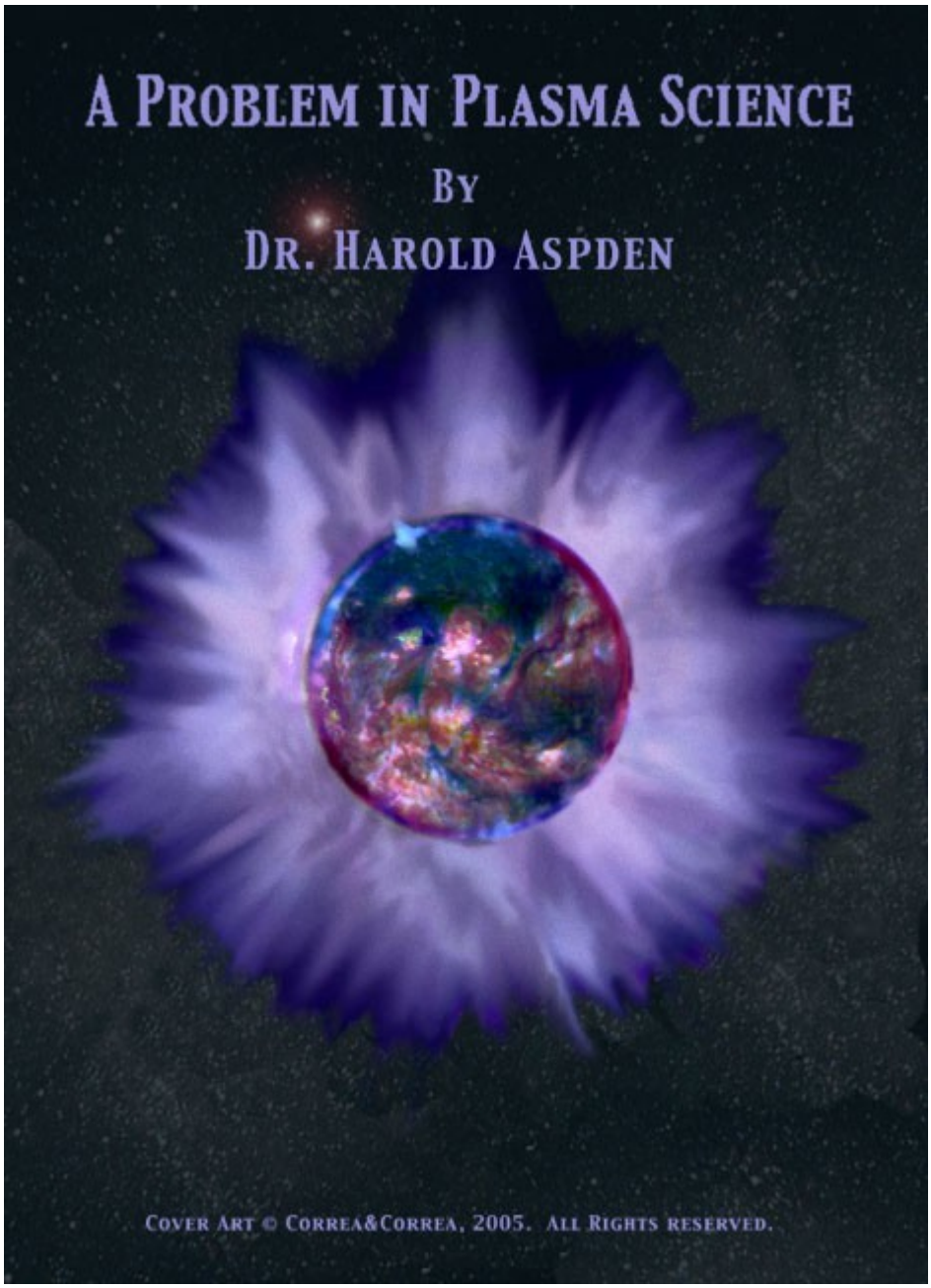

A Problem in Plasma Science

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Introduction

There is a quite serious problem that pervades the scientific theory relied upon in connection with research involving plasma discharges and so having bearing upon nuclear fusion experiments and even the interpretation of certain astrophysical phenomena. It

arises from leaving unresolved an issue raised by Clerk Maxwell in his *Treatise on Electricity and Magnetism* and so dating back to the 19th century.

Equally serious is the problem of scientific academia today by which physicists publish their ideas in numerous papers and in measure aimed solely at building their prowess and justifying their position, but papers most of which add nothing of significance to our knowledge base. Accordingly, university libraries tend to become poorly charted jungles in which genuine contributions of worthy research are hidden and so pass unheeded.

That 'issue' raised by Clerk Maxwell was in fact resolved and recorded in that 'jungle' some 37 years ago and, thanks to the author, myself, being still alive to point to its location, this item is now being remembered here on my website. I will below explain its importance.

The Sun and a Problem

We are told that the sun has a temperature of about 6000 degrees and can verify that this is a reasonable statement because we know the amount of solar heat radiation per square centimeter per second that reaches us here on Earth and we have Stefan's radiation law as determined from our laboratory experiments on radiation from hot bodies.

We are told that the sun's core has a temperature of over 100,000,000 degrees but that cannot be verified because it is founded solely on the assumption that the sun is powered by nuclear fusion and that is said to require such a high temperature. The evidence gleaned from the form of radiation said to comprise neutrinos is not a measure of temperature.

Yet we are also told that surrounding the sun there is a region we call the corona which is said to have a temperature of 1,000,000 degrees, inasmuch as the spectral lines of radiation sourced in that region were found in 1942 to exhibit energy properties akin to those arising from certain levels of electron transitions applicable to highly ionized iron atoms.

So the sun has three temperatures, none of which has actually been measured and all of which are inferred, one from an actual measurement of energy radiation, one from analysis of an energy spread in a spectral image and one from the mere imagination that the sun owes its energy source to the process we associate with the hydrogen bomb.

The problem I have is in wondering how the sun's corona can be at 1,000,000 degrees if the sun within that corona has a surface temperature of 6,000 degrees.

I think most readers will agree that understanding the deployment of energy in a plasma composed of heavy ions and electrons, such as we have in the sun, is important and yet here we have a blatant example of something accepted by the physics community that really does not make sense. Are we to suppose that we are looking at tiny specks of sunlight emitted from single atoms of iron that have a temperature of 1,000,000 degrees, mixed in the background of the sun's surface at 6,000 degrees? Or might it be that we cannot just use Boltzmann's constant to convert energy to temperature, assuming equipartition of energy between all ions of whatever size, and thereby stay with common

sense and assign the same temperature to all components of that plasma but admit there is some process at work that deploys energy unevenly? Why should we use gas laws formulated on the basis of there being no ionization when interpretating phenomena exhibited by ionized plasma?

The case I now put is that the problem confronted by Clerk Maxwell, had it been resolved, would have enlightened us on this important issue, one which has significant bearing upon the current research in the field of nuclear fusion.

Plasma Electrodynamics

Maxwell was concerned that Ampere's law of electrodynamics might not be a valid interpretation of experimental fact because it relied partly on empirical data and partly on assumption. He addressed the options available. The key point was that it was known how electric currents interact where one of the currents flows though wire around a closed circuit but it was not known how two discrete electric charges in motion might interact as a function of their motion. To define the law of force there had to be an assumption. Ampere had assumed total balance of action and reaction but one can have total balance of action and reaction for that closed circuit current condition without satisfying the precise formulation specified by Ampere.

In today's terminology the Lorentz force law suffices and meets the necessary balance criteria for such closed current circuit conditions, but an additional term, as formulated by Maxwell, is needed to cover the general case and that still depends upon an assumption. That additional term, expressed in vector form is simply:

(**v.r**)**v'**

times $ee'/\mathbf{r}_3$, where a charge e in motion at velocity **v** acts on a charge e' distant **r** from e and moving at velocity **v'**. The effect of this term integrates to zero for the closed circuit current condition.

Maxwell realized that this additional term could have any factor, positive or negative, large or small, and still comply with the empirical conditions. He opted for the factor being +1 because he knew that this would give an overall formulation for which the two charges in motion could interact without giving rise to an anomalous unidirectional net linear force that might suggest the interaction induced a linear push on something.

Instead, though it was not mentioned, that would lead to the two-charge interaction itself developing a turning couple as if it were exerting a twist action on that same something. Ampere's law had avoided both of these possibilities.

Given the belief in the existence of an aether in Maxwell's time and the fact that the motion of those charges is referenced on a frame of reference signifying a property of the aether, that 'something' did have a basis, one that could provide the balancing force along with the associated energy.

Maxwell, in being concerned with formulating force action, was addressing a problem that had important energy implications, but that seemingly escaped notice.

What I realized when I came onto the scene was that it would have been preferable for Maxwell to opt for the version with the minus sign preceding that (**v.r**)**v'** term, simply because that would avoid the twisting problem. Also, though introducing that out-of-balance net linear force, I could see that such a formulation, for **v** parallel with **v'**, would, in combination with the Lorentz component, result in a law for which mutual force action between the charges was of the simple inverse square of distance form acting along the line joining the charges.

Such a law made more sense especially as, at the time I discovered this, my thoughts were on linking electromagnetism and gravity.

The formal analysis, however, then had to take account of the possible interaction of charges of different mass, such as heavy ions interacting with electrons, and that added the factor (m'/m), where m' is the mass of charge e' and m is the mass of charge e, these charges being, of course, expressed in electromagnetic units.

My paper on this duly appeared in the library archives of universities in *Journal of the Franklin Institute*, **287**, 179 (1969) and there it sits gathering dust and serving no purpose unless whoever reads this decides to check what I am saying in this web item.

Given that, just as Clerk Maxwell saw reason to question the law of electrodynamics proposed by Ampere, I had good reason for going one step further and completing that task, I cannot understand why physicists interested in plasma experiments have not embraced what is surely the correct law.

Why is it that relevant? Well, just consider that term:

$$- (ee'/\mathbf{r}_3)(m'/m)(\mathbf{v.r})\mathbf{v'}$$

and imagine m' is the mass of a heavy positive ion and m is the mass of an electron sitting in an ionized plasma, be it that of the sun or that of a nuclear fusion reactor. Consider the collective results of four types of interaction. (1) Slow moving ion with electron moving closer: Ion gains speed slightly because ee' negative, **v'** small and **v.r** positive. (2) Slow moving ion with electron moving away: Ion slows to even lower speed because ee' negative, **v'** small and **v.r** negative. (3) Fast moving ion with electron moving closer: Ion speed escalates because ee' negative, **v'** large and **v.r** positive. (4) Fast moving ion with electron moving away: Ion loses speed rapidly because ee' negative, **v'** large and **v.r** negative.

The net effect of such charge interaction electrodynamically in a plasma must therefore be to cause each positive heavy ion on average to have kinetic energy far in excess of that of the average electron. It would be an interesting, though quite complicated mathematical task to evaluate statistically the mean energy apportionment between ions and electrons, one which I trust some enthusiastic mathematician might undertake. For my part it suffices

to point to the experimental evidence that supports what I am saying.

The Supporting Experimental Evidence

In my 1969 paper I drew attention to the fact that it had long been recognized that energy was being acquired anomalously by positive ions subjected to acceleration in a cold cathode gas discharge. The cathode reaction forces measured were high and inexplicable. I referred to a paper by E. Kobel in *Physical Review*, **36**, 1636 (1930). Clearly the effect of electrons flowing in the return path outside the tube and acting on ion flow within the tube accounted for that phenomenon, based on the law of electrodynamics as revised to replace the +(**v.r**)**v'** term in Maxwell's equation by that -(m'/m)(**v.r**)**v'** term. I note that Maxwell used cartesian formulation, whereas I am using the vector notation that Sir Edmund Whittaker used in discussing this subject in his 1951 book *History of the Theories of Aether and Electricity*. In saying that the action of electron currents exerts anomalous electrodynamic forces that accelerate heavy ions to higher than expected speeds, I am challenging orthodox theory which sees no basis for electrodynamic forces existing along the line of the ion current flow path, but the experimental evidence supports what I say. I refer to the subject of explosive arc discharges in liquids and wire rupture in experiments reported by P. Graneau and P. N. Graneau in *Physics Letters*, **97A**, 253 (1983) and *Applied Physics Letters*, **46**, 468 (1985). These were discussed in the context of the revised law of electrodynamics in my paper in *Physics Letters*, **111A**, 22 (1985) but see also my paper in *IEEE Transactions on Plasma Science*, **PS-14**, 282 (1986).

I also refer to my earlier paper on the subject of anomalous acceleration forces exerted by electrons on ions in IEEE Transactions on Plasma Science, PS-5, 159 (1977).

This latter paper was published just one year before the two fusion research papers that I next mention, whereas my original 1969 paper antedates these by nine years. I refer to the anomalous gain of energy by heavy ions found in plasma experiments and reported without mention of the theory that I had shown to be relevant.

J. Reece Roth, *IEEE Transactions on Plasma Science*, **PS-6**, No. 2, June 1978, studied the effect of radial electric fields in stabilizing a plasma discharge, but found that something was causing the heavy ions in the plasma to have a much higher temperature than the free electrons. The paper is entitled: '*Effects of Applied DC Radial Electric Fields on Particle Transport in a Bumpy Torus Plasma*'. Note that notion of 'temperature' as a sufficient measure of energy. What was meant was that the heavy ions have acquired a much greater energy than the electrons, whereas, seen as a kind of gas, they were supposed to have the same mean energy and so the same temperature. This was a report arising from reasearch aimed at nuclear fusion and here was energy gain by the heavy ions that are supposedly going to fuse and so deliver energy once containment and higher temperatures are reached. That observed energy gain surely warranted full investigation.

In that same year I saw a paper by J. D. Sethian, D. A. Hammer and C. B. Wharton in *Physical Review Letters*, **40**, 451 (1978) and quote the following words from that paper saying that they have found: "Experimental evidence for an anomalous electron-ion energy transfer in a relativistic-electron-beam-heated plasma that is 1,000 times faster than can be

predicted by classical processes."

At the end of their paper they suggest 'without particular justification' that the anomalous factor might be the hydrogen ion to electron mass ratio.

Here is another example of anomalous energy acquisition by heavy ions in a plasma, the energy per ion being quite enormous compared with the energy of electrons in that plasma, even though standard theory assumes they should have equal mean values.

Such research is aimed at replicating in a fusion reactor a process believed to be occurring in the sun and, for some reason, ignoring what my earlier papers have offered as explanation, those involved have not seen the common link, the fact that the sun's corona contains heavy ions that have energies far in excess (by a factor of the order of 160 greater) of that of the electrons that are seen as having the sun's temperature of 6000 degrees. Surely there is a natural physical process occurring by which apportionment of energy in a heavy ion-electron plasma favours the heavy ions in a very substantial way.

Assuming that I am right in declaring that an out-of-balance linear force action is asserted by the electromagnetic reference frame intrinsic to the medium I call the aether but which otherwise can be referred to as the quantum underworld, that medium may well be supplying that excess energy. Otherwise, it surely is interfering with the interaction between electrons and heavy ions in a way which promotes energy transfer from electrons to those ions.

Now I have stated that my writings on this matter, and particularly my 1969 paper in the *Journal of the Franklin Institute*, have not been heeded. I must correct that statement. There is just one instance, a quite important instance, where a researcher in Canada, Dr. Paulo Correa, somehow discovered that paper and saw its relevance to what he had discovered experimentally in his plasma discharge research. He and his wife, Alexandra Correa, in their laboratory research had discovered an anomalous inflow of energy that justified seeking patent protection for their project. My paper was a supporting reference mentioned by the Corrrea's in the patent description of their appatratus. The relevant U.S. patents are numbered 5,416,391 (issued May 16, 1995), 5,449,989 (issued September 12, 1995) and 5,502,354 (issued March 26, 1996).

Indeed, owing to the significance of that research, I did myself in 1996 write and publish a 35 page Report entitled *Power from Space: The Correa Invention*, which is now of record in the Report section of my website www.aspden.org.

Conclusion

As a conclusion I submit that there is something wrong with a highly academic scientific community funded to a large extent by governments concerned with our future energy resource problems, when research discoveries of this kind can be ignored. It seems that there can only be advances which conform strictly with scientific doctrines that are of textbook record without heeding discoveries which happen to emerge from free-lance research that trespasses outside textbook territory.

Electrodynamics was founded upon experiments confined to the interaction involving an electron currents carried around a closed wire circuit and experiment shows that textbook doctrine cannot cope with strange energy phenomena seen in plasma research where heavy ions are involved.

Is there an aether medium permeating all space or not? Textbook knowledge assures students that the aether has been eradicated, thanks to the doctrines proposed by Albert Einstein. So, if the aether is feeding energy into those plasma discharges studied by the Correas, that cannot be accepted and it is deemed appropriate to look elsewhere for our future energy resources. Where to look? Our fusion reactor research, of course, a seemingly never-ending quest, that even reveals its own anomalies. Energy seems to be creeping into the heavy ions from some mysterious source, but that has yet to warrant special study in its own right without us having to wait for the breakthrough that might come when a 100,000,000 degree temperature can be sustained for a long enough period without triggering our extinction.

I say we cannot be sure the sun is powered by nuclear fusion. Indeed I am sure it is not. However, we can be sure that energy is finding its way into heavy ions in a plasma contrary to accepted scientific principles and those in authority having concern for our energy future should heed the message here presented.

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