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SUSTAINABLE LIFE CONDITIONS FROM THE VIEW OF LOGIC, PHYSICS AND ASTRONOMY

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Abstract

Scientists have always been interested in the question of conditions for emergence of life. The aim of the study is to show the possibilities of life outside of Earth in the logic of possible worlds and through the view of Physics and Astronomy. It is necessary to say that this is not a simple question. It is a topic related to many multidimensional issues relating mainly to Astronomy, Physics and Chemistry. The above topic is also related to logic and semantics of possible worlds and it has more levels. First of all, there is the level of semantics and logic. Then there is the second - empirical level. With respect to the empirical level there are several issues – the question of parallel worlds, the question of Ockham's razor and multiverses, the question of fine-tuning the constants, and the theory of dwindling probability. The aforementioned questions form a puzzle directly connected to the basic question of conditions for emergence of life. Obviously, the said question correlates with the topic of anthropic principle. We are not convinced that the arguments for life in space are sufficient. In view of the anthropic principle, we believe that it is almost impossible to repeat similar conditions for life as in our Universe. If it were repeated for example in a parallel world, there would be no information link.

Keywords: semantics, possible worlds, theory, multiverses, physical constants

1. Introduction

The question of the Universe, its numbers, and the possibility of other worlds have its most general base in the field of logic and semantics of possible worlds. The first question we are going ask is how many worlds there are. Is there just one world or are there many worlds? What about the notions possible world and real world? These are the fields studied by logic and semantics of possible worlds which developed in the second half of the 20th century. The

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build-up of scientific researches has led, at the beginning of the third millennium, to a change in the classical vision of Science on the Universe and on the religious, philosophical and artistic experiences [1].

2. Logical aspects of the issue

The notion of possible worlds has been an inseparable part of logic, logical semantics and Philosophy since 1960s. Logic and semantics of possible worlds has become a well-developed scientific discipline whose most significant representatives defend various standpoints. Possible world semantics mostly uses modal logic framework, for example "input/output logic adopts mainly operational semantics" [2]. It is possible to differentiate between necessarily true propositions, i.e. propositions which are true in all possible worlds and necessary propositions, i.e. propositions which are true in at least one possible world. The question of possibility and impossibility was analysed by the scholastic philosopher John Duns Scotus [3]. Before Duns Scotus it had been Anselm of Canterbury whose work shows attempts to separate modal terms necessity, possibility and impossibility [4]. Also William Ockham addressed this question in his work – compare [5]. Parallel possible worlds exist in God's mind and only God decides which of them is real. It is this way Duns Scotus anticipates the logic of possible worlds. God is completely free in his actions. He only keeps what he has enacted, i.e. the first two commandments, and He is bound by the Aristotle's principle of dispute (A and simultaneously A). When God created the world He was not bound by anything. If He had created a different world or different commandments, that different world would have been beautiful and the commandments would have been good. There are other worlds in His mind and He can transform the world into other reality anytime he pleases. Duns Scotus was thus a philosopher who anticipated possibilism as a philosophical standpoint although he did not directly maintain this standpoint. Similarly, Leibniz is aware of the fact that there is an infinite number of possible worlds. He believes we live in the best one of them. Also Carnap and Wittgenstein mention the notion of possible world in their treatises. Whereas Wittgenstein speaks of the states of affairs [6] Carnap writes about state-descriptions. Carnap can be thus considered a pioneer in the field of semantics of possible worlds [7].

With respect to the logic of possible worlds we distinguish two different standpoints. They are actualism and possibilism. Actualism claims that there is one real world, an actual world, in which the observer lives. There are also other people. According to actualism, possible worlds can exist only in our fantasy or mind as something which could be real but certainly is not. One of the fully convinced actualists who rejected possible worlds as real was Willard van Orman Quine (1908–2000). For his strictness and clearly negative attitude to possible worlds, Quine is often referred to as lover of arid lands. Quine is a typical representative of actualism and opponent of the idea of existence of possible worlds. In his opinion they can exist in our fantasy only – compare [8]. With respect to the notion of possible world there is just one thing that actualists

can do and that is "to find suitable means for its reduction and expel it from the ontological slum (an expression used by Quine) back to the area of non-metaphysical semantics" [9]. On the contrary, the key notion of possibilism is possible world and possibilism counts on some degree of reality of possible world.

One of the representatives of actualism is also Alvin Plantinga who claims that "the actual possible world is one of the possible worlds, the real world" [10, p. 71]. With respect to possibilism and actualism it is difficult to categorise philosopher Saul Kripke. For Kripke the logic of possible worlds is a logical space – a set of possible worlds [11]. David Lewis is a philosopher with the strongest possibilist standpoint [12]. Lewis says that together with the world we perceive there are also other possible worlds which exist in the same extent as our world. „As D. Lewis points out, those worlds are causally isolated, because the causal relationship has as object the actual objects, requiring space-time continuity between cause and effect." [13]

However, they do not include more individuals. There are the so called Lewis's counterparts. What does it mean? Lewis's counterpart is an object which is almost identical with the original object existing in a different possible world. In every possible world the features of the counterpart and of its twin are identical with the exception of one feature. Within Lewis's theory the possible worlds do exist and they are counterparts in an existing world which is parallel to the world we live in. There are certain correlations between Lewis's approach and Physics.

For actualism the basic notion is the actual, i.e. real world which is of primary importance when defining the basis of the world. According to actualism the notion possible world has been derived from the expression actual world because this expression is ontologically superior to the notion possible world. On the contrary, notion possible world is primary and superior for possibilism. The world we live in is thus just one of the possible worlds. There are differences among various kinds of possibilism. David Lewis is a representative of the most radical form of possibilism and he promotes the idea of a world with counterparts. It is interesting that "the theory of counterparts can be theoretically adopted by also those physicists who simultaneously acknowledge the existence of other space-time" [9, p. 44]. For example, Saul Kripke presents quite moderate opinions on trans-world identity. He does not mention any counterparts. He speaks of the so called rigid designators, i.e. terms which are the same in each of the possible worlds. As Andreanský states Kripke's system of modal logic does not support actualism. It is rather on the side of possibilism as it does not clearly come to terms with the notion possible individual.

We have already explained our standpoint with respect to possible worlds. Possibilism contradicts metaphysical principle formulated by William Ockham. It is a principle of the economy of thinking according to which beings should not multiply unless it is necessary – compare [14]. Based on the aforementioned the entities are useless and illusory beings because knowing comes from experience

and logic only. The Ockham's razor is one of the basic procedures or principles contemporary science successfully draws from. The Ockham's razor deals with the problem of infinite diversity of theories leading to the same results. Let us present one peculiar example. It is possible to formulate an alternative theory to Newton's law of gravitation. This alternative theory claims that gravitation force is actually only a half of what it should be according to Newton's law. The rest of the force is provided by otherwise invisible and immeasurable dwarfs which push the bodies in a way which makes them seemingly behave in accordance with the Newton's law. However, in 2042 the dwarfs will stop pushing the bodies and it will be the end of all known physical laws. From a huge number of similar alternative methods the Ockham's razor chooses the Newton's law which does not need any dwarfs. Similarly Copernicus's argumentation against geocentrism and in support of heliocentrism was based on the fact that for its apology heliocentrism needs better configuration (symmetry and harmonic connection) as well as probability of structures, i.e. eventually far less assumptions [15]. Copernicus himself "accepted the axioms about uniform, circular motions of the heavenly bodies" [16, p. 41].

It is apparent that radical versions of possibilism, e.g. the Lewis's logic of possible worlds, which are considered real ontologically existing counterparts, contradict the above principles. "The acceptance of Lewis's response requires one to believe in modal realism in the first place." [17, p. 153] The version of the world as presented by possibilism could not succeed ontologically either (the number of beings would grow uncontrollably which situation is metaphysically unsustainable). As Tora believes "if modal realism incorporates ontological realism, it comes into conflict with its own formulation" [18, p. 1207].

3. Physical and astronomical aspects of the issue

Presentation of arguments against multiverses on the level of logic and semantics of possible worlds with overlaps to meta-physics must be complemented with other arguments on the empirical level of speculative theoretical physics. We mean the alternative cosmological theory of multiverses. Graham says the theory of multiverses offers several possible solutions [19]. One of them, the well-known strange interpretation of Quantum mechanics by Hugh Everett, is basically version of certain logic of possible worlds, i.e. of the possibilist standpoint [20]. Lewis himself accepts, as a special case of trans-world identity, the situation in which two identical worlds have the same history until the moment "when they start developing differently as if one world was being split into two parts with hitherto identical history but differing future" [9, p. 49]. Besides the above mentioned the theory of multiverses offers several empirical possibilities of various more or less isolated parallel universes. Three of the possibilities are in conformity with the theory of strings and superstrings which has basically no empirical results. Although, as Michael Duff says "the author showed that the Bekenstein-Hawking entropy of certain black holes arising in string theory is given by exactly the same mathematical formula that

describes the entanglement of three qubits in Quantum Information Theory" [21, p. 194] it is apparently the only undeniable though theoretical empirically unconfirmed result of strings theory. Therefore we do not consider the above mentioned possibilities convincing. According to A. Linde permanent exciting of vacuum practically means the emergence of new universes which exist also in reality. It is important to add that also in case of the above model the two last solutions would form one current universe from the viewpoint of logic of possible worlds. As Krempaský writes [22], universe is a word of Russian origin and it means the whole world – in Russian вселенная. The theory of multiverses brings also solutions which remind us of fantasy literature rather than serious scientific hypotheses. Holographic universe really seems to be a phantasmagoria only. Simulated universe, an artificially created duplicate, seems to be even less probable. If one lets their imagination run completely wild we get an ultimate universe which is also identical with the possibilist standpoint of the logic of possible worlds.

Let us describe the possibilities in more detail. Quantum multiverse of Hugh Everett – as an empirical version of the logic of possible worlds it absolutely contradicts the Ockham's razor (from ontological point of view it represents wasting of worlds), multiverse as occurrence of finite universes in boundless space is probably the most trustworthy of all given possibilities. However, there are no clues it exists and moreover it is not fully in accordance with the Ockham's razor although it is not logically and empirically impossible. In any case, it is a very improbable speculation. Inflation universe is something similar, however, it involves permanent emergence of new universes from vacuum. Its scenario contradicts the Ockham's razor as this hypothesis presumes enormous energetic potential of the Universe which would have many unimaginable outputs of energy. Even though "quantum uncertainty plays an essential role in the creation of a diversified complex universe with increasing entropy" [23], from energy viewpoint it would be a suicide for the universe if the universe emerged from vacuum permanently. There are several similar hypothetical reflections, e.g. "the special case where the universe emerges in a no-particle state" [24]. In the sense of bifurcation of the Universe Banks defends the sceptical standpoint too [25] especially with the existence of super symmetric vacuum of string theory in nature. Gate multiverse depends on the string theory which basically has no empirical confirmation. Cyclic multiverse is also dependent on the string theory, moreover, it is based on an unverified assumption that clash of the gates might resemble the Big Bang. The character of cyclic universe contradicts man's natural understanding of time which fact was emphasised by phenomenologist Sucharek "in the most frequently presented understanding the time is understood as a privative mode of eternity, i.e. something which has its place on the boundaries of the beginning and the end" [26]. String theories have the craziest vision regarding the enormous number of multiverses which is in direct conflict with the Ockham's razor. Holographic universe – generating identical universes on the basis of a hologram is nonsense. The idea of simulative universe, where it is possible to simulate the entire virtual

universe, goes beyond the limits of science fiction. The least probable is the idea according to which we can make any logically possible universe real. This idea denies any empirically verified facts and known invariants. The idea of a physicist Max Tegmark can be added to the above quaint proposals. Tegmark claims that each mathematical model of the Universe has its real existing parallel [27]. From the ontology point of view it is a totally erroneous idea according to which Platonic world of mathematical structures inevitably has its reflection in the world of idea reflection. Although there are several possible cosmogonical scenarios, for example "construct an infinitely cyclic cosmological model" [28], only few theoreticians come up with improbable hypotheses such as the existence of all mathematically construable universes.

The question of the existence of multiverse is an open problem. Standard cosmological model LCDM is from structure point of view a stable model [29]. One could only object that the existence of multiverses means ontological waste and that it is in sharp contradiction to Ockham's razor. At present it is not possible to either scientifically prove or refute the existence of multiverses. Taking into consideration the existence of dark energy Steven Weinberg says that if we wanted to generate a universe where there was life, we would have to generate a huge number of universes, a factor of 10 followed by 119 zeros [30]. Thus in case we succeeded in generating life, there would have to be a huge number of parallel universes which is impossible to achieve.

We can add that the Maupertuis principle is not applied to modern physics and if yes then only with the aim to derive other principles. Its basic idea that nature is thrifty in all its actions does not support at least some of the theories of multiverses. One could say that there are many objections and reservations to the Maupertuis principle [31], nevertheless, there are also theoretical concepts supporting the application of the Maupertuis principle to Quantum mechanics [32].

Our provably existing universe can lead us to very interesting findings regarding circumstances and conditions for occurrence of life. "The Universe starts with a big-bang at initial times having anisotropic behaviour and still remain anisotropic at late times." [33, p. 130] Specification determining the present day picture of the Universe has existed since the early stages of the universe. Haranas and Gkigkitzis proposed, "that in a complete quantum gravity theory the idea of information that might have to be included, with the quantum bits of information (q-bits) as one of its fundamental parameters, resulting thus to a more complete understanding of the universe, its laws, and its evolution" [34]. The question remains, however, how the said information got there. Situation looks similar in case of physical constants. It has turned out that even slight deviations of basic constants would unequivocally make life on our planet impossible. They are mainly physical constants which have been fine-tuned with almost absolute preciseness. "Constants of the Universe are such that they provide for the possibility of existence of stable systems - planetary system, atomic system, quantum system, and finally those systems which are the basis of organic life – cells, chromosomes, DNA spirals, etc." [35, p. 68]

It is basically possible to start from purely mathematical bases. They are basic physical constants such as gravitational constant, speed of light *c*, Planck constant, Hubble constant, and masses of known nuclear particles. Slight prevalence of particles over antiparticles, mainly prevalence of quarks and electrons over antiquarks and positrons at the time 10^{-11} s (violation of CP symmetry) makes it possible that the particles do not annihilate. Medium lifespan of proton and different ratio of proton and neutron masses would prevent the emergence of stars. Formation of deuterium was necessary for processes inside the stars for generating of other elements. To fulfil this condition it was necessary to have a proton with sufficient energy; however, just one proton in 10 million protons met this criterion. Precious isotope of helium 3 was produced from deuterium. Helium 3 and helium 4 merged into beryllium. Oxygen was formed via quite improbable clash of unstable beryllium and nucleus of helium 4. Formation of excited carbon was successful due to the clash of nuclei of beryllium and helium with their specific energy values [36]. If the electromagnetic interaction was stronger, the luminous intensity of stars would not be so strong. If it was weakened, the stars would shine more intensively but considerably shorter. If weak interaction became stronger, hydrogen would turn into helium. If strong interaction became even stronger, only heavy elements would be created, not light. Just a slight change of the ratio of electron and proton would change the DNA structure in a way which would prevent the formation of its replica. Equally important is the ratio between universe expansion and gravitational interaction. Changing of the ratio would result either in an inward collapse of the Universe or in fast expansion without conditions for formation of space bodies. The fact that the Universe expands and the speed of expanding accelerates is also of great importance. The reverse process would mean the collapse of the Universe and the necessary extinction of life.

Inclusion of arguments regarding physical constants is sufficient for application of thesis on an infinite number of both logically and empirically possible worlds. The weight of the argument increases in case we add other physical context such as average half-life of proton, mass of neutron higher than the mass of proton by a thousandth, formation of beryllium, formation of excited carbon via the nuclei of beryllium and helium, slight prevalence of quarks and electrons over antiquarks and positrons in the universe at the time 10^{-11} s, etc. Such case only confirms Weinberg's assertion that the Universe is unique and that alternative theory about multiverse containing a universe with living beings is senseless as such case would require the existence of an infinite number of universes. J. Colwell's remark [37] turns Plantinga's principle of dwindling probability upside down in case we apply established physical facts as conjunctive premises. On the background of Lewis's philosophy of possible worlds, of which there would have to be an infinite number, strikes the senselessness of multiverse theory in which there would be at least one universe with features identical with the features of our existing Universe.

There are meaningful hypotheses about the age of the Universe; however, it is not able to describe its beginning. The so called quantum cosmology seems to be a scientific discipline with often confusing conclusions. With respect to the above mentioned we need to add that although various interpretations of Quantum mechanics give the same predictions, when it comes to applying the said field to cosmology the situation changes dramatically [38]. Many controversial conclusions of quantum cosmology, however, do not contradict the idea of creation. Fluctuation from vacuum as well as the idea of formation of the Universe from something are compatible with the possibility of creation. We know the witnesses of inflation, relict radiation, redshift, and occurrence of chemical elements.

Anthropic principle is thus an interesting phenomenon of both Physics and Philosophy. Its definition is not clear therefore we need to differentiate between strong and weak anthropic principle. Strong anthropic principle is a statement that the universe has evolved to develop intelligent beings. The claim is made by Tipler and Barrow [39]. The Weak anthropic principle says that our Universe has such qualities that it can develop intelligent life.

The differentiation has to be approached from the viewpoint of Philosophy. On the other hand, the core of the principle is purely physical and it is based on empirically verified data. Its relation to Philosophy can be found also in the logic of possible worlds. There is just one question we need to answer. Shall we take anthropic principle seriously or is it just a last resort? Opponents of anthropic principle, e.g. Comitti [40], emphasise that the said principle was developed to serve as an arc bridging over our knowledge.

In our opinion the aforementioned premises have interesting consequences. In any case, our Universe is a unique structure. It is not possible to prove the existence of an intelligent plan which led to its creation. Nevertheless, one has to be amazed when it comes to physical and cosmological arguments. In our opinion the third version of the anthropic principle is the most acceptable. It says that the sequence of not very likely yet realized events points at very high probability of existence of an intelligent plan which was obviously used at projection of the Universe. It is not possible to present the plan scientifically and Physics cannot name its creator. Nevertheless, with respect to initial conditions for Universe development Physics clearly points at improbably feasible yet real constellation. If amazement accompanies Philosophy, let us leave it to philosophers to draw other consequences which transcend both theoretical and experimental physics. “Although Aristotle did not reach the knowledge of creation out of nothing, starting from the principles which Aristotle left established in his work one could come to the conclusion that that is how God caused the world to be.” [41] Smolin states that “the Anthropic Principle (AP) cannot yield any falsifiable predictions, and therefore cannot be a part of science” [42]. In this case Smolin’s argument is supported by Popper’s science methodology [43]. This does not mean, however, that it cannot belong to the field of philosophy which apparently has other competences than special science and which can be its meta-theory [44]. Giving up on such meta-theories

would necessarily lead us to a de-personalized understanding of the world. Hence, the philosophical impetus "to provide arguments against the Darwinian evolutionary determinism" [45]. Theologian Storoška mentions John Lennox who presents interesting arguments leading to social spheres and "who is attempting to respond to contemporary, widespread technical thinking about the world, as if our world was determined only by the forces of Physics and genetic self-development" [46, p. 62].

4. Conclusions

Authors Pathak, Guven, Patel and others assume that there is extra-terrestrial life in the Universe. However, they do not provide bullet-proof arguments just assumptions, such as "the planet which we call as Earth can't be only one to inhabit life. This ever expanding Universe which spread up-to 46 billion light-years definitely have life in its some untouched corners which we are yet to explore." [S. Pathak, U. Guven, S. Patel, S. Shalvi, V. Nair and L. Dutt, Sending a deep space probe for SETI research, Proc. of the International Astronautical Congress IAC, 67th International Astronautical Congress (IAC 2016), Guadalajara, Code 126413, 1] Argument relying on the size of the universe is not convincing enough. Moreover, if someone assumes that it is possible to meet some forms of life from the most distant corners of the Universe, it is necessary to present a counterargument regarding the continual acceleration of Universe expansion. With respect to the existence of anthropic principle, the occurrence of life elsewhere in the universe is quite improbable as the conditions and circumstances necessary for its emergence were so unique. Conditions inevitable for emergence of life are quite improbable and we are not able to provide a rational explanation for their occurrence. According to laws of thermodynamic, entropy grows with time. However, structures which appeared in the Universe were sophisticated and extraordinary. If we want to witness the emergence of extra-terrestrial life, there is just one possibility. The above mentioned improbable conditions and circumstances must re-emerge. The option that this could happen in the parallel universe remains almost impossible. We have shown that there are no possibilities for the occurrence of parallel worlds from the viewpoint of logic of possible worlds. These possibilities contradict the Ockham's razor and if there are empirical possibilities for the existence of multiverse we cannot verifiably prove their existence. Even if there was such a possibility, there would have to exist an enormous number of universes in order to prepare conditions for probability of life emergence. No forms of life would get to us from parallel universes, even if they existed. There is just one chance – if reasons which led to conditions relevant for emergence of life occurred also in some other parts of the Universe. Regardless of where the truth lies, however, one thing remains clear: the need to maintain and cultivate an open and honest discourse on these issues, while avoiding the "the pitfalls of scientism as well as blind and irrational fundamentalism" [47]. Besides academic journals and scientific conferences, mass media play a significant role and carry considerable

responsibility in promoting such open, holistic, and competent dialogue [48]. Some discussions may have an impact on society and culture [49-53].

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