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Pioneering Approach to Dyson Sphere

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***Abstract*- In this paper we contemplate in brief what Dyson Sphere is, the revolution of this doctrine since its original purpose, how is it connected to Extraterrestrial life, and what did this doctrine lead to in astrophysics. We also flag the main problems regarding its construction (gravity issue etc.), and at last we end up purposing a Hypothesis for the pioneering design, which would be relatively easy in construction, and will also subsides the gravity issue.**

***Index terms*- Dyson sphere, Kardashev scale, Level Ⅱ civilization, Dyson ring, Dyson swarm, intelligent celestial structures**

INTRODUCTION

Dyson sphere is a hypothetical celestial structure that is capable to harness the entire energy outcome from a star. The doctrine was originally purposed by a british physicist "J.Freeman Dyson" in 1960[1].

GLIMPSE OF ORIGIN

J. Freeman Dyson purposed this Doctrine in 1960, and he was inspired to do so after reading the 1937 novel start maker, he purposed the article about Dyson sphere in a magazine and the article was entitled "Search Artificial star sources of Artificial infrared Radiation" [1]. Freeman Dyson originally had no intention to purpose a construction of Dyson sphere, rather he wanted to highlight the fact that as an intelligent civilization continues to grow and evolve, in future it may develop a structure as Dyson sphere to fulfil its energy needs. This idea leads to a paradigm shift in the field of "Search for extra-terrestrials life". The scientists who search for intelligent life out in the galaxy had to face many new problems that they even didn't know existed, e.g. if a star is shrouded by a dyson sphere the overall radiation emitted by the star would be extremely small, thus scientists would conclude that this star is not capable of harbouring life as it was too cold, thus resulting in dramatic errors, and the interpretation of the data acquired from a faraway solar system would become peculiar.

WHAT IT LEAD TO

The idea of energy consumption (energy needs) lead to a much more counterintuitive idea. The idea of "KardashevScale". "NikolaiSemenovich Kardashev" [2] a Russian astrophysicist contemplated this idea of energy consumption and in 1964[2] he purposed a new idea in the field of astrophysics; a measurement scale for energy consumption. Kardashev argued that intelligent civilization (if any exist) must have different energy demands (energy needs) and he went further by classifying these intelligent civilizations in three major levels, and this scale was named the "Kardashev Scale"

A level Ⅰ civilization would have a full control over their home planet i.e. they would be using the energy produced by their home planet at its full potential, thus having a power consumption of ~10^{17}W.

A level Ⅱ civilization would have a total control over the resources of their star system, and they would have harnessed the total energy output emitted by their parent star (i.e. where dyson sphere is needed). The power consumption of this civilization would be ~10^{26}W.

A level Ⅲ civilization would be the supreme civilization in a galaxy, a civilization like this would be most advance and most intelligent (evolved) in the galaxy, they would control the total energy output of their entire galaxy i.e. all the stars in their galaxy, and they would also have total control over the resources of their galaxy. The power consumption of a civilization like this would be ~10^{26}W.

DYSON SPHERE

In the simplest way possible, Dyson sphere is (originally) a spherical shell that totally surrounds a star to intercept almost all of the light emitted by it. If we humans could build a dyson sphere around our sun i.e. of the radius of 1 AU (astronomical unit) or as the size of earth's orbit Fig. Ⅰ, we could harness almost all the power produced by the sun i.e. 3.846x1026 watts or 384.6 yotta watts, and that is a

tremendous amount of power in comparison to earth's current power consumption[3] (globally) i.e. $5067x10^{20}$ joules or 157481 Twh (terra watt hour).

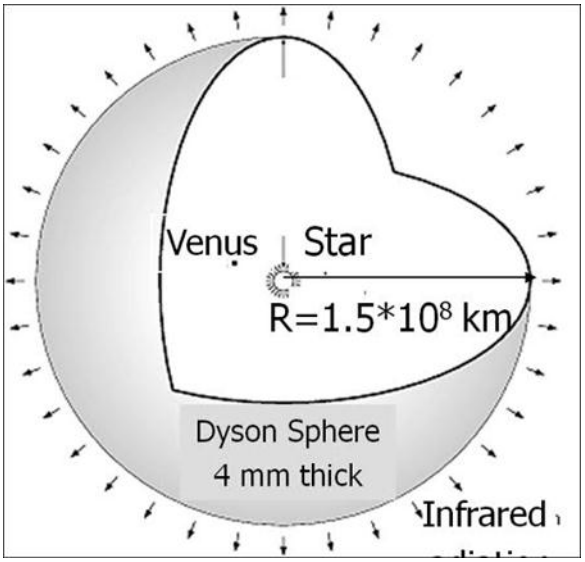

Fig. I

The idea of dyson sphere has gone through many phases since its original design. It's very hard to build a spherical shell that has a mass of $7.34767309x10^{22}$ kilograms, and has a radius of 1 AU, the new idea is relatively easy to imagine and maybe even to build. The new idea breaks down the process of building a spherical shell into two steps.

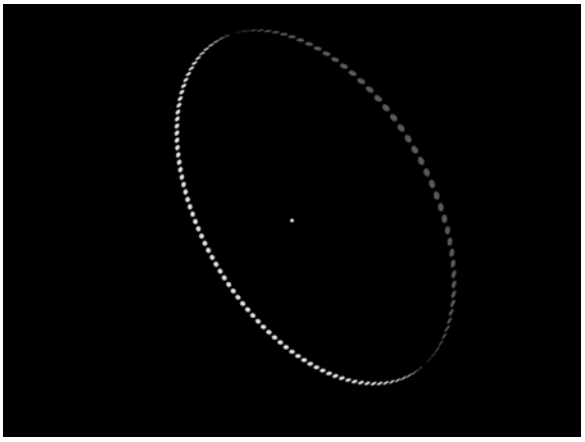

Fig. II

First we will build a ring Fig. II of solar panels around the sun, the solar panels would be individually in a separate orbit and will orbit the sun in an intelligent parameter (controlled by a supercomputer), and as we humans will grow in resources (asteroid mining), we would keep adding solar panels to this ring in different parameters eventually forming a swarm around the sun called as Dyson swarm Fig. III.

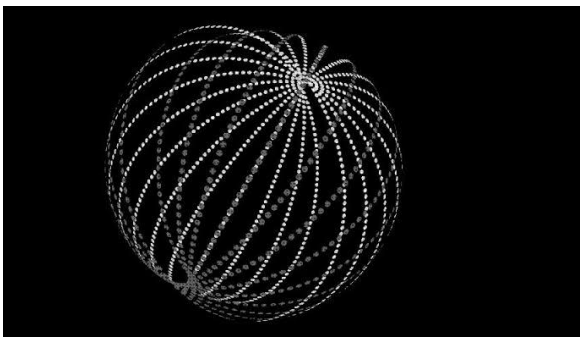

Fig. III

The mass required for the construction of the Dyson sphere is

$$M = \rho 4\pi r^2 t$$

Where ρ is the density of the material of the sphere and t its thickness of 1 meter, this is how we find a mass of ~$6x10^{23}$ kg, slightly less than the mass of moon. The mass of one terrestrial planet will easily give a 4-10m thick shell, so that the inhabitants will not worry very much about accidentally puncturing it.

PROBLEMS AND LIMITATIONS

The Dyson sphere would be subject to unacceptably large stress and its equilibrium around the star is neutral at best (as opposed to stable).

Another consideration is gravity: If the sphere was built in our solar system with 1 Au radius, the gravity due to the sun would be only $5x10^{-4}$g, so humans could not live inside it without genetic or physical modification to become compatible with microgravity [4] or if there was some way to simulate artificial gravity whichis very unlikely to happen.

The idea of Dyson ring and Dyson swarm may subside the first problem, but it cannot solve the second one as it is something beyond our capabilities yet, and we should not forget that it is basically a gigantic structure to be made.

Even if we humans were somehow able to construct this celestial structure, it will still have its limitations.

The first limitation is that at the time we would have completed the construction, the energy needs would have climbed up dramatically, and soon in a hundred thousand years we would be looking for new source.

The second limitation is that the Dyson sphere is dependent on the star, and our sun is going to die in next 7.5 billion years, and after our sun dies the

resources used in making the dyson sphere would be wasted and also we would be out of our energy source.

The third limitation is that the dyson sphere has to be made in space and thus is more prone to damage due to asteroids etc.

HYPOTHESIS

We will take Problem Ⅱ in consideration and try to make a hypothetical design that will subside the Problem Ⅱ.

The big problem with Dyson sphere is that it is gigantic in size and that is the root of all other engineering issues. To subside this problem, why not build a structure with $10773x10^3$ km in radius and if we do so, the mass will decrease too. Now why do we purpose this? Since the construction of a dyson sphere with 1AU radius would be unimaginable big leap for humanity and in fact to get a radius of 1AU directly is impossible. So we should construct a small structure, even though it won't be so efficient but it would be a head start for humanity.

Now to solve the gravity issue, we need to design this structure in rings Fig. Ⅳ, and these rings would have solar panels from inside out, these rings should also be free to rotate over a certain axis. But why?

Fig.Ⅳ (an artist's vision)

Well if originally somehow the sphere could rotate, it would produce (simulate) gravity, but that would be only of the equatorial regions of the planet or space station it surrounds, but if the sphere consists of rings at different latitudes, and if hose rings could rotate about the same axis, but with different angular velocities, one could simulate gravity, but here since we made the structure small, thus cannot surround sun, so we will have to construct a space station right in centre of the rings. The space station will act as the axis for rings and also a source where power will be stored.

CONCLUSION

In this paper we contemplated the problems regarding the construction of Dyson sphere, we also discussed what new doctrines did Freeman Dyson lead to (Kardashev Scale) and we ended up concluding that the problem of gravity can be solved by putting forward a hypothetical design which is relatively small to the original size that was put forward by Freeman Dyson. Even though it won't harness much of sun's energy output, but still it will be our pioneering step towards achieving level Ⅱ civilization.

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