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"Plasma-based Cosmologies: History, Description, and Assessment "

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Abstract

In this paper I discuss the origins, development, key elements, and mainstream criticisms of both the plasma universe (PU) and electric universe (EU) models. The EU is basically an extension of the PU. These plasma based cosmologies, though similar to each other, are in stark contrast to the currently accepted, though observationally challenged, ΛCDM cosmology, otherwise known as big bang theory (BBT). Although plasma based universe models are not accepted by most astronomers, astrophysicists, and cosmologists, their proponents have established compelling evidence in the form of both laboratory, in situ measurements, and experimental predictions of such phenomena as Birkeland currents, a key element of these universe models. When these concepts form technologies that are successfully applied to nuclear fusion reactors, the potential benefits will include cheaper, safer, and cleaner energy.

BBT Basics

BBT, as described in [1], is a complex multi-stage model with many parts hypothesized and unfalsifiable, such as inflation, dark matter, and dark energy. This model is based primarily on mathematics, with gravity acting as the main physics mechanism. However, the physics (or physical mechanism) causing gravity is unknown. Complex mathematical tools have been developed (e.g., general relativity and quantum mechanics) to predict cosmological observations and BBT proponents boast about their accuracy. However, to adjust to failed predictions and match observations required the invention of such unknown elements as inflatons, dark matter, and dark energy.

EU Basics

The EU model has been developed primarily by plasma physicists and electrical engineers, in contrast to the establishment of BBT by cosmological physicists and mathematicians. EU is based mostly on causal effects and empirical observations, both in the laboratory and astronomical in nature. Electromagnetic forces dominate in the EU whereas gravity is the dominant force in BBT. The driving physical mechanisms that drive the observations are plasmas, i.e., mixtures of positive ion and electrons that do not combine with each other due to their high velocities.

Plasma Physics

Plasma physics focusses on plasma phenomenology. In physics, a plasma is a gas-like mixture of highly energetic positively charged ions and electrons. The matter with which they are composed does not include any "dark matter" nor does their energy include any "dark energy". Due to the high energy of these particles, they do not combine to form atoms. According to the DOE [2], along with many others, roughly 99% of visible matter is in the plasma state.

In a broad sense, the foundations of plasma physics were laid in the early 1800's by such physicists such as John Townsend, Michael Faraday, and J.J. Thompson, with the discovery of the electron. There have been many key contributors to plasma physics over the years. The ones mentioned in this paper, beyond Townsend, Faraday, and Thompson, are not the only important contributors, but I have selected them because they appear to be the ones most influential in the development of these plasma based cosmologies. In the succeeding sections of this paper, I describe some key, overlapping topics in plasma physics with the intent to tie these key players that I will mention.

Plasma Filaments and Modes

Much national and international funding has been invested in the pursuit of evidence for dark matter to support the mainstream standard BBT cosmology. However, rather than finding dark matter, the most recent efforts have ironically provided us with the clear observation of plasma filaments that interconnect with stars and galaxies through the intergalactic space between them. Plasmas are known to display three main modes of intensity that are dependent on the plasma densities. Those with densities below a certain threshold are in the "dark" mode (not to be confused with dark matter since they are composed of baryons). Mid-level plasma densities give rise to the "glow" mode. The third and brightest plasma mode is called the "arc" mode. So, in Figure 1 we see the faint but visible glowing filaments [3]. We can also observe the bright spots which appear to be stars, or star clusters. A common example of a plasma in the glow discharge mode is lightening.

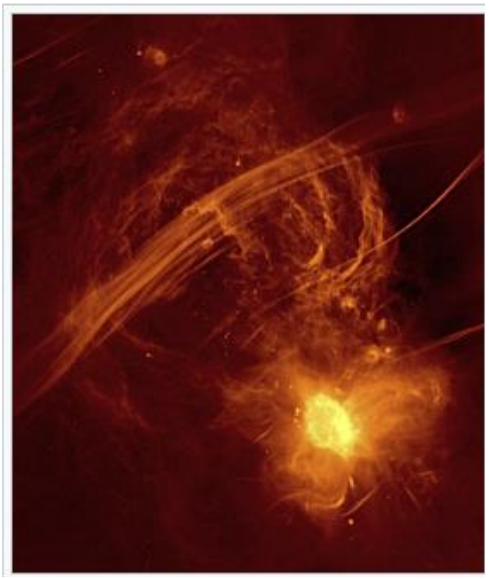

Figure 1. Radio image of plasma filaments in space [3].

Birkeland Currents

Early in the 20th century, the idea of plasma, stretched out in layers throughout the upper atmosphere, was of great interest. A model was proposed by Heaviside [4] and these layers were observed via radio measurements by Appleton in [5] in 1927 (for which he received the Nobel Prize in physics in 1947). Birkeland [6] was a key plasma physicist with his laboratory experiments in which he demonstrated the formation of plasma currents where the ions and electrons flow directly along parallel magnetic field lines and electric field lines. This concept was advanced by Alfven [7], Lerner [8], Peratt [9], Thornhill [10], and others in the 1980's. Much work has also been developed in this area by such PHD's in electrical engineering as Scott [11], Anderson, and Vondrak [12] who used measurements of Birkeland currents in Auroral latitudes.

As just stated, Birkeland currents are strong electric currents made up of plasma in which the ions and electrons initially travel along paths closely parallel to a local magnetic field line. If a charged particle begins to deviate from this direction, it will experience a magnetic force to draw it back, resulting in a helical path about the magnetic field line. This is the Lorentz force:

$$\vec{F} = q\vec{v} \otimes \vec{B}_1 \tag{1}$$

where q = charge, $\vec{v}$ = velocity, and $\vec{B}_1$ = magnetic field nominally along the velocity vector. Observe there is only a nonzero magnetic force when there exists a nonzero angle between the velocity and the magnetic field vectors. This is a conservative force, creating a circular path helically, about the field lines and generates additional magnetic field strength along the mean velocity vector via the Ampere's Law:

$$B_2 = \frac{\mu_0 I_2}{2r_2} \tag{2}$$

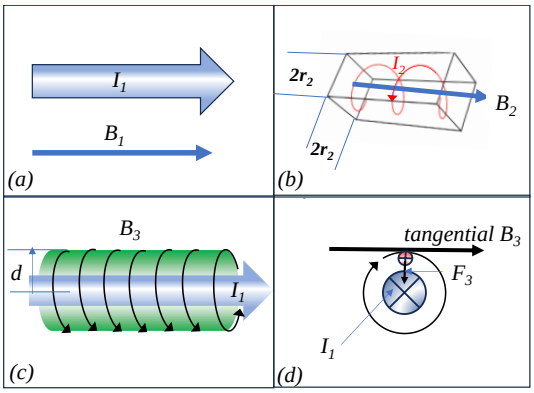

Figure 2. Illustrations of a current-generated magnetic field.

where μ_0 = vacuum magnetic permeability, I_2 is the helical loop current, and r_2 is the loop radius. There is also a generated magnetic that curls around the current via Biot-Savart's Law:

$$B_3 = \frac{\mu_0 I_1}{2\pi d} \tag{3}$$

Figure 2 illustrates this with.(a) Birkeland current, I_1, along B_1 magnetic field line, (b) helical current, I_2, generating additional field strength, B_2, along nominal B_1 direction, (c) cylindrical magnetic field, B_3, curled around Birkeland current, I_1, and (d) inward radial force on a positively charged particle with a velocity into the page, along with the Birkeland current, I_1. Negatively charged particles would be moving out of the page in (d) so would have an inward radial Lorentz force as well.

Where plasma current density is higher, there is a greater surrounding magnetic field, increasing the inward force on the particles and causing compression. Compressing matter into extremely high pressure and temperature causes thermonuclear fusion and radiation. This inward force is what provides the "z-pinch", a phenomenon that has been produced in laboratories by Bostick

[13], Peratt[14], and others. Data resulting from these experiments has been used to drive computer simulations to provide scaling to cosmic dimensions.

It has also been observed that when two plasma filaments approach each other and are nearly parallel, they are attracted and attach, as illustrated in Figure 3. These attachments are the tiny bright spots (believed to be stars) observed in Figure 1. Where there are intersections of many filaments, the plasma density is extremely high. We can see such a bright object in Figure 1.

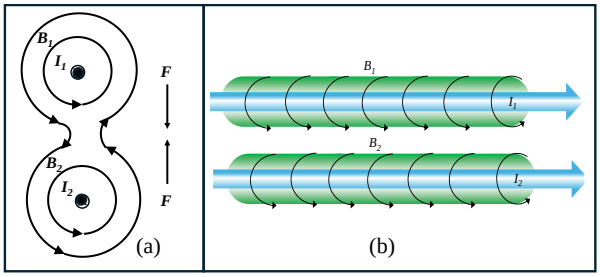

Figure 3. Illustration of magnetic field changes along two neighboring plasma filaments by Birkeland currents. Cross sections shown in (a) indicate how an attractive force. (b) is a side view.

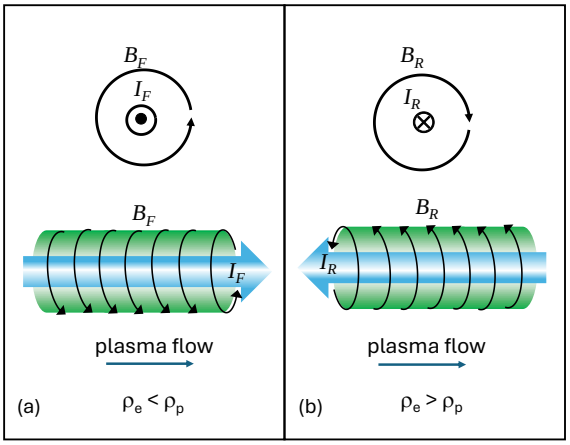

Figure 4. Illustrations of magnetic field changes along a plasma filament formed by a Birkeland current. In (a) the positive ion density dominates over the electron density. In (b) the reverse is true.

It has been observed that the magnetic field surrounding the Birkeland currents changes both temporarily and spatially. The plasma flow consists of electrons and positive ions flowing in the opposing directions yet separated into what is called "double layers". If this is true, the direction of the resultant surrounding magnetic field lines will be governed by the relative density between the electrons in one of the current layers and the positive ions in the other. This is illustrated in Figure 4.

Galactic Circuit

The above discussion leads us to the question, "What provides the force to generate these currents?" A leading plasma physicist, Hannes Alfven, was one of the key research developers in this area of science. In [15] he answered this question, along with a good description of his galactic circuit model, as illustrated in Figure 5. At the center of Alfven's galactic model for generating dual layered Birkeland currents is a unipolar inductor. Any rotating object with a magnetic field that rotates with it can serve as a unipolar inductor. When electric current flows into this rotating magnetic field an electromotive force (emf) is produced to keep the current moving. Notice in Figure 5 is Alfven's cross sectional schematic, showing current arriving at the galaxy (but could be any rotating celestial object such as a star with a rotating magnetic field) in the equatorial plane. Applying the Lorentz force, equation (1), to the charged particles sends them out the north and south poles, depending

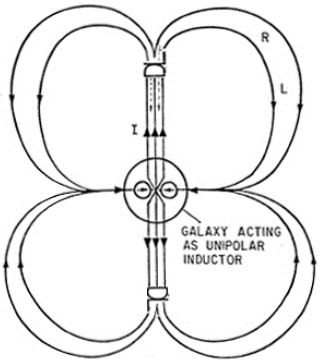

Figure 5. Alfven's galactic circuit.

on the sign of the charge. For this to work the current loop must be closed as shown in the schematic.

Cosmic Web

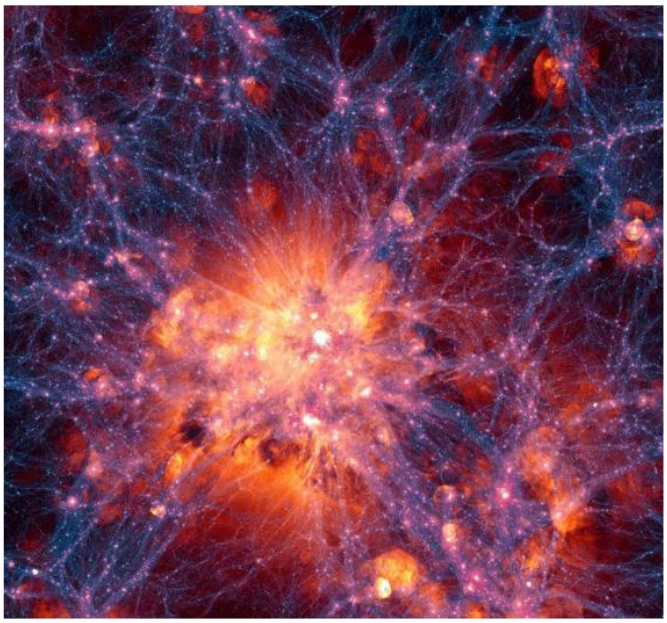

Figure 6. A three-dimensional simulated image of a portion of the cosmic web [16].

With the cosmic conducting and generating circuit elements just described, the model is assembled into a complex network called the "Cosmic Web". Such networks have been observed in the cosmos and the laboratory. Ironically, in the heavy mainstream cosmology pursuit of dark matter, what has instead been discovered through astronomical observation is more plasma filaments full of and connected by stars and galaxies. This is discussed in more detail later in this paper. With the use of empirical data measured in the laboratory and in space, high fidelity computer simulations have significantly contributed to a deeper understanding of the cosmic web as shown in Figure 6. Examining this image reveals all three plasma modes. Where the filaments are not visible, it is plausible that the plasma is in dark mode. The plasma glow mode is observed in the filaments and the arc mode is evident in the bright spots, like strings of pearls, with the intensity proportional to the local plasma density.

Galaxy Formation

The model for galaxy formation in the plasma and the electric universe cosmologies depends mainly on the Lorentz force (equation (1)) as opposed to the standard cosmology in which the Newtonian gravitational force is by far the most dominant. As more Birkeland currents approach each other and intertwine in a swirly motion, the z-pinch described earlier, where the plasma density is very high, this connection becomes the center of rotation for a new galaxy, according to both the plasma and electric universe models. This behavior has been demonstrated in the laboratory (see Figure 7) on a small scale by Winston Bostick[13,14] and computer simulated by Anthony Peratt[14] and several others following him. The angular momentum of these galaxies appears to be generated by the twisting Birkeland currents that

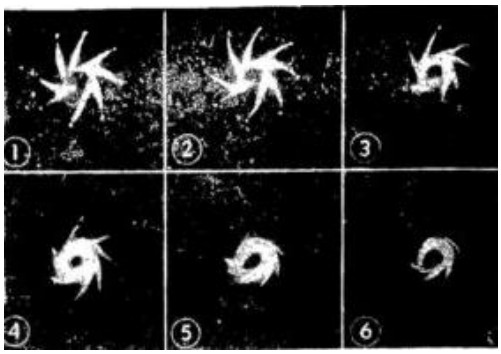

Figure 7. Photographs taken by looking down into Bostick's laboratory apparatus, demonstrating the formation of tiny galaxies by Birkeland currents.

combine to form them where the plasma density is extremely high. In this region there is much nuclear fusion, creating atoms with atomic numbers greater than helium. Centrifugal force propels these atoms outward, leaving a hole in the center. In plasma cosmology and the electric universe this is the hole is the inside of a plasmoid. It is only "black" because of lack of radiant matter. Plasma physicists and cosmologists believe what has been demonstrated in the laboratory is scalable to what has been observed by telescopes such as HST and JWST.

Quasars

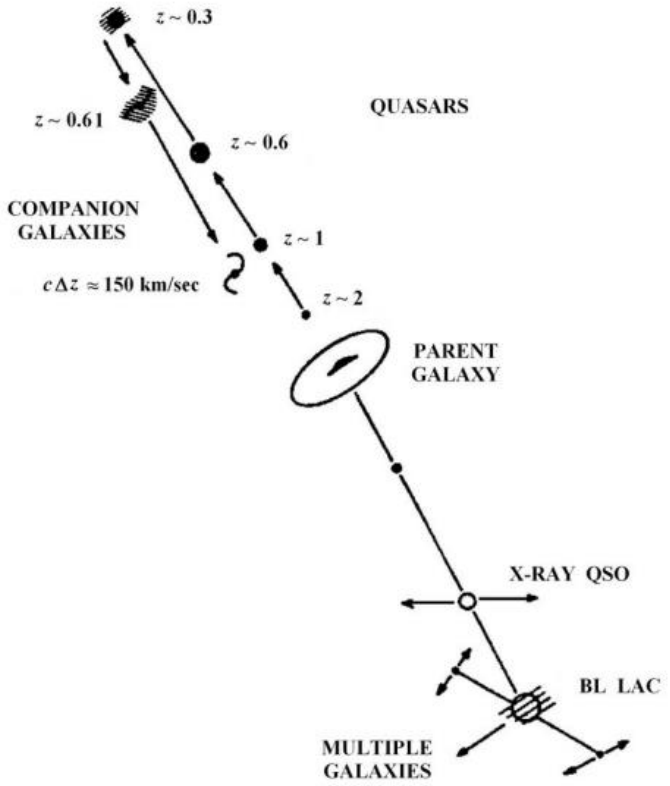

Figure 8. Halton Arp's diagram of a galaxy spawning a quasar with successive drops in redshift [17].

The plasma galaxy formation model just described has also been confirmed in Halton Arp's astronomical research [17]. Quasi-stellar objects, or quasars, were discovered in the 1960's. They exhibit enormous amounts of energy and luminosity in the radio wave portion of the electromagnetic spectrum. Observing the emitted light at such intensities in this part of the spectrum translates to significant redshifts.

Two key proponents for intrinsic redshifts have been the aforementioned Halton Arp and his colleague, Jayant Narlikar. In their co-authored 1993 paper [18], they laid out their claims and rationale, heavily supported by observational data, that quasars are created and ejected by parent galaxies called active galactic nuclei (AGN's). Halton Arp included an illustration of this in [17] as provided in Figure 8. Their model includes the assumption that, when a quasar is in its early stage of development, electron mass is less than what it becomes as the quasar matures. The initial redshift is therefore significantly higher in the beginning due to the lesser energy transition of electrons in the emission of a photon. At ejection, via Birkeland currents, the quasar, in the form of a plasmoid, undergoes extremely high acceleration away from the parent AGN. As the velocity increases, the mass is assumed to increase as well, resulting in significant increases in energy. This results in redshift reduction. Once the ejection force diminishes, the application of momentum conservation requires that the electron speed must decrease but yet still maintain the high energy that was gained by increased mass. This is illustrated in Figure 8. The quasar eventually forms into a galaxy and then spawns more galaxies. Such an explanation by Arp, Narlikar, Hoyle, and others provides an interesting theory for galaxy formation.

Over many years, Arp documented a host of observations where the quasar redshift and that of its nearby parent galaxy had sizable differences [17]. Critics, supporting the expanding universe model, claim the quasar is in a far more distant location. However, these critics cannot fully account for the observed quantization of redshifts where Arp's model does. Much more can be written here on this topic but that is not the purpose of this paper. Before moving on, however, it should be mentioned that, in Arp's catalogue [17], the highest quasar redshift recorded was 4.39 and the highest since then [19] is 7.64.

Langmuir Waves

A critical part of both the plasma and electric universe models is understanding what is the driving force that propels the ions and electrons in the Birkeland currents from one source to another. Irving Langmuir was one of the leading pioneers in this area. He is the one who dubbed this ion and electron mixture "plasma". In 1929 he, along with his colleague, Lewi Tonks published a paper that clearly describes plasma longitudinal wave propagation phenomenology, including derived equations and laboratory observations [20]. In this paper the authors provided derivations of key equations such as plasma oscillation frequencies that are generated by the electrostatic attraction between the free electrons and positive ions:

$$\nu = \left(\frac{ne^2}{\pi m_p + ne^2 m_p \lambda^2/(kT_e)}\right)^{1/2} \tag{4}$$

where ν is the Langmuir wave frequency, $\boldsymbol{n}$ is the electron density, $\boldsymbol{e}$ is the electron charge, $\boldsymbol{m_p}$ is the positive ion mass, λ is the plasma wavelength, k is the Boltzmann constant, and T_e is the kinetic temperature of the electron. When the second term in the denominator dominates, the ion acoustic wave mode is observed. When the first term in the denominator dominates a plasma wave is observed. The combination between these two extremes is what is called a Langmuir wave. Equation 4 has been validated in the laboratory and has been used to study measured Langmuir waves at different distances near the sun as they propagate toward the earth.

The electron beam speed within the Birkeland currents can also be determined as follows [21]:

$$V_b = \frac{2 f_{pe} V_{SW} cos(\theta)}{f_S} \tag{5}$$

Where f_{pe} is the plasma frequency, V_{SW} is the solar wind, θ is the angle between the solar wind vector and the beam direction, and f_S is the acoustic frequency. This equation assumes the acoustic wave speed is much lower than solar wind velocity projected onto the beam direction.

Langmuir waves not only exist in the laboratory but throughout the universe as well. Hannes Alfven's application of Langmuir's work has played a key role in understanding what propels the charged particles within Birkeland currents. Langmuir waves have been measured via instruments on satellites near the sun [22]. Langmuir wave frequencies are in hundreds of megacycles and are

therefore radio waves which can be measured. Using equations such as (4) we can solve for electron density, n. Such a relationship is extremely helpful in understanding the nature of Birkeland currents.

Alfven Waves

Alfven waves represent another form of plasma waves. Their predicted behavior has been verified by both heliospheric and laboratory measurements. By heliospheric, I am referring to in situ measurements on board satellites that were relatively much closer to the sun than the earth [23]. These waves, unlike Langmuir waves are much lower in propagation frequency. They are also transverse as opposed to longitudinal. They carry enough energy to transport the plasma from the sun to the earth's ionosphere and create the auroras we call the Northern Lights. It is believed by many that they, combined with the solar wind, are the driving propulsion of the plasma particles in the Birkeland currents. The research that led to the discovery of this phenomenon is largely attributed to Hannes Alfven. Figure 9 [24,25] illustrates on a grand scale how Alfven waves are generated and propagate away from the sun. Plasma particles oscillate around magnetic field lines, forming Birkeland currents.

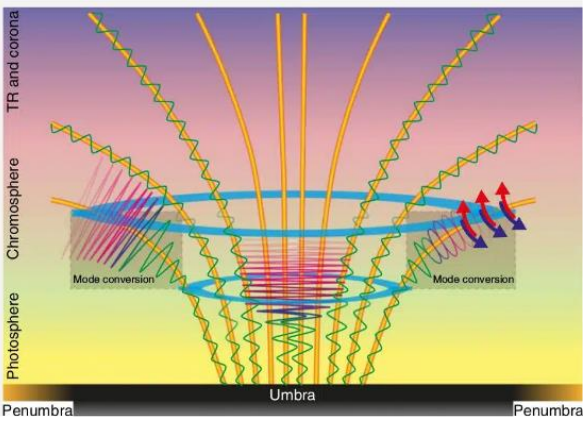

Figure 9. National Solar Observatory illustration of Alfven wave dissipation in the solar chromosphere [24,25].

Critical and interesting parameters related to Alfven waves are their propagation frequencies and velocities [26]. Using the plurals here is intentional since there are two related frequencies and two velocities. Alfven waves are both compressional (CAW) and shear (SAW). SAW's are anisotropic in their direction while CAW's are isotropic. In uniform plasmas, SAW angular frequency, $\omega \cong \boldsymbol{k}_{||} v_A$ where $\boldsymbol{k}_{||}$ is the parallel component of the wave vector, and v_A is the Alfven wave phase speed. For CAW's the angular frequency in uniform plasmas is $\omega \cong k v_A$, where k is the wave number per unit length. In terms of wave speed, for SAW's, the wave group velocity is along the primary magnetic field vector, $\boldsymbol{B_0}$, so $v_g \cong v_A \boldsymbol{b}_0$ where $\boldsymbol{b}_0$ is the magnetic field unit vector. The plasma particles move predominantly along $\boldsymbol{B_0}$ with velocities not far from v_A.

Magnetohydrodynamics (MHD)

Magnetohydrodynamics is a field of research that blends electromagnetics with fluid flow dynamics. The mathematics, theories and laws governing MHD are what have been used to develop the work and phenomenology understanding described in this paper. Plasma, which makes up over 99% of the universe according to NASA , is treated as a fluid consisting of positive ions and electrons across a wide variety of densities. Birkeland currents are double layers of current with one layer of positive ions flowing one direction and the other layer consisting of electrons flowing in the opposite direction and since the electrons are opposing in charge, they contribute to the current flowing in the same direction as the positive ions. This has been

demonstrated many times, originally by pioneers in the field such as Birkeland, Tonks, and Langmuir.

As stated earlier in equation (1), when an electric current passes through a magnetic field, there is a force (the Lorentz force) applied in a direction perpendicular both to the that of the current and the magnetic field. What makes MHD so complex is that when a charged particle is forced to move in a circular path by a magnetic field, it generates a current loop that creates a secondary magnetic field. This secondary magnetic field then acts on another charged particle or itself, spawning a tertiary magnetic field, and so on. Some success, however, has been achieved through the blending of Maxwell's laws of electromagnetics with Navier-Stokes equations for fluid dynamics.

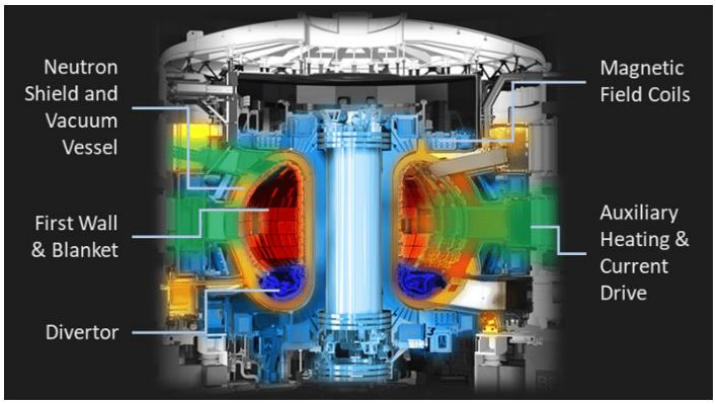

Figure 10. Illustration of a nuclear fusion reactor [27].

MHD has been demonstrated through laboratory experiments and cosmic observations. It has been used in a wide range of applications in metallurgy, nuclear fission, nuclear fusion, plasma cosmology, astrophysics, geophysics, and arc welding. It is now being applied to propulsion motors as well. Such applicability exists due to decades of scientific research and development. For nuclear fusion reactors such as the one depicted in Figure 10, it is imperative to understand and predict stability as well as instability in phenomena such as Langmuir waves, z-pinches, Birkeland currents, and radio waves generated by synchrotron radiation of helically accelerated electrons.

Scott's Birkeland Current Research

A recent key contributor to the electric universe model, Dr. Donald Scott has done much research in Birkeland currents. Earlier in this article, for the sake of simplification, I introduced Birkeland currents of being dual layered. Scott has shown through equation derivation using Bessel functions, backed by astronomical observations, that there can be several layers. Furthermore, he has found that when viewing a cross section of these layers they do not all rotate in the same direction as illustrated in Figure 11. An example of these are the ring patterns on the north pole of Neptune, as shown in Figure 12, which is an excerpt from a Nasa video that captured this

Figure 11. Illustrated cross section of a multilayered Birkeland current indicating counter rotating motion of particles [28]

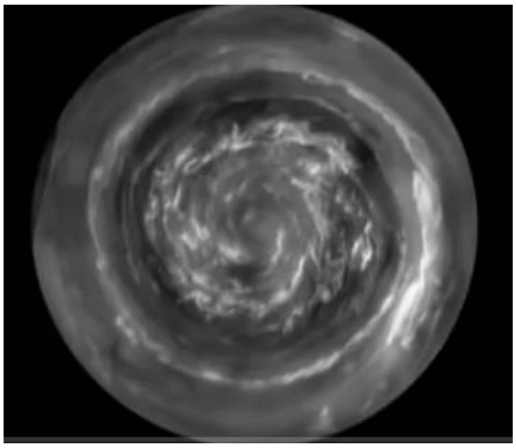

Figure 12. NASA photo of Neptune's north pole [28].

view looking down from the planet's north pole. Astronomers have long been puzzled by counter rotating concentrical rings of observable matter in galaxies. The theory of Birkeland currents accounts for this phenomenon. Due to its controversial threat to the standard cosmology (i.e. Big Bang), such observations and analysis are not accepted in the current astrophysics community.

Aurora Borealis

A strong element of evidence supporting the Birkeland current model, and consequently plasma and electric cosmologies is the Aurora Borealis, also known as the "auroras" or "Northern Lights". This phenomenon is easily observable from the ground at high latitudes although recently at even lower latitudes due to abnormally high sunspot activity. It is understood that these colorful light exhibits are caused by high energy particles (electrons and ions) from the sun, colliding with oxygen and nitrogen molecules in the upper atmosphere. These interactions result in emission of light due to electrons transitioning from higher to lower energy states. Such transitions in oxygen yield red and green light while those in nitrogen emit blue and purplish light. Figure 13 shows a photo of the auroras where red and green appear to dominate over blue and purple, suggesting more oxygen than nitrogen.

Figure 13. A night sky view of the auroras [29].

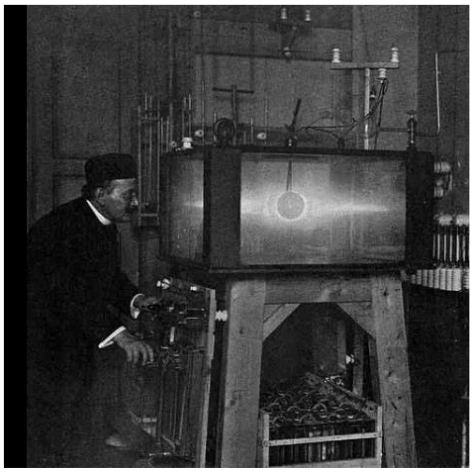

Figure 14. Kristian Birkeland in his laboratory (photo credit Wikipedia).

Kristian Birkeland was one of the first to determine that what we see in the auroras are the effects of field aligned currents (FACs). He was able to produce them in his laboratory in the early 1900's as shown in Figure 14. Unfortunately, his work was rejected by the mainstream physics community. Recently, however, observations and simulations [30] are showing Birkeland was right. However, rather than using the name "Birkeland Current", the accepted acronym, FAC, is used.

Direct in situ measurements of the auroras in space have also confirmed the Birkeland current model. A screen capture of an International Space Station (ISS) photograph is provided in Figure 15. Birkeland currents descend towards the earth from the sun. Once they reach the magnetosphere, the currents change direction, traveling along horizontal paths across the polar region until the earth magnetic field reverses. This drives the currents away from the earth, following the Alfven wave model described earlier.

Figure 15. A screen capture of a video recorded onboard the ISS showing the auroras conducting Birkeland currents at high latitudes in the ionosphere.

EU Distinctions from Plasma Universe

There are distinct differences between the plasma universe and EU models. EU is roughly considered to be an extension of the plasma universe, analogous to the multiverse being an extension to the ΛCDM model. Immanuel Velikovsky is considered by many to be the originator of the EU, a model he described with great detail in his book, "Worlds in Collision" [31]. Neither of these models address in depth the inner mechanism of a star nor origin of the universe. Plasma advocates seem to accept the thermonuclear model from the standard cosmology. EU advocates address the outer shell of a star to be electric similar to the charged particle carrying layers within a Birkeland current. Velikovsky's EU model faced strong criticism and rejection from the mainstream physics community. However, since critical plasma cosmology components, such as Birkeland currents and Z-pinches, have been observed both in the laboratory and in space and are consistent with what was predicted, other key figures in the EU stepped up in the 1990's to carry Velikovsky's baton and advance the EU further. One of the most well-known of these was Wal Thornhill [32].

Wallace ("Wal") Thornhill, a plasma physicist who recently passed away, was perhaps one of the most well known among the EU proponents. Thornhill focussed on plasma research similarly to others such as Velikovsky, Arp, Alfven, Scott, Sansbury, and Peratt. Throughout his career, Thornhill contributed much to the advancement of the EU in books such as "The Electric Universe" [33], articles such as[eg., 34], technical papers such as[10], speaking engagements, and documentary videos.

As shown in Figure 16, both models agree there was no big bang. Neither cosmology addresses the origin, probably because their proponents are empiracally motivated and prioritize their research on what can be observed and understood via magnetohydrodynamics. Both models are well established with successful predictions in plasma physics, with the key atributes being Birkeland currents forming filaments that provide the cosmic web structure, and form stars and galaxies via z pinches. The models part ways in areas such as star structure, cause for redshifts, expanse of documentation, role of gravity, the effects of plasma current flow on stars and galaxies, and EU's scale-unlimited applications.

Plasma Universe	Electric Universe
Commonalities:	
Excludes "Big Bang".	Excludes "Big Bang".
Universe is 99.9% plasma.	Universe is 99.9% plasma.
Filaments provide structure and transp	Filaments provide structure and transport.
Stars and galaxies formed by Z-pinch.	Stars and galaxies formed by Z-pinch.
Contrasts:	
Stars are assumed to be thermonuclear	Stars are assumed to be electric.
Redshift caused by tired light.	Redshift is mostly caused by age of the emitter.
Well documented.	Partly documented.
	Extensions:
	Fundamental force is electric.
	Flow of current affects stars and galaxies.
	Electric model is applied at every scale.

Figure 16. Main commonalities, contrasts, and extensions related to the Plasma and Electric Universe model.

Much EU-based research and development has been performed through what is called the SAFIRE (Stellar Atmospheric Function in Regulation Experiment) Project [35]. This development is now caried on by Aureon Energy Ltd, a new energy company based near Toronto, Canada. They have developed a plasma nuclear reactor based on the EU solar model and have had success with prototypes, generating not only clean efficient energy but matter composed of nine to eleven atomic elements as well, including rare earth materials. The SAFIRE reactor is a highly sophisticated spherically shaped vacuum chamber with a solid metal spherical anode rigidly attached in the center. A high voltage difference between the outer shell and the anode is applied. Hydrogen is injected into the chamber and begins the fusion process, creating energy and products which are the elements mentioned previously. Figure 17 shows the plasma glow inside the chamber. Aureon is now developing a full reactor, including turbine and control system.

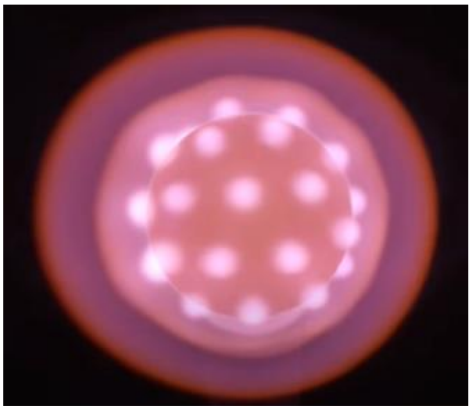

Figure 17. Aureon photograph of the plasma glow within the SAFIRE chamber [35].

Eric Lerner, the chief scientist at LPP Fusion is considered by many to be today's leader for the PU. He has done much research in plasma physics, written books and several papers [36] on the subject and is currently a major contributor to the development of a plasma nuclear reactor at LPP Fusion. Lerner is also probably the leading critic of what he calls the "Big Bang Hypothesis" and exposes the failures of this model based mainly on observations provided by the JWST (James Webb Space Telescopt) and the HUDF (Hubble UltraDeep Field).

Major Criticisms and Responses

There are some major criticisms of the PU and EU and they have come mainly from ΛCDM proponents. The ones with which I am familiar are now addressed.

Most dominant among these is that the universe is believed to be balanced with respect to charge and therefore as a whole, cannot impose an effective force as gravity (the major player in the ΛCDM model). PU and EU proponents rightly counter this with the empirically proven behavior of quasi-neutrality. That is, over a large volume the balance of charges may be neutral but the distribution within that volume is not necessarily homogeneous, meaning there are pockets where positive ions dominate over electrons, current densities have proven to be highly unbalanced both spatially and temporally. This has been measured in Birkeland currents. Such diversity in charge density creates an environment where electromagnetic force is much greater than that attributed to gravity.

Secondly, LCDM proponents criticize PU and EU for the seeming lack of explanation for the cosmic microwave background (CMB), one of the main pillars for the ΛCDM model. Eric Lerner addressed this question in a paper [37], stating :

> "In contrast to the conventional big bang hypothesis, the model assumes that helium, deuterium and the microwave background were all generated by massive stars in the early stages of galaxy formation. The microwave background is scattered and isotropized by multi-GeV electrons trapped in the jets emitted by active galactic nuclei. The model produces reasonable amounts of heavy elements, accurately predicts the gamma-ray background intensity and spectrum, and explains the statistics of quasars, compact and extended radio sources."

Robitailli, though not a plasma cosmologist, yet a leading expert in image spectroscopy, has also done much research in this area with his own analysis of the CMB empirical data (including Penzias and Wilson, COBE, WMAP, and Planck satellites) [38]. He concluded that the source of the CMB is not cosmic but resides within our own galaxy.

The driving motivation for the invention of "dark matter" in the big bang hypothesis has been the observation of unexpectable flat trend for rotation rates with increasing distance from the center of spiral galaxies. Computer simulations model this "substance" to match what is actually observed. Big bang proponents criticize plasma based cosmologists for their explanation, which is basically that every massive object within a galaxy is connected via the electromagnetic forces prevalent in the plasma filaments. There is now compelling observational evidence that the missing matter is not dark but visible in the form of plasma as shown in Figure 18. It has been discovered by using the HUDF image data [39].

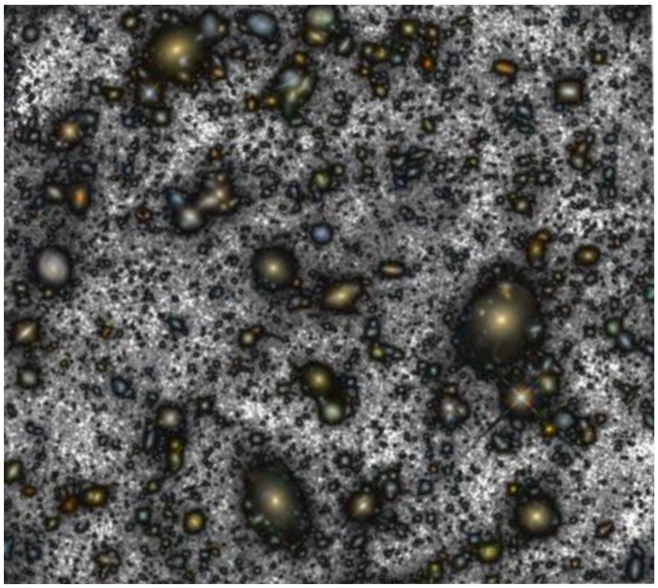

Figure 18. Luminance-RGB image from the HUDF showing in gray tones what has not been visible before now.

There has probably been more criticism of the EU model over the PU model due to what I refer to as extensions in Figure 16. The recently deceased Wal Thornhill was the leading representative and perhaps strongest proponent for EU. His stance concerning gravity was that it is actually an effect caused by the electric force, physically attributed to quantum vacuum electric dipoles.. Thornhill was also a strong believer that ether exists (this has been proven in the Casmir effect experiment [40). This ether is densely populated with virtual particle pairs of opposite charge, thereby forming electric dipoles. Thornhill was also the chief engineer and leader for the Thunderbolts Project, a consortium of scientist and engineers that support the EU model. There he has written many articles such as one proposing the Electric Sun model [41]. Another EU extension is that the principles governing the cosmos (e.g., Birkeland currents, ether, z-pinch) also govern physics on every scale, down to the atomic level. Finally, there has been criticism of a seemingly lack of peer-reviewed technical papers regarding research developments on EU projects such as SAFIRE. This is partly due to the bias of the "accepted" journals towards the standard big bang model.

Conclusion

As I bring this paper to an end, my general assessment of plasma based cosmologies such as PU and EU is that they have been strongly established with compelling observational data, both in the laboratory and in space, including the ionosphere and solar orbits. There has been no necessity for such unknown and unobservable entities such as dark matter, dark energy, or cosmic inflation. What has been discovered and made well understood are such predicted and observed phenomena as plasma filaments, Birkeland currents, and z-pinch star formation. Such science has cleared the path to extremely valuable technology spinoffs such as clean and safe nuclear energy, ion propulsion, and rare earth material formation. Research in Birkeland currents has also played an important part in understanding climate change in the area of solar forcing. More research funding should be channeled into developing these technologies.

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