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An Evaluation of Plasma Astronomy

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Abstract

Many recent creationists are attracted to plasma astronomy, the idea that electromagnetic effects rather than gravity are responsible for much of the structure of the universe. I examine the claims of at least one proponent of plasma astronomy, Donald E. Scott. Scott has written a book that discusses many aspects of plasma astronomy. This book appears to be the most concise treatment of plasma astronomy in print, so it ought to be a good source. However, his case is very weak, for he relies upon many misunderstandings of astronomy, and he presented much incorrect and misleading information. He also rejects general relativity, a well-tested physics theory. I urge extreme caution of these ideas in the creation community, and I encourage fair consideration of the operational science aspects of astronomy.

Keywords: plasma, astronomy

Introduction

For nearly a half century the dominant cosmogony has been the big bang theory. The big bang became the standard cosmology shortly after the discovery of the cosmic microwave background (CMB) in 1964 (Penzias and Wilson 1965). Prior to this, the steady state theory had wide support, but it largely was abandoned, because the steady state theory did not predict the existence of the CMB as the big bang model had. The steady state theory appealed to many people, because it relied upon the universe being eternal, which was a common idea in western thought going back to the ancient Greeks.[1] Besides causing a complete reevaluation of the history of the universe, the universe having an origin in the finite past hinted of theism to many scientists. Despite the atheistic direction that the big bang model has increasingly taken, some atheists remained committed to the steady state theory (or its variants). For instance, Sir Fred Hoyle, one of the main proponents of the steady state theory until his death 2001, was an atheist. I have not been able to identify a single theist among current supporters of the steady state theory. After the big bang became the dominant cosmogony, supporters of the steady state theory began to publish papers and hold conferences. At first their efforts concentrated on arguing against the big bang model, but they began to realize that they needed an alternate explanation for the universe. Eventually some supporters of the steady state model began to explore plasma explanations of things that we see in the universe, such as spiral structure of many galaxies. The publication of *The Big Bang Never Happened* (Lerner 1991) more than two decades ago brought much attention to the efforts of those pursuing plasma explanations in the universe. The first chapter of this book is a good description of problems with the big bang model, and the remainder of the book offers plasma cosmology as an alternate.

Because of the provocative title and its critique of the standard cosmology, some recent creationists read and liked Lerner's book and began adopting elements of plasma cosmology. Since that book's publication, plasma theorists increasingly have offered alternate explanations of more astronomical phenomena, such as nebulae, stars, and planetary surfaces. For purposes here, I will call this field of study plasma astronomy. Because I saw some recent creationists forwarding many of the claims of plasma astronomy, I thought that there was a need of a review of this field. There are technical articles on plasma astronomy, but they generally are not published in the astronomical literature. Instead, articles on plasma astronomy typically are found in publications of the Institute of Electrical and Electronics Engineers. As with any technical treatments, these articles concern themselves only with limited aspects of the subject. There are more general treatments on the internet, but I preferred something in print. I asked a creationist supportive of plasma astronomy for a single book that I could read, and that person recommended Donald E. Scott's book, *The Electric Sky* (Scott 2006). I haven't found another source that treats the subject of plasma astronomy so broadly. Scott has a Ph.D. in electrical engineering and for many years was a professor of electrical engineering. It appears that many of the supporters of plasma astronomy are electrical engineers. This ought to make them knowledgeable of plasma, but it doesn't necessarily qualify them in astronomy. In many respects my review of plasma astronomy will amount to a review of Scott's book. I

[1] The steady state theory required a rejection of the conservation of mass, opting instead for the assumption of conservation of average density in the universe. The appearance of matter to maintain constant density as the universe expanded led to an alternate name for the steady state theory, the continuous creation model. This substitution of constant density for constant mass apparently was of no great concern to many steady state theory proponents.

apologize for the length of this article, but anything less would not be a thorough discussion.

A Misunderstanding of What Astronomers Do

Very early in the book I encountered a statement that I knew was blatantly false:

> They (astrophysicists) rarely take any courses that discuss Maxwell's equations and electromagnetic field theory. (Scott 2006, pp. 2–3)

This statement reveals a fundamental misunderstanding of astronomy and of the education of astronomers. The recommended and most common undergraduate major for a budding astronomer is physics. An undergraduate degree in physics normally requires two semesters of electricity and magnetism, which includes Maxwell's equations. Most professional astronomers have a Ph.D., with about half of those degrees in astronomy and the other half in physics. The large number of physics degrees is because many universities don't have separate astronomy departments but instead treat astronomy as a subdiscipline within their physics departments. Any Ph.D. program in physics requires some course work in electricity and magnetism, with the standard text being that of Jackson (1975) (the course I took used this book). Even those astronomers who completed their doctorates within an astronomy program normally take graduate physics courses as well, and many of them have enough course work for a doctorate in physics. Thus, nearly every professional astronomer has taken graduate courses in electricity and magnetism including Maxwell's equations and electrodynamics. This wrong impression on Scott's part did not bode well for the rest of the book.

This misunderstanding continued throughout the rest of the book with numerous accusations of how astronomers have ignored plasma effects (for instance, page 78 and again on page 129). It is true that early on astronomers resisted the idea of plasma in space. This resistance mostly stemmed from the belief that interstellar space was absolutely empty. Starting in about 1930 astronomers began to realize that space is not empty, and so that picture slowly began to change. Today astronomers invoke plasma in all sorts of domains, so Scott's complaint is many decades out of date. Nearly all astronomers take a graduate level course in the interstellar medium (ISM). For three decades the standard text was that of Spitzer (1978). This is the text that I used when I took a course on the ISM. Scott complains that astronomers have ignored the contributions of Hans Alfvén, but the work of Alfvén was discussed several times in that class. Much has been learned about the ISM in recent years, so Draine (2011) authored a text to replace the one by Spitzer. Chapter 10 of this text is entitled "Emission and Absorption by a Thermal Plasma." The following chapter, entitled "Propagation of Radio Waves through the ISM" begins with these words, "Radio waves propagating through a plasma interact with the plasma particles…." (Drain 2011, p. 101). These two chapters explicitly deal with plasma interactions, but plasma topics repeatedly come up elsewhere in these texts. Thus the accusation that astronomers ignore plasma effects is false. Unfortunately, almost no one reading Scott's book would realize this. However, it is true that astronomers generally do not invoke plasma explanations to the degree that plasma astronomy enthusiasts do.

A Revision of History and the Philosophy of Science

Scott similarly claims that astronomers initially opposed the idea of charge separation in space, saying,

> Another "ugly" experimental finding that has forced a silent about-face in astrophysics is the discovery of large amounts of electrical charge in space. (Scott 2006, p. 21)

As with the claim that astronomers once resisted the idea of plasmas in space, there is truth to this. However, I question how silent the about-face was. Once astronomers realized how much gaseous material there was in space and how much ionizing radiation was present, it was very easy to conclude that ions existed in space. Again, these denials about charged particles in space have not been my experience (Scott mentions a "teaspoon of salt" (Scott 2006, p. 21) lecture supposedly given in astronomy graduate school classes illustrating the lack of ions in space, but I never heard such a lecture nor have I ever given one.) At best, his argument here is decades out of date.

On page 22 Scott makes similar claims about magnetic fields in space. Astronomers have mapped and measured such fields for decades, so, at best, Scott's argument is far out of date. He also asserts that the magnetic field energy density exceeds the gravitational energy density among local galaxies by an order of magnitude. This is supported by a private communication, so I cannot verify the nature of this claim. Astronomers have measured magnetic fields in the galaxy using several methods. Han et al. (2006) measured Faraday rotation of pulsars to determine large-scale magnitude fields. Their results varied according to location, but they found that the magnetic field typically is a few micro-Gauss. A magnetic field of this strength easily can dominate the motion of a charged particle, such as a proton, in the ISM. No one disputes this. The problem with plasma astronomy is that much matter in the universe, such as stars, appears to be electrically neutral. If so, then this magnetic field is of no effect.

Also on page 22 Scott attempted to show how magnetic fields predominate over gravity by pointing out that a small magnet can lift a ball bearing against gravity. Left unsaid is that this works only if the material under consideration is ferromagnetic, and it requires a considerable magnetic field. Of course, being made of steel, a ball bearing is ferromagnetic. Ferromagnetic dust exists in interstellar space. Dust particles often are elongated, having a whisker shape. The alignment of these whiskers with magnetic fields polarizes starlight. Thus, astronomers can use polarization measurements to infer magnetic fields in the ISM. However, much of matter in space is not ferromagnetic. Magnetic fields can exert forces on charged particles, provided that there is relative motion between the charged particles and the magnetic fields. It is revealing that astronomers invoke just this scenario in a wealth of situations, though one would miss this entirely by reading Scott or other plasma astronomy supporters.

In quoting astronomers and astrophysicists, Scott either intentionally misrepresented what they have said, or he didn't understand the quotes. For instance, Scott quoted John Wheeler,

> To me, the formation of a naked singularity [a black hole] is equivalent to jumping across the Gulf of Mexico. I would be willing to bet a million dollars that it can't be done. But I can't prove that it can't be done. (Scott 2006, p. 15)

Scott then comments,

> What he is actually saying is—"YOU can't prove that black holes don't exist, so I am free to use the concept as often as I like." It is a non-falsifiable hypothesis. It is intellectually dishonest. Scientists worldwide should have instantly challenged it. It should never have passed peer review. (Scott 2006, p. 15)

There are several problems here. First, Scott doesn't give a reference for the Wheeler quote, so it is impossible to check whether Wheeler actually wrote this,[2] and, if he did, to judge the context. This is strange, for Scott generally was good at providing references in his book.[3] Second, I can only assume that Scott inserted the words "a black hole" in the brackets in Wheeler's alleged quote. This is important, because Wheeler, who literally co-wrote the book on the physics of black holes (Misner, Thorne, and Wheeler 1970), certainly knew that a naked singularity and a black hole are not the same thing (a naked singularity has no event horizon; black holes do). Third, Scott apparently doesn't know the difference, or else he wouldn't have misused this quote. Scott continued building on his misunderstanding on pages 17–18 by accusing Wheeler of reifying singularities, that is, applying a mathematical abstraction to physical entities. But Wheeler did no such thing. Instead, there is a recognition that our physics breaks down near a black hole. A black hole's event horizon marks the boundary of where our physics breaks down.[4] Physics, as we now know it, can't handle the very high densities that must exist within a black hole event horizon, so singularities exist in the mathematical description there. Note that this is a failure of our mathematical description of physics, signaling that our physics likely is incomplete; perhaps a new development eventually will allow us to describe a black hole interior without the mathematical singularities. Because of Scott's fundamental misunderstanding of what a black hole is (and isn't), it is difficult to accept any of his criticisms of black hole physics.

On pages 19–21 Scott attempted to recount the history of our understanding of the atmosphere of Venus. What Scott said here had nothing to do with advancing the plasma model, so I suppose that this was merely an effort to show how astronomers have been wrong in their thinking. His account is so badly garbled, it is difficult to evaluate, but I will try. It is true, as he stated, that astronomers once thought that Venus had a benign atmosphere that gave it warm but comfortable temperatures globally. We've since learned that the surface temperature is extremely high, as Scott also correctly pointed out. But why was our understanding of Venus in error? It wasn't because of some preconceived notions (other than perhaps a desire that some other planet harbor life), but because of a complete misunderstanding of the composition and density of the venereal atmosphere. The temperature is high because of the greenhouse effect. But once astronomers got the atmospheric composition correct, they readily accepted the high surface temperature of Venus. In his discussion, Scott confused the greenhouse effect with the runaway greenhouse effect. The runaway greenhouse effect is an attempt to explain the evolution of Venus's atmosphere, not the explanation of why it is so hot now (that is the greenhouse effect).

Furthermore, Scott suggested that convection ought to take hot gas to the upper atmosphere where it can radiate its heat into space. This overlooks the fact that hot gas expands and cools as it rises so that Venus's upper atmosphere is much cooler than the atmosphere near the surface (this is a common feature in all atmospheres). The pressure in the

[2] I tried several Google searches for the quote and failed to find it.

[3] Scott also failed to reference a quote from Stephen Hawking on p. 13 and an unnamed "defender of black holes" on p. 16. Why these omissions? Could it be that the quotes are out of context or otherwise misrepresented?

[4] Since the event horizon prevents us from probing the interior of a black hole, the event horizon effectively clothes the black hole, so a black hole is not a naked singularity.

upper atmosphere is low, and relatively low pressure gases cannot emit blackbody radiation (Kirchhoff's first and second laws of spectroscopy), so they don't effectively shed heat. Rather, the tops of the clouds in Venus's atmosphere, being made of droplets or solid particles, emit radiation, but they are much cooler than the temperatures lying at lower levels, so they don't do this very efficiently. This is the mechanism that does let heat escape from Venus, so a steady state temperature is maintained in much of the atmosphere. I found it interesting that while Scott thought that he had shown that conventional astronomy could not explain the high surface temperature of Venus, he offered no plasma explanation for it either. It appears that Scott is convinced that astronomers are wrong about so many things, and it has clouded his judgment on this matter. Incidentally, in this matter Scott made a distinction between a cosmogonist and a cosmologist that he states has "general acceptance among astronomers." I am totally unfamiliar with his definition of a cosmogonist.

In Chapter 3 (and elsewhere in the book) Scott took astronomers to task (and many physicists too) for not properly doing science. For example, on page 22 (and mentioned again on page 97) he accused astronomers of overreaching by claiming that they can probe the sun with helioseismology. Scott argued that since astronomers rely upon naturally occurring vibrations in the sun to do helioseismology rather than producing vibrations themselves this is not experimental science. Geologists long have used natural earthquakes to probe the earth's interior. This is a false dichotomy between helioseismology and geoseismology—between active and passive measurements. The source of the wave is immaterial. The only advantage to inducing vibrations is that one can measure the vibrations when and where one wants to instead of relying upon natural vibrations. The induction of sound waves in the earth is useful in probing local geology, but as far as I know, deep probes of the earth's interior still rely upon naturally-occurring waves, but Scott apparently doesn't understand this.

It is true that for the most part astronomy is an observational rather than experimental science. But where is it written that science must be experimental? Sir Isaac Newton is recognized as one the greatest scientists who ever lived. While Newton did some experimental science (mostly in alchemy), his best work was in observational science. For instance, Newton's great breakthrough was realizing that the force that compelled the moon to orbit the earth was the same force that attracted objects at the earth's surface. Knowing the moon's distance and orbital period he was able to compute the acceleration required keeping it in orbit, and knowing the acceleration of gravity at the earth's surface and the moon's distance he was able to determine his law of gravity. The moon's distance and orbital period, and the acceleration of gravity had all been determined previous to Newton, largely through observational rather than experimental means. With his law of gravity, Newton was able to derive Kepler's laws of planetary motion, which had adequately described the motions of the planets and the satellites of the planets then known. Even Kepler had determined his three laws empirically by working with observational, rather than experimental, science. If we were to follow the standard espoused by Scott, none of this is science. Archaeology has neither experimental nor observational evidence (operational) but must rely on the evidence left by past events (historical). Yet it is still a valid science.

Without doubt Newton was one of the first theoretical physicists. Scott doesn't think much of theoretical physicists, as evidenced by his treatment of Albert Einstein (page 23). Scott charged that Einstein "never went near a physics lab." Einstein did complete a doctorate in physics, and it's inconceivable that one could do that without ever being in a physics lab. This false statement is further undermined by the fact that Einstein spent several years employed at the Swiss patent office, where his job was examining patent applications for electromagnetic devices. He was still employed there in 1905 when he completed his doctorate and published his four groundbreaking papers. Scott dismissed general relativity because Einstein conceived it by doing thought experiments. He claimed that such an approach has merit in deductive reasoning but not in science. Again, to be consistent, Scott must dismiss Newtonian physics on the same basis. Both Newtonian physics and general relativity have tremendous amounts of experimental data supporting them. Scott went on to make the accusation of circular reasoning against those who offer the observation of the Einstein Cross (a manifestation of gravitational lensing) as evidence of general relativity, for he stated,

> Now that experts accept the GR Theory, any new data (such as photographs of the astronomical object known as the "Einstein Cross") are discussed only within the context of this complicated theory. The images of the four small objects in the Einstein Cross, when looked at only from this viewpoint, are considered to be supporting evidence for the GR Theory. The Theory is used to interpret the data and then the data are used as proof of the Theory—a perfect example of circular reasoning. (Scott 2006, p. 23)

Scott's discussion here has the history backwards. Optical effects of GR, such as rings and crosses, were predicted long before they were found. Thus, there is no circular reasoning in this. Scott's approach here is typical of those who distrust general relativity theory—they conveniently omit the vast body of evidence in support of general relativity. General relativity has been one of the most experimentally tested theories of all time, but one would not get that by reading Scott.

In another swipe at general relativity, Scott criticized gravitational lensing as the standard interpretation of pairs of quasars (page 33). Astronomers occasionally find nearly identical closely spaced quasars on either side of a galaxy.[5] Scott and other steady state theorists generally think that the quasars were ejected by the galaxy. Astronomers mostly think that the quasar pair is two images of a single quasar aligned with a much closer galaxy. The galaxy's gravity produces two (or more) images of the very distant quasar. Scott claimed that astronomers invoked this explanation after the fact, but in reality Scott has it backwards. Gravitational lensing as a possibility in general relativity was predicted in 1924, but it wasn't observed until 1979, so this actually is an excellent example of good science making a prediction that eventually was testable. How do we know that the two quasars are images of a single quasar and not two independent sources? The two objects share similar brightness, redshift, and spectra. Both sources experience similar variations in brightness and other characteristics, though with some time difference due to the different light travel time distances of the two.

In discussing gravitational lensing Scott stated that the masses of galaxies don't act as point masses (page 34). The fact that any mass distribution can and does act as a point mass is a topic often taken up in a sophomore general physics class. Scott here used the complex dynamical motions of individual stars within galaxies to argue that galaxies don't behave as point masses. But this confuses the perturbing effects of matter within the distribution of the galaxy. Even then a point mass is a good approximation, an approximation that is exact for objects outside of the distribution. Also on this page Scott claimed that lensing can produce only two images, not four. This is not true. While two images is the most common form of lensing, the famous Einstein Cross has four images, and some images take the form of arcs or rings. All are possibilities that depend upon the peculiar geometry of each example.

On the following page (page 35) Scott criticized the search for gravitational lensing in the stars of the globular cluster M22, for he concluded that the probability of success as 10^{-7}. However, Scott assumed a stellar density far too low. He assumed that the average distance of stars in globular clusters is the same as in the solar neighborhood, but globular cluster stars are packed far more closely. When this is taken into account, the probability of gravitational lensing occurring in M22 is much higher, though it still is low. Scott missed the point, for astronomers don't claim that gravitational lensing is common. We merely recognize that with the incredible sample size in the universe gravitational lensing must occur occasionally. Even a pair of quasars occasionally can have a chance alignment. The only way to determine whether that is the case or if gravitational lensing is likely is to take additional astronomical observations to determine if the two objects truly are twins.

In the context of this discussion Scott also criticized the suggestion of stellar collisions to account for some otherwise inexplicable observations. Scott didn't give any specifics of what kinds of stars are involved or what observations the invocation of stellar collisions is supposed to explain. The only suggestion of stellar collisions that I am aware of is mergers of stars in close binary systems, for this process has been invoked to explain a number of phenomena, such as certain types of gamma ray bursts and supernovae. However, Scott appears to have missed the point that these are mergers in close binaries, because he criticized such suggestions on the basis of how improbable the collision of two unassociated stars is. Astronomers recognize this improbability too and hence do not propose such mechanisms.

Challenges to Cosmology

On page 24 Scott first took on the big bang model. One must understand that I don't support the big bang model, but in criticizing it, one must correctly describe the model. Scott failed to do this. First, he stated in a footnote that,

> The original big bang theory did not include magnetic fields, because it was claimed that there were no magnetic fields in space. (Scott 2006, p. 24)

This is not true. Most versions of the big bang model omit magnetic fields to make the mathematics easier, but primarily because most cosmologists don't think that magnetic fields are significant. Believing that magnetic fields are insignificant is a far cry from not existing at all. Second, Scott believes that the current big bang model (that the universe began 13.7 billion years[6] ago and has 23% cold dark matter and 73% dark energy) was determined entirely from mathematical equations. He then went on to state that the proper "use of mathematics in science is to 'curve fit' a previously observed set of data" (Scott 2006, p. 24).

Again, what previously observed set of data did Newton fit? But more to the point, Scott appears to be ignorant of the fact that while the big bang model does have a mathematical framework, the

[5] It often turns out the galaxy is merely one of the brighter members of an entire cluster of galaxies.
[6] The big bang age of the universe recently was increased to 13.8 billion years.

precise conclusions that he derisively dismissed were constrained (curve fitted) by a large amount of data, such as from WMAP[7] and observations of type Ia supernovae. Scott claims that all of this is untestable, but one could say the same of his preferred eternal cosmology.

On page 44 Scott made a case for plasma forces dominating the structure of the universe by giving misleading facts and figures. He began by correctly noting that if dark matter does not exist, then Newton's law of gravity doesn't explain the rotation of galaxies. Of course Scott's solution is plasma, for he stated, "They [galaxies] are formed, driven and stabilized by dynamic electromagnetic effects in cosmic plasma" (Scott 2006, p. 44).

Most of the oddities that we see in the rotation of galaxies come from the motions of stars. Stars don't appear to have net charge. True, much of the interiors of stars are ionized, making them a plasma, but that is self-contained by the stars, and stars appear to be electrically neutral. If stars are electrically neutral, then electromagnetic fields are of no effect upon their motions. Scott stated that 99% of the universe is made of low-density clouds of ions and electrons, making it plasma (similarly repeated on page 71). Scott further argued that electromagnetic forces dominate the motion of this gas, which supposedly explains galactic structure. It's not clear if the 99% is by mass or by volume, but it would appear that volume is the intended meaning. Much of the gas in galaxies follows motions similar to that of electrically neutral stars, so it is left unexplained how stars partake in this motion. There is a sparse component of the ISM that is heavily ionized and moving very quickly, which is motion so fast that it is effectively decoupled from stellar motion. But this extremely low density (and hence low mass) component cannot be what Scott is talking about here. Furthermore, both the high ionization and fast motion (or, alternately, high temperature) are indicative of a heating mechanism that accelerated this gas. This heating may not have required a plasma explanation. Scott here also claimed that the interstellar magnetic field in the solar neighborhood contains the equivalent of about 200 years' worth of solar radiation energy. Since this is based upon a private communication, it isn't possible to evaluate. Scott also pointed out that the electrostatic force between two protons is 10^{36} times greater than the force of gravity between the two. This is true, but largely irrelevant. First, not all material in the universe has a net charge. Second, if a charged particle is immersed in a vast sea of charged particles, the net electrostatic force will still be zero. On the other hand, the galaxy has a center of mass, which results in gravitational acceleration toward the center. Any object, whether a proton or a star, will have the same gravitational acceleration. The only variable is distance from the center of the galaxy. Scott repeatedly overstated the effects of electric and magnetic fields. The large distances and electrical neutrality of many objects involved render electromagnetic forces null. Electromagnetic forces dominate on atomic scales. Appreciable net charges can affect lab scales, but they cannot on galactic and cosmological scales.

Scott's description of the history of cosmology has problems. He incorrectly equated a cycloid with an epicycle (page 55). His discussion of the Galileo affair is entirely post-enlightenment with all the incorrect information and inferences. For instance, it wasn't the theologians who called Galileo's work into question but it was his fellow scientists who were upset that Galileo was challenging the Ptolemaic model. Recent creationists ought to pay careful attention to the erroneous information that Scott presented here.

Solar Neutrinos

Chapter 6 discussed solar neutrinos, but it is so desperately reasoned that it is difficult for me to respond to it. Scott suggested that astronomers altered nuclear physicists and hence the neutrino model to salvage the solar model (pages 47 and 51). The history of this is a bit different. There were two possible models for the neutrino, one where the neutrino has mass (and oscillates between the three types), and one where the neutrino is massless (and doesn't oscillate between the three types). The former model would have explained the shortage of solar neutrinos, but particle physicists were nearly universal in their preference for the latter model. It was particle physicists who ultimately did the work at Sudbury that undermined their favored model. This is important, because particle physicists were very reluctant to accept the model of neutrinos possessing mass, but now they almost universally believe it. The history of this is opposed to how Scott characterized what happened. The Sudbury experiment experimentally proved neutrino oscillation by measuring neutrinos at a distance from a laboratory source of neutrinos. In some sense Scott is technically correct when he argued that in order to definitely prove that solar neutrinos changed into the other two types along the way from the sun to the earth (per the headlines of the story), one would have to measure the neutrino flux at the sun and on the earth (pages 48 and 49). Scott suggested that since this isn't what happened we must disregard all that follows. However, once one establishes the alternate, originally unfavored model, that neutrinos have mass

[7] WMAP = Wilkinson Microwave Anisotropy Probe. Early in 2013 the Planck mission (a more sensitive satellite) slightly changed the details of the model derived largely from WMAP.

and oscillate, then, it follows that solar neutrinos share in this oscillation. Hence, if we measure the received solar (electron) neutrino flux, to determine the original solar (electron) neutrino flux, we must multiply the observed flux by three. Since this corrected figure is in line with the calculated solar (electron) neutrino flux, the solar neutrino problem is solved. This is particle physics, not rocket science, so Scott was just being stubborn about his conclusion (page 52). He is so convinced that modern astronomy is wrong that he cannot see the truth when it faces him. In desperation Scott suggested (page 49) that the sun might produce all three types of neutrinos, but offers no explanation of why this might be. We understand neutrino physics quite well, and the sun can produce only electron type neutrinos. If Scott wishes to challenge this, then he needs to redo the physics of neutrinos, but this would require a far more radical reworking of neutrino physics than what he accused astronomers of doing. At one point (page 49) Scott argued that there was no need for the Sudbury experiment. Earlier in the book Scott criticized astronomers for supposedly not doing experiments and ignoring data, but then he criticized them for doing just that. This illustrates that much of Scott's argument is illogical and confused.

The Plasma Model

Scott finally began to discuss the plasma model in some detail in Chapter 8, but there were problems in what he wrote. He asserted that the Helix Nebula is an example of Birkeland currents[8] (Scott 2006, p. 62) without any reference or explanation. I suppose that this assertion is based solely on the appearance of the Helix Nebula but without any data to support it. On pages 66 and 67 there is discussion of images in Figure 7, which are the result of simulations run by Anthony Perrat, another plasma theorist. Scott compared the three simulations to radio isophotes[9] of three double-lobed radio galaxies. In appearance the images and simulations match well. Two questions come to mind. First, how well does conventional modeling of these galaxies match the data? Second, what were the inputs of Peratt's model? It is not that difficult to tweak a model to fit the observations, but did Peratt "predict" these isophotes prior to consulting the data? If not, then Peratt merely constrained his model to fit the data, but when astronomers do a similar thing, Scott accused them of committing the fallacy of asserting the consequent (page 16). Apparently Scott doesn't understand that the conventional astronomical explanation for double-lobed radio sources is in itself a plasma explanation. If he understood this, why would he disagree with astronomers on this?

Though he doesn't describe it in the text, the caption of Figure 8 (page 67) stated that the figure is a Peratt simulation of the formation of a galaxy with two Birkeland currents. It doesn't state whether the material making up the galaxy is stellar or a gas. This is important, because ions can be manipulated by electromagnetic fields, but stars, as I previously mentioned, appear to be electrically neutral and hence would not be affected.

Discussion of the plasma model continued in Chapter Nine, but it too had errors. The second sentence stated that we cannot see gas. Chlorine and iodine are examples of gases that we can see. On pages 71 and 78 Scott gave estimates of the number density of electrons in interplanetary space but particularly near the earth. He then extrapolated the existence of electrons in the ISM, albeit with much less density. The implication was that astronomers don't recognize this, which is patently false. For instance, for at least 40 years astronomers have estimated distances of pulsars by the frequency dispersion of the pulsars' signals, which depends upon the number density of electrons in the ISM. More significantly, interplanetary space and the ISM also are well populated with ions which are oppositely charged from electrons.[10] The result is that nearly every volume of space has net zero charge. One could argue that electric fields in space would cause the oppositely charged electrons and ions to move opposite directions. Studies of the solar wind (which accounts for most of the electrons and ions in interplanetary space) show that the electrons and ions indeed are moving, but in the same direction, away from the sun. This strongly implies that electric fields in interplanetary space, if they exist, must be very feeble, and hence cannot be the dominating force that Scott claimed. As for magnetic fields, astronomers are fully aware of these effects, for they account for the structure of the solar corona and wind, and astronomers have long agreed with Alfvén and other supporters of plasma astronomy on the behavior of the solar wind as it interacts with the earth's magnetic field and the magnetic fields of other planets. Astronomers have mapped magnetic fields in the ISM, and they turn out to be very feeble. There are localized regions where magnetic fields are very strong and hence greatly affect plasma there. Examples would include supernova remnants (such as the Crab Nebula) and regions around neutron stars and black holes of all types.

[8] Birkeland currents are currents aligned by magnetic fields.

[9] An isophote is a map with lines connecting points of same intensity, similar to how contours on a topographical map connect points having the same elevation.

[10] Scott mentions ions in passing, but many readers likely will miss this or fail to understand the significance.

The Electric Sun

Scott next (Chapter 10) turned his attention to "The Electric Sun," the plasma model of the sun. On page 83 he stated that the standard solar model doesn't predict the sun's chromosphere. I suppose that this statement technically is true, but it is at best misleading. The standard solar model is a robust description of the sun's interior, based upon well-understood physics. The sun's chromosphere is one of three layers comprising the sun's atmosphere.[11] One would not expect the model of the sun's interior to "predict" the sun's atmosphere any more than one would expect a model of the earth's interior to "predict" the earth's atmosphere. As there is a standard model of stellar interiors, there is a standard model of stellar atmospheres, including the sun. Stellar atmospheric models use the same sort of physics employed in stellar interior models, plus a few more principles not relevant to the conditions in the much more dense stellar interiors. There is no conflict here as suggested by Scott's comments. There are similar statements on pages 83 and 84 about the failure of the standard solar model to account for the corona and solar wind. Again, this may be true technically, but such statements are very misleading. Contrary to the implications of this book, astronomers don't ignore plasmas. We've known for a long time about the interaction of the sun's magnetic field with the corona and solar wind.

The discussion under the "Temperature Minimum" section contained several untrue or misleading statements. Scott began this section with,

> If the standard model were correct, heat and light would simply radiate away from the photosphere as from a hot stove. But many processes, other than simple radiation of heat, are occurring above the photosphere. (Scott 2006, p. 84)

First, being a gas, the sun can't simply radiate as a hot stove might. The solar interior or deeper parts of the photosphere, being high pressure gas, follows Kirchhoff's first law and radiates similarly to a solid (hot stove), but the pressure and temperature drops throughout the photosphere, which has some depth. The photosphere produces an absorption spectrum (Kirchhoff's third law), which is very different from how a solid radiates. This is part of the many processes above the photosphere that Scott alluded to. Astronomers don't ignore these, as Scott at the very least implied. Second, the temperature minimum isn't a problem. By the way, the temperature minimum occurs in the lower chromosphere, though Scott doesn't state this. Third, the corona has a very high temperature, but it doesn't contain much heat, or, more properly, thermal energy.[12] By not mentioning that fact, many readers will not understand the difference. True, the extreme high temperature of the solar corona has been a mystery, though much progress has been made on explaining it. Some of the proposed explanations involve plasma effects incorporating magnetic fields. Scott's failure to mention this is misleading. Supporters of plasma astronomy are miffed that astronomers have rejected their main thesis, and they have retaliated by falsely claiming or at least implying that astronomers today reject plasma effects in their work.

Scott objected that since we can't produce a sustained hydrogen fusion reaction on the earth that such a thing is not possible (he called a sustained nuclear reaction in the sun's core "a stretch"). Scott ought to compute the pressure inside the solar core (for an estimate see Faulkner and Samec 2004). We know a lot about nuclear physics, and the likely pressure and temperature within the solar core can sustain these reactions. If we could duplicate the high temperature and pressure of the solar core on earth, we would sustain fusion reactions that likely occur in the sun. Actually, physicists have created hydrogen fusion in the lab, but only briefly, as we have no effective way yet (if ever) to contain, and hence sustain, such a reaction. But make no mistake, these experiments have shown that hydrogen fusion occurs much as nuclear theory predicts.

On pages 85 and 86 Scott described the "electric sun" (ES) model, but he left much unsaid. For instance, is the sun the terminus of charged particles, or is the sun a part of a closed circuit? If the sun is part of a closed circuit, what are the paths of the incoming and outgoing portions of currents? If the sun is accumulating charge, what is the rate of accumulation? If the sun is merely channeling galactic power, then this doesn't really tell us the source of the sun's (and other stars') energy. What is that source? For me this was one of the most irritating parts of the book. Scott never gave a hint as to where he thinks the sun's energy comes from.

Scott's discussion (page 98) of convective energy transport in the solar interior was a straw-man argument. No one thinks that convection tubes extend over 150,000 miles of the solar interior. Nor is it describable by laminar flow. Convection can't be modeled easily. The best estimate that we have is mixing length theory, which by its very nature is turbulent, so why did Scott categorize what astronomers do this way?

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[11] The other two layers are the photosphere (below the chromosphere) and the corona (above the chromosphere).

[12] Temperature is a measure of the average kinetic energy per particle; thermal energy is the total kinetic energy of the particles involved. If, as in the corona, particles are moving very fast, they have high average kinetic energy and hence high temperature. But in the solar corona the gas is so rarefied that the total amount of kinetic energy is modest.

There are other problems. Scott stated,

> Any charged particle has an electrical potential energy. The electrical potential energy is measured in Volts. (Scott 2006, p. 89)

Electrical potential energy in not measured in volts; it is measured in joules, as is any other energy. A volt is a joule/coulomb. That is, electric potential measures the amount of potential energy each unit of charge possesses. Obviously, what the author intended here is electric potential. I could just let this go as a slip, but a Ph.D. electrical engineer ought to know better. Furthermore, a charged particle has electric potential only if it's in an electric field. Figure 10 on page 90 is a plot of electric potential in the sun's atmosphere as a function of distance. Where did this plot come from? Were there any measurements to produce this? I don't think there are any, so this appears just to be a sketch to illustrate the ES hypothesis. Ordinarily this would be fine, but elsewhere Scott took astronomers to task for musing about reality with no measurements, so he ought to abide by the same standard.

Scott confidently extolled the virtues of the ES model with the phenomena that it supposedly explains but that the standard solar model cannot. For instance, on page 98 he claimed that the ES better explains the sun's differential rotation or why the sun rotates at all. But why just ask this about the sun? The Jovian planets have differential rotation. The answer is that both the sun and most of a Jovian planet are gaseous, not solid, so there is no requirement that neither the sun nor a Jovian planet rotate with a single period. As for the question of why the sun rotates at all, virtually everything in the universe rotates, which they must do if they possess any angular momentum. Many (most?) physical interactions (both electromagnetic and not electromagnetic) involve transfer of angular momentum, so the claim or implication that plasma affects alone can explain rotation is simply wrong. Also on page 98 Scott acknowledged that there is no evidence that electrons are indeed flowing into the sun, but he explains that we simply haven't found them yet, because we aren't looking in the right places (in the sun's equatorial plane, not its poles). In his book Scott repeatedly attacked astronomers for hypothesizing things without any experimental data, but he saw no problem with an identical approach for the ES model.

On page 99 Scott acknowledged the conventional explanation of why the sun doesn't collapse, but he didn't refute that explanation (for it really can't be refuted), but simply asserted that his model can explain the sun's stability too. In other words, there is no necessary reason to reject the conventional explanation, so his model must explain the non-collapse of the sun at least as well. Scott believes that the sun is isodense, that is, the sun has about the same density throughout. The conventional solar model requires that the density increases toward the center. It is the high density and accompanying high temperature that cause thermonuclear fusion to power the sun in the conventional model. If the sun is isodense as plasma astronomy supporters believe, then the sun's core is far too cool to sustain nuclear reactions, thus the sun requires a different model. In other words, belief in the isodense sun is driven to support the model. Scott went on to quote Thornhill (though, strangely once again there is no reference). That quote is,

> The electric star model makes the simplest assumption—that nothing much is going on inside the sun…. [In the plasma that makes up the sun] the nucleus of each atom, which is thousands of times heavier than the electron, will be gravitationally offset from the centre of the atom. The result is that the atom becomes a small electric dipole. These dipoles align to form a radial electric field which causes electrons to diffuse outwards in enormously greater numbers than simple gravitational sorting allows. That leaves positively charged ions behind which repel one another. That electrical repulsion balances the compressive force of gravity without the need for a central heat source in the star. An electric star will be roughly the same density throughout, or isodense. (Scott 2006, p. 99)

This separation into dipoles will not work. True, the nucleus of an atom (or ion) is attracted with a stronger gravitational force than the electrons are, but this force is proportional to mass, and acceleration is inversely proportional to mass, so both the nucleus and the electrons are accelerated the same amount. Thus, there is no segregation into dipoles. This really is elementary physics. Do Thornhill or Scott have computations to show all of this? If so, where are they? This paragraph had a lot of hand waving. In the short term, the stability of the sun doesn't require an energy source, for the sun can tap its considerable internal energy to produce its luminosity, so fusion isn't required, as stated or at least implied by Scott. Without an internal energy source, the sun would shrink, but that can be staved off by conversion of gravitational potential energy, with still no fusion required. Within timescales on the order of the Kelvin-Helmholtz time[13] or longer, nuclear energy is required, so it is not clear why Scott keeps tying the nuclear model to everything. Conventional physics apart from nuclear energy[14] can explain the current condition of the sun.

[13] The Kelvin-Helmholtz time is the time required to contract a large sphere of gas into a star. For the sun, the Kelvin-Helmholtz time is about 30 million years. This is the maximum life time of a star, if it is powered by gravitational potential energy.

[14] While the Kelvin-Helmholtz mechanism is sufficient to power the sun, it places an upper limit of about 30 million years on the sun's age, far less than the 4.5 billion years generally thought. Many recent creationists liked this mechanism for the sun's energy, but the solution to the solar neutrino problem put an end to this.

The following chapter (11) on "The Sun's Electrical Atmosphere" is no better. The introductory paragraph brought up a false dichotomy between the standard solar model and plasma explanations. It is a false dichotomy, because astronomers long ago incorporated plasma into their understanding of the sun. This false dichotomy was brought up again on pages 104 and 105 with regards to filamentary structure. The false dichotomy came up again in the discussion of sunspots on pages 106 and 108. The discussion treaded lightly on the standard explanation of sunspots, which is odd, since it is a plasma explanation. Why wasn't this acknowledged? It seems that Scott and other supporters of plasma astronomy even reject plasma explanations that come from astronomers. The continual complaint that astronomers reject plasma ideas is either ignorant or dishonest. There are facts about sunspots that Scott failed to mention in this section. These facts include that sunspots generally appear in pairs or small groups dominated by pairs, that sunspot pairs align parallel to the equator, that spots within pairs have opposite magnetic polarity, and that the leading spots in each pair in a particular hemisphere have the same polarity but are reversed in the other hemisphere. All of this is explained well by the standard explanation. The standard explanation was published a half century ago (Babcock 1961).

The short paragraph in the middle of page 107 suggested that the flow of ions rushing outward from the sun would produce strong localized magnetic fields around spots; this doesn't square with the data—these proposed magnetic fields would be loops in the plane of the photosphere (perpendicular to the ion flow), which is not what we see. How does this produce pairs of spots? The false dichotomy is implied again in the section of omega loops and coronal mass ejections (CME) on pages 109–111. While the text here didn't explicitly criticize the standard explanation of some of these phenomena, the naïve reader might gather than the standard model of astronomers can't explain these things. As it turns out, astronomers do invoke plasma explanations, including Alfvén's work on this.

In discussion of magnetic fields Scott wrote,

> They most certainly do not "break," "merge," "open," "pile-up," "get tangled," "recombine," or "reconnect." (Scott 2006, p. 118)

This is news to the Princeton University Physics Department, for they have produced magnetic field reconnection in the laboratory (Mozer 2006). Scott repeatedly scolded astronomers for supposedly hypothesizing phenomena that can't be replicated in the laboratory, but here he denied a phenomenon that has been replicated in the laboratory.

The Solar System

While I am on the subject of Scott's different standards, on page 129 he asserted that the planets, their moons, and the sun carry an electric charge. How was this determined? If this were true, we would expect electrostatic forces between the planets and their satellites, between the planets, and between the sun and the planets. As Scott has correctly and repeatedly pointed out, electrical forces dwarf gravitational forces by many orders of magnitude. If the sun, planets, and satellites had even the minutest net charge, electrostatic forces would dominate within the solar system. Unlike gravity which always is attractive, electrostatic forces are repulsive when charges are similar in sign. Therefore, if the sun and planets carried net charges, we would expect that some of them would interact attractively while others would interact repulsively. The forces between the sun, planets, and planetary satellites always are attractive. Thus we can confidently conclude that the planets are electrically neutral to a high degree and that Newton's laws of motion and law of gravity work well to describe their motions.

In his chapter (13) on the solar system Scott attributed many characteristics of solar system objects to electrical forces. On pages 135 and 136 he described how Grand Canyon may have been carved by electric discharge machining (EDM). His arguments for this are familiar to recent creationists as deficiencies of uniformitarian explanations for Grand Canyon (lack of a delta, difficulty in eroding through the Colorado Plateau), but many Flood models do account for these difficulties. Scott went on to suggest that EDM also formed the Arizona Meteor Crater. His argument was that no substantial meteoritic matter has been found in the area and there is a lack of detritus around the crater. Both of these claims are false. Tons of meteoritic material has been picked up in the area (I even own a piece, as well as a vial of small iron spheres from the surrounding soil). The ejecta blanket surrounding the crater has been extensively studied (Ramsey 2002). Scott further suggested that craters with "spires of material in their centers" could not have formed by impact, because "their central columns are sometimes stratified identically to the strata of the material beyond the crater walls" and so probably formed by circular arc machining. Scott must be talking about central peaks often found at the centers of large craters. I am puzzled by his claim that the material in central peaks is sometimes stratified identically to surrounding material. I am not aware of any craters with extant central peaks on earth, and no lunar or planetary craters with central peaks have been examined on-site, so where did he get this information?

Scott made several bizarre claims about Venus (pages 136–139). He noted that radar images from the Magellan spacecraft showed some bright regions in the highlands of Venus. He termed this "puzzling" and suggested (while quoting Wal Thornill, but without reference) that this was caused by electrical discharge known as St. Elmo's fire (better called coronal discharge) that produced a highly conductive dense plasma that is a very good reflector of radar. While this might be possible, there are at least two conventional explanations that work quite well, though one would not gather that from Scott's description. One is that some of the bright regions may have a different composition than other areas and hence may reflect better. For instance, iron pyrite on the surface would reflect radar quite well. But the more likely explanation is that the bright surface regions may be rougher than darker areas. In one of its modes the Magellan radar system used backscatter to determine surface texture. Scott claimed that ancients reported that Venus once had a "fiery tail" or "twisted hair," and suggested that this was the normal glow or arc mode of a plasma tail. Without any reference for this, it is impossible to evaluate this claim. Scott also invoked a plasma interaction to explain a phase lock between the earth and Venus. He incorrectly states that Venus is the only planet that rotates retrograde (Uranus does too).

On pages 138 and 139 Scott claimed that circular craters on the moon, Venus, and Mars cannot be due to impacts, because only vertical impacts could cause circular craters, but that impacts rarely come straight down. This statement displays ignorance of how impact craters form. It is the explosive release of kinetic energy that produces a crater from an impact.[15] Only grazing incident meteoroids would produce elliptical craters. On pages 139–141 Scott claimed that EDM can explain nearly all the diverse surface features of Mars. Many Martian features are best explained by water, though insufficient water now exists on Mars.

In his discussion of Jupiter's satellite Io (pages 141 and 142) Scott first dismissed the normal interpretation of Io but then on the next page quoted from the Jet Propulsion Laboratory (JPL). That quote represents much of the conventional thinking about Io, and it more or less agrees with some of what Scott claims, so why didn't he see that? Scott complains that Io's volcanos move across its surface but that terrestrial volcanoes do not move, so these must not be volcanoes on Io's surface. No one suggests that Io's volcanoes are an exact analogue to terrestrial ones (for instance, sulfur appears to be the molten material on Io, and there are far more eruptions on Io than on earth). While individual terrestrial volcanoes may not move, volcanic activity on the earth's surface does move. For instance, hot springs gradually disappear as new hot springs appear a short distance away. The Hawaiian Island chain is a series of extinct volcanoes with the only active volcanoes being on the eastern end of the chain. We explain these things with hot spots that relocate as plates move over them. Io's volcanism is far more active than earth's so it isn't surprising that volcanic activity on Io migrates much more quickly than on earth.

On page 143 Scott criticized the accretion theory of satellite formation by noting that Triton orbits Neptune retrograde. Few astronomers suggest that Triton formed in orbit around Neptune. Rather, most astronomers think that Triton likely resulted from a capture event. Admittedly, there are some peculiarities about Triton. Besides orbiting retrograde, its orbit is highly inclined to both the ecliptic and Neptune's equator, but its orbit is nearly circular. The high inclination and retrograde orbit are expected characteristics arising from a capture origin; a circular orbit is not. Many recent creationists think that these peculiarities suggest a creation origin. It isn't clear how a plasma origin explains this odd satellite any better than the conventional explanation.

On page 143 Scott incorrectly stated that the spokes in Saturn's rings were not observed since Voyager. However, they were seen again late in 2005 by Cassini; since the book has a 2006 publication date, it likely is just out of date. In his usual manner, Scott dismissed astronomers' explanation of the spokes. However, the conventional explanation involves the spoke particles being charged and compelled to move with the magnetosphere of Saturn as it rotates. One of the theories of the generation of the charged particles is lightning from Saturn. Since astronomers clearly appeal to an electromagnetic explanation for the spokes in Saturn's rings, I'm at a loss to understand Scott's criticism here.

In his section on comets Scott dismissed the usual understanding of comets with statements such as,

> Today, in the face of contradictory evidence, astronomers assume as fact that comets consist of aggregates of ices mixed with rock and dust. (Scott 2006, pp. 144–148)

However, Scott doesn't clearly tell us what comets are made of. It is clear that dust exists in comets from the characteristics of the light reflected off the dust tail. Also, if frozen, the material observed in the ion tail would be ices while in the nucleus of a comet. Astronomers long ago abandoned calling the ion tail the "gas tail," which would seem to signal that we astronomers agree with Scott on more than he thinks we do. The gas in the head and tail is ionized, so it is plasma. On page 145 Scott dismissed how jets can

[15] Craters produced by artillery shells are circular, though the shells rarely fall straight down. As with impact craters, artillery shell craters form from the energy released by the explosions involved.

occur in such a cold body. However, it is the core of the icy nucleus that is so cold. The skin of the nucleus, being so dark, rapidly absorbs solar energy near perihelion. As Scott pointed out, that heat can't penetrate very deeply, so the heat builds up and liberates gas near the surface, not the deep interior. On page 147 Scott asked why the dust is so dark. But dust is dark, as evidenced by the low albedo of the moon and other rocky objects. In addition, organics on the surfaces of dust particles can further darken the dust.

Scott concluded his discussion of the solar system with a section on the heliopause (pages 148 and 149). The sun is surrounded by its heliosphere, a bubble of charged particles. The solar wind is an outrush of those charged particles. Particles in the solar wind slow as they move outward, and eventually they are turned back by oppositely moving charged particles in the ISM. This boundary between the heliosphere and ISM is the heliopause. Of course, this is all plasma, so once again I'm amazed how Scott can see disagreement where there ought to be little, if any, disagreement.

Stellar Astronomy

In Chapter 14 Scott applied his ES model to stars in general. On page 153 he added current density to the horizontal temperature axis of the Hertzsprung-Russell diagram. How was this measured? I don't see that it has been or could be—it is merely assumed. Early in his book, Scott chastised astronomers for not doing experimental science (and hence not doing science at all) and interpreting everything in terms of their models, yet here is Scott doing precisely that. Scott discussed brown dwarfs on pages 154 and 155. Astronomers think that stars normally derive their power from nuclear fusion in or near their cores. However, an object must have sufficient mass for this to occur (probably around 7% of the sun's mass). Brown dwarfs are objects with mass below this minimum mass capable of sustaining fusion. As early as the 1960s astronomers began suggesting that brown dwarfs exist, but searches for them were not successful for more than two decades. Brown dwarfs are very faint, and they appear similar to the faintest, least massive stars that do support nuclear fusion, so it is not easy to distinguish a brown dwarf from a star. However, from Scott's discussion, one would get the impression that astronomers discovered brown dwarfs before there was a theoretical understanding of these stars, and then astronomers desperately scrambled to find an explanation for brown dwarfs. This retelling of the story of brown dwarfs is completely wrong, for they were hypothesized long before their discovery. Where do brown dwarfs get their energy? From gravitational contraction, which, as I previously noted, some recent creationists still prefer to nuclear fusion in the sun. The solar neutrino flux eliminates this possibility, and there is no evidence that the sun is contracting (DeYoung and Rush 1989). In a footnote here Scott called gravitational collapse "another ad hoc invention." This would be news to Lord Kelvin. On page 156 Scott stated that the present debate about the differences between a giant gas planet and a brown dwarf is pointless, for they are members of a continuum. This is what astronomers have thought for some time, so where did Scott get the idea that there is some debate about this?

On pages 156 and 157 Scott gave a very short explanation for novae. This glosses over the conventional explanation and the evidence for that conventional explanation. In the following section (pages 157–159) Scott gave a fanciful description of binary stars forming from fission. Novae are mentioned again in this context. Scott gave absolutely no data to support his claims here. Again, conventional astronomy is very rich in explaining data dealing with novae of all types. It appears that Scott is ignorant of this. For instance, in this section he appears to confuse novae with planetary nebulae ejection. Furthermore, he made much of binarity, but apparently he is unaware that for a half century astronomers have believed that novae of all types involve close binary stars.

On pages 160 and 161 Scott briefly discussed three stars, FG Sagittae, V605 Aquilae, and V4334 Sagittarii. Over the years these three stars have undergone outbursts that did stump astronomers for some time, and they continue to be discussed. Scott portrayed the situation as a continuing enigma for these three stars, but apparently he is unaware of how astronomers view these stars. Astronomers think that all three recently were asymptotic giant branch (AGB) stars that have or are in the process of forming planetary nebulae. The most common interpretation is that they are "born again" white dwarfs, back from a brief red giant phase. Schonberner (2008) recently has reviewed all three objects. Scott's mischaracterization of astronomers' understanding of these three stars is misleading at best. Scott mentioned that FG Sagittae has a companion 11″ away, which to Scott apparently is a sort of smoking gun of recent binary fission. The inferred distance of FG Sagittae is 2.5 kpc (8000 lt-yr) (Faulkner and Bessell 1970). If the two stars are related, their minimum separation is nearly one-third of a light year apart, but the other star likely is a foreground or background star. Either way, they are much too far apart to have recently fissioned as Scott suggested. Scott also discussed here V838 Monocerotis. This star is less well understood than the other three, but, given his poor handling of the other three stars here, one ought not to take Scott's pronouncements very seriously.

Scott badly handled information concerning the star Castor (α Geminorum). Scott stated that,

> The early astronomers always designated the most brilliant star in a constellation as "alpha," the second brightest was "beta," and so on. (Scott 2006, p. 163)

It's not clear what Scott meant by "early astronomers." I would interpret that as ancient astronomers, but the designation of stars with Greek letters goes back only to Johannes Bayer in 1603. While it is true that Bayer normally arranged his designations by order of brightness within a constellation, there are notable exceptions. For instance, in Ursa Major the seven stars that comprise the Big Dipper were named in order of increasing right ascension rather than brightness. In similar manner Bayer named Castor and Pollux, the two brightest stars in Gemini, according to right ascension, not magnitude. From his misunderstanding of this, Scott inferred that since Pollux today is brighter than Castor that Castor must have been brighter in the past but has since faded. There is no evidence of this, for it is based upon a misunderstanding on Scott's part. Scott also noted that Castor is a system consisting of three stars (Castor A, B, and C), each one being a binary so that the system consists of six stars. Scott obviously thinks that this all resulted from multiple fissions, for he called the system, "a celestial train wreck," but is this warranted? Each of the three binaries are reasonably close—we can't see but three stars, the binarity of the three stars is betrayed by the three being spectroscopic binaries and one being an eclipsing binary as well. However, the three binary systems are widely separated. For instance, Castor A and B are separated by 6″ and orbit in a 467 year period. At a distance of about 50 lt-yr, Castor A and B are separated by at least 100 AU. Castor C is 72″ away, which is very far for a binary star, but since Castor C shares a common space motion with the other two stars, it likely is physically connected, albeit with a separation of at least 700 AU and a period of many thousands of years. Even within Scott's belief about binary fission, this scenario seems very unlikely for such widely separated stars.

In his discussion of red giants on page 164 Scott gave the temperature of Betelgeuse as 1300 K, but its temperature is close to 3500 K (as a semi-regular variable star, its temperature varies, but it is never less than 3,000 K). He also stated that some red giants are very cool, in the 1000 K range. This isn't true, for few are cooler than 3000 K. He might be referring to some carbon stars, but those 1000 K temperatures are color temperatures, and the people who measured those color temperatures decades ago knew that the temperatures were erroneous.

While Scott's discussion of white dwarfs (pages 164 and 165) is not incorrect per se, it did raise my eyebrows. First, he mentioned two white dwarfs, PSR J0034-0534 and PSR J1713+0747, by name. I immediately recognized those designations as referring to pulsars, not white dwarfs. Scott offered this within a quote without reference, so it took a little time to find the citation. It turns out that the white dwarfs involved are in binary systems with the named pulsars, though Scott apparently didn't recognize the significance of this. Scott mentioned these two white dwarfs as the coolest yet found, and asked why they were called "white" when objects at such cool temperatures would clearly not appear white. He then correctly surmised that the first white dwarfs discovered were white (due to high temperature), but that some white dwarfs found later were much cooler. Astronomers normally interpret cooler white dwarfs as being older, since they think that white dwarfs, lacking an energy source, slowly cool over time as they tap their considerable store of internal thermal energy to shine. I am at a loss to understand what Scott's reason was for including this particular discussion. Left unsaid is their very small size yet significant mass that leads us to conclude that white dwarfs have incredible densities.

Scott's discussion of spectral line broadening (pages 165–168) was garbled. Spectral line broadening in stars can have several causes. One is rotation. On page 159 Scott appeared to like the idea of rapid rotation of upper main sequence stars, but here he attempted to undermine the data that support that conclusion. On page 166 he talked about smeared out lines in O stars, but then he gave evidence from B stars. On the next page Scott reasoned that if the smearing is due to rotation, that hydrogen lines ought to be no more smeared than calcium lines, but since they are, he concluded that the broadening is due to the Stark Effect. The Stark Effect is the splitting of spectral lines due to the presence of a strong electric field. Magnetic fields can split lines too, in what physicists call the Zeeman Effect. Scott's argument here makes no sense, because, calcium lines don't show up in either O or B stars, because their temperatures are far too high for those lines to appear, so such a comparison is not possible. On pages 167 and 168 Scott implied that astronomers can't explain emission lines from Wolf-Rayet stars or from Betelgeuse. These lines originate in gas clouds that surround the stars and probably were ejected from the stars. Since much of this material is ionized, this is plasma. Why can't we agree on that?

Scott concluded his chapter on stars with a summary of the electric star model (pages 168 and 169), a subject that he reiterated at the conclusion of the next chapter (pages 183 and 184). This largely was a gloss with claims that astronomers can't explain certain objects. He claimed without any supporting evidence that "the correspondence is better than it is with the standard thermonuclear model." With no discussion of the explanation of the latter, this amounts to no more than an assertion. Glaringly omitted here and elsewhere in the book is any discussion of the ultimate source of stellar energy. In his model, the stars are merely giving off electrical energy that presumably is produced elsewhere, but the location and mechanism for that energy production is never mentioned.

The next chapter (15) is on specific types of objects. On page 171 Scott badly handled population I and II stars. He stated that population I stars,

> are generally members of the main sequence of the HR diagram; they range from stars like our Sun to bright blue giants…. (Scott 2006, p. 171)

He describes population II as, "as less luminous stars—cooler, and with fewer heavy elements; many are red and yellow giants…."

From which he concluded,

> So we see that there is a roughly a left-half (Population I)–right half (Population II) partitioning of the HR diagram. Therefore, from the Electric Star point of view, we note that the stars in Population I must be more heavily electrically stressed than those in Population II. The usual physical locations of these two star types in a typical galaxy are vastly different in electrical activity. (Scott 2006, p. 171)

While it is true that population II stars primarily are to the right of the HR diagram, population I stars are found on the left and on the right. For instance lower main sequence stars consist of both populations. And while there is a general trend for the two stellar populations to be in different parts of the galaxy, there is considerable overlap. That is, there are many stars of both populations in the same portion of the galaxy, so electrical activity anomalies in different portions of the galaxy can't have anything to do with the dissimilarities between the stellar population types. Furthermore, his conclusion that population I stars are more electrically stressed can't possibly apply to lower MS stars, because he previously concluded that lower MS stars are amongst the least stressed, regardless of their population type.

On pages 171 and 172 Scott discussed globular star cluster HR diagrams and blue stragglers. He stated that the HR diagram of M5 is "recent," meaning that they were obtained not long ago. What he referenced here is recent, but the essential globular cluster HR diagrams (including M5) go back to the mid 1950s. He may be surprised to learn that it was Halton Arp (then a graduate student) who first produced some of these back then. Scott speculates that the red giants might lie at the center of M5 and thus might be shielded, but this definitely isn't true, for the core was imaged relatively recently, but we've known about red giants in globular clusters since at least the mid 1950s. Scott also speculated that the blue stragglers (though he doesn't call them that here) are the shielding stars. He further opined that globular cluster HR diagrams somehow defy stellar evolutionary explanation. Apparently, he is unaware of that explanation. Since Scott discussed blue stragglers separately from what he stated above, it appears that he doesn't really know what blue stragglers are. He implied that globular cluster blue stragglers have spectral types O and B. They normally are A, with a few that might be very late B. He dismissed the standard explanation of blue stragglers being in interacting binary systems, but there is much evidence now that this explanation may be correct. There are many other high energy emissions coming from the cores of elliptical galaxies. This is not explained by normal stars.

Scott's section on variable stars (pages 173–175) had problems. First, binaries are found in many variable stars. Scott implied that this is ignored by astronomers or at least it is a problem. This is not true, for binarity often factors into the explanation of variability. For instance, all the stars that Scott listed here are some type of nova. For a very long time (50 years) astronomers have explained novae of all types with interactions between close binary stars. U Geminorum consists of a white dwarf and a red dwarf (lower MS star), not a blue dwarf and G-type dwarf as Scott said. He lists one star as T Coronae. The correct name is T Coronae Borealis. Scott dismissed the conventional explanation for gamma ray bursts in favor of his model. However, this glosses over several things. First, the blob next to the burster that he discussed isn't a star; it's a galaxy. Second, I don't think that he understands the importance of the uniform distribution of gamma ray bursts requiring that they not be galactic (that is, stellar). Rather, that information argues persuasively that gamma ray bursters are extra-galactic and hence may be cosmological.

In his section on neutron stars (pages 176 and 177) Scott dismissed them because they supposedly violate the band of stability of nuclei. However, Scott got this backwards—it is the addition of neutrons with higher atomic number that stabilizes the many protons, not the addition of protons that stabilizes the neutrons present. The protons, having like charge, repel one another. It is the exchange of particles mediated by the neutrons that provides the attraction to hold the protons together. I'm not aware of any reason why two neutrons would bond together normally, but I'm also not aware of a reason why they would repel one another as Scott stated. As to why they're stable in a neutron star, my guess is what else are they going to do? They all can't decay into protons and electrons, for the electrons would then be degenerate. They can't fly away from one another, because of the extreme gravity. I think that they are stabilized by exchange of particles. Keep in mind that neutron stars were hypothesized by physicists 30 years before they were discovered, so probably there is no physical reason why they can't exist. Thus, neutron stars were not fabricated by astronomers to explain pulsars as Scott implied.

Scott mentioned the 1996 discovery of the millisecond pulsar (MSP) SAX J1808.4-3658 as a challenge to the conventional understanding of pulsars. He ought to have used PSR B1937+21, the first MSP discovered in 1982, though Scott mentioned it on page 178. There are nearly 200 known MSPs now. Most MSPs can be explained by spin-up, and there is evidence of this in several MSPs such as SAX J1808.4-3658. Spin-up occurs when a neutron star has a binary companion that transfers mass to the neutron star. Mass transfer also can transfer angular momentum, causing the neutron star to spin more rapidly. Scott also mentioned strange matter here, implying once again that astronomers have invented such things somehow to salvage their ideas. This isn't true, as strange matter comes from ideas of the standard model of particles. It so happens that the conditions inside some neutron stars may be such that strange matter exists there. In a similar vein, some have suggested quark stars. Again, Scott has the development of these ideas backward.

On page 177 Scott listed three characteristics of pulsar radiation. Item 3 states that the polarization implies that the sources have a strong magnetic field. This leaves out the synchrotron spectrum that requires not only a strong magnetic field, but also very fast moving charged particles. This is an important characteristic, so I'm curious as to why Scott omitted it. This characteristic is an important factor in the conventional explanation of pulsars. As so often happens, the conventional explanation involves charged particles moving with respect to a magnetic field (plasma). So why does Scott argue against it?

On pages 177 and 178 Scott again invoked binarity to explain pulsars, pointing out that a few pulsars do have companions. No one disputes that pulsars sometimes exist in binary systems. In fact, given that binary stars are so common, it would be strange if no pulsars were in binary systems. However, many more pulsars don't appear to be in binary systems. If just one pulsar is not a member of a binary, then the electric model fails. Some of these binary pulsars are very important in that they reveal the mass of the NS involved. We generally don't see the object that astronomers think is a neutron star, so if they are normal stars, why can't we see them? Scott mentioned five optical companions to neutron stars that have been found. To be seen as an optical pair, the two stars involved must be widely separated, but this apparently has not occurred to Scott.

In his discussion of the Crab Nebula Pulsar (pages 179 and 180) Scott called the nebula the remnant of a nova. Once again, this suggests that he doesn't understand the difference between a nova and a supernova. The difference is not just between the underlying theoretical mechanisms and supposed evolutionary precursors, but also observational differences. On page 179 Scott called attention to the knot 1500 AU from the pulsar. He doesn't explain the importance of the knot or even what he thinks it is. Does he think it is a star, as suggested by his description of the knot as "**a companion**" (emphasis his)? Looking at the knot (http://seds.org/messier/more/m001_hst.html), it does have a nebulous appearance, and thus appears as a knot, or dense cloud, of material, not a star.

Galaxies

Scott began his chapter on galaxies with the observation that new instruments and techniques reveal much radiation from galaxies that is non-optical and implies that the plasma theorists can explain this but astronomers cannot. He stated,

> We can now recognize the electric and magnetic mechanisms that generate this radiation, and this has given us a better definition of what a galaxy is: "a vast structure of magnetized plasma clouds that contain electric currents and occasional widely distributed concentrations of what are called nebulae, stars, and—rarely—planets." (Scott 2006, p. 187)

I suppose that Scott here referred to radio emission from some galaxies, something that astronomers have known about for at least 60 years. The radiation of most galaxies is dominated by visible light, and this is consistent with most of the radiation coming from a huge amount of stars. Normally radio emissions account for at most a few percent of a galaxy's radiation, and this appears to come from various radio sources within those galaxies. Much of the radio emission in spiral galaxies comes from 21-cm emission from neutral hydrogen gas, emission that astronomers use to map spiral structure of these galaxies. The 21-cm emission comes from a rare transition in electrons in the hydrogen atoms, and this has nothing to do with plasma. There are other such emissions that have no association to plasma. However, there are some galaxies whose radiation is dominated by radio emission, and astronomers call these radio galaxies. This calls for some unusual mechanism, and astronomers long ago settled upon electromagnetic explanations. The scenario involves a very massive black hole with a tremendously strong magnetic field. Material falling onto the black hole is heated to very high temperature, ionizing the gas, and imparting high speed to the ionized gas. With high velocity between the charged particles and the magnetic field, the charges are accelerated, resulting in much emission of radiation. Evidence of this scenario comes from the synchrotron spectrum and polarization of the radiation. Of course, this is a plasma explanation. I am at a loss to understand why Scott and other plasma astronomy supporters fail to recognize this. We ought to agree.

On pages 188–191 Scott discussed Alfvén's electric galaxy model, but this discussion omits any mention of elliptical galaxies, focusing instead on spiral galaxies. On page 190 Scott described an infrared (IR) image of the galaxy M82. IR normally is thermal radiation, usually from dust, so I don't see the electricity and magnetism connection. He also stated that the Subaru telescope is an orbiting IR telescope. The 8.2 telescope is on Mauna Kea, an extinct volcano in Hawaii; it is optimized for optical and near IR. On page 189 Scott incorrectly gives the diameter as 8.3 m.

Many supporters of plasma astronomy note the similar appearance of spiral galaxies and certain plasma effects (for instance, much of Lerner's book discusses this). Scott touched upon this lighter than others, though he briefly discussed this on pages 66 and 67 and page 220. Plasma astronomy supporters see a similarity in structure, and so they conclude both must have the same cause. However, there are several problems with this interpretation. First, there is a huge difference in scale. Second, spiral structure of galaxies includes many stars that don't appear to be charged, so it is difficult to conceive how electromagnetic forces can move stars. Third, mere similarity in appearance does not imply similarity in physical processes. Spiral galaxies also resemble the appearance of centralized storms, such as hurricanes, yet, I'm not aware of anyone who claims that hurricane structure is caused by plasma.

Scott claimed that plasma theorists predicted a number of things, presumably before their discovery, because if one explains something already known, that hardly is a prediction. For instance, on page 194 Scott claimed that plasma theorists predicted the filamentary structure that shows up in galaxy distributions, but the data showing filaments began to appear three decades ago. The caption on Plate 9 (page 196) says that Alfvén's model predicted double radio source galaxies "many years before any such objects were discovered," and that caption references Figure 57 on page 188. The discussion on page 188 states that Alfvén first described his model in 1986. I finished my graduate classes nearly five years earlier than that, and I distinctly remember discussing double-lobed sources in my galaxies and cosmology class, illustrated with images such as Plate 9. The classic introductory astronomy textbook of Abel (1964, pp. 573–574) discusses the two regions (lobes) of radio emission on opposite sides of Centaurus A. An early paper on the explanation of such sources is Blandford and Rees (1974). Obviously, Alfvén did not predict these things before their discovery.

At the beginning of his chapter on "Redshift and the Big Bang", Scott completely mischaracterized the famous 1920 debate between Harlow Shapley and Heber Curtis. In this debate, Curtis argued for the "island universe theory," that what were then called "spiral nebulae" actually were distant external galaxies similar to our own Milky Way, while Shapley argued that the nebulae were clouds of gas and dust within our own galaxy that were forming into stars and planetary systems. Scott described Shapley's case as an assertion, going on to comment, "Assertions made without much in the way of hard evidence to back them up are always precarious" (Scott 2006, p. 197).

Scott obviously knows little about this famous debate, for anyone familiar with it knows that Shapley used much evidence to support his position. It was Curtis who was short on evidence. Some of the data Shapley used were in error, such as the work of van Maanen's, something that I've discussed elsewhere (Faulkner 2007). Other evidence that Shapley used eventually was reinterpreted. An example of this was the appearance of the "nova" S Andromedae within the Andromeda "Nebula" (M31) in 1885. Shapley pointed out that if this were indeed a nova in an external galaxy, then it was far brighter than any nova ever seen. All Curtis could respond to this was that perhaps S Andromedae was some as yet unknown sort of brighter nova. Indeed, within a decade astronomers realized that S Andromedae wasn't a nova, but a supernova, eventually giving it the designation SN 1885A. It was Curtis, not Shapley, whose argument amounted to assertions, so Scott got this completely backwards. By the way, Scott incorrectly listed the year of Shapley's death as 1975 rather than 1972.

In his discussion of Hubble's work on pages 197–199, Scott unfairly implied some things. For instance, he stated that Hubble used the average brightness of galaxies to find distances. That is, the fainter a galaxy is, the farther that it is. Scott asked whether a galaxy could be nearby but smaller than average. Of course, that could be, but frequently there are ways to determine whether this is the case. Hubble did use this technique some, but he cautioned that those distances were least certain. Whenever possible, Hubble used Cepheid variables and a few other techniques. Furthermore, in the intervening 85 years astronomers have refined and expanded the use of Cepheids, and they have developed other techniques for finding extra-galactic distance. By not stating this fact, many readers of Scott's book could erroneously conclude that not much has changed since Hubble's original work.

Another unfair implication is the question of whether mechanisms other than expansion can cause redshift (page 198). Scott incorrectly stated that astronomers ignore this possibility. Other mechanisms can cause redshift, such as gravitational redshift, but this is a red herring, for the other mechanisms cause modest redshifts at most. On pages 198 and 199 Scott mischaracterized what Hubble thought of redshifts. He uses a quote from Hubble "if the redshifts are a Doppler shift…." Hubble indeed thought that redshifts arose from Doppler motions, which is viewed as a bit naïve today.[16] Hubble's use of "if" here was hypothetical. What he was addressing was the conflict that then existed between the age of the universe derived from his value of the Hubble constant and the age of the earth believed at that time, for the earth appeared to be older than the universe. Eventually the problem was resolved when astronomers determined that the Hubble constant was too large.

The discussion of Halton Arp's work in this chapter reflects a common misunderstanding. Arp doesn't argue that his data mean that redshift and distance have nothing to do with one another; indeed, Arp thinks that they normally do. What he challenges is the assumption that the two always are related. He accepts the expansion interpretation for most galaxies, but he rejects it for some galaxies and for all quasars. Scott basically argues in this chapter that if Arp is correct, then the big bang theory is dead. This sort of reasoning fundamentally misinterprets what Arp believes. If redshifts bore no relation to distance, then the big bang would be in trouble. But so would the steady state theory, a version of which Scott appears to support (pages 219 and 220). The twentieth century steady state theory is different from a static universe, originally favored by Einstein. A static universe is neither expanding nor contracting. A steady state universe is expanding, but new matter is introduced to preserve a constant density. For this reason the steady state theory sometimes was called the continuous creation theory. Therefore, if the universe is not expanding, then the steady state theory is not viable either. Here Scott asserted that Friedmann merely assumed that the total mass of the universe remains constant. However, this assumption amounts to the assumption of the conservation of mass, a well-established physical principle. Scott then implied that assuming violation of the conservation is a more reasonable and obvious assumption that thus is more warranted. I see a hint here of one of the main arguments for the steady state theory in its heyday, its elegance. Scott also conveniently fails to state the assumption of constant density necessary for the steady state theory. Most people find this assumption far less reasonable than the assumption of conservation of mass.

Finally, on page 211 Scott argued that quantized redshifts would imply that we're in the center of concentric shells of galaxies, but concludes that this can't be because of what Copernicus established (not discovered, as Scott states). However, isn't this just the sort of reasoning that Scott has criticized astronomers of for the past several pages—ignoring data that don't fit their preconceived notions?

Conclusion

Creationists have long made a distinction between operational and historical science. Operational science is the study of how the world now works. It can be tested in the here and now. In contrast, historical science is concerned with possible past processes. As such, we cannot test historical science in the same way that operational science can be tested. Both evolution and creation fall in the realm of historical science. Recent creationists have plenty to debate with much of historical science today. On the other hand, creationists generally don't have much quarrel with operational science. In astronomy, historical science would include theories about the origin of the universe (the big bang), about the origin of structures in the universe, and about the origin of stars and planets. Other questions, such as the current structure of the universe and properties and operation of stars and planets properly are in the realm of operational science, and hence ought not to be controversial for creationists. However, current physical models certainly are open to debate by all sides.

Many recent creationists who have read Lerner's book like his critique of the big bang model. That would be fine, if that was as far as it went. However, some must have thought that since Lerner was so right about the big bang that he must be right about other things, for some recent creationists have embraced much of plasma astronomy. I have demonstrated many problems with plasma astronomy ideas. Why do some recent creationists reject many conventional astronomical explanations of the world in favor of plasma explanations? There probably is an interesting sociology at work. Recent creationists see scientists making many claims about the world that contradict the creationary view of the world. In many cases it is very easy to identify the evolutionary assumptions involved, but in some situations it is not. The concept of creation is so radically different from

[16] The equation of redshifts with Doppler motion was common early in the twentieth century, and we see this often repeated in popular treatments today. Properly, redshifts primarily are due to universal expansion. There is a difference. For further discussion, see Faulkner (2004, pp. 58–60).

the evolutionary worldview that creationists realize that we are calling into question some very broad ways of looking at things. Unfortunately, too many recent creationists throw out the baby with the bath water in that they tend to automatically doubt all of conventional science without critically evaluating the issues to see if evolutionary thinking really is involved. To some it may just be much easier to doubt everything that a scientist says rather than to weigh whether some of those things may be true and have nothing to do with evolution. There develops a sort of anti-herd mentality, that if most of the world believes something, then it must not be true. To some we appear to be tilting at windmills, so some recent creationists automatically look for alternate explanations when far better explanations are readily available.

This seems to be the case with the attraction that plasma astronomy has for some recent creationists. The ideas promulgated by the plasma theorist are so shunned by astronomers that some recent creationists have difficulty resisting the notion that astronomers reject those ideas on the basis of evolution. Or perhaps it is the belief that if all of those scientists are so wrong about evolution, they must be wrong about much else as well. It is ironic that plasma theorists are almost exclusively atheists and hence must be evolutionists. That is, while motivated to avoid evolutionary thinking, some creationists may unwittingly embrace other evolutionary ideas. Unfortunately, it has been my experience that creationists who needlessly follow alternate explanations in astronomy tend to develop two standards of evidence. They seize upon any information that is presented as a problem for conventional astronomical explanation whether well-founded or not, but they exhibit almost no such examination of the alternate explanations.

As a professional astronomer with a Ph.D. in astronomy, I find the case for plasma astronomy to be seriously lacking. I trust that my examination here will cause others to carefully consider the problems that I have identified and realize that many conventional astronomy explanations, like any operational science, have no issue with creation.

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