

# Gamma Ray Bursts and CETI

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## Abstract

Gamma ray burst sources are isotropically distributed. They could be located at distances  $\sim 1000$  AU. (Katz [4])

GRB signals have many narrow peaks that are unresolved at the millisecond time resolution of existing observations. [1]

CETI could use stars as gravitational lenses for interstellar gamma ray laser beam communication.

Much better time resolution of GRB signals could rule out (or confirm?) the speculative hypothesis that GRB = CETI.

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# 1 Introduction

Gamma ray burst (GRB) sources were discovered by U. S. and Russian satellites searching for nuclear explosions. [1, 2]

Observations from the Compton Observatory made GRBs even more enigmatic, because they were found to be isotropically distributed about the earth. [3]

The isotropic distribution ruled out sources confined to the galactic plane, leaving three possibilities:

1. GRBs are at cosmological distances;
2. GRBs are at galactic halo distances; and
3. GRBs are relatively local, in the solar neighborhood.

In this speculative paper, it is assumed that GRBs are in the solar neighborhood at a distance  $\sim 1000$  AU, roughly the distance of an inner Oort cloud.

How energetic must Oort cloud GRBs be? GRBs located 100 light-hours (720 AU) from the sun radiate about  $10^{26}$  erg, assuming that they are spherically symmetric sources of gamma rays. [3]

Oort cloud GRBs have been discussed by Katz [4], a paper entitled "*A Burst of Speculation*".

As an energy source, Katz proposes (in a section entitled "*A Crazy Idea*") cometary collisions. The idea of colliding cometary ice producing gamma rays really may not be so crazy, particularly taking into account such poorly understood phenomena as sonoluminescence in water due to cavitation (Maddox [5] says that some researchers argue that the cavitation bubble could produce plasmas with black-body temperature at least  $\sim 100,000$  K. (For comparison,  $1 \text{ MeV} \approx 10^{10} \text{ K}$ )).

Although Katz may be right about Oort cloud comets, there are other possibilities, including CETI (Communications from ExtraTerrestrial Intelligences).

"It may be that the very first sign we ever find is some weird phenomenon that a conventional astronomer sees who wasn't even thinking about SETI at that time.", a quote from Thomas McDonough [7], might apply to GRBs.

The purpose of this paper is to discuss that possibility, and to propose that future observations (particularly better time resolution of GRB signals) should be undertaken to rule out or confirm the CETI possibility.

## 2 CETI

CETI (Communications from ExtraTerrestrial Intelligences) should be distinguished from SETI (Search for (or Signals from) ExtraTerrestrial Intelligences).

SETI (the subject of the first Thomas McDonough quote [7]) assumes that the ETs have set up a beacon to attract our attention.

CETI assumes that the ETs don't really care whether or not they attract our attention, but are busily communicating among themselves and that we might be able to eavesdrop on their conversations.

Beacons should be bright signals without much structure. Conversations should have a lot of structure.

Since GRB signals fluctuate erratically during their duration ( $\sim 30$  sec), and have many narrow peaks whose width is unresolved by existing observations ( $\sim$  milliseconds) [1, 3], it seems that, if GRBs are ET, they are more likely to be CETI than SETI.

Therefore, this paper discusses the CETI possibility.

## 3 Stars as Gravity Lenses

If ETs wanted to set up a galactic version of Internet, how would they do it?

Stars act as gravitational lenses.

The focal length of the sun as a gravitational lens is about 540 AU. Any beam of electromagnetic radiation (whether light, radio waves, or gamma rays) hitting the sun from  $\approx 540$  AU or farther out is focussed by the sun's gravitational field into a beam that could be used for communication.

”If we could but see it, this is what every star in the galaxy looks like, sort of a sea urchin if you will, a star making images of every other star, starting at the minimum distance and going out to infinity. The casting of very high-resolution images of the whole universe on the sky - and these images are in focus at all distances - is a really remarkable thing.” (Drake discussing the ideas of Eshleman in the book of McDonough [6])

”Each star produces hundreds of billions of tubes of light, one for every other star, so there are hundreds of billions of hundreds of billions of tubes of light in our galaxy.” (McDonough [6])

The network of tubes of light would be a natural foundation for the ETs to build on to construct their galactic CETI Internet.

For ET to set up a transmitter/receiver station using the sun as a gravity lens, the ET would have to put it at least  $\approx 540$  AU away from the sun, but they would want it as near as practical to minimize the time and energy spent in maneuvering from one target to another.

Therefore, I assume that the ET CETI stations using the sun are  $\sim 500 - 1000$  AU from the sun, and hence  $\sim 500 - 1000$  AU from the earth.

The tracking and maneuver requirements of using the Oort cloud neighborhood of the sun as a transmitter/receiver station in a galactic Internet involves a technology beyond my ability to outline, but I presume that it is within ET capability.

To maximize the information their signals could carry, the ET would use coherent signals with short wavelengths: gamma ray lasers.

Creation, modulation and demodulation of such a gamma ray signal involves a technology beyond my ability to outline, but I presume that it is within ET capability.

Even we can now use lasers for free-space laser communication [8], and the search for ET laser signals has been proposed by Townes and Betz (infrared) and Kingsley (optical) [7, 8].

If GRBs are the gamma ray CETI signals from such a galactic Inter-

net, then the duration of each message is  $\sim 30$  sec, and there are about 2 messages/day. [3]

What are the energy requirements?

If they were spherically symmetric sources, GRBs located 100 light-hours (720 AU) from the sun would radiate about  $10^{26}$  erg. [3]

However, if the ET were beaming the gamma rays in the direction of the sun, confining the beam to  $\sim 10^{-4}$  steradian, the earth would still be in the beam and the required energy would be  $\sim 10^{26} \times 10^{-4}/4\pi \approx 10^{21}$  erg.

For comparison,  $\sim 10^{21}$  erg is roughly the energy of fission of 1 kg of  $U^{235}$ , or of the annihilation of 1 gm of matter by antimatter.

How can we tell whether or not the GRBs we see are signals on a galactic gamma-ray laser CETI Internet?

## 4 Need for Better Time Resolution

To tell whether or not the GRBs we see are signals on a galactic gamma-ray laser CETI Internet, we need much better time resolution of the GRB signals than  $\sim$  milliseconds.

On that scale, there is a lot of substructure [3], and we have not yet resolved the time structure of the GRB signals [1].

One last quote from McDonough [6]:

”Perhaps the first signs of an extraterrestrial civilization are already sitting on magnetic tape, deep in the bowels of the U. S. National Security Agency or the Soviet KGB.”

The NSA may not yet have GRB signals with time resolution much better than milliseconds.

However, if GRB = CETI, the skills of the NSA will probably be required to figure out what the ETs are saying to each other.

## References

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