

Searching for the garbage signatures of alien civilizations

By their garbage, shall ye know them

The *Civage Scale* (“*Civilization Garbage*”) is a proposed scale for detecting and measuring a civilization's level of technological advancement based on the amount of garbage it dumps to foul the local neighbourhood. ‘Neighbourhood’ ranges from planetary to Kardashev Type V neighbourhoods. The current practice of searching for alien civilizations is called SETI: *Search for Extraterrestrial Intelligence*. This thought experiment proposes SETG: *Search for Extraterrestrial Garbage*.

Rating the Capabilities of Civilizations

Several authors have developed schema with which to rate the capabilities of a civilization.ⁱⁱ

- **Kardashev scale (Nikolai Kardashev, 1964):** Measuring technological advancement by measuring the amount of energy it is able to employ. *Type I*: use and store all of the energy of its birth planet; *Type II* (“*Stellar civilization*”): all of the energy of the local planetary system; *Type III*: all of the energy of the local galaxy. *Kardashev deemed other stages to be ‘impossible’*.ⁱⁱⁱ
- **Other Kardashev Tiers:** *Type 0*: Civilization does not control all of the energy of its planet. *Type IV*: Control of entire universes. *Type V*: Control of collections of universes.^{iv} *Humanity is at Type 0*.
- **Civilization/Planet Mastery (Robert Zubrin, 1999):** Refines the Kardashev scale by defining a civilization’s ‘mastery’ of its resources: *Type I*: planet-wide; *Type II*: solar-system wide; *Type III*: its local galaxy.^v
- **Information mastery (Carl Sagan, 2000):** Degree of control of information generated at each tier of expansion.^{vi}
- **Microdimensional mastery (John Barrow, 1998):** Posits the scale of control, by reverse-engineering control to the smallest of dimensions (down to Type Omega-minus, which refers to ‘controlling the building blocks of space and time’).^{vii}
- **Combinations:** As the above are civilization-scale tiers, there could be engineering constructions that combine and/or merge the different tiers of capability. For example:
 - **Light-Traps/Dyson spheres (Olaf Stapledon, Science Fiction Author, in the novel *Star Maker*, 1937):** proposed the capability of englobing a star to completely capture its energy output, imagining the system as “a gauze of light-traps.” Re-introduced by Freeman Dyson (1960) in the paper “Search for Artificial Stellar Sources of Infrared Radiation”. Now called “Dyson spheres” with variants (“swarms”, “bubbles”, “nets”).^{viii}
 - **Bubbleworlds (Charles Stross, Science Fiction Author, in the novel *Accelerando*, 2005):** proposing to construct a human-habitable world that is a shell of living space around a gas giant such as Saturn.^{ix}
 - **Intentional Silence (Cixin Liu, Science Fiction Author, in the novel *The Dark Forest*, 2008):** This Type is able to make its presence hidden. *The Dark Forest Theory* assumes that intelligent civilizations are risk-averse, and will avoid making their presence known for fear that every other civilization “is an armed hunter stalking;...This fear and risk aversion is the cause of the radio silence we are accustomed to.”^x

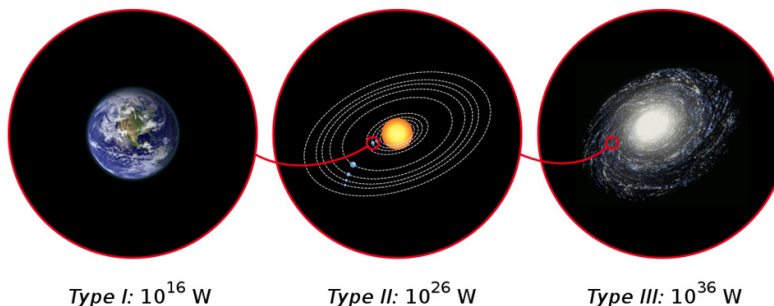


Fig.1. Kardashev scale: Type I, II, and III civilizations

Consommations énergétiques des trois types de l'échelle de Kardashev / Energy consumption estimated in three types of civilizations defined by Kardashev scale. See: Reference iii, below.

Current status of human civilization’s space-borne garbage output

Humanity is at Type 0 and is rapidly developing new capabilities. We have developed different garbage signatures as our civilization has expanded exploitation of resources. Past evidence is present in the archaeological record. Today, evidence of our terrestrial garbage practices are found across the planet; with physical waste that is visible to the naked eye, and types that are not visible but detectable (including greenhouse gas emissions; the fouling of land, sea and air; and contamination of the basic organisms of our world’s food web).

However, our presence has not been theoretically visible from other star systems until the modern age. First accidentally, with radio waves (Marconi, first transmission circa 1894^{xi}); atomic and nuclear weapons (from 1945); and satellites (from 1957). And then with intent: with artwork (Linda Salzman Sagan, artist, *Pioneer* spacecraft plaques, 1972 & 1973), intentional radio signals (1974: 3-minute message beamed to Messier 13 from Arecibo Observatory, National Astronomy and Ionosphere Center, Puerto Rico)^{xii} and recorded greetings (Carl Sagan, recordings sent with the *Voyager* spacecraft [two missions], 1977). The garbage signatures of our civilization have grown to be profoundly new.¹ The subject of this proposal is “3.”:

1. Swarms of electrochemical and greenhouse gas emissions’ signatures that signal the presence of an advancing civilization;
2. Electronic detritus alerting observers to rapid advances in cross-planet communications (Internet);
3. Space garbage (physical parts and bits of space vehicles, satellites, and human waste) englobing the planet.^{xiii}

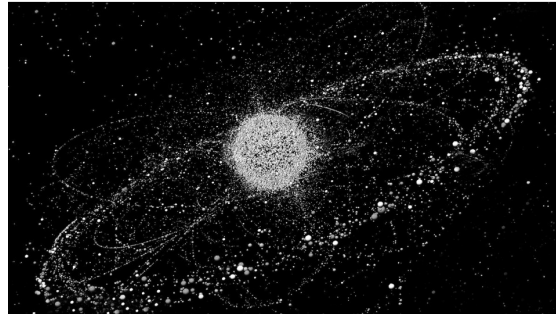


Fig.2.0 – Space Garbage orbiting Earth, See: Reference xiii, below.

Civilization implications – Current status of human civilization’s orbiting garbage output

If we assume that all civilizations similarly advance to spacefaring, and humanity follows the pattern of advancement, it is fair to hypothesize that other civilizations develop a similar pattern of expansion; whereby each civilization designs and launches an ever-increasing swarm of artificial constructs; and whilst doing this produces an array of space garbage that forms a “garbage sphere” around the host planet. Garbage spheres may expand as the civilization expands through the Kardashev schema. Garbage spheres will be detectable as *Extraterrestrial Garbage Spectra* (“EGS”) of exoplanets and other Kardashev tiers.

Proposed range of Garbage Types at each Kardashev Type & examples of possibilities associated with each type

1. Garbage Type 1: No detectable EGS spectra
 - a. Pre-industrial (equivalent to Kardashev Type 0)
 - b. Civilization does not want to be detected
2. Garbage Type II: Detectable EGS spectra
 - a. Matching humanity’s current orbital presence
3. Garbage Type III: Appearance and disappearance of EGS spectra
 - a. Civilization has developed the capacity to remove all space garbage from orbit
 - b. Civilization has intentionally reverted to being planet-bound
 - c. Civilization has collapsed (various scenarios)
 - d. Civilization has migrated, cleaning up the neighbourhood before leaving
4. Garbage Type IV: Appearance and disappearance of EGS spectra without disappearance of other orbital constructs
 - a. Civilization has fully developed up to the next tier of Kardashev Type.
5. Garbage Type V: EGS appearance with development of steady state EGS presence (englobing, equatorial orbital ring, etc.)
 - a. Civilization has reverted to being planet-bound
 - b. Civilization has collapsed (various scenarios)
 - c. Civilization has migrated, leaving its garbage behind
 - d. Civilization is testing its ability to construct a Dyson sphere.

¹ Our garbage signature might be considerably more evident if the June 2021 US government report into “unidentified aerial phenomena” (UAP) leads to definitive conclusion that these objects are not human-controlled constructs: <https://www.cnn.com/2021/06/27/politics/ufos-uap-extraterrestrial-life/index.html>

Searching for observational evidence

Dyson (1960)^{xiv} speculated that energy consumption patterns would alter the emission spectra of star systems; and that this could be used to search for ‘advanced civilization’ candidates. Others developed the idea of searching for radio frequencies; for example, in ‘Communication with Extraterrestrial Intelligence (CETI)’ (six-nation conference, Soviet Armenia, 1971; US report by MIT, 1973)^{xv} C.Sagan cited B.M. Oliver’s work at a conference at Green Bank Observatory (1961); with Oliver citing Cocconi & Morrison (1959)^{xvi} who suggested the use of the hydrogen line at 1420 megahertz as the natural frequency on which to search for ‘beacons’ (radio signals created by space-faring civilizations searching for other intelligent life). Echoing Cocconi & Morrison, Oliver proposed that the radio messages of space-faring civilizations will be detectable in an area of preferred detection [an area of minimum noise between 1 and 2 GHz where the hydrogen (21 cm or 1420 MHz) and the hydroxyl (18 cm or 1662 MHz) lines reside]. Oliver called the region “the Waterhole”. Astrophysicists subsequently developed the ability to detect the optical presence of exoplanets, and have developed methods to evaluate their signatures.

Now we can extend the search to space garbage signatures. Space-faring civilizations will develop signatures that are similar to ours if similar materials and methods are used. Human space garbage is a useful analog to search for alien EGS presence. Spacecraft can be programmed to look back to Earth, to record the receding EGS of Earth’s terrestrial shell. Past data records of observations of Earth could also be used. Earth’s garbage signatures could be used to develop hypotheses for SETI observing programs, to:

1. Evaluate emission spectra to determine the existence of EGS spectra;
2. Evaluate patterns of appearance, duration, and disappearance of EGS spectra;
3. Observe exoplanets, solar systems, and larger areas of space.

Experiment concept

New Kardashev Type 0 spacefaring civilizations will create a "Civage Sphere" or "Ring" orbiting their world. This will consist of discarded launch parts, discarded vehicles, detritus from micrometeorite impacts, and the like. It is assumed that these parts are manufactured from metals and plastics. The civilization will advance to the stage where it recognizes that the presence of garbage will harm its continued advance to space. It will become systematically able to remove garbage from orbit. The change from an early spacefaring era to a succeeding era will be marked by a rise, and then no change, and then decrease in EGS spectra. This pattern is one of the signatures of a spacefaring civilization. Our civilization can search for this pattern in observations of other solar systems.

1. Determine the observable atmospheric signature of common constituents of human space garbage
2. Calculate Earth's observable atmospheric signatures (observable, chemical, etc.):
 - a. Natural signature, current year circa pre-1945 (1st US nuclear test, 16-Jul-1945) - with and without space garbage
 - b. Natural signature, circa pre-1957 (Sputnik mission, 04-Oct-1957) – with and without space garbage
3. Determine occluding effect of increasing space junk over 10-year intervals (1956, 1966, 1976, 1986, 1996, 2006, 2016)
4. Forecast the change of occlusion of an observer examining our Solar System, and Earth, from another star
5. Brainstorm ideas for why space garbage could disappear (removal, war, change in materials, civilization collapse, etc.)
6. Design and carry out SETI surveys of exoplanets.

Note: References are not arranged to adhere to a formal method.

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ⁱ Trained as an industrial designer, David Huer is a systems thinker and entrepreneur who watches for opportunities to minimize waste. *Project Duration*: Got the idea. In 2014, started searching for a scientist with time to help. No luck. After seven years, wrote it up over a day this week. And then edited it for publication.

ⁱⁱ https://en.wikipedia.org/wiki/Kardashev_scale#Kardashev_alternative_rating_characteristics, and https://en.wikipedia.org/wiki/Dyson_sphere

ⁱⁱⁱ (Image) Indif - Own work derivative work: 1 Earth (blank 2).png 4 Milky Way (blank 2).png, *Consommations énergétiques des trois types de l'échelle de Kardashev.svg* / Energy consumption estimated in three types of civilizations defined by Kardashev scale, CC BY-SA 3.0, Created: 15 October 2013: https://handwiki.org/wiki/Astronomy:Kardashev_scale#/media/File:Consommations_%C3%A9nerg%C3%A9tiques_des_trois_types_de_l'%C3%A9chelle_de_Kardashev.svg

^{iv} http://mono.eik.bme.hu/~galantai/longfuture/long_futures_article1.pdf and Michio Kaku, *Parallel Worlds: The Science of Alternative Universes and Our Future in the Cosmos*. New York: Doubleday. 2005. p. 317. ISBN 978-0-7139-9728-6.

^v <https://archive.org/details/enteringspacecre00zubr>

^{vi} Sagan, C., Jerome Agel (ed.). *Cosmic Connection: An Extraterrestrial Perspective*. Freeman J. Dyson, David Morrison. Cambridge Press, 2000, ISBN 978-0-521-78303-3; <https://www.amazon.com/Cosmic-Connection-Extraterrestrial-Perspective/dp/0521783038>

^{vii} Barrow, J., *Impossibility: Limits of Science and the Science of Limits*. Oxford: Oxford University Press, 1998. ISBN 978-0198518907: <https://archive.org/details/impossibility00barr>

^{viii} <https://www.osti.gov/biblio/4165164-search-artificial-stellar-sources-infrared-radiation>

^{ix} <https://lost-contact.mit.edu/afs/adrake.org/usr/rkh/Books/books/accelerando.pdf>

^x Cixin Liu (2008): *The Dark Forest* (Part of Liu's hard science fiction trilogy, Remembrance of Earth's Past). English translation by Joel Martinsen (2015), Tor Books, theilliteratereader: cf. <https://medium.com/predict/why-the-dark-forest-theory-says-we-should-stop-looking-for-aliens-7e307dd96d3a>

^{xi} <https://www.history.com/this-day-in-history/marconi-sends-first-atlantic-wireless-transmission>

^{xii} <https://haypopup.com/2017/08/03/the-soviet-era-conference-on-communicating-with-aliens/> and <https://www.messier-objects.com/messier-13-hercules-globular-cluster/>

^{xiii} Debris around Earth, ESA Public Domain: https://www.esa.int/ESA_Multimedia/Images/2018/09/Debris_around_Earth

^{xiv} Search for Artificial Stellar Sources of Infrared Radiation, Freeman John Dyson, *Science*, Vol. 131, June 3, 1960, pp. 1667-1668:

<http://www.islandone.org/LEOBiblio/SETI1.HTM>

^{xv} Callimahos, L.D. (Lecture at Cosmos Club, Washington, 1975): https://www.nsa.gov/Portals/70/documents/news-features/declassified-documents/cryptologic-spectrum/communications_with_extraterrestrial.pdf

^{xvi} G.Cocconi and P.Morrison, Cornell University, Ithaca, New York: "Searching for Interstellar Communications", *NATURE*, vol. 184, no. 4690, pages 844- 846, Sept. 19, 1959: <http://bigear.org/vol1no1/interste.htm>