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An assessment concerning neutron stars and space propulsion implications

Abstract

There are many uncertainties concerning stellar evolution of neutron stars. Neutron stars might possess multipolar architecture in lieu of a single dipole claimed by the conventional wisdom. The multipole issue cannot be resolved using a single observer reference point such as the Earth, but would require an additional non-terrestrial observer location with a significant offset. Without observing multiple beacons, we could not verify or deny the existence of multiple poles from observing the sweeping lighthouse effect from Earth. Moreover, a neutron star's magnetic field may be created by differences between the neutron core and a gas surface layer of protons and electrons. These differences between the layers constitute charges and moving currents that result in a magnetic field supported by a fast moving rotating core. If electrons in Cooper pairs exist in a neutron star, then the amount of magnetism may increase by a similar order via superconductivity. By symmetry, proton pairs should also exist to produce similar charge redistribution. Observing the different layers where an electron gas probably evaporates, rotating a proton gas over a neutron core can develop a strong magnet. These issues warrant further discussions as well as a proposal that provides implications for developing a space propulsion scheme.

Keywords

Binary pulsar; Neutron star; Asteroid; Gravity; Jefimenko; Rotation; Angular momentum; Trajectories.

INTRODUCTION

There is a need to discover numerous secrets about neutron stars and binary pulsars to gain possible insights about new types of energy creation. Pulsars are mentioned because they "pulse" with emissions at a steady observable rate. For example, PSR 1919+21 pulses every 1.337 seconds. These pulsars rotate incredibly fast, throwing off beams that sweep across the Earth of radio waves or X-rays from their magnetic poles. Knowledge about neutron stars within pulsars would allow us to understand the far-field environment of space and possibly enable the creation of new propulsion system concepts. Let us first examine some background information to obtain an understanding of a neutron star before discussing possible propulsion implications.

Most of the magnetic fields of cosmic objects are generated and maintained by the dynamo action using electrically conducting fluids in motion[1]. Essential features of the dynamo theory of cosmic objects are developed, first on the kinematic level and later taking into account the full interaction between magnetic field and motion. Particular attention is paid on electrodynamics as well as magnetofluid dynamics with application to dynamo models for surface objects on a planet showing irregular or turbulent motion and magnetic fields. A few explanations are given by acting on such a single dynamo in the Earth and the planets, in the Sun and stellar objects and in galaxies.

Magnetic fields of cosmic objects show a great variety[1] not only with respect to their magnitudes and spatial extents but also to their geometrical structures and time behavior. As far as our Sun is concerned, not only sunspots, but also all phenomena of solar activity such as flares, protuberances, and coronal mass ejections are connected with magnetic fields. These magnetic properties are measured with the help of the

Zeeman effect[2,3] that splits a spectral line into several components in the presence of a static magnetic field. From the study of sunspots and related phenomena of the solar activity cycle, we may conclude that the Sun possesses in general a large-scale magnetic field[4] that consists mainly of two field belts beneath the visible surface with flux densities exceeding at least 10^{-1} Tesla[1]. This belt is in the northern hemisphere and the other exists oppositely oriented in the southern hemisphere. In addition, there is a much weaker poloidal field with only a few 10^{-4} T intersecting the visible surface. Clearly, the near surface magnetic field is not easily established but rather complex; however, a stronger dipole relationship exists for the far-term view in our solar system.

After the discovery of the pulsar phenomenon[1] in the late sixties, it turns out that the only acceptable explanation for a pulsar could be given by assuming a rapidly rotating neutron star with a very strong non-symmetric magnetic field oriented misaligned about the rotation axis. That is the field is oriented as an oblique rotator. From the observational data flux densities of the order of 10^8 T were derived. In a few cases the existence of such strong fields has been confirmed in an independent way by the interpretation of X-ray spectral features due to electron cyclotron resonance scattering. Recently the observation of anomalous X-ray pulsars suggests that there are even enough neutron stars with flux densities as large as 1,012 T.

DISCUSSION

The objective is to understand how a neutron star may exist based upon our own sun. There are many theories about how a neutron star collapses. Let us assume that we look at our star with a given initial rotational axis. There are several magnetic fields on the sun as previously mentioned and shown in Figure 1. The poles may not be aligned in a given dipole axis that is not with a clearly distinguished north or south magnetic pole normally expected. The classical theory of electromagnetism offers two causes for magnetic fields: permanent magnetization of condensed matter and/or moving electric charges that become currents. Conditions allowing permanent magnetization can be excluded for almost all cosmic objects by several reasons. Electric currents in conducting matter are, of course, subject to Ohmic dissipation, which converts the energy stored in the magnetic field into heat. If there is no electromotive force that maintains the currents and so to compensate this energy loss, the currents and the magnetic field are bound to decay.

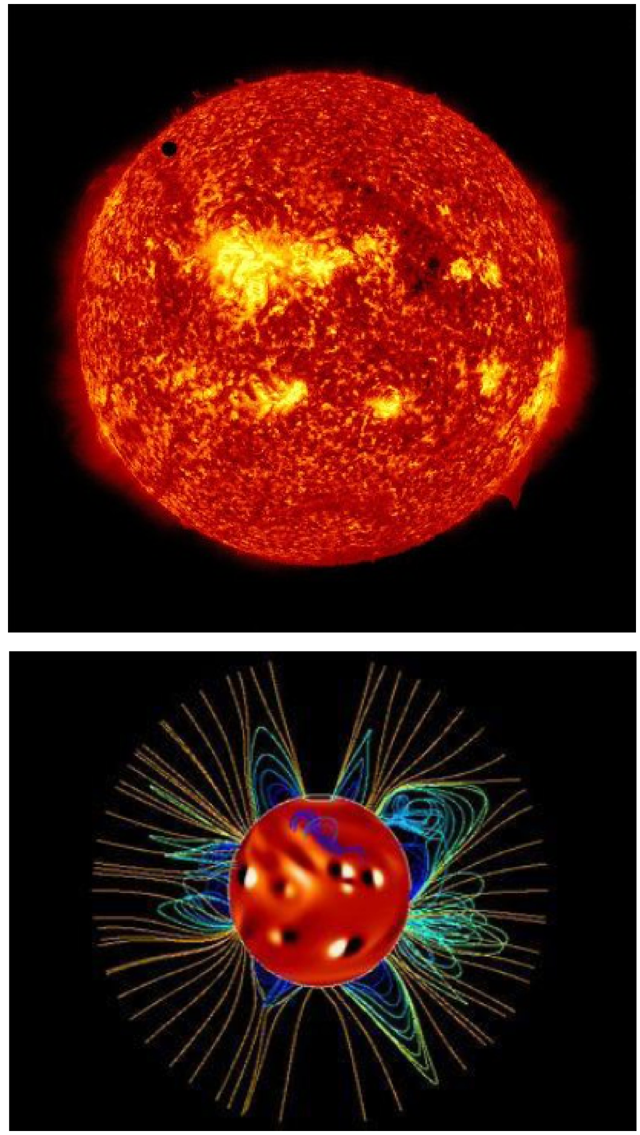

Figure 1 : The first picture is the Venus transit across the sun on 5 June 2012. Note the solar flares are anchored to the edges on the surface acting as independent magnetic field poles that are not in a singular pole as observed on Earth. How does this change with a neutron star during formation?

In contrast to the Earth, where the kernel[5] lies inside the iron core, the material at the center of the sun resides in the state of an ideal gas. Our sun consists of several different or multiple poles throughout the sun's surface as seen in Figure 1, which implies that each field is bound upon itself. These poles may be considered as 'minor' poles. Moreover, our star has an unusual magnetic field that is far stronger and different than expected. The impact upon the far field of the sun's magnetic field results in a growing increasing spiral.

This data is shown on Figure 2 based upon instruments over decades from Pioneer 10 and 11. This magnetic field from considerable distance appears that the sun acts as a singular pole in lieu of multiple poles observed on the sun surface. Since these satellites discovered a gravitational anomaly as well as demonstrated with three other long-range satellites, the data may support the contention that gravity can be altered. These may occur when a satellite passes through the spiral's magnetic trenches that might influence long-range gravitation. Thus, there will always be some unexpected events with gravity as we get exposed to further distances from the Earth.

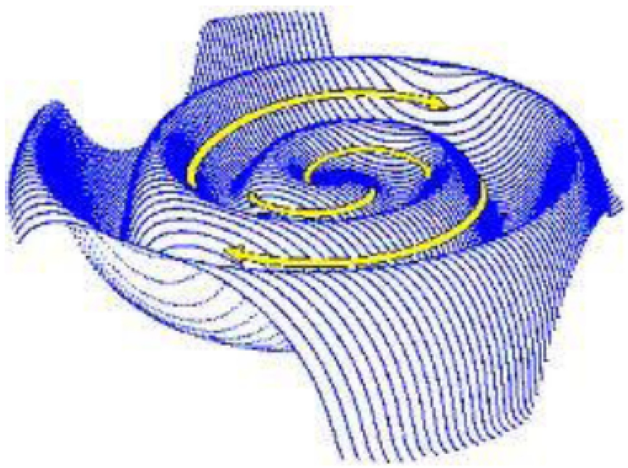

Figure 2 : The sun magnetic field based upon a spiral based upon measurements made by the Pioneer 10 and 11 where each moved in opposite directions within the solar system. (*Image is from J. Jokipii, University of Arizona*.)

AN ASSESSMENT

Let us address the evolution of a neutron star that is initially born with a star similar but larger than our sun. Once these views are somewhat understood, the question becomes one of using this knowledge to develop a space propulsion scheme.

Pulsar models

There are many uncertainties in stellar evolution[3]. Let us examine a basic star similar to our sun that will undergo a process that leads toward creating a neutron star. Several processes could occur. The conventional wisdom suggests that a neutron star occurs after many stages of nuclear burning of the star core that becomes unstable and implodes while the outer layers of the star explodes as a supernova. There is a massive output of energy. Neutrons are created from decomposition of the core that moves through the outer layer and nucleosynthesis for heavy elements. Outer layers of the gas are thrown off and become some of the supernova remnants. The subsequent core explodes and may leave a remnant such as a neutron star that consists mostly of neutrons. The neutron star rotates rapidly observable as a radio pulsar. It is possible that the remnant may either create a neutron star or create a black hole.

The structures of the neutron stars more closely resemble a planet than a star[6] but its atmosphere on a smaller denser scale. The atmosphere, if any, is unlikely to be more than a few centimeters thick[7]. The outer layer of the star is considered as a crust that is solid and crystalline and probably several centimeters thick. This crust consists of a neutron cloud or superfluid containing a few protons and electrons to stabilize the environment.

In some cases neutron stars[8] are expected to slow down such as PSR 1913-16 where the difference in mass and energy is believed converted into gravitational waves. In some cases, the star can actually spin up with X-ray stars that are unlike radio pulsars without power by their stored rotational energy. Neutron stars are alone in interstellar space and capture material from its surroundings. Moreover, since supernovas are rare events, we must conclude that most stars die peacefully for the transformation into a neutron star.

A contrasting view

Let us look at this differently. Neutron stars are believed to be a product of a massive star after a supernova. The first thought that would arise is if there are enough supernovae that exist to satisfy the number of existing pulsars. Basically at least 200 pulsars exist and astronomers with the number of supernovae have discovered more than the lower number that, four of which exist alone in the Milky Way. However, the star is not big enough to create a black hole but is large enough to create a tiny, dense and hot mass of neutrons. Intense gravity forces the matter into a tiny

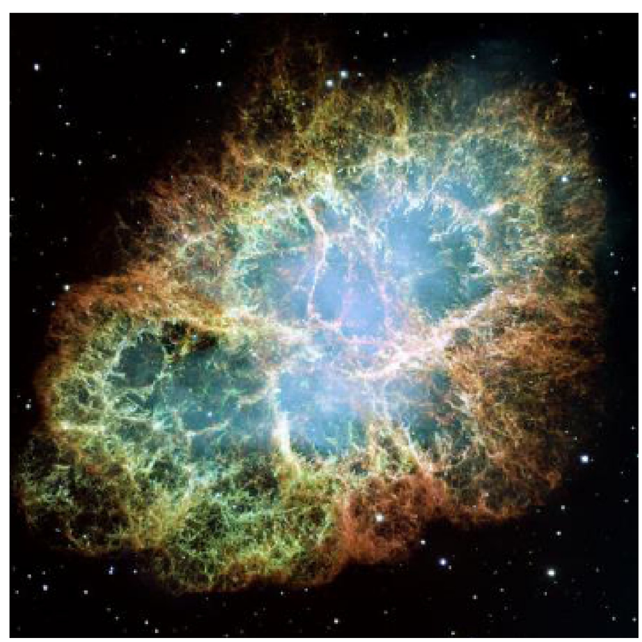

Figure 3 : The Crab Nebula represents the first neutron star that expended with a large amount of energy.

volume but quantum effects repel the neutrons. At the center of the Crab Nebula lies the Crab Pulsar, a neutron star, 28–30 km across, which emits pulses of radiation from gamma rays to radio waves with a spin rate of 30.2 times per second. The nebula in Figure 3 was the first astronomical object identified with a historical supernova explosion.

The birth of a neutron star

If an explosion occurs on the star's surface, this would compress the central core. However, the explosive process would require that the entire region of the star is evenly distributed covered for compression to produce a spherical-like object. This probability for a star is most likely an ovoidal-like geometry or possibly contains topological ridges. The probability of a perfect sphere should be viewed as having a very low probability and the differences in geometry may produce unexpected topological effects. Likewise, the probability that the surface is smooth may also be impractical. This could have an impact on the onset of turbulence when the gas boundary layer interacts with the rotating core. Furthermore, a large portion of the star would separate outwardly due to the compression process or explosion and the resultant rotational rate that would count upon available mass for angular conservation due to a reduction in the moment of inertia of the initial star. That obviously includes a minus portion of mass that moved outward during the supernova explosion.

There is an issue of how a star becomes unstable, most likely due to magnetic field changes, to produce either a neutron star or a black hole. What are the criteria and the processes? If the star becomes unstable, it most likely occurs on the surface for an implosion. How does the surface allow the instability to propagate over the entire surface before an implosion occurs to produce a near-perfect sphere? If such an instability moves radially from an initial point, inhomogeneous density variations exist within the initial star's interior. The mechanism for only allowing a surface disturbance is not well-understood or addressed because an implosion must be perfectly timed but the probability should be low for this to occur.

If the instability occurs at the center, all of the star should move outward radially to probably form an accretion disk and the result would most likely be a black hole.

There is another issue. Let us assume the star explodes and the explosion is a spherical shell. The star will have a distribution based upon the initial pressure and gravitational distribution. Obviously the center should have the largest density. If there is a concentric layer of different particles or elements in the initial star interior that become unstable to produce an explosion, it could be unevenly distributed to produce a constant density neutron sphere. However, if the layer has a specific thickness, it could form the explosion with an offset that compresses the star with considerable differences in density distributions. Here, the possibility of generating a perfect spherical core geometry should be extremely low based upon these density variants. Moreover, these asymmetric density structures may create unusual dynamic responses. Based upon a high rotational rate, these effects would be difficult to ascertain. The other part of the conventional lore is that the atmosphere is very low. The neutron core does not create an electric charge and will not induce magnetism unless there is free motion of electrons or protons within a high-density neutron matrix. The separate layers of electron and proton gases[7] are probably the prime ingredients to induce a large magnitude magnetic field. This will induce an electromagnetic effect from eddies and vortices that will spin in closed loops attached to the surface depending upon surface sharp edges or ovaloidal-like geometries. Each of these layers will create charges and the diffusion between the layer interfaces will induce moving currents that will result in magnetism. This may involve Taylor instabilities of the boundary layer in the proton and electron gas layers to support magnetism.

Another approach to create a neutron star would be with a more gradual change or a slow crunch. This would be valid if no supernova remnant debris exists. As the growth of the gravitational attraction starts the collapse, the central core in the star would pull under hydrostatic and gravitation pressure that will push together electrons and protons available in an atom to form neutrons. If gradual, you would not observe any remnants of the supernova. Moreover, this layer of the neutron core is due to gravitational fields that should grow as the neutron core density layer increases in an outward radial direction within the remnants of the remaining portion of the reducing star. The size of the star collapses in volume and compresses the core into a smaller overall volume. It is difficult to determine if the changes in the star during this process would increase or decrease the initial strength of the existing gravitational and magnetic fields by conservation; however, if you look at the gravitational source term, the density should increase in strength with the formation of densely packed neutrons.

The density concentration within the core throughout the neutron star could have two possibilities; the concentration could be either a constant distribution layer of neutrons within an evenly distributed matrix in a crystallize structure or they could obey as a matrix as an inverse radius relationship due to pressure differences throughout the interior core toward the surface. This distribution needs to adjust the effect of centrifugal force due to the high rotation rate. From the short-range nuclear force between neutrons, this could be suspect of a near-constant density if thermal effects and the Pauli Principle are ignored. Neutrons would try to minimize the Pauli effects by exhibiting crystalline structure, at least in local volumes on the surface region. Thus, the neutron must align itself due to a pressure-like relationship.

Assuming that the entire star consists of neutrons, how is the magnetic field created along a detected singular axis? Recall that our sun has many poles and how is this reduced to a singular pole? In this model, a celestial body consisting solely of neutrons should not allow a magnetic field. The rotation of the neutron star would conserve the initial star's angular momentum. However, differences considering making measurements at long distances from the Earth are always problematic and tainted by uncertainty. This suggests observations could be distorted due to gravitational lensing either by other stars or galaxies that intercept between receiving the pulsar on the Earth. Finally, the effects observed by a neutron star's magnetic field would be similar as Figure 2 for the sun except that the spirals would be closely spaced due to the high rotation rates and extend further due to the higher magnetic field.

Pulsar lighthouse effects

In time, either violently or more likely during gradual evolution, the star crunches down from an average size of about 1.25 times the size of our sun to decrease to about a 10 to 20 km diameter. To do this, conservation of angular momentum makes the neutron star's initial rotation rate, say from ten times a month, to increase rotation at anywhere from about 10 to 600 revolutions per second. When one observes the neutron star from the Earth, a beacon may be observed as a lighthouse effect that sweeps across the Earth as shown in Figure 4.

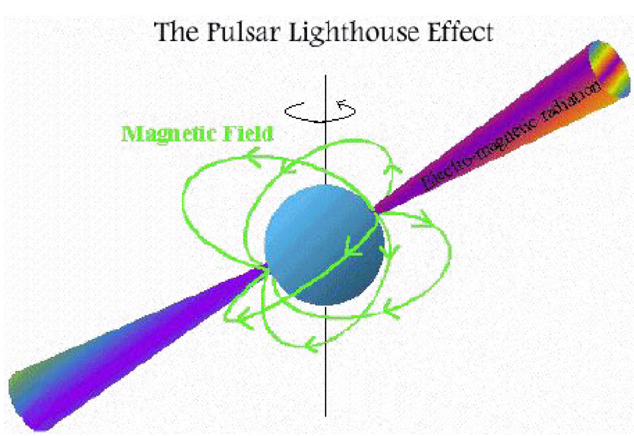

Figure 4

Obviously there can be possible situations where a neutron star exists but the beacon does not sweep or is not observable as a beacon on the Earth. This could be a situation where we see a supernova but there is no detection of a neutron star because of no lighthouse sweeps. Thus a neutron star may rotate with an axis along the 'major' dipole magnetic field misaligned from the rotational axis. Electromagnetic energy is aligned with the beacon due to the magnetic field along the direction of the poles in the neutron star. Briefly, this assumption that we have found for every pulsar may be profoundly incorrect; however, this will be found only if we travel freely through the cosmos.

There are many different possibilities that need consideration in the collapse process. If the rotational axis and magnetic pole of a neutron star was collinearly oriented, the lighthouse effect would not occur if seen by the Earth but would appear as a continuous beacon; however, a continuous radiation source to date has not been observed as a pulsar unless it was either classified as a Quasar or other types of unusual celestial stars. In these situations as an assumption, the neutron star most likely would possess a perfect spherical topography.

A mechanism to create magnetism

How does the semblance of neutrons induce a magnetic field if they consist only of neutrons? If you look at the Earth, the moving molten core generates a magnetic field around the Earth. The core rotates at a different rate from the Earth's crust or there exists moving tectonic surface plates and this difference creates currents that result in magnetism. There is no moving or molten core on the Moon and it only has minute amounts of magnetic ore on the lunar surface. The same is true about the Martian surface where magnetism is based upon only specific regions of magnetic ore. If the neutron star is so densely packed, there is probably no internal motion of the neutron star core. Thus, what is the mechanism for creating a magnetic field from our sun or even a neutron star?

The neutron star could consist of a layer of proton gas covered with an electron gas used to create neutrons. If this were true, then the rotational motion of the collapsed star would have a magnetic field due to the difference between the neutron core, the trapped protons, and a layer of electrons. The proton gas consists of higher density than electrons and would fall underneath the electron layer due to gravitation and buoyancy. However, the high rotation rate could create centrifugal motion forcing convection for heavier proton gas further away from the electron gas but this is highly unlikely considering the large gravitational field. Some interactive motion can occur in the interface between both layers that generate electric currents between the layers and, with stationary charges in the layers will produce a magnetic field using Maxwell's equations.

A loop of proton current can encircle a magnetic flux and be trapped by that flux. This need not happen at a magnetic pole. To escape, the proton or electron currents would have to cut the flux and thereby create an electric field opposing the action. A surface vortex loop would tend to drift on a rotating body due to Coriolis. If the opposing electromagnetic forces overwhelm the Coriolis force, the loop will remain in the same physical place on the surface of the star. As long as the overall strong flux field is fixed on the rotating body, the current loops trapped in the field are dragged around with it. There is another matter of where the energy is coming from the power in the radiating loops. The gas state[4] could generate eddies of protons and waves of electrons on the surface of the star producing strong electromagnetic waves. These could be thought[7] of similar as the "Red Spot" on Jupiter's surface. Storms of surface proton and or electron gas could carry around trapped magnetic lines of force to remain at the red spot and still become similar to a "lighthouse" beacon.

This situation is quite complex. The proton and electron gas will form the magnetic dipole of the neutron star and if so, this is not oriented in the rotational axis of the neutron star based upon edges embedded in the exterior surface of the neutron core or ovaloidal geometry. This would naturally align with the proton gas along this axis. There is another possibility.

That is a neutron star may indeed have quadrupoles or multipoles in lieu of a single dipole model similar to the surface of the Sun and possibly other stars. If the beacons may exist and are oriented in such a manner, these beacons may not be swept or observable from the Earth. If this goes with the belief of a proton and electron layer, the layers would obviously not be smooth but wrinkled as well as with the neutron core surface and the separate layer interface region. Here is a mixing area at the interface that allows convection and diffusion between the proton and electron gases. Moreover, electrostatic and electrodynamic attractions would also involve such attractions. The proton gas would reflect turbulence on the geophysical interactions with ridges or small hills created by the core. Finally, as the Earth's magnetic field and polar orientation changes as a function of time, it is also conceivable that the magnetic pole, either for a dipole or multipole may also shift in the neutron star with comparison to the rotational axis. Star quakes if possible may reorient the geography of the star's topology that would allow such motion and actions altering the magnetic fields.

Pulsar timing and other options

The rotational rate seen by the magnetic pulse signal, many times per second, may be more accurate regarding timing than an atomic clock used in the GPS system[8]. There is an important challenge to use space navigation to go to the far planets or to the stars. GPS satellites will only have usefulness basically near the surface of the Earth and possibly up to the satellites' orbits. Anything higher may limit GPS algorithms other than, say satellites above GEO. With specific binary pulsar characteristics that use a continuous timing mechanism with a neutron star, it is obvious that pulsar timing offers a means for accurate space navigation for using the various pulsars that are observable at various orientations in the cosmos. The algorithm could be similar to a GPS approach where four or more satellites are used for GPS accuracy as well as 4 different specific pulsars that could serve a similar navigation function with considerable or have a higher accuracy than observed by an atomic clock. This could be used similar to a GPS-like algorithm to use a navigation network outside of the Earth for travelling to far-term solar system.

Other possibilities for space navigation

A Quasar[11,12] is also a very energetic and distant active galactic nucleus. Quasars are the brightest and most distant objects in the known universe and show a very high redshift, which is an effect of the expansion of the universe between the quasar and the Earth. They are extremely luminous, first identified as being high redshift sources of electromagnetic energy. This includes radio waves and visible light that were point-like similar to stars, rather than extended sources similar to galaxies. This was a prime motivation for accepting the theory of an expanding cosmos. The most luminous quasars radiate at a rate that can exceed the output of average galaxies, equivalent to two trillion (2×10^{12}) suns. This radiation is emitted across the spectrum, almost equally, from X-rays to the far-infrared with a peak in the ultraviolet-optical bands, with some quasars also being strong sources of radio emission and gamma-rays. In early optical images, quasars looked like single points of light (i.e., point sources), indistinguishable from stars, except for their peculiar spectra. Quasars could be implemented within this architecture as reference or touch stones to assist the pulsar-timing navigation process. They tend to inhabit the very centers of active young galaxies and can emit up to a thousand times the energy output of the Milky Way. However, these bodies are a galactic representation whereas this should be a singular source. In other words, observations for the perfect alignment as well as finding multiple poles for a rotating neutron star would be extremely difficult to observe at a single point of observations such as the Earth. Some of these insights and characteristics[5] are discussed in the Appendix.

This requirement may satisfy a quark star or a strange star that is a hypothetical type of exotic star composed of quark matter, or strange matter. These are believed to be ultra-dense phases of degenerate matter theorized to form inside massive neutron stars. On this basis, the neutron star density would not be uniform but dictated by the pressure differences between the surface and the core center. It is theorized that when the neutron-degenerate matter makes up a neutron star under sufficient pressure due to the star's gravity, the individual neutrons break down into their constituent quarks – up quarks and down quarks. Some quarks may then become strange quarks and form strange matter. The star then becomes similar to a single gigantic hadron (but bound by gravity rather than the strong force). Quark matter/strange matter is one candidate for the theoretical dark matter that is a feature of several cosmological theories.

Statistically, the probability of a neutron star being a quark star is low, so in the Milky Way Galaxy there will only be a small population of quark stars. Quark stars[11,12] and strange stars are entirely hypothetical as of 2011, but observations released by the Chandra X-Ray Observatory on April 10, 2002 detected two candidates, designated RX J1856.5-3754 and 3C58, which had previously thought to be neutron stars. These different cosmic events may be used to augment as guide stones within a pulsar timing algorithm.

Death of a neutron star

Earlier interpretation suggests that a supernova creates a neutron star. As the sun is consumed where mass is converted into energy, the gravitational pull will decrease and the planets will move further away from the sun. The question is how does a neutron star evaporate or disappear similar to a normal star especially in a binary pulsar? In other words, is there a mechanism that allows the neutrons in a crystalline structure separate that converts the external edges where neutrons are converted into a proton and electron to induce nuclear fusion? Does a sufficient element in the electron and proton gas that generates the magnetic field(s) would exist over the surface of the neutron star to create sufficient nuclear fusion? In PSR 1913+16[8-10] where the change in trajectory performance implies reduced kinematic energy, the suggestion is that the mass of the pulsar undergoes converting energy into gravitational waves. What is the physical mechanism that occurs to create gravitational waves especially with a neutron star?

Basically there is another view. The question is how can all of the energy be created by a rotating neutron star? The possibility is that there may be no need to consume a neutron star's mass in that the amount of energy revealed is created solely by the electron and proton gas layers possibly percolating beneath a rotating neutron core. This may be a perpetual motion device based upon kinematic rotation as the prime source for energy creation.

RESULTS

There is insufficient data to evaluate the anomalies previously mentioned. Obviously more data and analysis is warranted. It is not questionable at all about using the presence of a large magnet in space and its impact to induce motion for propulsion. Such a device may take advantage of the solar system's magnetic field and act to oppose its alignment as a dipole with respect to the magnetic flow as part of the solar wind. If the view that Gerstenshtein[13] and Forward[14] are correct that magnetism and electricity relate to gravitation as well as the Murad-Brandenburg Equation[15] concerning that a Poynting field conservation could induce torsion or possibly a gravitational field, may allow developing one a propulsion system to operate. The objective is to place such a large magnet in a far-term trajectory moving toward celestial bodies that are toward the outer reaches of the solar system or a travel trajectory that is moving toward another star.

A potential magnetic model for a neutron star

With all of these differences, how would a typical model represent a neutron star in a laboratory environment? The question about a perfectly spherical core is crucial. In nuclear explosions, the implosion process requires that charges be uniformly displaced about the fuel. Each charge is equal in strength and these implosions are detonated to time simultaneously to produce the nuclear reaction. If any of these charges fail, chances are high that a jet will squirt outside of the shell and this would result in a reduced energy detonation. For a supernova, the shells are not evenly distributed and sometimes jets result. The implication is that the explosion is not evenly distributed and that the possibility of resulting with a perfectly spherical neutron star should be considered as extremely low.

If a rotating body spins in an axis-symmetric fashion, a vortex will be created that would most likely be oriented along the spinning axis. This vortex would consist of electron and proton gases that would generate a magnetic field. Since we do not see a beacon where the magnetic field is oriented with the rotational axis, it is safe to assume that the neutron core is not perfectly spherical.

Assuming that the neutron core creates edges of a neutron crystal or matrix, each of these edges can create vortices due to the neutron star's weather based upon the rotational rate. The atmosphere is not a few protons or electrons but has to be considerable a considerable amount to create large magnetic fields. Electron pairs or Cooper pairs will generate intense magnetism similar to superconductivity. It is amazing that electrons and protons have the same magnitude in terms of charge while they have a difference in mass of 1 to 1840. Apparently the electrons because of their lower mass have a higher level of efficiency so to speak. If electron pairs exist, it is reasonable by symmetry that proton pairs may also exist. The layers of the proton and electron gases generate separate charges while their currents, based upon vortices and turbulent mixing, will induce large magnetic fields. These electron and proton filaments are created by Taylor instabilities. Some efforts applied for neutron stars, however, are assumed that the core is perfectly spherical. This requires some additional thinking to discover the realities of these stars.

These views are different from the conventional lore and indicate that each pulsar represents a unique capability based upon the protuberances on the surface topology. Although they can be defined generally, the topology covered by the rotation rate as well as presence of a companion or other star(s) further attest to the uniqueness of these cosmic events.

A magnet to create a space propulsion scheme

The proposed propulsion system consists of a strong magnet that is rather simple. It will consist of a large air-bearing device using a spherical ball that is manufactured with Neodymium and nickel married in a steel alloy. This will have roughness and small fins that will act similar to a turbine forcing the ball to rotate within a structural casing. The clearance between the ball and casing will be large enough with spacing clearance to withstand a very large voltage. The voltages would be set at 511 KV using microwaves or through other means, which are the voltage needed to strip electrons from atoms as well as anomalous behavior as observed by Maker[16,17].

The gas-levitating ball bearing will operate a gas with low-pressure hydrogen. This will dissociate, through ionization, the Hydrogen into electron and proton gases as separate entities. Jets will induce rotation on the ball concentric with respect to the casing to spin at some speed of say, 600 revolutions per second or considerably higher. The system gas spins the ball and levitates it centered by the casing. When conditions permit, the electrostatic voltage is provided and the magnet should operate as expected. Both the core and casing should act as an electric charge. The moving core with the gas mixture of electrons and protons should create a magnetic field. Moreover, a Faraday cage would be required for biological safety due to the extensive electrical currents and some of the magnetic effects. Obviously the device should be located at some extension to the basic body structure away from instrumentation or any biological functions.

A hybrid fusion reactor may be required to generate the electricity if used in a spacecraft role. Other suitable geometries could be used with these magnets. These can conform to specific requirements needed with the space ship and to use specific volume requirements.

APPENDIX A. PULSAR TIMING DETAILS

The signal observed by the pulses has specific characteristics. As mentioned, these characteristics are of such accuracy that they can have higher accuracy then obtained with an atomic clock. In The Talk of the Galaxy (2000), astrophysicist Paul LaViolette[18] revives Sagan's speculation. Here is a brief listing of some characteristics 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 can 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. 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. They may also 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 their cycle 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 can continue from there. When averaged over several minutes or so, these complexities disappear, leaving only extreme regularity.

These capabilities are important to the point that unique characteristics are obtained for each pulsar. Thus these are easily seen as a keystone location to be used to determine a spacecraft's locations within a four dimensional space.

CONCLUSIONS

In defining how a neutron star may exist, there are several questions regarding the existing knowledge. The logic raises a model that uses a neutron core that rotates in a layer that contains electron and proton gases forming as separate entities. These gases would be the primary ingredients for creating a large magnetic field. Other information about a neutron star suggests using an advanced navigation system for travel past the translunar region based upon the measurable performance of several pulsars. Moreover, it is feasible despite these uncertainties, to create a propulsion device that uses this knowledge to create a large magnet. Magnetism will impact the spacecraft's gravitational forces and with its field provide mechanism acting against the inherent environment. The resulting device using a neutron star replication for a magnet may exceed certain specifications for such a spacecraft.

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