space).

As we mentioned above, the way of proceeding to the construct of the beginning of the universe, or, in different words, cosmological singularity, is based on extrapolation of the visible display of the astronomical universe backward in time. In this case all contingent facticity of the present-day visible universe at large scales is transferred to the cosmological singularity which becomes the initial condition for cosmological equations and which exhibits some idiosyncratic properties because of the infinite values of all physical parameters in it. It was understood long before that cosmological singularities represent strange "initial conditions" of the universe, whose facticity can hardly to be explained within available physics. It was admitted that classical physics collapses at the singularity[9] and since no credible quantum description of the initial state of the universe exists so far, we deal here with a problem which exceeds the scope of physics and tests its limits. For example, it is difficult to understand what the beginning of the universe could mean in terms of space and time. Did time or space exist before the expansion started; in other words: did the expansion begin in pre-existing space and time, or were space and time brought into existence at the origin and thus their actual presence explicates the act of their beginning. It is possible to use a simple diagram to illustrate the problems arising with the interpretation of the origin of space and time of the universe[10].

This diagram attempts to express the unity of space and time as being generated from their non-originary origination "event" depicted by a point at the centre of the diagram. The diagram consists of series of expanding concentric circles which aim to represent spatial sections of space-time. The circles expand from the initial zero point which symbolizes the origin of the universe. The radii correspond to the world lines of particular objects (clusters of galaxies, for example) which originate at the singularity (corresponding to zero linear scale) and diverge in all directions. It is along these lines that time, associated with imaginable clocks of all galaxies experiencing the overall kinematic expansion is measured (this time is somehow synchronised at the zero point, that is the beginning.) The fact that the spatial sections (that is, concentric circles) in this diagram are compact must not be interpreted as if we deal with a topologically closed universe. If these imaginable circles are associated with some structural units of the universe (galaxies or their clusters), their expansion reflects only the process of the mutual recession of galaxies. The major conceptual difficulty with the interpretation of this diagram is to conceive the meaning of the point of origin of the world lines. One must not treat this diagram as if it depicts the actual process of expansion in pre-existent space or time. Actually this origin is not *in* space and in time, so that its depiction as a point in the plane of the page is a metaphor. However, the diagram as a whole can be treated as representing the global structure of space and time in the natural attitude, that is as if they existed objectively and independently of the human observer who appeared in the universe at its late stage. The distinction between past, present and future has a purely symbolic nature (associated with the radius of a circle,

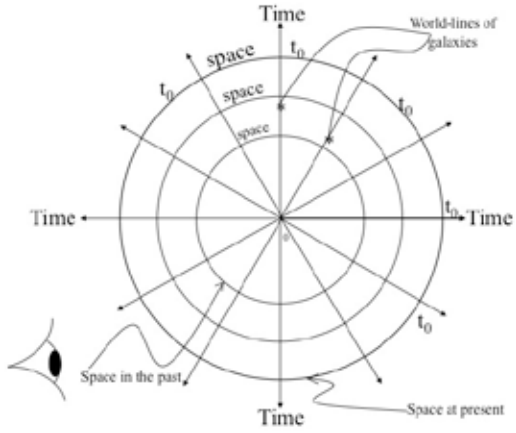

Fig. 1

or progression of the world line) as divisions in abstract objective time.

It is worth noticing that the enquiring intellect is implicitly present in this picture: this picture is a mental creation, that is its content is the product of human subjectivity which is present in all articulations of the universe; it places the diagram with singularity which is supposed to initiate all being, including this same incarnate subjectivity, outside itself. This is the reason why this subjectivity experiences difficulties with explicating the sense of the cosmological singularity: it is impossible to explicate within the natural attitude that which is supposed to be in the foundation of everything with which this subjectivity deals, including the facticity of subjectivity itself. When the enquiring intellect draws such a diagram it positions itself outside the universe as if it could look at it from some vantage point. However, this mental operation is possible only in abstraction, because one cannot get out of this universe, which would be tantamount to breaking the conditions of consubstantiality with it. To get out from the universe would also be tantamount to breaking the conditions of the embodied consciousness in order to "look" at its origin from outside its own incarnate facticity which is impossible to the same extent as it is impossible to transcend the universe (Cf. Marcel 1965, p. 24).

The construct of the initial singularity brings into play a certain correction in perception of causality in the universe and of temporality. Logically, the ideas of the initial singularity appeared as the result of theoretical reversal back in time of the presently observed expansion of the astronomical cosmos. This reversal corresponds to the reversal in the solutions of cosmological equations which are extrapolated to their nexus at the point with time equal zero. The thus obtained state represents the initial state of the universe in the past. However, since the Einstein equations are time-reversible they transfer (according to efficient causality) the information encoded in the present state of the universe backward in time. In this sense, technically, the state of the universe at the singularity (related to its large-scale structure) is isomorphic to the state of the universe at present, that is, to what is observed here and now, in spite of the fact that the numerical values of some cosmological parameters become unbounded at the singularity. One can say that the distinction between present and past is a matter of common-sense convention, for, as we have mentioned above, the cosmological expansion does not account for the growth of entropy, that is for irreversibility of time.

If the cosmological singularity is only considered as a construct which outlines the limits of physics in exploring the nature of facticity of things, then cosmology does not run into a problem of justifying the physical status of this singularity. Singularity, in this view, becomes no more than a parable of the mystery of the facticity of the universe whose appearance in cosmology is inevitable, simply because the efficacious *telos* of cosmological research requires one to introduce a notion of the overall unity of the universe whose role is played by the singularity. However, if the singularity is considered as the point of initiation of all contingent display in the universe in a physical sense (as a *nexus finalis* in the reversed temporal order), so that the distinction between the singularity and the present state of the universe is associated with the asymmetry between past and future in existential, irreversible time, there arises a problem because the singularity is fundamentally non-observable (apart from its remote consequences in the present), so that any claim for the viability and truth of its concept must follow a different pattern of justification in comparison with that for experimental science. This can be simply understood if one realises that, by placing the singularity in the past as the

foundation of the explanation of the present and assuming temporal causality between past and present, one exercises an act of belief in which a characteristic transition from an intelligible entity (construct of singularity) to the empirically real (present day universe) takes place. This kind of transition does not follow the pattern of explanation based on the principle of correspondence because there is no independent empirical verification of the idea of the singularity. It fits theory on the grounds of epistemic coherence and aesthetical criteria. Correspondingly the cosmological scenario of the origin of the universe cannot be verified because the universe cannot be subjected to physical experimentation[11], so that all inferences in cosmology are grounded in the realm of extrapolation and analogy with other "historical" natural sciences.

One may further clarify the spatio-temporal representation of the universe in the standard cosmological model and, in particular, the sense of the cosmological singularity or the Big Bang by taking into account the special position of the human observer in the universe. In spite of the fact that the cosmological principle claims that the location of human observers is mediocre in order to create an average statistical picture of the universe it turns out to be that "what" human agents can actually observe is subject to general causal limitations following from the physical laws established in the terrestrial domain. The universe, considered as luminous objects, invisible radiations and cosmic particles, is perceived from the given space-time location through the so called past light cone along which electromagnetic signals travel with the speed of light.

In Fig. 2 this situation is depicted through photons (γ), travelling on the surface to the curved light-cone and reaching the observer at present. In this case the geometrical manifold of the observable universe represents two symmetric

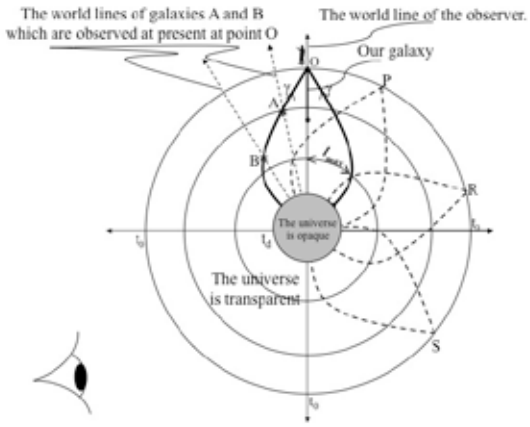

Fig. 2

curves that originate at the cosmological singularity and reach the observer's location. The universe is observed along the past light cone and the maximal spatial distance of objects whose radiation could be detected is determined by the linear size denoted in Fig. 2 as l_{max} (Rothman, Ellis 1993, p. 886). It is not necessary to be a qualified mathematician in order to realise that if the wholeness of the universe as space-time is anticipated in this diagram as the two-dimensional interior of the circle with the radius corresponding to the present time t_0, then the observable universe represents a one-dimensional manifold whose quantitative measure with respect to the whole universe is zero. In other words, the observable universe in this view is an infinitely small contingent piece of the allegedly existing whole. This result is not surprising, because it follows from the contingency of the observer's location in space at the present moment of time. In Fig. 2 this is indicated by a random choice of the point (with a tiny human figure) on the circumference symbolising the whole space at present. Since there are infinitely many potential locations on this circumference, the contingent choice of a particular one (linked to the contingent choice of the past light cone) makes this contingency acutely felt through the incommensurability in

measure of the one-dimensional circumference and a chosen point which, strictly speaking, has no dimension at all.

One could raise an issue here as to whether it is legitimate to attempt to infer to the universe as a whole from an infinitely small part of it. One must remember, however that the Fig. 1 and Fig. 2 are both drawn in the natural attitude, that is both treat the universe within the phenomenality pertaining to objects; correspondingly, in order to make sense of these objects one had to appeal to the cosmological principle which allows one to speculate about the universe as a whole while being chained to one single point of it. Indeed without this principle any representation of the universe as a whole would not be possible: we could responsibly speculate on the origin and evolution of the visible astronomical universe but not about the universe as a whole originating from the same Big Bang. The cosmological principle makes irrelevant the question about observer's location on the circumference, because, according to it, all its points corresponding to all possible spatial locations are equivalent (for example, the density of cosmological matter is the same at different points such as O, P, R, S). This means that we, as observers, could be anywhere. Correspondingly the past light cone could be anywhere, giving, in accordance with the same principle, a similar picture of all possible observable universes. In Fig. 2 this situation would correspond to rotating the light cone keeping its apex on the same circumference thus covering entirely the interior of the circle. It is because of the possibility of this rotation that the difference in measure between the interior of the circle and the past light cone disappears: the infinite multitude of light cones corresponding to all possible contingent locations of observers covers entirely the interior of the universe giving thus statistically the same picture of its structure from any imaginable location.

The result of this simple analysis is that the cosmological singularity whose existence is inferred from the expansion of the visible universe is unique because it would be predicted in all possible cosmological scenarios based on observations from all possible locations. This implies that the *construct* of the cosmological singularity as related to the *whole* universe is ultimately based on the cosmological principle. It follows then that similar to the certainty of belief from within which originates the cosmological principle, the validity and truth of the construct of the cosmological singularity is also situated in the certainty of belief. Together they form a *coherent* framework of interrelated beliefs which form a basis of cosmological methodology. One can also add that the cosmological singularity (or the Big Bang), as a direct consequence of the cosmological principle, reveals itself as a transcendental principle of explicability of the universe as a whole with corresponding teleological connotations related to the methodology of research: to provide a coherent view of the universe as a whole one has to introduce a unification principle of all, which is imitated by the concept of the Big Bang.

The cosmological principle removes the ambiguity of the human observer encoded in Fig. 2 (this ambiguity is another explication of the paradox of the human subjectivity in the world; see on this paradox (Nesteruk 2008, pp. 175-84; 2011, p. 571)). Indeed, on the one hand human subjectivity is present outside the schemata of the universe, because the universe as a whole (including its observable part) is the result of a theoretical hypothesising: it is reflected in Fig. 2 through an eye looking over the universe. On the other hand, human observers, being embodied creatures, establish their insights of the physical universe from a particular location in space thus selecting that part of reality which is linked through physical causation to the place of embodiment. The cosmological principle

allows one to balance these two approaches to the universe by telling us that our particular location in the universe and its constructed image can be reproduced from all possible physical locations. The universe becomes not only intelligible, which is implied epistemologically by the cosmological principle, but also intelligent: the universe is represented as a continuum of potentially possible human-like observers. However this latter intelligence is *de facto* disembodied in the sense that it is not related to the sufficient conditions of embodied consciousness on the planet Earth. Correspondingly the phenomenality of the physical universe is reduced to the phenomenality of an *object* explored by the postulated disembodied and anonymous reason. Historically such a point of view can be contrasted with that of ancient philosophers who treated the universe in terms of "cosmos" (as beauty and order). The universe as cosmos denotes the *way* the reality of all nature is; it denotes not "what" the all-encompassing reality is but its "how". In this sense the cosmological principle professed with respect to the universe manifests the expression of the personal relationship to the universe in which the universe as a whole is recognised and valued through existential participation in it and not only through an abstract knowledge. This personal relationship (an instantaneous synthesis or communion) receives its expression in the belief in the universe's uniformity as its intelligibility. In this case it effectively reproduces an old idea of Plato that the universe is alive in a very non-trivial sense: the universe allows the presence of human intelligence in it not only in an anthropic physical sense, but in that sense that all predications about the universe contain the deposit of the human hypostatic subjectivity.

It is clear from Fig. 2 that human observers in their contingent and indifferent location in the universe, see only the past of the universe: while gazing at the celestial sphere they see the images of that which was emitted by cosmic objects long ago. These images are delivered to us by photons travelling through space for billion of years: these are images are of the past. On the level of the perceived phenomena we deal with the image of *the past in the present*. However, this past is not a fixed past referred to a particular historical stage of the universe, but it is the accumulated image of different objects at different distances, and hence different eras. Theoretically we deal not with a particular past which could be marked in terms of a fixed figure of years passed after the Big Bang, but an integrated past bearing images of different galaxies and their remote ancestors since the times of their formation. This can be illustrated with the help of Fig. 2 which shows that we receive simultaneously signals from galaxies A and C which are at different distances from the world line of the observer. This simple geometrical fact implies that these images correspond to different times at which signals from the galaxies have been emitted: the images of the galaxies A and C come from the same location in the celestial sphere, but they correspond to objects which have crossed the surface of the past light cone at different moments of time. It is not difficult to see from Fig. 2 that both these galaxies are beyond our reach at present (their world lines at present are separated from us by a space-like interval) so that we receive only the optical signatures of their *past* existence. When we observe the images of these galaxies we must, on strictly philosophical grounds, assert their existence only as phenomena. Any hypothetical affirmation of their physical existence can only be made by using the language of past tense.

Some elucidation of the assertion of the accumulation of the past in the universe's display as a phenomenon, can be achieved by changing the perspective and not considering the Big Bang as "out there", but contemplating it as being encapsulated in the display of the

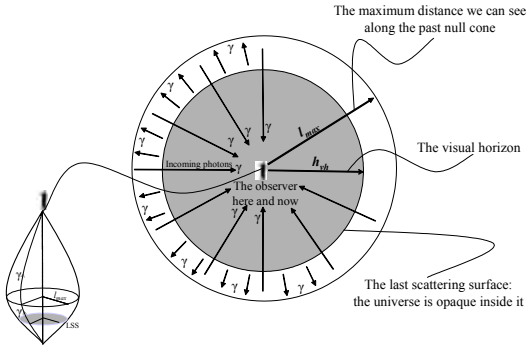

Fig. 3

universe here and now (see Fig. 3). This is in correspondence with a simple truth that the point of the beginning of the universe has no location in space because space appears together with this point, so that while looking at all possible directions in the sky we, strictly speaking, look towards nowhere which appears to us in the disguise of everywhere.

Whatever comes to us from the singularity, goes through the maximal distance $l_{max.}$ so that the initial singularity is perceived by us as the boundary of the circle (with the radius l_{max}) with the centre at the point of observation: independently of the direction of observation in the sky, one encounters the singularity; the singularity is out there but, at the same time, it is nowhere (compare with the graph of "The Cosmic Spheres of Time" (Primack 2006, p. 135), (Abrams 2011, p. 74). A similar graph can be found in (Cazenave 1995, pp. 57-9)). On the level of a phenomenological reflection Figs. 2 and 3 are seen not to be equivalent since the position of the observer in Fig. 2 is spatially contingent, so that a selection of what is observed is not the whole universe. However, this contingency is removed through the cosmological principle making all points on the circumference in Fig. 2 equivalent, so that it is believed that the picture of the universe in Fig. 3 gives a generic view of the universe as a whole.

In view of this a comment must be made related to the cosmological principle. Let us recall that this principle, as affirming the uniformity of distribution of matter in space, is based on the observed isotropy of this distribution from our vantage location. One may ask what is the meaning of this isotropy; from Fig. 2 it is clear that the observed isotropic distribution of matter in space corresponds not to what "happens" in the universe at present, but is related to the past, because whatever is observed as a phenomenon corresponds physically to the accumulated past. In this sense the alleged isotropy of "space" is not isotropy *in* the present, because we cannot observe spatial locations of distant objects at present apart from our galaxy (which is depicted in Fig. 2 by the bold line going down from the point O) and which is not isotropic at all. In other words, one can assert that the distribution of matter is isotropic only in the sense of the accumulated past. It is from this fact that an inference is usually made, by means of extrapolation, to assert the isotropy and then uniformity of matter not in terms of the integrated past but at every particular era of the past and in present. Formally this is expressed, for example, by assigning to the density of matter a constant value for all possible locations at a given moment of cosmic time, that is at all locations on the circumference in Figs. 1-2. This observation strengthens the conviction that the cosmological principle, that is the universe is uniform at any space-life surface corresponding to a moment of cosmic time, is based on the idea that the integrated image of the past of the universe can be decomposed in terms of consequent stages of the universe's evolution. Said philosophically, in order to deal with the contingent image of the frozen past of the universe in scientific terms, one should decompose this image into consequent layers of reality corresponding to different cosmic eras. Thus it is from this decomposition that the

idea of the universal cosmic time receives its epistemological justification.

Generalising what has been said so far, in observational cosmology we deal with the phenomena which, according to theory based in the laws of relativity, are living images of the past or its remote consequences. Unlike the events of human history whose re-enactment requires the appeal to the witnesses of the past through documents and archives, through the communion with the mind of those who were present behind the artefacts, in cosmology we have a different situation in which a certain past of the universe is constantly present: the artefact of the universe's past is always given to us and is being constantly gazed at. Since this is not a fixed past, but the accumulated past, the past stretched through time but frozen in its image given to us, human beings live in the presence of the extended and never-ending *event* of the past whose contingent facticity remains a mystery. Thus the contingent facticity of the observable universe represents the contingency of the accumulated image of the past: the universe is contingent being "an event" with extended spatio-temporal characteristics. This event, theoretically explicated through the past light cone of Fig. 2 is linked to the human observer which itself represents an extended event of the overall human history[12].

A scientific attempt to unfold the phenomenon of the observable universe as existing in space and time presupposes an idea of the continuum of space and time as pre-existing entity. However, all objects corresponding to their observable images "exist" in different moments of pre-existent time. In this sense our intuition of existence of these objects manifests itself as fundamentally non-local in time, that is we affirm existence not in proportion and connection with the fact of our existence, which is local in space and in time, but as supra-temporal or trans-temporal when all moments of allegedly pre-existent time are reduced to the facticity of their observability at present[13]. The universe as a phenomenon is here and now: it is that which we see in the sky and perceive as an immediate medium of our indwelling and embodiment. There is no distinction between past, present and future in this phenomenon. In this sense the phenomenon of the universe as a whole is contingent because it is given. Scientific cosmology, in its instinctive desire to overcome this contingency, appeals to the idea of the originary origin of the universe (for example, its temporal origin), in order to objectify the contingency of its givenness by shifting it into the remote past under the disguise of the ill-articulated apodicticity. However, the idea of time and the "past" which stands behind such an appeal, ultimately originates in human historicity whose facticity cannot be scientifically accounted for[14].

The universe as a construct: its rationality in rubrics of faith

Let us reflect upon the links of the notion of the universe as a whole to the life-world as attuned medium of all contexts and thematisations of the universe associated with the conditions of corporeity. The reader will have noticed that we have used the term "construct" several times when introducing some basic mathematical statements about the universe; for example Fig. 1 depicting the expanded space-time can be considered as a construct. "Construct" in this case represents a certain departure from the immediately given and a combination of the empirically given which has already been accumulated in knowledge of the universe (for example astronomical observations) with an intelligible image of reality as a whole (global space-time manifold). The validity and efficacy of constructs in theory is determined through the rules of correspondence with the reality of the empirically given (what could be called reification), the rules which also include

other forms of approval and reference to truth relying on the experience of communities in the life world (this could be called objectification) (Margenau 1977, p. 70).

For example, the construct of the spatially uniform cosmological fluid is obtained from further extension of that ideation which is used in earthly physics to construct the notion of the ideal gas. The ideal gas is used as a *gestalt* for a cosmological fluid where its elements (atoms) are replaced by clusters of galaxies. The notion of a cosmological fluid has its origin in empirical physics, but in its content it exceeds the realm of the empirically observed and relies on an intuition of the global space which represents another construct. The construct of a perfect cosmological fluid can have verification through astronomical observations at the home place of Earth. However, as mentioned before, the constituents of the cosmological fluid have a precarious ontological status related to their non-locality in time, so that it is the human mind which brings together different elements of the cosmic display in order to construct a model of this "fluid" as if related to a particular moment of time. It is important to realise that constructs, as mental accomplishments, do not presume any strong commitment to realism. In this sense if one asks a question about the correspondence of cosmological constructs to empirical reality, one must admit that this correspondence exists for sure only in that sense that the constructs are produced by us who are part of this reality. Certainly the concept of the universe as a whole depicted in Fig. 1 must contain a place for the reality of the life-world. But, as has been already stated, the quantitative measure of this reality is infinitely small with respect to the universe as a whole, so that in physical terms the diagram in Fig. 1 has a link to the empirically given only at one point corresponding to the place of humanity in space and time.

In order to relate the construct of global space of the universe to the life world one must understand how the global space is related to the spatiality of the earthly world and the corporeal spatiality of human beings. In other words there must be some legitimisation in the transition from the centrality of human beings in their attuned space of the life-world (or centrality of humanity on Earth as its home-place) to the periphery locations in a thematised and actually infinite space. This transition is effectively connected with mental procedures which can be called ideation and abstraction. Their essence requires some verbal reification. The attuned space of the lived space associated with corporeity has a character of self-givenness "in flesh", that is presence "in person" in the sense that space and objects in it are given in confrontation with functioning corporeity. Obviously this can be said about the space of the planet Earth and all objects in it. In a certain sense one can say a similar thing about the images in the celestial sphere which enter the reality of the life world as a certain horizon.

In cosmology the extension in cosmic space looses the character of presence "in flesh" simply because the mathematical components of this extension have no direct relationship to corporeity. However, in similarity with that intellectual procedure which led us to the construct of the perfect cosmological fluid, one exercises here ideation, as a special case of abstraction, which disregards all particularities of spatiality present in the individual subjects or objects. This ideation does not bring simply something common in a given multitude of objects, rather on the basis of perception "in flesh" it intuits the universality of the essence. This ideation is crucial for introducing constructs with respect to which a *new type of objectivity* is constituted as a new type of intentionality in which the founding acts of corporeal intuition are not included in

this objectivity. This new intentionality contains those determinations with respect to the universe that are not found in the objects initiating this intuition. But if the construct of the global space of the universe is introduced along the lines of this new intentionality, its components, as essential universals and ideal objects, are indifferent not only to number of empirical cases which could represent them but to the possibility of their empirical realisation and hence verification at all. One can say that the global space of the universe appears as immediately self-given in the overall intuition of the universe as communion in the life-world, but this self-givenness is not directly related to the aspect of corporeity and has rather a categorical nature. However at this stage of constitution this global space is not yet mathematised and hence one cannot say that it is purely non-sensible. For example, it receives a pictorial representation in Fig. 1 which is not non-sensible in spite of the fact that it already contains the elements of the mathematical (geometrical) ideation. But what is important, and this was the achievement of the phenomenological analysis of mathematical knowledge, is that in the foundation of such a constitution lies the intuition of mathematical continuum[15]. This intuition correlates with the sense of unity of experience that pertains to every subjectivity: the unity and continuity of the field of consciousness cascades towards the unity of reality which includes the concreteness of corporeity (the belief in consistency of nature). Corporeity as existence-in-situation entails the sense of belonging and this is intuited as a continuum whose presentation is achieved by using mathematical ideas. In its function the sense of continuum corresponds to the ancient Greek idea of underlying substance as the unity of being and belonging to it. Now it is not difficult to realise that the pictorial presentation of the universe in Fig. 1 is based on the assumption that the underlying mathematical continuum (corresponding to the existential unity of experience) is geometrised (as space) in the class of pseudo-Euclidian metrics under the condition of uniformity of space. Once again this construct contains both sensible elements (its image as such) as well as categorical elements. In this sense by asserting the idea of the global space and its representation through the Fig. 1 we avoid either the commitment to realism or to idealism. The fact that this kind of representation is a construction, but not a purely mathematical concept, originates in that it is obtained through the accumulation of facts in the field of astronomy and astrophysics, so that it is a historical intellectual achievement and, unlike pure mathematical ideations, does not possess a trans-temporal nature. The construct is not part of the physical reality of the universe, but, at the same time, being an element of a cosmological narrative it is a part of the reality of cosmology as a cultural phenomenon. In this sense the positing of constructs in cosmological theories represents the work of a different type of intentionality which, being related to the natural attitude through an attempt of an inferential causation from the empirical, yet points towards a fundamentally different intentionality relating to the questioning on the facticity of the unity of experience in the conditions of corporeity; but this, as we mentioned before, brings us to the intentionality of existential faith in its particular realisation as faith in the unity of experience (and hence as consistency of nature). Hence one understands that all basic notions of the standard cosmological model, including the cosmological principle, constructs of global metrics and perfect fluid, the dynamics of the scale factor and the prediction of the Big Bang are all constructs related to the realm of the immediately given only indirectly in the sense described in previous paragraphs. It becomes evident that the existential belief in the unity of reality corresponding to the unity of conscious experience permeates the

whole standard cosmological model including all its constructs.

The question now is what makes this standard model so convincing for scientific communities and a wider audience. Why, in spite of the fact that cosmology is characterised by uncertainty and untestability (Ellis 2007, pp. 1259, 1274), does it remain appealing to the scientific and common sense and its constructs are treated in realistic terms? Here we come to the question of logical and philosophical requirements on constructs and their epistemic function in the particular case of cosmology (Margenau 1977, p. 75).

First of all, according to the very definition of a scientific enterprise it is assumed that it is to disclose some aspects of reality through an empirical contact with things, thus phenomenalising them and making them immanent to the enquiring subjectivity. In that case, when cosmology attempts to predicate the wholeness of the universe, it is obvious that immanent phenomalisation is not possible or a-priori incomplete because there is not and never will be direct empirical contact with that which is implied by the notion of the universe as a whole. This situation is well known in many parts of theoretical physics where the predicated realities and objects are represented by abstract mathematical forms and their physical existence can be verified only in a mediated way through special experimental equipment. Contemporary critical realists assign to these realities physical existence[16]. In the case of critical realism, one believes that if the constitution of phenomena takes place at the theoretical level, there must be rules of *correspondence* between what is theoretically introduced and what is observed empirically. In this sense the difference between objects (empirical versus theoretical) and the extent of their immanent phenomenality is not of an ontological kind: in both cases they have a similar ontic status. In a way, if some empirical phenomena (in a physical sense) are modelled mathematically, both their empirical evidence and mathematical representation exhaust what they are aimed at (intentionality conditions that which appears). The correspondence principle, as a constituent of the intentionality pertaining to the natural attitude, guarantees the link between visible and observable on the one hand, and that which is logical, mathematical and non-observable on the other. But, since the mathematical and non-observable enter as constituents of the correspondence rules, it is clear that these rules are not only enforced by data, but in many ways by the internal consistency of the facts and constructs based in these rules.

The situation becomes crucially different if the correspondence principle does not work. This happens in cosmology where theory attempts to predicate (on the basis of extrapolation) something about the long distant past of the universe with no hope of verifying theoretical constructs related to this past by means of direct observations in this past. In this case, even if mathematics is applied for modelling some aspects of the universe, there is always a possibility that this mathematics is incomplete and historically contingent, that is, it will be eventually replaced by something new, so that the theoretical vision of reality (its construct) will change. Indeed, if one speculates about the past of the universe on the grounds of a simple physical causation, one can assert that the varied display of the cosmos (which reaches us through light and other channels of physical information) is the remote consequence of some originary event which took place in the past (and which cosmology attempts to predicate in theoretical terms) and which is beyond the conditions of observablility. The frozen image of the past of the universe is given to us through its display here and now, but the sense of this past can only be conceived in certain limits, because this very past is "present in absence." Cosmology

attempts to phenomenalise this past through its theories which are incomplete and constantly corrigible. In other words, any attempt to reduce our knowledge of the past of the universe to the limits of the constituting subjectivity of a cosmologist is a reasonable but never ending, inexhaustible enterprise. The universe in its historical past is predicated from within a short strip of human history. Then the question arises: what is the methodological justification for the science of the universe as a whole if this science is unfolded from a tiny piece of this whole? If we have no direct observational access to the past of the universe in its past, what is the sense of its theoretical modelling in terms of constructs with respect to which the correspondence principle (as related to a fixed temporality of objects) does not work? The answer comes from an intuition that theoretical cosmology (not observational astronomy and astrophysics), *de facto*, bases its methodology not on the correspondence principle, but in the *coherence of epistemic justification*. E. McMullin argues that cosmology, as well as other disciplines which attempt to reconstruct the past (such as geology, paleontology or biology) rely on *retrodiction* as that foundational principle which can bring into focus the past of the universe. The acceptance of this principle "is due to the cumulative success of the historical sciences, of geology, of paleontology, and of evolutionary biology. Success is not measured here as it might be in physics and chemistry but is as matter of *coherence* rather than of novel prediction. The *coherence* lies not just in the particular historical reconstruction of a long-past geological or biological episode but in the ways in which one reconstruction supports another, and the scope of the concepts and explanatory concepts on which the reconstruction is based gradually widens" (McMullin 1994, pp. 120). Here, however, we have to face an ontological question as to what extent the implied *coherence* of justification entails truth. For McMullin, who associates retrodiction with a realistic methodology this entailment is paramount because "when reconstructions of quite different sorts of evidence drawn from geology and evolutionary biology, say, begin to 'jump together', as it were, begin to blend fairly harmoniously into a single story, then our conviction grows that the story is not just coherent but is also close to truth" (Ibid.). Certainly there remains a question whether the experience of dealing with geology and biology is so easily transferable towards cosmology, in particular towards what is concerned with the origin of the universe as a whole, but not only of that part of it where we find ourselves (McMullin 1994, p. 136).

The legitimacy of invoking coherence theories of justification in cosmology proceeds from the fact that cosmology starts its discourse with a set of propositions, which can be qualified as beliefs, rather than verified assertions. We have discussed above that physical cosmology is only possible under the assumption that there is a fundamental uniformity in the universe in space (as well as in time, in what concerns physical laws). As we have mentioned above, the "cosmological principle" cannot be empirically verified. Let us now analyse carefully how this basic belief enters all cosmological constructs and makes the whole theory coherent. In order to avoid repetition and simplify visual perception we introduce in Fig. 4 a simplified graphical representation of the epistemic structure of the construct of the universe in classical cosmology, produced in analogy with the analysis of constructs in physics by H. Margenau (Margenau 1977, pp. 84-88).

At the right hand side of this graph one finds a representation of a sensible world, the world in which the human embodiment takes place and which determines in physical and social terms that aggregate of experience which, by borrowing phenomenological terminology,

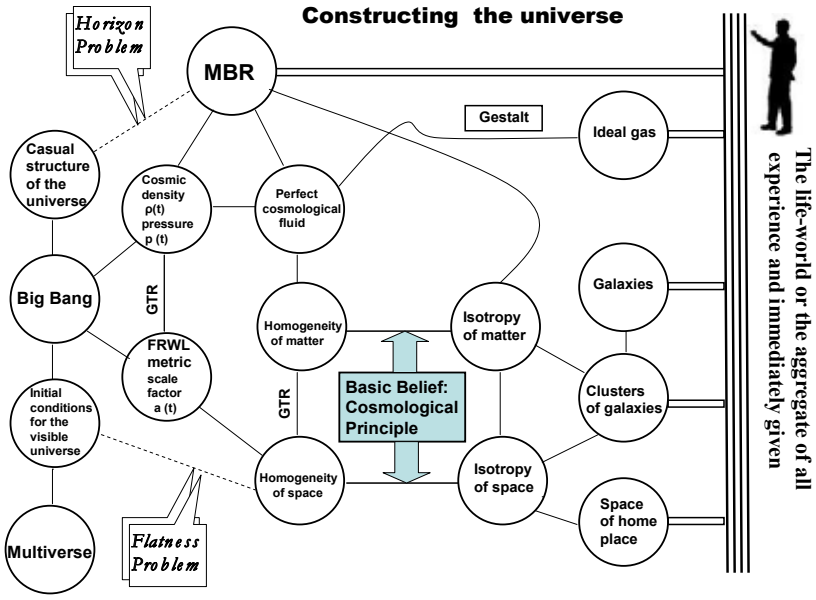

Fig. 4

is called the life-world. To the left from the life world the reader finds a space of knowledge which is populated by major epistemic elements. The circles represent constructs. The shaded rectangle illustrates a basic belief in cosmology. All constructs are linked by single lines which illustrate formal connections between them. Some constructs are linked to the life world through double lines which represent epistemic connections. One sees that many cosmological constructs, in accordance with what we discussed before, do not have epistemic connections with the life world, that is immediate observations and measurements. However all constructs are connected creating a coherent volume of theoretical knowledge. Their coherence and the very possibility of this knowledge depends on the basic belief in uniformity of the universe which efficacious presence is depicted through a box in the centre of the diagram. This belief makes it possible to proceed beyond the contingencies of observations from a particular location in space to space as a whole, which itself represents a construct because, in spite of its obvious presence in the conditions of the life world, is not present in its entirety and is thus sensibly unavailable, being supplemented by the mental construction (Ströker 1965, pp. 176-224). To give this intuition of space a physical content one has to postulate that one can shift our home place and potentially experience a similar structure of space everywhere. The most natural attribute of this shift is a simple spatial translation which presupposes the uniformity of the overall structure. This presupposition forms a basic belief, that is the cosmological principle, which allows one to apprehend the totality of space physically. This belief is exercised in the natural attitude thus positioning all shifted home-places as physically real (Kerszberg, 1987). A similar belief asserts that the distribution of the material content of the universe which is observed astronomically from our home-place is not only isotropic for us but for all possible shifted home-places. This entails the overall uniformity of matter across the visible and

invisible universe. The link between space and matter is established through the General Relativity Theory's assertion of the relationality of space and matter. Correspondingly both constructs, the global isotropic and uniform metric space, as well as the perfect cosmological fluid consisting of clusters of galaxies, are based in the certainty of belief. The fundamental role of the cosmological principle is that being implemented it allows one to use the formal connection between space-time structure of the universe and its material content across the global structure of the universe. The choice of the physically motivated equation of state (for example the equation for dust in present era cosmology) in the cosmological perfect fluid allows one to develop a formal connection between the constructs of the energy density of the cosmological fluid and the universal scale factor *a(t)*, which in turn introduces new constructs. These formal connections follow from the Einstein equations and lead to the conclusion that since the scale factor grows in terms of the metric time the universe expands. It is this last connection which leads to the introduction of the notion of the hot (radiation-dominated) universe if the expansion above is reversed. Through a limiting procedure when the cosmic time tends to zero another construct of the beginning of the visible universe (the Big Bang) is introduced. This construct as such represents a limiting reference point with respect to all other possible constructs. For while the construct of the Big Bang is the highest possible term of cosmological theory to which ultimate aspirations are addressed; physically it is supposed to be treated as that initial point in the state of the universe which is responsible for all other physical effects. On the one hand the Big Bang becomes the goal of the explanatory process (Nesteruk 2012[2]), on the other hand, physically it corresponds to the original foundation from which everything unfolds. One must remember here that in order to draw a conclusion as to the Big Bang being the all-encompassing "beginning" of the universe as a whole one needs to have a basic belief that the universe is uniform. In this sense all constructs presented at the very left hand side of Fig. 4 are imbued with this belief and hence represent the formal constructions in rubrics of belief.

If we generalize the latter observation one can state that the depiction of the universe as a whole through the diagrams in Figs. 1-2 (which contain in encapsulated form all formal connections among the cosmological constructs from Fig. 4) represents a generalizing construct which is deeply dependent upon the basic belief in the uniformity of the universe. The link between this generalised construct and the life world can be illustrated with the help of another diagram Fig. 5.

This diagram shows that the epistemic connection between the construct of the universe as a whole and the life-world exists only through the point describing the observer and correspondingly along the past line cone (that is the visible universe) whereas all other parts of the allegedly existing spatial structure of the universe are in formal connection with the construct of the visible universe. These formal connections are possible only through the basic belief that the structure of the universe outside the visible realm can be potentially comprehended by some hypothetical observers similar to that one of the visible universe. However, this potentiality as an eidetic variation of home places does not actualize its physicality because the similar *necessary* conditions for the observers to exist outside the visible universe do not guarantee their actual existence, that is the fulfilment of the *sufficient* conditions. In other words, the hypothesis of the similarity of the necessary conditions for embodiment in other places of the universe

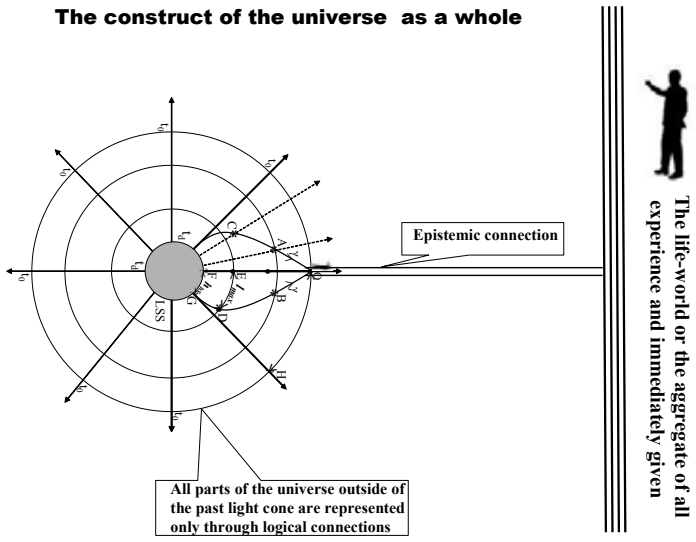

Fig. 5

(related to similar physico-biological conditions) dos not entail automatically the fulfilment of the sufficient conditions for such an embodiment, that is for the actual existence of observers, thus remaining no more than an eidetic intuition, or a belief.

One must however admit that the resulting picture of the universe (recapitulated differently in Figs. 1-5) is in a high degree epistemically coherent because its constructs align in an aesthetically attractive theory through multiple connections which can be easily seen from the Fig. 4. Apart from the construct of the Many Worlds (Multiverse) which is usually invoked for explaining away the problem of contingent facticity of the initial conditions in the visible universe, all other constructs are connected with each other and have some epistemic references related to the life world. The construct of the multiverse, which, by using terminology of Margenau, can be called peninsular (Margenau 1977, p. 86), is linked to the whole construct of the visible universe through mental causation, that is on the level of intentionality and not physical causality. In this sense its status is crucially different from all other constructs which in one way or another have some epistemic connections. The construct of the multiverse in this sense requires another sort of belief in the possibility of shifting of home places but this time not in terms of space and time but in terms of different types of worlds (universes) or types of being. Here one can detect a similar idea of "democracy" among the worlds and an attempt to remove the hidden *teleology* of the initial conditions of the visible universe (if they are related to the fact of the human observer's existence) in favour of a generalized principle of indifference (mediocrity) which removes all particular specificity of our universe. Thus the construct of the multiverse is peninsular, lacking multiple connections with other constructs and can hardly acquire any sense of truth even on the level of epistemic coherence. The major problem with this construct is that it does not stand in any realistic sense of causality with other constructs in the visible universe. Even if the visible universe is thought as one out of many members of the multiverse it is completely unclear as to how to describe in terms of real physical processes the phenomenal actualization

of this particular universe, that is the phenomenal facticity of our universe. Since any imagined mechanism would, by default, transcend this universe, its verification is impossible leaving the whole conjecture to the field of beliefs. In this sense the construct of the multiverse does not fall in the rubric of epistemically justified belief at all. It lacks the coherence in agreement among members of the cosmological community and in this sense it remains hypothetical and problematic[17].

Unlike peninsular constructs such as multiverse, which by themselves cannot have any direct relation to the life-world, the construct of the visible universe possesses a heuristic quality of predicting some new properties of the universe which are subject to empirical testing. On the one hand we have an epistemic coherence among different cosmological constructs which follow from their mutually dependent nature under the assumption of cosmic uniformity. On the other hand there is a certain percolation of this epistemic coherence towards coherence of truth by predicting new epistemic links with the life-world. An interesting historical example of this is the prediction of the cosmic microwave background radiation (MBR) as a remaining matter ingredient from the early hot stage in the universe's evolution which was detected in 1965 (in Fig. 4 the construct of the MBR has an epistemic connection with the life-world). According to the theory, the MBR represents a newly predicted construct which turned out to have (through technology) epistemic connection with the world of experience (this is reflected at the Fig. 5 through the double line linking it to the life world). However, even in this case one must be cautious in asserting the correspondence between the theory which predicts the Big Bang and the observable MBR, because the latter is interpreted (through constructs) as the remote consequence of that which is asserted as physically existent in the past. We are unable to verify all details of the cosmological scenario by making direct experiments which reproduce in any feasible physical sense that long gone past[18]. In this sense the predication of the past takes place on the basis of coherence of constructs-beliefs, coherence which is supported by the communal convention in established cosmology. One can argue that the very sense of the past is established from the present, so that one cannot affirm this past as physically existent on the grounds of correspondence with the present (in spite of an obvious temptation to use analogy with other historical sciences, such as geology or paleontology). The correspondence between the observed phenomena and their preexistent past takes place on the level of intentionality, but not that of physical causality when the past is assumed to exist in a sense different from what the universe displays being de facto the image of the past. In this sense the discovery of the MBR becomes a signifier of that which allegedly took place in the past of the universe but as such does not exhaust the whole content of what is signified. The discovery of MBR does not change the status of cosmological theory of the past whose truth is asserted through epistemic coherence, it just strengthens this coherence by referring one of its signifiers to the reality of the life-world.

The important requirement for constructs is their extensibility: indeed any working theory cannot be static and involves growth of new elements. But this extensibility as a fact of scientific process can or cannot depend on the formal connections among constructs. In some cases it arises on a so to speak meta-empirical level when theories bring forward some puzzles and paradoxes which do not contradict observations but disturb the consciousness of physicists who are not satisfied by their sheer presence and want to get rid of them (see Fig. 4). A famous example of such an extensibility is the

extension of the hot Big Bang cosmology towards the so called inflationary cosmology as a reaction towards three cosmological problems; we deal with inflationary cosmology below.

Coherence of Epistemic Justification in Cosmology

Now we would like to articulate with more precision what is meant by epistemic coherence in general and why it seems plausible to conjecture that cosmology follows this route in justification of its theories. If one proceeds in cosmological study of the early universe beyond the observable limit towards the universe before the decoupling of matter from radiation, one has to hypothesize of entities and corresponding physical mechanisms which are not directly observable and sometimes not related to any known forms of matter[19]. These hypotheses, being abstractions from experience, in many ways function as intentional objects which by their function in theory can have no direct relation to that which is observed (they can also be described as metaphysical assumptions). There is an element of irreducible belief present in their invocation which reflects the fact that cosmology is driven not only by strong logical connections following from established physical causality but from the intentionality of cosmologists who are driven by intuitions about the unity of the universe encoded in its past. Since the initial conditions of the universe cannot be tested, not only because they are separated from us by an unbridgeable gulf of temporal immensity, but also because one cannot transcend this universe in order to "have a look" at its beginning from "the outside", any predication of this beginning must entail a certain epistemic justification which cannot by definition be based in correspondence with the empirical reality. Since this predication does take place, it implies belief in the realities of what is predicated. The presence of such beliefs makes sense of the success of modern cosmology, its popularity and ability to preach about the universe, as if cosmology's truth would be the truth of really existing things. Indeed it is because the principle of correspondence cannot be employed directly in the cosmology of the early universe, that it implicitly bases assurance in its hypotheses and models in the *coherence* and mathematical rigor of its theories[20]. In other words, the justification of cosmological theories comes not from their direct reference to the observable facts, but through coherence of explanation which is achieved by applying a set of mutually consistent and connected beliefs which aim ultimately to codify in terms of mathematics the fundamentally contingent display of the large-scale universe. The coherence theory of justification holds that a belief is justified to the extent to which the belief-set of which it is a member is coherent (Dancy, 1989, p. 116). "According to the coherence theory, to say that a statement is true or false is to say that it coheres or fails to cohere with a system of other statements; that it is a member of a system whose elements are related to each other by ties of logical implication" (White, 1967, p. 130). In different words, what is at issue in a coherence theory is a matter of a proposition's relation to other propositions and not its coherence with *reality* or with the *facts of matter*. This is similar to Margenau's requirement for constructs to possess *logical fertility* and to obey logical laws: "It asserts little more than that they have relational meaning. But in no sense does the present requirement make it necessary for the proposition involving constructs to be materially true, to have an existential counterpart" (Margenau 1977, p. 82), that is that they cohere with the facts of matter. Coherence theories of justification operate with propositions-beliefs, or constructs-beliefs. As we have already seen all major cosmological constructs contain the presence of a basic belief in the uniformity of the universe. In inflationary cosmology the belief

that there exists a material field Φ (inflaton) which drives the evolution of the universe during the very early period is invoked in order to construct a theoretical model of the exponentially growing period of expansion which in turn solves some problems of the radiation-dominated cosmology, making thus the cosmological model even more coherent.

However, the major problem here is that epistemic coherence does not guarantee that knowledge progresses towards truth. Justification can grow, but there is no criteria that it delivers truth: cosmological models can become more sophisticated and expanded, but there will still be a problem whether their advance guarantees any convergence towards that alleged reality which they aim to describe. In technical philosophical terms this situation sounds as if there is no conduction from the coherence of epistemic justification to coherence of truth. It is in this sense that a coherentist epistemology can be characterised as knowledge without a foundation of certainty. Since the coherence of epistemic justification in cosmology has to abandon the principle of correspondence with empirical reality and a foundation of certainty, it has to appeal to different criteria in asserting the truth of these theories. Cosmology, in what relates to radical mathematisation, in similarity with the coherence approach, maintains that truth is accessible in the extralogical realm where all criteria of reasonability as its foundation do not work. For example, by insisting that there are many disjoint universes which comprise a totality, "cosmology of the multiverse" enters a certain contradiction with the main stance of existential philosophy: it predicates the universes where no condition of embodiment is possible. In spite of the existential futility of such predications, which can have sense as no more than an eidetic variation of the *possible* in order to affirm the *actual*, cosmology finds a kind of "extralogical" justification for the existence of such universes. This extra-logicality follows exactly from the fact that the *discursive entailment* is replaced by *beliefs*. But for beliefs to sustain the challenge of scepticism one needs a *communal*, that is conventional argument[21]. This implies that epistemic justification in theoretical cosmology where the correspondence principle cannot be applied relies on the acceptance of certain ideas about the universe by a community (Rescher, 1989, pp. 331-33). The community of cosmologists then establishes the sense of truth of that which is inferred from a theory. The coherent system of beliefs in cosmology determines as justified all sorts of statements about the remote past of the universe, including the statement that there was the universe before there were intelligent agents who articulate it. It is typical for the coherence theorist not to be constrained to only that which one will someday be able to verify. The validity of cosmology's propositions about the past of the universe is thus not under obligation to be tested in any direct observations because the very reality of this past is established on the grounds of *coherence* of a certain set of *beliefs* about this past.

If cosmology relies on the coherence of its own statements it is enclosed in itself and cannot be assessed from an outside system of thought. Since there is no direct link between coherence of justification and coherence of truth, which naturally requires breaking out of the system of coherent suppositions, cosmology can afford to create as many theories allegedly explaining the origin of the universe as it wants, without even a slight idea whether these theories correspond to truth. In fact, the question of truth is inappropriate in this context because everybody, philosophically honest, understands in advance that the fullness of truth of what concerns with the foundations of the universe cannot be grasped through some fragmented theories. All references to correspondence with the available

empirical material do not reach their aim, because the process of adjusting theories of the early universe in order to fit observable data is in a state of permanent advance, so that all theories, seen through the prism of the philosophically understood "certitudes négatives" (Marion 2010) with respect to any knowledge of the universe as a whole, seem to be metaphors and abberations of the incessant human desire to know the universe. They also manifest a fundamental human incapacity to achieve this goal on the grounds of discursive thinking. In this case the whole pattern of coherent epistemic inference in cosmology functions in the rubrics of belief in the possibility of knowledge of the universe, *attempting* to express *communion* with the universe, by reducing it to the object-like phenomenality. This phenomenality is limited and hence does not exhaust the sense of that image of the universe which has been signified by it. Thus cosmological knowledge acquires the features of an apophatic enterprise retaining the ever-going possibility for further explication of the universe[22].

Now it is not difficult to conjecture along the lines of phenomenological reasoning that the communal nature of knowledge established on the grounds of epistemic coherence leads to the view that physical reality (and the universe) is a mental accomplishment[23] ("hypostasis of mental creations"[24]). Here a distinction is implied between nature as it appears in primary perceptual experience and nature-for-physicists, as an *ideal* limit of the allegedly convergent sequences of "images of nature" which are constructed in the course of history. Any particular articulation of what is called nature can be assigned a character of an historical event. The articulation of the past is thus an event within the life-world of a particular community, loaded with a sense of the community's lived past and of decisions to be made in the future. As P. Heelan points out, "it is not the case that every historical event is also an event of a scientific kind…, but when the local community is one of expert witnesses, then the scientific data produced by that community are also historical events in relation to that community" (Heelan 1992, p. 66). In his classical paper on phenomenology and physics H. Margenau argued along the same lines that "physical reality" is best defined as the totality of all valid constructs and rules of correspondence. In this approach the universe is defined not as a static, but as a dynamic formation: "…the universe grows as valid constructs are being discovered. Physical entities do not exist in a stagnant and immutable sense but are constantly coming into being" (Margenau 1944, p. 278). The reality changes with the flux of experience (Margenau 1977, p. 295). However, for Margenau the belief of many scientists in the convergence of the system of the entire set of physical explanations which would deliver them an ideal of their aspirations, that is a unique and ultimate set of constructs for which would reserve the name 'nature' or 'reality', is problematic because it is not capable of scientific proof (Margenau 1977, p. 76). Since this convergence assumes a sort of historical process, it implies the postulate of history which is not physics (Margenau 1952[2], p. 343). Historicity, according to Margenau, involves knowing which "arises through a union of a knower and his object of knowledge"[25]. Thus the very ideal of "reality" independent of the process of knowledge, seems to be dependent on the factors linked to human existence which develops the sense of history and defines its goals. In this case the abovementioned convergence of "images of reality" can have its source rather in a philosophical argument asserting the existence of a certain *telos* of the human spirit which drives this convergence to its fulfilment, but this argument exceeds the scope of scientific justification and is grounded in beliefs about humanity as transcending the certainty of nature itself (that is a certain commitment to

seeing humanity as made in the image of God). The situation in modern cosmology, where the ever increasing set of theoretical constructs reveals the components of the matter content of the universe which escapes any physical description (dark matter and dark energy, for example) points exactly to the danger of idealisation of the scientific description of the universe as ultimate and accomplished in an a-historical sense: the more details we know the less we understand the whole. In this sense the ideal of convergence of constructs in cosmology remains no more than wishful thinking.

The point of view on the historical contingency of scientific research and thus fundamental conditionality of its results and views of reality, which we exemplified above, raises the conviction that the statements of cosmology (with respect to realities inaccessible to any empirical verification) established on the grounds of coherence and logical fertility of its constructs cannot have truth-values independently of our verification and, because it is our verification, it can never be conclusive. In spite of an explicit belief of the physical cosmologists in the possible convergence of the sense of these statements to a kind of truth which lies beyond our reach, at every particular stage of research the truth of what these statements deliver turns out to be contingent and incomplete, open to further exhaustion through research. To say that the verification of this or that statement in cosmology is never conclusive[26] is to say that although our assertion of this statement may well be warranted in the circumstances, our warrant for it is always defeasible: new elements of theory or insertion of new indirect data could always make the assertion in question unjustifiable at all. In the case of the lack of empirical verification the cosmological statement has no truth-condition independent of the capacity of the scientific community to recognise it as true. Thus the claim of cosmology for objectivity and neutrality does not hold. One can speak about the weak objectivity which includes the transcendental conditions of establishing truth (Bitbol et al., 2009, pp. 1-10), (Nesteruk 2012[1], pp. 375-78).

There are two philosophical qualifications which can be made with respect to this last conclusion. For philosophers working in the natural attitude such a position would raise some suspicion of being anti-realistic. If one denies the verification-transcendent truth (even in a weak form as an ideal of a convergent set of self-correcting explanations based upon the ultimate rules of correspondence) one effectively adopts an anti-realistic view that truth is not independent of our capacity to find out about it, or, in other words, to have beliefs about it in a particular context. The meaning of this "context" can be very different according to the field of research, starting from a simple sensual perception in an experimental science and finishing by a more sophisticated scheme, let us say in theology. Anti-realism emerges naturally in that particular modification of a coherence theory which does not think of the set of truths as a determinate totality; it is the case which we discuss here: what we can recognise as true in cosmology is indeterminate and open-ended. Scientific truth in this approach is not that hypothetic unique which transcends the conditions of knowledge, but is determined by the fundamental plurality of that which we are able to discover and recognise in that kind of truth.

If, however, one adopts a phenomenological stance in which any knowledge is possible only within the noetico-noematic correlation, the suspicion of anti-realism falls away, simply because the certainty of knowledge is immanent to the constituting consciousness, so that, by definition, knowledge of the universe cannot escape the conditions of its origin in a particular realisation of consciousness (be it

personal or collectively historical). The issue of the verification-transcendent in this case becomes a question on the possibility of retaining transcendence, in knowledge which is immanent. The stance of the coherence theories of explanation and truth, in particular in their anti-realistic versions, points towards the possibility of such a transcendence simply because it claims that the process of knowledge is intrinsically incomplete and open-ended, leaving the immanent discursive consciousness with an image of reality and some statements of its truth without any exhaustion of that subject matter which it aims at. In this sense the knowledge of the universe as a specific contingently historical process, based in many ways on the conventional agreements of the community of scientists, never exhausts the sense of the universe, or, the excess of intuition of the universe through communion over its knowledge through discursive reason. Indeed one can attempt to express the experience of admiration of the forces of the universe through very complicated mathematical theories (a kind of incantation), but all of them will remain no more than symbolic and metaphoric images of that anticipated unity and infinity of the universe which is present in the incarnate human subjectivity through belonging to it, through a partial consubstantiality with it. For example, since there is no empirical access to the alleged happening of the Big Bang, all that we express about it by using cosmological theories can be characterised as metaphors and esoteric symbolism based in the mathematical formalism. The beauty of this symbolism, its coherence, give us some assurance to believe in the possibility of the Big Bang as a principle of explanation and justification. However the "truth" of the Big Bang in an ontological sense remains unclear (uncertain) and, what is more important, fundamentally inaccessible. In other words, all cosmological theories give us some symbolic representation of that towards which they aspire (the universe as a whole or its encapsulated image in the Big Bang), but it is that which will never be known and reached in a sense of certain truth. The apophaticism in cosmological research is thus present as the limitation of thought: it wanders around the idea of the Big Bang, but it will never reach it as ultimate origin of the universe[27]. In this case all competing theories are epistemologically and axiologically equal, but no one can pretend to claim the fullness of truth and the knowability of the Big Bang as that intended ideal which is implied in a hidden teleology of cosmological explanation. Thus all cosmological knowledge is apophatic in the sense of its limited validity determined by the boundaries of the physical, because of the open-endedness of the intended horizon and a fundamental inexhaustibility of truth about the universe by means of discursive thinking. However, in order to realise this fact, one should shift cosmologist's consciousness towards a phenomenological attitude, which is capable of bracketing all theoretical statements about reality and to conceive them as varieties of expression of the human intuition about the entirety and identity of the universe. But this attitude is simply not available to cosmologists themselves. They will never agree with the verdict of philosophy that all eidetic imagination in cosmology, incarnate in complicated formulae, is only a wandering around truth, but not truth itself. At the same time it is exactly the limited nature of our knowledge of the universe, its apophatic character, which makes it possible to render the *belief* in the transcendent other of all that we see in the universe, not as an ideal of convergent rules of correspondence with something which is out there waiting for our grasp, but, on the contrary, as that unobjectifiable givenness whose gaze upon us constitutes our subjectivity through the never-ending enquiry about the universe.

The last question we need to briefly discuss in the context of coherence of justification is the

issue of mathematisation. Namely, the question is: if cosmology predicates reality in mathematical terms following the rules of logic, does it leave any chance to claim that cosmology is still based on the coherence of epistemic justification with an inevitably following open-endness of its justification. Mathematical truths are not beliefs but logical rules invariant to all situations and, as some claim, existing independently of the "human baggage." However there is still a slot for a proponent of coherentism to claim that the usage of this or that particular mathematics in this or that particular physical theory is a matter of a human choice and thus of belief in the efficacy of mathematics. The choice of particular mathematical models in cosmology is dictated by basic beliefs. For example, the cosmological principle as philosophical statement entails the choice of particular geometries to describe the universe. The "initial methodological condition" for using these geometries is not in mathematics itself but beyond, in the belief of uniformity of space. As soon as a mathematical model is chosen all further computations follow the "iron" logic of the algorithm, so that their realised "apodicticity" is still initiated by basic beliefs. In another example, when the scalar field in inflationary cosmologies (inflaton) is chosen as that hypothetical ingredient which is coupled to geometry and drives its evolution, the game of construction of a suitable potential and equations for this field is predetermined by this very choice. But this choice is not an empirically driven or correspondence based rule; it is a conjecture in a certainty of belief which turns out to be very fertile in solving paradoxes of the standard cosmological model.

To generalise, one can say that the use of a particular mathematical model and logic is determined by the human choice. If some aspects of the physical universe are mathematised and expressed in simple logic, the intuitive content of the notions in question is reduced to zero. However it is the very choice of what logic and mathematics to employ that is driven by intuition whose excess, by definition, makes the advance of the whole knowledge possible. This implies that even a coherent mathematical description of some global aspects of the universe does not entail the exhaustion of the "phenomenon of the universe" through mathematics (mathematical signifiers do not exhaust the content of the universe as physical or existential outcomes of the physical laws). Mathematical simplicity and logical coherence is related only to those aspects of the universe which allow in principle their simple logical representation, that is the phenomenality of objects. Some proponents of extreme mathematisation of the universe[28] believe that if mathematical structure exists, it reflects the existence of a corresponding physical reality. Even if this were to be true, the problem is that the existence of mathematical structure as articulated by human consciousness does not account for its own contingent facticity: it cannot transcend its own givenness. The self-explanatory justification of mathematics is not even possible if one gets rid of the human baggage present in mathematical articulations and thus postulates mathematics as non-contingent apodicticity[29]. However this suggestion is tantamount to the claim that mathematics is related to impersonal, anonymous, disembodied consciousness, whose very facticity remains an utter mystery.

Classical phenomenology could not pose the question of consciousness' facticity, for any transcendence of the field of consciousness was ultimately prohibited by the phenomenological reduction. In a new phenomenological development, mostly related to its merger with theology and other aspect of the human sciences the question about the facticity of discursive thinking is being posed as the question about the possibility to retain the intuition of the

initial whole behind the dissecting discursive mode of thinking. It is the question of retaining transcendence as that donating intuition which is not subject to immanent constitution and which is always behind the facticity of thinking. It is because of this intuition that the presence of the universe is never fully disclosed through logic and mathematics. The very contingent facticity of mathematics is seen thus as a part of the fundamental incomprehensible facticity of the universe. The universe manifests itself here: it exists, and it is given to us in its particular mode of phenomenalisation through mathematics linked to the conditions of our embodiment.

Thus we have seen that coherence of epistemic justification in cosmology works at the level of intuition by ordaining all mathematical models which are employed by cosmologists for achieving their computational synthesis of the universe. In this sense the principle of epistemic justification becomes, in a way, a *maxim* of reason in a Kantian sense, rather than an analytical prescription (c.f. (Nesteruk 2012[2]).

Case study: Coherence of Epistemic Justification in Inflationary Cosmology

Inflationary cosmology represents a special phenomenon in the field of cosmology because of its being efficient in advancing a theoretical cohesion of the standard hot Big-Bang cosmology and, at the same time, as a clear theoretical case when there is a lack of direct correspondence between mathematical constructs and that physical reality which is known today. It is because of this ambivalence that the attitude to the inflationary model of the universe is ambiguous among cosmologists and theoretical physicists, not saying at all about philosophers. However, all those researchers who are involved in calculations and data processing are eager to develop this theory through more and more detailed adjustments without any commitment to a realistic analysis. They often exercise a positivistic approach implying that theory serves observations and one does not need to enquire into the realistic nature of those entities and equations with which it operates[30]. Certainly, such an implicit positivism has some sociological connotations related to the fabric of scientific research and not to any serious position with respect to the quest for truth.

Inflationary cosmology proposes quite exotic theories of the very early stages of the evolution of the universe which can never be justified on the grounds of correspondence simply because it refers to the era which not only cannot be observed directly, but whose experimental imitation in the earthly laboratory is still a matter of hopes and aspirations[31]. Then it seems trivial to base any criticism of the inflationary cosmology on the grounds of its empirical inaccessibility. Any such criticism would confess implicitly a certain ontological commitment in cosmology which, as we argued before, is problematic. This is the reason why our analysis of the inflationary model does have an objective to reveal its precarious status. It is the persistence of inflationary cosmology in spite its allegedly hypothetical and precarious status is that what interests us, because if theory persists in the community of cosmologists it implicitly contains deep existential motives, which we intend to reveal. While avoiding any ontological commitment we are still concerned with the sense of realism embedded in cosmology because of different reasons. The inflationary scenario is preached by cosmologists, lovers of popular science and science-fiction apologists, as if it relates to truth which appeals to some existential motives. This is an interesting case of how the unclear and precarious commitment to realism cascades down towards social acceptance of scientific beliefs as if they reflect truth of fact. Here we again observe an interplay between

different modalities in grasping the sense of the universe. Historically, inflationary cosmology appeared as a result of responding to puzzles arising not on the level of facts, which are subject to physical causality, but on the level of meta-empirical facts, that is conscious reflections upon the entirety of all facts about the universe, that is on the level of intentionality. Since the intentionality employed by physicists is always imbued with ontological commitment, it is hoped that its correlates (that is noematic references) will have to acquire physical sense, so that intentionality will result in physical causality. The phenomenon of inflationary cosmology confirms our argument, which we have formulated before, that no clear-cut demarcation between the motivations employed in both the natural and human sciences is possible in cosmology.

To become more formal in order to explicate a phenomenological sense of the ideas about the inflationary universe, without any positive or negative attachment to whatever ontological commitment present in them, we consider its theories as part of the cosmological narrative which, as such, represents an element of culture, a particular historical event associated with scientific advance in general. Our desire is simple: we would like to demonstrate that inflationary cosmology exhibits such a type of generic proposal motivated by philosophical, non-observable problems (see, for example, (Ellis 2007, p. 1210), (Earman, Mosterin 1999)). which bases it truth on *coherence of epistemic justification* and thus is crucially dependent on historical and sociological factors related to the community of cosmologists. In this sense we intentionally avoid any enquiry in whether the inflationary theory is true or false, or whether it is good or bad. Our main task is to understand what this theory wants to assert in the context of humanity's quest for the sense of the universe. To achieve this goal we need to give a brief account of history present behind the appearance of inflationary cosmology, in particular in conjunction with our analysis of constructs, basic beliefs and the elements of epistemic justification in "pre-inflationary" hot Big-Bang cosmology. Since literature of inflation is vast, so that all existing books on cosmology repeat one and the same story, we will omit its detailed history (see, for example, (Blau, Guth 1987), (Guth, 1997), (Linde, 1990), (Turok, 1997)) and quote a very limited selection of sources chosen exclusively from the point of view of clarity and briefness, assuming that we avoid the loss of generality by omitting many others.

Historically, the emergence of inflationary cosmology is usually accounted as a response to the three problems in the standard hot Big Bang cosmology[32]. These problems have, so to speak, a meta-empirical character. They did not appear as a result of formal disagreements on the level of theory and observations but rather represent the influence of the intentional motives to account for the contingent facticity of the observable display of the universe. The three problems (or puzzles) which led to the advance of cosmology towards inflation are known as "the flatness puzzle", "the monopole problem" and "the horizon problem". These problems originate from different aspects in vision of the universe and thus have a different weight in the inflationary argument which attempts to resolve them. We give a very brief account of the flatness problem and analyse more carefully the horizon problem, thus leaving the monopole problem for footnotes.

The flatness problem appears from an observation that the spatial curvature of the universe which appears to be very small at present must be extremely small and hence fine tuned in the early universe. This fine-tuning of a cosmological parameter does not represent a paradox as such, for there is no reason why the curvature should not have been very small, however, as S.

Weinberg affirms, "it is a sort of thing physicists would like to explain if [they] can." (Weinberg 2008, p. 203). What effectively is meant here is that the fine tuning of the curvature parameter at the beginning of the universe makes an impression of a very specific (but still contingent) initial condition for the universe. This means that the postulated homogeneity of the universe affirmed here and now, has to be transferred to the initial conditions of the universe, so that the cosmological principle, de facto, states the fine tuning of the initial conditions (it is because of this that, in Fig. 4, we link the flatness problem to the initial conditions as well as to basic belief in uniformity of the universe). It is this contingency which bothers physicists: they do not want to see any "teleology" in these conditions (related, for example to the fact of our existence) and attempt to find generic initial conditions. The implicit conviction which drives cosmologists is to have a theory which would allow these special conditions, as we observe them here and now, to be a result of the natural process and not of setting them up from "outside" of the universe[33]. Inflationary cosmology by introducing an exponential stage in expansion of the universe removes this problem in a sense that if the radiation-dominated Big Bang was preceded by a sufficient period of such an expansion (inflation), the spatial curvature, regardless its initial value, would necessarily have started with the negligible curvature at the beginning of the radiation dominated era which followed the inflationary period (Weinberg 2008, p. 203). The argument in favour of existence of the exponential period in expansion of the universe originates in the intentional desire of cosmologists to explain away the contingent initial conditions of the universe. This is not, strictly speaking a demand of physics, but an aesthetic or philosophical input in motivation of inflationary cosmology. In different words, one can assert that it is a prejudice against a possible teleological setting of this universe that leads to a belief that there must be a mechanism which removes any teleological connotations and leaves theory with a principle of indifference of the initial conditions which seem to be more philosophically attractive. If the flatness problem arises as a meta-empirical fact, an attempt to resolve this problem represents a counter-reaction to this fact as a strong faith-like commitment to the fundamental generality of the cosmological initial conditions which remove any suspicion in a teleological selectiveness of our universe. Effectively we have here a situation of competing beliefs, reminiscent of the perennial dilemma on whether the universe has a certain *telos* or not (McMullin 1993). However the inflationary solution of the flatness problem is not a unique one (Weinberg 2008, p. 208), so that the appeal to inflation on the grounds of flatness alone would not demonstrate any necessary entailment. Here there are more problems to come.

The monopole problem is of a different kind for it relates to the interdisciplinary nature of cosmology, in particular its close ties with the physics of elementary particles and quantum field theory. So that this problem is less important for our analysis and we skip its detailed account[34]. The horizon problem is the most serious puzzle in cosmology (Weinberg 2008, p. 208) for it relates not only to theoretical predictions but also to observations. The problem arises when the construct of he causal structure of the universe in the hot Big Bang cosmology is correlated with the measurements of some parameters of the microwave background radiation (see Fig 4). To make it clear one needs to discuss in more detail what is effectively observed in the universe from the planet Earth, appealing to Fig 2. It is seen that the human observer has some physical limits in observing the universe in its past which constitutes its natural epistemological horizon. On the one hand this limit has a spatial character: the universe is observed along the past light

cone and the maximal spatial distance of objects whose radiation could be detected is determined by the linear size denoted in Fig. 2 as l_{max}[35]. On the other hand there is a limit in time: the early universe was opaque to radiation and became transparent after approximately 300,000 years since the beginning. From Fig. 2 one understands that our ability to penetrate deep in its past is limited by the age of decoupling of radiation from matter, so that no direct access to early times (even less to the beginning of the universe) exists. However, if one imagines that this access would be possible (that is the universe somehow would be transparent since the very beginning) we would come to a strange conclusion: whatever we observe in the sky is linked to the event of the beginning. The surface of the past light cone curves in such a way that we always, when look at different directions in the sky we effectively look at one and the same point of the Big Bang, so that whatever we observed would be causally connected simply because it came from one and the same point).

The presence of the non-transparent stage in the universe's evolution makes things complicated and this ultimately leads to the horizon problem. Indeed looking carefully at Fig. 2 one realises that what we can effectively observe comes from the surface of the last scattering (that is time when radiation decoupled from matter). Since this surface is not a point and has a spatial scale corresponding to the scale factor which a thousand time less than it is at present, one can say that by measuring the parameters of the microwave background radiation, which is a leftover from the era of decoupling, we receive signals from spatially separated domains, which, in spite of their ultimate origin in one and the same point-like Big Bang, never been in causal connection with each other[36]. This observation can be made more quantitative: in fact, according to the theory the horizon at the time of the last scattering, in angular measure, now subtends an angle of about 1.6°, so that all now observable effects which are separated in the sky by the angle bigger than this one correspond to phenomena which have never been in causal contact before. And here arises a paradox or a problem, because observations claim a high degree of isotropy of the background radiation as if it was in a state of equilibrium, that is a causal contact, before decoupling. In other words, the problem is that according to the radiation-dominated or dust cosmology no physical influence could have smoothed out the initial inhomogeneities and brought points corresponding to the angle bigger than few degrees to the same temperature (Weinberg 2008, p. 205).

As we mentioned before the horizon problem is the most serious problem which demands an interpretation, however, it does not contradict any experiment. It can be related, as it was with the flatness problem, to the specificity of the initial conditions, but this creates the same unease of its contingency and unexplainability by means of physics, as it is with the flatness problem (Ellis 2007, p. 1205). The inflationary hypothesis provides the interpretation of the horizon problem and its solution by claiming that because of the exponentially growing expansion the part of the universe we can observe would have occupied a tiny space so that all forms of substance were in a casual contact before inflation started so that the observed isotropy of the microwave background radiation corresponds in the long run to the uniformity of matter achieved before inflation. The success of the inflationary explanation of the horizon problem is strengthened by the fact that the order of growth of the scale factor (radius) of the universe during the exponential inflation that solves the horizon problem, automatically solves not only the flatness problem, but also the monopole problem (Weinberg 2008, p. 208). This makes the hypothesis of the exponential expansion

epistemically coherent in the sense that it provides some joint explanation for three meta-empirical problems of the standard cosmology. However, since cosmologists treat the inflationary model as realistic not only on the level of epistemic coherence, but the insert its constructs into the fabric of the proper physics, the question arises as to what are those grounds which make it possible to assign to inflationary cosmology a realistic status. It is here that inflationary cosmology creates a diversity of opinions in the community of physicists and raises a certain scepticism of its naively-realistic (or critically-realistic) pretensions from philosophers.

Constructs-beliefs in inflationary cosmology and their epistemic status

It is known that, in inflationary cosmology, there is a distinction between "old inflation" introduced by A. Guth, and "new inflation" of A. Linde, A. Albrecht and P. Steinhardt which leads to the idea of "eternal inflation" (Weinberg 2008, p. 216). These historical differences do not play a pivotal role for the purposes of our analysis. However, the "eternal or chaotic" inflation which is related to the idea of the multiverse is not considered by us. The main idea of inflationary cosmology is that in the very early universe (prior to the radiation-dominated era) there was an exponentially growing expansion of the universe. From Einstein's equations, which describe the evolution of the scale factor a(t), it is seen that in order to have an exponential growth of a(t) the energy density of matter which drives expansion must be approximately constant and satisfy an idiosyncratic equation of state corresponding to the so called vacuum with the negative pressure responsible for the acceleration of expansion. Since this matter differs considerably from all known forms of matter (fields and particles) the initial idea, as it appeared historically in Guth's work, was that inflation is driven through dynamics of some spatially uniform but evolving in time scalar field φ(t) (which became known as *inflaton*) which symbolizes the generic undifferentiated state of matter and which makes the potential V(φ) large enough to dominate expansion. Being nearly constant the potential becomes responsible for the relative velocity of expansion (Hubble parameter) to decrease very slowly so that the universe to experience exponential expansion.

The introduction of the scalar field φ is the most speculative ingredient of all inflationary models. For it is the physically unclear nature of this field which casts doubts about realistic nature of inflationary cosmology leading to its criticism[37]. The main question is: what is the epistemological mechanism employed which allows cosmologists to assert the realistic nature of the *inflaton* field φ (in spite of its precarious physical status) and the whole inflationary scenario. The answer comes from the fact that the theory of inflation turns out to be very flexible in being able to adjust its parameters in order to conform to any novelties in observations. By solving cosmological puzzles and providing some predictions with respect to the fluctuations in the background radiation inflationary cosmology satisfies the criterion of epistemic coherence. However, the whole construct of inflationary cosmology can only satisfy the criterion of consistency and mathematical representability with not commitment to realism with respect to the entities invoked in it. Thus one can speak of the epistemic coherence of justification for inflationary model. However if one dose not want to remain positivistically oriented in its methodology, the question remains on the transition from the coherence of mathematical description (as justification) to the coherence of truth which is behind this description, that is to whether the constructs entail truth of the physical

reality (in view of an obvious ineffectiveness of the principle of correspondence in this case).

On the level of formal (mathematical) connections the most important construct in inflationary cosmology is the potential V(φ) whose parameters can be adjusted in order to achieve a required exponential expansion. This potential enters a formal connection with the geometrical parameters of the universe through Einstein equations. Matter which is described by the field φ (and its potential V(φ) correspondingly) is supposed to be somehow converted into radiation which dominates the consequent phase in the universe's expansion and which is the directly observable physical agency. Thus the construct of the hypothetical field φ is inserted into equations related to that physics which is subject to verification. However this construct, apart from a purely mental substitution into physical equations, does not have any epistemic connections with those physical entities it supposed to describe. In view of followers of the coherence theory of justification this does not represent a problem, for the reality of the inflaton field is the constructed, constituted, reality working on the level of convention among cosmologists. The philosophically sceptical position would be to claim that cosmology proposes an illegitimate transition from the intelligible entities associated with the field φ towards those entities that are related to the empirically approved realm. In other words, one suspects that the causation which is implied here is not properly physical but intelligible (in agreement with the adherents of coherence), that is, it is dictated not by the physically evident necessities, but intentional volitions related to the desire to assign to the inflationary theory a realistic character. A position of a coherence of epistemic justification would probably be to claim that the construct-belief of the field φ does not have to connote with anything in empirical reality because its "realistic" status follows simply from the fact that this construct coheres with other constructs-beliefs through formal connections (for example equations for the field φ which follow from Quantum Field Theory) as well through helping to solve cosmological puzzles. As it is recognised by cosmologists, the major experimental success of inflationary cosmology is the prediction of some properties of the fluctuations in the microwave background radiation and large scale structure of the universe. However all these predictions as such have a precarious ontological status for they also represent eidetic transitions from what is fundamentally unknown (but possessing generic intelligible features expressed mathematically) to that which is empirically known in its variety and differentiation.

In other words, the situation can be described through the following reasoning: there are three cosmological puzzles which all point towards the contingent facticity of that state of affairs in the universe which human physicists face. This contingent facticity manifests itself in an allegedly non-generic (specific) state of the universe: we live in the flat universe, with no monopoles and strange uniformity of the microwave background radiation observed in the sky. All this strangeness initiates in physicists a desire to explain it as a variation of, or derivation from, an underlying substance or the state of matter which does not have any features of differentiation apart from its sheer existence. In fact, by introducing the field φ one effectively introduces through the power of intellection a generic entity (similar, for example, to that ancient *water*, proclaimed by Thales of Miletus, to be the ultimate and underlying level of being) which allegedly is responsible for all varieties of matter in observable universe. Certainly the complexity of this new hypothesis, in comparison with the ancient Greek ideal of the unifying substance, is that it is supplemented by mathematical theory which, however, does not

provide any evidence for this substance to be physical: mathematical entities, such as the field φ, being Platonic constructs, remain in the same realm of generic mentality as the construct of *water* in Thales.

As one sees from the analysis above, the impetus of inflationary cosmology is thus related not only to the desire to explain away the contingent initial conditions in the universe but also to invoke an idea of an all-encompassing, unknown, but yet immanent entity, the field φ, as that undifferentiated and impersonal agency in the universe, which lies in the foundation of all varied appearances of the universe. Seen in this perspective the whole enterprise acquires, from a philosophical point of view, some clear features. One can conjecture that inflationary cosmology reproduces the same transcendental jump, which has already been detected by us in other models of the initial state of the universe (Nesteruk 2003, chs. 5,6).

The major issue now is the question of the epistemic efficacy of the field φ, namely its participation in the mental activities which attempt to find its correlates in physically causal processes. This problem is similar to the explication of the transition from the *water* of Thales to any particular empirically given material formation. Such an explication, if it pretends to be honest, entails a serious difficulty; for the very desire to construct such a transition would invoke a transcendental bridging of two epistemologically and ontologically distinct regions of being (and this certainly will lead to the break beyond the limits of coherence of epistemic justification). Thus the very transition from *water* to that which is observed has a hypothetical character, based in intentionality which itself is grounded in a belief that there exists some underlying "causal" mechanism governing this type of transition. The field φ in inflationary cosmology is implanted into the process of causation through the Einstein equations: the postulated properties of the potential V(φ) drive the metric scale factor so that the causal structure of space and time (which is not observable anyway) in inflationary universe is based on properties of the V(φ) (one recalls that this causation is based on the General Relativity assumption that any type of matter contributes to the gravitational force and thus affects geometry of space). In this sense it is difficult to evaluate the realistic nature of φ through a direct insight in the resulting geometry. This is the reason why the major (epistemological) test for the physical status of φ comes forward when cosmology conjectures of the origination of all forms of observable matter as a result of the decay of φ, that is the transformation of the energy associated with this field into classical radiation and matter. This transition can be schematically presented in the following way:

$$V(\varphi) \rightarrow \rho(t),$$

where ρ(t) stands for the energy density of radiation and matter which are potentially observable. As we have mentioned above, this transition which supposes to relate two entities, V(φ) and ρ(t), has a strange feature: the two terms of the stated relationship are of a different epistemological kind, namely one is physically non-observable and hypothetical and the second is physically measurable in principle[38]. Here we face a crucial question: does the field φ indeed participate in "causal" processes on the level of the physics, and not only on the level of intentionality? If it does, in this case it has a status of more than a simple mathematical entity (which, according to philosophers of mathematics, and in contradistinction to physics, are causally passive (see, for example, (Resnik 1997, pp. 102, 106)). However it is exactly this, which is difficult to comprehend (even if one goes into the details of this transition) bearing in mind that the

physical status of the field φ is uncertain[39]. From the point of view of a coherent theorist it is not important whether the construct of φ corresponds to physical reality. However, when this φ is inserted into the equation for transformation of energy, one definitely commits oneself to a sort of realism. Here inflationary cosmology leads to a generic philosophical problem related to the dual ontological structure of being, that is the ontological *difference* between intelligible and empirical. The detection of this structure (which has been done not only in inflationary cosmology, but also in other scenarios of the early universe[40]) makes it possible to grasp a certain idealistic character with which the ideas based on the coherence of epistemic justification are imbued. However this cannot be done from a theologically neutral position because the distinction between intelligible and sensible acquires an *ontological* (not only an epistemological) character in the context of the doctrine of creation, whereas the mediation between them receives its justification in a theological teaching of humanity as microcosm and mediator resembling the difference in its own hypostatic composition through the distinction between body and soul[41].

One may remind the reader that the notion of the ontological *difference* in creation is related to the Christian understanding of *creatio ex nihilo*. When the Nicene Creed affirms the belief God, "Maker of heaven and earth, and all things *visible* and *invisible*", it affirms that God created the world out of nothing in such a way that there was an initial distinction between two realms: the realm of intelligible forms (*invisible*) and the realm of sensible reality (*visible*). The intelligible realm is simply understood as the "spiritual", "intellectual" level of created being often labeled as a *noetic* level of creation, or *kosmos noetos*. On this level God formed the angels, who have no material body. But this level contains also intellectual images of sensible reality, that is, ideas. This makes the noetic realm reminiscent of the world of Platonic ideas (which are created in a Christian context). Ideas as intellectual images of sensible reality are inevitable ingredients of scientific theories, so that scientific ideas seem to have an immediate relation to the noetic realm which complements the realm of the material universe. The existence of the intelligible realm can be asserted trough the fact that it contains the community of living minds following from humanity's ability to think, rationalize, memorize and symbolize the sensible creation in intelligible forms. However, the world of intelligible forms has an ontology *different* in comparison to the ontology of the sensible realm. If this fact is disregarded scientific theory becomes predisposed to making a naive assumption that their mathematical constructs have the same ontology as the objects which they suppose to describe. Theology is much more certain in the two-fold structure of creation, proclaimed in the Creed, because it is this structural difference in the unity of creation, which explicates the mystery of creation from the side of the created. The dichotomy in creation in general has its particular manifestation in the constitution of human beings, their composite hypostasis, traditionally described in terms of body and soul (or its analytical part – intellect). Theology asserts the human condition in the garments of skin as embodied (corporeal) existence in two levels of reality, so that it is natural to expect that humanity can be a mediator between these levels and hence to grasp their inherent unity in their createdness out of the same otherwordly foundation.

Correspondingly any theory of the universe which attempts to formulate the concept of contingent facticity of the observable display of the universe must detect the *difference* between intelligible and sensible, which carries in itself what the Greeks called the *logos* (the underlying and forming principle and sense) of creation. The

Greek Church Fathers used the word *difference* as a cosmological and theological term in order to articulate the *creatio ex nihilo* from within the world. This term comes as the translation of the Greek διαφορα′ (*diaphora*) (this term has theological contradistinction to another Greek word διαιρεσις (*diairesis*) which means *division*) (see, for example, (Thunberg, 1995, pp. 51-56)). It was Dionysius the Areopagite who used first the term *diaphora* beyond the Christological context, applying it to the *differences* of all things in creation[42]. Maximus the Confessor followed him and used the term *diaphora*, as a characteristic of created being, its *constitutive* and distinctive feature which will never disappear. It plays a constructive role in creation, because it provides a common principle of all created things: all things are differentiated in creation and at the same time the principle of their unity is that they are differentiated; in particular it provides a common principle for the unity of intelligible and sensible creation through its *constitutive* meaning in the creatio *ex nihilo*. From this perspective the issue of the *creatio ex nihilo* can never be separated from the issue of *differentiation* in creation between intelligible and sensible. The *diaphora* in God's creation is an established order, the principle of variety and unity in creation.

The immediate implication of the ontological category *diaphora* in creation, as applied to a scientific quest for the justification of the contingent facticity of the observable universe, is that any physical or cosmological model trying to imitate the mechanism of this facticity, that is the causal principle of the world in scientific terms, should deal with the fact that it is not enough to produce a reasonable scenario of how the empirical visible (sensible) universe came into being from some hypothetical underlying substance similar to the inflaton field φ. Such a scenario can attest not to the demonstration of the causal principle of the observable display, but to the natural detection of the presence of the "parallel" level of the created, that is the world of intelligible forms or the noetic realm. Scientific reasoning appeals instinctively to this realm as if it is given and is not subject to its own genesis. In other words, the contingent facticity of the noetic realm is not questioned by science because it cannot question the facticity of consciousness which has access to this realm[43].

Scientific reasoning based on physical causality therefore can responsibly be applied only to a "half" of the created (that is, the empirical realm), assuming that the meaning of this "half" is provided from the *noetic* realm, which is not itself subject to investigation on the basis of physical causality. The noetic realm is involved into the formation of scientific knowledge, so that it is this realm which is the guarantor of its expression and preservation, but the origin of this realm is not subject to science in spite of the fact that science can employ its constituents for interpreting the empirical universe. Mathematics can be used, but the justification of its facticity that is, the possibility of its use, is not accountable by science to the same extent as the facticity of consciousness is not accountable. In this sense science deals with being, but it does not produce the mechanisms of generation of being. As Heidegger was saying: "science is not thinking yet!" It is because of this that the maximum science can claim in the analysis of the contingent facticity (as specificity) of the world, is that it found the mechanism of *differentiation* in creation between empirical (sensible) and intelligible (noetic).

Now we are in a position to give a certain interpretation of inflationary cosmology. If inflationary cosmology insists on the physical nature of the transition $V(\varphi) \rightarrow \rho$, then the neutrality to ontological commitment is broken and both the realms to which $V(\varphi)$ and ρ belong, must be assigned a proper ontological status. Naturally the construct of the field φ

(and potential V(φ)) can be naturally associated with the realm of intelligible forms, intelligible universe (*IU*). The observable (visible) universe (*VU*) is associated with the density ρ of matter and radiation. Correspondingly the transition through physical causation in the formula V(φ) → ρ can be interpreted as the mechanism of *differentiation* between two created realms *IU* and *VU*. The ontological difference between two realms represents the constitutive element of *creation ex nihilo* in a theological sense. To make it more articulate, one can elucidate the situation by subjecting it to the transcendental analysis in the spirit of Kant.

The pivotal idea of cosmology is to explain the observable cosmos. The idea of the universe as a whole is invoked in cosmology in order to operate mathematically with equations applied to the universe beyond the horizon of its visibility for us. Yet it is assumed that the universe, being a uniform continuum of matter and space-time at large is subject to a scientific grasp. The specific features of this universe are supposed to be explained in terms of simple principles of unity, which aim to provide the explanation for the variety of things in the universe, which seems to be completely contingent. Cosmology hopes to replace the contingency of observable universe by some "necessary law" which itself will need no further explanation. In inflationary cosmology the contingency expressed through three puzzles is aimed to be removed through a scenario in which the observed specificity would be the result of the dynamics of the universe regardless whatever initial conditions it might have. The difficulty with this attempt is that the postulated state of matter does not belong to the series of causations related to what is visible, that is, the postulated state transcends the visible universe by breaking the series of causations in the visible universe through appealing to such a "state of matter" which does not have any empirical references, but which yet allegedly initiates the visible universe. This *primordial* "state of matter" was qualified before as belonging to the intelligible universe. The invocation of the intelligible "object" in order to explain the empirical universe becomes subjected to the Kantian critique of the argument for the existence of absolutely necessary being. Since V(φ) can not be found as an element of the empirical series in visible universe, its invocation as an explanatory element has sense only as a construct. This means that V(φ) which is to explain the structure of the visible universe, in fact, departs from the field of empirical realities and the causal series in the visible universe by acquiring the properties of a pure construct. This is the logic of the epistemic transition from the observed cosmological puzzles to the postulate of the intelligible V(φ) and all that theoretically follows from it. It is quite natural for one to ascend from the variety of data and puzzles to a unified principle, that is the field φ, which is to explain this data. However, the status of this filed remains precarious since it remains no more than a construct, which, as such, does not depart from the series of the sensible world (life-world).

The situation changes, however, when the transition from the visible universe to the intelligible is reversed, that is, when the state of matter pertaining to inflation is now treated as a level of reality more fundamental than the visible universe itself, for it gives rise to the visible universe. According to the logic of inflationary cosmology, the transition V(φ) → ρ describes the actualization of the visible universe out of the invisible, assuming that V(φ) and ρ have a similar ontological status. This ontologizing can be criticised on the same grounds as it has been done for Hawking's model of the quantum universe (Nesteruk 2003, ch. 5), so that the transition V(φ) → ρ is interpreted as a causation in a conceptual space, invoked by the thinking intellect. This implies that the *mechanism*

which actualizes the visible universe out of the invisible is *itself* a construct with the intelligible ontology.

We observe here a kind of intellectual inversion from causation originating in the physical causal series (cosmological puzzles → V(φ)), to causation originating in the purely intelligible series (V(φ) → ρ), the completeness of which is based upon existence of an absolutely necessary cause (that is, the state of matter described by the inflaton φ). This jump in reflection is based on an inability to build the empirical content of the concept of the unconditioned condition (V(φ)) in the series of empirical causes. According to Kant, however, from the structure of the visible universe one can not conclude via the empirical analysis to the existence of such a necessary cause which would not be contingent itself. And that is why one can state that there is no an absolutely necessary cause or being which would explain the visible universe. This means that the inflationary universe has no direct ontological references in the empirical realm in spite of it fertility in predicting the right spectrum of fluctuations in the microwave radiation. It exists as an intelligible object, which functions in thought only as the purpose for the epistemic justification of the detected (through the three puzzles) contingent state of affairs.

The clash between the realistic treatment of φ (V(φ)), and the opposite claim that it is no more than an intelligible object, leads one to an antinomial puzzle, which points to the only justifiable formula for dealing with the situation; namely to treat the transition V(φ) → ρ, as an example of antinomial reasoning, which is similar to the Kantian reasoning on an absolutely necessary, being expressed in his fourth antinomy[44]. The antinomy about the origination of the visible universe out of the "state of matter" pertaining to the inflationary phase of expansion of the universe can now be formulated as follows:

Thesis: There belongs to the world the field φ which is ultimately responsible for the observable protean display in the visible universe, and whose existence is absolutely necessary for the visible universe *VU* to be as it is.

Antithesis: There nowhere exists the field φ in the (physical) world, as the cause of the visible universe (there is no physical connection between intelligible and sensible universes): they belong to the different ontological realms.

The appearance of such an antinomy in the discourse of origin of the visible universe is quite remarkable because, as we remember, the initial motivation of inflationary model was to overcome the difficulties associated with the contingent nature of the initial conditions in the universe asserted in the hot Big-Bang cosmology (before the idea of inflation emerged). The critique of any attempts to deal with the initial conditions of the universe can be developed through the famous Kantian antinomy on the beginning of the universe in time[45]. What happened, as a result of inflationary cosmology's attempt to remove the problem of the contingent specificity of the initial conditions in the universe, that is, de facto, to remove the antinomy on the origin of the universe in time, is very interesting: one detects a certain metamorphosis of antinomies. The trend of theoretical research attempting to overcome the antinomy of temporal origin led, with a certain inevitability to the formulation of the antinomy of the origin of the universe not in terms special initial conditions related to temporality of the universe, but in terms of an absolutely necessary being or cause, responsible for the contingent display of the universe. This shift in explication of the problem of origin of the universe happened not on purely philosophical grounds, but under the pressure of developments in cosmological theory. In other words, the very progress of knowledge contributed to philosophy, namely to a concrete scheme of that how to explicate the intrinsic

interconnectedness of the Kantian antinomies. This shift, as we have argued elsewhere, reflects some general patterns of scientific attempts to find the generic features in the foundation of the world undertaken by human subjects.

Kant could use the antinomy formulated by us for a negative conclusion about the empirical evidence for the existence of the field φ (absolutely necessary being) as a cause of the factual display of the visible universe. His argument would be that the inflaton filed belongs to the intelligible realm and does not have an independent ontological status apart from thinking, which brought the ideas of φ into being. This conclusion indicates that the antinomies, can be considered as difficulties of reason arising in relating the ontology of the sensible world to the ontology of the intelligible world and vice versa; these difficulties rather point towards the limits of the human powers of knowledge. However, one can go further and claim that the new explication of the fourth cosmological antinomy of Kant, in fact, refines how human cognitive faculties are constituted. Namely, this antinomy in its logical performance by reason, manifests the process of mediation between the sensible and intelligible worlds, performed by a human subject in virtue of the fact that this subject is a complex of the physical-biological and intellectual-spiritual, so that the mediation between the sensible and the intelligible worlds happens within this human subject. Thus the structural similarity in the constitution of humanity and the universe (the idea of microcosm and mediator) is manifested once again: it can be formulated as that there is a common underlying principle (*logos*) which lies in their foundation and the content of this principle is that there is the ontological difference (*diaphora*) between the sensible and intelligible in both the universe and humanity.

An interesting feature of inflationary cosmology, is that it confirms the unity of the human reason with respect to the two realms in the created being. This unity is revealed through the metamorphosis of the Kantian antinomies, the transformation through which the problem of the underlying foundations of the contingent facticity of the world is explicated in a new way. This fact demonstrates that cosmology implicitly contains knowledge of human hypostatic composites, of their transcendental consciousness with the antinomial difficulties arising as soon as the understanding transcends the boundaries of experience and endeavors to speculate on the foundations of its own facticity. Taking this into account, one can only reassert that cosmology must be seen not only as a natural science, but also as having the dimension of the human science, which narrates not only about the external world, but also about humanity and its place in the universe (Nesteruk 2011).

The presence of antinomies in the cosmological discourse, points to the fundamental *difference* in the contingent creation, that is, the *diaphora* between the intelligible and sensible realms. It makes possible to conjecture whether this tendency of a split in theory between empirical realities and their conceptual images always leads a scientist to the detection of the ultimate frontier in attempting to synthesize the variety of physical experience in a single principle of unity, namely, to the unbridgeable ontological *diaphora* in the created domain. The mediation between intelligible and sensible, which is performed by philosophizing cosmologists, and which is theologically justifiable, reflects the unification of the *divisions* in creation (that, is the division between intelligible and sensible realms) which takes place not ontologically, but on the level of cognition and morality (Thunberg 1995, ch.6).

The antinomial structure of the proposition about the causation between the intelligible inflationary universe and the visible leads us finally to the conclusion that inflationary cosmology deals

with *differentiation* in the contingent creation, that is, with the basic *diaphora* in creation, rather than with the explanation of the observable display in terms of physical causation. However, since the presence of the *difference* between the intelligible and sensible reflects a general tendency and specific feature of all scientific attempts, which try to provide the genesis of the attributes of the empirical universe in a single unified theory, it becomes evident that these scientific models are not theologically irrelevant in what concerns their particular schemes which allow one to detect the presence of the *diaphora* as a constitutive element of *creatio ex nihilo*.

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1 That which was inaugurated by E. A. Milne (after Einstein's suggestion) as "cosmological principle", that is "all places in the universe are alike" has many motivations. One of them which is more close to the spirit of physics was to extend the observable isotropy of the universe at the scales of clusters of galaxies to every possible location. Here we deal with a refined version of the hypothesis of a formal interchange of home-places having a counterpart in physical reality of related to a particular geometrical aspect of what as a phenomenon is given to human consciousness on Earth. Thus the uniformity of matter distribution as well as space itself can be understood as the postulate of an isotropic view of the universe from every possible location.

2 The concept of matter of the universe in relativistic cosmology is similar to the concept of ideal gas in which real physical particles are treated as point-like objects, material points. Any set of material point can be taken than as prototype, which can be filled in with different meaning. For the ideal gas one can take a prototype of chaotic motion of material points and substitute molecules for these points. In cosmology, by substituting material points by clusters of galaxies one can obtain the notion of "matter of the Universe" (Misner, 1973, pp. 711-713).

3 The red-shift in astronomical objects is varied with their distance from our galaxy, which has been established by E. Hubble as far back a in 1929. The velocity of recession of a galaxy is proportional to its distance with the coefficient known as the "Hubble constant" H_0 which is treated as a fundamental cosmological parameter characterizing the rate of expansion of the universe as a whole. Here, for the sake of our objectives, we disregard possible objections to this interpretation of red shifts in galaxies' spectra which doubt the idea of the expanding universe. See, for example, (Rhook 1994).

4 See a representation of this statement in the graph of "The Cosmic Spheres of Time" in (Primack 2006, p. 135). See also (Abrams 2011, p. 74). The seeing of the universe as the frozen past connotes with the notion of the "block universe" according to which all points of space-time have an equal ontological status, so that no fundamental meaning can be ascribed to the distinction between "past", "present" and "future". (See more details, for example, in the paper (Isham 1996).

5 The given description of the universe corresponds to its disclosure by human beings in the course of their history. Because of the finitude of this history, which itself can be treated as an *event*, *humankind event* (this notion was introduced in (Nesteruk 2003, pp. 194-214), the disclosure of the universe as a particular action of the human spirit can be treated as an event within the humankind event. The notion of an event entails the presence of fundamental contingency. It is because of this contingency that cosmology attempts at all costs to get rid of this notion by grounding the counterintuitive content of this event in something apodictic and undeniable, inferred through a kind of an extra-logical argument (for example some abstract mathematical theory which allegedly governs the physics of the universe regardless a simple fact that this very theory is a product of embodied subjectivity, which forms the essence of the humankind-event) which itself transcends the givenness of an event. In this aspiration cosmology exercises a leap of faith, making it similar to theology which predicates humanity's existence and the presence of the world in this particular condition as an event of their communion with God, who is transcendent indeed.

6 Assuming that the reversal of initial velocities is possible (Davies 1974, pp. 22-27).

7 This point was made clear, with reference to R. Tolman, in the paper (Penrose 1979).

8 This point was emphatically defended by Penrose in many of his writings. See, for example, (Penrose 1979), (Penrose 1989, pp. 440-47), (Penrose 2005, pp. 726-732; 765-769).

9 Later J. A. Wheeler articulated this point in order to assert the intrinsic mutability of physics, including its conceptual ingredients, such as space and time. See, for example (Wheeler 1973, 1994).

10 See more details on cosmological diagrams used by us in (Harrison 1986, pp. 215, 375-387).

11 One cannot re-run the universe with the same or altered initial conditions to see what would happen if they were different. See (Ellis, 2007) (Thesis A1, p. 1216).

12 This is a different way of stating a Christian theological assertion that it is cosmic history that is treated in theology as part of human history and not vice versa. (See, for example, (Clément 1976, p. 80)). It is here that cosmology effectively explicates its hidden theological commitment linked to the Divine image in humanity which articulates the universe from within its history.

[13] This assertion can be considered as a certain variation of the idea of a block-universe, where all points related to the past light cone (related to our vantage location in the cosmos) are considered as having an equal ontological status.

[14] This point reasserts that which was said before that theologically, it is cosmic history which unfolds from within human history and not vice versa, because the primacy of existence (understood as communion) belongs to hypostatic human beings, and not inorganic rocks in the cosmos, in spite of the fact that the conditions of embodiment originate in the star-dust.

[15] On the phenomenological treatment of the intuition of continuum see, for example, papers (Longo 1999, 2002).

[16] See, for example, (Allen 2006). According to N. Smith's terminology, "one who gives a realist construal of all scientific sentences will be called a global realist" (Smith 1996, p. 29). A claim for a radical mathematical realism identifying mathematical constructs with physical realities can be found in (Tegmark 2008).

[17] For a strong critique of the concept of multiverse see, for example, (Ellis 2011).

[18] As it was expressed by Ellis in one of his Theses on philosophy of cosmology: "The universe itself cannot be subjected to physical experimentation. We cannot re-run the universe with the same or altered conditions to see what would happen if they were different, so we cannot carry out scientific experiments on the universe itself." (Ellis 2007, p. 1216).

[19] One means here the inflaton field in inflationary cosmology, dark matter, dark energy etc. See more on this in (Ellis 2007, pp. 1208-1211).

[20] See on the coherence theories of justification, for example, (Audi 1998, pp. 187-204). See also a book of (Bowker 2005, pp. 118-48), in which the author persuasively argues on the importance of coherence considerations in science and religion as a different form of justification in comparison with the correspondence principle.

[21] In this sense the coherence of justification in cosmology works similarly to theology where the catholicity ("sobornost") of the Church acts as the guarantor of collective wisdom which opposes to any sort of ethical individualism in religion. See more details in (Nesteruk 2008, pp. 211-219).

[22] See (Nesteruk 2012[1]). The intrinsic apophatic meaning of cosmology is similar to that of theology. In theology apophaticism implies the wholeness and consistency of religious beliefs in their limitations by what is called dogmas (the meaning of what is called dogmas originates in the Greek word *horos* (boundary, fence) which was used in theology in the context of the Church's definitions with a purpose to set out the boundaries of Christian faith and protect it against heresies). These dogmas, as Church definitions, are those boundaries of faith which cannot be demonstrated from outside. Apophaticism intends to proclaim the freedom of expression of faith within its boundaries if the coherence of this expression with respect to dogmas is observed. Coherence in this case means faithfulness and absence of desire to doubt dogmas. In this case the experience of faith can expand unlimitedly within the boundaries of faith, being coherent with the content of dogmas. Apophaticism reveals itself as a principle of coherence in theology, which stops reason from attempts to treat dogmas as definitions of the essence of God thus guaranteeing freedom of expressing experience of God through music (liturgy), poetry, painting etc. if the limits of this expression are observed. However, apophaticism in theology leads to coherence of truth. Here one reveals the real meaning of apophaticism not as a logical proclamation of truth about God, but as participation in this truth through prayer and liturgy. The reality of what the Christian Church teaches in its dogmas cannot survive outside doxological proclamations (Zizioulas 1997, p. 117). Thus the apophatic coherence in theology implies, so to speak, liturgical coherence as ever-presence of tradition in space and time, that is in history. Coherentism in theology acquires a historical dimension. It is clear why a theological apophaticism makes it necessary to rely on coherence of interpretation in religious matters: God is not an object, he is present in absence, we know that he is with us but we do not know "what he is". No theory of correspondence is possible here. However, we affirm God on the basis of our faith in him, that faith which implies the coherence of dogmas, tradition and liturgy. Dogmas, definition and theological opinions can point towards God, can change our attitude to his presence in absence, but they never qualify God as essence and substance to which one can refer in the mundane sense of empirical evidence. One should mention here that prayer and liturgy, as genuine means of transcendence, create in theology that breakthrough from the seclusion of its dogmatic system, making thus demonstrable that any theology has no direct sense as a carrier of truth if it does not imply faith and living communion with God. And it is this last element of genuine transcendence which makes a theological apophaticism crucially different, in comparison with the sense of the apophatic in cosmology.

[23] See, for example, (Walker 1988, p. 19). As the coherence theorist would say, the nature of objective reality is determined by the coherent set of beliefs about it. Independently of this M. Munitz, discussing whether the universe as whole can be discovered, suggests that it would be better "to say that the concept of the universe as a whole is a creative, constructive achievement, and invention, not a discovery" (Munitz 1990, p. 141). The fact that the universe as a whole is a construction of our thought can be inferred from a counterintuitive sense of what can be called its "existence". The term existence cannot be applied to the universe in a sense pertaining to ordinary objects available as their unity at hand through their pieces and moments. The existence of cosmic objects, such as clusters of galaxies, for example is problematic because each galaxy in a cluster is seen by us at different time in its history (due to the finitude of the speed of light delivering us signals from it): thus the cluster we observe is a mental construction. C.f. (Primack 2006, p. 171). This mental construction, being referred to the embodied subjectivity thus reveals all signs of its historical contingency. In this sense the whole construct of the "universe as a whole", being an ideal accomplishment still bears in itself some features of contingent formation.

[24] This expression is used in (Gurwitsch 1974, p. 44), where the term "hypostasis" is meant not in a theological sense. Elements of nature as "mental creation" also appeared in the terminology of A. Einstein (Einstein 1973, p. 291).

[25] (Margenau 1952 [2], p. 209).The fact that the ideal of science to search for the ultimate "reality" is historical by its constitution, that is the concept of "objective nature" can only be a mental accomplishment, makes doubtful recent attempts to advocate for the radical mathematisation of nature in which the "final theory" would be free of human baggage (see, for example, (Tegmark 2008)).

[26] C.f. Ellis's Thesis of Uncertainty: "Ultimate uncertainty is a key aspect of cosmology. Scientific exploration can tell us much about the universe but not about its ultimate nature, or even much about some of its major geometrical and physical characteristics. Some of this uncertainty may be resolved, but much will remain. Cosmological theory should acknowledge this uncertainty" (Ellis 2007, p. 1274).

[27] One may remind the reared that the apophatic approach to i knowledge can be formulated as an attitude which refuses to exhaust the content of knowledge in its formulation, that is, refuses to exhaust the reality of things signified in the logic of signifiers. It correspondingly refuses to verify knowledge merely by controlling the correct representational logic of the signifiers (Yannaras 2004, p. 84).

[28] A popular trend in philosophy of mathematics which effectively advocates such a view is so called structural realism. It is enough to give a couple of references: (Lyre 2009); a popularised version of structural realism can be found in (Shapiro 2000, pp. 257-289).

[29] Here one implies results related to Godel's incompleteness theorems.

[30] One can point towards S. Hawking, who builds his cosmology on the grounds of positivistic, (according to his own definition) methodology, that is, in an approach which never makes enquiries on the ontological meaning of those "realities" which are present in cosmological theories. He describes his understanding of the meaning of cosmological theories in the following words: "Theory is just a model of the universe, or a restricted part of it, and a set of rules that relate quantities in the model to observations we make. *It exists only in our minds and has no other reality* (whatever that might mean)." (Hawking 1988, p. 9, 139) (Emphasis added).

[31] One means the search for the so called Higgs-boson undertaken in the Hadron Collider at CERN.

[32] Some authors list some other problems which can motivate inflation. All these problems are related to the issue of the initial conditions in the universe. Before the advance of the inflationary model in the 1980s it was believed that the problem of the initial conditions of the universe needed a quantum description. However, since quantum gravity was yet to become developed in the 1980s, it seemed to be very speculative and far from any possible experimental verification. The discovery that one can use classical gravity (which is implied in inflationary cosmology) to address the problem of the initial conditions made the whole theory less speculative (but still speculative) and in this sense "more realistic" (Peacock 1999, pp. 323-324).

[33] As was asserted by T. Torrance, "by its nature, science is concerned with discovering and formulating the…laws of nature governing the processes of the universe, but it is incapable of establishing the initial conditions out of which the universe took its absolute rise and which ought surely to enter as rational equations into a full understanding of its singularity and intelligibility" (Torrance 2001, p. 103). The fact that the universe is an utterly specific and unique event is hardly to be accepted by physicists and reaction to such a state of affairs causes a "horror of the unique event" (Ibid.) See also in this respect (Torrance 1996, pp. 166-167).

[34] Briefly, the so called grand unified theories of elementary particles and fields relevant to the early universe predict a mechanism (spontaneous breakdown of symmetry) through which the presence of field configurations with a non-zero magnetic charge is inevitable in the early universe (which should result in one monopole per nucleon at present) and their obvious absence in the present-day universe represents a certain problem. The inflationary scenario provides a possible solution of this problem, but once again it does not entail with the necessity the invocation of this scenario, because some other mechanism can lie in the resolution of the monopole problem. Like the flatness problem, the monopole problem does not follow from any contradiction in observations of the universe. It rather demonstrates a lack of coherence at the interdisciplinary level when different block of physical theory demand a sort of reconciliation. The demand for coherence among two theories leads to their mutual advance, but with no ground-based ontological commitment. The motivation to solve the monopole problem has a different character in comparison with what happens in the flatness problem. Here one invokes a philosophical belief in the unity of physics at the level of micro- and macro-world, the unity which originates in the unity of consciousness and its desire of the overall encompassing insight of the universe. In similarity with the flatness problem there is the hidden belief that the generic scenario of the grand-unified theory (GUT) predicting the abundance of monopoles as realized in the past of the universe must not be ruled out by the fact of the present day specialness of the universe which effectively excludes the macroscopic presence of monopoles in the same abundance as nucleons. In order the physical causality between the past and present to be uninterrupted (that is the GUT prediction on monopoles be consistent with their effective absence at present) cosmology appeals to the idea of inflation. The inflation idea appears as a product of the human intentionality of the unity of the physical description of the universe to be transferred towards the causality of physical forces and processes. Once again there is no necessity in the entailment from the monopole problem towards inflationary cosmology. The problem can be solved through a different explanation. However the fact that the hypothesis of the exponential expansion of the universe provides the argument for resolving two puzzles in cosmology and particle physics makes this hypothesis attractive and coherent. See more details in (Weinberg 2008, pp. 206-208).

[35] One can show that in the matter-dominated universe $l_{max} = 4ct_0/9$, where c is the speed of light, t_0 is time today, and it corresponds to the time of emission of a signal $t_e=8t_0/27$ (Rothman, Ellis 1993, p. 886). The limit of causation outlined in these calculations does not reflect a realistic situation which is linked to the fact that many physical interactions do not propagate with the speed of light so that the true domain which influences us is much less that it is indicated by the particle horizon.

[36] In most of sources on the horizon problem a diagram is employed by using the so called conformal time in which case the initial singularity is depicted as a straight line and past line cones correspond to those ones in flat space. See, for example, (Ellis, Stoeger 1988, pp. 208, 210), (Rothman, Ellis 1993, pp. 890-891).

[37] Penrose, while commenting on inflationary cosmology points that the introduction of a new field φ into "menagerie of known (and conjectured) physical particle/fields" was dictated solely by the desire to have an exponential expansion, so that no other physical motivation of relating this field to other known physical was established (Penrose 2005, p. 751).

Weinberg on his side, while commenting on the hypothetical predictions of eternal inflation about existence of many disjoint universes, asserts that the validity of this idea "will probably have to come from progress in fundamental physics, which may verify the existence of a suitable inflaton field, rather than from astronomical observation" (Weinberg 2008, p. 217). See also (Ellis 2007, p. 1210). We do not enquire into a realistic nature of this field in spite of ongoing attempts to detect the so called Higgs-boson (which, as believed, corresponds to this field), at the Hadron collider in the European Centre of Nuclear Research.

[38] Mathematical details and theoretical assumptions for this transition to take place can be found in (Weinberg 2008, pp. 208-216).

[39] One can agree with Resnik that "combining mathematical principles with empirical hypotheses can commit one to objects whose status is neither clearly mathematical nor clearly physical" (Resnik 1997, p. 107).

[40] See our analysis of Hawking and Penrose's models for the origin of the universe in (Nesteruk 2003, chs. 5, 6).

[41] As the most striking patristic reference, one can point to St. Maximus the Confessor who developed an allegorical interpretation of the universe as man, and conversely of man as microcosm and mediator between the elements of the universe, and between the universe and God. He articulates the similarity between the composition of the human being and the composition of the universe from a point of view of the hypostatic unity of the different parts in them. A passage from Maximus' *Mystagogy* 7 elucidates the meaning of this similarity: "Intelligible things display the meaning of the soul as the soul does that of intelligible things, and [...] sensible things display the place of body as the body does that of sensible things. And [...] intelligible things are the soul of sensible things, and sensible things are the body of intelligible things; [...] as the soul is in the body so is the intelligible in the world of sense, that the sensible is sustained by the intelligible as the body is sustained by the soul; [...] both make up *one world* as body and soul make up *one man*." (Berthold 1985, p. 196) (emphasis added).

[42] Dionysius the Areopagite, *The Divine Names*, 5,8; *The Celestial Hierarchies*, 4,3,1.

[43] Some attempts to incorporate the formation of intelligence into the global genesis of physical reality, based on the transcendent applications of quantum principle were made in papers of J. Wheeler, which have not been seriously regarded by scientific community. The importance of this attempt is rooted in an explicit appeal to such factors of modern scientific discourse, which transcend the boundaries of "normal", established physics. For the analysis of Wheeler's ideas see my paper in which the reader can find all relevant bibliography (Nesteruk 2013).

[44] Kant I., *Critique of Pure Reason*, A452-453/B480-481.

[45] *Thesis*: The world has a beginning in time and is also limited as regards space; *Antithesis*: The world has no beginning and no limits in space; it is infinite as regards both time and space. (Kant , *Critique of Pure Reason*, A 426-427/ B454-455. ET: (Smith 1933 p. 396)).

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Вселенная как конструкт: эпистемологические верования и когерентность обоснования в современной космологии

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В этой статье мы продолжаем исследование эпистемологического статуса некоторых положений космологии, в частности понятия вселенной как целого. Показано, что последнее всецело зависит от постулируемой однородности вселенной и представляет собой конструкт, отчасти имеющий связи с эмпирической реальностью. Однако развивается аргумент о том, что эффективно действующей методологией современной математической космологии, моделирующей ранние стадии эволюции вселенной, является не традиционный принцип соответствия между теоретическими конструктами и эмпирическими реальностями, а известный из теории познания принцип эпистемологической когерентности, который

не требует апелляции к эмпирическому опыту и строится на предпосылках правоты и истины, устанавливаемыми сообществом космологов-исследователей. Как частный случай рассматрена инфляционная модель ранней вселенной и показана, что критерий эпистемологической когерентности приводит к трансцендентальной проблематике в стиле Канта.

Ключевые слова: верования, вселенная, космология, конструкты, когерентность, принцип соответствия, экстраполяция, эпистемология.