Fast radio wave bursts: is life a cosmic fractal?

M. Pitkänen

Email: matpitka6@gmail.com.

http://tgdtheory.com/.

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Abstract

Fast radio wave bursts (FRBs) are a mysterious looking phenomenon. They can occur periodically which has inspired the question whether communications by intelligent entities might be involved. Their duration is measured in milliseconds, the time scale of nerve pulses. The latest finding of the burst is from our own galaxy and supports the view that magnetars carrying huge magnetic fields are the source of the bursts. The emitted energy would be huge - the energy created by Sun during century in nuclear fusion assuming that the emission is isotropic - an assumption challenged by the TGD based model relying on the vision that Universe is filled with a network of nodes of magnetic flux tubes with nodes identifiable as flux tube tangles - kind of spaghettis.

This picture suggests that the interpretation in terms of a neural network with a tree-like structure could make sense with few or even a single axon-like flux tube emanating from a given stellar object. This reduces the estimate for the emitted energy dramatically - to about 7.5 Planck masses.

Assuming Nottale's hypothesis as a formula for the gravitational Planck constant $\hbar_{gr}$ and that the receivers of the bursts consists also of objects with mass of order Planck mass, one ends up to a model in which the FRBs correspond to the analogs of nerve pulse patterns from the magnetar along axon-like flux tube tube splitting to large number of tubes and covering an area of the order of the cross section of Sun. The ratio of the total energy to the energy of radio wave radiation is equal to the ratio $\hbar_{gr}/\hbar$ as predicted.

1 Introduction

I encountered a highly interesting popular article with title "*Mysterious 'fast radio burst' detected closer to Earth than ever before*" (`https://cutt.ly/QdNX5Xc`)

Fast radio wave bursts (FRBs) arrive from a distance of hundreds of millions of light years - the scale of a large void. If the energy of FRBs is radiated isotropically in all directions - an assumption to be challenged below - the total energy is of the same order of magnitude that the energy of the Sun produced during a century. There are FRBs repeating with a period of 16 days located to a distance of 500 million light years from Earth.

The latest bursts arrive from a distance of only about 30 thousand light years from our own galaxy Milky Way described in the popular article can be assigned with magnetar (see `https://cutt.ly/udNMKRF`), which is a remnant of neutron start and has extremely strong magnetic field of about 10^{11} Tesla.

Below is the abstract of the article [E3] (`https://cutt.ly/sdNX69z`) reporting the discovery.

> We report on International Gamma-Ray Astrophysics Laboratory (INTEGRAL) observations of the soft γ ray repeater SGR 1935+2154 performed between 2020 April 28 and May 3. Several short bursts with fluence of $\sim 10^{-7}$–10^{-6} erg cm^{-2} were detected by the Imager on-board INTEGRAL (IBIS) instrument in the 20200 keV range. The burst with the hardest spectrum, discovered and localized in real time by the INTEGRAL Burst Alert System, was spatially and temporally coincident with a short and very bright radio burst detected by the Canadian Hydrogen Intensity Mapping Experiment (CHIME) and Survey for Transient Astronomical Radio Emission 2 (STARE2) radio telescopes at 400800 MHz and 1.4 GHz, respectively.

> *Its lightcurve shows three narrow peaks separated by ~ 29 ms time intervals, superimposed on a broad pulse lasting ~ 0.6 s. The brightest peak had a delay of 6.5 $\pm$ 1.0 ms with respect to the 1.4 GHz radio pulse (that coincides with the second and brightest component seen at lower frequencies). The burst spectrum, an exponentially cutoff power law with photon index $\Gamma = 0.7^{+0.4}_{-0.2}$ and peak energy $E_p = 65 \pm 5$ keV, is harder than those of the bursts usually observed from this and other magnetars.*
>
> *By the analysis of an expanding dust-scattering ring seen in X-rays with the Neil Gehrels Swift Observatory X-ray Telescope (XRT) instrument, we derived a distance of $4.4^{+2.8}_{-1.3}$ kpc for SGR 1935+2154, independent of its possible association with the supernova remnant G57.2+0.8. At this distance, the burst 20200 keV fluence of $(6.1 \pm 0.3) \times 10^{-7}$ erg cm^{-2} corresponds to an isotropic emitted energy of $\sim 1.4 \times 10^{39}$ erg. This is the first burst with a radio counterpart observed from a soft γ ray repeater and it strongly supports models based on magnetars that have been proposed for extragalactic fast radio bursts.*

What could be the interpretation of the finding in the TGD framework? The weirdest feature of the FRB is its gigantic total energy assuming that the radiation is isotropic during the burst. This assumption can be challenged in the TGD framework, where the stellar systems are connected to a monopole flux tube network and radiation flows along flux tubes, which can also branch. This brings strongly in mind the analog of a nervous system in cosmic scales and this analogy is used in what follows.

2 TGD based model for the FRBs

TGD based model is motivated by the fractality of the TGD Universe and zero energy ontology (ZEO) based view about quantum measurement theory predicting that self-organization correspond in all scales corresponds to a formation systems living in at least primitive sense.

An essential element is the hierarchy of effective Planck constants $h_{eff} = nh_0$ implied by adelic physics formulating the number theoretic vision about TGD. h_{eff} labels phases of ordinary particles behaving like dark matter and n corresponds to the dimension of extension of rationals. The first generalization of Nottale's hypothesis $\hbar_{gr} = GMm/v_0$ to be discussed below in more detail was to $h_{eff} = \hbar_{gr}$. The recent form of the hypothesis is that $\hbar_{gr}$ corresponds to a large integer factor of $h_{eff}/h_0 = n$.

The differences between TGD based view about classical fields lead to the notion of magnetic body consisting of flux quanta. Entire Universe would be a fractal network of nodes (say stars, planets, etc... identifiable as flux tube tangles identifiable as spaghetti like structures) connected by flux tubes, which can come in two varieties depending on whether the magnetic flux associated with them vanishes or is monopole flux.

2.1 Heuristic picture

With this background in mind one can start the heuristic model building.

1. The duration of pulses is few milliseconds: the duration of nerve pulses is the same. Is this a wink-wink to the Poirots of astrophysics?

2. Bursts can arrive regularly - for instance with a period of $T = 16.35$ days [E1] (`https://cutt.ly/xdNMjQK`). This brings in the mind of astro-Poirot biorhythm, in particular EEG rhythms. This would not be the only such rhythms: also the period of $T_{alpha} = 160$ minutes, for which have proposed an interpretation as a cosmic analog of alpha rhythm is known [L6]. The ratio $T/T_\alpha = 147.15$ would give for the analogous brain rhythm the value of 14.7 seconds.

3. Let us assume that stellar systems indeed form an analog of neural network connected by flux and assume that the topology of this network is analogous to that defined by axons. In TGD framework neural communications between neurons occur actually by using dark photons with effective Planck constant $h_{eff} = nh_0$ along the flux tubes with the velocity of light so that feedback from brain and even from the magnetic body of brain back to sensory

organs as virtual sensory input becomes possible. The function of nerve pulses is to connect the outgoing branch of the flux tube associated with the axon and those associated with dendrites of the post-synaptic neuron to a longer flux tubes by using neurotransmitters as relays.

4. The stellar object as an analog of a neuron would send its dark photon signals along the flux tube assignable to a single axon. Axon would later branch to dendrites arriving to other stellar systems and eventually perhaps to planets as analogs of synaptic contacts. An interesting question is whether also the analogs of nerve pulses and neurotransmitters acting as relays in the synaptic contacts defined by planets could make sense. What could nerve pulses propagating along the flux tube correspond to?

   Remark: In the TGD based model of brain there would be also flux tube network analogous to the meridian system of Eastern medicine and responsible for the holistic and spatial aspects of consciousness since more than one flux tube can emanate from a given node making possibly non-linear networks [L2]. Nervous system with tree- like structure would be responsible for the linear and temporal aspects of conscious experience. Meridian system would be a predecessor of the neural system.

5. The distances of FRBs are of the order of large voids having galaxies at their boundaries and forming lattice-like networks possibly assignable to the tesselations of 3-D hyperbolic space defining cosmic time= constant surfaces. This kind of tesselations could accompany also brain [L8]. In the fractal Universe of TGD one can wonder whether these voids are analogs of cells or even neurons and form cosmic biological organisms with flux tubes forming a network allowing communications.

2.2 The total emitted energy if it is analogous to nerve pulse pattern along flux tube directed to solar system

The basic implication is that the energy of the emitted radiation could be dramatically smaller than that predicted by am isotropic radiation burst. It is interesting to look whether the proposed picture survives quantitative modelling.

1. The reduction factor r for the total emitted energy would be essentially $r = S/A$, where S is the area of the "axonal" flux tube and $A = 4\pi R^2$ is the surface area of the magnetar. One must estimate the value of r.

2. Flux quantization for a single sheet of the many-sheeted magnetic flux tube involved would give $eBS = \hbar_0$ $h = 6h_0$ [L1, L5]. The general order of magnitude estimate is $eB \sim \hbar_0/S$. If each sheet carries out the same energy, the number of sheets is $n = h_{eff}/h_0$ and the effective area of a flux tube is $S = \hbar_0/eB$. Does the magnetic field assigned with magnetar correspond to a single sheet or to all sheets? If the field is measured from cyclotron energies assuming $h_{eff} = h$ it would correspond to all sheets and the measured magnetic field would be the effective magnetic field $B_{eff} = nB/6$ for $h = 6h_0$.

3. The branching of the flux tube could correspond to the splitting of the many-sheeted flux tube to tubes with smaller number of sheets and involve reduction of h_{eff}. This would give the estimate $r = \hbar_0/eBA$. Magnetic field of 1 Tesla corresponds to a unit flux quantum with radius - magnetic length - about 2.6×10^{-8} meters. Assuming the estimate $R = 20$ km for the magnetar radius, one has $r \sim 10^{-25}/6$.

4. The estimate for the total emitted energy assuming isotropic radiation is the energy radiated by the Sun during a century. Sun transforms roughly $E_{100} = 1.3 \times 10^{19}$ kg of mass to radiation during a century. This gives for the energy emitted in FRB the estimate $E = rE_{100} \sim 10^{-6}/6$ kg which is roughly 7.5 Planck masses $m_{Pl} \simeq 2.2 \times 10^{-8}$ kg $= 1.2 \times 10^{19}$ GeV. The order of magnitude is Planck mass. The estimate is of course extremely rough.

   In any case, the idea that pulses could have mass of order few Planck masses is attractive. Note that a large neuron with radius about 10^{-4} meters has a mass of order Planck mass [L7].

5. From the total detected energy $dE/dS = 6.1 \times 10^{-7}$ erg m^{-2} = 3.8×10^9 eVm^{-2} and total radiated energy $E = 7.5 m_{Planck}$ one can estimate the total area S covered by the branched energy flux if it covers the entire area with a shape of disk of radius R. This gives some idea about how wide the branching is. The total energy is $E = (dE/dS) \times \pi R^2$ giving $R = \sqrt{E/\pi(dE/dS)} \simeq .9 \times 10^9$ m. The equitoral radius of the Sun is $R_{Sun} = .7 \times 10^9$ m. $R_{Sun} \sim .78R$ This conforms with the idea that the radiation arrives along the axon-like flux tube connecting Sun and the magnetar branching so that it covers entire Sun.

2.3   Is the ratio $\hbar_{gr}/\hbar$ equal to the ratio of the total emitted energy to the total energy received by Sun?

The ratio h_{eff}/h should be of the same order of magnitude as the ratio $X = E/E_{rad}$, where E_{rad} is the energy of the radio wave photon with frequency 1.4 GHzfor $h_{eff} = h$: $X \sim h_{eff}/h$. The ratio $Y = X/(h_{eff}/h)$ should satisfy $Y \sim 1$.

1. To proceed further, one can use the TGD variant of Nottale's hypothesis. The hypothesis states that one can assign to gravitational flux tubes gravitational Planck constant $\hbar_{gr}$. The original hypothesis was $\hbar_{eff} = \hbar_{gr}$ and the more recent form inspired by the adelic vision states that h_{gr} corresponds to a large integer factor of h_{eff}. One has $\hbar_{gr} = GMm/v_0 = r_S m/2v_0$. Here M is the mass of the large object - now that of magnetar. m is the mass of the smaller quantum coherent object in contact with the gravitational flux tube mediating gravitational interaction as dark graviton exchanges.

   v_0 is a velocity parameter, which for Sun would be $\beta_{0,S} = v_0/c \simeq 2^{-11}$ from the model for the inner planets as Bohr orbits [E2] [K6, K4, K5, K3].

2. The Planckian educated guess is $m \sim m_{Pl}$ so that one would have $\hbar_{gr}/\hbar = r_S(M)/(2L_{Pl}\beta_0)$, where L_{Pl} is Planck length and $r_S(M)$ is the Schwartshild radius of the magnetar. This would give $Y = X/(h_{gr}/\hbar) = .4$ if one has $r_S = 3$ km as for the Sun. r_S is probably large but smaller than magnetar radius about 20 km. The masses of the magnetars are in the range 1-2 solar masses. For $M = 2M_S$ one obtains $Y = .8$

   The rough estimate is not far from $Y = 1$ and suggests that the interacting quantum units at the receiving end have mass of order Planck mass. Interestingly, the mass of a large neuron with radius 10^{-4} m is about Planck mass [L7], which supports the view that quantum gravitation in the TGD sense is fundamental for life - even in the cosmic scales.

2.4   The parameter v_0 as analog of nerve pulse conduction velocity?

The physical interpretation of the velocity parameter v_0 is one of the key challenges of TGD.

1. The order of magnitude of v_0 is the same as for the rotational velocities in the solar system. I have considered a geometry based interpretation in [L4, L3] [K2].

2. The analogy with the neural system encourages the question whether v_0 could have a concrete interpretation as the analog of the nerve pulse conduction velocity assignable to the dark magnetic flux tubes connecting distant systems.

   In TGD framework nerve pulses [K1] are proposed to be induced by Sine-Gordon solitons for the generalized Josephson junctions assignable to the cell membrane and identifiable as transversal flux tubes assignable to various membrane proteins such as ion channels and pumps. The dark variants of the biologically important ions would give rise to the supra currents.

   Could the gravitational flux tubes analogous to axons have this kind of structure and give rise to generalized Josephson junctions with ions serving also in this case as current carriers?

To sum up, the proposed interpretation as cosmic neural networks conforms with the basic assumptions of TGD. Most importantly, quantitative predictions are correct. The picture is of course not deduce from axioms: this is pattern recognition with basic principles predicting a lot of new physics.

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