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Are Pulsar Signals Evidence of Astro-Engineered Signalling Systems?

Invitation to a Collaborative Study

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In his recent book, *The Talk of the Galaxy*, Dr. Paul LaViolette (2000) shows how new high-resolution recordings of pulsar signals reveal features that are inconsistent with the long-standing "neutron star lighthouse" pulsar model. LaViolette argues compellingly that the interesting and quite intricate behaviors of pulsars fit much more easily with a model of an ETI beacon carrying information. Part 1 of the present paper summarizes LaViolette's key points and describes the need for follow-up studies. Part 2 describes a multi-layered and multi-disciplinary program of research aimed at examining and testing LaViolette's assertions, and if the results merit, continuing with a search for information content in the pulsar signals. Readers are invited to join in this collaborative study.

LaViolette on Pulsars

Background

The original discoverers of pulsar signals, Jocelyn Bell and Anthony Hewish of Cambridge University, thought at first that they might be observing artifacts of some extraterrestrial civilization (Sturrock and Rockefeller, 2000). But a more acceptable if tentative explanation was soon found: the signals might be emanating from white dwarf stars that were contracting and expanding, or dimming and brightening (Hewish *et. al.*, 1968).

The radially-pulsing white dwarf model was itself soon discarded after two pulsars with periods less than 0.1 second were found in the Crab and Vela supernova remnants. Out of some twenty different proposed theoretical models of possible sources of these pulsing signals, astronomers settled on the "neutron star lighthouse" put forward by Thomas Gold (1968). In that model, a neutron star emits two opposed beams of synchrotron radiation confined to a narrow cone about the star's magnetic axis. We perceive pulses as the beams swing by us if we happen to be in the cone that they sweep out.

The original impression of pulsars (and other newly-discovered astrophysical objects and phenomena) as ETI beacons was not completely forgotten, however. In a note added to his published proceedings of the 1971 USSR conference on Communication with Extraterrestrial Intelligence (CETI), Sagan (1973) wrote:

> "The very serious current energy problems both in quasar and in gravity wave physics can be ameliorated if we imagine these energy sources beamed in our direction. But preferential beaming in our direction makes little sense unless there is a message in these channels. A similar remark might apply to pulsars. There are a large number of other incompletely understood phenomena, from Jovian decameter bursts to the high time-resolution structure of X-ray emission which might just conceivably be due to ETI. Perhaps, in the light of Doctor Marx's presentation, we must ask if the fine structure of some fluctuating X-ray sources is due to pulsed X-ray lasers for interstellar spaceflight. But Shklovsky's principle of assuming such sources natural until proven otherwise, of course, holds. Extraterrestrial intelligence is the explanation of last resort, when all else fails.
>
> "The pulsar story clearly shows that phenomena which at first closely resemble expected manifestations of ETI may nevertheless turn out to be natural objects – although of a very bizarre sort. But even here there are interesting unexamined possibilities. Has anyone examined systematically the sequencing of pulsar amplitude and polarization nulls? One would need only a very small movable shield above a pulsar surface to modulate emission to Earth. This seems much easier than generating an entire pulsar for communications. For signaling at night it is easier to wave a blanket in front of an existing fire than to start and douse a set of fires in a pattern which communicates a desired message."

Sagan's suggestion was not taken up by the astronomical community. Astronomers were unwilling to (publicly) consider an ETI-based source for the signals they were receiving. One reason they gave (Jastrow and Thompson, 1977), was that the pulse type of beacon was too wasteful of energy and wouldn't be the method *they* would choose.

Pulsar Behaviors

In *The Talk of the Galaxy* (2000), astrophysicist Paul LaViolette revives Sagan's speculation. Reviewing years of observations made since that CETI conference in 1971, with particular attention to high-resolution recordings of individual pulses, LaViolette finds significant support for considering pulsars as possible ETI beacons.

He of course notes the difficulties presented to the standard model by pulsars with millisecond periods. But there have been many other challenges to the model in the form of quite interesting features of pulsar spatial distributions, and intricate behaviors seen in high-resolution recordings of individual pulses and pulse sequences.

Here is a brief listing of some behaviors found in the current literature and discussed by LaViolette:

- *Time-Averaged Regularity* - Time-averaged pulse contours do not change over days, months, or years. Timing of averaged profiles is similarly precise.
- *Single-pulse Variability* - Timing and shape of individual pulses vary considerably.
- *Pulse Drifting* (certain pulsars) - Individual pulses occur successively earlier and earlier within the averaged profile ("drifting pulsars"). For certain drifting pulsars, drift rate abruptly shifts in value. Or drift may be random with occasional recurring patterns.
- *Polarization Changes* - Polarization parameters vary within individual pulses, but time-averaged profile of polarization is constant.
- *Micropulses* - About half of observed pulsars exhibit micropulses within individual pulses. Micropulses typically last a few hundred microseconds. Or they may have oscillatory periods.
- *Pulse Modulation* - Signal strength may wax and wane over a series of pulses. Or this may be seen only when sampling every other pulse. Or maybe only at particular times in the profile.
- *Pulse Nulling* - Pulse transmissions may be interrupted for seconds or hours. When resumed, varying parameters continue from where they had left off!
- *Mode Switching* - More than one stable pulsation mode, with sudden switching between them.
- *Pulse Grammar* - "Grammatical" switching rules.
- *Glitching* - Pulse periods grow at a uniform rate (as though spinning pulsar is slowing down), but occasionally the period abruptly changes to a smaller value (pulsar instantaneously assumes a higher rotation rate?) and the sequence continues from there.

When averaged over several minutes or so, these complexities disappear, leaving only extreme regularity.

Spatial Distributions

The neutron star lighthouse model predicted that pulsars would be formed in supernova explosions and in fact several of them have been found near supernova remnants. If that were truly how they were formed, one would expect to find pulsars concentrated toward the center of the galaxy where most supernovas occur. However, LaViolette has noticed that the distribution of observed pulsars in the galactic plane differs markedly from that. (He also cites studies of neutron stars associated with supernova remnants showing that the stars were <u>not</u> formed in the supernovas.) In fact, there is a clumping of them near a point one radian north of the galactic center. He depicts a sharp fall-off of pulsars just beyond that point. He also noticed that some of the most unusual pulsars are found right at that edge in the distribution.

The position of these anomalies at a one-radian angular distance from the g.c. is especially odd because 1) the radian is arguably a natural angular unit that would be recognized by

many societies, and 2) this particular angular position would exist only from a point of view located exactly where we are – giving the impression of a deliberate signal or sign to our society or any society at our location.

In the same vein, LaViolette points out that the two fastest known pulsars are located at the two one-radian positions. These pulsars have other unique features that are listed by LaViolette. He also looks at the constellations in which the pulsars appear, and finds curious associations. The constellation Sagitta (the "Celestial Arrow") is located "adjacent" to a one-radian point. The arrow of Sagittarius' bow (and the stinger of the Scorpion) designate the galactic center, and the cross of Crucis marks the southern galactic one-radian point. These star formations all involve "marker" imagery.

Since the system of constellations was presumably invented here in our ancient cultural past, these oddly congruent associations suggest the constellations may have been devised in such a way as to embody and preserve knowledge of the significance of the pulsar signals for the benefit of future civilizations.

Pulsars as Artifacts

Unlike Sagan, who accepted the conventional model of a pulsar but wondered if ETI could be adding fine-grained modulation, LaViolette proposes a way in which the steady emissions of stars could be focused into the pulses we see. He explains that ETI might be using a nearly-collimated beam of synchrotron radiation, applying technology that we actually are developing today. This dramatically offsets the effect of distance on the detectability of a beacon over interstellar distances.

Although we may now have or soon will have the capability to transmit focused synchrotron beams, LaViolette's postulated transmitting society has access to energy on a scale far exceeding ours. Although pulsars are probably not neutron stars, they are still stars - white dwarfs modified to produce the pulsar signals. The short of it is that we are observing a Kardashev/Kaku Type II civilization in terms of its ability to harness the total energy of a star.

Impact of LaViolette's Hypothesis

LaViolette's hypothesis has received some interest in the borderland science literature, but has not been taken very seriously by astrophysicists. I am not aware of any that have taken the trouble to refute or even discuss his work; there also has been no follow-up in terms of 1) reviewing the published data from which he drew his conclusions, 2) obtaining and re-analyzing any of the original data on which the publications he used was based, or 3) searching for more of the kinds of patterns noted by LaViolette in fresh pulsar data.

Proposal for a Collaborative Study

Framework of Collaboration

The suggestions for studies that will be made in this proposal are not the intellectual property of anyone, and therefore any persons or groups may undertake to perform them. However, there would be value in establishing a research group dedicated to these studies, using e-mail, a list server, electronic forum, or some combination of these, for developing a program of research and coordinating research activities.

An informal organization structure is envisaged, intended more to promote, support, and share this research than to contain it.

Research Program

The research program itself is a subject of discussion and will be decided upon by the participant researchers. However, to initiate discussion, I here suggest a possible program. Studies would be performed in a series of phases, each consisting of a number of *projects*. Although the phases possess an intrinsic logical sequence, they in fact can be conducted concurrently according to the choices and predilections of participant researchers. Accordingly, I term them *Layers*, as follows:

- *Layer 0* (Program Layer). This is the meta-layer, the design and oversight of the program itself. This activity will continue throughout the duration of the program, setting and continually refining its goals, and planning its future activities (i.e., creating, continuing, and terminating the other layers), in response to the findings of the other layers.
- *Layer 1* (Validation Layer). The validity of the issues raised by Dr. LaViolette is addressed by this layer. It consists of two projects:
    - Literature Review. Assess the accuracy of LaViolette's presentation of published pulsar studies,[1] including his presentation of pulsar spatial distributions based on information contained in published pulsar catalogs.
    - Science Review. Assess the adequacy of currently held pulsar models to explain detailed pulsar behavior currently being observed and reported. If existing physical models are found to be inadequate, then *anomalies* are present, needing alternative explanations. This project should be performed by one or more astrophysicists with deep background in pulsar research.
- *Layer 2* (Computing Layer). This layer contains a number of projects devoted to developing the computing environment and related resources required for accessing and analyzing pulsar recordings.
- *Layer 3* (Replication Layer). Using such high-resolution pulsar recordings as they become available,[2] and the computing facilities developed in *Layer 2*, search for

[1] Literature references are found in *The Talk of the Galaxy*.
[2] Dr. LaViolette has obtained and supplied high-resolution recordings of the Vela pulsar.

pulsar signal features previously reported. The purposes of this layer are 1) to ensure that this entire program is on solid footing; 2) to acquire the capability of accessing and deeply analyzing pulsar signal recordings; 3) to enrich the set of features under study.

- *Layer 4* (Explanation Layer). Assuming that verified anomalies are actually in hand, begin to seek alternative explanations. Projects in this layer must not proceed on the assumption of ETI origin, but rather be willing to consider a wide range of possible explanations not encompassed in any existing paradigm.
- *Layer 5* (Technology Layer). Dr. LaViolette has suggested a number of technologies that could be employed by an astro-engineering society to generate the pulsar signals that we observe. He provides enough details to launch a further investigation of each of his ideas. Plasma physicists and electrical engineers might find it rewarding to explore these areas, coordinating with those working in other layers of this program both to point the way to further investigation and to acquire detailed data that might assist them in determining which technologies might actually be in use.
- *Layer 6* (Interpretation Layer) LaViolette offers what I call a zero-order interpretation of the pulsar signals: ET civilization exists, and a first-order interpretation: the signals call our attention to the existence and dangers of a *galactic superwave*. But if the signals are truly an artifact of an intelligent civilization, much more information is likely contained in the details. Researchers with a linguistic bent will be called upon to begin the process of interpreting the meanings possibly conveyed in the detailed features.
- *Layer 7* (Relativistic Communications Layer). Dr. LaViolette calls attention to the galactic scale of the communication system he is suggesting. Any civilization that constructs such a system must not only be of galactic size itself, but must be able to coordinate its activities with superluminal rates of information exchange. Projects in this layer will be devoted to fleshing out the characteristics of communication systems required to mount projects of the scale being studied, and to relate that to current theories and experiments that are leading our own society in the direction of possible superluminal communication. A possible sublayer could be a much-needed reconsideration of the early twentieth-century theories that led us to believe in the light-speed limit to communications and physical travel.[3]
- *Layer 8* (Publications Layer). Individual researchers associated with this program are always at liberty to publish their work in any way they choose. However, there would be value in an occasional combined publication of current work being conducted in this group. I envision this publication in the form of a series of printed volumes, or perhaps special issues of scientific journals. I also would be happy to post research papers and news of ongoing work in my Open SETI website http://openseti.org or to help set up a new website devoted to this research activity.

[3] Refer to the collection of articles in *Infinite Energy*, Vol. 7, No. 28, July/August 2001.

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