Astrophysical Technosignatures

Pauli Laine[1]

[1]University of Jyväskylä

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Abstract

Our conventional SETI endeavors have focused on detecting artificial signs with communication techniques that are in everyday use in our present state of technical culture. These include the use of electromagnetic waves, i.e. radio, laser, and visible light communication techniques. What would be the most extreme (on a planetary scale) ways of showing one's existence over the vast distances and hiding structures (i.e. interstellar clouds, star clusters etc.)? Could ETI use e.g. neutrino transmission, or high energy peaks to overcome the difficulties the conventional techniques have? This paper will review some of the extreme, but feasible channels that could be incorporate into SETI from advanced particle and astrophysics.

Astrophysical Technosignatures

Pauli E. Laine
University of Jyväskylä, Finland

Introduction

Our conventional SETI endeavors have focused on detecting artificial signs with communication techniques that are in everyday use in our present state of technical culture. These include the use of electromagnetic waves, i.e. radio, laser, and visible light communication techniques. What would be the most extreme (on a planetary scale) ways of showing one's existence over the vast distances and hiding structures (i.e. interstellar clouds, star clusters etc.)? Could ETI use e.g. neutrino transmission, or high energy peaks to overcome the difficulties the conventional techniques have? This is a short review of some of the extreme, but feasible channels that could be incorporate into SETI from advanced particle and astrophysics.

High Energy Peaks

High energy peaks are e.g. bundle of accelerated atomic nuclei, such as gamma rays. Accelerating lot of signal nuclei would require lot of energy and would need to be somewhat targeted to receiver's direction. These energy peaks could be easily detected from space, but are filtered by the atmosphere.

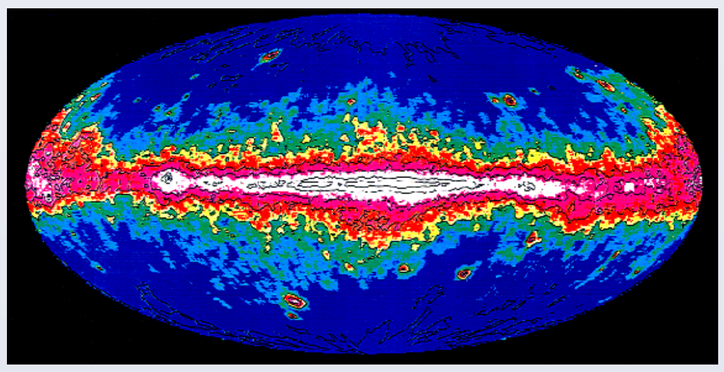

Figure 1. EGRET gamma ray all-sky survey (NASA)

Neutrino Transmission

Neutrinos are ideal for communicating over long distances and through hiding strictures. But it also make them extremely difficult to detect. Existing, very large neutrino detectors (e.g. Super-Kamiokande) could already be used to make statistic analysis about neutrino sources. Neutrinos can be produced in e.g. nuclear reactors.

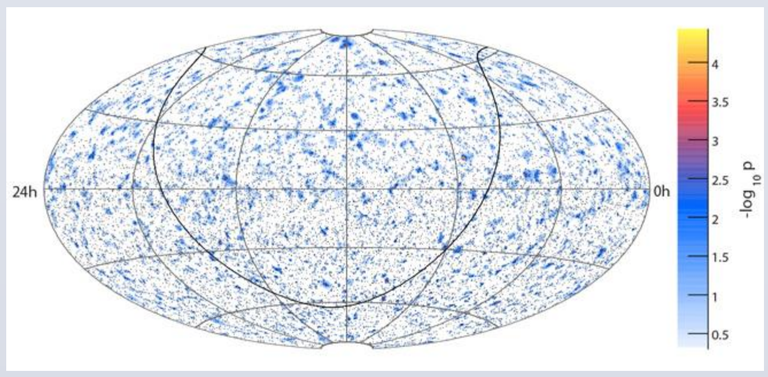

Figure 2. AMANDA neutrino sky (IceCube)

Artificial Illumination

Future exoplanet telescopes could observe exoplanets directly. Detecting phase modulations produced by very strong artificial illumination on the night side of the planet could reveal technological civilization.

Figure 3. Artist's view of alien planet (Public domain)

Fast Radio Bursts

Fast radio burst (FRB) is a high-energy astrophysical phenomenon of unknown origin manifested as a transient radio pulse lasting only a few milliseconds (Wikipedia). We have detected over 20 FRBs in the past 15 years. It has been proposed that these bursts are artificial.

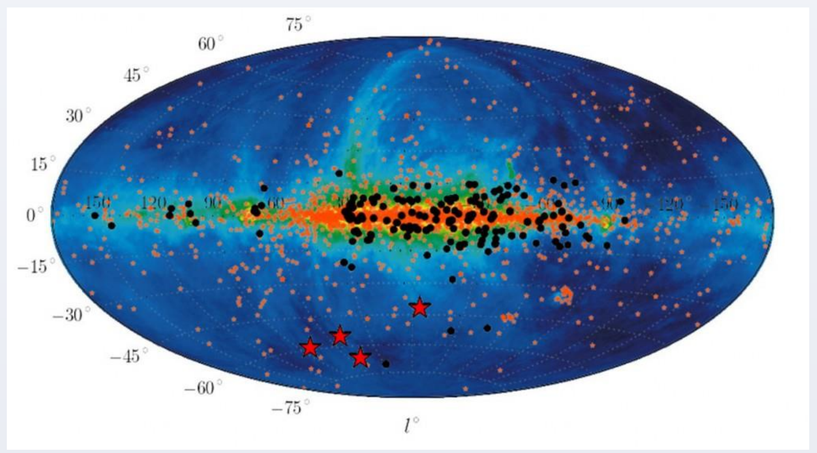

Figure 4. High Time Resolution Universe Survey. Red stars indicate positions of some of the detected FRBs (MPIfR/C. Ng)

Artificial Transits

Just for saying 'Hello!", by sending a very large, but lightweight object in to solar orbit would not be so difficult. Such a thin, lightweight structure would act like solar sail, and would have to move time to time perpendicularly to solar wind. However, it could easier to just distort the apparent shape of transit light curve with controlled laser emission (Fig. 5).

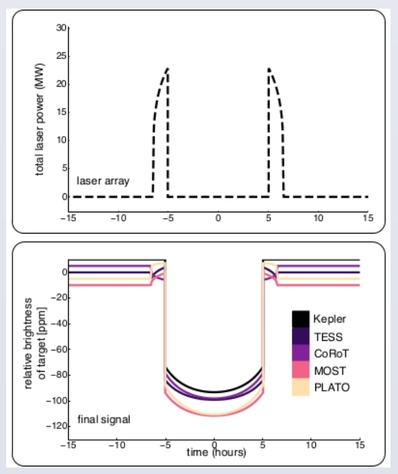

Figure 5. Top: Power profile of a laser array. Bottom: Resulting light curves [Kipping, D.M., Teachey, A. 2016]

Hypothetical Ways

More extreme ways of saying 'Hello!' could include using CMB (around 279.5 GHz), gravitational waves, or even highly hypothetical faster than light communication, i.e. quantum entanglement or tachyons. These are some examples of hypothetical channels that could be incorporate into SETI if feasible detection becomes available.

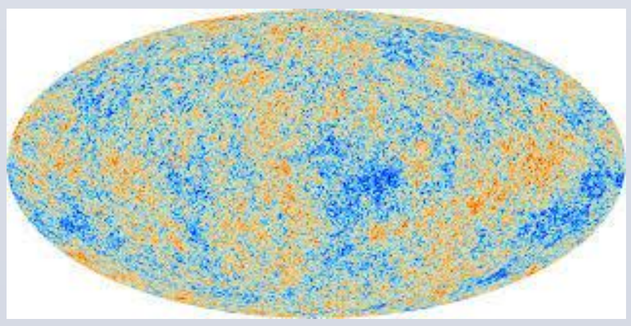

Figure 5. Cosmic Microwave Background (ESA)

Conclusions

There are many ways of showing one's existence over the vast distances and hiding structures in the Universe. It seems that only our imagination and instrument sensitivity are the only limitation for finding new channels for detecting potential artificial signals or technosignatures.

Further Readings

Fishbach, E., Gruenwald, J.T. NU-SETI: A Proposal to Detect Extra-Terrestrial Signals Carried by Neutrinos. arXiv:1702.03341

Kipping, D.M., Teachey, A. 2016. A Cloaking Device for Transiting Planets. arXiv:1603.08928

Wright, J.T. et al. 2014. The G Infrared Search for Extraterrestrial Civilizations with Large Energy Supplies. arXiv:1408.1133v1