GIANT NEGENTROPY FROM THE COMMON DIPOLE

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Abstract

Decomposing the scalar potential between the end charges of a dipole reveals a harmonic set of EM waves flowing into the dipole from the complex plane, and a precisely correlated set of EM waves flowing out of the dipole in 3-space. The well-known broken 3-space symmetry of the dipole in its energy exchange with the vacuum thus releases 3-symmetry in EM energy flow, while conserving 4-symmetry in the manner indicated. The dipole thus becomes a universal kind of negative resistor extracting electromagnetic energy from the vacuum. Specifically, it absorbs EM energy from the time domain (complex plane) and emits the energy in real 3-space.

Considering the spread through space of the Whittaker-structured potential formed with the dipole, the dipole's formation initiates a giant reordering of a fraction of the vacuum energy, spreading at the speed of light in all directions and continuing as long as the dipole is intact.

By considering an isolated charge and its clustered virtual charges of opposite sign, the charge becomes a set of dipoles, each with a decomposable potential. The "isolated" source charge thus exhibits the giant negentropy mechanism. This explains how a source charge, once created, continuously pours out the electromagnetic energy comprising its fields and potentials and their energy.

Some non sequiturs in the present definition of field and potential, and in the electromagnetic energy flow theory, are corrected. The vast nondiverged Heaviside dark (unaccounted) energy flow component surrounding every circuit and accompanying every field interaction is restored, and the historical background of how it was and is arbitrarily discarded is given. Applications to circuits are given, particularly to using the new giant negentropy principle for permissible open dissipative Maxwellian systems which permissibly extract electrical energy from the vacuum and use it to power their loads. Because of the increasing world energy crisis and oil supply peaking with subsequent declining, a high priority project under U.S. government auspices is recommended, to rapidly develop such open dissipative electrical power systems using electrical energy from the active vacuum.

Introduction

We report the possible discovery of a process for initiating giant re-ordering of a substantial portion of the vacuum energy. The hypothesized negentropic process is easily triggered by making a common dipole, and once initiated the vacuum reordering continues and spreads at the speed of light, radially in all directions. In addition, the ongoing process outputs an enormous 3-space EM energy flow from the dipole. The flow is continuously replenished by a corresponding giant EM energy flow into the dipole from the complex plane. EM energy flow is conserved in 4-space, but not in 3-space {1}.

Simultaneously, if valid, this process constitutes a remarkable new EM energy flow symmetry in 4-space, *without* the added condition of EM energy 3-flow symmetry. Hence we may have uncovered what we believe to be an extended EM energy flow conservation law, that is more fundamental and useful than the 3-spatial EM energy flow symmetry and conservation law presently used in electrodynamics and specifically in the design of electrical power systems.

Nature requires 4-space EM energy flow conservation, but does not require imposing the *additional condition* of 3-space energy flow conservation. Thus the most fundamental 4-symmetry in EM energy flow would appear to be a symmetry between the inflow of EM energy from the imaginary plane (the time domain), and the outflow of real EM energy in real 3-space, where symmetry in energy 3-flow is broken and EM energy 3-flow is not conserved.

We propose a "first order" mechanism by which the dipole charges transduce the reactive inflowing EM energy into real outflowing EM energy. By treating the isolated charge and its clustered virtual charges of opposite sign as a set of composite dipoles, the problem of the source change and the source of its self-fields and self-potentials would appear to be resolved by the hypothesized negentropic process.

We correct some long-standing non sequiturs in EM energy flow theory itself, and briefly give the background of how these non sequiturs developed.

The new negentropy principle, if found valid, should be directly usable in electrical power systems which extract EM energy from the active vacuum, intercept and collect it, and use it to permissibly power themselves and their loads.

Re-Examining the Common Dipole

Any dipole has a scalar potential between its ends, as is well-known. Extending earlier work by Stoney {2}, in 1903 Whittaker {3} showed that the scalar potential decomposes into—*and identically is*—a harmonic set of bidirectional longitudinal EM wavepairs. Each wavepair is comprised of a longitudinal EM wave (LEMW) and its phase conjugate LEMW replica. Hence the formation of the dipole actually initiates the ongoing production of a harmonic set of such biwaves in 4-space {4}.

We separate the Whittaker waves into two sets: (i) the convergent phase conjugate set, in the imaginary plane, and (ii) the divergent real wave set, in 3-space. In 4-space, the 4th dimension may be taken as -*ict*. The only variable in -*ict* is *t*. Hence the phase conjugate waveset in the scalar potential's decomposition is a set of harmonic EM waves converging upon the dipole in the time dimension, *as a time-reversed EM energy flow structure inside the structure of time* {5}. Or, one can just think of the waveset as converging upon the dipole in the imaginary plane {6}—a concept similar to the notion of "reactive power" in electrical engineering.

The divergent real EM waveset in the scalar potential's decomposition is then a harmonic set of EM waves radiating out from the dipole in all directions at the speed of light. As can be seen, there is perfect 4-symmetry in the resulting EM energy flow, but there is broken 3-symmetry since there is no observable 3-flow EM energy input to the dipole.

Further, there is perfect 1:1 correlation between the convergent waveset in the imaginary plane and the divergent waveset in 3-space. This perfect correlation between the two sets of waves and their dynamics represents a *deterministic re-ordering* of the 4-vacuum energy, initiated by the formation of the dipole, and spreading radially outward at the speed of light.

Interpreting the 4-Symmetry in Electrical Engineering Terms

The EM energy flow in the imaginary plane is just incoming "pure reactive power" in the language of electrical engineering. The outgoing EM energy flow in the real plane (3-space) is "real power". So the dipole is continuously receiving a steady stream of reactive power, transducing it into real power, and outputting it as a continuous outflow of real EM power.

To initiate the hypothesized giant negentropy process, all one has to do is first expend a little energy to form the dipole. Once the dipole is formed, the process is automatically initiated and sustained by the broken 3-symmetry of the dipole {7}. The process continues indefinitely and freely, so long as the dipole remains intact {8}.

How the Reactive Power is Transduced into Real Power

We suggest a mechanism which accomplishes the transduction or at least models it. As is well-known, the charges comprising the ends of the dipole have a very special characteristic: Simply modeled, a charge may be said to spin 720º in making one complete rotation, not just 360º. It spins 360º in the imaginary plane, and spins 360º in the real plane (3-space). Let us examine a dipole charge spinning 720º per rotation in that manner. During its 360º spin in the imaginary plane, it *absorbs* the converging reactive power. During its 360º spin in the real plane (in 3-space), it *re-radiates* the EM energy it has absorbed from the imaginary plane, as real power in a steady, divergent, radial 3-flow of EM energy at the speed of light in all directions.

If one does not press it too far, this simple analogy is useful for visualization of the transduction process.

What This All Means

So if the hypothesis holds, we have arrived at some interesting findings:

a. As is well-known in particle physics, a dipole is a broken 3-space symmetry in the violent flux exchange between the active vacuum and the dipole.

b. This dipole's broken 3-space symmetry in EM energy flow, provides a *relaxation* to a more fundamental EM energy flow symmetry in 4-space.

c. There is no law of nature or physics that requires 3-symmetry of EM energy flow as an additional condition applied to 4-symmetry of EM energy flow.

d. The dipole is a practical and very simple means of "breaking" the additional 3-flow symmetry condition in EM energy flow and relaxing to the fundamental 4-flow symmetry *without* 3-flow symmetry.

e. So long as the dipole statically exists (e.g., imagine an electret suddenly formed, or a charged capacitor with no leakage), real usable EM energy will pour from the dipole at light speed in all directions. At the same time, reactive EM power (actually, energy) will continuously flow into the dipole from the time-domain (the complex plane), and be transduced into real EM power output in 3-space by the dipole.

f. A dipole and its scalar potential thus comprise a *true negative resistor* system of the most fundamental kind. The dipole continually receives EM energy in unusable form (reactive power, which cannot perform real work), converts it to usable form (real power, which can perform real work), and outputs it as usable, real EM energy flow (real power) in 3-space.

g. Simultaneously, at its formation the dipole initiates a continuing *giant negentropy*—a progressive reordering of a substantial and usable portion of the vacuum energy {9}. Further, this reordering of vacuum energy continuously spreads in all directions from the initiation point, at the speed of light. Some dipoles in original atoms formed shortly after the beginning of the universe, have been pouring out real EM energy for some 15 billion years or so, and have reordered a fraction of the entire vacuum's energy, where the magnitude of the re-ordering varies inversely as the radial distance from the dipole.

h. If the dipole is destroyed, the ordering of the vacuum energy ceases, leaving a "separated chunk" of reordered vacuum energy that continues to expand at the speed of light in all directions, steadily reducing in local intensity as it expands.

i. At any very small volume in space, from the dipole dynamics of the universe it follows that a great conglomerate of reordered vacuum flows and fluxes—some continuous, some chopped—is continually passing through that volume. Further, the situation is totally nonlinear, so that direct wave-to-wave interactions occur continuously amongst these energy flows and waves. We hypothesize that this is the actual mechanism constituting Puthoff's cosmological feedback mechanism {10}.

j. Further, in 1904 Whittaker {11} showed that any EM field or wave pattern can be decomposed into two scalar potential functions. Each of these two potential functions, of course, decomposes into the same kind of harmonic

longitudinal EM wavepairs as shown in Whittaker 1903, plus superposed dynamics. In other words, the interference of scalar {12} potentials—each of which is actually a set of longitudinal EM waves, and not a scalar entity {13} at all, but a *multivectorial* entity—produces EM fields and waves and their dynamics. Hence we hypothesize that the Whittaker interference of the propagating reordered EM energy entities, continuously occurring at any point in space, generates the zero-point EM field energy fluctuations of the vacuum itself. Indeed, an AIAS group paper by Evans *et al*. {14} has already shown that just such "scalar interferometry" produces transverse EM fields and waves in the vacuum.

Solution to the Problem of the Connection Between Field and Source

We use the foregoing hypothesis to propose a solution to a previously unsolved major foundations problem in electrodynamics. Quoting Sen {15}:

> *"The connection between the field and its source has always been and still is the most difficult problem in classical and quantum electrodynamics."*

The problem really lies in how we approach the notion of the "source charge", since the usual classical electrodynamics does not model the interaction of the vacuum and the charge {16}. With no active vacuum input to the charge, the received crippled and fragmentary model of electrodynamics implies that the charge not only creates the fields and potentials which surround it, but also creates *out of nothing* all that EM energy comprising those associated fields and potentials. Since energy can neither be created nor destroyed, but only changed in form, the conventional notion that the source charge produces its associated fields and potentials and EM energy, in the absence of any interaction with the vacuum, is a non sequitur.

So the problem is that the conventional model eliminates the vacuum interaction. Hence that model must grossly violate the conservation of energy law in its view of the charge as the source of fields and potentials and their energy. In short, it simply posits an output of EM energy without any energy input or change in state of the charge.

Experimentally, of course, it is easily shown that EM energy does pour out of that charge, creating all its associated fields and potentials which do appear around it. Just create a charge (e.g., as in pair production), and measure the resulting outflow of the fields and potentials and EM energy from it, at the speed of light in all directions.

However, the charge alone cannot be a true *source*, since rigorously there can be no such thing! As Semiz {17} puts it:

> *"The very expression 'energy source' is actually a misnomer. As is known since the early days of thermodynamics, and formulated as the first law, energy is conserved in any physical process. Since energy cannot be created or destroyed, nothing can be an energy source, or sink. Devices*

we call energy sources do not create energy, they convert it from a form not suitable for our needs to a form that is suitable, a form we can do work with."

We really do not have *energy sources* as such in nature, even though we sloppily use that term. Instead, we actually have *energy transducers*.

A priori, since we measure no real 3-space input of EM energy to the unchanging charge but we can measure real 3-space EM energy pouring from it, energy must be input to it from the active vacuum in a *nonobservable* form, and converted by it into an *observable* form that is re-emitted, usable, and produces what we call the "fields and potentials" and their energy, associated with that "source charge". As is common usage, we will use the term "source charge" or "source dipole", but with the understanding that we refer to a special kind of energy transducer.

The Charge As a Composite Dipole

To solve the source charge problem, we first point out that there exists no such thing as an *isolated charge*. As is well-known in quantum electrodynamics, clustered around any "isolated charge" in the vacuum are virtual charges of opposite sign. We take one of the separated virtual charges, and a piece of the observable charge of opposite sign, and call the pair a *composite dipole*. So the so-called "isolated charge" is actually a set of composite dipoles. Any of the clustering virtual charges and any of the pieces of the observable charge thus comprise such a composite dipole. The charge is thus seen as a great entanglement of composite dipoles.

Further, each composite dipole has its own scalar potential. With the previously stated reservation {4}, this scalar potential decomposes per Whittaker 1903 and thus initiates a giant negentropic reordering of the vacuum energy as previously discussed. So any charge is really an entire set of composite dipoles, composite negative resistors, and broken 3-symmetries in the vacuum flux exchange. However, energy flow 4-symmetry must rigorously apply.

The charge is a dipolar system (actually it is a *great set* of dipoles). It pours out a continuous flowset of real EM power in 3-space, radially at the speed of light in all directions. The composite dipoles comprising the charge system are being fed by a continuous converging flow of reactive power from the imaginary plane, as we discussed above.

The real EM wave energy flow pouring out radially in all directions in 3-space from the charge system, forms the well-known fields and potentials associated with that "source charge". The actual source of the EM energy flow from the charge is the hypothesized negentropic reordering of the 4-vacuum energy into a giant 4-circulation of EM energy flow. The 4-symmetry in EM energy flow is conserved at all times. *Energy is not created by the charge*—which creation has been implied in classical EM theory without the vacuum interaction, without the charge as a composite dipole, and without the

Whittaker decomposition of the scalar potential between the poles of every dipole. Instead of the present "creation of energy" non sequitur in the conventional model, the charge's received EM energy flow in unusable form is *transduced* by the charge's spin into usable form and output continuously.

In short, a charge is an open system far from thermodynamic equilibrium *in 3-space EM energy flow*, hence classical equilibrium thermodynamics does not apply. The charge is simultaneously in perfect equilibrium in 4-flow. It continuously receives EM energy from the time dimension (imaginary plane), transduces the energy into real 3-space, and radiates it radially outward in 3-space as a real EM energy flow, producing the fields and potentials associated with that "source charge".

As a dipolar system, the charge's broken 3-symmetry in EM energy flow has allowed the system to relax to a more fundamental 4-symmetry energy flow without the arbitrary additional condition of 3-symmetry energy flow. The charge and the dipole are thus the ultimate and universal *negative 4-resistors*. The dipole furnishes the energy to power every electrical system and circuit, since all EM systems and circuits must involve charge which is nothing but a set of composite dipoles receiving reactive power and pouring out real power (real EM 3-energy flow).

Entropic Engineering

When we "make entropy", we must do work. We wrestle nature fiercely to the mat, so to speak, by brute force. All the while, nature protests our entropic brutality by providing the Newtonian third law reaction force back upon our causative wrestler performing the "forcing". To do entropic engineering, we have to continually input energy to the wrestling mechanism or engine, losing a bit of the input energy in the inefficiencies, and fighting the "back emf", "back mmf", or Newtonian third law reaction that is nature's protest all the while. Those are nature's penalties for imposing 3-space EM energy flow symmetry upon her as an *additional and highly undesired condition*.

In short, we have to provide the continual input energy to our entropic processes by burning fuel, damming rivers, erecting windmills, building waterwheels, erecting solar cell arrays, building and charging chemical batteries, etc. In the process, we destroy and pollute the biosphere on a giant scale as we rip down forests, strip-mine and drill the earth, and spill pollutants into the atmosphere, the rivers, the oceans, etc. We do all that biospheric destruction because we inexplicably insist upon 3-space energy flow symmetry, and thus adamantly require adherence to classical equilibrium thermodynamics.

We have to pay and pay continuously, for insisting on doing such atrocious entropic work. In so doing, we "tie nature's feet down" with that added arbitrary 3-symmetry in energy flow. We ourselves prohibit nature from performing the giant negentropy she so dearly loves. We also arbitrarily and *meanly* discard the bountiful electromagnetic energy flow that nature loves to furnish us so freely by her vast preference for negentropy.

Negentropic Engineering

A far better way is to cooperate with nature and "let nature make copious negentropy". To do that, we now can see the startlingly simple mechanism. We simply make a little dipole, entropically. So we have to pay for *making* the dipole, *once*, and we have to do a little gentle violence to nature, *once*. Then we need do no more violence, if we just leave the dipole intact and do not destroy it.

When we make the dipole, we make a little bit of "broken 3-symmetry" in the universe's energy flow. Voila! Nature sings for joy at finally having her feet freed from the shackles of 3-symmetry energy flow. In great glee, she instantly sets to re-ordering a substantial and usable portion of the vacuum energy, in all directions at the speed of light. As long as we do not destroy the dipole (the broken 3-symmetry) which breaks the shackles, nature's feet remain freed from the 3-space symmetry, and she delightedly continues to reorganize a portion of the vacuum energy, with the reordering spreading radially outward at the speed of light.

Simultaneously, in great gratitude, nature pours out an immense real EM energy 3-flow from that little dipole. She will continue to pour it out forever, if we do not destroy the dipole.

Entropic Versus Negentropic Engineering

To summarize: If we make *entropy*, we tie nature's feet and she forces us to pay for it, and pay continuously.

If we make *negentropy*, we only pay a very tiny "initiation fee." From then on a delighted nature pays us for our thoughtfulness, and pays us copiously.

The smart thing to do is make just a little bit of entropy wisely, using it to break 3-space energy flow symmetry (basically, to make a dipole). Then leave that *mother of all negative resistors and free energy generators* alone! Concentrate on intercepting, extracting, and using the free energy copiously flowing forth from the giant negentropy, without destroying the dipole that is freely providing it.

How Circuits Are Actually Powered

Let us now look at the great magnitude of the energy flow that nature gives us from that dipole. We have to get into the subject a bit, because EM energy flow theory has been rather thoroughly confused for about a century.

First, batteries and generators *do not* use their available internal energy—the shaft energy we input to the generator, or chemical energy available in the battery—to power the external circuit. Instead, each uses its available internal energy {18} to perform work on its own internal charges, forcibly separating the charges to form the *source dipole*.

All the hydrocarbons ever burned, all the nuclear fuel rods ever consumed, and all the dams ever built, added not one single watt directly to the power line. All the energy from those activities was input to the generator shaft after normal losses en route, to provide internal energy available to the generator. In turn, the generator used that available internal energy only to do internal work on its own internal charges to force them apart, forming the source dipole connected to the terminals.

Batteries and generators expend their internal energy available to them, to make the source dipole, and for no other purpose! None of their internal energy is used to power their external circuit. It never has been, and it never will be.

Once the source dipole is formed, it does all the hypothesized 4-functions we pointed out previously. It induces the spreading giant negentropic reordering of the vacuum energy, extracts (transduces) EM energy from the continuously reordering vacuum, and pours out from the terminals of the generator (or battery) a vast 3-flow of EM field energy along the external circuit. As shown by Kraus {19}, this giant EM energy flow fills all space surrounding the circuit, out to an infinite lateral radius. The energy flow is generally parallel to the conductors of the circuit. Only a tiny "sheath" of this flow—the little boundary layer that slides along the surface of the conductors—strikes the surface charges and gets diverged into the conductors to power the Drude electrons and the circuit. All the rest of that vast EM energy flow pouring forth from the terminals just misses the circuit entirely, roars on off into space, and is wasted.

So the diverged, utilized, and accounted energy flow component—the *Poynting component*—is only a tiny, tiny fraction of the entire giant EM energy flow produced by the source dipole for every circuit.

Relative Magnitude of the Heaviside Component Versus the Poynting Component

Unless Heaviside and Lorentz did rigorous calculations in a work I have not yet uncovered, I could not find any development of the functions and equations required for computing the ratio of the unaccounted Heaviside "dark energy flow (*nondiverged* energy flow component that misses the circuit), to the tiny Poynting energy component that strikes the surface charges of the conductors {20}and is diverged into the wires to power the circuit.

Consequently, I performed a very crude "special case" estimation {21}—a back-of-the-envelope type, with highly simplifying assumptions—for a very simple circuit in which one resistor is powered by a DC source. About 10^{13} times as much EM energy flow *misses* the circuit, is not diverged, and is *wasted*—as *strikes* the circuit, gets collected, and then is dissipated to power the load and losses. Until electrical physicists re-examine the energy flow theory and again recover the Heaviside unaccounted component in it, that brute force estimate will have to suffice as at least an illustrative example.

What does that 10^{13} ratio mean? For a little 1 watt generator of that DC type with that specific size conductors and that specific resistor, the Heaviside unaccounted energy flow component was about *10 trillion watts*, if all of it could be intercepted, collected, and used to power loads {22}. But the little circuit was only intercepting and collecting—and using to power loads—about 10^{-13} of the available energy flow surrounding the circuit, *if* all of it could be intercepted, collected, and used to power loads.

We have never had, and we do not now have, an *EM energy* problem. Instead, we have the two problems that

(i) only a tiny, tiny component of the available 3-energy flow extracted from the vacuum by the source dipole and poured out of the terminals of the power source, is caught and used by the circuit, and

(ii) half of that small component that is intercepted and caught, is used only to destroy the source dipole and cut off the free flow of EM energy from the vacuum.

We have previously discussed this further in several papers {23}.

A Short History of the Discarding of the Heaviside Dark Energy

Let us now see how the enormity of the EM energy flow from the dipolar source was treated in the early electrodynamic theory, and how it is treated in the received view today.

In the 1880s after Maxwell was already deceased, Poynting {24} and Heaviside {25} independently (and rather simultaneously) discovered EM energy flow through space. Before that, the concept did not appear in physics. Poynting {24} published prestigiously, while at first Heaviside published more obscurely {25}, then finally more prestigiously {26} {27}.

With respect to circuits, from the beginning Poynting assumed only that small amount of EM energy flow that enters the circuit. Here are Poynting's {28} own words:

> *"This paper describes a hypothesis as to the connexion between current in conductors and the transfer of electric and magnetic inductions in the surrounding field. The hypothesis is suggested by the mode of transfer of energy in the electromagnetic field, resulting from Maxwell's equations investigated in a former paper ("Phil. Trans.," vol. 175, pp. 343-361, 1884). It was there shown that according to Maxwell's electromagnetic theory the energy which is dissipated in the circuit is transferred through the medium, always moving perpendicularly to the plane containing the lines of electric and magnetic intensity, and that it comes into the conductor from the surrounding insulator, not flowing along the wire."*

As can be seen, Poynting considered only the energy flow actually entering the wire, and subsequently being dissipated in the circuit. Poynting also got the direction of the flow wrong, later to be corrected. Hence Poynting never considered the huge EM energy flow

component around the circuit that (a) is *not* diverged, (b) *misses* the circuit entirely, (c) *does not* contribute to the energy dissipated by the circuit, and (d) is *wasted*. So there is a vast "dark energy flow" associated with every dipolar interaction—a huge energy flow component which Poynting never considered. By "dark" we mean *unaccounted for*.

Heaviside's theory was an extension of what Poynting had considered, and he also corrected Poynting as to the direction of flow. Heaviside was fully aware of the enormity of the "dark energy" flow missed by Poynting, but had absolutely no explanation as to where such a startlingly large EM energy flow—pouring from the terminals of every dipole, generator, or battery—could possibly be coming from. Consequently he was very cautious in referring to it, usually doing so only obliquely in terms of the angles and components. In Heaviside's {29} own words:

> *"It [the energy transfer flow] takes place, in the vicinity of the wire, very nearly parallel to it, with a slight slope towards the wire… . Prof. Poynting, on the other hand, holds a different view, representing the transfer as nearly perpendicular to a wire, i.e., with a slight departure from the vertical. This difference of a quadrant can, I think, only arise from what seems to be a misconception on his part as to the nature of the electric field in the vicinity of a wire supporting electric current. The lines of electric force are nearly perpendicular to the wire. The departure from perpendicularity is usually so small that I have sometimes spoken of them as being perpendicular to it, as they practically are, before I recognized the great physical importance of the slight departure. It causes the convergence of energy into the wire."*

As can be seen, Heaviside was fully aware that the energy flow diverged into the wire was only a minuscule fraction of the total. And he was fully aware that the remaining component was so huge that the energy flow vector remaining—after the divergence of the Poynting component into the circuit—was still almost parallel to the conductors. However, he had no explanation at all of where such an enormous and baffling energy flow could possibly originate.

Had Heaviside strongly stated the enormity of the nondiverged component of the energy flow, he would have been viciously attacked and scientifically discredited as a perpetual motion advocate. So his words were measured and cautious, but there is no doubt that he recognized the enormity of the nondiverged EM energy flow component.

We have chosen to call that huge unaccounted component the "Heaviside dark energy component" in his honor, since he actually discovered it. By the word "dark" we mean "unaccounted", which hides it from scientific view.

Lorentz Disposed of the Problem Rather than Solving It

Lorentz entered the EM energy flow scene to face the terrible problem so quietly raised by Heaviside. Lorentz understood the presence of the Poynting component, and also of

the Heaviside component, but could find no explanation for the startling, enormous magnitude of the EM energy pouring out of the terminals of the power source (pouring from the source dipole) {30} if the Heaviside component was accounted. Had he developed and retained this enormous dark energy flow component, even the great Lorentz would have been castigated as a perpetual motion advocate.

Unable to *solve* the dark energy flow problem by any rational means, Lorentz found a clever way to *avoid* it. He reasoned that the nondiverged Heaviside component was "physically insignificant" (his term) because it did not even enter the circuit. Since it did nothing, he reasoned that it could just be discarded.

So Lorentz {31} simply integrated the entire energy flow vector (the vector representing the sum of both the Heaviside nondiverged component and the Poynting diverged component) around an assumed closed surface enclosing any volume of interest. *A priori* this mathematical procedure discards the dark *Heaviside* energy flow component because of its nondivergence. It retains only the intercepted *Poynting* diverged component that enters the circuit.

A century later, electrodynamicists are still happily avoiding the dark energy flow problem by continuing to use the Lorentz integration procedure {32} to dispose of all but the Poynting component that enters the circuit and is then dissipated by the circuit. As a result, the "Poynting energy flow" has come to be loosely regarded as "the" entire EM energy flow, though electrodynamicists find it necessary to give stringent warnings about it. E.g., Panofsky and Phillips {33} state it this way:

> *"…only the entire surface integral of N [their notation for the Poynting vector] contributes to the energy balance. Paradoxical results may be obtained if one tries to identify the Poynting vector with the energy flow per unit area at any point."*

Most electrodynamicists note the freedom to add a vector—few call it an *energy flow* vector, though that is the type of vector being discussed, and one must add apples to apples—which has zero divergence. Jones {34} states:

> *"It is possible to introduce the Poynting vector* $\boldsymbol{S}$*, defined by* $\boldsymbol{S} = \boldsymbol{E} \times \boldsymbol{H}$*, and regard it as the intensity of energy flow at a point. This procedure is open to criticism since we could add to* $\boldsymbol{S}$ *any vector whose divergence is zero without affecting [the basic integration procedure's result]."*

Jackson {35} says it even more plainly, and also uses Lorentz's "no physical significance" argument for disposing of any energy flow vector with a zero divergence. Quoting:

> *"...the Poynting vector is arbitrary to the extent that the curl of any vector field can be added to it. Such an added term can, however, have no physical consequences."*

Needless to say, any energy flow vector which is the curl of a vector field will have zero divergence, by elementary vector algebra. In short, to be pertinent at all, it must be an *energy flow* vector (since energy flow is what $\boldsymbol{S} = \boldsymbol{E} \times \boldsymbol{H}$ is all about. Since the curl of any vector has no divergence *a priori*, then any energy flow vector that is a curl of a vector field will be part of the Heaviside dark energy flow component, rather than part of the Poynting energy flow component. It will also be discarded by Lorentz's closed surface integration.

Jackson errs in assuming such a divergence free vector (energy flow) can have no physical consequences. That is true so long as one does not intercept and diverge—and utilize—some of the otherwise nondiverged energy flow. If one inserts *intercepting charges* into that nondiverged energy flow component, the charges will immediately diverge some of the formerly nondiverged energy flow around them and hence "collect additional energy". That is most certainly a useful physical consequence. There are others also, as we used in deriving the negentropy of the dipole. There the input of a non-Poynting energy flow component certainly has universal and physical significance, because it progressively reorders a significant fraction of the vacuum energy, producing a spreading giant negentropy from the dipole. An important physical significance of this negentropic reordering steadily spreading in all directions is that the dark energy component has gravitational consequences {39}.

Schwarz {36} expresses it this way:

> *"There will be many opportunities in which the interpretation of* $\boldsymbol{E} \times \boldsymbol{H}$ *as a rate of flow of energy per unit area will be profitable. In most cases of practical interest, such an interpretation is valid, although it must always be kept in mind that only the integral of* $\boldsymbol{S}$ *over a closed surface can be physically measured…Just how it is that the connections to the energy source, say a battery, are at the ends of the wire, yet energy flows in through the sides, should be pondered by the reader."*

For recommended changes to the Poynting vector, Jones {37} presents many conditions the changed vector must fulfil. Then he falls back on the Lorentz closed surface method again, but without realizing that he therefore (i) includes both the diverged and nondiverged component, and (ii) invokes a procedure that arbitrarily discards the nondiverged component. In thus disposing of the problem, Jones says:

> *"It does not seem likely that an expression satisfying all these conditions will be simple.… …fortunately, we are rarely concerned with the energy flow at a point. In most applications we need the rate at which energy is crossing a closed surface."*

Finally, we note that even today, a debate on what the Poynting vector is or should be, is still politely ongoing. As an example, it has been ongoing for more than 40 years in the American Journal of Physics alone {38}.

Concluding Remarks

In this paper we have proposed what we believe to be a great new *principle of giant negentropy*, leading to direct extraction of EM energy from the vacuum in copious quantities. That principle is to retain 4-symmetry of EM energy flow, while breaking 3-symmetry of EM energy flow. It is implemented by making a common dipole.

We have pointed out the implications of the new principle of negentropy in EM energy flow, and how all our circuits and electrical power systems actually use it but then are designed so as to negate the negentropic process's potential for self-powering electrical power systems.

Presently we are told by the conventional scientific community that the dream of freely extracting EM energy from the vacuum, and using it to efficiently and easily power our electrical needs cleanly, is either a fool's concept of perpetual motion, or the science of the next century. It is neither; it is good physics, and already misused in all our electrical power systems and circuits. Unlimited electrical energy from the vacuum is here and now, if we but overcome our mindset and grasp it.

We have argued that all electrical loads and circuits are now and always have been powered by just such EM energy extracted directly from the vacuum by the giant negentropy principle, evoked by the source dipole. We have removed the artificial and erroneous notion that batteries and generators provide some of their available 3-space internal energy to the external circuit. Instead, we have emphasized that batteries and generators dissipate their available energy to form their source dipole, and nothing else.

In dealing with the function of the dipole in extracting the EM energy from the vacuum and pouring it out to power the circuit, we have shown errors in present energy flow theory and how they came to be made. We also indicated the enormous magnitude of the EM energy flow actually extracted and present with every conventional circuit, but wasted. Some processes for intercepting, collecting, and using additional amounts of this available Heaviside "dark EM energy" flow component, surrounding every circuit, have been mentioned, and references have been given to other papers more fully discussing such processes. In a previous paper {39} we have proposed that the Heaviside dark energy, accompanying all EM field-charge interactions, is responsible for the excess gravity observed to be holding the spiral arms of those distant spiral galaxies intact—in short, we have proposed an unaccounted *dark energy* solution to the well-known *dark matter* problem in astrophysics.

The ordinary closed current loop circuit inherently yields a system COP<1.0, because it destroys its source dipoles faster than it powers the load. Indeed, the circuit self-enforces the Lorentz symmetrical regauging condition during discharge of its free excitation (potential) energy.

Finally, we have endeavored to present to the reader a very different view of electromagnetic circuits and how they are powered. Previously we have also cited actual experiments—such as Bohren's {40} experiment—which demonstrate the principles.

The present world energy crisis is real and increasing, while at the same time the availability of oil is beginning to decrease and oil becomes more costly. The need for electricity obtained from oil-combustion-related processes is ever increasing worldwide. Unless a substantial fraction of the "electricity from oil" curve is shifted to "electricity from the vacuum" rather quickly, the economic collapse of the Western world, followed by concomitant collapse of other economies, may ensue within a surprisingly few years.

We believe that a transfer of much of the "electricity from oil" curve to an "electricity from the vacuum" curve can be quickly accomplished, if the government can be induced to move with full priority and vigor in the directions indicated in this paper.

As a major objective, we fervently hope that scientists, engineers, and environmentalists will interest themselves in these new principles and viewpoints. We have called attention to the new electrodynamics pioneered by AIAS, Evans, Sachs, Barrett, Lehnert, and others, and indicated the capability of this emerging electrodynamics to model this new *energy from the vacuum* functioning. Many of the AIAS papers are carried on a DOE internet website {41}, and can be made available by permission from the website manager, Dr. David Hamilton, for downloading by the interested scientist or engineer.

Finally, we wish to thank Dr. Hamilton and the DOE for the support rendered in posting and supporting the AIAS papers on the web, so that interested scientists can review them and understand the detailed technical development of the vacuum energy principles. I also express my personal appreciation to several private persons who have contributed funding support toward this effort.

References:

1. We point out that Maxwell assumed a plucked string wave in his theory, which accounts for the concept of the transverse EM wave in the vacuum. At the time, the atom, nucleus, and electron had not been discovered, and the molecule was a structureless blob. "Charge" meant "piece of electric fluid", such as a cubic centimeter. Electricity flow in a wire was rather like fluid flow in a pipe. There was no notion of the Drude electron gas, nor the positively charged nuclei in the wire. Consequently only the "perturbation of the (unitary) electric fluid in the wire" was considered. Today we know that any field perturbation in spacetime, entering a wire, must perturb all charges exposed to the field. This includes perturbing both the positively charged nuclei and the Drude electrons, with equal energy (though the amplitude of the recoil of the positively charged nuclei is highly damped because of the very high m/q ratio compared to that of the Drude electrons. The perturbation of the nuclei by the incoming fields is missing from Maxwell's consideration, hence is said to be due to Newton's third law—which is assumed to be a force without a cause. This is why the electrodynamic mechanism

generating Newton's third law is missing from Maxwell's electromagnetics. The reverse is also true. When we perturb a wire antenna with EM fields, we perturb both the positive charges in the nuclei and the Drude electrons with equal energy. These two equal and opposite energy perturbations thus (from general relativity, which also was not in existence for Maxwell's theory to consider) perturb the surrounding spacetime, in equal and opposite directions. The resulting wave actually launched into spacetime is thus a wave of rarefaction and compression—in short, a longitudinal wave. There is, however, not quite 180º phase difference between the two half-waves, due to the very small but finite spatial separation of the "average" nuclear positive charge and its "average" Drude electron. Hence the EM wave in vacuo is actually a quasi-longitudinal EM wave. We may also argue that the standard active vacuum, being an energy flux, is a scalar potential. As such, it can be decomposed via Whittaker 1903 into the same set of longitudinal EM wavepairs. Hence we argue that the Whittaker longitudinal EM waves emitted in 3-space by the dipole by decomposing its potential, are actually "normal" EM waves in vacuum. Since the vacuum is naught but these Whittaker wavesets and perturbations to them, then when the vacuum potential is perturbed, such "perturbation wavesets" must be what are produced. Finally, we point out that mostly our instruments measure the perturbations of the Drude electrons, which are highly restrained longitudinally, moving down the wire at only a drift velocity, not at the signal velocity. These spinning electrons, longitudinally restrained, thus precess sideways, producing the actual transverse Drude electron gas waves our instruments detect. Indeed, if the lateral precession of the Drude electrons are accepted, then gyro theory proves that the incoming disturbance from spacetime was longitudinal or quasi-longitudinal.

2. G. Johnstone Stoney, “Microscopic Vision,” Phil. Mag. Vol. 42, Oct. 1896, p. 332; , “On the Generality of a New Theorem,” Phil. Mag., Vol. 43, 1897, p. 139-142; “Discussion of a New Theorem in Wave Propagation,” Phil. Mag., Vol. 43, 1897, p. 273-280; “On a Supposed Proof of a Theorem in Wave-motion,” Phil. Mag., Vol. 43, 1897, p. 368-373.

3. E. T. Whittaker, “On the Partial Differential Equations of Mathematical Physics,” Math. Ann., Vol. 57, 1903, p. 333-355.

4. Evans in a private communication has pointed out that Whittaker's method depends upon the Lorentz gauge being assumed. If the latter is not used, the Whittaker method is inadequate, because the scalar potential becomes even more richly structured. My restudy of the problem with this in mind concluded that, for the negentropic vacuum-reordering mechanism involving only the dipole and the charge as a *composite* dipole, it appears that the Whittaker method can be applied without problem, at least to generate the minimum negentropic process itself. However, this still leaves open the possibility of additional structuring, so that the actual negentropic reordering of the vacuum energy (and the structure of the outpouring of the EM energy 3-flow from the charge or dipole) may be much richer than given by the simple Whittaker structure alone. In other words, the Whittaker structure used in this paper should be regarded as the *simplest* structuring of the negentropic process that can be produced, and hence a lower boundary condition on the process.

5. Time-like currents and flows do appear in the vacuum energy, if extended electrodynamic theory is utilized. E.g., in the received view the Gupta-Bleuler method removes time-like photons and longitudinal photons. For disproof of the Gupta-Bleuler method, proof of the independent existence of such photons, and a short description of their characteristics, see Myron W. Evans *et al*., AIAS group paper, "On Whittaker's F and G Fluxes, Part III: The Existence of Physical Longitudinal and Time-Like Photons," J. New Energy, 4(3), Winter 1999, p. 68-71; "On Whittaker's Analysis of the Electromagnetic Entity, Part IV: Longitudinal Magnetic Flux and Time-Like Potential without Vector Potential and without Electric and Magnetic Fields," *ibid*., p. 72-75. To see how such entities produce ordinary EM fields and energy in vacuo, see Myron W. Evans *et al*., AIAS group paper, "On Whittaker's Representation of the Electromagnetic Entity in Vacuo, Part V: The Production of Transverse Fields and Energy by Scalar Interferometry," *ibid*., p. 76-78. See also Myron W. Evans *et al.*, AIAS group paper, "Representation of the Vacuum Electromagnetic Field in Terms of Longitudinal and Time-like Potentials: Canonical Quantization," *ibid*., p. 82-88.

6. For a short treatise on the complex Poynting vector, see D. S. Jones, The Theory of Electromagnetism, Pergamon Press, Oxford, 1964, p. 57-58. In a sense our present use is similar to the complex Poynting energy flow vector, but in our usage the absolute value of the imaginary energy flow is equal to the absolute value of the real energy flow, and there is a transformation process in between. This usage is possible because the imaginary flow is into a *transducer*, which takes care of transforming the received *imaginary* EM energy into the output *real* EM energy. We stress that the word "imaginary" is not at all synonymous with *fictitious*, but merely refers to what "dimension" or state the EM energy exists in.

7. It has been known for nearly 50 years that any dipole is a broken symmetry in the fierce energy exchange between the active vacuum and the charges of the dipole. We believe that the present paper hopefully may shed additional light on the exact nature of that broken 3-symmetry of the dipole.

8. Thus the significance of the closed current loop circuit, ubiquitously utilized in all electrical power systems. Such a circuit utilizes half its collected Poynting energy to destroy the dipole, while using less than the other half to power the load. In short, it shuts off the giant negentropy and free 3-flow of energy, faster than it can freely collect and discharge energy to power the load. Such a circuit exhibits COP<1.0 *a priori*. Further discussions of the closed current loop circuit containing the source dipole and the load, are given in T. E. Bearden, "On Extracting Electromagnetic Energy from the Vacuum, " Proc. IC-2000, St. Petersburg, Russia, July 2000 (in press). Deliberate use of nonunitary currents in the closed current loop, to provide COP>1.0, is discussed in T. E. Bearden, "Bedini's Method For Forming Negative Resistors In Batteries," Proc. IC-2000, St. Petersburg, Russia, July 2000 (in press).

9. Unfortunately entropy is one of those concepts in physics for which there are several differing major views. For our work in energy from the vacuum, we take the very simple view that a negentropic process is like a negative resistor: It receives energy in a form unusable to us, transforms it, and outputs it into a form that is usable. We

completely avoid the various notions of "information" and attempts to equate information and energy. We do point out, however, that a time-reversal process in one form or another is involved. In that sense, e.g., Newton's third law is a negentropic process and involves time-reversal.

10. H. E. Puthoff, "Source of Vacuum Electromagnetic Zero-Point Energy," Phys. Rev. A, 40(9), Nov. 1, 1989, p. 4857-4862.

11. E. T. Whittaker, "On an Expression of the Electromagnetic Field Due to Electrons by Means of Two Scalar Potential Functions," Proc. Lond. Math. Soc., Series 2, Vol. 1, 1904, p. 367-372. The paper was published in 1904 and orally delivered in 1903.

12. As Whittaker showed in 1903, *ibid*., the scalar potential is actually a harmonic set of bidirectional EM longitudinal EM wavepairs, where each pair is composed of a longitudinal EM wave and its phase conjugate replica. Only because classical electrodynamicists have erroneously defined the field and potential as their own reaction cross sections with a unit point static charge, has the "static" potential been misidentified as a *scalar* entity, which it is not. The energy diverged from a uniform potential, around a fixed static point unit charge, is actually the set of divergences around the intercepting charge of the energy flows of all those EM waves comprising the potential. The sum total of all these individual wave divergences indeed has a scalar magnitude, but the magnitude of the total energy divergence from the potential is neither the potential itself nor its magnitude.

13. We point out the obvious: A "scalar" mass in 3-space actually has a time-vector since it moves through time continually, just to continue to exist. Further, it is a special form of energy (energy compressed by c^2) moving through time. Since we may choose any form of energy we wish by simple transduction, we may take it as compressed EM energy. So the mere continued existence of any mass proves conclusively that EM energy can and does ubiquitously flow through the time dimension. The combined continued existences of numerous masses proves conclusively that the flow of time can have a myriad internal electromagnetic energy flows. An equilibrium between (i) an inflow of EM energy to a transducer from the time dimension, and (ii) an outflow of EM energy in 3-space from the transducer, will be seen as a discrete excitation (potential energy) associated with the transducer. Hence the notion of the charge.

14. Myron W. Evans et. al., "On Whittaker's Representation of the Electromagnetic Entity in Vacuo, Part V: The Production of Transverse Fields and Energy by Scalar Interferometry," J. New Energy, 4(3), Winter 1999, p. 76-78.

15. D. K. Sen, Fields and/or Particles, Academic Press, London and New York, 1968, p. viii.

16. For example, the notion of charge is very much more complicated in gauge field theory than is usually assumed in more classical EM theory. In gauge-theoretic electrodynamics, the field is a curvature in spacetime and so is charge, so that the field intrinsically possesses charge. Further, being a curvature in *spacetime*, the charge is

inextricably connected both to the time coordinate and the 3-space coordinates. *A priori*, field changes thus may involve changes in the very nature of charge as we observe it, and correspondingly charge changes may involve changes in the very nature of the field effects we observe. As a crude example, changes in the "time" portion of the charge-as-spacetime-curvature can readily affect changes in the "spatial energy" aspect. It is not too difficult then to visualize that an inflow of EM energy into the time portion of the charge-as-spacetime-curvature alters the time aspects—which in turn causes a corresponding alteration of the 3-space aspects of the charge, producing an outflow of 3-space EM energy from the charge. Indeed, conservation of energy would require such. Several AIAS papers are being prepared in this symmetry area, and a magnificent paper by Mendel Sachs, "Symmetry in Electrodynamics: From Special to General Relativity; Macro to Quantum Domains," has been completed and will be published in Contemporary Optics and Electrodynamics, Edited by Myron W. Evans, 3 vols., John Wylie & Sons, 2001.

17. Ibrahim Semiz, "Black hole as the ultimate energy source," Am. J. Phys., 63(2), Feb. 1995, p. 151.

18. The available internal energy of a generator is the shaft energy we input to it—say by turning the generator shaft with a steam turbine or hydro turbine. The available internal energy of a battery is the chemical energy possessed by it at any given time, and available for performing work on the internal charges to form a dipole between the plates (and the battery terminals).

19. John D. Kraus, Electromagnetics, Fourth Edn., McGraw-Hill, New York, 1992. Figure 12-60, a and b, p. 578 shows a good drawing of the huge Poynting energy flow filling all space around the conductors, with almost all of it not intercepted and thus not diverged into the circuit to power it, but just "wasted."

20. The surface charges in the conductors of a circuit are of enormous importance to the powering of the circuit, etc. E.g., see J. D. Jackson, "Surface charges on circuit wires and resistors play three roles," Am. J. Phys., 64(7), July 1996, p. 855-870. See also Mark A. Heald, "Energy flow in circuits with Faraday emf," Am. J. Phys., Vol. 56, 1988, p. 540-547 ; “Electric fields and charges in elementary circuits,” Am. J. Phys., 52(6), June 1984, p. 522-526.

21. See T. E. Bearden, “Energy Flow, Collection, and Dissipation in Overunity EM Devices,” Proc. 4th Internat. Energy Conf., Academy for New Energy, Denver, CO, May 23-27, 1997, p. 5-51. In Figure 5, p. 16 the fraction of the Poynting energy flow that is intercepted and collected by the circuit is roughly shown to be on the order of 10^{-13} of the entire Poynting energy flow available.

22. Rigorously, there is no power in an EM energy flow, regardless of how great in magnitude, if it is not altered in form or diverged. That is because "power" is rigorously the rate of doing work, not the rate of energy flow. Exactly, the Heaviside dark energy flow component had some 10 trillion joules per second magnitude, but zero watts of power. Unfortunately, electrical engineers just loosely refer to it as "power", regardless of the illogic.

23. T. E. Bearden, "On the Principles of Permissible Over Unity EM Power Systems," J. New Energy, 4(2), Fall 1999, p. 16-39; — "EM Corrections Enabling a Practical Unified Field Theory with Emphasis on Time-Charging Interactions of Longitudinal EM Waves," J. New Energy, 3(2/3), 1998, p. 12-28; — "Use of Asymmetrical Regauging and Multivalued Potentials to Achieve Overunity Electromagnetic Engines," J. New Energy, 1(2), Summer 1996, p. 60-78; — "Regauging and Multivalued Magnetic Scalar Potential: Master Overunity Mechanisms," Explore, 7(1), 1996, p. 51-58; — "The Master Principle of EM Overunity and the Japanese Overunity Engines," Infinite Energy, 1(5&6), Nov. 1995-Feb. 1996, p. 38-55; — "Use of Regauging and multivalued Potentials to Achieve Overunity EM Engines: Concepts and Specific Engine Examples," Proc. Internat. Sci. Conf., "New Ideas in Natural Sciences," St. Petersburg, Russia, June 17-22, 1996, Part I: Problems of Modern Physics, 1996, p. 277-297; — Energetics of Free Energy Systems and Vacuum Engine Therapies, Tara Publishing, Internet node www.tarapublishing.com/books, July 1997.

24. E.g., see J. H. Poynting, "On the transfer of energy in the electromagnetic field." Phil. Trans. Roy. Soc. Lond. A, Vol. 175, 1884, p. 343-361.

25. Oliver Heaviside, "Electromagnetic Induction and Its Propagation," The Electrician, 1885, 1886, 1887, and later. A series of 47 sections, published section by section in numerous issues of The Electrician during 1885, 1886, and 1887.

26. Oliver Heaviside, Electromagnetic Theory, 3 vols., Benn, London, 1893-1912. Second reprint 1925.

27. Oliver Heaviside, "On the Forces, Stresses, and Fluxes of Energy in the Electromagnetic Field," Phil. Trans. Roy. Soc. Lond., 183A, 1893, p. 423-480. Discusses the Faraday-Maxwell ether medium, outlines his vector algebra for analysis of vectors without quaternions, discusses magnetism, gives the EM equations in a moving medium, and gives the EM flux of energy in a stationary medium. On p. 443, he credits Poynting with being first to discover the formula for energy flow, with Heaviside himself independently discovering and interpreting this flow a little later by himself in an extended form.

28. J. H. Poynting, "On the connexion between electric current and the electric and magnetic inductions in the surrounding field," Proc. Roy. Soc. Lond., Vol. 38, 1984-85, p. 168.

29. Oliver Heaviside, Electrical Papers, Vol. 2, 1887, p. 94.

30. T. E. Bearden, "On Extracting Electromagnetic Energy from the Vacuum," Proc. IC-2000, *ibid*., 2000 (in press).

31. Lorentz is believed to have done this in the 1890s. In 1902 he published the method in a book, which strongly implies it was first done in an earlier paper. See H. A. Lorentz, Vorlesungen über Theoretische Physik an der Universität Leiden, Vol. V, Die Maxwellsche Theorie (1900-1902), Akademische Verlagsgesellschaft M.B.H., Leipzig, 1931, "Die Energie im elektromagnetischen Feld," p. 179-186. Figure 25 on p. 185 shows the Lorentz concept of integrating the Poynting vector around a closed cylindrical

surface surrounding a volumetric element. My thanks to Marcus Reid for furnishing a copy of the actual Lorentz reference from a library in Leipzig, Germany.

32. E.g., see W. K. H. Panofsky and M. Phillips, Classical Electricity and Magnetism, Addison-Wesley, Reading, MA, 1962, 2nd edition, p. 181; W. Gough and J. P. G. Richards, European J. Phys., Vol. 7, 1986, p. 195.

33. Panofsky and Phillips, *ibid*., p. 180.

34. Jones, *ibid*., p. 52.

35. J. D. Jackson, Classical Electrodynamics, 2nd Edn., John Wiley & Sons, New York, 1975, p. 237.

36. W. M. Schwarz, Intermediate Electromagnetic Theory, John Wiley & Sons, New York, 1964, p. 280-281.

37. Jones, *ibid*., p. 53.

38. For typical references, see J. Slepian, Am. J. Phys., 19, 87 (1951); Mario Iona, *ibid*., 31, 398 (1963; Udo Backhaus and Klaus Schafer, *ibid*., 54, 279 (1986); C. J. Carpenter, IEE Proc. A (UK), 136A(2), Mar. 1989, p. 55-65; J. A. Ferreira, IEEE Trans. Edu., 31(4), 1988,p. 257-264; Mark A. Heald, Am. J. Phys., 56(6), 1988, p. 540-547. The debate has also appeared in many other leading journals, e.g., T. H. Boyer, Phys. Rev. D, 25, 3246 (1982). Interestingly, M. Abraham and R. Becker, The Classical Theory of Electricity and Magnetism, Blackie, London, 1932, p. 146 and p. 194 give two examples of the controversy over the Poynting vector. Finally, see D. F. Nelson, Phys. Rev. Lett., 76(25), June 17, 1996, p. 4713-4716 for advanced work requiring a greater generalization of the Poynting vector.

39. T. E. Bearden, "Dark Matter or Dark Energy?", J. New Energy, 4(4), Spring 2000, p. 4-11.

40. Craig F. Bohren, "How can a particle absorb more than the light incident on it?", Am. J. Phys., 51(4), Apr. 1983, p. 323-327. Under nonlinear conditions, a particle can absorb more energy than is in the light incident on it. Metallic particles at ultraviolet frequencies are one class of such particles and insulating particles at infrared frequencies are another. See also H. Paul and R. Fischer, {Comment on "How can a particle absorb more than the light incident on it?'},” Am. J. Phys., 51(4), Apr. 1983, p. 327.

41. DOE website http://www.ott.doe.gov/electromagnetic/.