PLAUSIBILITY OF SELECTED 'ELECTRIC SUN' MODELS BASED ON MASS-DENSITY CONSIDERATIONS

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Three proposed models for an 'electric sun' are examined here, with evaluation of their plausibility based on the required mass-density relationship of the proposed composition assuming our sun is comprised purely of hydrogen (an idealized examination). The three models include (1) the 'Electric Sky' hypothesis, first proposed by Juergens and since then championed by advocates of a plasma/electric universe; (2) a sun comprised of an interior of liquid metallic hydrogen, proposed for more than the past decade by Robitaille; and (3) a sun composed of a superconducting, 'cold' solid hydrogen core, more recently developed by Burchell. The three models are not necessarily contradictory, as each includes aspects of the other. An overview of each is presented, followed by a simple analysis of the required mass-density of a sun composed of a solid hydrogen 'core' with a gaseous hydrogen surrounding annulus, potentially consistent with each model.

1. INTRODUCTION

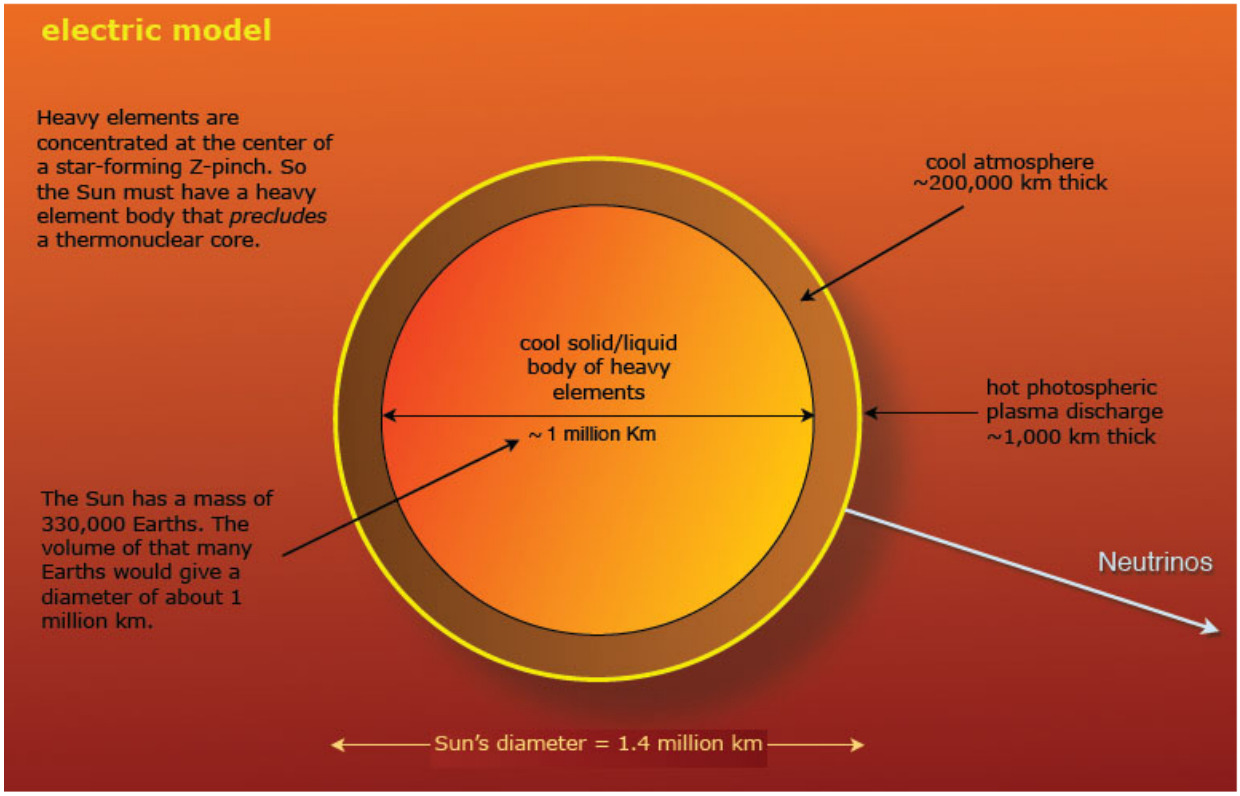

FIGURE 1. One conceptual model of the electric sun (from http://www.holoscience.com/news/img/Electric%20Sun.jpg)

In 1941 Dr. Charles E. R. Bruce, of the Electrical Research Association in England, began developing a new perspective on the Sun. Bruce's insights began when his attention was drawn to a solar prominence traveling a million miles in a single hour—roughly the propagation speed of a

lightning leader stroke. It was this observation that opened the path of his life's work, [1] leading to the conclusion that the appearance of solar flares, their temperature, and their spectra, provided a perfect match with lightning. The visible surface or photosphere of the Sun appears to be animated by electric discharge. [2]

In the 1960s, Bruce's work inspired a U.S. engineer, Ralph Juergens, to undertake an independent investigation of the Sun. Over the following decade, Juergens published a series of articles contending that the thermonuclear model "is contradicted by nearly every observable aspect of the Sun." His answer to these contradictions was to suggest that the Sun is the focus of a galaxy-powered "glow discharge." [3] With this, Juergens was effectively the first to argue that the Sun is actually powered by electricity rather than nuclear fusion.

Juergens' work had a profound effect on those who considered it most closely. One was the late Earl Milton, professor of physics at Lethbridge University in Canada, who devoted several years to exploring an electric model of the Sun. Around the same time, Australian physicist Wallace Thornhill also found inspiration in Juergens' hypothesis, coining the phrase the "Electric Universe" in the mid-nineties. Thornhill has since devoted much of his life to researching this new paradigm and the core tenet of an electric Sun. [4] The work of Thornhill and his colleagues led to a broad interdisciplinary synthesis attracting researchers from around the world. One such researcher was retired professor of electrical engineering, Donald Scott, author of the [then] recently published book, The Electric Sky. *[5] A centerpiece of the book is the electric Sun hypothesis.*

The preceding summary by D. Talbott [6] introduces the concept of the electric sun (Figure 1), an alternative to the widely accepted concept of the gravitationally-driven thermonuclear sun (Figure 2) that forms a foundation of mainstream physics, astronomy and cosmology today. A leading proponent of this concept, D. Scott, summarizes the electric sun hypothesis as follows: [7]

In this day and age, there is no longer any doubt that electrical effects in plasma play an important role in the phenomena we observe on the Sun. The major properties of the "Electric Sun (ES) model" are as follows:

- *Most of the space within our galaxy is occupied by plasma (rarefied ionized gas) containing electrons (negative charges) and ionized atoms (positive charges). Every charged particle in the plasma has an electric potential energy (voltage) just as every pebble on a mountain has a mechanical potential energy with respect to sea level. The Sun is at the center of a plasma cell, called the heliosphere, that stretches far out – several times the radius of Pluto. As of 9/9/2012 the radius of this plasma cell has been measured to be greater than 18 billion km or 122 times the distance from the Sun to Earth. These are facts, not hypotheses.*
- *The Sun is at a more positive electrical potential (voltage) than is the space plasma surrounding it – probably in the order of several billion volts.*
- *The Sun may be powered, not from within itself, but from outside, by the electric (Birkeland) currents that flow in our arm of our galaxy as they do in all galaxies. This possibility – that the Sun may be externally powered by its galactic environment – is the most speculative idea in the ES hypothesis and ius always attacked by critics while they completely ignore all the other more obvious properties of the ES model. In the Plasma Universe model, cosmic sized, low-density currents create the galaxies and the stars within those galaxies by the electromagnetic z-pinch effect. It is only a small extrapolation to ask whether these currents remain in place to power those stars. Galactic currents are of low current* ***density****, but, because the sizes of the stars are large, the total current (Amperage)*

is high. An electrically powered Sun's radiated power would be due to the energy delivered by that amperage. As it travels around the galactic center the Sun may come into regions of higher or lower current density and so its output may vary both periodically and randomly.

Our interest here is not to attempt defense or refutation of the electric sun hypothesis but to examine two related theories for their plausibility in light of the possibility that the sun may be electrically-powered as proposed by Scott and others.

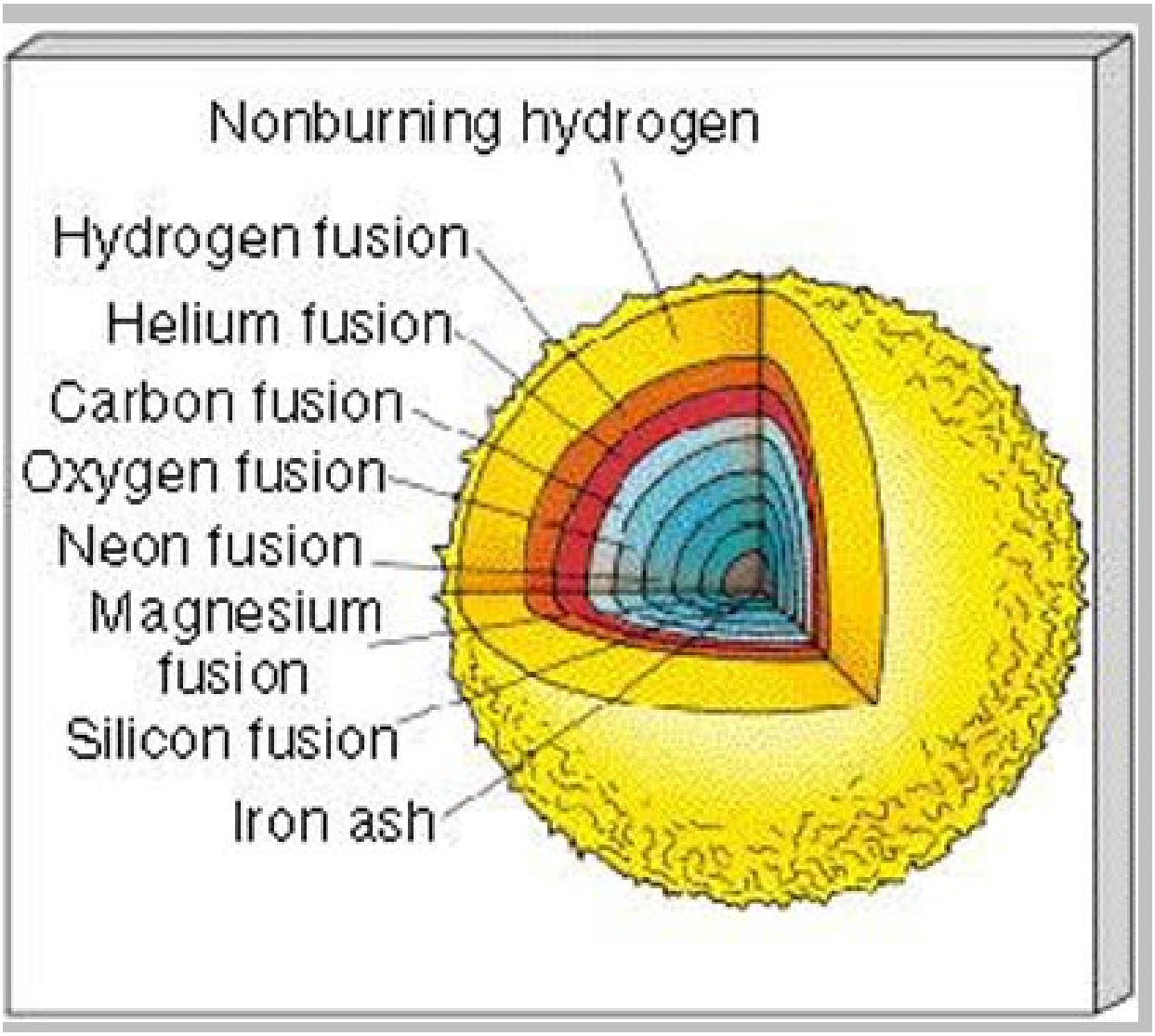

FIGURE 2. The conventional view of the gravitationally-driven thermonuclear sun (from Chaisson & McMillan, Astronomy Today, http://ircamera.as.arizona.edu/NatSci102/NatSci102/ lectures/ starevolution.htm)

2. LIQUID METALLIC HYDROGEN IN THE SUN

For over a decade, P-M. Robitaille has championed that "[l]iquid metallic hydrogen provides a compelling material for constructing a condensed matter model of the Sun and the photosphere. Like diamond, metallic

hydrogen might have the potential to be a metastable substance requiring high pressures for formation. Once created, it would remain stable even at lower pressures … The metallic form of hydrogen was initially conceived in 1935 … At that time, solid metallic hydrogen was hypothesized to exist as a body centered cubic, although a more energetically accessible layered graphite-like lattice was also envisioned. Relative to solar emission, this structural resemblance between graphite and layered metallic hydrogen should not be easily dismissed. In the laboratory, metallic hydrogen remains an elusive material. However, given the extensive observational evidence for a condensed Sun composed primarily of hydrogen, it is appropriate to consider metallic hydrogen as a solar building block. It is anticipated that solar liquid metallic hydrogen should possess at least some layered order. Since layered liquid metallic hydrogen would be essentially incompressible, its invocation as a solar constituent brings into question much of current stellar physics." [8]

Robitaille continues his argument for liquid metallic hydrogen within the sun, as follows: [8]

> *Metallic hydrogen, with its critical temperatures in the thousands of degrees Kelvin, overcomes all concerns raised regarding a liquid Sun … A liquid Sun composed of metallic hydrogen benefits from elevated critical temperatures for liquefaction, permitting hydrogen to adopt a condensed state even within an object like the Sun … A Sun composed of metallic hydrogen provides an interesting model to explain sunspots and other structural elements. The photospheric material in this case might be considered as liquid metallic hydrogen where the lattice dimensions are relaxed at lowered pressures. Perhaps, the material exists much like graphite at the limits of conductive behavior. Conversely, within sunspots, pressures would be more elevated, and liquid metallic hydrogen might assume a more compact lattice, with increased metallic behavior. This would help account for the stronger magnetic fields observed within sunspots. As a result, scientists could be considering the conversion from a Type I lattice in the photosphere to a Type II lattice in the sunspots. Such a scenario has great advantages in terms of simplicity.*
>
> *Gases have always been an unsustainable building material for an object like the Sun. Gases know no surface and cannot, even momentarily, impart structure. Hence, one cannot be surprised to find that there is no physical evidence which supports a gaseous Sun, while ample evidence has been revealed for its condensed state. In order to bring structure to the gas, astrophysics must depend on the action of magnetic fields. However, strong magnetic fields themselves are a property of condensed matter, not gases. In order to maintain a gaseous Sun and impart it with structures, astrophysics must therefore have recourse to phenomena best produced by condensed matter. A simple illustration of these issues can be focused on the understanding of solar prominences. Such objects appear as sheet-like structures in images captured by NASA … In a Sun built from layered metallic hydrogen, it can be envisioned that a layer of material simply peeled away from the surface to form a prominence. In contrast, within a gaseous body, the creation of such overwhelming structures would remain difficult to explain, even with magnetic fields forming and maintaining these entities. Perhaps it would be more logical to presume that magnetic fields were simply associated with the presence of metallic hydrogen, whether on the surface of the Sun itself or within the prominences. Moreover, the active photosphere and chromosphere supports structural features. Prominences contain fine structure, which would be easier to explain if a condensed solar model was adopted. For more than one century, prominences have been known to emit continuous spectra in addition to the line spectra which characterize the quiescent state.*

3. THE METALLIC SUN – A SUPERCONDUCTOR

Building off both the electric sun hypothesis and that for the presence of hydrogen in other than gaseous form within the sun, B. Burchell asks "what if, instead of the high-temperature thermonuclear model, we said the Sun steadily grew cooler as we headed inwards … [i.e.,] so cold that [the temperatures] approached

levels nearing absolute zero Kelvin ...?" [9] He champions the plausibility of this by envisioning the compression of nitrogen gas within an airtight cylinder. As the gas is compressed, it initially heats up with increased pressure. However, if the heat is allowed to dissipate, the process can be repeated incrementally until the gas would be so compressed that it would transform first into a liquid, then finally into a solid. Both liquid and solid nitrogen are extremely cold, yet the pressure is extremely high.

> *Now consider a similar situation for a star. Under the standard astronomy model, stars are formed when loose accumulations of hydrogen gas are drawn together under the force of their own gravity. As this occurs, gas is compressed and heats up, giving out infrared heat. This increase in temperature might halt the compression process for a time. But adding more gas will force the compression to continue. Eventually the internal gaseous resistance will give way, allowing the hydrogen to liquefy. Although this liquid will be still be quite hot. We continue to add more hydrogen, increasing the external pressure. Eventually this liquid also gives way, and the hydrogen collapses into a solid. At this stage the solid is somewhat disorganised, its atoms not arranged according to any particular pattern. We continue to increase pressure. Eventually the hydrogen atoms are forced into crystalline lattice structures. We could now refer to this as 'metallic hydrogen' .. [I]f enough pressure were applied to the lattice, the hydrogen atoms would be almost unable to move. They would effectively have become frozen and could thus be described as having a temperature of near absolute zero. So ... what happens when we freeze a metal or crystalline material to near absolute zero? The title of this essay gives it away: it becomes superconducting!* [9]

The presence of this interior superconductor is critical to Burchell's model, in that it explains an anomaly he finds with the ES hypothesis:

> *... [W]hat powers this electrical giant [the Sun]? Specifically, what gives it a positive charge, and what drives the currents necessary to explain its magnetic fields? According to the theory, the Sun is powered by streams of electrons funnelling inward toward the polar regions. These 'galactic powerlines' interconnect all the stars in the galaxy and feed them the necessary current to power their photospheres. The presence of these has been partially observed via the Ulysses craft, which passed over the polar regions. But while there could be little disagreement that a positively-charged ball would attract electrons, there are major problems in suggesting that this could be its power source. First, a stream of electrons 'falling' into the Sun is not going to do much other than steadily discharge it. In order to power an electrical device (e.g. a desk lamp), charge must be forcefully fed into it and then extracted again. This is because the device has resistance that needs to be overcome. But the electrical Sun model describes a one-way inward current flow. And it's not forced, just free-falling. Second, since the Sun is emitting positive charges, the net current supply must consist of protons rather than electrons otherwise the output current – the solar wind – would eventually cease.* [9]

Burchell proceeds to describe how the superconducting interior of a sphere such as the sun can become a power source without the need for an incoming current such as proposed by the ES hypothesis.

> *... [A] superconductor formed into a ball should also be able to maintain internal currents that cycled forever and without the need for any power supply ... [I]f the Sun were a giant superconductor, we should likewise expect it to contain powerful circling currents. These currents would then generate large magnetic fields. And we certainly do observe magnetic fields and related effects like plasma loops coming from the Sun ... [F]or superconducting wire, especially where large currents are concerned, magnetic forces may well focus the electrons along the middle of the wire ... Next consider the situation for a superconducting disk. We'll start by having*

electrons circle around its centre. Since these electrons are moving in parallel, we should expect them to magnetically attract each other, resulting in a situation like this [Figure 3]:

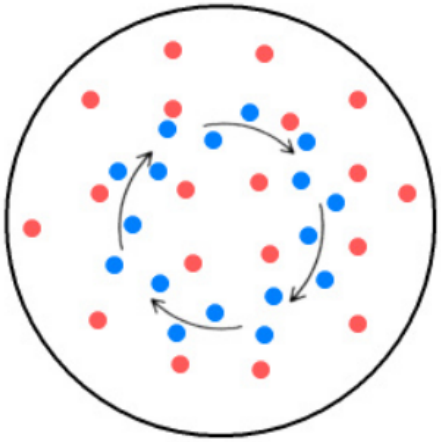

FIGURE 3. Burchell's image of electrons circling in a disk, with internal magnetic attraction

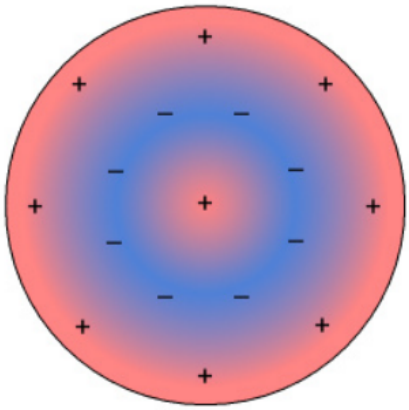

FIGURE 4. Burchell's image of magnetic attraction and repulsion of circling electrons leaving positive and negative regions within a disk

… [T]he electrons have concentrated themselves into a negatively charged ring-shaped region located between the centre and the perimeter. The reason for a ring and not a small inner disk is that the electrons moving in opposite directions on either side of the 'inner disk' will magnetically repel each other. The result will be a negatively charged ring with a positively charged regions either side: one in the centre and the other along the outer part of the disk, as shown [in Figure 4] … Now extend the above situation to a ball-shaped superconductor. Particularly one the size of the Sun. We should expect large internal currents, which focus themselves into a middle negative region, whilst leaving a positive region in the centre and on the outside … If the charge were strong enough, we should expect electrical discharges to occur across the surface of the Sun, as protons leapt off the surface. If the surface were covered by a gaseous layer (and it is with the Sun) the motion of protons passing through it would cause the surface to light up with electrical sparks, also known as 'anode tufts'. We should also expect a steady discharge of protons accelerating out as a solar wind. And if for some reason the sparking stopped at some area, causing sunspots, we should also expect those regions to be darker because we would now be looking at the relatively cooler solid surface of the Sun. And sure enough, this all corresponds to what we see! Since currents can circle forever within a superconductor, the above describes a model in which a star can glow indefinitely, without any external power source or requirement for internal fusion. Electrons will still be attracted and flow inward toward the Sun's positive surface. However, these are not required for the Sun to glow and act more as a power discharge than a power supply.

Observe the similarity between Burchell's concept (Figure 4) and that from the ES hypothesis (Figure 5), at least so far as the sun's surface being positively charged is concerned. At this point, the key features from the three theories (ES hypothesis, Robitaille's liquid metallic hydrogen sun, and Burchell's superconducting-powered sun) required for the plausibility evaluation based on solar density are complete.

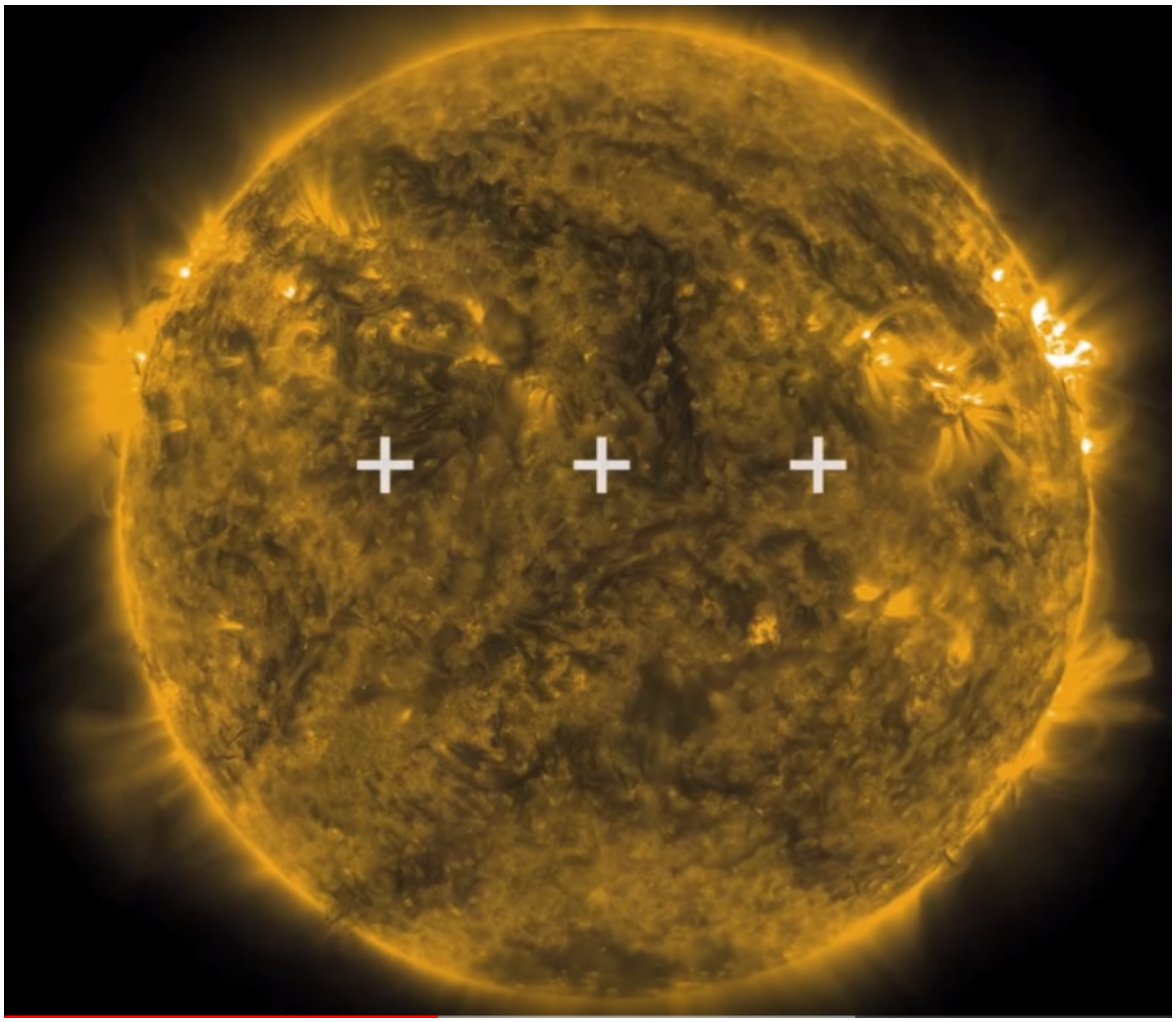

FIGURE 5. An image of the electric sun, with positively-charged surface, from the ES hypothesis (http://www.safireproject.com/)

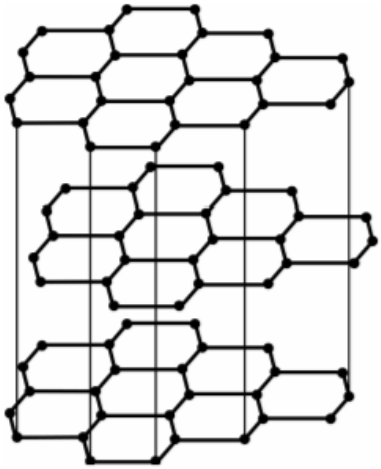

FIGURE 6. Schematic representation of the layered lattice of graphite, proposed to be the most energetically favorable crystalline form of metallic hydrogen

4. SOLAR DENSITY

Burchell recognizes that, for his model to be plausible, the hydrogen within the sun must be deposited in such a way as to yield the observed density of the sun, approximately 1400 kg/m^3. He concludes that a combination of hydrogen gas, with a density of 0.09 kg/m^3, and solid hydrogen, with a density of approximately 600 kg/m^3, cannot yield the required density of the sun. "Solid hydrogen has a density of 600kg/m^3. The 1400 Sun-density value seems to correspond to hydrogen compressed to a bit over double that amount. If we estimate a higher density for the Sun's interior of 1800 kg/m^3, that makes it 3 times the 600 hydrogen figure. Admittedly the 1800 number is a guess and the real density might be higher; although could not be too much higher because the 1400 average would be wrong. Thus, a Sun comprised of compressed solidified hydrogen would have a density consistent with what we observe, and is supportive of the model described here. Of course it would also be possible to achieve the 1400 average using a combination of elements." [9]

Let us explore Burchell's supposition further. The density of a (spherical) hydrogen atom is its mass per unit volume, i.e., $1.674x10^{-27}kg/\left(\frac{4}{3}\pi[5.292x10^{-11}m]^3\right) = 2697\frac{kg}{m^3}$, based on the mass of a hydrogen atom and the Bohr radius. If the hydrogen atoms in the sun's interior are compressed into a solid (metal) such that they are hexagonally closest packed, as suggested by Figure 6 from Robitaille [8], this theoretical maximum density is reduced to a value of $\left(\frac{\pi}{3\sqrt{2}}\right)2697\frac{kg}{m^3} = 1997\frac{kg}{m^3}$.

Hydrogen gas has a density of 0.08988 kg/m^3. For the sun, with mass = 1.989 x 10^{30} kg and radius = 6.957 x 10^8 m and, therefore, density = $1.989x10^{30}kg/\left(\frac{4}{3}\pi[6.957x10^8m]^3\right) = 1410\frac{kg}{m^3}$, composed exclusively of hydrogen in two states, solid metallic in the 'core' and gaseous in the surrounding annulus with the densities shown, the volumetric ratio between the solid core and gaseous annulus is as follows (with V_s = solid volume and V_g = gaseous volume = 1 - V_s):

$$2697\frac{kg}{m^3}V_s + 0.08988\frac{kg}{m^3}(1 - V_s) = 1410\frac{kg}{m^3}$$

$$V_s = 0.7060, V_g = 0.2940, V_s/V_g = 2.401$$

Thus, such a sun would be about 71% solid hydrogen 'core' and 29% gaseous hydrogen 'annulus.' The corresponding radius of the core would be $0.7060\sqrt[3]{6.957x10^8m} = 6.195x10^8m$, or 91.77% of the sun's radius. Referring back to Figure 1, the radius of the solid interior 'core' would be just over 90% of the total. Interestingly, this can be viewed as consistent with all three of the models for an electric sun reviewed here, such that all three are plausible at least from a mass-density perspective.

5. CONCLUSION

There has been no attempt here to favor one of the three electric sun models over either of the others. Examining all three from a mass-density perspective suggests that all could individually or collectively be on the right track. Other phenomenological aspects, such as electromagnetism, plasma properties, properties of different states of hydrogen or other elements, likely will be more definitive.

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