Please use Contact in Context:v2i2/farewell.pdf in any reference to this article

AFTER KARDASHEV: FAREWELL TO SUPER CIVILIZATIONS

Zoltan Galantai, Ph.D
Technical University of Budapest (Hungary)
zgalant@eik.bme.hu

ABSTRACT

Kardashev's typology is based on a belief that we can categorize super civilizations by their energy consumption. But on the one hand we can imagine an advanced civilization which conquers either its own solar system or its galaxy without reaching the second or third level of the Kardashev Scale. On the other hand it will be impossible to build a civilization which can harness the energy of an entire galaxy, unless we discover new physical laws. So it is reasonable to create a new typology which is based on the possible spatial extents of an advanced civilization.

KEYWORDS:

SETI, Kardashev Scale, Super Civilizations, Extraterrestrial Imperative, Torino Scale

INTRODUCTION

Soviet astronomer Nikolai Kardashev published a classification about the possible levels of technically advanced civilizations in 1964 which was based on the energy consumption.

Type I (K I) was a civilization with "technological level close to the level presently attained on Earth" (~4X10^19 erg/sec); a Type II (K II) civilization was said to be able to harness its own star's total energy (~4X10^3 erg/sec) and a Type III (a.k.a K III) civilization to harness the energy of an entire galaxy (~4X10^44 erg/sec). A so-called Type IV civilization would be able to manipulate its environment on the highest possible scale and would be able to control an entire universe, but it wasn't a part of the original typology.

Kardashev assumed that the annual increase of energy consumption would be a 1% per year in the future (at least), and so we would have to wait 3200 years before reaching the second level; and 5800 years before we would consume the energy of all the stars of a galaxy.

Kardashev tried to answer the question of the technically advanced civilizations' detectability, and considering the results of Project OZMA and other American experiments, he believed that the probability of the observation of a Type I civilization was "extremely low" while we had a chance to detect the signs of the higher levels of energy consumption [1].

He developed a classification system to label any possible civilization from an observer's point of view, and his classification was based on an assumption that a more advanced civilization uses more energy. Which means that their activities would be detectable from longer distance. While his scheme wasn't accepted in the United States until 1973, when Carl Sagan suggested searching for Type II or Type III civilizations [2], it remains a generally accepted tool to describe the advanced civilizations even today.

Both Kardashev's contribution to SETI and the historical role of his scheme are unquestionable, but it is possible to create another classification to indicate an advanced civilization without guessing their energy use.

SUPER CIVILIZATIONS?

One of Kardashev's presupposition was that our civilization's future history is the history of energy consumption, and we can say the same about extraterrestrial civilizations (ETC). But this conception has some serious weaknesses.

First of all, it is doubtful whether it is reasonable to extend our experiences, which are based only on two hundred years' development. Before the beginning of the Industrial Revolution, the growth of energy consumption wasn't a significant parameter of our society, and it is possible that that it won't be typical for us in the far future. American SETI researcher Donald Tarter believes that our expectations of Type III civilizations represents only the expectations of an adolescent technology, and although a Type III civilization is technically possible, possibility doesn't mean necessity. We have to take into consideration the downsides and the enormous expenses of a gargantuan Type II or III structure, for example.

But there is another model based on miniaturization, perhaps on nanotechnology and quantum engineering. An ETC following this direction will not call attention to its existence through huge energy consumption, and will not use interstellar beacons for communications. So Tarter suggested supplementing the "thinking big" search strategies with "thinking small" methods [3].

Adopting a similar approach, transhumanists Paul Hugnes and John Smart argued that since nobody observed the sings of a Type III civilization, they either destroyed themselves before achieving this level, or didn't follow the Kardashev trajectory [4].

What is more, we have to make a distinction between energy consumption and the spatial extent of a civilization. Thinking in terms of Kardashev Civilizations, it seems to be obvious to say "K II civilization" when we would like to describe either a civilization which controls the energy of its own star or which explored entirely its own star system, but these categories are not necessarily the same. While it is acceptable that an intelligent race is able to colonize its star system if it is able to harness the

Copyright 2006 Contact in Context

Please use Contact in Context:v2i2/farewell.pdf in any reference to this article

total energy of its central star, the reverse does not have to be true. It is possible for a civilization to establish colonies in its own star system even if they are unable to collect all of the energy of their central star.

To give an example, it seems to be technically possible to establish a continuously habited colony on the Mars before the end of the 21th Century, although it seems to be impossible to achieve the level of a Type I civilization by that date. It is not a surprising conclusion that it is easier to build such a colony than to control the energy of an entire planet.

Needless to say, colonization have a vital importance for the human race in the long run. German born space visionary Kraft Ehricke pointed out in his Extraterrestrial Imperative that unless we want to "back down into a no-growth mode" and reduce the quality of life of the future generations, we have to extend "our industrial capabilities beyond Earth" to get access to new and almost unlimited resources [5]. Thus we should follow the "Don't put all your eggs in one basket" rule to save our human race. If we establish planetary outposts, we will be able to survive a disaster which sweeps out all life forms on Earth.

American physicist Michio Kaku argues that the only real threat (in case we are willing to eliminate the possibilities of a collective, either wanted or unwanted suicide) to a Type II civilization is an explosion of a nearby supernova, as its eruption could scorch their planets. But reaching the next level, they would become really immortal, says Kaku, as "No natural catastrophe known to science is capable of destroying" a Type III civilization [6]. This statement implicitly assumes that it is possible to reach this technological level, but among others American physicist Freeman Dyson suggest that it was not possible to establish a Type III civilization, as "Each little piece of the galaxy will be a world of its own, isolated from other pieces by the immensity of space and the quickness of time". It means that there will not exist a central authority which would be able to regulate or register all distant, independent colonies, at all [7]. But it is at least possible to imagine a civilization which conquers an entire galaxy without using K III level energy sources or technologies.

To give another example, we can toy with the idea of colonizing the comets in the Oort Cloud. This solution would have great advantages: to name one, supposing that interstellar comets are common, "the galaxy is a much friendlier place for interstellar travelers than most people imagine", Freeman Dyson stated. The nuclei of the comets are vast supplies of material resources, and the settlers would be able to build gigantic aluminum mirrors to collect starlight as a resource of energy. It is supposed that an average comet would be able to support some hundred people with 1 megawatt energy per capita [8]. Neglecting more details, we can emphasize that the Oort Cloud is halfway to the nearest stars and although we do not have technologies to colonize or ride comets today, it does not seem to be reasonable to deny this scenario. And to reach the level of a Type II civilization is not a precondition of the Oort Cloud's colonization. It is possible to populate the fringes of our Solar System using only K I or K I+ level technologies, and we would be able to use similar technologies to conquer the inner parts of our Solar System, as well. That is to say, a Type I civilization would be able to conquer a whole planetary system.

So Kardashev's original specifications with its energy consumption levels seem to be unable to describe possible growths of technically advanced civilizations adequately.

TOWARDS A NEW SCALE

To create another typology, we can choose Torino Scale as a starting point. Its aim is to convey "the risks associated with asteroids and comets that might collide with the Earth" [9], and it classifies the certain collisions (regarding the effects of the impact) into three categories.

First of all, there is the case when the effect is a localized destruction; in the second category the impact causes unprecedented regional devastations and a collision of the third category means a "global climatic catastrophe that may threaten the future of civilization as we know it" [10]. Namely, it measures the collisions by the disasters' magnitude, and we could apply this approach to categorize any possible civilizations considering their abilities to survive a natural disaster. Following the Torino Scale, we can describe three types of those civilizations which have not left the surface of their home planets.

The first type would unable to survive a local disaster. Anasazi culture is a good example for it: when they cut out their local forests, and their environment became desert, their civilization collapsed [11].

A second level civilization is not able to resist a regional catastrophe.

The third type is threatened only by global disasters. Regarding the incidence of homo sapiens, a major asteroid or comet impact could exterminate us, but neither an eruption of a super volcano nor a new Ice Age would be able to wipe out us totally [12].

We will achieve a next level "not putting all our eggs in one basket" when we establish independent and self-sustainable colonies in our Solar System. But we still will be vulnerable to some cosmic dangers, such as a nearby supernova explosion.

A civilization that populates an entire galaxy, on the one hand is potentially immortal, as there is not known natural catastrophe capable to destroy it, but on the other hand the result of distances between the colonies and the isolation of the groups will cause speciation, and "Our one species will become many" [13]. Not homo sapiens, but their descendants will spread, and the traditional idea of "civilization" will become meaningless.

Copyright 2006 Contact in Context

Please use Contact in Context:v2i2/farewell.pdf in any reference to this article

Level of Civilization	*Description*	*Kardashev Scale*
C I – planetary	A local disaster can wipe it out – example: Anasazi culture (cca. City state)	< K I
C II - planetary	A regional disaster can wipe it out – example: Roman Empire	< K I
C III - planetary	A global disaster can wipe it out (an asteroid impact, for example) – today's human civilization	~ K I
C IV – solar system	"Not putting all our eggs in one basket" - but vulnerable to some cosmic threats	K II
C V - galaxy	Potentially immortal civilization, but the isolation results speciation	K III
~~C VI – universe~~	Colonizing the entire universe	~~K IV~~

The final theoretically possible step is to colonize our entire Universe. Dyson in his lecture about the cosmic future of life asked in 1979 whether "converting matter into radiation and causing energy to flow purposefully on a cosmic scale, we could break open a closed universe and change the topology of space-time" [14]. Supposing that the known laws of physics will not change in the future, it seems to be enormously improbable that even a super civilization will be able to connect the distant parts of our Universe and will be able to harmonize its endeavors to use the energy sources. But there is nothing to prevent a civilization populating galaxies after galaxies if they have enough time, while regarding their technologies, there is not an inevitable difference between those who conquered "only" a galaxy and those who inhabited the entire Universe.

CONCLUSION

Kardashev's classification suggested the existence of super civilizations with high energy consumption and it gave a hope to observe them. It was a product of an age that it was believable to Kardashev that CTA-102 was a Type III civilization [15].

Though recognizing its historical importance, we have to notice the weaknesses of this typology. While we are not sure whether any advanced civilization's development would follow this direction, this classification becomes meaningless after the second level, since there will be too huge distances between the colonies. "Whole historical epochs will pass, cultures will rise and fall, between a telephone call and reply" [16], Dyson writes. So it is technically impossible to establish a super civilization to harness a galaxy's all energy sources, and we can believe that a K II megastructure is similarly improbable. But an advanced civilization can begin to conquer its own solar system and the nearby stars before reaching the technical level which is needed to construct a Dyson Sphere. Kardashev wanted to find the sings of super civilizations, but we should search for less energy consuming activities.

An advanced civilization has to expand (as Ehricke points out), unless they want to die out because of a planetary cataclysm. So it is reasonable to use a scale which is based on an intelligent race's spatial expansion, since it can show their ability to survive a disaster.

REFERENCES

1. Kardashev, Nikolai S.: Transmission of Information by Extraterrestrial Civilizations
P. K. Shternberg Astronomical Institute, Moscow, Russia. Translated from Astronomicheskii Zhurnal 41(2):282-287 (March-April, 1964)
http://www.aeiveos.com/~bradbury/ETI/Authors/Kardashev-NS/ToIbEC.html

2. Dick, Steven J.: The Biological Universe. The Twentieth-Century Extraterrestrial Life Debate and the Limits of Science. Cambridge University Press, 1996. p. 436.

3. Harrison, Albert A.: After Contact. The Human Response to Extraterrestrial Life. Perseus Publishing, 2002. p. 163.

4. Hughes, Paul: Kardashev Civilizations. April 12, 2004, Future Hi.
http://www.futurehi.net/archives/000105.html

5. Ehricke: Krafft A.: The Extraterrestrial Imperative. Air University Review, January-February 1978.
http://www.airpower.maxwell.af.mil/airchronicles/aureview/1978/jan-feb/ehricke.html

6. Dyson, Freeman J.: Imagined Worlds. Harvard University Press, 1998. p. 163.

7. Kaku, Michio: The Physics of Extra-Terrestrial Civilizations. How advanced could they possibly be? Without date.

Copyright 2006 Contact in Context

Please use Contact in Context:v2i2/farewell.pdf in any reference to this article

http://www.mkaku.org/articles/physics_of_alien_civs.shtml

8. Jones, Eric M. - Finney, Ben R.: Fastships and Nomads: Two Roads to the Stars. In Interstellar Migration and Human Experience. Univ. of. California Press, 1986, Ed. by: Jones, Eric M. - Finney, Ben R. p. 95-96.

9. Torino Scale - Press Release - July 22, 1999
http://www.whatonearth.com/pressrel.htm

10. THE TORINO IMPACT HAZARD SCALE. Assessing Asteroid And Comet Impact Hazard Predictions In The 21st Century. Last Updated: 14 Apr 2005
http://neo.jpl.nasa.gov/torino_scale.html

11. Diamond, Jared: The Rise and Fall of the Third Chimpanzee. How Our Animal Heritage affects the Way We Live. Vintage, 1991. p. 297-298.

10. McGuire, Bill: A Guide to the End of the World. Everything You Never Wanted to Know. Oxford University Press, 2002. p. 173.

13. Imagined Worlds, p. 155.

14. Dyson, Freeman J.: TIME WITHOUT END: PHYSICS AND BIOLOGY IN AN OPEN UNIVERSE. Reviews of Modern Physics, Vol. 51, No. 3, July 1979
http://www.aleph.se/Trans/Global/Omega/dyson.txt

16. Kardashev, ibid.

17. Imagined Worlds, p. 163.

Copyright 2006 Contact in Context

This article is available at http://www.contactincontext.org/cic/v2i2/farewell.pdf