

Toward a Real Cosmology in the 21st Century

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Abstract: A real cosmology must be a broad and coherent *natural philosophy*. It may always be incomplete, based on our limitations, but to be valid there can be *no exceptions* in our experience. In particular, cosmology must address issues of life and the human condition. 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 while it 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*."

Keywords: Natural philosophy, Big Bang cosmology, plasma cosmology, electric universe cosmology, cosmic microwave background, discordant redshift, electric star, red giant, white dwarf, supernova.

1. REMARKS ON THE STATE OF COSMOLOGY

The discarding of an old prejudice and the cultivation of a new outlook are not matters that can be completed in a moment. One first catches a glimpse of a new way of regarding things, and begins to see a few outstanding features of his surroundings in a new light. But he does not immediately realise that the whole scene has been transformed. Deep-seated beliefs remain, incompatible with the new outlook though they may be, and only gradually begin to take on a strange appearance and arouse misgivings. —Herbert Dingle, Astronomer Royal [1].

Cosmology is defined as the study of the origin, history, structure and dynamics of the universe. As such it provides a global context for both our science and culture so that cosmology is sometimes called 'the queen of the sciences.' To live up to this title, cosmology must be a broad and coherent natural philosophy since to be valid there can be *no exceptions* based on all of our experience. In particular, cosmology *must* address issues of life and the human condition. So cosmology must be a truly interdisciplinary pursuit. Modern specialized science is a hostile environment for such a quest. Stephen Hawking epitomizes the problem when he confidently asserts, "*philosophy is dead*" [2]. Specialized mathematical theorists have usurped cosmology. It is one field where imagination reigns unchecked by principles, epistemology, observation or commonsense. A philosopher retorts to Hawking, "*These thinkers appear unworried—blithely*

unfazed, one is tempted to say – by the fact that their theories are incapable of proof or confirmation, or indeed of falsification as required by Karl Popper and his followers. After all, it is the peculiar feature of such theories that they posit the existence of that which at present, and perhaps forever, eludes any form of confirmation by observation or experiment" [3]. If natural philosophers are no longer in the vanguard of cosmology perhaps it is because there is no advantage in being the leaders in a rush to nowhere. "*Who, indeed, are we as a species to dare ask such mighty questions as concern the origin of the universe and in unique arrogance believe we may have the correct answer within cosmic microseconds of the asking*" [4]. Despite the media hoopla, there is no *real* cosmology at the beginning of the 21st century.

There are major issues that must be addressed. The biologist Rupert Sheldrake has carried out experiments that confront our mechanistic view of biology. His commentary applies particularly to cosmology:

"It is interesting that the roots of the 17th-century mechanistic world view can be found in ancient mystical religion. Indeed, the mechanistic view was a synthesis of two traditions of thought, both of which were based on the mystical insight that reality is timeless and changeless. One of these traditions stems from Pythagoras and Plato, who were both fascinated by the eternal truths of mathematics. In the 17th century, this evolved into a view that nature was governed by timeless ideas, proportions, principles, or laws that existed within the mind of God. This world view became dominant and, through philosophers and scientists such as Copernicus, Kepler, Descartes, Galileo and Newton, it was incorporated into the foundations of modern physics.

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Basically, they expressed the idea that numbers, proportions, equations, and mathematical principles are more real than the physical world we experience. Even today, many mathematicians incline toward this kind of Pythagorean or Platonic mysticism. They think of the physical world as a reification of mathematical principles, as a reflection of eternal numerical mathematical laws. This view is alien to the thinking of most of us, who view the physical world as the “real” world and consider mathematical equations a man-made, and possibly inaccurate, description of that “real” world. Nevertheless, this mystical view has evolved into the currently predominant scientific viewpoint that nature is governed by eternal, changeless, immutable, omnipresent laws. The laws of nature are everywhere and always” [5].

The dominant belief in immutable, universal mathematical laws keeps us in the dark, as witness the reification of hypothetical mathematical constructs like ‘dark matter,’ ‘dark energy’ and ‘black holes.’ In the words attributed to Artemus Ward: “The researches of many eminent scientific men have thrown so much darkness upon the subject, that if they continue their researches we shall soon know nothing.” Mathematics may describe observed behavior but it cannot explain it. Having mathematical laws of physics does not equate with understanding of those laws. They may require redefinition with better understanding. For example, we have a cosmology built upon equations for gravity and quantum mechanics but with no real explanation for either. The words of the Astronomer Royal, Herbert Dingle, in 1951 still apply to cosmologists today:

“...they were completely deceived about the extent and nature of their achievements. They thought they were approaching the end of their task of discovering the causal laws that governed the world of material substance: actually they were at little more than the beginning of their task of understanding the world of experience. Thinking they knew almost everything, they in fact knew next to nothing” [1].

Considering the brief history of our science the notion that we know the universe’s origin would seem to indicate not that we are so advanced but that we are unable to abide the essential mystery of creation. For the Big Bang hypothesis requires a miracle of creation less than a nanosecond before its narrative can commence. It is an example of “that curious relief from an unfathomable mystery which comes from ascribing it to another one” [1]. It seems there is a human need for a creation story, together with its priesthood, to feign mastery of the universe and to ease our existential angst. Our Big Bang cosmology is merely another creation myth, a miraculous story with a beginning, middle and a predicted end. It is attractive because it is familiar, having been based on biblical tradition, and doesn’t take much thought.

However, the Big Bang is ideology and not science. Science welcomes refutation and the unknown while Big Bang adherents exhibit the same disregard of contrary evidence and religious intolerance of dissent, as do fundamentalist believers in other creation myths. “The common ancestor of religion and science is ignorance” [6] and Big Bang cosmology has not yet evolved beyond a belief system. The Templeton Foundation [7] gives prizes more valuable than the Nobel Prize to reconcile science and religion. There is no

need. They haven’t yet separated. That can only occur when cosmology can explain coherently and scientifically the origin of human myth and religions, which logically have nothing to say about the creation of the universe but much to tell about mankind’s earliest memories of terrifying events in the prehistoric heavens. It requires an interdisciplinary forensic investigation technique, which is not taught in any university. But it is only from investigating *all* human experience, particularly the meaning of capricious, battling celestial ‘gods’ hurling thunderbolts in the heavens, that a panorama opens on the human situation on this fragile blue planet and we comprehend our ‘doomsday’ fear and religious longing for the reestablishment of ‘paradise on Earth.’ From such an understanding a real cosmology must begin if it is to have any relevance for us.

2. BIG BANG COSMOLOGY

While advancing technology provides a deluge of new information and surprises about the cosmos, our understanding of the universe has stalled for at least a century. More thoughtful scientists are beginning to express frustration about the lack of breakthroughs in fundamental physics while the technology around them seems to advance at a faster pace every day. It can be argued that the problems stem from modern education, which no longer fosters “*desire and pursuit of the whole*” but rather a narrow prescribed expertise devoid of historical context. The selection of earlier ‘giants’ whose shoulders we must stand on is predetermined and unquestioned. But standing on someone else’s shoulders does not make us taller. The debates and politics that surrounded the consensus that raised those ‘giants’ to their exalted status are lost in the myth-making. We must worship the sainted geniuses our forefathers chose for us. Questioning the ‘laws,’ the contradictions and misleading language of science is discouraged. Yet educators are surprised by the growing disinterest in science. Perhaps it is because Big Bang cosmology has nothing to offer about life and the human condition. Instead, our cosmology is a bizarre narrative of miracles, chance, isolation and the hopelessness of eventual total darkness or a return to a cauldron of rebirth. This claim may seem harsh but the clamour of dissent is rising. Sir Fred Hoyle, who coined the dismissive name “Big Bang” maintained a healthy skepticism throughout his career:

“Big-bang cosmology is a form of religious fundamentalism, as is the furor over black holes, and this is why these peculiar states of mind have flourished so strongly over the past quarter century. It is in the nature of fundamentalism that it should contain a powerful streak of irrationality and that it should not relate, in a verifiable, practical way, to the everyday world. It is also necessary for a fundamentalist belief that it should permit the emergence of gurus, whose pronouncements can be widely reported and pondered on endlessly—endlessly for the reason that they contain nothing of substance, so that it would take an eternity of time to distil even one drop of sense from them. Big-bang cosmology refers to an epoch that cannot be reached by any form of astronomy, and, in more than two decades, it has not produced a single successful prediction” [8].

Thanks to Einstein’s promoters, Big Bang cosmology has become an exercise in geometric metaphysics and computerized ‘virtual reality,’ with its practitioners vying for attention

with the most bizarre confabulations. It began by wedding the distinctly different concepts of time and space into a 'fourth dimension.' "Henceforth space by itself, and time by itself, are doomed to fade away into mere shadows, and only a kind of union of the two will preserve an independent reality" [9]. There is an unconscious irony in the use of the word 'reality' in such a context. If time is a dimension, point me in the direction of time! Meaningless statements such as "Gravitational waves are ripples in the fabric of space and time and are an important consequence of Einstein's general theory of relativity," [10] epitomize the imaginary nature of theoretical physics. What material object is 'the fabric of space-time' and how does matter cause it to 'ripple?' Those who do not learn from history are doomed to repeat it. We have returned full circle to the Pythagoreans with their inner circle of 'mathematikoi.' The Big Bang hypothesis is no better than the two thousand year old Ptolemaic model of the cosmos, with the Earth at the center of everything and ad hoc epicycles added as necessary to preserve a geometric model.

The 'epicycles' being added to the Big Bang are physically absurd. For instance, consider the invention of 'dark matter' that responds to gravity but is electromagnetically undetectable. Matter is an electromagnetic phenomenon, so how is this possible? More recently, 'dark energy' has been added because observations interpreted by means of the Big Bang hypothesis suggest that the universe is not merely expanding but the expansion is accelerating. Ignoring the absurdity of having all of the matter in the universe expanding from a non-physical point, perhaps the wildest epicycle is that of 'inflation' following the inexplicable creation event. Inflation is the doubling in size of the universe about one hundred times in 10^{-35} second! Inflation was invented merely to satisfy mismatches of mathematical theory with observations. The Big Bang is, by scientific standards, an execrable hypothesis that is not predictive and defies the principles of physics and common sense.

The burst of energy from the Big Bang fireball is supposed to have cooled until it formed the relic 'cosmic microwave background radiation (CMBR),' coming to us from the edge of the expanding universe, which 'edge' is itself a purely abstract concept. What is on the 'other side' if it is not part of the universe? There cannot be an edge, or a beginning to the universe, based on our current understanding (nor can there be 'multiverses'). Even so, it is claimed that the Big Bang has been proven. For example, an event in 1991 distinguished by the 2006 Nobel Prize in physics was the alleged proof of the nature of the CMBR. The prize was shared between John C. Mather and George F. Smoot "for their discovery of the blackbody form and anisotropy of the cosmic microwave background [CMB] radiation" in the Cosmic Background Explorer [COBE] project. They announced in 1992 the discovery of residual heat from the Big Bang, as well as minute variations in temperature across the sky that are believed to indicate the beginning of structure in the early universe that was essential for matter to gravitate into galaxies and clusters of galaxies. Such variations are crucial in the Big Bang hypothesis, otherwise the universe would be filled with a diffuse gas of hydrogen and helium and not galaxies and stars. The British mathematical physicist Stephen Hawking said the results from COBE were "the greatest discovery of the century, if not all times." The Nobel Prize

jury said in its citation, "These measurements... marked the inception of cosmology as a precise science." Dr. Smoot said, "Those measurements really confirmed our picture of the Big Bang... Human beings have had the audacity to conceive a theory of creation and now, we are able to test that theory... If you are religious, it is like looking at God." The irony is breathtaking. Big Bang cosmology is neither precise nor science. It is a pseudo-religion. No alternative, like a local origin for the microwave background radiation, was entertained. History had been rewritten to omit any mention of the accurate predictions by earlier authors based on a universe in equilibrium. Instead the credit was given to George Gamow, a Big Bang advocate, despite his calculated CMBR temperature of 50K! [11]. That is an error in energy density of the universe of 10,000 times! It seems the human imperative for a creation myth trumps the scientific method in cosmology and is itself worthy of psychological study.

Long before the reported discovery of the CMBR, Sir Arthur Eddington estimated the temperature a body in space would cool to if all of the energy it received were from starlight within the galaxy. He found it to be 3.18 degrees Kelvin (3.18K) [12]. André Assis noted, "Guillaume had obtained a similar figure 30 years earlier. Although Eddington did not quote Guillaume or any other author, it is clear that he was here following someone's else derivation" [13]. Later, Regener calculated the temperature of a body heated by cosmic rays in starless intergalactic space to arrive at 2.8K [14]. The blackbody temperature of microwave background radiation measured today is 2.725K. It remains to be established whether that radiation is cosmic or local. The shadowing effect expected from concentrations of nearby galaxies has not been found. One expert has called into question both the theory and experimental detection of the CMBR. "...it appears that many of the devices used as emissivity references on satellites and in the laboratory are inaccurate. They are simply unable to provide the emissivity believed to exist using return-loss measurements. This is a significant scientific oversight which affects the monitoring of global climate change and the microwave background" [15]. If he is correct, the results from the recent Wilkinson Microwave Anisotropy Probe (WMAP), which was designed to map the CMBR, may not be as claimed.

Strictly, theories are hypotheses that have been tested and found valid. So technically, the Big Bang was never a theory. It is a hypothesis that ignores the physics principle that prohibits creation from nothing. All of the matter and energy in the Big Bang universe came from a 'singularity,' which is a fancy word for 'we know not what.' As a result, the hypothesis is magical and non-predictive. When it was calculated that there was not enough time to synthesize all of the helium we observe during the age of the Big Bang universe, a burst of energy was added and the mass density of neutrons and protons fudged to make things come out right. As Geoffrey Burbidge noted, "This is why the Big Bang theory cannot be claimed to explain the microwave background or to explain a cosmic helium value close to 0.25" [16]. The astronomer Tom Van Flandern documented "The Top 30 Problems with the Big Bang." He wrote, "Perhaps never in the history of science has so much quality evidence accumulated against a model so widely accepted within a field" [17]. Yet exponents of the Big Bang turn logic on its head and claim

the microwave background and the helium abundance as proof of their hypothesis!

The Big Bang hypothesis is a highly adjustable model for which supporters claim success after failing tests. The lack of detection of gravitational waves [18] and dark matter [19] are proclaimed to vindicate the quest and requests for more funding! Outrageous statements such as “*Pulsars are almost perfect spheres made up of neutrons and contain more mass than the sun in an object only 10 km in radius*” are presented as facts with no empirical support other than a complex, rapidly pulsating signal. Meanwhile, plasma scientists have been able to model such complex signals as transmission line oscillations in a normal stellar magnetosphere, triggered by arc discharges. Their results “*support the 'planetary magnetosphere' view where the extent of the magnetosphere, not emission points on a rotating surface, determines the pulsar emission*” [20]. But cosmologists, by introducing ad hoc ‘facts’ and rewriting history, give the false impression that there is no serious dissent or alternative ideas on offer. Myth has become history so that science history has become myth. Science has become a didactic monologue rather than a fruitful dialogue. Future historians of science will judge this era a scientific dark age of “*created myths, fantasies, and therefore a fallacious teaching of physics*” [21].

3. DISCORDANT REDSHIFT

Michael Turner, a cosmologist at the University of Chicago, likes to say, “*We know much, but we understand little,*” which reminds me of Josh Billings’ aphorism, “*It ain’t so much the things we don’t know that get us into trouble. It’s the things we know that just ain’t so.*” For example, it is ‘known’ that the redshift of the spectrum of faint extragalactic objects is proof that the universe is expanding. Now called the ‘Hubble expansion’ it is the central pillar supporting the Big Bang hypothesis. Yet Hubble himself sternly advised against interpreting redshift as a Doppler effect due solely to recessional velocity of galaxies. He convinced Robert Millikan (the 1923 recipient of the Nobel Prize for Physics and director of physics at Caltech) the year before both of their deaths in 1953 that the redshift interpretation as an expansion of the universe was probably wrong. On this question too, history has been rewritten and the ‘Hubble expansion of the universe’ is stated routinely as an observational fact. The astronomer Halton Arp, early in his career, conducted Hubble’s nova search in M31. For 28 years Arp was staff astronomer at the Mt. Palomar and Mt. Wilson observatories. While there, he produced his well-known Catalog of Peculiar Galaxies, which inventories galaxies that are disturbed or irregular in appearance. He found numerous physical associations of highly redshifted quasars with low redshift galaxies. At a stroke it confirmed Hubble’s view that “*...on the basis of the evidence now available, a choice seems to be presented, as once before in the days of Copernicus, between a small, finite universe, and a sensibly infinite universe plus a new principle of nature. And, as before, the choice may be determined by the attribute of simplicity*” [22].

Amy Acheson later wrote in 2003, “*The disproof of the Big Bang is already nearly 40 years old. Halton Arp’s first*

major paper on discordant redshifts [“Companion Galaxies on the Ends of Spiral Arms”] was submitted to The Astrophysical Journal in 1966, at a time when he had just finished his Atlas of Peculiar Galaxies and was listed by the Association of Astronomical Professionals as ‘most outstanding young astronomer’ and among the top 20 astronomers in the world. The editor, Chandrasekhar, rejected that paper because of its subject, without even being submitted to peer review.” He scribbled across the top of the paper, “*This exceeds my imagination.*” That may be. However, it is not a valid reason for rejecting a paper. It says more about human limitations. Imagination is vital to scientific progress. It is more likely that the consequences for the reputations of leading astronomers were un-imaginable if he accepted Arp’s paper. Chandrasekhar returned it to Horace Babcock, the Director of Arp’s Institute. Bowing to the pressure, Babcock called for Arp’s resignation verbally but didn’t put it in writing. Instead, the telescope time allocation committee wrote to Arp, “*The committee feels that it is no longer reasonable to assign Arp to pursue researches aimed at establishing the association of quasars with nearby galaxies.*” Arp was squeezed out of his Palomar telescope assignment because the allotment committee would not permit telescope time to a project that threatened Big Bang ideology!

Concerning M87, 2C273, and M49, one of several aligned configurations discussed in that first paper, Arp later wrote, “*It is incomprehensible to me how the field could have gone on believing quasars were at their redshift distances after even this one single result. More than 30 years ago astronomy took a gamble, against odds of a million to one, that this observation was an accident*” [23]. Amy Acheson was not the only one to have sounded a warning. Carl Sagan wrote, “*If Arp is right, the exotic mechanisms proposed to explain the energy source of the distant quasars—supernova chain reactions, super-massive black holes and the like—would be unnecessary. Quasars need not then be very distant*” [24].

On May 22, 2004 New Scientist published an ‘Open Letter to the Scientific Community.’ Hundreds of researchers around the globe had signed it. The letter notes: “*the Big Bang theory can boast of no quantitative predictions that have subsequently been validated by observation. The successes claimed by the theory’s supporters consist of its ability to retrospectively fit observations with a steadily increasing array of adjustable parameters, just as the old Earth-centered cosmology of Ptolemy needed layer upon layer of epicycles.*”

The open letter led to a conference, ‘Crisis in Cosmology: Challenging Observations and the Quest for a New Picture of the Universe,’ held in Portugal in June 2005. Its stated aim was to “*consider the present state of understanding of the universe in the light of the increasing number of observations that challenge the conventional cosmological model. Participants will address observations such as the non-Gaussianity of the CMB, the excessive apparent ages of high-z galaxies, discrepancies in dark matter observations, the early formation of large-scale structure, the increasingly discordant results for light element abundances, the angular-size/redshift relation, and others.*”

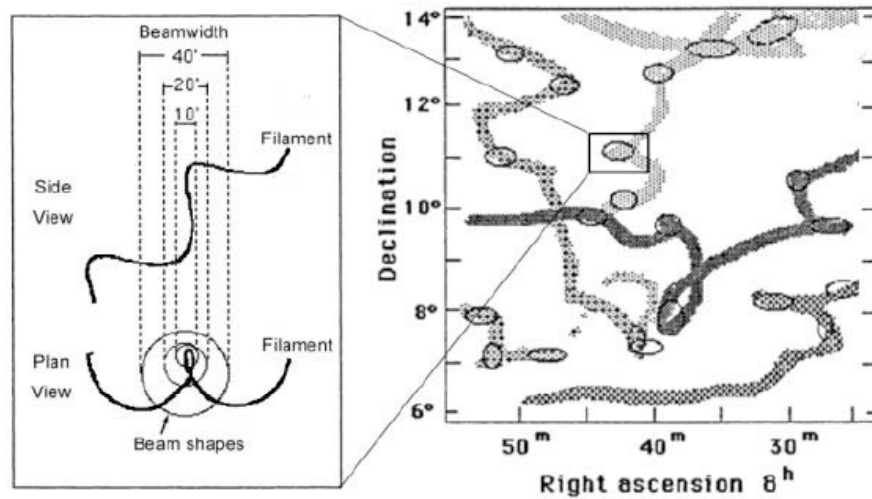


Fig. (1). Neutral hydrogen filaments at high galactic latitudes.

4. WHAT IS THE MICROWAVE BACKGROUND RADIATION?

If Arp and others are right and the Big Bang is dead, what does the Cosmic Microwave Background Radiation signify? The simplest answer, from the highly successful field of plasma cosmology, is that it represents the natural microwave radiation from electric current filaments in interstellar plasma local to the Sun. "A simple, inhomogeneous model of such an absorbing medium can reproduce both the isotropy and spectrum of the CBR within the limits observed by COBE, and in fact gives a better fit to the spectrum observations than does a pure blackbody" [25]. Radio astronomers have mapped the interstellar neutral hydrogen (HI) filaments by using long wavelength receivers. The dense thicket formed by those filaments produces a perfect fog of microwave radiation. Instead of the *Cosmic Microwave Background*, it carries the imprint of the *Local Interstellar Microwave Background*. That makes sense of the fact that the CMBR is too smooth to account for the lumpiness of galaxies and galactic clusters in the universe. We cannot 'see' them through the local microwave fog. Fred Hoyle wrote of the CMBR, "A man who falls asleep on the top of a mountain and who awakes in a fog does not think he is looking at the origin of the Universe. He thinks he is in a fog" [23].

Ironically for the Nobel jury, the death notice for the Big Bang may have been provided by the WMAP project. The microwave signals are claimed to "pinpoint when the first stars formed and provide new clues about events that transpired in the first trillionth of a second of the universe." But all filamentary plasmas generate microwaves. The radio astronomer Gerrit Verschuur asked, "do those signals truly reveal the fingerprints of processes that took place shortly after the universe was born? Upon closer inspection, certain features in the WMAP maps look hauntingly familiar to those who have spent their careers studying the HI [neutral hydrogen] structure and radio emission from the Milky Way galaxy" [26].

This more plausible possibility should have been headline news. However, the established institutions of astronomy recognized the threat and quickly mobilized their opposition. New Scientist picked it up under the contrary head-

line, "Big-bang satellite data 'not flawed'" [27]. A co-author of a critical paper [28] was reported as saying, "If the correlation he [Verschuur] claimed was true then this would be major news. I would be surprised if such a big effect which Verschuur claims would escape the WMAP team anyway, but nevertheless, it is worth testing. What we found is what is expected, that there is no correlation between these two maps." Of course, the statistical test was not designed so that it would find Verschuur's correlation, where the WMAP peaks are predictably offset from the 21-cm radio peaks. Most astrophysicists are ignorant of the real electromagnetic activity of space plasma, which is far more complex than the 'magnetized fluid' (MHD) theory of plasma behavior they are trained to employ. MHD theory is mathematically attractive but applies only in dense plasma, a fact that has crippled fusion research for decades.

In 2000 Verschuur, with leading plasma physicist Anthony Peratt, used the concept of critical ionization velocity (CIV), first introduced by Alfvén, to explain neutral hydrogen (HI) emission from gas in the local interstellar environment. "An effective means for producing CIV in interstellar space involves the relatively little known plasma phenomenon in space called the Marklund convection mechanism" [29].

The authors conclude, "a striking coincidence has been discovered between radiotelescope measurements of HI emission linewidths in the vicinity of interstellar neutral hydrogen filaments at high galactic latitudes and the critical ionization velocities of the most abundant atomic species in interstellar space, thereby revealing nature's signature of CIV" [30].

Fig. (1) is an adaptation of Verschuur's *Neutral Hydrogen Filaments at High Galactic Latitudes* [31]. The HI plasma filaments are formed by the scavenging action of interstellar Birkeland currents flowing in our galaxy. Seen from Earth the filament twists gives the misleading impression of a puzzling HI 'cloud' seen as an 'enhanced emission feature' (EEF) in the 21-cm radio telescope beam. The closed ellipses in the right-hand schematic are EEFs where the filament orientation twists away from the plane of the sky. Verschuur concludes that "...much of what is observed to be 'cloud' structure in the interstellar medium is telling us

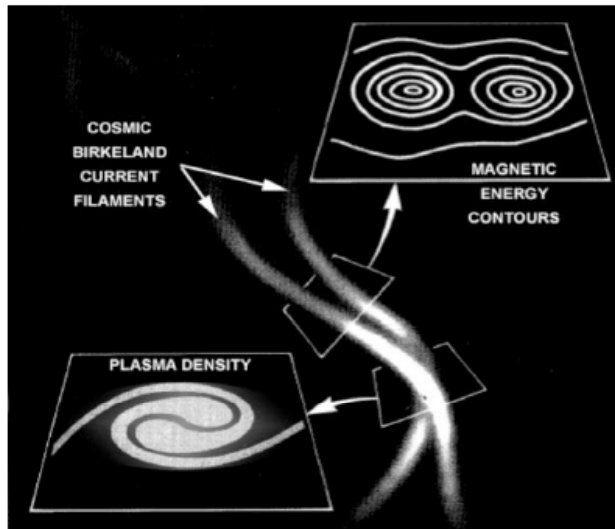


Fig. (2). Plasma galaxy formation.

about geometry of filaments and not about the physics of ‘clouds.’”

When the higher resolution WMAP results were published, Verschuur’s predicted offsets of the WMAP hotspots from the EEFs were supported. He modestly concluded, “...it may be difficult to rule out the possibility that some if not all of the small-scale structure usually attributed to the cosmic microwave background may have a galactic origin” [32]. If cosmologists sought refutation this research should be top priority. If the CMBR is local radiation a fundamental prop is removed from the Big Bang.

An example of the disconnection between astrophysicists’ ‘magnetohydrodynamic’ (MHD) view of plasma and electrodynamic plasma science occurred recently. Electrons trapped in Birkeland current filaments are forced to spiral in the magnetic field and emit synchrotron radiation. It is significant therefore that there is an unaccountable non-blackbody peak in the CMB spectrum. Such a signal was discovered accidentally while scanning the skies in July 2006 with a set of sensitive radio receivers called ARCADE (Absolute Radiometer for Cosmology, Astrophysics and Diffuse Emission) lofted 21 miles high on a balloon. NASA reported the remarks of Alan Kogut, team leader of the ARCADE experiment [33]. “The universe really threw us a curve,” Kogut says. “Instead of the faint signal we hoped to find, here was this booming noise six times louder than anyone had predicted.” The problem is that there don’t appear to be enough radio galaxies to account for the signal ARCADE detected. “You’d have to pack them into the universe like sardines,” said Dale Fixsen of the University of Maryland at College Park. Detailed analysis ruled out an origin from primordial stars or from known radio sources, including gas in the outermost halo of our own galaxy. “The source of this cosmic radio background remains a mystery.” It may not be a mystery when electrical currents in local interstellar plasma are recognized.

5. PLASMA COSMOLOGY

On the cosmological scale this brings us to the subject of plasma cosmology [34], a laboratory-testable *theory* that is not taught to students of astronomy, while it is recognized by

the world’s largest professional body, the Institute for Electrical and Electronic Engineers (IEEE). Verschuur is perhaps the only astronomer who attends IEEE Space Plasma conferences and consequently could see the significance of his discovery of the slight offsets between some WMAP ‘hot spots’ and the interface between interacting neutral hydrogen (HI) filaments in local interstellar space.

Historically, the only noteworthy challenge to the Big Bang hypothesis was the ‘Steady State,’ or ‘Continuous Creation’ hypothesis, developed by Fred Hoyle, Thomas Gold, Hermann Bondi and others. Although more appealing to commonsense than the Big Bang, it too fails by invoking creation of matter and accepting the metaphysical notion that space can expand. These two faults alone are sufficient to reduce the field of modern cosmological theories to perhaps one—plasma cosmology.

“Space is filled with a network of currents which transfer energy and momentum over large or very large distances. The currents often pinch to filamentary or surface currents. The latter are likely to give space, as also interstellar and intergalactic space, a cellular structure”. —Hannes Alfvén.

The scandalous truth is that there is a model of spiral galaxy formation (Fig. 2) that has long been demonstrated by laboratory experiment and ‘particle in cell’ (PIC) simulations on a supercomputer. But instead of using stars, gas and dust as the particles subject to Newton’s laws, the particles are charged and respond to Maxwell’s laws of electromagnetism. This seems like an obvious approach when we know that more than 99.99 percent of the visible universe is in the form of plasma. Most cosmic plasma is a gas influenced by the presence of free electrons, charged atoms and dust. Plasma responds to electromagnetic forces that exceed the strength of gravity to the extent that gravity can usually be ignored over interstellar distances. This simple fact alone suggests why gravitational models of galaxies fail.

The plasma universe may be eternal and infinite. Large scale field-aligned filaments may extend hundreds of megaparsecs or more in space. Where pairs of these spaghettilike structures interact, the particles gain kinetic energy and at narrow pinch regions produce the entire range of galaxy types as well as the full spectrum of electromagnetic radiation. Thus galaxies must lie along filaments, much as they are observed to do on a large scale [35].

The simplest geometry for galaxy formation is two adjacent Birkeland currents of width 35 kiloparsecs separated by 80 kiloparsecs. The interaction region, and hence the thickness of a galaxy is 10 kpc. By scaling the current flows in astronomical objects by size, it is determined that the average flow in a galactic Birkeland current is approximately 10^{19} amperes—the Alfvén galactic current. The radiated synchrotron power is of the order of 10^{37} watts, that is, the power recorded from double radio galaxies.

The images in Fig. (3) from a supercomputer simulation trace the development of spiral structure in two interacting plasma blobs over a span of nearly 1 billion years. At the start of the interaction at upper left the filaments are 260,000 light-years apart. All 10 panels are reproduced at the same scale. Simulations such as this can reproduce the full range of observed spiral galaxy types using electromagnetic processes rather than gravitational [34].

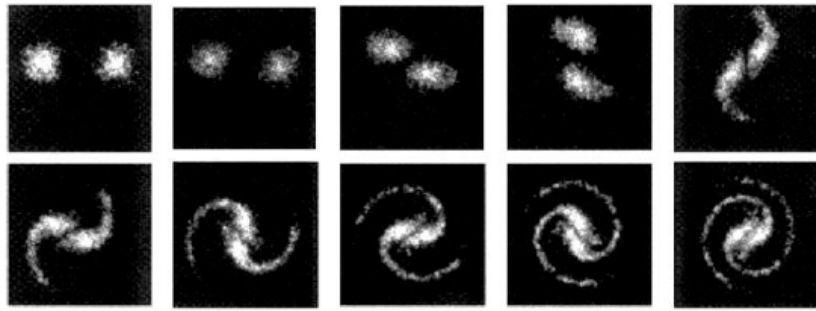


Fig. (3). Particle in cell plasma galaxy simulation.

And so that there can be no objection, the computer simulations have been backed up by electrical discharge experiments in the highest energy density laboratory—the Z-pinch machine. The experiments verify each stage in development of the electrodynamic particle-in-cell (PIC) simulations. This important work demonstrates that the beautiful spiral structure of galaxies is a natural form of plasma instability in a universe energized by electrical power.

We are liberated from all of the whimsical nonsense accompanying the Big Bang hypothesis—the invisible dark matter, the dark energy, the expanding universe (whatever that meant) and creation of matter from nothing.

But as the Open Letter notes, “*Big Bang proponents have won the political and funding battle so that virtually all financial and experimental resources in cosmology are devoted to Big Bang studies. Funding comes from only a few sources, and supporters of the Big Bang dominate all the peer-review committees that control the funds. As a result, the dominance of the Big Bang within the field has become self-sustaining, irrespective of the scientific validity of the theory.*” The dominance of the Big Bang points to a failure of the government funded, institutionalized way science is done today and the way that scientists are trained in narrow specialties. And the effort to ‘discover’ new particles and forces is misdirected when we do not understand those we are subject to every day.

Plasma cosmology is a good theory because it is predictive and empirically testable. It accommodates new discoveries without resort to ad hocery and inventions of new forms of matter or energy. The latest example is the ‘double bubble’ of radiation detected above and below our own Milky Way. This discovery poses huge problems, dubbed by one researcher as “double bubble trouble” for the gravitational model. The paper [36] announcing the discovery begins, “*The inner Milky Way is home to a massive black hole,*” which is a categorical statement about a hypothetical object that can never be observed. Meanwhile, high-energy plasma research shows that the most concentrated source of energy known is the dense plasma focus, which stores electromagnetic energy in a compact toroidal plasmoid until instability sets in and that energy is emitted in two highly collimated axial jets. Active galactic nuclei (AGNs) conform to the plasma focus model. Plasma cosmology maps the magnetic-field-aligned currents (Birkeland currents) spiraling into galactic nuclei and out along the rotation axis. Where there are currents flowing in space plasma, thin double layers (DLs) [37] may be formed across which charge separation and large voltages exist. A characteristic form of DL is a ‘bub-

ble,’ often visible in planetary nebulae where the circuit is lit up. Alfvén notes that “*relativistic DLs in interstellar space may accelerate ions up to cosmic ray [TeV] energies*” [38] and electrons will produce X-rays and gamma-rays. This simple model explains the sharp edge to the bubbles and answers the enigma of the TeV energy of the electrons required to produce the observed gamma-rays so far from the galactic nucleus. The explosive black hole or nuclear starburst models requires the energy to be somehow delivered from the galactic nucleus. But TeV electrons would ‘cool’ long before reaching the bubble edge. Plasma cosmology has no such difficulty because electrical power is being delivered from the rotation of the galaxy to form the DLs. The coincidence found between the gamma-ray bubbles and the X-ray and WMAP ‘haze’ may be explained by the broad-spectrum electromagnetic ‘noise’ generated by DLs.

However, even with 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. It does not explain the apparent concentration of mass in AGNs, attributed to black holes, nor does it work on the broader interdisciplinary canvas: “life, the universe and everything.” Clearly, it is a vital component of any *real* cosmology because it is a *real* science of the fundamental constituent of the universe —plasma, and its electrodynamic behavior. It has its pioneers traceable back to the end of the 19th century, including Nobel Prize winners: Birkeland, Langmuir, Bostik, Alfvén, etc. It has had funding and opportunities as a spin-off of supercomputer access and high-energy plasma research facilities at Los Alamos and elsewhere, and also in fusion research. The IEEE, the largest professional organization in the world, recognizes plasma cosmology. Plasma cosmology has its textbooks and peer-reviewed papers [39].

However, if you look at the thirty-nine historical cosmological models listed on Wikipedia, you will see plasma mentioned in a *single* entry under Alfvén’s name. And rather than providing a *balanced* overview of his considerable contribution to plasma cosmology, it mentions only his *speculative* idea of ambiplasma, involving matter and anti-matter. This gives some insight into the difficulties facing any challenge to Big Bang ideology.

6. ELECTRIC UNIVERSE COSMOLOGY

I know that most men, including those at ease with problems of the greatest complexity, can seldom accept even the simplest and most obvious truth, if it be such as would oblige them to admit the falsity of conclusions which they have de-

lighted in explaining to colleagues, which they have proudly taught to others, and which they have woven, thread by thread, into the fabric of their lives. —Leo Tolstoy

This is the kind of theory we are looking for—simple, capable of being visualized—one that can connect together the puzzling observational facts that presently confound understanding. —Halton Arp.

The human urge to know the truth cannot be stifled. In recent decades a nascent, unfunded interdisciplinary cosmology has arisen that adopts plasma cosmology and places it on a much broader canvas. Called the Electric Universe [40], it is an attempt in the 21st century to meet the requirements of a real cosmology — a holistic natural philosophy which aims for *no* exceptions in the totality of human experience. There is good reason to trawl for the earliest observations of the heavens because no matter how comforting the Newtonian clockwork paradigm, it has been calculated that *“the evolution of the solar system as a whole is chaotic, with a time scale of exponential divergence of about 4 million years”* [41]. Geologists, paleontologists and astronomers are on notice because they cling to dating systems that take for granted a relatively undisturbed Earth, following its present orbit for aeons. In this context an amazing discovery was made in the last decade that *“objects from the Neolithic or Early Bronze Age carry patterns associated with high-current Z-pinches, as would result from an intense plasma impinging Earth”* [42]. That find came from a remarkable interdisciplinary convergence during a conference organized by advocates for a new Electric Universe cosmology. The conference included leading comparative mythologists, astronomers (notably Halton Arp and Tom van Flandern), a professor of electrical engineering, Donald Scott, and the plasma physicist after whom the Z-pinch plasma instabilities are named: “Peratt Instabilities.” The excitement at that meeting was palpable as a glimpse of real Earth history and the electrical nature of the solar system was revealed. It showed that we cannot simply assume that conditions on Earth and in the solar system have remained unchanged, even during the brief time of human existence.

The Electric Universe is based on simplicity, causality and a forensic investigation of information from antiquity about the heavens. It adopts the principle of repeated patterns at different scales. It accepts Hubble’s preference, and Arp’s evidence, for a static universe of unknown age and extent. It makes no outrageous claims about first causes. We must first learn our real place in the universe before we can formulate meaningful questions about its origin or fate. The Electric Universe is an attempt to understand the real nature of stars and the causes of mass, gravity, magnetism, light and quantum interactions. These basic phenomena form the foundations of cosmology and our existence. It is sobering to realize that all of them currently have mathematical descriptions with no physical understanding. Newton at least had the sense to “frame no hypotheses,” but Einstein and his disciples have had no such reserve. Mathematical logic has nothing to do with physics and does not adhere to the principles of physics. Clearly, the equations that are found empirically to work must be retained but with fresh insights and understanding. *“The modern physicist may rightfully be proud of his spectacular achievements in science and technology.*

However, he should always be aware that the foundations of his imposing edifice, the basic notions of his discipline, such as the concept of mass, are entangled with serious uncertainties and perplexing difficulties that have as yet not been resolved” [43]. Textbooks demonstrate this uncertainty by confusing ‘mass’ with ‘quantity of matter.’ Yet we know that the mass of a subatomic particle is variable when accelerated in an electric field. Such confused thinking has resulted in wasting countless billions of dollars on such experiments as the Large Hadron Collider, which is looking for a virtual (i.e., unreal) particle, the ‘Higgs boson,’ to somehow give rise externally to the property of matter we call ‘mass.’

The famous Einstein equation, $E = mc^2$, is an example where books and encyclopedias slip unnoticed into referring to mass ‘m’ not as a phenomenon of matter but as matter itself. Yet this simple equation is telling us many profound truths that have consequences for cosmology. They are: *energy, mass and the speed of light are all attributes of matter.* This realization sweeps away the fog of metaphysics instantly. It means that energy is bound up in the electromagnetic structure of matter. Einstein was wrong when he spoke in 1920, *“...according to the special theory of relativity, both matter and radiation are but special forms of distributed energy”* [44]. Without matter there can be no ‘pure energy’ at the instant of the Big Bang or ‘vacuum energy’ afterwards. Matter cannot be annihilated. So the term ‘antimatter’ is misleading and incorrect. The merging of a particle and its ‘anti-particle’ must result in the release of stored electromagnetic energy and the coalescence of the combined constituent sub-particles to form a collapsed stable particle of vanishing internal energy, or mass. Such particles are called neutrinos. The process can be reversed if a neutrino receives sufficient resonant electromagnetic energy that it re-forms a particle and its mirror image particle. Arp writes, *“...there can be no such thing as ‘new’ matter. So when we speak of creation of matter we do not mean matter coming into our universe from somewhere else (there is nowhere else) or from nothing. We must mean the transformation of previously existing mass-energy”* [23].

Mass is related to the energy bound up in the structure of all subatomic particles. There must be structure to account for magnetic moments of particles and resonant quantum interactions. The mass of a particle appears to increase in an accelerator as an applied electric force increasingly distorts the particle rather than accelerates it. The fact that inertial and gravitational masses are equivalent shows that gravity is an ultra-weak electric force.

It is the inconsistent and contradictory use of language by mathematical theorists that has allowed non-physical and absurd concepts to flourish in physics. The word ‘dimension’ can mean a ‘degree of freedom’ to a mathematician, but in its original meaning it refers to a volume in 3D space. It is a vector in three orthogonal directions. There are no physical ‘extra dimensions’ in which to point time or ‘curl up’ empty space. Physics cannot *“involve jettisoning commonsense concepts of continuous time and three-dimensional space”* as proposed by the Astronomer Royal and President of the Royal Society, Martin Rees [45].

Similarly, nothing physical can exist in one or two dimensions. Newton’s law of gravity maps all of the mass to a

point, which has no physical meaning. It has allowed the nonsense of ‘black holes’ to gain currency. There is also a tendency to make grandiose assumptions. Turning to Newton’s law again, ‘G’ or ‘big G’ is given the grand title “the *universal* constant of gravitation.” But repeated experiments show that it is not even constant on Earth! What is worse, it has the dimensions of length cubed, divided by mass and by time squared. It has been argued that physical constants should be dimensionless. The “...*questioning the constancy of fundamental parameters is essentially trying to understand a more fundamental theory behind*” [46]. If mass is an electromagnetic variable dependent on the distribution of matter and charge, then ‘G’ is different for every celestial body! This means, in practice, that we cannot derive the densities or composition of any celestial body by its size and calculated mass. Stellar theory, based on gravitational compression and the presumption of an implausibly dense, hot core and composed predominantly of the lightest element, hydrogen, has no real support. The mass-luminosity function of stars is meaningless, as we shall see clearly later. And there is no empirical support for a thermonuclear core to provide stellar radiant energy. These are errors of the first magnitude for astrophysics and cosmology that demand a new model for stars. But before addressing that problem there are other issues with present concepts in basic physics.

As noted above, there must be a material medium, the æther, to carry the electromagnetic energy of light at its characteristic speed, c . Einstein ‘postulated away’ the æther while Maxwell’s theory of light waves requires it. Einstein objected to Maxwell’s mechanical æther on the grounds that it required the rigidity of steel to carry a transverse wave. But the mechanical properties of steel arise from electrically polarized inter-atomic forces in neutral matter. So all that is required is that the æther be electrically polarizable. In addition, it should have been clear that an electric field cannot originate in a vacuum. It must have its origin upon the electric charge in matter. And what normal matter exists almost undetectably in a vacuum? The answer is simply — neutrinos. Neutrinos must be polarizable, that is, they are composed of equal numbers of positive and negative charges, and have orbital structure. The æther is a plenum of neutrinos. Their electric dipoles ‘daisy-chain’ the electric force through ‘empty space.’ Their moment of inertia determines the speed of transverse electromagnetic waves through space; the speed of light, ‘ c .’ Since neutrinos have mass they respond weakly to gravity. So light is refracted in an extensive ‘atmosphere’ of neutrinos surrounding stars. Gravity is an indirect cause of bending of light paths by ponderable bodies.

Of course, the Michelson-Morley experiment was supposed to be the defining test for the presence of an æther. However, there has been sharp criticism by some scientists who argue that that experiment did not support Einstein’s dismissal of the æther. Subsequent more accurate experiments confirm the presence of an æther and the motion of the Earth against that background. Cahill writes, “*the Einstein postulates have had an enormously negative influence on the development of physics, and it could be argued that they have resulted essentially in a 100-year period of stagnation of physics*” [47]. Despite dire warnings like this, no money is diverted from the juggernaut of the science industry to test a fundamental challenge to its ideology.

The Electric Universe takes the view that there is a more compelling argument against Einstein’s theories of relativity. It is the fact that gravity must operate without appreciable time delay, rather than at the speed of light, to maintain a stable solar system. Newton’s formula for gravity does not include time. This fact may be explained because gravity is a longitudinal dipolar *electrostatic* force. There is no inertial rotational delay in the neutrino æther. It suggests an explanation for so-called ‘anti-gravity’ effects in gyros and spinning superconductors where rotational inertia of the spinning matter offsets the alignment of its subatomic electric dipoles from the ambient gravitational field direction.

Observations show that the Earth is drawn to where the Sun is at the instant, not to where the Sun was 8 minutes ago. “*Six experiments bearing on the question of the speed of gravitational force propagation indicate a strongly faster-than-light speed. The strongest of them sets a lower limit of $2 \times 10^{10} c$* ” [48]. A near-instantaneous speed of gravity is required on the cosmic scale for coherence of planetary systems and spiral galaxies. A near-instantaneous electric force is also required to maintain coherence within all subatomic particles and within the atom. That this obvious requirement has been overlooked is surprising. For example, it has never been explained why electrons do not simply radiate their orbital energy away and join with the nucleus of an atom. These blind spots are a measure of the power of the spell cast by Einstein’s metaphysics and the equally mysterious and yet incompatible quantum mechanics. If the electric force connects all matter in our local region of the universe in real time, we can dispense with Einstein’s theories of relativity. We have a Machian mechanism to make sense of inertia, since all matter in the local universe is connected in real time. Space is Euclidean. And causality is reinstated in physics. Quantum effects are not ‘spooky’ but due to near-instantaneous resonant electrical matter interactions. The acausal, probabilistic nature of quantum theory has a remedy. Electrons exchange energy instantly with the nucleus and each other in an atom so that the energy sums to zero over each orbit. No energy is radiated in a stable ‘quantum’ state. In other words, each atom is a complex resonant electrical system.

A bolster to this argument is Arp’s discovery that quasars are nascent galaxies often ejected from a parent active galaxy along the spin axis (Fig. 4). Quasars are ‘born’ with high intrinsic redshift, low mass and low luminosity. They brighten, increase in mass and decrease their redshift in periodic steps [49], which dismisses the notion that quantum theory only has significance at the subatomic scale. These effects can be understood in terms of resonant changes in the masses of subatomic particles as the electrical environment within the quasar changes. Arp realized the implications of his discoveries, “*...if it turns out that mass is primarily a phenomenon of frequency, that means we might affect it by subtle wave and resonance interventions. If we live in a Machian universe, the atoms in our bodies are in communication with the far universe. If our matter was materialized from a previously diffuse state we carry the information of an enormously complex pattern that is somehow connected with everything else*” [23]. This view parallels the Electric Universe model and has profound implications for life in the

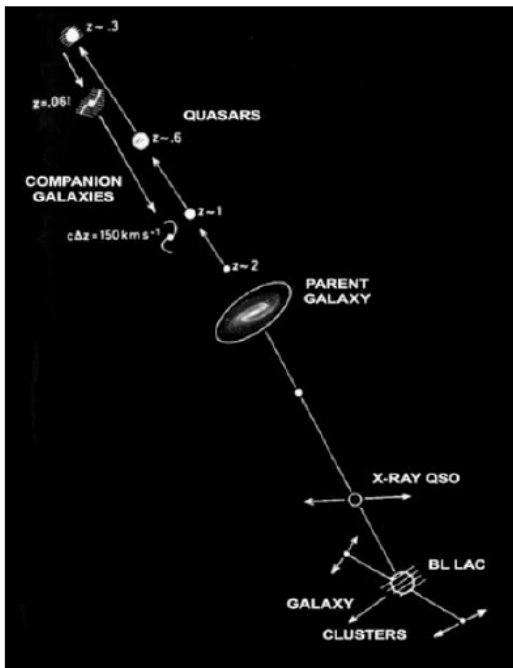


Fig. (4). Galactic ‘family tree.’ H. Arp [23].

universe and ‘taboo’ subjects in biology like the ‘mind-body’ connection, etc. The unexplained randomness of radioactive decay can also be understood as the resonant interaction between a neutrino from the æther and a radioactive nucleus. And ‘non-locality’ is revealed as a typically misleading, mystical term hiding real-time resonant electrical matter interactions.

7. STARS IN AN ELECTRIC UNIVERSE

Sit down before facts like a child, and be prepared to give up every preconceived notion, follow humbly wherever and to whatever abysses Nature leads, or you shall learn nothing. — T.H. Huxley.

This brings us to the crucial cosmological question, ‘what is a star?’ The subject requires much more than can be covered in this article, so here is an outline of the concept of an electric star. It should be judged in this context by its simplicity, coherence and universality.

An undergraduate introduction to the structure and evolution of stars opens with, “*As to the birth of a star, this is a complex process, which presents many problems that are still under intensive investigation*” [50]. However, plasma cosmologists have shown that the electromagnetic pinch effect in parallel Birkeland current filaments can produce bright concentrations of plasma (plasmoids) along their common axis. Recently, ESA reported the discovery of a star birth region, imaged by the Herschel infrared telescope. It was described as “*A view of 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*” [51]. It should not have been “incredible” since Alfvén in 1950 predicted the morphology of matter in the universe to be concentrated along filaments [52]. It is a repeated pattern shown also at the galactic scale [53].

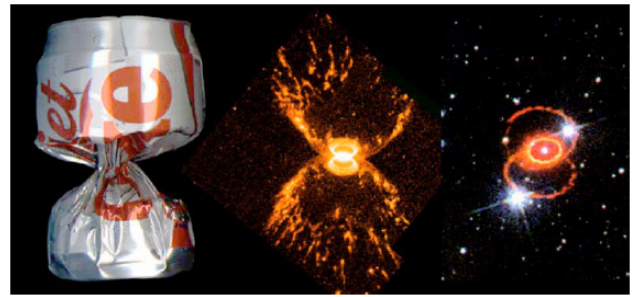


Fig. (5). Electromagnetic pinch experiment vs. planetary nebula and supernova.

The hourglass-shaped stellar electromagnetic (Bennett) pinch can be recognized in planetary nebulae, where the ‘dark current’ mode of a plasma circuit becomes visible in ‘glow mode.’ The electrical model of stars has that pinch operate continuously from the birth of the star. Stars are not isolated in space, they have a galactic electrical energy source. The magnetic fields of spiral galaxies have been mapped and are consistent with current flows along the spiral arms. “*In the galactic circuit, the EMF is produced by the rotating magnetized galaxy acting as a homopolar inductor, which implies that the energy is drained from the galactic rotation, but from the interstellar medium, not from the stars*” [54].

The conductive metal can in Fig. (5) (left) was pinched and inductively heated by a strong poloidal magnetic field. The conductive cylinder of Birkeland filaments surrounding a star behave in the same way (center). And supernova 1987A (right) shows the bright ‘beads’ where the cylinder of Birkeland filaments strike the stellar equatorial current sheet to form the ring of bright beads, and the fainter coaxial rings where polar Alfvén double layers occur in a cylindrical circuit.

Alfvén developed circuit schematics for an isolated star and galaxy. He did not, however, link the two. The electromagnetic coupling between the stellar magnetic pinch and Alfvén’s heliospheric circuit remains to be investigated. The axial beaded rings structure of Supernova 1987A shows that novae are an electrical phenomenon involving exploding plasma double layers and electrical ejection of stellar matter. They are not due to anything happening inside the star [55]. There can be no ‘neutron star’ remnant [20]. Also, supernovae Type Ia cannot be used as ‘standard candles’ because their intrinsic luminosity is dependent upon the power available from their host galaxy; the higher the redshift, the lower the power and luminosity, which has given rise to the erroneous theory of an accelerating expansion of the universe and the introduction of another ad hoc ‘fix’ – ‘dark energy.’

We have no knowledge of primordial abundances of elements. A feature of the powerful long-range $1/r$ electromagnetic scavenging force of interacting Birkeland currents is a phenomenon called ‘Marklund $\mathbf{E} \times \mathbf{B}$ convection,’ which sorts elements from the natal molecular cloud coaxially along the filament axis according to their critical ionization velocities (CIVs) [56]. The heavy elements Fe, Si, and Mg are nearest the axis, while H and He are furthest from the axis. This has significance for the structure of stars. It is a fundamental and naïve error to assume that stars are composed chiefly of the elements radiating in the plasma dis-

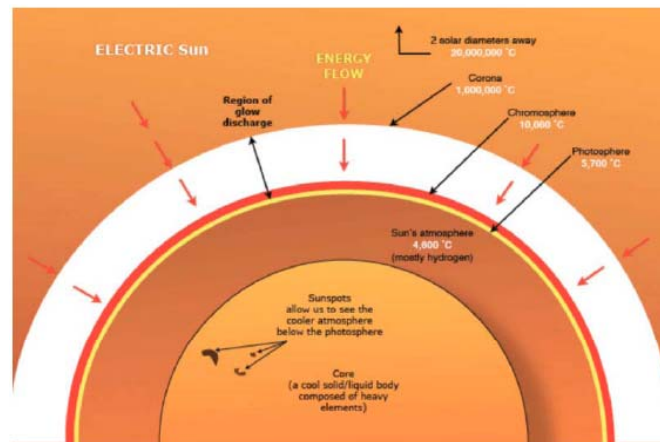


Fig. (6). Schematic from the e-book, ‘The Universe Electric—Sun.

charge at the very tops of their ionospheres. Stars are born with a dense body of heavy elements (revealed in spectra of supernovae) and an extensive upper atmosphere of hydrogen and helium. All stars produce heavy elements in their photospheric plasma discharge, principally by neutron capture. Laboratory ‘dense plasma focus’ discharges are the most copious man-made source of neutrons known.

It is worth noting that the electrical model helps to explain why recent exoplanet discoveries have failed all theoretical expectations [57]. Giant planets are born efficiently along with a nascent star in a Z-pinch or later in an electrical parturition event, seen as a flare or nova outburst, from the atmosphere and surface of the heavy-element bodies of the gas giants or star. It may be significant that the characteristic number of matter concentrations (plasmoids) formed in a Z-pinch is nine. This mechanism may explain the many multiple star systems and close-orbiting giant exoplanets that have been discovered. More distantly orbiting stars and exoplanets, some with odd or retrograde orbits, are more likely due to an efficient electrical capture mechanism of an interloper upon the collision of both stars’ electrical sphere of influence, which in our own Sun’s case extends to the heliosphere (~100AU) and beyond.

Unaware of the detailed electrical theory of galactic and stellar birth, an undergraduate textbook opens with, “*The theory of stellar structure and evolution is elegant and impressively powerful*” [49]. Yet a star was recently discovered that “*shouldn’t exist*” because it is too big to be inflated by a central fire [58]. The standard model makes a star seem a simple thing: “*A star can be defined as a body that satisfies two conditions: (a) it is bound by self-gravity; (b) it radiates energy supplied by an internal source*” [49]. But observations show that stars, their behavior, and their immediate environments are very complex and don’t fit this simple model of an isolated body merely radiating energy into space.

Hidden in the standard definition are some critical assumptions that Sir Arthur Eddington bequeathed to us long before the space age in his 1926 opus, *The Internal Constitution of the Stars*. But how many undergraduates now read his original work with a critical eye? Eddington wrote, “*The problem of the source of a star’s energy will be considered; by a process of exhaustion we are driven to conclude that the only possible source of a star’s energy is subatomic; yet it*

must be confessed that the hypothesis shows little disposition to accommodate itself to the detailed requirements of observation, and a critic might count up a large number of ‘fatal’ objections” [12].

A single fatal objection would suffice to falsify the hypothesis, but the apparent isolation of stars in what was believed to be ‘the vacuum of space’ encouraged the *belief* that stars must self-immolate and therefore observations must be forced to fit the theory. The fatal objections would be sorted out later. Eddington argued the need for a central fire as follows: “*No source of energy is of any avail unless it liberates energy in the deep interior of the star. It is not enough to provide for the external radiation of the star. We must provide for the maintenance of the high internal temperature, without which the star would collapse*” [12]. But this assumes that a star is simply a bloated ball of hot gas, obeying the standard gas laws. If this were so, “*We should expect on the basis of a straightforward calculation that the Sun would ‘end’ itself in a simple and rather prosaic way; that with increasing height above the photosphere the density of the solar material would decrease quite rapidly, until it became pretty well negligible only two or three kilometres up. ... Instead, the atmosphere is a huge bloated envelope*” [59]. Eddington’s ‘logic of exhaustion’ had to set aside facts that didn’t fit the ‘only possible’ theory.

8. THE ELECTRIC SUN

The idea of an electric Sun is not new. Proposals for its electrical nature (and that of comets) have a long and continuous history stretching back at least to the early 19th century. Friedrich Wilhelm Bessel in 1834 speculated on there being charge on the Sun. Sir John Herschel wrote in 1852, upon the discovery of a link between magnetic storms on Earth and sunspots, to Michael Faraday, the vaunted experimentalist who was investigating the links between electricity and magnetism, “*We stand on the verge of a vast cosmical discovery such as nothing hitherto imagined can compare with.*” Herschel’s assessment was accurate, but he could not have imagined that we have still not crossed that verge in the 21st century.

In stark contrast to the standard definition of stars, in an Electric Universe (Fig. 6) “*A star can be defined as a body that satisfies two conditions: (a) it forms the anode focus of a plasma glow discharge; (b) it radiates energy supplied by an*

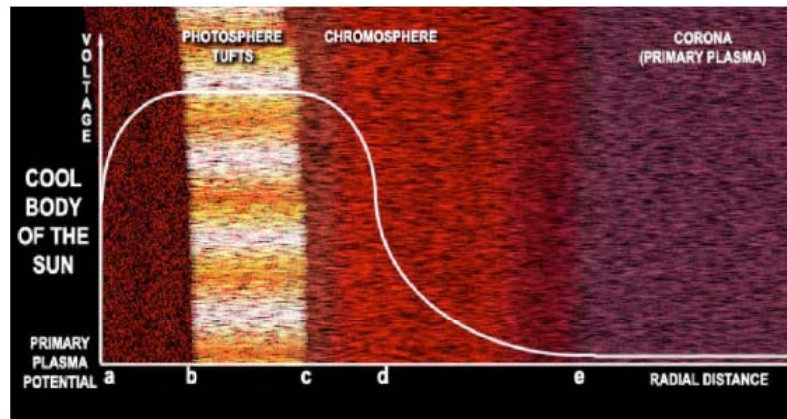


Fig. (7). Schematic of the potential distribution across the Sun's anode (photospheric) tufts, the double sheath of the chromosphere and primary plasma of the corona.

external source." As dark sunspot umbrae indicate, the photosphere is a thin discharge layer, high in an extensive atmosphere of a cool body.

The standard gas laws do not apply to the size of the photosphere. Models used in helioseismology based on the gravitating gas model do not apply. A recent summary of difficulties in reconciling helioseismology with solar composition suggested, "*either new physics—exciting, if unlikely—or major errors in the existing physical ingredients of the models, which ...could be very important for our understanding of the physics of stars*" [60]. In contradistinction, photospheric dynamism and complexity are all explained in terms of plasma discharge experiment and theory. The impossible situation in the standard model of a 6,000 K photosphere situated between a hypothetical 16 million K thermonuclear core and a millions of K corona is solved. There is no need to propose a body, unknown to science, which transfers internal heat by radiation instead of by conduction and convection. The photospheric 'granulation' is not due to convection. It is a plasma discharge phenomenon where bright secondary 'tufts' of plasma form in a primary plasma above an anode. The electrical nature of the granulation can be seen in sunspot penumbrae where the granules form the tops of towering plasma 'tornadoes' with characteristic edge brightening of a hollow, semi-transparent cylinder of plasma. The solar wind, the complex sunspot cycle with reversing solar magnetic field, the constant (non-dipolar) intensity of the Sun's magnetic field over the photosphere, the Sun's differential photospheric rotation — fastest at the equator where most of the momentum should be lost to the solar wind, the variability of the Sun in X-rays while the radiant energy remains steady, all fit a straightforward electrical model. A few examples are given here to demonstrate the coherence of the model.

The tufted plasma sheath above the stellar anode seems to be the cosmic equivalent of a 'PNP transistor,' a simple electronic device using small changes in voltage to control large changes in electrical power output. The tufted sheath thus regulates the solar discharge and provides stability of radiated heat and light output while the power to the Sun, evidenced in X-rays, varies over the sunspot cycle.

The white curve in Fig. (7) shows how the voltage changes within the solar plasma as we move outward from

the body of the Sun. Positively charged protons tend to 'roll down the hills.' So the bright 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 in the corona but remains non-zero throughout the heliosphere. 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. 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, the regulating plasma sheath performed normally and there was no noticeable change in the Sun's radiant output.

Perhaps the greatest and most obvious mysteries of the Sun are sunspots and the sunspot cycle. Kristian Birkeland published an electrical theory of the Sun in 1913. He was a renowned Norwegian scientist and Nobel Prize nominee who set up magnetic observatories in the Arctic Circle to study the Aurora Borealis. His theory that the aurora is due to 'charged particle beams' from the Sun has only recently been confirmed. In recognition of his work, Birkeland's name has been applied to the electric current filaments discovered in space—'Birkeland currents.' Birkeland's approach was largely experimental. He managed to reproduce sunspot behavior in his famous Terrella experiments where he applied *external electrical power* to a magnetized globe suspended in a near vacuum (Fig. 8)

The discharges from the solar plasmoid punch through the bright photospheric discharge to form the dark sunspots, which vary in latitude and number with the varying power input to the solar plasma storage ring.

A recent report misleadingly headlined "*Longstanding Mystery of Sun's Hot Outer Atmosphere Solved*" [61], announces new observations of the curious jets of plasma, known as 'spicules,' that blast up from between photospheric granules, through the chromosphere toward the corona. Some of the jets have now been found to be faster and con-

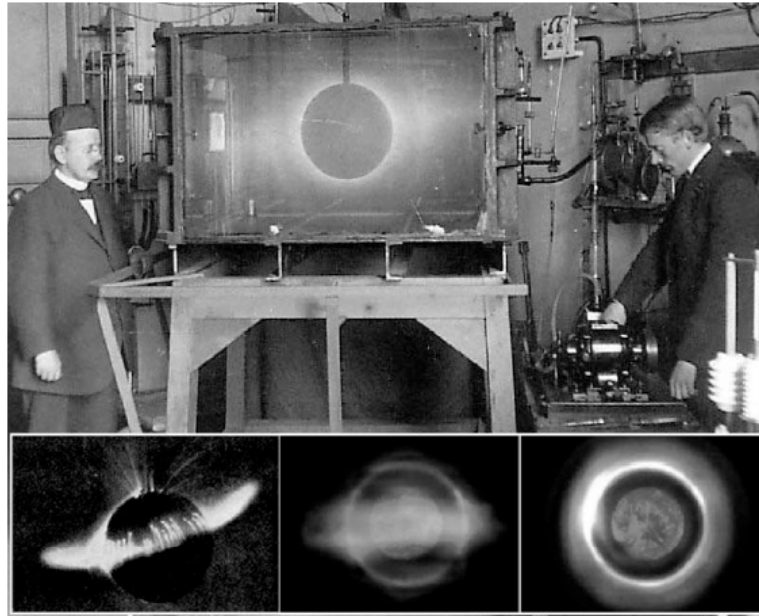


Fig. (8). Birkeland (top left) and his Terrella. Inset (left) discharges to a magnetized sphere from an equatorial plasma toroid, (center) solar equatorial plasma toroid in UV, (right) polar view.

tain “plasma heated to temperatures between ~0.02 and 0.1 million kelvin (MK) and a small but sufficient fraction to temperatures above 1 MK.” However, this fact does not explain temperatures up to 20MK with increasing distance from the Sun. Worse, the report concludes, “there are currently no models for what drives and heats the observed jets” [62]. Theorists have no explanation for the origin of the hot plasma in the solar corona because the energy does not come from within the Sun.

The anode discharge model of the Sun *requires* the ubiquitous solar chromospheric plasma jets, or ‘spicules.’ They are ionized gas fountains that find an analog in porous discharge anodes of some electric-arc lamps. Ionizable gases must be introduced into the discharge to satisfy Langmuir’s finding that the bright anode plasma sheath is stable only when the current densities of the positive-ion and electron flows across it are properly related:

$$(\text{electron current/ion current})^2 = \text{ion mass/electron mass} \quad [63].$$

Chromospheric spicules stabilize the solar discharge.

- Sunspots are intimately associated with that other great puzzle — the Sun’s magnetic field. The 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 global variability. The Sun has a generally dipolar magnetic field that switches polarity with the sunspot cycle. But unlike a dipole magnet, in which the field is twice as strong at the poles as at the equator, the Sun has a rather evenly distributed photospheric field strength. This oddity can be explained only if the Sun is the recipient of magnetic field-aligned (Birkeland) electric currents flowing radially into the photosphere. These 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. Also, 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. The field is not ‘anchored’ to a hypothetical dynamo inside the Sun. As the input power to the Sun increases, sunspot numbers rise (reflecting current input) and the magnetic field strengthens. Birkeland demonstrated this sunspot discharge pattern with his Terrella experiment [64]. More recent experiments utilizing low-pressure glow discharges to a magnetized conducting sphere have shown the relationship between power input and latitudinal shift of discharges from an equatorial plasma torus to the surface of the sphere [65]. Dark sunspots are caused by powerful ‘dark mode’ Birkeland currents from an equatorial plasma torus, detected in UV by SOHO, ‘punching’ through the thin photospheric tufted plasma discharge layer and filamenting lower in the deep atmosphere of the Sun. The cool umbrae of sunspots reveal the true temperature of the sub-photospheric solar atmosphere. The enigma of sunspots of the same magnetic polarity showing mutual attraction is solved. Parallel currents attract according to Ampère’s law.

- 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 power supply from local interstellar Birkeland current filaments, identified by radio astronomers as a thicket of HI filaments. The varying current may be due to Alfvén waves, oscillating double layers, or other resonant effects in the Sun’s local stellar ‘wiring harness.’

Fig. (9) is a schematic of Alfvén’s heliospheric circuit. According to Alfvén, the Sun acts as a unipolar inductor (A) producing a current which goes outward along both the axes (B2) and inward in the equatorial plane along the magnetic

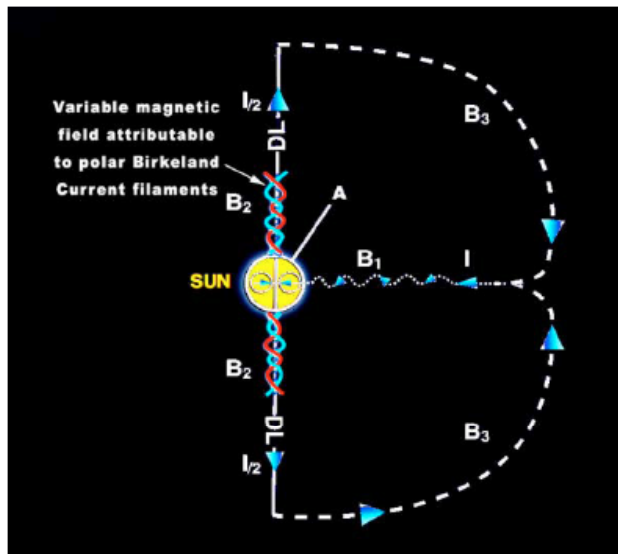


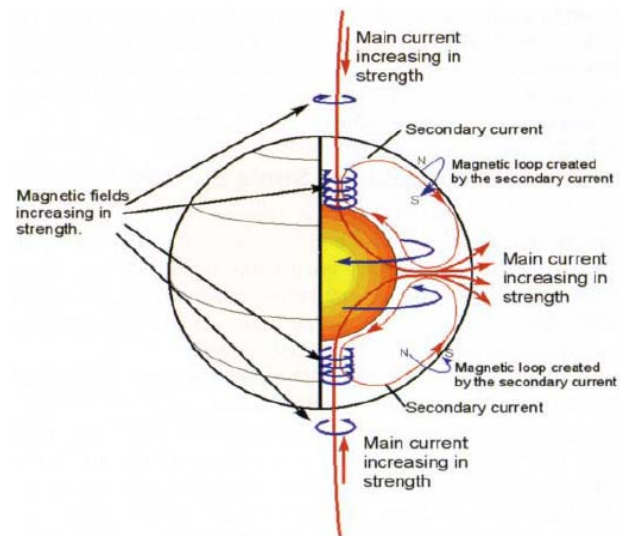
Fig. (9). Alfvén's heliospheric circuit.

field lines (B1). The current must close at large distances (B3), either as a homogeneous current layer, or — more likely — as a pinched current. The Birkeland current (B2) signature may have been discovered by the Ulysses spacecraft as unexpected variations in the magnetic field above the solar pole [66].

It is important to note the double layers (DLs) in the polar regions. Alfvén was of the opinion that “double layers in space should be classified as a new type of celestial object.” They are capable of producing cosmic rays of TeV energies, high-energy electrons, X-rays, gamma-rays and synchrotron radiation. He wrote, “Application to the heliospheric current systems leads to the prediction of two double layers on the sun's axis which may give radiations detectable from Earth” [67]. The recent discovery of an “unexplained” source of small-scale anisotropy in cosmic rays (protons) may find resolution in the electrical model [68]. Note that polar double layers provide a local source of cosmic rays aligned with the interstellar magnetic field. This small-scale anisotropy was unexpected because it is generally assumed that there is no local source of cosmic rays. Sources more distant than about 0.03 light-years have their origin masked by magnetic scattering in the galaxy. ‘Magnetic reconnection’ as an explanation is conceptually flawed and cannot be proposed as a particle acceleration mechanism [69].

Alfvén's model has the Sun's rotation generating the heliospheric current. The concept presented here has an externally induced heliospheric current powering the Sun as a unipolar (homopolar) ‘motor.’ This would also explain the Sun's differential rotation. The solar magnetic field reversals may then be understood to be a result of simple ‘transformer’ action produced by a varying direct current (DC) input to the heliospheric circuit .

Fig. (10) shows a schematic of the effects of the solar power ‘transformer’ action. Following Alfvén's circuit diagram of the heliosphere, D.E. Scott offers the following explanation for solar magnetic field reversals: “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)



Primary and secondary electric currents in the Sun.

Fig. (10). Solar transformer circuit.

currents will reverse direction.” This ‘transformer’ action does not require the solar driving current to reverse direction. “...these reversing magnetic fields provide a classic example of a phenomenon that cannot be understood without reference to the electric currents that produce it” [70].

Strong evidence for the presence of the Sun's ‘wiring harness’ in the shape of a bipolar planetary nebula type plasma ‘pinch’ came recently from the surprising discovery of energetic neutral atoms (ENAs) arriving from a ring orthogonal to the local interstellar magnetic field. Even more surprising to researchers, the ring of ENA's showed rapidly changing structure. But since all stars are the same electrical phenomenon, a precise analog of the ENA ring is lit up in the bright equatorial ‘ring of beads’ of supernova 1987A where the matter in the stellar expulsion disk acts as a ‘witness plate’ for the encircling cylinder of Birkeland filaments.

Fig. (11) shows (left) the conceptual schematic of the Sun's electrical environment. The Z-pinch filaments form a cylinder around the solar system, aligned with the interstellar magnetic field. The coupling between the stellar ‘pinch’ and Alfvén's heliospheric circuit remains to be elucidated. This is compared with a perspective view (right) of a Z-pinch simulation and its relationship to the Birkeland filament pairs interacting with the supernova ejecta ring in SN1987A.

Perhaps we also have here a simple explanation for the observed excess of cosmic ray electrons at energies of 300-800 GeV. Such energetic electrons must have a source within 1 kiloparsec of the Sun and therefore could be from “an unseen astrophysical object” [71]. A measure of the incoherence of standard astrophysical theory is the suggestion that the source might be the decay of imaginary ‘dark matter.’ When taken together, the ENAs ring structure and the unseen local sources of high-energy particles are strong evidence for an external Z-pinch power source of the Sun.

9. ELECTRIC STARS

Electric lights come in a wide variety. There are the original incandescent filament lamps where the light comes from a filament heated internally by electric current. Today we have fluorescent lights, high-intensity gas discharge

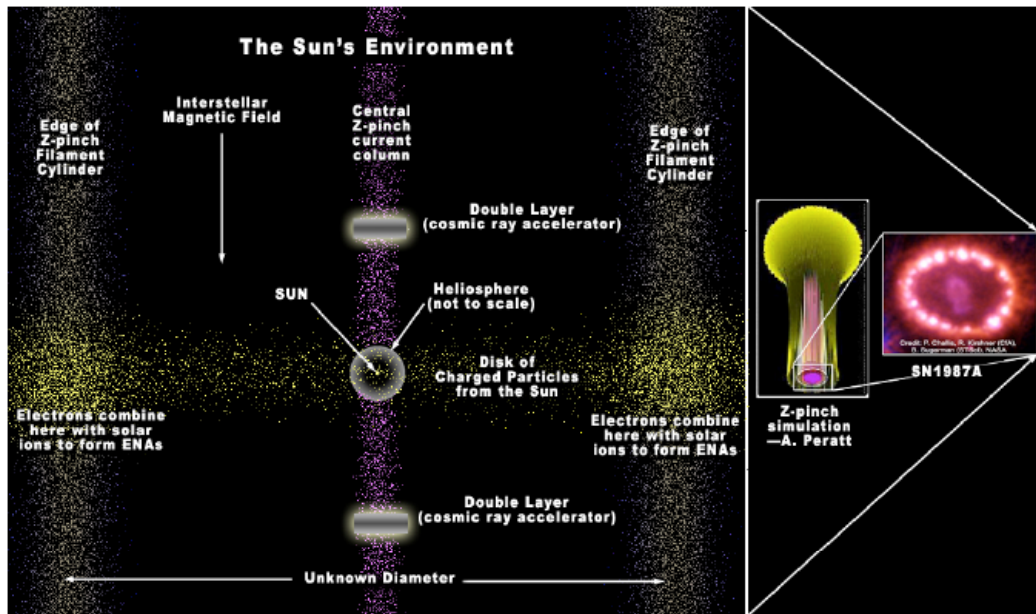


Fig. (11). Solar environment, Z-pinch and supernova 1987a.

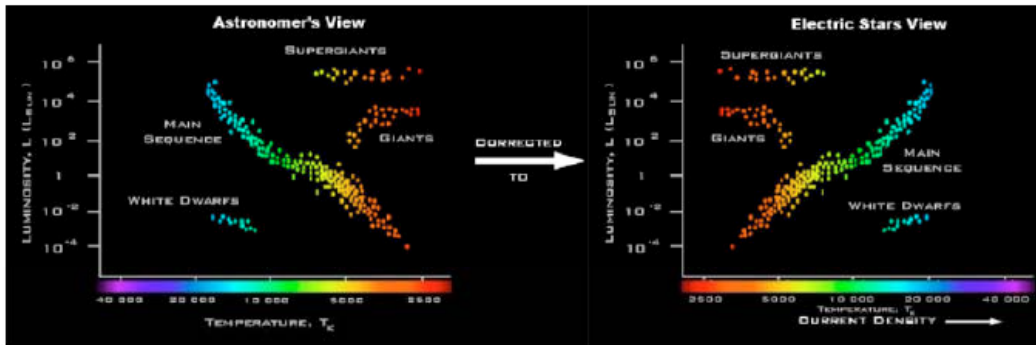


Fig. (12). Modification of Hertzsprung-Russell diagram.

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 (heated from within). The main differences between these types of lights are the power density of the discharge and the location in the gas discharge path where most of the light comes from. For example, in a neon tube 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 in a thin sheath above the electrode. As the power of an arc light is increased, its color changes from yellow-white to white to blue-white. The sharp discontinuities in the nature of the light from an electric discharge as it switches from a red glow to a bright arc explain many of the mysteries of starlight.

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. (12) [from *The Electric Sky* by D. E. Scott] shows the familiar Hertzsprung-Russell diagram (left), a plot of luminosity (absolute magnitude) against the colour of the stars. The data graphed by the H-R diagram are observed quantities, while assumptions drawn about the diagram's meaning are not. Clearly, not being electrical engineers, as-

tronomers have got the graph mirror reversed. As the current density is increased in an electric arc the light becomes brighter, hotter, and therefore bluer. In other words, the current density is responsible for both the luminosity (y-axis) and the color temperature (x axis) of the H-R diagram. That explains the near 45° slope of the so-called 'main sequence' stars in the corrected H-R diagram (right).

At the lower left-hand end of the main sequence we find the red dwarfs — stars under low electrical stress, in which a good deal of the red light comes from the chromospheric anode glow. Anode tufting or flaring is sparse, if any, and may occur preferentially at the magnetic poles.

As we move diagonally upward and to the right on the H-R diagram the stars become more massive under greater electrical stress and the current density increases. Anode tufting becomes more intense and the tufts' mutual repulsion forces them to adopt polygonal packing and the photosphere to expand to accommodate them. At the top right of the main sequence the light from the tufts is the electric blue of a true arc, and the stars appear as 'blue giants' — intensely hot objects considerably larger than our Sun. These blue giants tend to be concentrated on the central axes of our galaxy's spiral arms, where the interstellar Birkeland current density is highest.

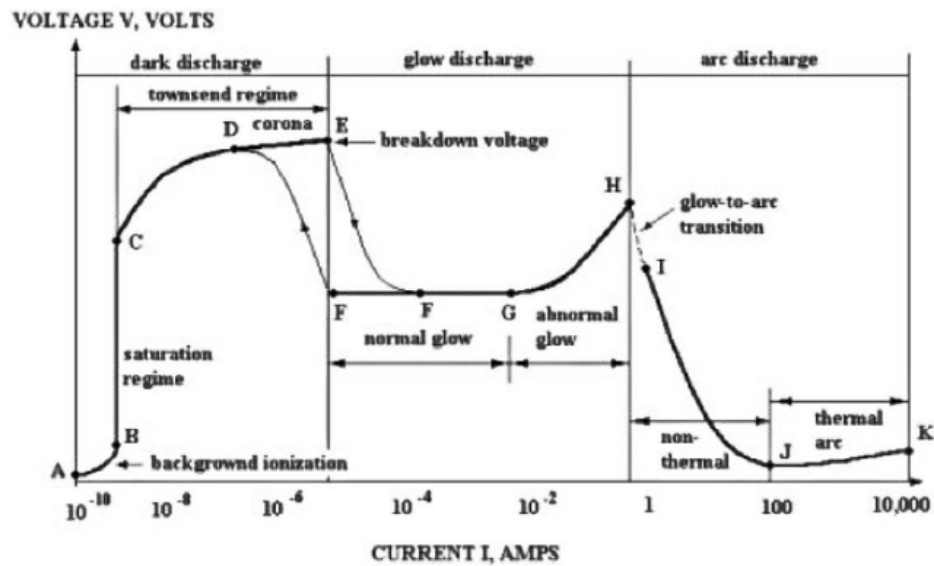


Fig. (13). Voltage-current curve of a DC discharge.

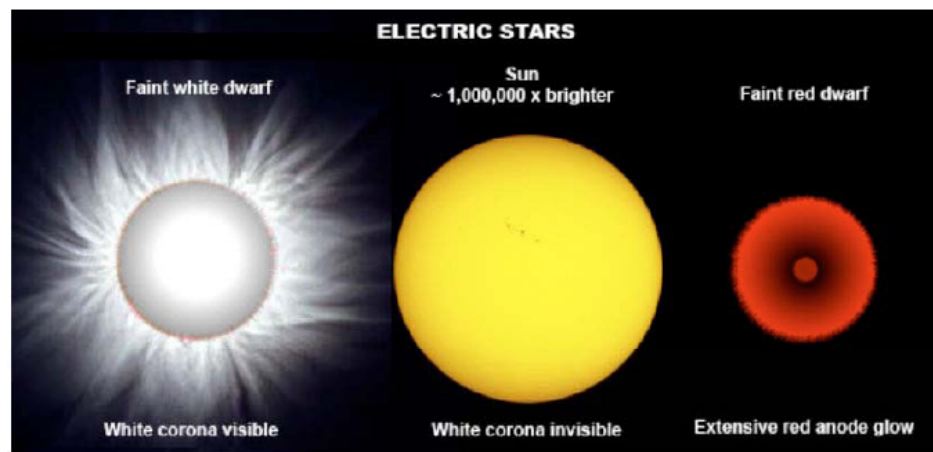


Fig. (14). Stellar discontinuities.

But what about the stragglers — the red giants and the white dwarfs? Here the natural simplicity of the electric star model shines. Stellar color and luminosity are discontinuous functions for good reason: low-pressure plasma discharge phenomena exhibit sharp discontinuities.

Fig. (13) shows the voltage-current curve of a DC glow discharge in low-pressure gas. Three main regions can be distinguished from each other, dark discharge, glow discharge and arc discharge. Cosmic Birkeland currents operate for the most part in 'dark' mode. Red giants and red or brown 'dwarfs' operate in chromospheric glow mode (they are not 'failed' stars), and white dwarfs have only a faint white coronal glow. Bright main sequence stars owe their brilliance to arc mode, while their faint red chromosphere and white corona are glow discharges.

Engineers find it easy to light our cities with electrical power generated at some distance from the city. It never occurs to astronomers that Nature uses the same principle for lighting the stars in galaxies; that stars might be a cosmic electrical phenomenon, like streetlights tracing the path of galactic power lines. Thermonuclear star models projecting theoretical stellar evolution onto the H-R diagram require highly imaginative ideas, largely unverifiable, to explain the

discontinuities. Usually it requires a star to explode or else to move off the main sequence so rapidly that we don't see a continuous plot.

Fig. (14) shows the principle discontinuities in stellar type due to plasma discharge discontinuities. Nearby red and white stars that appear faint are not different to other stars. Red and brown dwarfs are physically much smaller than the Sun but their visible glow discharge is large and of low current density and energy (red).

10. WHITE DWARFS

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*" [72]. He was right. A white dwarf is a star that is under low electrical stress so that bright photospheric 'anode tufting' is not required. It has no photosphere. This may occur, for example, in binary star systems like that of Sirius, where the brightest visible star usurps most of the available electrical energy. A white dwarf appears extremely hot, white and under-luminous because it is equivalent to having the faint white corona discharge of the Sun reach down to

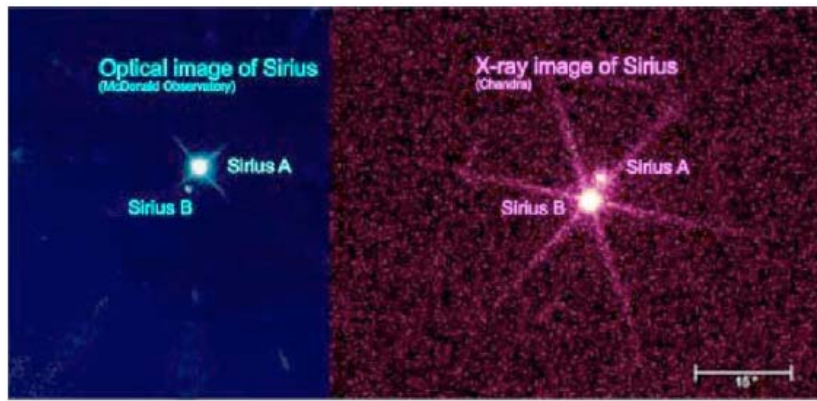


Fig. (15). Sirius A and B in optical and X-ray.

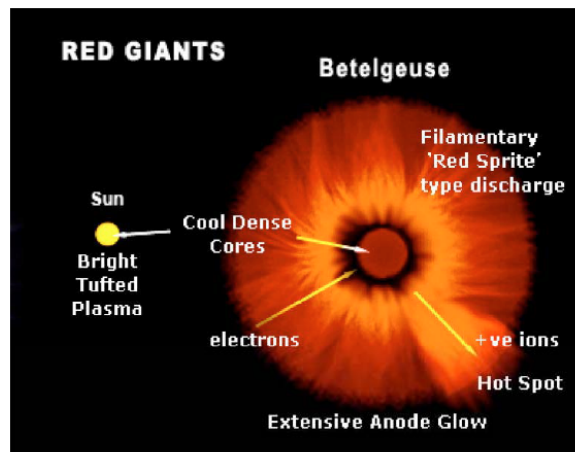


Fig. (16). Comparison of plasma discharge features of the Sun and Betelgeuse.

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 ultraviolet light and 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. The spectral lines are broadened, sometimes to the point of disappearance, due to the coronal electric field. This gives the misleading impression that hydrogen (whose spectral lines are smeared the most) is missing in many of these stars and that therefore they are remnants of larger stars that have conventionally lost or burned their hydrogen fuel. Significantly, the larger the white dwarf, the lower the current density and the lower the apparent temperature. This trend has been noted with some puzzlement by researchers.

Fig. (15) shows (left) an optical image of the nearby double star system of Sirius, which is the brightest star in the sky and one of the closest. Sirius has a partner, called Sirius B, a ‘white dwarf.’ To our eyes, it is 10,000 times fainter than the primary star, Sirius A. In the X-ray image (right), Sirius A is the lesser of the two lights. Sirius B, the white dwarf, is the greater.

White dwarfs are often found in multiple star systems, 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 stars has nothing to do with their age. In multiple star systems the brighter pri-

mary star may usurp most of the electrical power, dissipating the energy in optical wavelengths. The white dwarf converts its share of power into coronal X-rays.

11. RED GIANTS

Red stars are those stars that cannot satisfy their hunger 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 becomes 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, or in more conventional terms—a prodigious stellar ‘wind.’ Indeed, such loss of matter 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. Seen in electric terms a red giant is not a dying star.

Fig. (16) compares the plasma discharge features of a red giant with the Sun. The visible disk of Betelgeuse tells us nothing about the physical size of the central condensed body. Betelgeuse’s size, seen in more energetic UV light, is double its already gigantic dimensions in visible light. The

existence of high-energy UV light at large distances above the star fits an external power source like that producing the superhot solar corona.

Internal heating doesn't cause the giant red glow of Betelgeuse. It is an electrical plasma glow like that seen in a neon tube. And like a neon or fluorescent light tube it is relatively cool. In fact, measurements of temperature (random motion) of plasma in an electric field (directed motion) will be misleading because the electric field tends to align motions in the direction of the field. Radio measurements of the temperature distribution in Betelgeuse's atmosphere give readings that decrease with distance from the photosphere and are lower than those derived from the optical and ultraviolet (UV), where the temperature is calculated from theoretical model atmospheres. The radio astronomy findings could be explained by current flowing in radial filaments in the extensive, diffuse envelope of Betelgeuse, like the red sprites seen stretching up to the ionosphere above earthly thunderstorms.

Red dwarfs will be found to be bloated since they shine in the same mode as red giants. Evidence for this came in a report in 2008 of the discovery of a very cool (~600K) brown dwarf. The researchers found it required "*a highly inflated radius which cannot be reconciled with brown dwarf structure models*" [73].

So the notion that brown dwarfs are 'failed' stars, red giants are old dying stars, and that white dwarfs are the remnant of exploded stars, have no validity. The complex evolutionary story of stars, involving unknown forms of matter, unexplained bipolar jets, matter transfer and explosions, is unnecessary. While enormous time and resources have been poured into the effort to understand stars based on an outdated model, those familiar with plasma discharge phenomena have been paying close attention to detailed observations of the Sun and finding simple electrical explanations. After 100 years of neglect, an electrical model of stars is beginning to emerge.

12. CONCLUSIONS

The Electric Universe is an interdisciplinary theory that attempts, in the words of E. O. Wilson, "*consilience*," or "*the unity of knowledge*." I have not discussed here the development of the Electric Universe, but it had its origin in accepting the convergent traditions of planetary 'gods' battling in the heavens with thunderbolts. That convergence climaxed in 2000 with the identification of strange prehistoric petroglyphs as recordings of the many phases of "mega-auroral" discharges [74]. It demonstrated that our belief in a stable, clockwork Newtonian solar system is untenable. It raised the issue of electrical activity in the solar system during a period of instability and how this could quickly achieve the present peaceful state. That required an understanding of the electrical nature of gravity. Without some form of negative feedback involving cometary charge exchange *via* planetary plasma sheaths (magnetospheres) the Newtonian solar system is chaotic. The acknowledgement of the electrical character of cometary jets in the process of surface arc machining will open the door to the electrical nature of the solar system. It will show the true nature of the 'non-gravitational' accelerations of comets. And that comes full-circle to an understanding of what our prehistoric breth-

ren were desperately trying to convey to us about celestial chaos and the 'thunderbolts of the gods' [75].

It is clear that humanity still suffers from a 'doomsday' fear, which is reflected in all cultures through art, literature, religion and an irrational destructive urge. So perhaps the most urgent message from this research is to work toward consilience; to understand our real past or else we may have no future. As Wilson says of consilience, "*The belief in the possibility of consilience beyond science and across the great branches of learning is not yet science. It is a meta-physical world view, and a minority one at that, shared by only a few scientists and philosophers... Its surest test will be its effectiveness in the social sciences and humanities. The strongest appeal of confidence is in the prospect of intellectual adventure and, given even modest success, the value of understanding the human condition with a higher degree of certainty*" [76].

The electric universe offers a coherent understanding of ourselves and our place in the universe. It provides practical insights for science breakthroughs and the exploration of space. If the Sun shines as an electric light 'plugged in' to an electric galaxy, the objective tests become obvious and the data is already to hand. Perhaps with the beginnings of a real understanding of the universe we may achieve, as Arthur C. Clark imagined it, "childhood's end" in the cosmos.

"*This is the kind of theory we are looking for—simple, capable of being visualized—one that can connect together the puzzling observational facts that presently confound understanding.*" —Halton Arp, "the modern Galileo" [23].

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CONFLICT OF INTEREST

None Declared.

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