THE GREAT FILTER AND THE FERMI PARADOX

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ABSTRACT: This paper tries to give answers to the questions "What is the Great Filter?" and "When will it arrive?". Through the answers that we obtain to those questions, it is possible to reckon an objectival explanation to the famous Fermi paradox: "Where is everybody?". The goal of this theory is to give a solution using only the facts we can see and evaluate, finding a logical path that could give a full solution, and to raise awareness to the notion that we have of technological developement.

1. INTRODUCTION

"Where is everybody?" a simple question that gave life to one of the most fascinating and complex problems of the theoretical physic and the humanity. The cryptic question and the litte amount of information we have make the paradox open to different kind of possible solutions. Thousands of theories and hypotesis have been formulized with the purpose of giving a definitive solution. So, what makes this theory different from the others? Considering the true definition of ***Great Filter***[1] we could formalize an assumption about our percieved loneliness, and defining also what is life, we could explain what could cause the arrival of the Great Filter. Knowing why the civilizations are directly prepared to fall, since their birth, we could explain why we can't see signs of extra-terrestrial life and why it is impossible to speculate the inexistence of other species in the Universe.

2. MODEL

Having to give a solution to the Fermi paradox, we need to give a definition for the Great Filter first. To do this we have to explain what life is, when a species is called intelligent and what are the consequences of the technological developement (Td) on the preservation (P) of a civilization. The circle of life teaches us that everything has an origin and an end, this helps with the definition of life, which is$L = \sum_{\overrightarrow{Eg}=1}^{\infty} \overrightarrow{Eg} \cdot \frac{S}{D}$(f.1)(this formula is just a conceptual view of what will be explained after). This definition puts the life(L) equal to the sum of the general events(Eg), starting from 1, multiplied for the situations(S) divided by the decisions(D). The **Eg** value is equal to the integral from the negative events(En) to the positive events(Ep)$\overrightarrow{Eg} = \int_{\overrightarrow{En}}^{\overrightarrow{Ep}} d\vec{E}$(f.2). For every event and every choice that we take, in our life, corresponds a consequence$\forall E \exists C$which defines the path that we will follow for our life and, for consequence, following event. If we actually think about it, we make a lot of choices during our life, and also not choosing is a choice, so as we make choices, even the objects and the things that we don't know make indirect choices too. Related to this we have the concept of intelligence, I'm going to give an example of our world. We have a lot of species on planet Earth, but, besides all, we are the smartest one, so, what exactly defines us as the smartest species of the world? First we need to consider that the other species are strictly related to their instincts. Us humans, instead, use our intellect to better us and control our instincts. In my opinion, a species is intelligent when it is trying to better and preserve herself. This gave us the formula$K = P \cdot Td$(f.3) which explains us the goal of an intelligent civilization, which is to mantain **K>0** and to

adapt themselves. This formula puts the variable **K** equal to the product between the preservation(P), which is the capability of a species to mantain unchanged their survival, and the technological developement(Td), which is the amount of phases that a specie passed$\sum_{i=0}^{\infty} P_i$(f.4). The preservation and the technological developement follow two phases too, the first sees them directly proportional$P \propto Td$while the second sees them indirectly proportional$P \propto \frac{1}{Td}$. We could view this definition as a sort of Gaussian curve described by the equation$f(k) = Pe^{-\frac{(k-Td)^2}{t}}$(f.5).

Now, there is a problem, the technological developement is a positive element, but, as every event does, it brings consequences, and with consequences come risks$\forall P \exists C$which could undermine the preservation of a species. In fact, the preservation is affected by the amount of the risks of phases$\sum_{i=0}^{\infty} Rp_i$(f.6).

3. SOLUTION

Before all, we need to examine the probability that we are alone and there aren't other civilization in the Universe. We know thanks to the *Kardašëv scale* [2] that there are, hypothetically, a lot of intelligent species in the Universe and we can even classify them in a sort of ranking. For example, according to *Carl Sagan* [3], we are a 0.71 type civilization. Anyway, we need to consider that there is only a single probality, on close to infinite probabilities, that we are alone in the space. Therefore, it is statistically almost impossible that there aren't any other civilization. We know this also thanks to the *entropy* [4], in fact, the chaos is much more frequent then the order, so it is very probable that we aren't alone, but there also are thousands of intelligent civilization placed randomly in the Universe. Now then, following *the third law of dynamics* [5], we could assume that$\forall D \exists C$for every decision exists a consequence, so we can formalize that$D_n AB = c_n$. Assumed that, we can consider the Great Filter not as an event by itself, but as a consequence of the evolution, of the time and of our decision. In fact, the greatest menace for a species is the species itself. The amount of the risks of phases (Rp) is strictly related to our evolution process and our phases. Let's make an example of our world again: the (i) is the moment when our civilization started developing, our first phase, the instrument one could be defined as the (Pa); the second one is the phase of the mechanization (Pb); the (Pc) could be the phase of the automation, our actual phase. Clearly in our case the phases are 3, we could assume that for a much more developed species the phases could be even more (Pd,Pe,Pf,…). During this process, the risks for our preservation increases a lot, because, for example, we have the atomic bombs, which could hypothetically destroy our species if used. We must not forget what is going on with our planet, in fact, for example, even the pollution formed by our decisions is actually damaging the world, putting in risk our preservation. We could formalize this concept with this formula, the Great Filter will arrive in case$\frac{[(\sum_{\overrightarrow{Eg}=1}^{\infty} \overrightarrow{Eg}) \cdot \sum_{i=0}^{\infty} Rp_i]}{\Delta t_c} \cdot k = 0$(f.5) if we want to semplify our formula with the assumptions that we made before it is$\frac{L \cdot C_i}{\Delta t_c} \cdot k = 0$(f.6).

The product between the consequences and the decision that a species takes, according to the events and the situations, is divided byΔt_cwhich is the time that a civilization spent during their evolving process, and multiplied for **K**, which is the variable that must never be$k \leq 0$.

Now, considering an intelligent species, if they are much more developed than us, they undoubtedly surpass so many times the risk of the Great Filter, which means that they wouldn't search a contact with other species without knowing exactly what kind of species we are(as an intelligent species would do). Indipendently from their date of origin, we can suppose that the other civilizations are

far from us, if they are type 2/3. This because, we are capable to observe Black Holes and Galaxies, we can also measure the radiation from the Big Bang, so we could certainly notice signs of an intelligent civilization, which evolved that much, especially if we consider that there will be strange movements of energy and signals everywhere. Besides all, we actually don't know what kind of technology they would be using. However there is another problem, the amount of material that a species could use. As said in point[3] nothing is infinite and everything comes to an end, in fact, theΔt_c, defines also the time limit that we could have. Of course we could obviate the problem bringing energy and materials from other Planets, but for doing this we need to be capable of transporting something to planet x to planet y, and that is not so easy. For what concern the other species, it is possible that they would try to limitate the contact with other species, because it is a risk that they wouldn't want to take. For example a war is the dumbest thing that a species could do, because there are two possible endings for a space war, the species A loses or the species B loses. So, there is a 50% of probability to run in front of the Great Filter, and in my opinion it is too high of a risk. Regarding the possibilities that they won't come to us , as a human does with an insect, it isn't totally correct. Because, for example, on planet Earth there are a lot of insect scholars, and the insect percieves us, they just don't understand what we are because of their low mental level. In the future there will surely be different jobs, and maybe one of that could be the historical of other planet/species. But if they are watching us, it means that they are alive and close to us; and if they are close to us we would have noticed them. We need to consider one more thing about the developement of the species, which is the *Game theory* [6]. The greatest result for a subject is the result of the group. As in economy, the cooperation is the key for a great success, so, we should start cooperating between us for the future.

4. REDUCTIO AD ABSURDUM

To try and demonstrate the theory I'm going to do a "reductio ad absurdum". If I'm wrong, the Great Filter is not a consequence, but it wouldn't be possible, because, as a consequence of the developement, would conceptually contrast the third law of dynamics, contrasting also the formula(f.1) and(f.4) where for a decision belongs a consequence. Also, if the Great Filter doesn't exists, we could hypotize the immortality of a species. This is impossible as well, because on Earth, for example, civilizations have already fallen, and we have the proof that it is possible(for external or internal causes). The developement also brings risks, and we have the proof considering all the wars that we have done during the years. Regarding the Fermi paradox, we know thanks to the entropy that the distribution of the civilization is casual, and we could assume that it is statistically impossible that we are alone in the Universe. If I'm wrong it would mean that the evolved civilizations are close to us, but that is not possible because we would have noticed them. If they passed before our origin it is also irrilevant to the paradox, because we can't be 100% sure of the fact. If I'm wrong, it means that the species are inclined to confront with other species, but this means that they are close to risk their preservation, and, following our definition of intelligence, this wouldn't be the attitude of an intelligent species.

5. CONCLUSION

After all, we could assume that the Great Filter is a direct consequence of the developement and it will arrive when the value **K** of the function will reach the value of 0. The Fermi paradox is related to the Great Filter and to the concept of intelligence and life. We saw that it is impossible that we are alone in the Universe, and we examinated the fact that if there are civilizations of type 2/3 close to us we would have noticed them. Assuming that, the only possible answer is that: if there are

species close to us they won't be too much more developed of us, and the type 2/3 species must be far from us. Said that the possible answer for the question **"Where is everybody?"** is "**Somewhere, but not here and not now."** A deceptively simple question deserves a deceptively simple answer, in my humble opinion. Anyway, the principal goal of the theory is to give a solution to the Great Filter and the Fermi paradox, but also to give a message. We need to cooperate to preserve our species, we suppose to preserve ourselves and not to risk our survival. We need to be more farsighted and efficent when we make decisions for our world and our species. We can't avoid the Technological developement, but we can avoid our extintion.

6. FORMULARY

$L = \sum_{\overrightarrow{Eg}=1}^{\infty} \overrightarrow{Eg} \cdot \frac{S}{D}$	(f.1)Formula of Life, which describe how the life is a sum of events, moltiplicated for the quotient of the situations and the decisions.
$\overrightarrow{Eg} = \int_{\overrightarrow{En}}^{\overrightarrow{Ep}} d\vec{E}$	(f.2)Formula of the general events, that describes how they are equal to the integral from the negative events to the positive events.
$k = P \cdot Td$	(f.3)Formula of the status of an intelligent species, with K equal to the product of the Preservation and the Technological developement.
$\sum_{i=0}^{\infty} Pi$	(f.4)The sum of the technological phases, related to the technological developement.
$\sum_{i=0}^{\infty} Rpi$	(f.5)Sum that describes the risks that a species runs in relation to the amount of phases of the technological developement.
$f(k) = Pe^{-\frac{(k-Td)^2}{t}}$	(f.6)Function that describes the Gaussian curve, relative to the Great Filter.
$\overrightarrow{D_n}AB = c_n$	(f.6)Equation that describes the consequences of the decisions.
$\frac{L \cdot C_i}{\Delta t_c} \cdot k = 0$	(f.7)Formula that describes the moment of the possible arrival of the Great Filter.

7. REFERENCES

[1] Robin Hanson, *The Great Filter – Are We Almost Past It?*, 15 september 1998.
[2] Nikolaj Kardašëv, *Kardašëv scale,* 1964.
[3] Carl Sagan, *Carl Sagan's formula*.
[4] *Entropy*, 1824/1861 (first definition).
[5] *Third law of dynamics*, Isaac Newton, 1687.
[6] *Game theory*, Blaise Pascal and Pierre de Fermat, 1654/ John Forbes Nash, Jr., 1994.

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