A solution to the Fermi paradox

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The Fermi paradox states in essence that we seem to be desperately alone in the universe and that the Earth seems to be the only inhabited planet of the creation.

There is an easy solution to that paradox.

If we suppose the universe to be isotropic then we can assume that life (considered in general as whatever form of organised, autonomous and possibly intelligent matter) developed in similar ways as Earth in other places of the universe.

We can also assume uniform repartition of the probability of appearance of life on a planet or moon or whatever cosmical body located in a ball $B = B(r)$, let us say $p_l(r)$ which could be defined as a density depending on a radius r measured in metres.

Let's say that $p_l(r_G) \approx 1$ where $r_G = 5.\,10^{20} m$ so that we only consider distance $r \leq r_G$.

This means roughly that on average there is one world per galaxy (taking the milky way measures as an etalon). This is obviously completely heuristic.

If $\rho(r)$ is the density probability over a sphere of radius r, this means that

$$\int_{B(r_G)} \rho(r)dr \approx 1$$

Or equivalently :

$$\rho(r) \approx \frac{3.4/3.\pi r^2}{4/3.\pi r_G^3} = \frac{3r^2}{r_G^3}$$

That is to say over a radius of 1 metre:

$$p_0 \approx \frac{1}{r_G^3} = 8.\,10^{-63}$$

That measure (totally arbitrary and heuristic here) would represent the probability of encountering life at some random point of the universe.

This seems coherent with the apparent ‘rarity’ of the presence of life that we experience. At the scale of our solar system the probability of the appearance of life would be:

$$p_S \approx \left(\frac{143.10^9.10^3}{5.10^{20}}\right)^3 \approx 7.81.10^{-15}$$

Knowing that there is Earth (B) , what is therefore the probability $P_{A|B}$ for another world to exist (A) in terms of distance r from Earth?

$$P_{A|B} = P(A|B)(r) = P(A \cap B)(r)/P(B)(r) = P^2(B)(r)/P(B)(r) = P(B)(r) = \left(\frac{r}{r_G}\right)^3$$

since $P(A) = P(B)$ and A, B supposed to be independent of each others

This means that the probability that another word exists in our galaxies is close to 1 but at the scale of our solar system, it’s still very small.

The farest we are from the origin , the more chance there is to find the world provided with life but with a much greater factor!

Indeed if we compare the chance P_1 of finding a world in a radius $0 \leq r \leq a$ and P_2, of finding it inside a sector $a \leq r \leq 2a$, we get:

$$\frac{P_1}{P_2} = \frac{\frac{3}{r_G^3}\int_{r=0}^{r=a} r^2}{\frac{3}{r_G^3}\int_{r=a}^{r=2a} r^2} = \frac{\frac{1}{3}a^3}{\frac{1}{3}(8a^3 - a^3)}$$

This means we have 7 more chances to find a world in a sector $a \leq r \leq 2a$ than in a ball B(a) of radius a: the more we travel, the greater the chances.

With that simple model, there would be on average one world per galaxy with possibly two inhabited worlds in the same galaxy for a very small amount of them and so on…

Now why do we not see any existing activity from our telescopes?
Maybe for the same reasons that the other world that would be closer to us would not see us, they would see a very young Earth without any life present because it would be too early.

The more they are distant from us the more likely they exist but also the older is the information we receive from their worlds.

Finally they did not yet travel to us for the same reason that we did not yet travel to them. There are no reasons to believe that our world is so fundamentally retarded compared to other worlds.

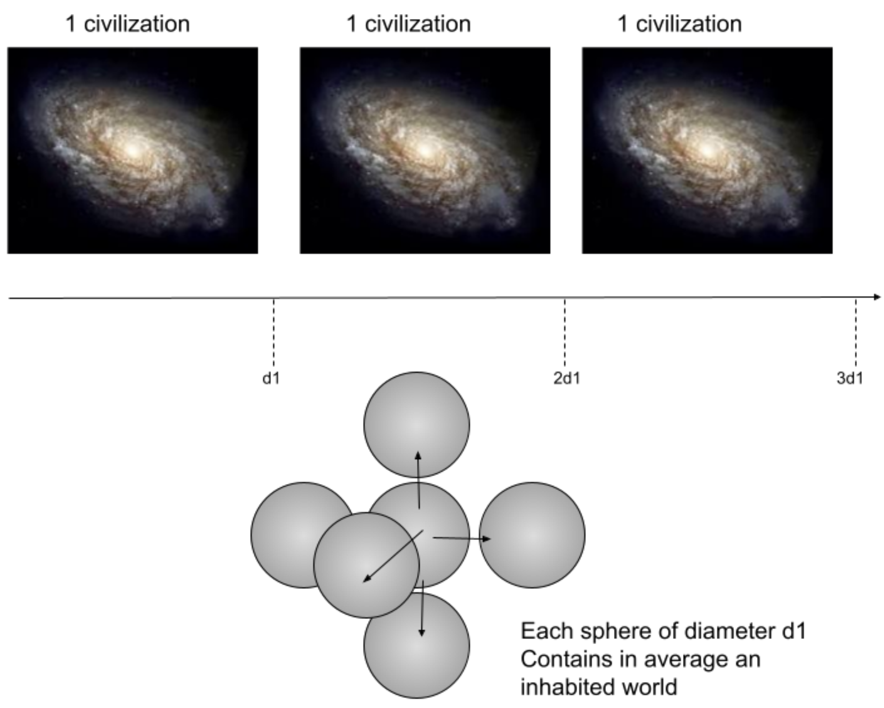
Humanity may have not always evolved the optimal ways but the progress of science and techniques were finally steadily achieved… on average.

Other worlds may have followed a more optimal course and they may be older and more advanced or the other way round but on average there may not be such a significant difference since roughly, “on average”, all started at the same time and the older worlds we see are also the more distant , meaning more complicated and advanced means of transportation are required.

Finally, according to Einstein theory, the speed of light is the maximal speed that can be achieved in the universe.

Since that principle has never been proven wrong so far, this means that as advanced as a world could be, they could not move beyond that speed limit (or at least not before reaching a ‘mega-advanced’ state of their civilization), creating de facto a formidable barrier for the communication between the worlds.

If there is roughly one world per galaxy, then there would be potentially more than 100-200 billions of inhabited worlds in the universe… and in fact since some galaxies are much wider than our own galaxy, the milky way, that number would be only a minimum!



1) We do not see the other worlds because we see the closest Galaxy 13 billion years in the past (Our Earth is 4.5 billions years old…) and so everything we see is too ‘young’ in its past.
2) Assuming worlds follow the same evolution at ‘roughly’ the same periods (modulo astronomical time) , each world is in same state of evolution and each world is unable to communicate with other worlds for now
3) Assuming that this ‘solution’ is true, worlds will start to communicate with others in the same relative period of cosmical time as they will have reached the same level of scientific and technological evolution, so worlds will somehow mutually ‘discover’ each other.
4) Therefore we do not see other worlds for the same reasons that they do not see us
5) Assuming scientific and technological progress follows an exponential curve, interstellar flights and inter-galactic flights should become a reality for each world at some period T of their evolutions, possibly with Faster-than-light flights.

A solution to the Fermi paradox is that we, by our “loneliness”, are experiencing a measure of the probability of apparition of life throughout the whole cosmos. If we knew what it takes for a world to be provided with life, we could compute an estimate of that probability and estimate how far the nearby distant civilization could be.

The paradox still remains that there would be hundreds of billions of worlds that would never manage to know each other until they reach a theoretical level of mega-advanced civilizations allowing them for example to travel faster than light or using teleportation (if that is ever possible). This seems completely contradictory with any sort of intuition and would reveal somehow an absurd, strange and somewhat deeply unintelligible nature of the cosmos.