Considering the Electric Sun

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In the twentieth century, the pioneers of plasma cosmology began to identify a crucial role of electric currents in interstellar and intergalactic space. The "electric universe" hypothesis extends the underlying principle of plasma cosmology into domains that were, at best, only partially touched by plasma cosmology pioneers. This paper will present a brief summary of the "electric Sun" hypothesis, with pointers to the interdisciplinary contributions of others toward a radically new perspective.

1. Introduction: Gravity Dethroned?

For well over a century the commonly accepted view amongst astronomers and cosmologists was unequivocal: gravity is king. Gravity rules the heavens. It is the ultimate driver behind the evolution of galaxies and stars. Though this core dogma grew more complicated with the advent of relativity theory, then more complicated still by a continuous stream of space age surprises, gravity remained supreme. It is the weakest of the fundamental forces known to science, but the prior theoretical "consensus" continued to treat gravity as the only fundamental force capable of acting across cosmological distances.

The hypothesis reviewed here, however, suggests that the electric force has a far more significant role in the cosmos than was ever recognized under the standard theories of 20th century astronomy. We now know that space is not empty, but filled with charged particles, a sea of conductive plasma. Rapidly accumulating evidence suggests that electric currents flow across intergalactic, interstellar, and interplanetary space, contributing significantly—often decisively—to the evolution of cosmic structure. As today's theorists come to acknowledge this role, the picture of space will be forever changed.

The emerging electrical perspective suggests an integral connection of stars and galaxies to their external environments. As observation began to reveal unexpectedly high and strongly focused energies in space, prior theory required that the motor come from inside the observed structures, initiated either directly or indirectly by gravity. That requirement, in turn, could only dissuade cosmologists from asking the most fundamental question: is it possible that external electric currents, powered by the stored charge in deep space, could drive much of the observed structural evolution?

2. The Plasma Universe

Many details of the plasma universe have been available to astronomers and cosmologists for at least several decades [1]. As new telescopes and probes extended the frontiers of human knowledge, space came alive with the full signature of electromagnetic radiation. Technicians and engineers of the space age delivered to the theoretical sciences all the evidence needed to confirm electrical activity across the farthest reaches of space.

The new picture removed the assumptions of textbook cosmology formulated prior to the space age. Now, the steady stream of surprises remind us of earlier visionaries, from Kristian Birkeland and Nikola Tesla to the founder of plasma science, Hannes Alfven, all of whom anticipated the role of electricity in cosmic events [2].

Fig. 1. Amongst the countless surprises from space in recent decades is this axial jet of galaxy M87, captured by the Hubble Space Telescope. The coherent jet, spanning thousands of light-years, together with the galaxy's intense synchrotron radiation, continue to baffle astronomers. But electrical theorist Hannes Alfven had predicted galactic synchrotron radiation in 1950 [3].

Most astronomers and cosmologists, working with assumptions formulated long prior to the space age, had learned to ignore electricity. They did this first by dismissing the possibility of electric currents across the "vacuum" of space. Then, when it was discovered that all of space is a sea of conductive plasma, the theorists reversed their position, asserting that any charge separation would be immediately neutralized. One false assumption gave way to another.

Alfvén and his colleagues recognized that intricate cosmic structure and high-energy events in space are the witnesses to electric currents threading a sea of interstellar and intergalactic plasma. For example, we now detect the "hum" of these cosmic power lines by their radio signals[4].

When currents flow in space plasma, the magnetic fields produced will tend to confine the flow to narrow, twisting filaments. That's what we now observe filling the "vacuum" of space, as Alfvén himself had predicted. More intense focusing of this current flow (the plasma *z-pinch*) will often generate explosive electric discharge, and the consequent electromagnetic radiation can include—at the highest energies—"synchrotron" radiation, now abundantly observed in space. Intense electric fields remain the only plausible explanation. But when Alfvén predicted galactic synchrotron radiation, astronomers did not respond. Electric fields in space had not yet entered their lexicon.

3. "Magnetic Universe"

Until quite recently most astronomers barely gave electricity in space a sideways glance. And yet, through the back door, we now see a growing interest in the role of magnetism across the cosmos. In the rarefied plasma environment of space, magnetic fields are the proof of active electric currents, even if the proof is ignored. But with surprising rapidity, the "magnetic universe" is now emerging as a permissible expression within the scientific mainstream. This radical turn may prove to be the most promising bridge to an intellectual revolution, eventually making it impossible to ignore the electric currents without which the "magnetic universe" would disappear.

Alfvén's lifelong experimental work laid the foundations for a new approach to galaxy formation. Galaxies are often dwarfed by the full spectrum of electromagnetic radiation in their surrounding environments, and the source of these energies must be taken into account.

In the plasma universe, electric currents will intersect at critical points to drive an electric vortex, giving birth to spiral galaxies. This envisioned behavior of electricity in space is based on the laboratory observation of electric currents and electric discharge in plasma, together with supercomputer simulations of the way charged particles interact under the influence of electric currents.

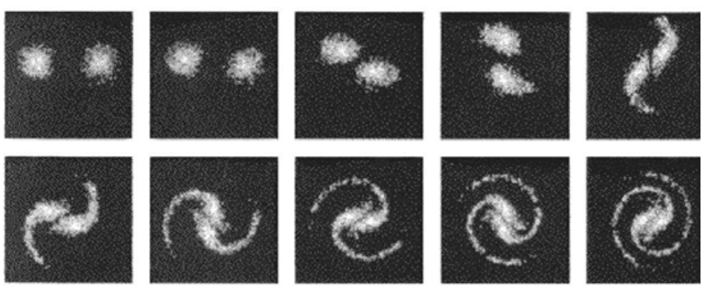

Fig. 2. Supercomputer simulation of spiral galaxy formation by Anthony Peratt, based on charged particle interactions.

The point was well illustrated by the leading plasma scientist Anthony Peratt in 1986. An expert on high-energy plasma instabilities and author of **The Plasma Universe** [5], Peratt used a super computer to simulate the behavior of a cloud of charge (a particle-in-cell simulation) illustrating the manner in which electric currents in plasma will generate the familiar shape of spiral galaxies and of other galactic structures.

Based on diligent laboratory work spanning decades, Peratt's mentor Alfvén suggested that electric currents flow inward along the arms of galaxies, generating an encircling magnetic field. On reaching the galactic center, the electric charge that drives these currents is stored in a compact electromagnetic *plasmoid* – a rotating torus or donut-shaped structure episodically releasing its stored energy as jets along the galaxy's spin axis. Alfvén concluded that this is how an "active galactic nucleus" (AGN) is born. From this vantage point, the electrical behavior of the galactic plasmoid, though often hidden by dust, is the confirmation of immense electric potential. Moreover, in this radical break from earlier theory, the newborn galaxies could in fact be lit by *electric* lights – the stars strung along galactic filaments as witnesses to interstellar power lines or current streams.

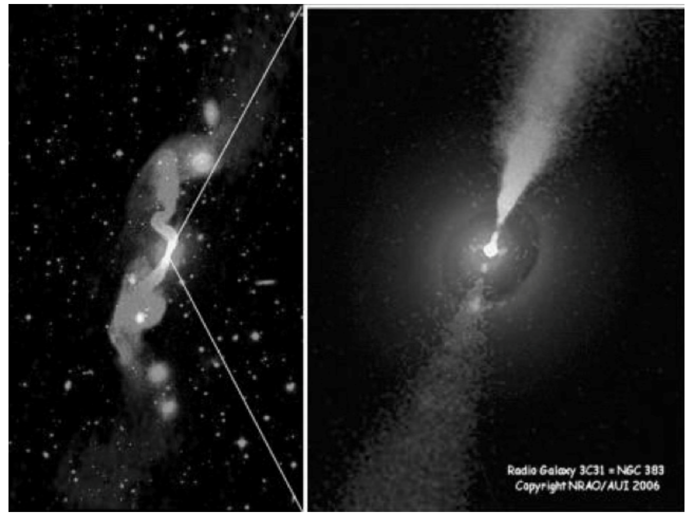

Fig. 3. The galaxy 3C31, depicted on the right, appears as a mere speck within the energetic radio signals that surround it (left). Credit NRAO/AUI 2006.

4. Why Does the Sun Shine?

Electric fields in space lead to a possibility categorically excluded from the "settled science" of the 20th century. Could the Sun's light and its entire range of electromagnetic activity be partly or entirely due to the flow of electric currents into and through the heliosphere. In the plasma universe, such currents originate in the stored charge and related movements of charged particles along the arms of the Milky Way.

The present paper will summarize the electric sun hypothesis, emphasizing its contrast to the present fusion model. Both perspectives have a long history, but by mid-20th century, astronomers had fully settled on one idea: a nuclear furnace at the Sun's core.

Prior to the emergence of the fusion model, a "consensus" theory had survived for a hundred years. The earlier view, formulated by Sir William Herschel early in the 19th century, held that the heat and light of the Sun were due to gravitational collapse of a primordial nebular cloud. Textbooks described the theory as a crowning achievement. "As a scientific conception it is perhaps the grandest that has ever entered into the human mind," wrote Edward Holden in 1881 [6]. But a few decades later the theory lost its credibility as astronomers realized it could not account for the emerging billion-year scenarios of Earth evolution.

It was the mathematician Arthur Eddington who, in 1920, announced the foundation of a new standard model based on a hypothesized release of nuclear energy in the Sun's core. Later, in 1938, the astrophysicist Hans Bethe offered a rigorous mathematical formulation of the envisioned "fusion" process, for which he won the Nobel Prize 29 years later [7]. A new consensus arose, a conviction that only a fusion reactor at the Sun's core could explain the sun's powerful emissions of heat and light. And now every student in the sciences reads about the discovery as fact. Hans Bethe "discovered how nuclear fusion powers the Sun and other stars." [8] Today's electric sun hypothesis challenges this sweeping theoretical assumption.

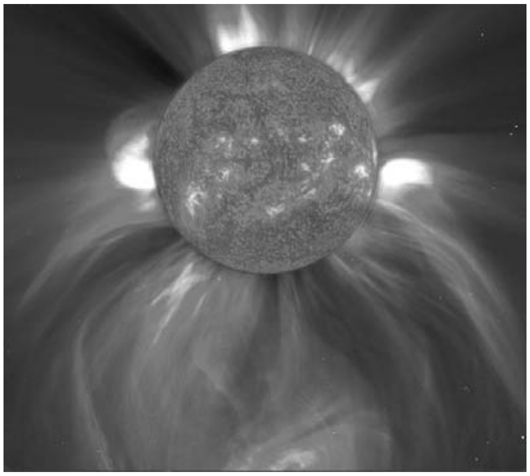

Fig. 4. Is this eruption of the Sun due exclusively to a power source at the Sun's core? Or is the Sun responding to a vastly larger electrical environment? Credit: SOHO (ESA & NASA).

At one level, the electric sun is a logical extension of the "plasma universe" as formulated by Alfvén and his students and colleagues such as Anthony Peratt. But certain tenets of the electric model rest on the work of others. The first argument for a sun actually *powered* by electricity rather than nuclear fusion was offered by engineer Ralph Juergens in the late 60s and early 70s.

Today the hypothesis is best known through the labors of Wal Thornhill [9] and the work of Thornhill's colleague, retired professor of electrical engineering, Don Scott, author of *The* **Electric Sky** [10]. Others have played roles in the evolution of the concept as well.

Since the hypothesis suggests electric currents flowing into the heliosphere, the investigation must consider all evidence bearing on this possibility, from the behavior of the Sun's visible surface and corona to Earth's auroras; from the worlds of Jupiter and Saturn out to the boundary of the heliosphere, the presumed limit of the Sun's influence. It must extend also to the galactic neighborhood, where subtle but vast currents flow along galactic arms. And it must even reach beyond the Milky Way to the unfathomable power now evident in intergalactic space.

Virtually all of the considerations discussed here came after the fusion model of the Sun had emerged as a "consensus" of the scientific community. Astronomers considered the most basic issue—the source of the Sun's heat and light—to be fully resolved as we launched satellites and probes into space. Certainly, no one believed that a retroactive, qualitative assessment of the fusion model was necessary. And no one seemed to blink when the one and only quantitative argument for the Sun's nuclear core failed, as the neutrino count came in at a third to a half of the theoretically required figure.

5. The Role of Qualitative Evidence

When theorists propose a fundamentally new scientific perspective they are asking that it be considered as a useful starting point. A useful model will spell out proposed relationships between causes and effects. It will typically involve a broad interdisciplinary range of evidence. Causes are hypothesized and the claimed effects are named. A new model can then be generalized to see how well its underlying assumptions correlate with more detailed observations and a broader range of measurements bearing on the question.

With increasing specialization in the sciences, the most costly mistakes will typically involve a failure to generalize a qualitative argument, to weigh its predictive power within a sufficiently broad field of view. Carried out properly, this essential phase will throw a spotlight on weaknesses or outright failures of a theory, if they exist. This is where we look for contradictions, things that don't fit the underlying assumptions. "Provably wrong if incorrect" is the ideal when stating a theory. In fact, the most useful qualitative arguments will be readily falsifiable, and the question of correlation between theory and observation can be explicitly tested against the full range of critical data.

There can be no rational justification for short-circuiting the qualitative phase. In the case at hand, where a theory effects how we see our celestial environment as a whole, the generalization of a qualitative argument is indispensable, requiring that the field of view be every bit as broad as the theory's logical implications. A more narrow field of view will virtually guarantee that at least some falsifying observations, if they exist, will be ignored.

In 1950, the Sun's hypothesized "nuclear furnace" rested entirely on mathematical foundations. Virtually no qualitative tests of the conjectured nuclear furnace were yet in hand. And the scientific mainstream was unaware of the plasma universe and the profound role of electric currents in space.

Today, after decades of solar exploration, the qualitative accord that theorists had hoped for is glaringly absent. To see that this is so, it's only necessary to review the stream of *surprises* arising from exploration of the Sun—a collective exclamation point to the gap between theory and observation. Nothing fit the original expectations. The original model did not anticipate, and was never able to explain, the spectacular acceleration of charged particles *away* from Sun. No one envisioned the "impossible" increase in temperature with distance upward from the solar surface, culminating in 2 million Kelvin at the solar corona.

At the dawn of the space age, the complex electromagnetic activity of the Sun's photosphere was unknown. An electrified plasma torus around the Sun would have seemed quite ridiculous. Polar jets had never entered the imagination of solar theorists. Sunspot penumbra were supposed to be convection currents, not electric current ropes guided by magnetic fields. And established dogma, exemplified in the work of mathematician Sydney Chapman, had categorically excluded the possibility that Earth's auroras could be caused by electric currents from the Sun penetrating Earth's upper atmosphere.

The story yet to be announced is that more than 50 years of space age investigation produced only anti-correlations to the supposedly settled science of the Sun.

6. Quantification

A broad qualitative agreement between theory and observation will provide the foundation for quantification. Specialized inquiry can then test the rigor and precision of the qualitative argument with equations and numbers. In a successful test, the quantitative results will correlate well with predictions arising from the underlying theoretical assumptions; they will add logical strength and precision to the prior qualitative argument.

In the case of the Sun, however, neither a qualitative nor a quantitative argument exists, since the dominant attributes of the Sun, as now recognized, lie beyond the predictive ability of the theoretical assumptions. This sweeping failure of predictive ability can only throw into doubt the more specialized assumptions, equations, and simulations offered in the name of solar physics today. The only way to overcome this profound deficiency would be to demonstrate a logical pathway of quantified analysis leading from the theoretical starting point to major attributes of the Sun. After decades of trying, the promise of a quantified model was never fulfilled, not even in a partial sense of reasoning from the assumed nuclear furnace to *just one* major attribute. And now the specialized debates go on and on, guided by the seeming certainty that an ideologically "acceptable" answer must be available.

7. "Meeting Our Global Energy Needs"

In the absence of reasonable, successful tests of a hypothesis it is a grave mistake to pretend that issues are settled. Nevertheless, with the support of popular media, a guess about the "nuclear core" of the Sun led to a leap of faith. Limitless energy should be available to humanity by controlling a fusion process—"just like the controlled fusion in the center of the sun."

The cost of this exuberance may never be accurately calculated. Globally, governments poured billions upon billions of dollars into research, seeking to replicate the imagined events hidden inside the Sun. From the 1950s onward it was an easy sell. But the only fusion the experiments provoked lasted a second or so— typically much less than a second—and never produced as much energy as was pumped into the experiments. In physics, that's the definition of an unworkable idea—and it's very likely the most expensive failure of theory the world has ever witnessed [11].

8. The Electric Sun: Photospheric Lightning

In 1941 Dr. Charles E. R. Bruce, of the Electrical Research Association in England, began developing a new perspective on the Sun. Inspired by the unique behavior of solar flares, he found that the appearance of these flares, their temperature, and their spectra, provided a perfect match with lightning. The visible surface or photosphere of the Sun appears to be driven by electric discharge [12].

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, he 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." [13]

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 Juergen's hypothesis. Thornhill has since devoted much of his life to researching the "Electric Universe" (a phrase he himself had coined in the mid nineties) and the core tenet of an electric sun. 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 recently published book, **The Electric Sky**. A centerpiece of the book is the electric sun hypothesis.

9. Glow Discharge (Geissler Tube)

Is it possible that the unsolved mysteries of star formation could find a unified explanation close to home, in the hypothesis of an electric sun? The concept would extend the plasma universe to the observed features of stars. From this perspective, electric currents flowing along galactic arms are pinched into focal points of star formation (the z-pinch effect). Stars are then seen in an electrical connection to the stored energies of the plasma oceans through which galaxies and galactic clusters move.

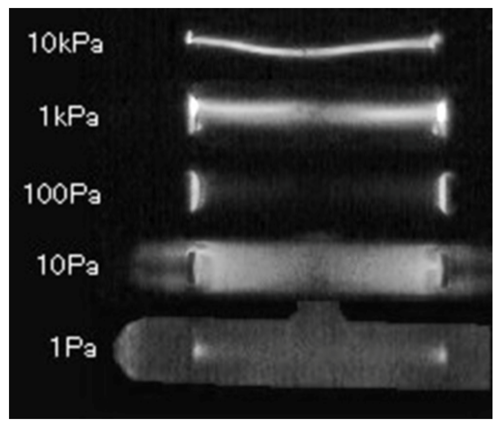

Fig. 5. Geissler tube. As pressure is reduced within the glass tube, changes occur in the glow discharge.

The electrical hypothesis envisions the Sun immersed in a medium of extremely low-density plasma. Its glow discharge is similar to that of a Geissler tube. Only *very close to the Sun* will the concentration of atoms be sufficient to excite them to emit visible light in an electric discharge.

We see that light as the photosphere and the corona, but the "atmosphere" of the Sun extends outward as a sea of plasma through which the planets move, all swimming in heliospheric currents, all affected by the movement of charge. In this way, the electrical activity within the heliosphere and beyond provides a laboratory in space for evaluating the electric Sun hypothesis.

10. Contrasting Theory and Observation

A dispassionate, qualitative test of two models is now essential. Is the Sun an isolated ball of gas in space, slowly consuming itself through nuclear reactions at its core? Or is its energetic output largely—perhaps entirely—the consequence of external electric fields and the heliospheric movement of charged particles, powered by circuitry along the arms of the Milky Way?

Investigators of the electric sun hypothesis have devoted many years to contrasting the two models, leading to one overriding conclusion: the *failures* of the standard model are the *predictions* of the electric model. To see that this is so, and to appreciate what this means, one must trace the connection between theoretical assumption and prediction. The accent must be on *inescapable* implications of the underlying assumptions, eliminating ambiguity. Wherever the implications are logical *requirements* of the model, the absence of the predicted findings will amount to falsification of the model as stated.

Though the electrical hypothesis remains in its infancy, and the qualitative phase of the investigation is far from complete, the predictive success of its underlying claims can be readily contrasted to the predictive failure of the fusion model. Hence, an issue-by-issue comparison of the two models cannot be avoided.

11. Defining the Field of Evidence

The fundamental challenges posed here will directly affect the breadth of the required investigation. Over several decades, the "electric universe" hypothesis extended into new vantage points for understanding widely varying levels of theoretical science, ranging from cosmology and issues of star- and galaxy-formation to meteorology, planetary science, and the study of comets. For this reason, debating fragments will tend not to work, whereas as a sense of the whole *will* work. The cited evidence suggests that the Sun itself is profoundly influenced by external electric currents. This possibility, in turn, leads to deep layers of available data, often unexplored, concerning planets, moons, comets, asteroids, and meteorites, all raising issues with respect to the Sun, though virtually none of the questions posed, and virtually none of the suggested answers have found their way into theoretical discussion of solar physics.

Nevertheless, the hypothesis invites us to apply the well-tested standards of natural philosophy to space sciences that have been fractured through a combination of excessive specialization and the momentum of beliefs. Untested theoretical assumptions narrowed scientific vision, preventing a sufficiently broad field of view. The fusion model of the Sun, together with the electrical alternative, must be evaluated at a level more fundamental than has occurred in 60 years of "peer reviewed" research. This means applying elementary tests to the two competing concepts.

On both sides, the protocol must include a clear sense of the theoretical assumptions inherent in the model or interpretation offered, with attention to the full range of implications, in particular the *inescapable* implications, since these will serve as falsifiable "predictions" of the model.

In fact, the Sun offers new opportunities for resolving a fundamental dilemma in the sciences. The required investigation will remind us of the nature and purpose of natural philosophy, with its pathways to convergence across distinct fields of inquiry. Interdisciplinary considerations will continually draw our attention to larger contexts for evaluation theoretical interpretations. Very little of the 20th century "consensus" that will withstand scrutiny.

12. The Constant and Inconstant Sun

Under the assumptions of the fusion model the Sun's electromagnetic emissions appear enigmatic, with unexplained variations depending on wavelength. "Solar spectral irradiance variations are known to exhibit a strong wavelength dependence with the amount of variability increasing towards shorter wavelengths." [14]

Traditional theory assumes that, over hundreds of thousands of years, heat from a fusion reaction at the Sun's core travels first through a supposed "radiative zone." It then rushes upward through an imagined "convective zone" to create the Sun's visible surface, the photosphere. Unexplained events then energize the chromosphere and corona *from below*. But why would this theorized process produce highly constant visible light but much more variable extreme UV light and X-rays above the photoshere?

13. "Solar Constant"

The least variable emissions occur in the infrared, which accounts for more than half of the Sun's radiative output. Moving up to visible light the Sun's output varies only slightly more. In the recent solar minimum it's visible light dimmed by only .1% [15].

Does the constancy of the Sun's output in IR and visible light follow logically from the standard model? The only known analogies for nuclear fusion are at the extremes of *inconstancy*: on the one hand a hydrogen bomb and on the other the failed laboratory attempts to control the fusion process. A hydrogen bomb underscores the fact that thermonuclear reaction rates are highly unstable and particularly sensitive to core temperature. Even a modest increase in temperatures at the Sun's core would multiply the likelihood of a runaway reaction a thousandfold and more.

The refusal of the Sun to become a "hydrogen bomb" is a good reason to consider the electrical alternative.

14. Solar Variability

At higher frequencies the Sun's "constancy" disappears. At the wavelengths of extreme ultraviolet light the Sun's emissions dimmed by 30% during the last solar minimum, a 300% greater dimming than in visible light. And at the frequency of X-ray generation the Sun is vastly more variable, as seen in the X-ray images of a solar cycle below. "The Sun is a variable X-ray star," states R. L. F. Boyd. "It is fortunate for us that the variability is not reflected in the energy flux in the visible." [16]

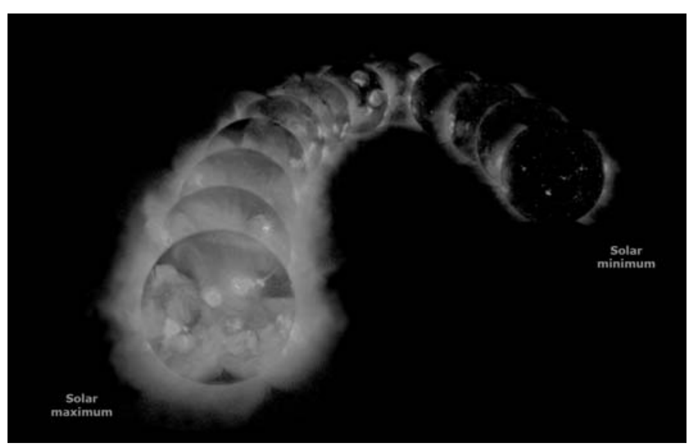

Fig. 6. Solar cycle observed in X-ray emissions. Credit: the Yohkoh mission of ISAS(Japan) and NASA.

What could be causing a constant Sun at one frequency to become an inconstant Sun at a higher frequency? From the region below the photosphere, up through the photosphere, through the chromosphere and the transition region, into the corona, we find an increasing dominance of higher frequencies and *greater variability*.

Perhaps our own Earth provides a useful analogy. Above the earth—in the ionosphere and Van Allen radiation belt—we know that the flow of charged particles and associated energetic activity is not generated from within the Earth. It is a direct result of arriving particles from beyond the Earth, specifically, from the Sun. Is it reasonable, therefore, to ask if the layers of more variable and energetic activity around the Sun could be due to electrical contributions from its larger environment, the heliosphere, fed by electrical currents along the arms of the Milky Way?

15. Overview of the Electric Sun

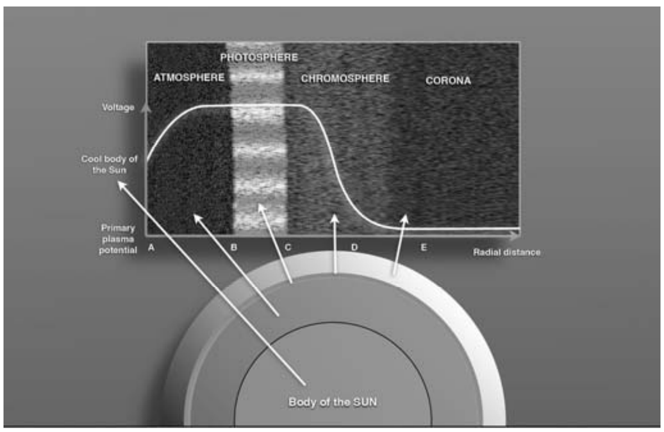

Fig. 7. The Sun's implied voltage curve in relation to elevation, as originally envisioned by Ralph Juergens, and further analyzed by Wal Thornhill and Donald Scott.

The Sun's thin photosphere exhibits a distinctive voltage curve as seen above, suggesting that this plasma layer acts as a PNP transistor (a device used to control current flow), maintaining the photosphere's steady radiation of heat and light while the power input varies over the sunspot cycle and through other variations in electrical input. (See discussion of "The Sun's PNP Transistor" below.)

The "hills" are the slopes of voltage change outward from the subsurface of the Sun (region beneath the photosphere). Positively charged particles will "roll down the hills." So the tufted plasma of the photosphere (B-C) acts as a barrier, limiting the Sun's power output. When it is breached we see gigantic coronal mass ejections.

As observed by professor Scott, solar protons that reach the point (C) on the voltage curve accelerate down the "waterfall," causing the turbulence at the bottom of the steep curve that is the source of the million-degree corona.

These events occur because the Sun is immersed in a medium of extremely low-density plasma. Under the Geissler tube analogy, it is only *very close to the Sun* that the concentration of atoms is sufficient to excite them to emit visible light in an electric discharge. We see that light primarily as the photosphere, with more energetic but largely invisible shells of higher frequencies above it.

Electrical theorists are not surprised by the fact that the most energetic and variable activity of the Sun occurs well above the Sun's photosphere, in the corona—the spectacular halo which shows up when the Sun's light is blocked by a solar eclipse (below). In electrical terms its counterpart is the corona of a glow discharge.

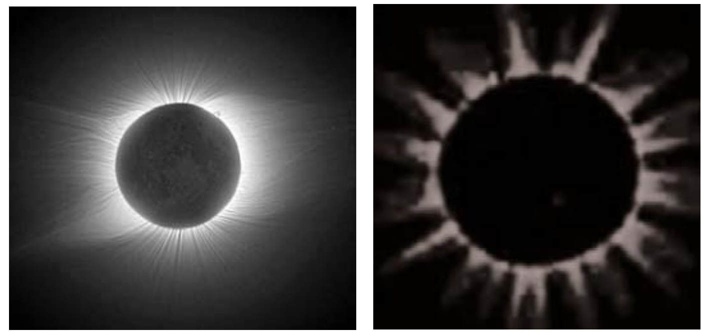

Fig. 8. *Left:* the corona of the Sun as seen in an eclipse. *Right:* glow discharge in the laboratory.

16. Coronal Heating

The temperature gradient from the Sun's surface to the corona has always presented a problem for astronomical models. If the Sun were like a glowing ember or a flame (or a nuclear furnace), one would expect the temperature to drop off with distance from the central heat source.

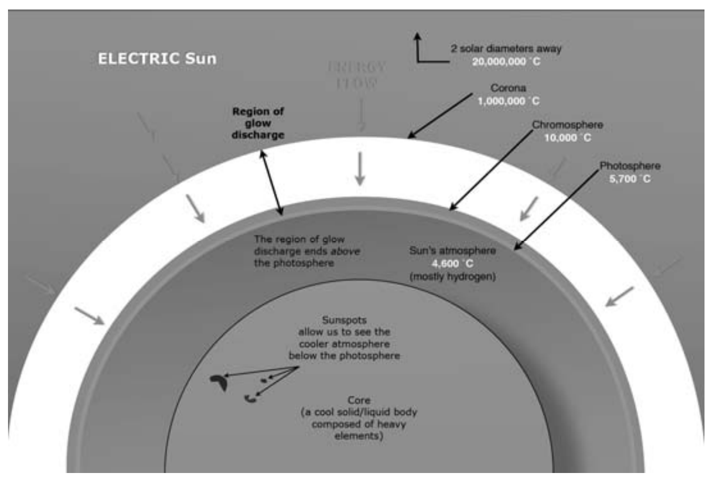

Fig. 9. Graph illustrating the Sun's reverse temperature gradient. Credit: W. Thornhill.

At about 500 kilometers (310 miles) above the base of the photosphere, we find the coldest measurable temperature of the Sun, about 4400K. Moving outward, the temperature then rises steadily to about 20,000K at the top of the chromosphere, some 2200 kilometers (1200 miles) above the Sun's surface. Here it abruptly jumps hundreds of thousands of degrees, then continues slowly rising, eventually exceeding 2 million degrees. And incredibly, ionized oxygen atoms at a distance of 1 or 2 solar diameters reach 200 million K!

Professor Jay Pasachoff, in the Department of Astronomy at Williams College, puzzles over the manner in which the heating of the solar corona defies "everyday physics." How could this be? he asks. What events are "transporting energy from the cold part to the hot part?" Pasachoff's wry assessment is refreshing.

"The problem has been solved," he states. "It's been solved a dozen times over, and there are a dozen different answers. So of course that means it really hasn't been solved..." [17]

But can astronomers and astrophysicists break free from the arbitrary assumption that the energy is "*coming from the cold part*"? In fact, the reverse temperature gradient of the sun contradicts every original expectation of the thermonuclear model. But it mirrors perfectly the behavior of glow discharge phenomena in the laboratory.

The inescapable key is the *external* energy source. A crude analogy would be the flame of a candle. The relatively cool temperature at the base of the flame gives way to much higher temperature above the candle at the region of maximum exchange with the oxygen-bearing atmosphere. In a weightless environment, as seen in an experiment on the Mir Space Station a few years ago (below), the exchange shows up as a luminous shell around the candle. The analogy with the corona is crude, but it does illustrate the indispensable *external contribution* to a reverse temperature gradient. Nature as we know it offers no contradiction of this principle.

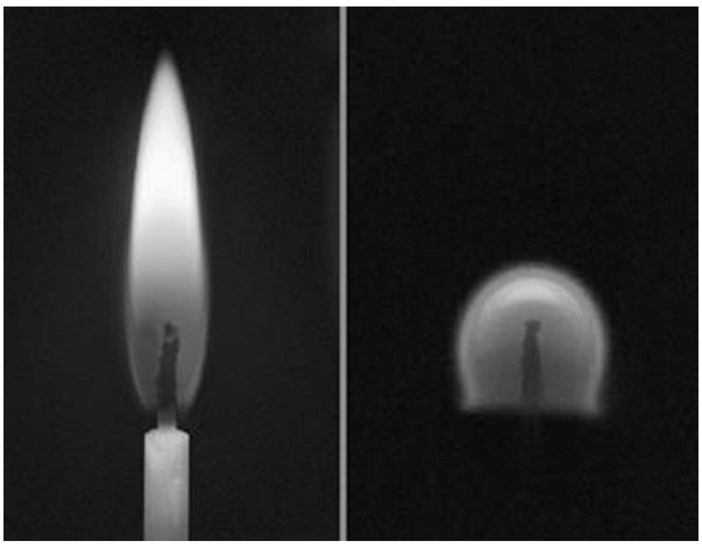

Fig. 10. In contrast to the candle on the left, a candle in a Mir space station experiment produces a luminous surrounding shell, signifying the transaction between the vaporized wax of the candle and the external atmospheric oxygen.

17. Mysteries of the Solar Wind

A direct confirmation of the Sun's electric field is the solar wind, a continuous flow of charged particles streaming from the Sun and continuing to accelerate out past the planets. *Electric fields accelerate charged particles*, and it is not reasonable to reject the obvious when no comparable effect can be achieved by any other force in interplanetary space.

Great volumes of material depart from the Sun without regard to its massive gravitational tug. The Sun's blast of particles typically reaches speeds of 400 to 700 kilometers (about 250 to 435 miles) per second. And though a few authorities anticipated a "wind" from the Sun due to thermodynamic expansion in the solar atmosphere, it soon became clear that the measured rapid acceleration was far beyond the explanatory ability of any prior guess about "heat" expansion as the source.

The solar wind is also highly variable. In 2010, its speed dropped by 3%, its temperature by 13%, its density by 20%, and its magnetic field strength by more than 50%. Why a stable star will send out a wind of charged particles at widely varying speeds, is a mystery with no apparent connection to anything going on inside the Sun.

When considering unsolved mysteries of this sort, often the most critical evidence comes from the extremes. In this case the two extremes would be, 1) a blast of solar wind in the form of a coronal mass ejection in 2005, reaching up to a quarter the speed of light before striking the Earth, and 2) the complete cessation of the solar wind for two days in May, 1999; (See discussion below.)

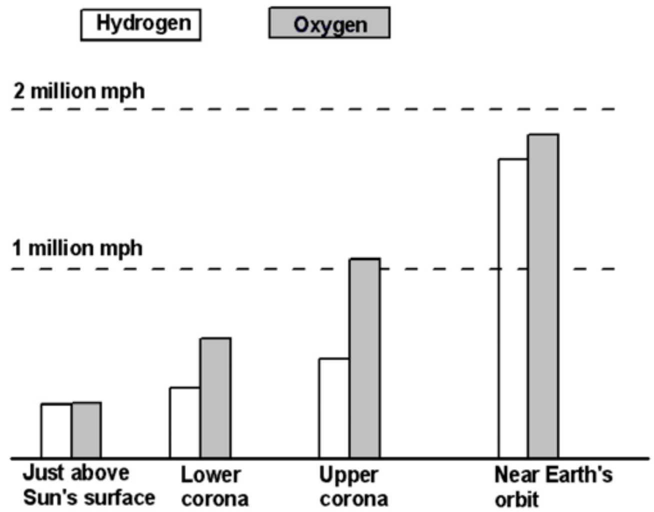

Fig. 11. Chart of ion velocities in the solar wind. From D. Scott, **The Electric Sky**.

The first problem is that even the more normal ranges of solar wind velocities are beyond the reach of any model. The "typical" coronal mass ejection (CME) will reach Earth in perhaps 24 hours. But an acid test of the nuclear Sun came in January 2005, when a CME exploded from the Sun, to be accelerated so rapidly that it reached Earth in only 30 minutes, leading to what NASA scientists called "*the most intense proton storm in decades.*"

The protons reached the Earth at nearly one quarter the speed of light—a theory-busting testament to the electric Sun, the center of a heliospheric electric field.

18. The Sun's PNP Transistor

The three plots below, provided by Don Scott, show the energy, electric field strength, and charge density as a function of radial distance from the Sun's surface. But Scott goes further, drawing our attention to the fact that the three plots provide a stunning match to those of a pnp transistor, while explaining the extreme variability of the solar wind as well:

"In a transistor, the amplitude of the collector current (analogous to the drift of +ions in the solar wind toward the right) is easily controlled by raising and lowering the difference between the base and emitter voltages…If the Sun's voltage were to decrease slightly - say, because of an excessive flow of outgoing +ions - the voltage rise from point a to b in the energy diagram would increase in height and so reduce the solar wind (both the inward electron flow and the outward +ion flow) in a negative feedback effect....The transistor-like mechanism described above is certainly capable of causing these phenomena. The fusion model is at a complete loss to explain them. Transistor 'cutoff' is a process that is used in all digital circuits."

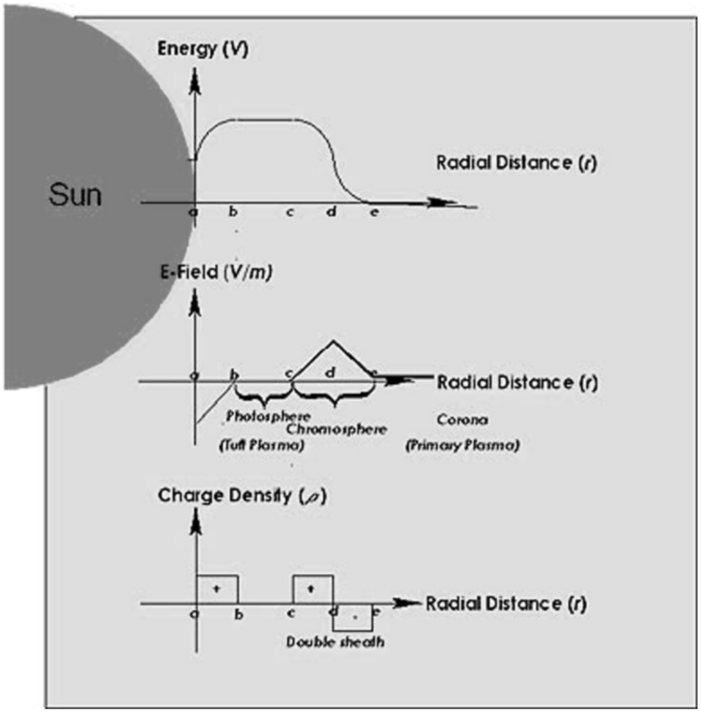

Fig. 12. Energy, electric field strength, and charge density as a function of radial distance from the Sun's surface. Illustration from Don Scott's book **The Electric Sky**.

Could it really be that simple? The answer is yes, since electric fields are the most efficient means of accelerating charged particles, and they are the *only* known way to accelerate charged particles up to the higher speeds of the solar wind.

19. Photospheric Granulation

One puzzle of the Sun is the "rice grain" appearance of its photosphere (below right), which gave rise to the phrase "photospheric granulation." Scientists now believe that each granule is the top of a "convection cell" because the opaque gases of the Sun, in the nuclear fusion model, need a mechanism for slowly transferring internal heat to the surface.

Immediately, problems arise with this interpretation. The gas density in the photosphere diminishes rapidly with height so that convection there should be completely turbulent. Instead, the granules seem to quietly appear, grow brighter for some minutes, then fade. As one proponent of standard theory concedes, "Convection remains the outstanding unsolved problem in photospheric physics." [18]

The statement confirms what Ralph Juergens wrote years earlier, "...photospheric granulation is explainable in terms of convection only if we disregard what we know about convection. Surely the cellular structure is not to be expected." Juergens proposed instead that "a [photospheric] granule may be viewed as a relatively dense, highly luminous, secondary plasma that springs into being in the embrace of a thinner, less luminous, primary plasma... We are led directly to ask whether the granules might not be akin to certain highly luminous tufts of discharge plasma variously described in the literature as anode glows, anode tufts, and anode arcs."

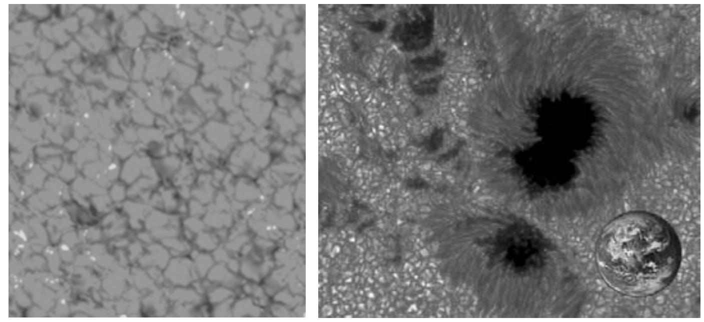

Fig. 13. On the left, surface granulation of the Sun. On the right, sunspots reveal the penumbra filaments beneath the surface "grains." Original Windows to the Universe artwork by Randy Russell using images from the Royal Swedish Academy of Sciences (sunspot image) and NASA (Earth image).

Anode tufts appear as bright spots above an anode surface and increase in number as the voltage and current is increased.

20. Photospheric "Lightning"

Juergens recognized the significance of Bruces's observations of the photosphere's lightning-like spectra and the similarities to the behavior of plasma discharge in arc mode. For Juergens, a key principle was the role of anode tufting, a unique electrical phenomenon.

Today's electrical theorist Don Scott takes up the subject of anode tufting in his book, **The Electric Sky**. It is necessary, he says, "to visualize the 'trap' (or pit) that each photospheric tuft is for incoming electrons. As the trap fills with electrons, the bottom of this inverted pit will rise, and so the tuft weakens, shrinks, and eventually disappears. This is the cause of the observed shrinkage and disappearance of photospheric granules." (p.99)

Of course it is important to remember that an electric sun must be driven by a heliospheric circuit that is itself powered by current flow along the arms of the Milky Way. Another tuft immediately replaces each disappearing tuft. That's the power of the heliiospheric electric circuit, maintaining the Sun's glow discharge.

Every year the dynamic activity of the photosphere raises more puzzles, while conventional solutions seem ever more elusive. Photospheric flares and chromospheric spicules leap upward with spectacular energies. But solar physicists long imagined that all of this activity was the result of convection as subsurface material, at temperatures of millions of degrees, blasted material upward into the photosphere, chromosphere, and corona.

Is it possible to confirm the electrical interpretation of solar prominences and flares, including coronal mass ejections, as first proposed by Charles Bruce in the early 1940s? Bruce's prescient observation in 1941 was that a solar prominence, reaching a million miles in a single hour, was roughly the rate of propagation of a lightning leader stroke. It was this observation that opened the path of Bruce's life's work, and inspired the explorations of the "electric sun" by Ralph Juergens [19].

The electrical interpretation of solar flares requires a powerful release of charge in the atmosphere *above* the surface. This consideration leads us to a more recent investigation by NASA's Peter Schuck who sought to determine "whether the eruptions are driven by energy surging through the sun's surface, or by the sudden release of energy that has slowly accumulated in the atmosphere."

"In some sense, the idea that energy from below triggers the eruption is the easiest explanation – like a geyser," says Schuck, a physicist who studies space weather at NASA's Goddard Space Flight Center in Greenbelt, Md. "But if the idea doesn't agree with what's observed, then it's wrong. End of story."

Schuck's research led him to conclude that the trigger does indeed occur in the sun's atmosphere. He found that the required velocities of the photospheric plasma, to blast the flares upward, would be a thousand kilometers per second, speeds that would be easily detected. What he saw instead "was a sudden explosion triggered from above, *more like lightning*."

And yet, in NASA's official comments on the study (November 18, 2010), notice how the momentum of ideology reared its head: "Either way, the energy originally comes from the surface."

21. Sunspot Enigmas

Sunspots underscore the profound enigmas for the thermonuclear model. Their darkness, structure, and behavior have required great ingenuity in attempts to explain them. The visible "granulation" seen at the Sun's surface is said to be "boiling gases" forced upward by million degree temperatures beneath the surface. As seen in the Sunspot image above, the margins of its dark regions reveal that the granules are the tops of rope-like structures rising from below. The thermonuclear model identifies these structures as the "convection currents" that the model requires.

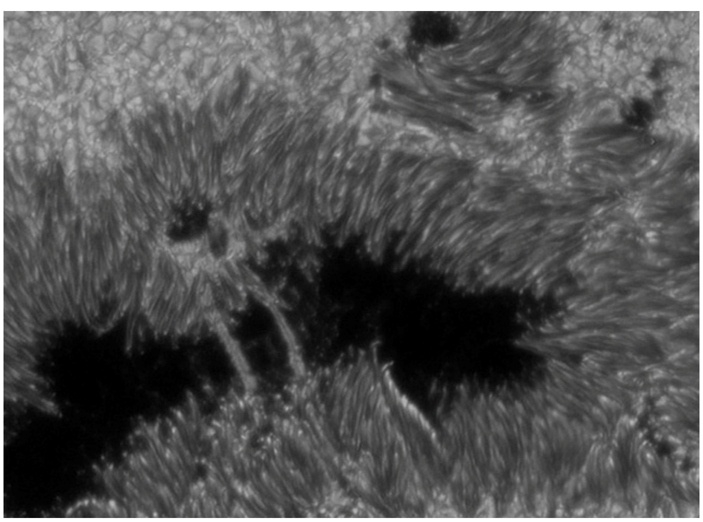

Fig. 14. The bridges seen reaching across this sunspot highlight the role of charge redistribution in a highly active region just beneath the surface. Credit: Swedish Solar Observatory.

But strangely, the dark umbra of the sunspot itself, a window to subsurface events, is cooler, at around 4000 K, compared to the photosphere temperature around 5700 K. This is claimed to be due to the strong magnetic field of the sunspot hiding the heat below, though the explanation requires that magnetic fields do something that magnetic fields are not known to do. Magnetic fields do not "conceal" extreme temperatures. But amazingly, solar physicists have yet to find, by peering into a sunspot, the slightest hint of the supposed extreme temperatures beneath the photosphere.

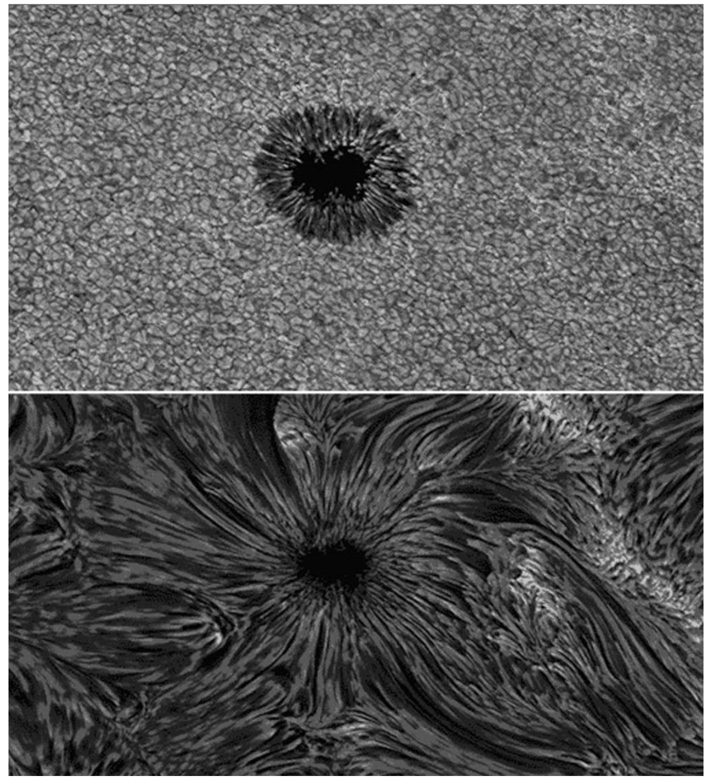

Fig. 15. Two views of a sunspot at different wavelengths. Upper image is in visible light; lower is in ultraviolet. Credit: Dutch Open Telescope/Sterrekundig Instituut Utrecht.

Seen above are two images of a single sunspot. The top image in visible light, shows the penumbral, vortex-like ropes, as they reach the surface of the photosphere. But to see the forces actually driving and configuring the sunspot penumbra one must step back (or "up") from the visible surface and follow the paths of the filamentary structures into the chromosphere above the surface. As seen in ultraviolet light, the "ropes" of the penumbra do not stop at the surface of the photosphere, but extend outward thousands of kilometers across the chromosphere to create a maze of filaments, all constrained by complex *magnetic fields*.

It was Hannes Alfvén, the father of modern plasma science, who advised astrophysicists that it is essential to understand electrical circuitry in order to comprehend the electrical behavior of plasma. The logical place to look for an explanation of photospheric granulation will be in the laboratory, through a detailed study of "anode tufting" in a low-pressure gas discharge.

22. Evidence First, Not Theoretical Assumptions

Limitations of space for this article prevent us from summarizing a couple dozen additional pointers to the electric nature of the Sun. The sunspot cycle, the very existence of the corona, an electrified torus around the solar equator, the relationship of this torus to sunspot appearance, distribution and behavior, relationship of the torus to the "ballerina skirt" of the Sun's current sheet, super rotation of the Sun's equatorial photospheric plasma, distribution of coronal holes, bi-polar jets, temperature and energy profiles of chromospheric spicules, and the so-called "open" magnetic field lines connecting the Sun to interstellar space—these and many other attributes must be brought into a broader investigation, permitting questions that have not been asked for at least 60 years.

Attention must extend to electrical activity evident across the entire domain of the Sun out to the heliospheric boundary and beyond to the interstellar plasma filaments on which stars are now observed to form. It will now be essential to give closer attention to the direction of discovery since the space age began, as the electrically neutral solar system gave way, one surprise at a time, to evidence for electric currents and associated magnetic fields in. An immense library of surprises, pointing consistently to electrical events, can hardly be accidental, and there can no longer be any reason to cling to theories held in place by nothing more than inertial.

With this in mind, the following papers presented by "electric universe" proponents to this 18th conference of the NPA, can be viewed in the light of a more unified ground floor for considering not just the electric Sun, but the many fields of investigation opened up by this new perspective.

- *Star formation*. In the 2011 John Chappell paper and lecture, **Wallace Thornhill** reviews persistent mysteries of star formation and offers an interpretation of the newly revealed connection of the Sun to the flow of galactic currents [20].
- *Guide for newcomers*. **Tom Findlay** offers a first look at elementary principles easily grasped by lay people, but with potentially huge effects on scientific understanding [21].
- *Essential guide*. **Jim Johnson**, the managing editor of the forthcoming "Essential Guide to the Electric Universe," discusses the core science of the Guide. What is the connection between plasma behavior in the laboratory and the new understanding of electricity in space? [22]
- *Electric currents from the Sun*. **Michael Gmirkin** tales up "The Earth-Sun Connection," underscoring the electrical component. His paper also questions theoretical assumptions established long before astronomers discovered electric currents in space [23].
- *Saturn's hexagon*. Saturn's electrified hexagon is the topic of a paper by **Tim Erney**, who suggests that answer lies in a pinched plasma column aligned with Saturn's magnetic axis and coupled to the conductive upper atmosphere [24].
- *The speed of light*. Perhaps no question is more fundamental to the theoretical sciences than the speed of light. In his reconsideration of the question, **Robert Johnson** shows that the speed of light is apparently effected by the strength of electromagnetic fields [25].
- *Hidden history of plasma science*. How could mainstream theorists have ignored the story of space plasma and electricity for a century or more. That's the question posed by linguist **Rens van der Sluijs**, co-author of more than one scientific paper with the leading plasma physicist Anthony Peratt [26].
- *Swimming in electric currents*. In a second presentation, **David Talbott** considers electrical events now occurring on planets and moons,illustrating the role of complex currents and magnetic fields across the heliosphere.
- *The comet Venus*. An issue of solar system history almost entirely ignored today is the subject of a paper by **Ev Cochrane**. Why did the early cultures envision the planet Venus as a comet-like body in the heavens? [27]
- *Earth's primeval polar heat*. **Dwardu Cardona** discusses numerous contradictions in attempts to understand the ancient polar conditions through standard models of solar system evolution [28].
- *A new approach to mountain building*. Unanswered questions about mountain formation are the subject of a paper by **Michael Steinbacher**, who has gathered evidence for intense electric winds and dune-like formations on a "mountainous" scale [29].
- *Paradigm lost, paradigm found*. **Nicholas Sykes** discusses the educational challenges posed by the Electric Universe, seeing these challenges in terms of new opportunities for "paradigm renewal." [30]

References

[1] Carl-Gunne Fälthammar, "Plasma Physics from Laboratory to Cosmos—The Life and Achievements of Hannes Alfvén," *IEEE Trans. Plasma Sci.* **25** (3): 409-414 (June 1997); Eric Lerner, **The Big Bang Never Happened** (Vintage, 1991); "Pioneers in the Development of the Plasma Universe", http://plasmauniverse.info/people/history.html.

[2] Wallace Thornhill & David Talbott, **The Electric Universe**, pp. 55ff. (Portland: Mikamar Publishing, 2007), pp. 55ff.

[3] Hannes Alfvén, N. Herlofson,"Cosmic Radiation and Radio Stars," *Physical Review* **78** (5): 616 (1950).

[4] W. T. Sullivan, Ed., **The Early Years of Radio Astronomy: Reflections Fifty Years After Jansky's Discovery** (Cambridge University Press, 2005).

[5] Anthony Peratt, **Physics of the Plasma Universe** (Springer-Verlag, 1992).

[6] Eward S. Holden, **Sir William Herschel: His Life and Works**, p. 212 (New York, 1881).

[7] Hans A. Bethe, **Selected Works of Hans A. Bethe: with Commentary**, pp. 355ff (World Scientific Publishing, Singapore, 1997).

[8] Kyle Kirkland, **Physical Sciences: Notable Research and Discoveries**, p. 1 (New York, 2010).

[9] Thornhill & Talbott, op.cit., pp. 53ff.

[10] Donald E. Scott, **The Electric Sky** (Portland: Mikamar Publishing, 2006).

[11] Michael Moyer, "Fusion's False Dawn", *Scientific American* (March 2010).

[12] http://www.catastrophism.com/texts/bruce/.

[13] Ralph Juergens, "Reconciling Celestial Mechanics and Velikovskian Catastrophism", *Pensée* (Fall, 1972).

[14] M. Fligge, et al, "Variations of Solar Spectral Irradiance from Near UV to the Infrared: Measurments and Results", *J. of Atmospheric and Solar–Terrestrial Physics* **63** (14): 1479-1487 (Sep 2001), http://www.sciencedirect.com/science/article/pii/S1364682601000207.

[15] Tom Woods, "Solar Irradiance Variability Observed During Solar Cycle 23", presentation, http://solar.physics.montana.edu/SVECSE2008/pdf/woods_svecse.pdf.

[16] R. L. F. Boyd, **Space Physics: the Study of Plasmas in Space** (Oxford University Press, 1975); cited by Wal Thornhill, http://www.holoscience.com/news.php?article=x49g6gsf.

[17] From an interviews in the National Geographic Channel documentary, "Easter Island Eclipse" (2010).

[18] L. S. Anderson & E. H. Avrett, "The Photosphere as a Radiative Boundary", in A. Cox, W. C. Livingston, M. S. Matthews, Eds., **Solar Interior and Atmosphere**, p. 671 (U. of Arizona Press, 1991).

[19] C. E. R. Bruce, "Successful Predictions of the Electrical Discharge Theory of Cosmic Atmospheric Phenomena and Universal Evolution," Electrical Research Association Report 5275 (1968), http://www.catastrophism.com/texts/bruce/era.htm.

[20] Wallace Thornhill, "Galaxies and Stars in an Electric Universe (2011 John Chappell Memorial Lecture)", *Proceeding of the NPA* **8**, this volume (2011).

[21] Thomas Findlay, "Introductory Guide to the Electric Universe", *Proceeding of the NPA* **8**, this volume (2011).

[22] Jim Johnson, "The Essential Guide to the Electric Universe", *Proceeding of the NPA* **8**, this volume (2011).

[23] Michael Gmirkin, "The Sun-Earth Connection (and Other Considerations)", *Proceeding of the NPA* **8**, this volume (2011).

[24] Tim Erney, "The Drift-Alfvén Model for a Magnetized Plasma Applied to Saturn's Polar Vortices", *Proceeding of the NPA* **8**, this volume (2011).

[25] Robert Johnson, "Evidence for the Anisotropy of the Speed of Light", *Proceeding of the NPA* **8**, this volume (2011).

[26] Rens van der Sluijs, "Towards a History of Plasma-Universe Theory", *Proceeding of the NPA* **8**, this volume (2011).

[27] Ev Cochrane, "Ancient Testimony for a Comet-like Venus", *Proceeding of the NPA* **8**, this volume (2011).

[28] Dwardu Cardona, "Earth's Primeval Polar Heat", *Proceeding of the NPA* **8**, this volume (2011).

[29] Michael Steinbacher, "A New Approach to Mountain Formation", *Proceeding of the NPA* **8**, this volume (2011).

[30] Nicholas J. G. Sykes, "The Paradigm of the Electric Universe", *Proceeding of the NPA* **8**, this volume (2011).