Life originated during accelerating expansion in the multiverse

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It is argued that all notions associated with the origin of life should be related with the participatory anthropic principle of Wheeler and must be extended into the realm of the multiverse. Also discussed is the notion that life can only be possible in a given universe during a finite period along which such a universe expands in an accelerated fashion. We advance finally the idea that life, cosmic accelerated expansion and quantum theory are nothing but three distinct faces from a single, unique coin which describes the physical reality.

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1. The idea that life and cosmology are intimately linked to one another is not new [1]. Neither is at all recent a set of assumed likely connections between the notion of life and the basic principles of quantum mechanics [2]. On the other hand, the current period of accelerating expansion of the universe could be related to a state where the universe would adopt a quantum mechanical behavior (see later) and therefore that period might also be most straightforwardly related with the emergence of life in the universe [2]. All of such questions are the subject of a new scientific discipline which could most naturally be dubbed "astrobiology", an activity which is flourishing in new research centers spread throughout the entire world. The aim of this paper is nevertheless more akin to what can be rather denoted as biocosmology, which would be hypothesized to be a branch of cosmology making use of the above biological and cosmological ideas together with the anthropic principles and the dark and phantom energy help, in the extent that this paper actually aims at presenting the hypothesis that for all notions related with the origin of life and the Wheeler’s participatory anthropic principle [3] to become effective, they should be extended into the realm of the multiverse.

2. It appears quite a widespread accepted opinion that the origin of life is a cosmological problem [1]. In order for life to be an operative concept in this way two conditions are simultaneously required to hold: the formation of self-replicating long molecules and aminoacids and the synthesis of conveniently folded proteins made of out from such aminoacids. However, if we assume these two conditions to be fulfilled as a consequence from the evolution of the universe, then we are confronted with two big problems. On the one hand, such as it was many times stressed by Hoyle [4], the probability that self replicating molecules able to support life had been formed at any place of the universe is similar to that a tornado has of being able to mount a Boeing 747 out from the materials of a junk-yard. On the other hand, the well-known Levinthal paradox [5] makes it sure that a supercomputer which was based on plausible physical-chemical and spectroscopic rules (such as internal hindered rotation, bending or wagging vibrations, etc) would take $10^{127}$ years in finding the native (active for life) configuration of a protein made of some 100 aminoacids, which is properly folded and has a suitable biological behavior. It follows that during its entire evolution until now the universe would only allow for an extremely tiny room for life to be created anywhere on it.

It has been believed during many years that only the smallest particles or objects show a quantum-mechanical behavior. However, recent years have witnessed the emergence of the idea that such a belief is no longer valid in the realm of the accelerating current cosmology. In fact (i) if the present universe is filled with phantom energy (such as it appears to be most supported by astronomical data [6]), then the larger the universe size the greater its energy density and therefore a sharper quantum-mechanical behavior should be expected to be manifested for the current universe as far as it rapidly expands with time, tending to a true singularity when the size of the universe and its energy density are both simultaneously infinity, at the big rip [7]. On the other hand and quite more importantly, (ii) it has been recently shown [8] that the ultimate cause for the current speeding-up of the universe is a universal quantum entanglement and that one should expect that the very existence of the universe implied the violation of the Bell’s inequalities and hence the collapse of the superposed cosmic quantum state into the universe we are able to observe, or its associated complementarity between cosmological and microscopic laws, and any of all other aspects that characterize a quantum system as well. Actually, the formation of molecules able to self replicate is by itself a quantum process. The billions of smaller molecules in the primordial soup collided and quantum-mechanically formed trillions of new molecules throughout quantum processes. In any event, the probability that these random collisions would produce a molecule able to self replicate is tiny actually, so tiny that such a molecule could never have been formed on Earth or on billions of planets alike [4]. Likewise, protein folding is also a process governed by quantum
rules and describable by a wave equation that contains a power-law potential which can be expressed in terms of an order parameter expressible as a scalar field that jointly represents the set of all internal motions of the molecules along its normal coordinate modes [9]. A dependence of such a potential with temperature allows us to express the protein folding process as described by means of a mechanism of spontaneous symmetry breaking, the symmetry being the number of contacts among hydrophobic groups in the protein [9]. In any case the probability for the above whole process leading to the emergence of life to occur in a single universe is very small really.

It follows that the generation of life in a single universe like ours is an extremely unlikely process, in spite of such a single universe being a quantum-mechanical system without any classical analog and all physical biological processes leading to life have a deep quantum character. Even though there were yet unknown processes that linked protein folding with the creation of molecules able to self replicating in such a way that once such molecules are synthesized the required protein folding process would automatically take place, the creation of life in a single universe would still be extremely unlikely.

Anthropic principles correspond to a notion that is somehow against such a conclusion. In particular, the Wheeler notion of the participatory principle [3], according to which we exist in a universe which creates itself along a self-reference process. Of course, this idea has a quantum-mechanical origin as well, and predicts the existence of observers who are by themselves able to create all the physical reality that they are able to observe, even the Big Bang and themselves. Thus, rather than intelligent observers being created by the universe, what matters here is a universe which is created and evolved by the observers or at least an entity where one does not know what was before, the hen or the egg.

3. Another crucial notion is that of Boltzmann brains [10]. Perhaps ours is a typical civilization [10,11] that was created by some random fluctuation from vacuum and its condition of mediocrity [11] (typicalness) created the universe we are able to observe or imagine. Such a solution to the problem of unlikeness is actually not a solution because the Boltzmann spontaneous fluctuation is a process which is also extremely unlikely to occur along the life of the universe from the big bang until now. It has been hitherto said that the probability that molecules able to self replicate be synthesized and that for even the smallest proteins to properly fold into their native structure, are actually tiny. Even so, strictly speaking, such probabilities are not exactly zero. Therefore, since everything that may happen with whatever small but still nonzero probability actually happens with real certainty in the realm of the quantum multiverse [12], our main hypothesis is that molecules able to self replicate and properly fold must have been immediately synthesized, and hence life must necessarily have emerged in the context of the quantum multiverse. That happened and it did rapidly. The solution of the problem of the origin of life in the context of the quantum multiverse must actually be based on an analysis of conditional probability rather than just probability. In fact, one can always be sure that however small can be the probability for protein folding to occur provided the corresponding biological molecules able to self replicate have already been synthesized, it will not be strictly zero and therefore the whole process for originating life in the quantum multiverse must be true certainty actually.

However, for that to become physically feasible in the cosmic realm we are dealing with, it ought to conform to both the Wheeler participatory anthropic principle and a civilization able to be typical with respect to the universe we know; that is to say, if we extend the notion of typicalness [10], and hence of mediocrity [11], to the whole multiverse, a civilization which is typical in a given universe, would be so also in the whole multiverse, that meaning that either the typical observers can in someway observe the universes they are not living in or that such universes do not actually physically exist, at least from a participatory physical standpoint principle.

Physical space-time connections between two universes of the multiverse through which the observers can retrieve some relevant physical information from these two universes can only be achieved by means of Lorentzian wormholes with relative speeds between their mouths at all unspecified. The latter feature expresses the otherwise mutual independence between the space-times of the universes that form up the multiverse, and makes it impossible to establish any kind of simultaneity among distinct civilizations potentially living in different universes. Therefore, even though life is originated almost immediately in the whole context of the multiverse, it can only be realized in just one universe if we want observers to be typical, no matter whether they are able to perceive just one universe or many through connections by means of wormholes, the second possibility being more probable certainly.

4. The great scientist and scientific divulger Carl Sagan used to declare [13] that we all were somehow present in the primeval Big Bang and became later what has been dubbed as powder of stars. If life actually is an endeavor of the whole multiverse rather than a matter that concerns particular universes, then the Sagan’s idea had to be actually extended to the context of the multiverse. Instead of his declared observations, one could well say that we all were somehow present at the moment in which the whole multiverse was created, that is to say eternity, quite likely.
Panspermia is an ever credit-gaining theory which shifts the origin of life on Earth from Earth itself to the single cosmological context [14]. Etymologically, it means seeds everywhere, so expressing the idea that the seeds of life are spread in a rather homogeneous form throughout the entire universe, and that such seeds once reached the Earth where they developed into the known living beings. If life is a matter concerning the whole extent of the multiverse, then one had to replace the notion of panspermia for that of what could be dubbed as holospermia. Etymologically, holospermia would mean seeds in the wholeness and would express instead the idea that the seeds of life were spread throughout the whole multiverse in our remote past, and that such seeds once reached our own universe, possibly through a wormhole.

It was Sir Fred Hoyle who coined the term panspermia for his cosmic theory for the origin of life on Earth [14]. It is possible- and actually claimed by the notion of holospermia- that, rather than being present at the Big Bang, we were all originated in the set of all universes making up the multiverse. Actually, if as stressed many times by Hoyle himself [4], the probability for life to have been spontaneously generated in our own universe is extremely tiny, and that on the contrary, it becomes full certainty in the set of all universes making up the multiverse, then the probability for holospermia to be responsible for the origin of life in our universe is by far much bigger than for panspermia making that job.

5. It has been shown [15] that whereas life cannot be maintained in the future of a de Sitter or decelerating universe, it can be extended indefinitely in the case that the universe is filled with dark energy. We can see also in a rather straightforwardly way that the latter result keeps being valid also in the case of a universe filled with phantom energy. In fact, for a constant equation of state with $w = \text{Const.} < -1$, the condition

$$\frac{dH}{dt} = -\frac{3}{2}(1 + w)H^2,$$

amounts to $H \propto -t^{-1}$, so that the Hawking temperature will turn out to be expressed as $T_H \propto H \propto -t^{-1}$, which, in the Dyson’s notation implies $q = 1$ so preserving the Dyson requirement [15] and hence eternal endurance in the future of life in a phantom universe. The emergence of a big rip singularity in a finite time of the future would at first sight seem to indicate that there will be a doomsday at that singularity where life, together with all other physical objects and the laws of science themselves, will inexorably perish. Intervening wormholes connecting both sides of the singularity might slightly -in cosmic terms- delay the final destructive destiny of life, but even though some living patches would bridge the singularity abyss getting on the other side, the space-time there is contracting rather than expanding and hence life would again have its hours counted by application of the Dyson argument. The only way to be followed by future civilizations and living beings to try to get in a future trail getting into eternity would be by using the big trip connections among an infinite number of universes [16]. Thus, even in the case that the universes are filled with phantom energy, life could endure eternally in the realm of an infinite number of universes.

In what follows we will argue that whereas life will in this way eternally persist in the future of an ever accelerating universe, it is bound to be confined at times longer than the coincidence time in the past of that universe. The reason for that confinement is simple: since any decelerating equation of state does not allow life to persist long enough in the future of any evolutive hypersurface when we trace evolution back to a sufficiently early time, one would always have a situation which is lifeless before the coincidence time.

This result would confirm the intuition that ultimately life is nothing but a property of the accelerated period of the universe, a period which, on the other hand, is closely related to the deep quantum-mechanical character of the universe in such a way that it should somehow be connected with sharp quantum properties such as entanglement, wave packet reduction and non-locality [8]. In this way, life, cosmic accelerated expansion and quantum theory are nothing but three distinct faces from a single, unique coin.

Let us finally briefly consider the issue of life survival in relation with the second law of thermodynamics in the contexts of our single universe and the multiverse. We notice that such an issue can be dealt with by using the following two analogies. On the one hand, one has the well known Schrödinger idea, which was advanced in his famous book "What is life?", that life is noting but information (in the Shannon sense) or, in Schrödinger terminology, negative entropy or negentropy; on the other hand, it has been many times stressed that the biological process of self-replication is equivalent to computation, that is to say, it is like a computer. By adopting these standpoints, one can deduce that in an accelerating universe, one can see less infinite space rather than more of it. The bounds of the observable universe shrink as the space between objects accelerate and expand as the spaces close because no light from objects outside a range of 13.7 billion light years - the time of the birth of the universe - has enough time to reach the Earth. It follows that entropy in our universe should increase very quickly in the presence of dark or phantom energy. Moreover, since entropy increases rapidly in an ever accelerating universe, a computer could not run forever in an ever accelerating universe like ours. Therefore, life cannot last forever in the presence of dark and phantom energy in a single universe. Clearly, it can only be in the context of the multiverse that this entropic effect can be compensated.
by the opening of an infinite number of classical (and possibly quantum) information channels which can ultimately render life itself to last forever. Such classical information channels would be made of the above alluded inter-universal wormhole connections. Moreover, a computer (self-replicating biological system) which can run forever this way has a potentially infinite amount of memory available. It then follows that, in the context of the multiverse, every thought will be destined not to be forgotten and then re-discovered, but rather to be preserved forever.

In this Letter we have discussed some relations between the current evolution of our accelerating universe and the origin of life and intelligent civilizations in the full context of a multiverse model where the distinct universes are linked to each other by means of traversable Lorentzian wormholes. Adhering to the recent view that the emergence of life is a business of the whole multiverse rather than individual universes, we argue in favor of the ideas that once life appears in the multiverse it lasts forever, and that life, the accelerating universe and the deepest aspects of the quantum theory are nothing but three distinct faces from a single coin describing the physical reality. Also favored is the idea that the knowledge which is being achieved by the civilizations will be accumulated and preserved forever.

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