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Lost in Void on a Pale Blue Dot

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To the partners of CALIBRE: Richard Cathcart, Charles Finkl, Viorel Badescu and David Noel

Resumo: O presente artigo faz uma síntese das principais ideias que tenho desenvolvido ao longo dos últimos anos acerca da conjuntura epistemológica contemporânea em cosmologia e áreas afins, evidenciando as contribuições disruptivas que tenho procurado trazer a estes campos. Centrei o ponto focal da discussão precisamente sobre a plausibilidade da expectativa de vida inteligente extraterrestre. A existência comprovada de planetas extrassolares aumentou as esperanças de encontrarmos um mundo semelhante à Terra, dotado de condições ambientais pelo menos para as formas de vida mais simples. Agora, o número crescente de exoplanetas aumenta a excitação pela descoberta de sinais de rádio de inteligências alienígenas, que de fato nunca vieram. O "Grande Silêncio" parece consistente com a diversidade de acidentes que ocorreram para que existíssemos, e com as prováveis restrições físicas de larga escala. Partindo-se da lógica de que a biologia não pode contrariar as leis da física, meu objetivo final é ressaltar os fatores físicos restritivos que foram favoráveis ao surgimento da vida complexa inteligente como a conhecemos. Trata-se de uma abordagem predominantemente conduzida no plano da filosofia da ciência, de modo que o leitor precisará consultar as referências técnicas indicadas para maiores detalhes formais.

Palavras-chave: cosmologia, vida complexa inteligente, restringência física.

Abstract: This article summarizes the main ideas that I have developed over the last few years about the contemporary epistemological situation in cosmology and related areas, emphasizing the disruptive contributions that I have sought to bring to these fields. I have centered the focal point of the discussion precisely on the plausibility of extraterrestrial intelligent life expectancy. The proven existence of extrasolar planets has raised hopes for an Earth-like world with environmental conditions capable of supporting at least the simplest forms of life. Now, the growing number of exoplanets adds to the excitement over the discovery of radio signals from alien intelligences, which in fact never came. The "Great Silence" seems consistent with the diversity of accidents that occurred to bring us into existence, and with the likely large-scale physical restrictions. Starting from the logic that biology cannot contradict the laws of physics, my ultimate goal is to highlight the restrictive physical factors that were favorable to the emergence of complex intelligent life as we know it. This is an approach predominantly conducted in terms of the philosophy of science, so the reader will need to consult the technical references indicated for further formal details.

Keywords: cosmology, complex intelligent life, physical constraint.

1 Introduction

Since the discovery of exoplanets, which already number in the thousands, a new wave of invigorated expectation about the existence of beings similar to us has been occupying our minds. Excited by the frequent appeals of science fiction and the invasion of fanciful conjectures about other universes, humankind revives the crucial questioning about its loneliness in the cosmos. It is believed that we have a good chance of answering definitively, in the coming decades, the fundamental query regarding our apparent uniqueness. A confirmation of the existence of other intelligent beings would have a tremendous impact on our lives, our culture and our religions. However, even if there is optimism on the part of some people, there is also an increasing recognition that the idea of being alone is very plausible (for the sake of objectivity, and for lack of comparative patterns, I hereby rule out speculations about inorganic metalloid life).

The literature on the subject of life beyond Earth is relatively wide, covering approaches ranging from the real possibilities of simple life, passing through the habitability of other planets for humankind, and reaching the debate about complex alien intelligent life [1-10]. It can be said that, despite the infancy of the subject at the time, the first serious record on habitability was the 1964 work of Stephen Dole [1]. Considering the state of knowledge in the 1960s, in many ways the book still offers useful content, sixty years after its publication. Reference should be made to Hoyle and Wickramasinghe's *new panspermia* for its daring and innovative character in contrast with the canonical thinking [11]. Particularly, in my point of view, after many decades of theory and observation[1], the resulting model predicting a cosmos that undergoes expansion brings by itself extreme restrictive consequences for the flourishing of life.

In present article I intend to summarize, by means of a philosophical discourse, the main ideas addressed in my previous works on thermodynamics and cosmology, including some recent findings in the field of theoretical cosmology. I explain to the reader that when referring him to my former papers, solo or in co-authorship, I do so because it is a continuous research with several original points, and not for personal vanity. Whenever in doubt, the reader should consult them.

2 A new look at the real situation

I've always been a science fiction reader, mainly the stories of Arthur C. Clarke and the novels of Poul Anderson, a distinguished and awarded American writer, today almost forgotten. Clarke was a visionary that influenced some of our current achievements and still potential conquests for the next decades or centuries. Anderson was a

[1] An interesting approach to the history of some conflicting ideas on the nature of the universe after Einstein's general theory of relativity can be found in the nice article of Cormac O'Raifeartaigh and Simon Mitton [12].

physicist, which certainly ensured the techno-scientific plausibility of his wonderful narratives, despite the necessary typical concessions of the genre. One aspect that always caught my attention in his literature was, as the writer Sandra Miesel pointed out, a certain fixation on the fight against entropy [13], a theme of thermodynamics that occupies a special prominent place in my scientific production. I have written many pages about my view of thermodynamics, and entropy in particular [14-16], so that the essential thing to say here is the following:

A) Entropy is a perfectly defined concept exclusively within the scope of thermodynamics, having nothing to do with stochastic approaches.
B) Entropy is a quantity that does not decrease under any circumstances, and its progress can only be slowed down.
C) There is no real reversible processes; reversibility characterizes a partial disposition and, especially, an artificial one in the sense of being forged anthropically by means of some technological device such as a thermal machine.
D) There are no real closed systems.

Failure to observe these fundamental premises has led to a series of misunderstandings regarding the general comprehension of the laws of nature with respect to the evolution of the universe. I must reiterate that this is my way on thermodynamics with interesting consequences for cosmology.

In the movies, I'm an unconditional fan of Star Trek, all the series. Unfortunately, teleportation of biological beings is a physical impossibility — both for the dissipation of energy involved (which would irremediably destroy any living being) and for the insurmountable complexity of information to be computed —, and the space-time warps, although mathematically formalizable [17], are physically beyond our technological capabilities, and we don't even know if they shall be feasible in the coming centuries. A utopian federation of planets will probably remain in the imagination of good science fiction writers. The universe doesn't care what we believe to be illogical, such as being so vast and yet harboring only one intelligent species. I think our reality is more like the recent James Gray's “Ad Astra”, in all aspects (disputes over the exploration of the moon, the capitalist model of colonization of our satellite, the absence of evidence of extraterrestrial intelligence, the always double-faced political way of dealing with crises, etc.). "We are world destroyers", so said Brad Pitt's character Roy McBride; shocking, but true. Yet, although this seems clear at least to the minority responsible for science, there is a certain infantilization of the public, something that has been happening in increasing proportions since postmodernism as a result of the massive attack of pseudoscience, the gap between society and academia, and the support of the techno-sensationalist media to the profusion of extravagant ideas about space tourism and other fooleries. Reason tells us that none of this is intended to improve people's lives, just to feed the ego of the few billionaires and jacks in offices who dictate the course of humankind. Also, we don't live in a trusting world. Journalism ridiculously feeds more and more on media lynching, dehumanization and extreme caricaturization. The manipulation of information is so blatant that I stopped following television news a long time ago. I am not a conspiracyist, but it is certain that discoveries considered strategic from the point of view of institutions in power will always be kept secret until it is convenient to disclose them.

That said, although so far we have not been able to get rational communication signals from outer space, the high likelihood of the hypothesis of absolute solitude does not rest on this fact, which, by itself, would not be sufficient for a negative answer. In fact, unless a *sui generis* combination of several events was configured — such as the balanced number of impacts of asteroids and comets on the surface of a planet so that much more is added than subtracted, a suitable combination of water and rocks, and the chirality involved in the influence of muons on the generation of mutations —, biological evolution will not be able to act in a manner analogous to what led to the human species (not to mention the need for a magnetic field strong enough to shield the planet from lethal cosmic radiation). Of the thousands of cataloged exoplanets, none is so far substantially similar to Earth. Still, there might be another Earth, though it's not a matter of probability and statistics, but of physics.

As one can easily see, the physical constraints are immense, starting with the fact that the very expansion of the cosmos conspires to distance hypothetical civilizations. An even more critical factor is that intelligent life may be fundamentally constrained by the universe's expansion rate, that is, it can only occur within a very narrow range of accelerated expansion values (only a certain average rate of expansion – corresponding to a certain average acceleration of entropy – would make the emergence of complex life viable) [10]. This way, we got lucky; we showed up at the right time, it seems[2]. When we talk about Universe's expansion, we are also speaking of the expansion of what constitutes us in ultimate essence: space-time. In order for us to exist, it is necessary that the amount of expansion in our bodies, as well as in the world on which we act, be very small in contrast to the electromagnetic ties that keep us intact. This makes us think that we have probably misunderstood gravity, mistaking it as either an ordinary force or a quantizable field. But if we model it after sub-Planckian compressions and expansions of space-time[3], we might imagine something else from dark matter to match the flat rotation curves in galaxies[4] and large scale observations. Since the expansion of the cosmic woof from a figurative dot occurs in all directions, a certain neighborhood in expansion may be being overcome in its borders by others with

[2] Of course, if there are inhomogeneities in the rate of expansion, we might expect to find bubbles of space-time potentially favorable for the emergence of intelligence.
[3] This is well intuitive since gravitational waves are successions of pulses that alternate compressions and expansions of space-time. They can even help us to understand more deeply the first moments of the universe.
[4] Space-time as a single physical entity, dually defined by a dynamic of expansion and compression, seems to encompass the two cosmic trends — while dark matter pulls matter inward, dark energy pushes it outward — in a simpler and more objective way.

greater expansion power, thus suffering a compression effect. By this reasoning, it seems, certain regions of the space-time woof are confined zones that expand compressed by their surroundings under such intensity that they end up shrinking at risk of even collapsing. It's like walking on a conveyor belt in the opposite direction without ever reaching the exit. This dynamic of interactions between expansion zones conflicting with one another can explain what I call the “dark effect”, which would aid to “close the bill” of the amount of matter, today supposedly equalized only by dark matter. We thus have the energy of expansion (dark energy) and its dark effect, which is nothing more than ongoing gravitation. This is true natural logic; for expansion to occur, something had to be compressed. We can keep our usual mathematics, however applied to slightly different objects due to the physical continuity assumed from the sub-Planckian expansion. Indeed, it is difficult to imagine something continuously small, and yet finite. But it is precisely this conception that allows the elaboration of o sub-Planckian physics that makes sense and that is not a purely mathematical lucubration.

2.1 The continuum in physics

In a nutshell, space-time compression-*cum*-expansion is equal to gravity in action, expressing the same and unique phenomenon (note that mass is never referred to; this for a very simple reason: mass only amplifies what already happens naturally in the cosmic woof absent of matter). Therefore, expansion is not, strictly speaking, due to a mysterious repulsive force, but is part of a game of opposed tendencies based on a single energy. As the expansion does not have a privileged spatial direction, dark energy is the same that compacts space-time whenever one expansion neighborhood opposes and overlaps another. As observed by Serpa & Veras (thinking physically),

“To exert gravity is to compact (dense) space-time, and to compact space-time is to contract the infinite intervals of space-time by contracting the interval that contains them into an infinite succession of intervals that contain intervals. This is precisely an example of what we mean by continuity in physics.” [18].

This is like we had, in a *Gedankenexperiment*, a infinite mirroring effect in which the images are always finite, but their sequence is an infinite and continuous change of scales.

As I've often said, dealing with infinities is not a matter of physics. Whenever we run into them it means that something is wrong with our representations. We can deal with the abstraction of an infinite number of objects, but the object itself must be finite. At this point, within the isomorphism that is sought between mathematical representation and the represented nature, there is a fundamental approach in my work: the space-time has no parts, and the intervals we suppose are not constituents of a geodesic but simple artifices of thinking. Any interval can be supposed in any scale, thus representing all geodesics. To understand with precision, let me declare an axiomatic body.

-Axiomatics-

Definition I
A_i is a finite set of closed real intervals:
$$A_i = \left([a_1],[a_2],[a_3],[a_4],...,[a_n]\right),\ i \in \mathbb{N} / i \le n.$$

Definition II
$\mathbb{R}$ is the set of real numbers.

Definition III
$]b_j[$ are open sets of $\mathbb{R}$.

Definition IV
An application $f\colon A \to \mathbb{R}$ is said a "meddling" if A can be ordained in $\mathbb{R}$, such that
$$f([a_i]) \in \left(]b_{j-1}[a_j]\ b_j[\ ,\ ]b_{n-1}[a_n]\ b_n[\right),\ \text{for } j \le i \le n.$$

Definition V
A set A is said to be quasi-homeomorphic to $\mathbb{R}$ *iif* there exists a meddling $f\colon A \to \mathbb{R}$, no matter how small the selected scale of the intervals taken over A.

Axiom I
Space-time intervals are quasi-homeomorphic to $\mathbb{R}$.

What does this mean precisely? In physical terms, it is much more useful to imagine a continuum of scales, since the object has space-time factuality; it exists *in facto*, unlike the mathematical object, which exists only *in abstracto*. In other words, in physics the small is always finite, no matter how small, regardless of the fact that we cannot reach it (nature does not exist for our absolute control). *Definition IV* is a topological rule to insert an ordered set of closed intervals into $\mathbb{R}$, whilst *Definition V* is similar to tell that, physically, "a regular n-agon is quasi-homeomorphic to the circumference, no matter the scale of the hexagon", being each side a closed set, and each vertex an open set; there is no discontinuity, only a language artifact to thereabout represent what we may realize from nature. In the cosmic woof, between two closed intervals — artifacts of thought — there is always an open interval. This seems difficult to intuition because we are used to treating the physical object as if it were a mathematical entity, which is an error. As we all remember the great Bohr, physics is about what we can say regarding nature, not what nature is. Therefore, there is no point in claiming that the universe is mathematical, something that has been heard so many times. This is perhaps the greatest silliness of all time in science, a direct reflection of its postmodern distancing from philosophy.

Now, if we understand gravity as resulting from the space-time dynamics explained above, those movements of expansion and compression take place from sub-Planckian domains, since space-time is continuous. Another way to understand this continuity goes back to the Big Bang, when space and time were created. We always consider Planck time as the unit of duration for computing the first moments of the universe. The intervals are then counted as multiples of this unit. However, the universe is independent of the systems of units we have invented. There is a continuous passage of time up to the one Planck unit mark, however fast with or without inflation.

3 Back to the natural restraints

If we think that all hypothetical forms of intelligence are based on the same neurocognitive and neurosystemic principles, which is quite reasonable, we should expect essentially familiar behaviors from aliens, however bizarre they may seem. They wouldn't be so different in mental proclivities. A spacefaring civilization, or sentient agglomerate as I've called it [7], advanced million years compared to ours, living in the borders of an old galaxy, would already have mastered an unimaginable technology (perhaps even incomprehensible to us), having miraculously survived the psychosocial storms and the events that lead to extinction. It would have already colonized large regions of the outer edge of its pale and dull galaxy, considering the hypothetical natural constraint of at most one civilization per galaxy [8]. The primary of its homeworld would long ago be surrounded by a Dyson sphere, and its form of communication would be beyond our reach. With such scientific and technological power, the aliens could plan and implement a policy of colonizing other galaxies with their artificial wormholes (certainly at a high energy cost!), but why would an advanced civilization to the point of controlling colossal energies do such a thing? Perhaps in flight from its reddened dying galaxy, where hardly a new star is born, buffeted by the harmful hot wind blown from its supermassive central black hole, a constant, disquieting wind preventing new star formation. The Milky Way, although already in a slight decline, would seem a new and bright future to these aliens, and if they discovered us with our primitive chemical rockets, they would probably take us for insignificant insects. However, if they deemed it necessary to carry out preventive fumigation in the new house, I believe they would do it without hesitation (we know what happens in encounters between aborigines and conquerors!). Apart from this imaginary extreme and somewhat improbable situation, we shall remain isolated and alone, according to a suspected natural constraint that prevents contact between two civilizations [8].

In my view, in a galaxy, considering the time needed for cosmic evolution to give rise to Darwinian evolution to the point of reaching the oddity of intelligence, the spread of intelligent life would take place from what Dyson conceptualized as green technology [2]. According to him, "green technology means that we don't live in containers, but that we adapt our plants, animals, and ourselves to live haphazardly in the universe as we found it." This particularly applies to the occupation of our solar system with its impressive multiplicity of worlds, starting with a very promising satellite, very close to a virtually inexhaustible source of Helium-3 (He-3): Titan, the fantastic moon of Saturn, bigger than Mercury. As is known, He-3 is the ideal fuel for fusion engines, being abundant in Saturn's atmosphere. On the other hand, Titan has a dense, yet unbreathable atmosphere, offering a pressure compatible with the human presence, as well as a gravity that is comfortable by our standards. Although icy, it does not have strong winds, a fact that makes its climate surmountable with the protective resources we have at our disposal. As one can see, contrary to the dreamy plans of interstellar travels that are not feasible for our fragile bodies, a hospitable, balanced and resource-rich solar system appears to be a key factor for the emergence and perpetuation of an intelligent species. So far, apart from ours, none of the known systems has such a configuration; *exceptio regulam probat*!

4 The unappealable logic of nature

Just as it is unlikely that we shall be visited, for better or worse, by another civilization, it would be unlikely that we shall leave the solar system for reasons of survival, if not for other impediments, at least for the complete lack of reasonableness of such an undertaking. As hinted at in the previous section, our suite of planets exhibits configuration features that apparently favored the emergence and preservation of life. The positioning of a gaseous giant in the exact location of Jupiter, assisted by a second gaseous giant, Saturn, enabled the formation of a kind of "management barrier" for the movement of smaller bodies that could threaten the Earth, considerably reducing the chances and frequency of dramatic events over long geological periods; this gave time for intelligent life to flourish, but it was required the presence of two admirable giant worlds that completed the seemingly stable balance of the solar system: Neptune, the champion in speed of winds; Uranus, the ring-and-moon recycling champion. Also, in terms of survival of the species, the solar system looks auspicious with a great diversity of rocky moons and surely abundant water, in addition to a veritable infinity of asteroids virtually available for mineral exploration. In face of all this, I believe the idea of interstellar travel in search of other solar systems is unproductive, in fact, very far from practical reality. I still prefer to suspect there is a kind of virial principle that balances the survival potential of an intelligent species with the resources available in its own home system, dispensing the need for projects with little or no technological viability.

5 Probability, statistics and faith

Carl Sagan was undoubtedly one of my inspirations when I was a boy motivated by the telescope my father gave me at age 14. In one of his famous books, "Pale Blue Dot: A Vision of the Human Future in Space", which motivated the title of this article, he pointed out that the Voyager missions never found signs of life on the worlds of the outer Solar System, despite the fact that organic matter was found on abundance, or, as he called it, "premonitions of life" [3]. This picture has not changed with the most recent observations. Once flourished, life proves resistant judging by the damage we have done to its various forms developed on Earth, but it seems to be a very rare phenomenon outside our planet. If this is the case for life in its most primitive forms, what about complex and, ultimately, intelligent life? As Don Lincoln commented, "The expectations of a universe full of neighbors similar to us did not prove true." [5]. And continues further:

"It also seems safe to say that there is probably no civilization in our stellar neighborhood that has been making radio transmissions for hundreds of years. Nearby intelligent life, at least of the radio-transmitting variety, appears to be rare."[5].

There is also a search for laser-coded emissions, with equal failure. In any case, for those who argue that we are looking for intelligence signals in the wrong sources and frequencies, it is important to point out that it is reasonable to assume it would occur to any emerging civilization to use radio waves as an obvious first resource of communication.

As I said earlier, evaluating the possibilities of intelligent alien life is not a matter of probability and statistics, but of physics, more precisely, of physical constraints. Imagination has no barriers, but efforts to bargain with physics are futile, just as ignoring the very real obstacles to man's survival in space is a demonstration of impressive naivety, a finding that should hold true for any higher form of life well adapted to its planetary conditions. In particular, statistics, as it has often been used, has done little to advance science (this is pitiful!). Statistics describes properties of sets of numbers representing some scenario, so that predictive extrapolations can be made to larger sets of such numbers for the same scenario. At the present time, the number of known civilizations we have at hand is 1, with which we can do little but fervently wish that there are others with recognizable technological skills. On the other hand, to estimate the occurrence of a phenomenon in a context of randomness, such as in Drake's equation, countless factors would be necessary[5], some of them we have no control, and some of which, eventually, we do not even suspect.

One civilization at most in each galaxy [8], perhaps only those galaxies within the correct range of expansion acceleration [10]; this hypothesis I recently suggested does not leave us very hopeful. If so, I think it's better for everyone, humans and aliens alike. Humankind is not even ready to fully give up its worst power intentions in the name of survival, sustainable development, and a brighter future for the new generations, a bit like in “*La Nuit des Temps*” (“The Night of the Times”, translated to English version as “The Ice People”), a science fiction novel by René Barjavel [19]. On the other hand, if we accept the reasonable presumption that aliens and humans should not differ much in neurocognitive and neurosystemic aspects, what can we expect from a fortuitous encounter? When in doubt, perhaps we should remain silent.

[5] Even the presence of a giant moon like ours may have played a fundamental role in establishing conditions for the emergence of life due to the tidal regime that it originates, allowing the formation of chemical slops on the continental edges with substances necessary for biological activity.

6 Never ending the limits of knowledge: many unknown unknowns

Knowledge in general astronomy and cosmology — on which everything we imagine to know about the universe depends — progresses with a lot of uncertainty, especially in astrophysical cosmology, a lot of comings and goings. Stancliffe *et al*. published an interesting article about uncertainties in stellar physics based on a project to intend to estimate the systematic uncertain ties involved in the calculation of stellar evolution tracks[6], with the following very inspiring statement:

"Stellar evolution codes are a lot like religions: there are many of them to choose from, they possess many similarities, and it is not obvious which of them (if any) is correct." [20].

Until recently, there was consensus on the formation of the solar system from a cloud of materials originating in a supernova, as in fact supernova explosions are the providers of all the constituent elements of biological systems and of all known matter. However, the frequent presence in asteroids of a rare radioactive aluminum isotope, Al-26, raised doubts about the precise origin of the primordial cloud, since this isotope is produced only by super hot Wolf-Rayet stars. At the other extreme of the investigation are unlikely galaxies in regions very close to the Big Bang where they shouldn't be. The bizarre side of the universe is revealed in astonishing phenomena, with planets orbiting pulsars and neutron stars that behave simultaneously as pulsars and magnetars, such as the Swift J1818.0-1607, cataloged as a young radio-loud magnetar [21]. There are many surprising puzzles which succeed and interconnect in a sequence that seems to have no end. The only thing that hasn't surprised us yet is life beyond Earth.

It is a fact that science will always advance by improving or replacing its theories as we improve our tools of corroboration. Science also advances with risks and new beginnings. I remember that Einstein, in his historic reflections on the nature of the universe, proposed at a certain point, when examining more closely the hypothesis of a universe in constant creation of matter, that his cosmological constant would represent the creation term in his field equation, associating a certain energy to the vacuum, which soon proved to be unsustainable. However, I fear that the scale of uncertainty is on the way to disproportionately overcoming the few certainties that the great Laws of nature assure us. We have no idea how many unknown unknowns there are, especially when it comes to the

[6] Furthermore, the authors note that "..small systematic uncertainties in the stellar parameters may be strongly significant in terms of planet properties, for example for planets in the 5−10 $M_\odot$ transition region between gaseous and rocky planets. For these planets, underestimating the uncertainty of their mass and/or radius may lead to dramatically wrong conclusions: a planet presumed to be a super-Earth in the habitable zone may instead by an uninhabitable gaseous planet."[20].

transition from the purely physical to the biological[7]. Dealing with so many limitations is sometimes tiring and discouraging, but that's the nature of things. This is how we move forward. As once Fred Hoyle said,

“Defining the universe to be everything there is, manifestly we cannot be expected to understand it exactly, since to do so we would need both a complete command of the laws of physics and the fantastic calculating power to work through the detailed properties of assemblies containing very large numbers of particles.” [23].

And he added further:

“The big problem in biology, as I see it, is to understand the origin of the information carried by the explicit structures of biomolecules. The issue isn't so much the rather crude fact that a protein consists of a chain of amino acids linked together in a certain way, but that the explicit ordering of the amino acids endows the chain with remarkable properties, which other orderings wouldn't give.”[23]

Still, without some degree of creativity and independence, scientific way of thinking freezes, and the freezing in theoretical physics is frequently marked by a lot of intellectual energy consumed with sterile mathematics and fanciful assumptions. Furthermore, it is customary, and even understandable, to cross one's arms in face of certain difficulties assuming a model that shows great success in some respects, leaving others aside. For instance, as much as we adopt the Standard Model as the best available option, some answers we seek exceed its possibilities, not because it is wrong, but because it does not cover certain important features that require alternative approaches, as far as possible, consistent with its main findings.

There is certainly an andragogical problem too. Physics teaching suffers from an archaic model of thematic presentation that follows the history of physics itself, without ever giving space to a disruptive perspective [24], displaced from classical ties and directly connected to contemporary findings. As well said Regan,

“Not only is physics not taught in a sequence that emphasizes our best, present understanding, this perspective is never presented. The standard physics curriculum never gets around to saying, ‘if we were starting from scratch, this is how we would do it’.” [25].

Let me go a little further, drawing attention to the fact that there are serious language problems, especially semantic ones. Obviously, these semantic problems configured in natural language end up falling on mathematical representational formalism, making the latter a erroneous justification of the misinterpretation itself. Very few

7 On this subject, it is worth reading the beautiful book by Schrödinger [22].

authors pay due attention to this fundamental subject. However, a lot of conceptual confusion would be avoided, not only in contemporary physics, but also in classical physics, where, quite contrary to what one might think, there are still many misconceptions. In the words of Lévy-Leblond,

“[…] paying attention to our linguistic choices and assessing their relevance, may be of great significance for research, as it should go beyond formalism, for teaching, as it should go beyond technicalities, for popularisation, as it should go beyond catchwords.” [26].

Lastly, as I have commented elsewhere, there is a strong tendency to fix attention on math disregarding physics in formal representation. Heisenberg had a very clear and honest position on mathematics as a language of representation:

" When we pursue rigorous mathematical methods too hard, we fix our attention on those points that are not important in terms of physics, and thereby we move away from the experimental situation. When we try to solve a problem with coarser mathematics, as I often did, we are always forced to think about the experimental situation."[27].

This clearly applies to theoretical cosmology, just replacing the word "experimental" with "observational".

7 Final comments

The points discussed here reflect a necessary neocritical view of science as it is done today. This more open vision implies disruption and innovation. I really was blessed with great open-minded advisors in postgraduate studies, both in Brazil and France. However, as not infrequently happens, a haphazard antagonist gets in the way, trying to extinguish creativity "with a stick", as it is said in Brazil. Ironically, this *persona non grata* was the reason for my later studies on white dwarfs, magnetars, and Wolf-Rayet stars, so I am grateful for the obstacles he unsuccessfully tried to create for me during a course on stellar evolution. If I had listened to the nonsense and bullying about age differences, I would not have achieved the scientific stature of today. It is with this sinister bias that Brazilian public academy banishes the less resilient and the more independent candidates, insisting with a merely repetitive model on what was already known sixty years ago.

In astronomy there is still a wide field for innovative theoretical work, including in support of astrobiology. I have tried to open my students' horizons, sincerely hoping that the new generations will bring the desire to go beyond the canons.

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