Stars in an Electric Universe
(2011 John Chappell Memorial Paper)

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There is nothing more powerful than a paradigm. When viewed through the lens of the standard gravitational and magnetohydrodynamic paradigm the Sun blinds us with paradoxes. Meanwhile models based on the electrodynamic behavior of plasma are ignored. The Nobel prizewinning plasma physicist, Hannes Alfvén, was a pioneer in this new plasma cosmology. Two recent discoveries stand out in relation to Alfvén's predictions so that ultimately he cannot be ignored. The first concerns the birth of stars and the second the electric circuit of the Sun. The Electric Universe extends plasma cosmology and views all stars as an electric discharge phenomenon.

1. Introduction

A real cosmology must be a broad and coherent natural philosophy. Therefore, it must be a truly interdisciplinary pursuit. Modern specialized science is a hostile environment for such a quest. For example, the world's largest professional body, the Institute for Electrical and Electronic Engineers (IEEE), recognizes plasma cosmology, but that discipline remains unheard of by students of astronomy. Plasma cosmology receives no publicity although it deals empirically with the electromagnetic behavior of plasma, which constitutes almost the entire visible universe. Unlike theoretical big bang cosmology, plasma cosmology can claim successful predictions without recourse to hypothetical matter, energies and forces.

However, despite its many successes, plasma cosmology cannot claim to be the final answer because it does not deal with unsolved problems in basic and stellar physics. The new Electric Universe cosmology addresses those fundamental problems, and in doing so offers a breakthrough in understanding of ourselves and our place in the universe. It provides practical insights for broad scientific progress and space exploration. The Electric Universe is a convergent, interdisciplinary cosmology that attempts, in the words of E. O. Wilson, "consilience," or "the unity of knowledge."

2. Electric Star Birth

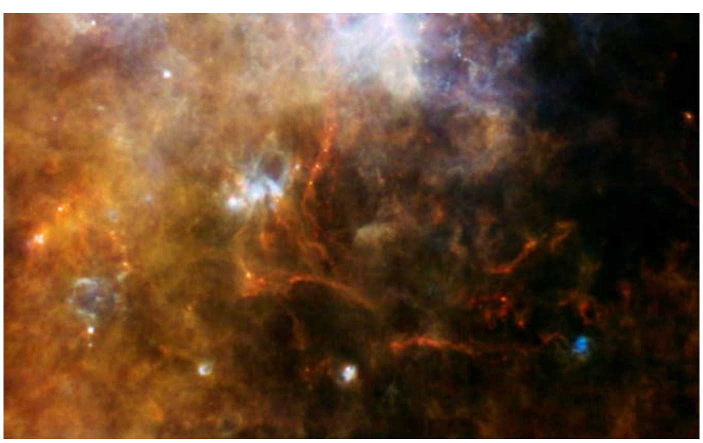

Fig 1. Star formation in a cloud of cold gas in the constellation of the Southern Cross. Image credit: ESA and the SPIRE & PACS consortia.

The European Space Agency's Herschel Space Observatory (formerly called Far Infrared and Sub-millimetre Telescope or FIRST) has been giving astronomers an unprecedented look inside molecular clouds to find that stars are formed in *"an incredible network of filamentary structures, and features indicating a chain of near-simultaneous star-formation events, glittering like strings of pearls deep in our Galaxy."* [1] Although described as "incredible" by astronomers, the image in Figure 1 precisely matches the decades-old expectations of plasma cosmologists.

In another ESA report the high-resolution of the Herschel space observatory produced another surprise.

> *"The filaments are huge, stretching for tens of light years through space and Herschel has shown that newly-born stars are often found in the densest parts of them... Such filaments in interstellar clouds have been glimpsed before by other infrared satellites, but they have never been seen clearly enough to have their widths measured. Now, Herschel has shown that, regardless of the length or density of a filament, the width is always roughly the same."* [2]

Ninety filaments were analyzed and all were found to be about 0.3 light years across, or about 20,000 times the distance of Earth from the Sun. *"This consistency of the widths demands an explanation."* [3]

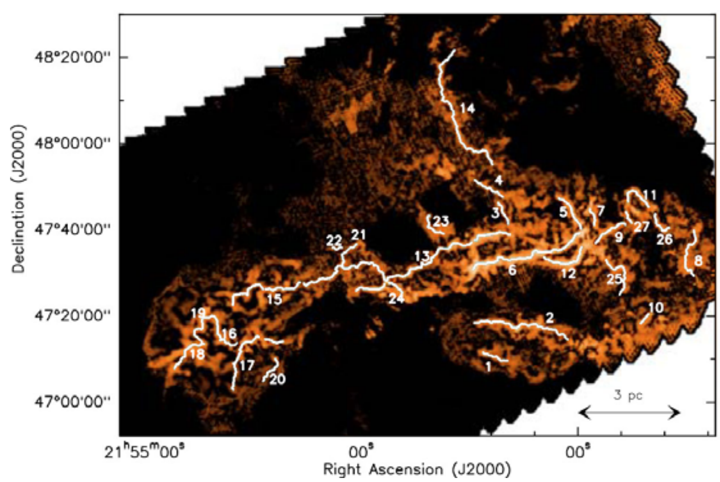

Fig. 2. A network of 27 star forming filaments derived from Herschel observations of the IC 5146 molecular cloud. Credit: D. Arzoumanian et al.

The favored conventional explanation for the glowing filaments is “sonic booms generated by exploding stars” and lit by starlight. [4] But where are the exploding stars? And explosions should impose some degree of radial curvature on these filaments. But what we see is more like the tortuous paths of cloud-to-cloud lightning bolts. For that is what they are, in fact, on a cosmic scale. And like lightning bolts, they are lit not by reflected light but by their own internal energy.

The ‘father’ of plasma cosmology, Hannes Alfvén, wrote in 1986,

> *“That parallel currents attract each other was known already at the times of Ampere. It is easy to understand that in a plasma, currents should have a tendency to collect to filaments. In 1934, it was explicitly stated by Bennett that this should lead to the formation of a pinch. The problem which led him to the discovery was that the magnetic storm producing medium (solar wind with present terminology) was not flowing out uniformly from the Sun. Hence, it was a problem in cosmic physics which led to the introduction of the pinch effect...*
>
> *“However, to most astrophysicists it is an unknown phenomenon. Indeed, important fields of research, e.g., the treatment of the state in interstellar regions,* ***including the formation of stars****, are still based on a neglect of Bennett's discovery more than half a century ago... present-day students in astrophysics hear nothing about it.”* [5] (Emphasis added).

The constant width over vast distances is due to the current flowing along the Birkeland filaments, each filament constituting a part of a larger electric circuit. In a circuit the current must be the same in the whole filament although the current density within the filament may vary due to the Bennett pinch effect. Therefore, the electromagnetic scavenging effect on matter from the molecular cloud, called Marklund convection, is constant along each current filament, which explains the consistency of widths of the filaments. The stars form as plasmoids in the Bennett pinches, also known in plasma labs on Earth as Z-pinches.

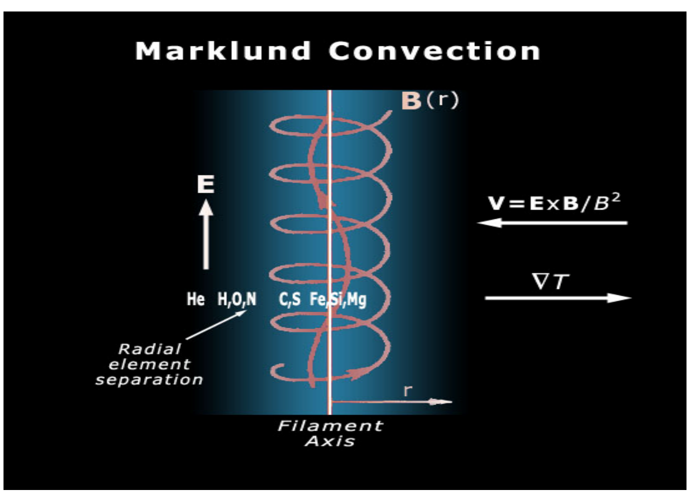

Fig. 3. Marklund convection schematic [6]

Figure 3 shows the true nature of the filaments inside the molecular cloud. The electric field vector (E) and helical magnetic field configuration (B) are shown. Inward Marklund convection of ions at velocity, V, across a temperature gradient ∇T is a mechanism for rapid filament formation and chemical separation in cosmic plasma. In consequence, the heavy elements (“metals” in astrophysics-speak) are concentrated on-axis and must therefore constitute the core matter of stars rather than hydrogen!

In May 2010 in a similar star-forming cloud, Herschel uncovered an

> *“...impossible star in the act of formation... This is because the fierce light emitted by such large stars should blast away their birth clouds before any more mass can accumulate. But somehow they do form. Many of these ‘impossible’ stars are already known, some containing up to 150 solar masses, but now that Herschel has seen one near the beginning of its life, astronomers can use the data to investigate how it is defying their theories.”* [7]

“Impossibilities” signal that standard astrophysical theories are unrealistic. The answer in an Electric Universe is simple. The electric currents that form stars do not dissipate after giving birth. The luminosity of a star is not related to its massiveness because no nuclear fusion is taking place in its heavy-element core. And the massiveness of a star is not related to its size because the photosphere is not a surface in the usual sense. Rather, it is an electric discharge phenomenon some height above the surface of the star. There are no “impossible stars.” The light of a star comes from the available electrical energy coursing along the enveloping Birkeland filaments. As for “sonic booms” caused by the pressure of light from the star, that force is negligible compared to the electromagnetic forces in the enveloping plasma. Any such collision would serve to further ionize the dust and gas and make it more susceptible to the electromagnetic force. However, if any reservation remains about the electrical environment of the Sun (and therefore all stars) then the following report should dispel that doubt.

3. Alfvén’s Solar Circuit Confirmed

Cosmic rays over the South Pole appear to be coming from particular locations, rather than being distributed uniformly across the sky. Similar cosmic ray "hotspots" have been seen in the northern skies too, yet there is no known source close enough to produce this pattern.

Fig. 4. The IceCube neutrino detectors buried at the South Pole. Image credit: NSF/B Gudbjartsson.

IceCube detects muons produced by neutrinos striking ice, but it also detects muons created by cosmic rays hitting Earth's atmosphere. These cosmic ray muons can be used to figure out the direction of the original cosmic ray particle.

Between May 2009 and May 2010, IceCube detected 32 billion cosmic-ray muons, with a median energy of about 20 teraelectronvolts (TeV). These muons revealed, with extremely high statistical significance, a southern sky with some regions of excess cosmic rays ("hotspots") and others with a deficit of cosmic rays ("cold" spots) [8].

Over the past two years, a similar pattern has been seen over the northern skies by the Milagro observatory in Los Alamos, New Mexico, and the Tibet Air Shower array in Yangbajain. The hotspots are considered "a good mystery." It's a mystery because the hotspots must be produced within about 0.03 light years (1900 Astronomical Units) of Earth. Further out, galactic magnetic fields should deflect the particles so much that the hotspots would be smeared out across the sky. But no such sources are known to exist [9].

In the 1920s Irving Langmuir and Harold Mott-Smith showed that in a discharge tube the plasma sets up a thin boundary sheath which separates it from a wall or from a probe and shields the wall or probe from the electric field. The electric field in this sheath, or 'double layer' (DL) of separated charge, accelerates charged particles. In 1958 Alfvén suggested that this phenomenon might be important in space plasmas. Alfvén predicted in 1986 particle accelerating DLs situated along the Sun's axes:

> *"By analogy with the magnetospheric circuit we may expect the heliospheric circuit to have double layers. They should be located at the axis of symmetry, but only in those solar cycles when the axial current is directed away from the Sun.*
>
> *"No one has yet tried to predict how far from the Sun they should be located. They should produce high-energy electrons directed toward the Sun, and synchrotron radiation from these should make them observable as radio sources. Further, they should produce noise. They may be observable from the ground, but so far no one has cared to look for such objects."* [10] [Emphasis added].

In the circuit model, it was noted that every circuit that contains an inductance is intrinsically explosive. This is true because a conductive circuit will tend to supply all of the inductive energy to any point of interruption of the circuit. Double layers are known to tend to interrupt current in a plasma. Hence, the entire energy of a circuit can be released at the point where a double layer forms regardless of the source of the energy of the circuit.

Because of their properties of generating cosmic rays, synchrotron radiation, and radio noise, as well as occasionally exploding, Alfvén proposed, *"DL's may be considered as a new class of celestial objects... For example, the heliospheric current system must close at large distances* (cf. Fig. 5), *and it is possible – perhaps likely – that this is done by a network of filamentary currents. Many such filaments may produce DL's, and some of these may explode."* [12] To give an idea of their omnipresence in space, DLs are implicated in the planetary auroral regions, extragalactic jets, stellar jets, novae and supernovae, X-ray and gamma-ray bursts, X-ray pulsars, double radio sources, solar flares, and the source of cosmic ray acceleration. Now it seems that Alfvén's DLs have been detected in the form of "cosmic ray hotspots" generated in Birkeland and current filaments "less than 0.03 light years" from the Sun. The hotspots should be found to align with the local interstellar magnetic field. The median energy of the cosmic rays reported at 20 TeV is within the range expected from a cosmic DL.

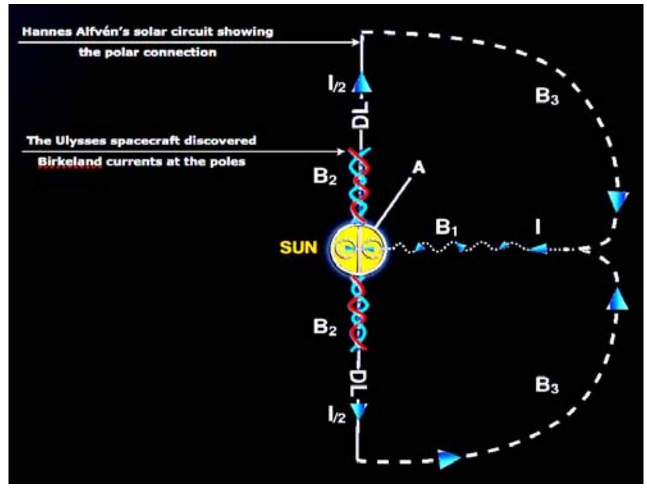

Fig. 5. Alfvén's Heliospheric Circuit. The Sun acts as a homopolar generator (A) producing a current which goes outward along both the axes (B_2) and inward in the equatorial plane along the magnetic field lines (B_1). The current must close at large distances (B_3), either as a homogeneous current layer, or – more likely – as a pinched current. Analogous to the auroral circuit, there may be double layers (DLs) which should be located symmetrically on the Sun's axes. *"Such double layers have not yet been discovered."* Credit: Original diagram by H. Alfvén. [11]

4. The Electric Sun

To have any confidence in our understanding of the Sun, and stars in general, we must first be able to explain simply the things we can see. Alfvén did not go so far as to consider the Sun an electrical discharge phenomenon. He assumed the solar heliospheric current was driven by the Sun's rotation. But the reverse seems to be true. The Sun's equator rotates fastest, as if it is being driven like a homopolar motor.

> *"Typically, the differential [solar] rotation shows speeds of rotation of about 2000 m/s near the Equator and about 1000 m/s near latitudes of 80 degrees. The differential rotation has undergone changes over surprisingly short periods of time. In short, the central latitudes have been somewhat constant, whereas the regions near the Equator and the poles have changed substantially in a semi-periodic fashion, which appears to be correlated with the solar magnetic cycle.* [13]

Also the energy of the axial DLs' cosmic rays implies a galactic source. A star therefore can be viewed as a pinpoint object at the center of a vast plasma sheath, or DL. The plasma sheath forms the boundary of the electrical influence of the star, where it couples with the Birkeland currents of interstellar space. The Sun's plasma sheath, or 'heliosphere,' begins about 100 times more distant than the Earth is from the Sun. To give an idea of the immensity of the heliosphere, all of the stars in the Milky Way could fit inside a sphere encompassed by the orbit of Pluto. The Sun's heliosphere could accommodate the stars from 17 Milky Ways!

In the immense volume of the heliosphere, a small *drift* of electrons (superimposed on their thermal motion) toward the Sun and ions away from the Sun (the solar wind) can satisfy the electrical power required to light the Sun. The magnetic field of the solar wind is the signature of a drift current. It is only very close to the Sun that the current density and electric field become appreciable, the plasma discharge switches from 'dark mode,' and the effects become visible. The enigma of the Sun's millions-of-degrees corona above a relatively 'stone cold' photosphere is immediately solved when the Sun's power comes from the galaxy and not from the center of the Sun.

It is clear from observation that the Sun is an anode phenomenon in a very low-pressure glow discharge. The red chromosphere is the counterpart to the glow above the anode surface in a discharge tube. When the current density is too high for the anode surface to accommodate it, a bright secondary plasma forms within the primary plasma. It is termed "anode tufting." On the Sun, the tufts are packed together tightly so that their tops give the appearance of granulation. The granulation and the behavior of the 'granules' is not to be expected from chaotic convection.

5. Sunspots

Sunspots are a phenomenon that is not expected in the thermonuclear model of stars.

> "*The very existence of sunspots is intriguing. They should be heated quickly from the sides and disappear. They should never have formed – but they do form. Their behavior is so strange that there is still argument between scientists as to why they are there at all. The Sun is full of mysteries apart from sunspots. Rarely do we discover anything we would have expected.*" [14] If we do not understand sunspots, we do not understand stars!

Sunspot umbrae are much cooler (4000K) and darker than the photosphere (5770K), which is prima facie evidence that heat is not trying to escape from within the Sun. And the Sun's corona is millions of degrees hotter than the photosphere. These simple observations point to the energy source of the Sun being external. Add to this the dominant influence of magnetic fields on the Sun's external behavior and we arrive at the necessity for an electrical energy supply. Magnetic fields do not exist without electric currents.

Electric currents in plasma take a filamentary form. The penumbral filaments are observed to split near their 'footpoints' in the dark umbra and to move around. It is typical behavior of plasma filaments and can be observed in novelty plasma balls. But the greatest shock is that the penumbral filaments have dark cores! How could this be so if they are convecting gas? In that case, the filament center should be hottest and brightest.

An electric discharge offers a simple explanation. Because electrical phenomena are scalable over at least 14 orders of magnitude, we may look to electric discharge phenomena in our atmosphere to gain insights into what may be happening in the Sun's atmosphere. There is a temptation to simply equate the penumbral filaments with gargantuan lightning bolts, but the features do not match well.

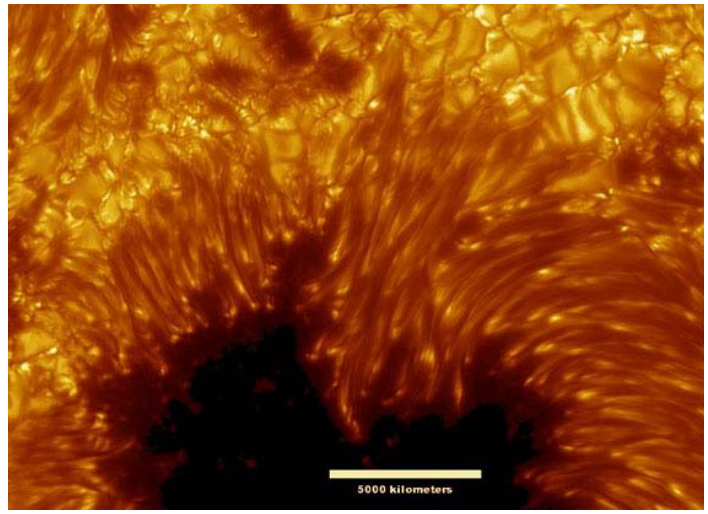

Fig. 6. This image shows remarkable and mysterious details near the dark central region of a planet-sized sunspot in one of the sharpest views ever of the surface of the Sun. Along with features described as hairs and canals are dark cores visible within the bright filaments that extend into the sunspot, representing previously unknown and unexplored solar phenomena. The filaments' newly revealed dark cores are seen to be thousands of kilometers long but only about 100 kilometers wide. Image Source: NASA. Courtesy: Göran B. Scharmer, and Boris V. Gudiksen, Swedish Institute for Solar Physics.

A typical lightning flash lasts for 0.2 seconds and covers a distance of about 10 km. The penumbral filaments last for at least one hour and are of the order of 1000 km long. If we could scale a lightning bolt 100 times we might have a flash that lasted between 20 and 200 seconds and was 1000 km long. The lifetime is too short. Also, measurements of scars on lightning conductors show that the lightning channel is only about 5 mm wide. Scaling that by 100 times would have solar lightning channels below the limit of telescopic resolution.

However, there is another familiar form of slow atmospheric electric discharge that does scale appropriately and could explain the mysterious dark cores of penumbral filaments. It is misleading to equate a simple mechanical fluid vortex with a tornado. A tornado is a slow electrical discharge constrained to spiral by powerful electromagnetic forces created by swiftly moving charge. Tornadoes last for minutes and can have a diameter of the order of one kilometre. Scale those figures up 100 times and we match penumbral filaments very well. And if the circulating cylinder of plasma radiates heat and light, as we see on the Sun, then the solar 'tornado' will appear in profile to have a dark core.

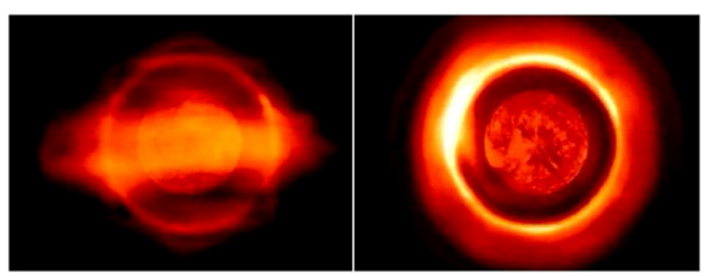

Fig. 7. The sun's plasma torus in UV light (equatorial view [left] & polar view [right]). Image courtesy of SOHO / NASA.

What causes a sunspot? In the electrical model, the Sun receives electrical energy from interstellar space in the form of a glow discharge. Birkeland's 'Terrella' experiments with a magnetized sphere show that electromagnetic energy is stored in an equatorial donut shaped 'plasmoid'.

The energy is released sporadically from the plasmoid by discharges to the mid-latitudes of the Sun. (Incidentally, plasmoid resonances may give rise to simultaneous flares on opposite sides of the central body, as recently reported on the Sun). The global tornadic storm of the photosphere is pushed aside by more powerful Birkeland currents that deliver electrical energy from the plasmoid to lower levels in the Sun's atmosphere. The resulting holes in the photosphere are what we call sunspots.

Instead of being a site where energy flow has been restricted, a sunspot is a site where it is enhanced. This is shown by the intense magnetic field of about 3,000 gauss (about 10,000 times the Earth's magnetic field). The latitudinal migration of sunspots has been duplicated in Terrella experiments by simply varying the power input. Sunspot umbrae are packed with 'umbral dots,' which are longer-lived (15-30 minutes) and even hotter (6200K) than the photosphere. These make sense in the electrical interpretation since the current passing through the sunspot will filament and reduce in cross-section as it enters and heats the denser atmosphere, rather like lightning.

This model can explain why sunspots of the same magnetic polarity are strangely attracted toward each other instead of being repelled. The sunspots are receiving electric current flowing in parallel rotating streams, which results in their being mutually attracted over long distances and repelled at short distances. That, in turn, explains why sunspots often seem to maintain their identity even if they come close enough to merge. There is also other evidence that suggests the presence of electric currents aligned with the magnetic field in a sunspot.

6. The Variable Sun

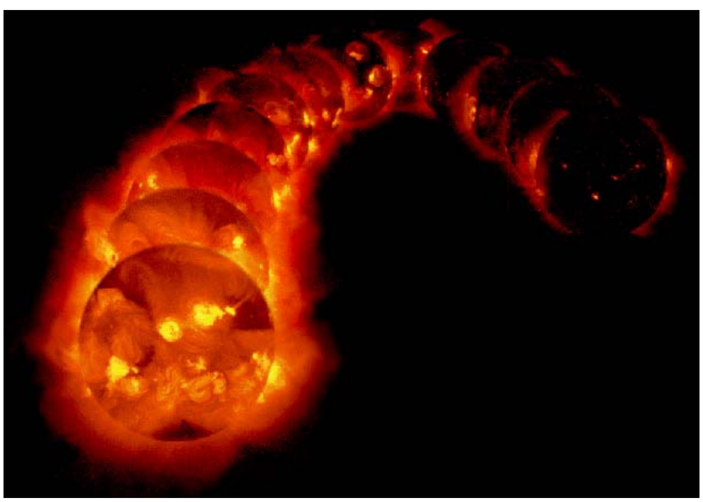

Fig. 8. The X-ray Sun from solar minimum to maximum between 1991 and 1995 as imaged by the Yokhoh satellite. Credit: G.L. Slater and G.A. Linford; S.L. Freeland, The Yohkoh Project.

Astrophysicists struggle to explain X-rays in terms of heating by the poorly understood solar magnetic field, which is also observed to undergo the solar activity cycle. The simple answer is that the two effects have a common electrical cause. Figure 8 shows the Sun has a variable power input since X-rays are emitted where an electric discharge is most concentrated. *"The Sun is a variable X-ray star; it is fortunate for us that the variability is not reflected in the energy flux in the visible."* [15]

The variation in light and heat from the Sun is measured to be a fraction of one percent from year to year. So the electrical model must explain how the Sun can be a steady source of life-giving radiant energy if it has a variable power source? The answer, once more, seems to require electrical engineering. The tufted plasma sheath (photosphere) high above the stellar anode seems to be the circuit equivalent of a PNP transistor, a simple electronic device using small changes in voltage to control large changes in electrical power output. The photosphere itself regulates the solar discharge and provides stability of radiated heat and light output, while the power input to the Sun varies throughout the sunspot cycle. This regulation is not available to stars off the main sequence, without bright photospheres.

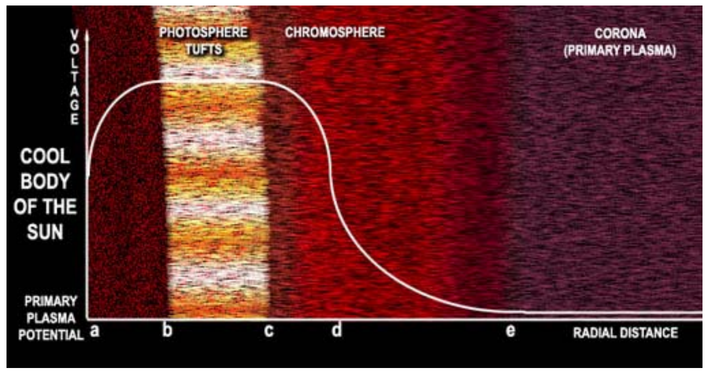

Fig. 9. Credit: W. Thornhill (after W. Allis & R. Juergens).

Figure 9 depicts a cross-section of the Sun's photospheric plasma sheath. The white curve shows how the voltage changes within the solar plasma as we move outward from the body of the Sun.

Positively charged protons will tend to "roll down the hills." So the photospheric tuft plasma acts as a barrier to limit the Sun's power output. The plateau between (b) and (c) and beyond (e) defines a normal quasi-neutral plasma. The chromosphere has a strong electric field, which flattens out but remains non-zero throughout the solar system. As protons accelerate down the chromospheric slope, heading to the right, they encounter turbulence at (e), which heats the solar corona to millions of degrees. The small, but relatively constant, accelerating voltage gradient beyond the corona is responsible for accelerating the solar wind away from the Sun [16].

This ability of the Sun's plasma sheath to modulate the solar current was demonstrated dramatically in May 1999, when the solar wind stopped for two days. The bizarre event makes no sense if the solar wind is being 'boiled off' by the hot solar corona. But in electrical terms, its regulating plasma sheath performed normally and there was no noticeable change in the Sun's radiant output.

7. Solar Magnetism

One of the greatest mysteries of the Sun is the sunspot cycle. It is intimately associated with that other great puzzle — the Sun's magnetic field. This puzzle is that it is extremely difficult to conjure a magnetic field from inside a hot ball of conducting plasma, particularly when the solar magnetic field shows amazing complexity and often rapid variability.

The Sun has a generally dipole magnetic field that switches polarity with the sunspot cycle. Unlike a dipole magnet, in which the field is twice as strong at the poles as at the equator, the Sun has very evenly distributed field strength. This oddity can be explained only if the Sun is the recipient of electric currents flowing radially into it. These magnetic field-aligned currents adjust the contours of the magnetic field by their natural tendency to space themselves evenly over an anode surface. An internal dynamo will not produce this magnetic field pattern.

The Sun's interplanetary magnetic field increases in strength with sunspot number. Electrically, the relationship is essential, since the interplanetary magnetic field is generated by the current flow to and from the Sun. As the power increases, sunspot numbers rise (reflecting increasing current input) and the magnetic field strengthens.

The standard thermonuclear star theory has no coherent explanation for the approximately eleven-year sunspot cycle. In the electrical model the sunspot cycle is induced by fluctuations in the DC power supply from the local arm of our galaxy, the Milky Way, as the varying current density and magnetic fields of huge Birkeland current filaments slowly rotate past our solar system. The solar magnetic field reversals may be a result of simple 'transformer' action.

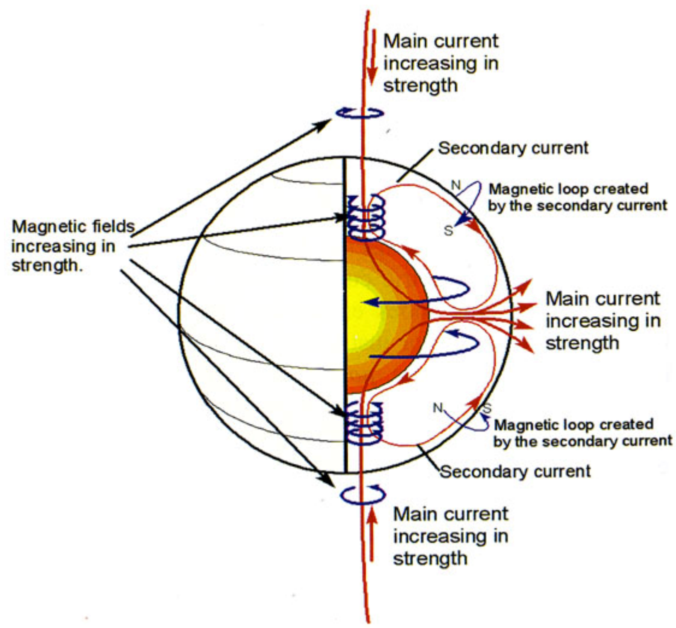

Fig. 10. Primary and secondary electric currents in the Sun. Credit: D. Scott, **The Electric Sky.** [16]

In contradistinction to Alfvén's 'homopolar generator' model of the solar circuit, Scott offers the following explanation for solar magnetic field reversals in terms of an externally powered 'homopolar motor' and its associated magnetic induction effects:

"If the main magnetic field that induces the surface currents is growing in strength, the surface current will point in one direction. If the main magnetic field weakens, the secondary surface currents will reverse direction." [17] This 'transformer' action does not require the solar heliospheric current to reverse direction as in Alfvén's model—something that is not observed.

8. The Electrical Hertzsprung-Russell Diagram

Electric lights come in a wide variety. There are incandescent filament lamps with a filament lit internally by electric current. And there are fluorescent lights, high-intensity gas discharge lamps, arc lights, neon lights and solid-state light emitting diodes (LEDs).

Stars fall into the categories of neon lights, gas discharge lamps and arc lights. They are not incandescent (bodies heated to a high temperature). The main differences between electric discharge lights are the energy density and location in the gas discharge path where most of the light originates. For example, in neon tubes the light comes from the extensive plasma column between the electrodes at each end of the tube. In an arc light, the light is concentrated at the electrode. As the power density of an arc light is increased, its color changes from yellow-white to white to blue-white.

Astronomers use the Hertzsprung-Russell (H-R) diagram to categorize stars. It is a plot of the absolute brightness of stars against their spectral class (temperature).

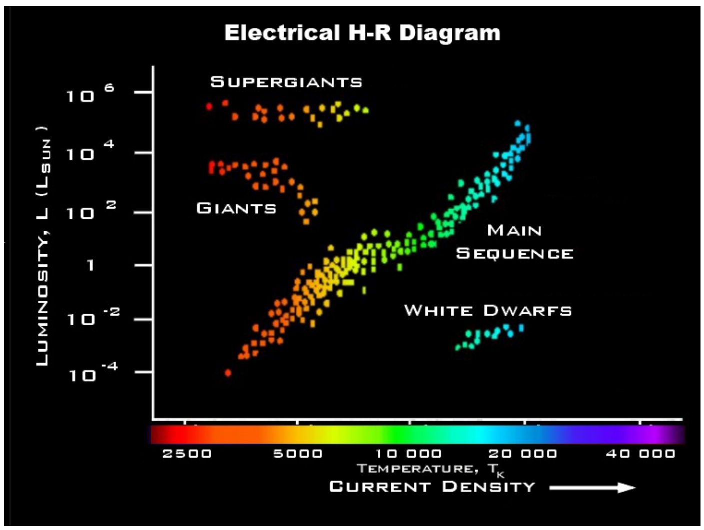

Fig. 11. The Electrical H-R plot

The data graphed by the H-R diagram are observed quantities, while assumptions drawn about the diagram's meaning are not. Figure 11 shows how the H-R diagram should be plotted to make engineering sense, with current density, temperature and rotational energy increasing from left to right. Main sequence stars operate with bright photospheres, like the Sun.

The test for the electric star model [18] comes from the stragglers — the red giants, and the red and white dwarfs. The terms 'giant' and 'dwarf,' when applied to these stars are highly misleading since a star's size is a plasma phenomenon. So the notions that a red giant is an old, bloated and dying star, and that a white dwarf is a collapsed remnant of an exploded star, have no validity. In an Electric Universe, stars do not evolve. The notion of stellar evolution and the age of stars is an invention of the standard thermonuclear model of stars. Eddington himself expressed his puzzlement about white dwarfs:

"Strange objects, which persist in showing a type of spectrum entirely out of keeping with their luminosity, may ultimately teach us more than a host which radiates according to rule."[19]

He was correct. A white dwarf is a star that is under low electrical stress so that bright anode tufting is not required. The star appears extremely hot, white and under-luminous because it is equivalent to having the faint white corona discharge of the Sun reach down to the star's atmosphere. As usual, a thin plasma sheath will be formed between the plasma of the star and the plasma of space. The electric field across the plasma sheath is capable of accelerating electrons to generate X-rays when they hit atoms in the atmosphere. And the power dissipated is capable of raising the temperature of a thin plasma layer to tens of thousands of degrees.

White dwarfs are often found in multiple star systems (for example, Sirius A and B), which puzzles astronomers because it is not easy to understand how two stars of the same age could be so different. The answer is simple. The appearance of electrical stars has nothing to do with their age. In multiple star systems, the brighter primary star usurps most of the electrical power, dissipating the energy in optical wavelengths. The white dwarf converts its share of power most efficiently into X-rays.

On the other hand, red stars are those that cannot satisfy their need for electrons from the surrounding plasma. So the star expands the surface area over which it collects electrons by growing a large plasma sheath that becomes the effective anode in space. The growth process is self-limiting because, as the sheath expands, its electric field will grow stronger. Electrons caught up in the field are accelerated to ever-greater energies. Before long, they become energetic enough to excite neutral particles they chance to collide with, and the huge sheath takes on a uniform 'red anode glow.' It becomes a red giant star. The electric field driving this process will also give rise to a massive flow of positive ions away from the star—a prodigious stellar 'wind.' Indeed, such mass loss is a characteristic feature of red giants. Standard stellar theory is at a loss to explain this since the star is said to be too cold to 'boil off' a stellar wind.

It is noteworthy that red giants do not have the self-regulation mechanism of stars with bright tufted photospheres. They must respond to changing electrical input by altering their radius and ejecting matter. Over 15 years the red giant Betelgeuse (α Orionis) has decreased in size smoothly by 15 percent, but faster as time progressed. [20] It is to be expected that its radius will reflect a roughly sinusoidal pattern over time.

Red giants are a scaled-up example of how a brown dwarf star might appear close-up. There are no "failed" stars in an Electric Universe. Stars have no thermonuclear "engine" to fail. All bodies in the galaxy receive external electrical energy from the galactic circuit. The apparent size and color of an electric star is an electrical phenomenon. For example, if Jupiter were an independent galactic body such that its plasma sheath lit up as a brown dwarf, then that star would appear from Earth the size of the Sun, although five times more distant. Jupiter's satellites would orbit within Jupiter's distended red anode glow and receive the same energy density over their entire surface. The Electric Universe model speculates that the environment on such satellites is the most widespread and hospitable in the universe for life to flourish.

9. Conclusion

The renowned solar astrophysicist, Eugene N. Parker, wrote in his Special Historical Review:

"It is essential in these exuberant times to pay critical attention to both the observational constraints and to the basic mathematical laws, with a clear sense of what is solid theory and what is only unsupported speculation. This seeming platitude is offered here without jest...

"...the pedestrian Sun exhibits a variety of phenomena that defy contemporary theoretical understanding. We need look no farther than the sunspot, or the intensely filamentary structure of the photospheric magnetic field, or the spicules, or the origin of the small magnetic bipoles that continually emerge in the supergranules, or the heat source that maintains the expanding gas in the coronal hole, or the effective magnetic diffusion that is so essential for understanding the solar dynamo, or the peculiar internal rotation inferred from helioseismology, or the variation of solar brightness with the level of solar activity, to name a few of the more obvious mysterious macrophysical phenomena exhibited by the Sun." [21]

Such frank admissions should be a warning that scientists don't understand the Sun or stars at all. All of the problems can be ascribed to an invalid stellar model that dates to the gaslight era. From the perspective of the Electric Universe, the thermonuclear model of stars was an unfortunate historical accident of timing. Plasma science and gas discharge theory were in their infancy when the unlocking of the energy of the atom in Eddington's time seemed to provide the answer to the baffling problem of the energy source of the Sun.

A final word from Alfvén, who took the unprecedented step of predicting in his December 11, 1970 Nobel prize acceptance speech [22] the eventual failure of astrophysics:

"In conclusion, it seems that astrophysics is too important to be left in the hands of theoretical astrophysicists who have gotten their education from the listed textbooks. The multibillion dollar space data from astronomical telescopes should be treated by scientists who are familiar with laboratory and magnetospheric physics, circuit theory, and, of course, modern plasma physics. More than 99 percent of the Universe consists of plasma, and the ratio between electromagnetic and gravitational forces is 10^{39}." [23]

If stars are electrically powered from a galactic circuit then the consequences of this fact alone for science and society are profound. We have been following a mirage of knowledge that leads into a desert of ignorance. Our story of the Sun and the planets is a myth. The holy grail of nuclear fusion energy "like the Sun" is a false quest. In fact, our entire cosmology of the big bang, galaxy formation, the formation of the Sun and its family of planets, and the history of the Earth is fiction. It ignores the most powerful organizing electric force in favor of the feeblest force—gravity. Most of our 'big' science, like the costly fusion experiments and space missions, has been misdirected and wasteful. All sciences must be re-examined from a fresh interdisciplinary perspective based on an interconnected Electric Universe [24].

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References

[1] *ESA News*, "Herschel Views Deep-space Pearls on a Cosmic String" (16 Dec 2009), http://www.esa.int/esaMI/Herschel/SEMUABGNA0G_3.html.

[2] D. Arzoumanian, et al, "Characterizing Interstellar Filaments with Herschel in IC 5146", *Astron. & Astrophysics*, **529**: L6 (2011).

[3] *ESA News*, "Herschel Links Star Formation to Sonic Booms (13 Apr 2011) http://www.esa.int/esaCP/SEMQVH7S9MG_index_2.html.

[4] Ibid.

[5] H. Alfvén, "Double Layers and Circuits in Astrophysics", *IEEE Transactions on Plasma Science* Dec. 1986; PS-14; 6: 790.

[6] G. T. Marklund, "Plasma Convection in Force-free Magnetic Fields as a Mechanism for Chemical Separation in Cosmical Plasma", *Nature* **277**: 370-371 (1 Feb 1979).

[7] *Physorg*, "Herschel Reveals the Hidden Side of Star Birth" (6 May 2010), http://www.physorg.com/news192368995.html.

[8] A. Ananthaswamy, "Strange Cosmic Ray Hotspots Stalk Southern Skies", *New Scientist* (4 May 2011), http://www.newscientist.com/article/dn20436-strange-cosmic-ray-hotspots-stalk-southern-skies.html.

[9] Ibid.

[10] H. Alfvén, "Keynote Address", in **Double Layers in Astrophysics**, p 13 (NASA Conference Publication 2469, 1986), http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19870013880_1987013880.pdf.

[11] Ibid., p. 27.

[12] Op. cit. [10], p. 15.

[13] J. C. LoPresto, et al, "Solar Polar Vortex?", *NOAO/NSO Newsletter*, p. 3 (Sep 2009), http://www.nso.edu/press/newsletter/SolarPolarVortex.pdf.

[14] R. Giovanelli, **Secrets of the Sun**, p. 1 (Cambridge University Press 1984).

[15] R. L. F. Boyd, **Space Physics: The Study of Plasmas in Space** (Oxford: Clarendon Press, 1974).

[16] D. Scott, **The Electric Sky**, pp. 96-7 (Portland, OR, Mikamar Publishing, 2006).

[17] Ibid., pp. 112-3.

[18] W. Thornhill, "The Z-pinch Morphology of Supernova 1987a and Electric Stars", *IEEE Transactions on Plasma Science* **35** (4): 832-844 (Aug 2007).

[19] A. S. Eddington, **Centenary Address, 1922**, RAS Monthly Notices, 82, 436.

[20] C. H. Townes, et al, "A Systematic Change with Time in the Size of Betelgeuse", *Astrophysical Journal* **697**: L127–L128 (1 Jun 2009).

[21] E. N. Parker, "Reflections on Macrophysics and the Sun: (Special Historical Review)", *Solar Physics* **176**: 220 (1997).

[22] H. Alfvén, "Plasma Physics, Space Research and the Origin of the Solar System", Nobel Lecture, p. 308 (11 Dec 1970).

[23] Op. cit. [10], p. 16.

[24] W. Thornhill, D. Talbott, **The Electric Universe** (Portland, OR, Mikamar Publishing, 2007); also http://www.holoscience.com.