An Extention of The Murad-Brandenburg Poynting Field Conservation Equation and Possible Gravity Law

Paul A. Murad[д] and John E. Brandenburg[Ђ]

Morningstar Applied Physics, LLC
Vienna, VA 22182

Abstract Is it conceivable that the Poynting vector is a separate intermediate entity before this separation of forces gravity, near- and far-distance nuclear, electromagnetic forces that occurred in the corollary of the 'Big Bang' theory with respect to electric and magnetic fields? Considering the GEM unification theory, the Poynting vectors are present in both gravity wave fields as well as EM fields. An obvious conclusion is that since the Poynting vector consists of the cross product of the electric and magnetic fields, of which each obeys wave equations, then it is reasonable to assume that conservation of the Poynting vector or field itself should also obey a wave equation. Moreover, by converse reasoning, this Poynting field mathematically establishes that either a torsion field or gravitational field may be directly coupled that also obeys a wave partial differential equation. This was rederived from the initial paper to further understand and clarify the Poynting conservation field equation that includes both electric and magnetic forces and currents. Surprisingly a Poynting field may also offer a new path for investigating physics and electrical engineering as well as creating a new methodology to expand advanced space propulsion systems by altering gravity.

Keywords Poynting vector, conservation, magnetic field, electric field, GEM Theory.

1. Introduction

Many theories describing the onset of the cosmos exists. One such theory is that all of the mass, energy and momentum from another dimension(s) was injected into our conventional space-time continuum. The most popular of these theories is that the Big Bang tends to describe events as they unfold at extremely small time scales. A major hypothesis is that initially there is only one type of force. When creation undergoes during a small time span, this unusual force is broken down into nuclear forces both at near and far distances, gravitational forces, electric and magnetic forces. If this corollary is true, it is conceivable that some of these different forces may undergo intermediate steps. If this step exists, how does it simplify problems of mathematical physics and does it interface with respect to Einstein's field equations?

If electric and magnetic forces are separate entities, then it is reasonable to assume that the Poynting vector may represent such an intermediate step of evolution during the Big Bang process. A derivation is offered to derive a conservation equation using the Poynting field. An obvious conclusion should represent that since the Poynting vector consists of the cross product of the electric and magnetic field that both obey wave equations, then it is reasonable to assume that the Poynting vector or field should also obey a wave equation.

The requirement for defining a conservation equation for the Poynting vector is unusual. We do not intend to prove the theory that the Poynting vector is an intermediate step for the Big Bang to go from the original force element into forces that break down into electric and magnetic fields.

[д] CEO, *pm@morningstarap.com*.
[Ђ] Chief Scientist, *jb@morningstarap.com*.

These effects unfortunately appear to be intuitive. The motivation for this problem is based upon understanding the nonlinear behavior of the Morningstar Energy Box [1] that consists of a body with a three-dimensional rotating magnetic field that resulted in a weight reduction or increase. This Morningstar device uses rollers that move about a ring and both contain laminated structures that enhance the electric and magnetic field, which strangely somehow impacts gravity. Specifically in one experiment, the device that weighs 190 pounds lost as much as 7% weight in steady-state rotation while as much as 20% during transient rotation. Of the various postulates concerning operations on the Energy Box, one hypothesis assumes that a Poynting field creates a force that influences the system. On the basis of these results, the authors derived this conservation law to possibly establish the Energy Box results and understand the unusual weight loss events. Furthermore, the purpose of this paper [2] is to further extend portions of the mathematics and provide additional clarification.

2. Objectives

The Poynting vector [3-5] is present in all EM waves as shown in Figure 1. Moreover, other terms in this conservation equation should represent a vorticity or curl operator as well as a possible source term regarding generation of the Poynting vector that can be characterized in an idealized context. The Poynting vector is a key ingredient in the GEM theory, which proposes to unify electromagnetism and gravity and the need to demonstrate this is important. In the GEM theory, the Poynting vector carries momentum and energy in both gravity and EM fields, so a wave equation for the Poynting field may describe both gravity and EM waves. Finally this equation should have some usefulness to unravel realistic problems in the purview of solving the basic Maxwell-Heaviside equations. Finally, is it possible to more readily identify this equation with gravity than expected in a unification theory approach previously discussed that treats the electric and magnetic fields as separate entities?

These are all essential issues that affect many technical disciplines. Another issue worthy of mentioning is if the combination of electric and magnetic forces conceivably represent a Poynting vector as a separate entity that may be more easily allied with gravity? In the context of derivations by Gertsenshtein [6] where he relates light or electromagnetism to gravity using Einstein's Field Equations. This is under the assumption that if these fields all move at the speed of light, then they must be coupled. If E-M radiation is involved, is there such coupling with the Poynting vector? A year after Gertsenshtein's 1962 paper, Robert Forward [7] parroted similar notions as well. Is the Poynting vector the missing ingredient to solve the unification mystery?

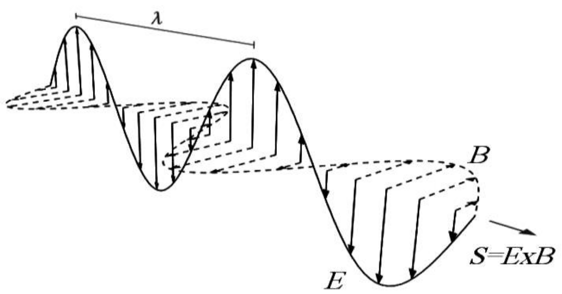


Figure 1. An EM propagating wave showing the E and B fields as well as the Poynting vector *S*= *E*×*B* that points in the direction of the wave propagation.

3. Methods

The following sections present a derivation with relevant assumptions and conclusions. If the Poynting vector consists of the electric and magnetic field vectors of which both obey wave equations, then it is feasible that the ***S*** vector also obeys a wave equation. The issue is to be proven to also understand the source terms and how they impact the results as well as further other findings.

3.1. A Wave Equation Approach- The Field Equations

In several early efforts, Murad [8-10] identified a generalized form of the wave equations for the electric and magnetic fields. These wave partial differential equations are easily derived directly from Maxwell-Heaviside's equations; however, for completeness, the approach will retain several terms that are usually ignored. One may argue that including all terms and currents in an E-M field may be unnecessary; however, the derivation may result in a symmetry which may provide some insights.

For example, magnets should be treated as a magnetic *source term*. In reality, they represent dipoles and one can create pseudo-monopoles with the correct terminology. Thus monopoles represent a first-order eigenvalue solution to the equations whereas a dipole is a second-order eigenvalue. Moreover, since magnets produce lines of force, the effects are never really included in a realistic analysis with respect to being a segment of a magntic current. Here, we shall assume that the magnetic field lines represent conduits for the transport of some as of yet undefined substance that constitutes a *magnetic current*. Usually one likes to think of a current as a particle with some coherent velocity and a specified direction of some quantity. If one looks at electrons trapped in the van Allen belts around the Earth, this definition for a magnetic current is physically satisfied. This has to be considered as a magnetic effect because the magnetic field is far stronger by orders of magnitude than, say the Earth's electric field. If in the end, these additional terms represent magnetic properties as inadequate, they can always be set equal to zero and we will extend that analysis to treat only electric and only magnetic fields.

Normally the standard convention as mentioned usually does not use magnetic currents and magnetic source terms because such terms disappear in the standard definitions for the electric and magnetic fields using a potential and a vector with these fields as: $-\boldsymbol{E}=\nabla\varphi+\partial \boldsymbol{A}/\partial t$, and $\boldsymbol{B}=\nabla\times\boldsymbol{A}$. Additionally the desire is to include these extra terms that may provide insights into the increase or control of the magnitude and direction of the Poynting vector to say, transfer energy or create an antenna. Thus the basic Maxwell-Heaviside equations are modified with these magnetic terms treated as follows:

$$\nabla\cdot\boldsymbol{E}=4\pi\rho_e\,,\quad \nabla\times\boldsymbol{E}=-\frac{1}{c}\frac{\partial\boldsymbol{B}}{\partial t}-4\pi\boldsymbol{J}_m \text{ and}$$
$$\nabla\cdot\boldsymbol{B}=4\pi\rho_m\,,\quad \nabla\times\boldsymbol{B}=\frac{1}{c}\frac{\partial\boldsymbol{E}}{\partial t}+4\pi\boldsymbol{J}_e\,. \qquad (1)$$

Capital letters will refer to vector quantities; ***E*** and ***B*** are the electric and magnetic fields respectively, ***J*** values are currents and ρ values are source terms. Subscripts **m** and **e** imply magnetic and electric fields respectively. The conservation of charge equations can be immediately derived from these expressions by taking the gradient operation on the curl equations resulting in:

$$\frac{1}{c}\frac{\partial\rho_m}{\partial t}+\nabla\cdot\boldsymbol{J}_m=0. \text{ and}$$
$$\frac{1}{c}\frac{\partial\rho_e}{\partial t}+\nabla\cdot\boldsymbol{J}_e=0. \qquad (2)$$

Thus the time rate of change of the source terms will produce a gradient of each current. In other words, if the current changes, there has to be a corresponding change in the source term.

Taking the curl of the curl of the electric field and using known vector identities results in:

$$-\nabla\cdot\left(\nabla\cdot\boldsymbol{E}\right)+\nabla^2\boldsymbol{E}=\frac{1}{c^2}\frac{\partial^2\boldsymbol{E}}{\partial t^2}+4\pi\left[\nabla\times\boldsymbol{J}_m+\frac{1}{c}\frac{\partial\boldsymbol{J}_e}{\partial t}\right]. \qquad (3)$$

With proper substitutions, this results in a wave equation for the electric field:

$$\frac{1}{c^2}\frac{\partial^2\boldsymbol{E}}{\partial t^2}-\nabla^2\boldsymbol{E}=-4\pi\left[\nabla\rho_e+\frac{1}{c}\frac{\partial\boldsymbol{J}_e}{\partial t}+\nabla\times\boldsymbol{J}_m\right]. \qquad (4)$$

Using a similar procedure for the magnetic field results in:

$$\frac{1}{c^2}\frac{\partial^2 \boldsymbol{B}}{\partial t^2}-\nabla^2\boldsymbol{B}=-4\pi\left[\nabla\rho_m+\frac{1}{c}\frac{\partial \boldsymbol{J}_m}{\partial t}-\nabla\times\boldsymbol{J}_e\right]. \quad (5)$$

Note that if there are no electric or magnetic currents (***J***), these two fields can be totally uncoupled from each other. This means that without currents, one field cannot produce the other. This is an absolute. An electric current can cause a magnetic field and a magnetic current can produce an electric field. In other words, the use of a magnetic current may unknowingly exist and could result in unexpected values because they are not included in an analysis.

Hence, one could have a pure electric or a pure magnetic field that may have unique propulsion implications. However, since these currents usually exist, both electric and magnetic are usually coupled; we are able to create one field from the other field. On this basis, we insist upon including the magnetic current and source terms though the final derivation. There is also another interesting point in these two wave equations. Note that the conservation of charge terms exist. However, there are different mathematical operations that act upon the current and source terms.

3.2. Poynting Conservation

With these ground rules, the issue is to use these wave equations to create a similar expression for the definition of the Poynting vector such that:

$$\boldsymbol{S}=\frac{1}{\mu_o}\left(\boldsymbol{E}\times\boldsymbol{B}\right) \quad (6)$$

Details for the derivation are included in the Appendix. The idea is to produce a wave equation for the conservation equation and include a term with the curl of the Poynting vector.

To do this we need to use the following mathematical identities:

$$\frac{\partial^2}{\partial t^2}\left(\boldsymbol{E}\times\boldsymbol{B}\right)=\frac{\partial}{\partial t}\left[\frac{\partial \boldsymbol{E}}{\partial t}\times\boldsymbol{B}+\boldsymbol{E}\times\frac{\partial \boldsymbol{B}}{\partial t}\right]=$$
$$\mu_0\frac{\partial^2 \boldsymbol{S}}{\partial t^2}=\left[\frac{\partial^2 \boldsymbol{E}}{\partial t^2}\times\boldsymbol{B}+2\frac{\partial \boldsymbol{E}}{\partial t}\times\frac{\partial \boldsymbol{B}}{\partial t}+\boldsymbol{E}\times\frac{\partial^2 \boldsymbol{B}}{\partial t^2}\right] \quad (7)$$

This allows forming the basic definitions for relations of the electric and magnetic fields to produce the Poynting vector. A gradient for the Poynting vector is as follows:

$$\mu_0\nabla\cdot\boldsymbol{S}=-\frac{1}{2c}\frac{\partial}{\partial t}\left[B^2+E^2\right]-4\pi\left[\boldsymbol{B}\cdot\boldsymbol{J}_m+\boldsymbol{E}\cdot\boldsymbol{J}_e\right]. \quad (8)$$

A second expression for the LaPlacian term using a vector definition results in:

$$\nabla^2(E\times B)=\nabla\cdot\left[\nabla\cdot\left(E\times B\right)\right]-\nabla\times\nabla\times\left(E\times B\right)=\mu_0\nabla^2 S=$$
$$=-\frac{1}{2c}\nabla\frac{\partial}{\partial t}\left[B^2+E^2\right]-4\pi\left[\nabla\left(B\cdot J_m\right)+\nabla\left(E\cdot J_e\right)\right]-\mu_0\nabla\times\nabla\times S. \quad (9)$$

The final result for this expression is:

$$\mu_0\nabla^2\boldsymbol{S}=-4\pi\left[\rho_e\nabla\times\boldsymbol{B}-\rho_m\nabla\times\boldsymbol{E}\right]-\mu_0\nabla\times\nabla\times\boldsymbol{S}. \quad (10)$$

Let me make a suggestion. Let us assume that when you make terms of no sources, we are referring to no sources or currents. For the case that you examine without currents or sources, these terms will disappear. In other words, if you are in space and there are no sources or currents, there is no Poynting field or the null solution. The issue is that these sources and currents drive the problem which is the main point we are suggesting for developing a space drive propulsor or other electrical engineering problems.

The approach is to use the magnetic field cross product on the electric field wave equation and add to the electric field cross product of the magnetic field wave equation. Note that the curl term exists for the Poynting vector. This is a circulation or vorticity effect that is desired. An intermediate step from the first equation involves:

$$2\frac{\partial \boldsymbol{E}}{\partial t}\times\frac{\partial \boldsymbol{B}}{\partial t}=-2c^2\nabla\times\boldsymbol{B}\times\nabla\times\boldsymbol{E}+$$
$$-8\pi c^2\left(+\nabla\times\boldsymbol{B}\times\boldsymbol{J}_m-\boldsymbol{J}_e\times\nabla\times\boldsymbol{E}\right)+32c^2\pi^2\boldsymbol{J}_e\times\boldsymbol{J}_m. \quad (11)$$

This is substituted into the expression for the second derivative and takes the other cross-products:

$$\frac{\mu_0}{c^2}\frac{\partial^2 \boldsymbol{S}}{\partial t^2}=-2c^2\nabla\times\boldsymbol{B}\times\nabla\times\boldsymbol{E}-4\pi\left[\frac{1}{c}\frac{\partial}{\partial t}\left(\boldsymbol{J}_e\times\boldsymbol{B}+\boldsymbol{E}\times\boldsymbol{J}_m\right)+\right.$$
$$\left.+\boldsymbol{B}\cdot\nabla\boldsymbol{J}_m+\boldsymbol{E}\cdot\nabla\boldsymbol{J}_e-\nabla\left(\boldsymbol{J}_e\cdot\boldsymbol{E}+\boldsymbol{J}_m\cdot\boldsymbol{B}\right)\right]. \quad (12)$$

The last expression in the RHS is found in this equations as well as from eq. (10) and this is used after considerable algebra for the conservation of the Poynting vector as a wave equation:

$$\mu_0\left[\frac{1}{c^2}\frac{\partial^2 \boldsymbol{S}}{\partial t^2}-\nabla^2\boldsymbol{S}\right]=\mu_0\nabla\times\nabla\times\boldsymbol{S}-2\nabla\times\boldsymbol{B}\times\nabla\times\boldsymbol{E}+$$
$$-4\pi\left[-\frac{1}{c}\frac{\partial}{\partial t}\left(\rho_e\boldsymbol{E}+\rho_m\boldsymbol{B}\right)+\frac{1}{c}\frac{\partial}{\partial t}\left(\boldsymbol{J}_e\times\boldsymbol{B}+\boldsymbol{E}\times\boldsymbol{J}_m\right)\right.$$
$$\left.-\nabla\left(\boldsymbol{J}_e\cdot\boldsymbol{E}+\boldsymbol{J}_m\cdot\boldsymbol{B}\right)\right]. \quad (13)$$

This is the desired result. Note the symmetry of terms exist between the electric and magnetic effects on the RHS of the first equation. The large denominator in the RHS for a time derivative, these values may be inconsequential. Moreover, both currents and source terms play a role. This demonstrates that cross-coupling between the electric and magnetic fields creates Poynting vector components.

The derivation also reveals that you can have a Poynting vector purely with situations where only an electric or magnetic field exists as separate entities if there are no currents as seen by the second equation. Using Maxwell's equations can produce terms that are purely due to the magnetic field or electric field as separate entities. This surprisingly suggests that a Poynting vector can be produced independent of any coupling of the fields. This could have unusual consequences where additional unaccounted forces may exist that can create unexpected problems and warrants further investigations. Furthermore, the results also depend upon alignment of both the fields and opposing field currents as well as the magnitude of the electric and magnetic source terms assuming that the curl terms are not zero. Finally, we see that the terms in the RHS with the curl of the Poynting vector are very prevalent.

3.3. A Possible Torsion or Gravitational Field

An analytical function may be used for elliptical as well as wave partial differential equations to define additional terms. This is rather simple to determine such a relationship with this wave equation for the Poynting field's conservation. However, the large amount of variables in the RHS requires a different approach to this problem.

Let us assume that we are defining psuedo-analytical functions to consider these additional terms. The approach is similar to using Cauchy-Reimann conditions using complex variables. Variables will include *V*, *u*, and *v*. Moreover, vector gradients or the curl of a vector may also represent the variables for *u* and *v*. However, let us simplify this for an initial assessment as follows:

$$\mu_o \nabla \cdot \boldsymbol{S} + \frac{1}{c}\frac{\partial \boldsymbol{V}}{\partial t} = \boldsymbol{u},$$
$$\mu_o \frac{1}{c}\frac{\partial \boldsymbol{S}}{\partial t} + \nabla \cdot \boldsymbol{V} = \boldsymbol{w}. \qquad (14)$$

A wave equation for the Poynting conservation can be defined if the equations are subtracted with the first term used as a gradient and the second term involves a time derivative. The factors are straightforward to define both *u* and *v*. If the first equation is a time derivative and the second term is equal to the gradient, these equations are subtracted to remove the Poynting vector and result in a wave equation for the *V* field that becomes a wave equation as follows:

$$\mu_o\left[\frac{1}{c^2}\frac{\partial^2 \boldsymbol{S}}{\partial t^2} - \nabla^2 \boldsymbol{S}\right] = \mu_o \nabla\times\nabla\times \boldsymbol{S} + \frac{1}{c}\frac{\partial w}{\partial t} - \nabla\cdot \boldsymbol{u}$$
$$\left[\frac{1}{c^2}\frac{\partial^2 \boldsymbol{V}}{\partial t^2} - \nabla^2 \boldsymbol{V}\right] = \nabla\times\nabla\times \boldsymbol{V} + \nabla\cdot w - \frac{1}{c}\frac{\partial u}{\partial t},$$
$$\textit{where } w = -4\pi\left[\left(J_e\times B + E\times J_m\right) - \left(\rho_e E + \rho_m B\right)\right], \textit{ and}$$
$$\nabla\cdot u = +2\nabla\times B\times\nabla\times E - 4\pi\nabla\left[J_e\cdot E + J_m\cdot B\right]. \qquad (15)$$

If these terms are combined, the results are:

$$\frac{1}{c^2}\frac{\partial^2 V}{\partial t^2} - \nabla^2 V = +\nabla\times\nabla\times V + \frac{4\pi}{c}\frac{\partial}{\partial t}\left(J_e E + J_m B\right) +$$
$$-4\pi\nabla\cdot\left[\left(J_e\times B + E\times J_m\right) - \left(\rho_e E + \rho_m B\right)\right] - \frac{2}{c}\frac{\partial}{\partial t}\int_0^r\left[\nabla\times B\times\nabla\times E\right]\cdot dr. \qquad (16)$$

Now this new variable represents a tensor and may be a torsion field. Without details, we can only speculate that this can also be a gravitational tensor. It is interesting that Gertsenshtein suggested coupling between gravity with both an electric and magnetic fields. What is of interest is that such a coupling may exist; however, we also include an impact with the Poynting field. This could be a considerable improvement or higher level of granularity over Gertsenshtein that is a function of electric/magnetic fields and sources as well as the vorticity of the Poynting vector. If one assumes a gravitational field that has a velocity that differs from the speed of light, this relationship will not work. On this basis, if gravitation fields move faster than light, then this is a second or torsional field that would resemble a field similar to electric and magnetic fields.

3.4. Further Considerations for Magnetic/Electric Field Convection

There is a problem that may or may not resolve this issue. The question is if there are missing terms that may impact results. One specific problem is convection. Normally when convection is included, the thoughts treat movement of fluid dynamic or ionic flows. This is not the point of concern. For example, would the Energy Box strange behavior occur if the same events were performed in a vacuum chamber? Moreover, the convection velocity is not due to particles but rather the rotation induced by the Energy Box.

Tombe [11] and Pinheiro [12] offer a means for treating convection effects that account for a convection current. Tombe treats the convection term as the total derivative for the magnetic field; Pinheiro derives a different term. When this is achieved, the result is that the curl of the electric field from Maxwell's equation respectively becomes:

$$\nabla\times \boldsymbol{E} = -\frac{\partial \boldsymbol{B}}{\partial t} - \left(\boldsymbol{v}\cdot\nabla\right)\boldsymbol{B},$$
$$\nabla\times \boldsymbol{E} = -\frac{\partial \boldsymbol{B}}{\partial t} - \nabla\times\left(\boldsymbol{B}\times\boldsymbol{v}\right). \qquad (17)$$

Basically these terms can be used throughout the previous derivation to establish the conservation equation. However, there is an easier way where these terms can be treated as additional terms. For example, these expressions can be viewed as magnetic currents. Similar terms can be expanded with similar logic to extend the additional terms regarding an electric current. This becomes:

$$J'_m = J_m - \nabla\times\left(B\times V\right) - \left(V\cdot\nabla\right)B, \textit{ and}$$
$$J'_e = J_e - \nabla\times\left(E\times V\right) - \left(V\cdot\nabla\right)E. \qquad (18)$$

4. Results

If you have no sources or currents, you would go further and suggest that you have no fields as well. Under these conditions, everything should disappear and there should be no reason to allow for the existence of the Poynting field.

This is an important conclusion but without sources or currents, that has no applicability to solve any engineering or physics problems. It only offers you with the obvious conclusions of a null field. The issue is to deal with the fields, sources, and most importantly with the currents.

Let us look at the initial comments regarding creating a pointing field without a coupled electromagnetic field. For example, if there is only an electric field with eq. 14, this becomes:

$$\mu_0\left[\frac{1}{c^2}\frac{\partial^2 \boldsymbol{S}}{\partial t^2} - \nabla^2 \boldsymbol{S}\right] = \mu_0 \nabla\times\nabla\times \boldsymbol{S}$$
$$-4\pi\left[-\frac{1}{c}\frac{\partial}{\partial t}\left(\rho_e \boldsymbol{E}\right) - \nabla\left(J_e\cdot \boldsymbol{E}\right)\right]. \qquad (14)$$

And for only a pure magnetic field:

$$\mu_0\left[\frac{1}{c^2}\frac{\partial^2 \boldsymbol{S}}{\partial t^2} - \nabla^2 \boldsymbol{S}\right] = \mu_0 \nabla\times\nabla\times \boldsymbol{S} - 4\pi\left[-\frac{1}{c}\frac{\partial}{\partial t}\left(\rho_m \boldsymbol{B}\right) - \nabla\left(\boldsymbol{J}_m\cdot \boldsymbol{B}\right)\right]. \qquad (15)$$

These results, if correct, suggest that a pure electric and a pure magnetic field without any coupling should be able to produce a Poynting vector by itself. These results are unexpected.

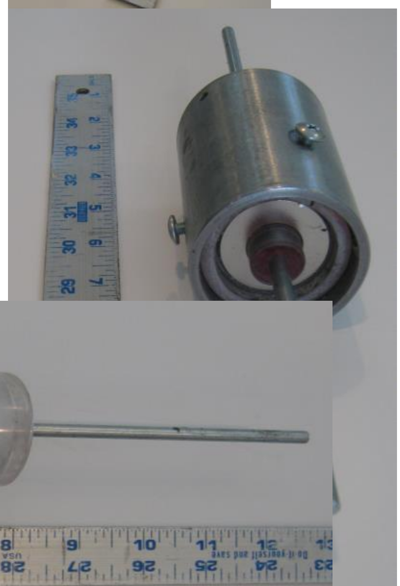
Similarly for the torsion or gravitational equation, the results for a electric field by itself is:

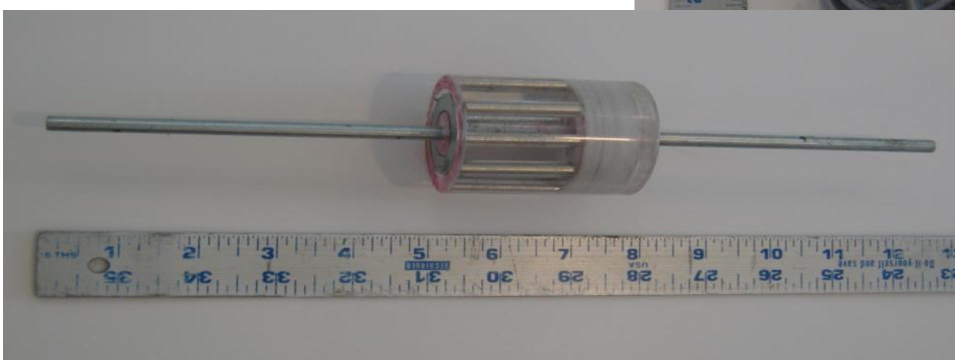
$$\frac{1}{c^2}\frac{\partial^2 \boldsymbol{V}}{\partial t^2} - \nabla^2 \boldsymbol{V} = +\nabla\times\nabla\times \boldsymbol{V} + \frac{4\pi}{c}\frac{\partial}{\partial t}\left(\boldsymbol{J}_e \boldsymbol{E}\right) - 4\pi\nabla\cdot\left[-\left(\rho_e \boldsymbol{E}\right)\right]. \qquad (16)$$

and for the magnetic field are:

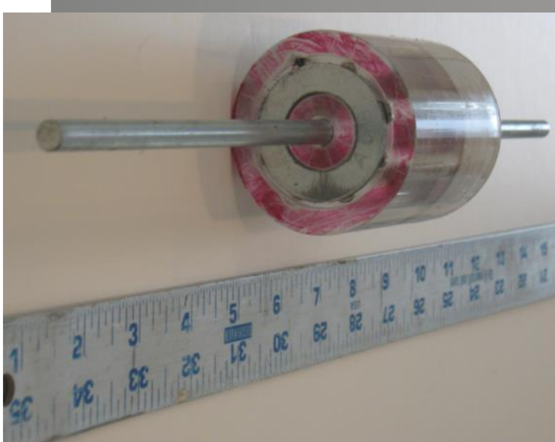
$$\frac{1}{c^2}\frac{\partial^2 \boldsymbol{V}}{\partial t^2} - \nabla^2 \boldsymbol{V} = +\nabla\times\nabla\times \boldsymbol{V} + \frac{4\pi}{c}\frac{\partial}{\partial t}\left(\boldsymbol{J}_m \boldsymbol{B}\right) - 4\pi\nabla\cdot\left[-\left(\rho_m \boldsymbol{B}\right)\right]. \qquad (16)$$

Obviously, as expected these equations without the coupled terms are greatly simplified. As mentioned, these equations show that they can induce a vortex term that will impact the Poynting conservation and possibly a gravitational effect.





d shield.



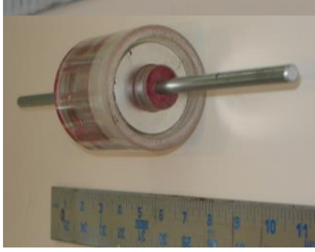
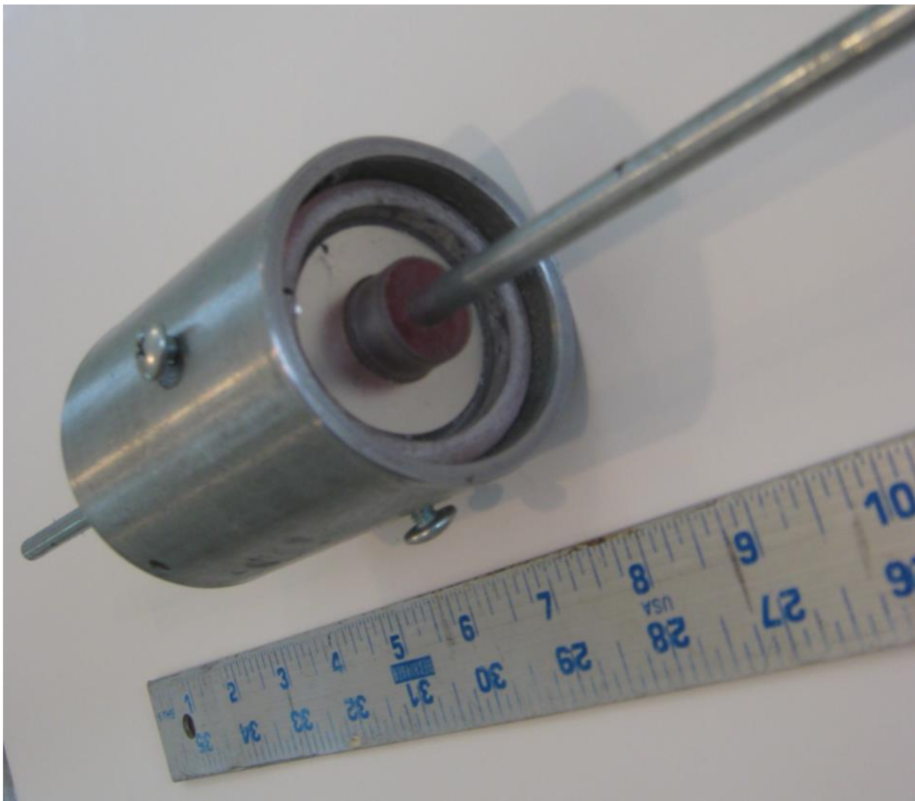
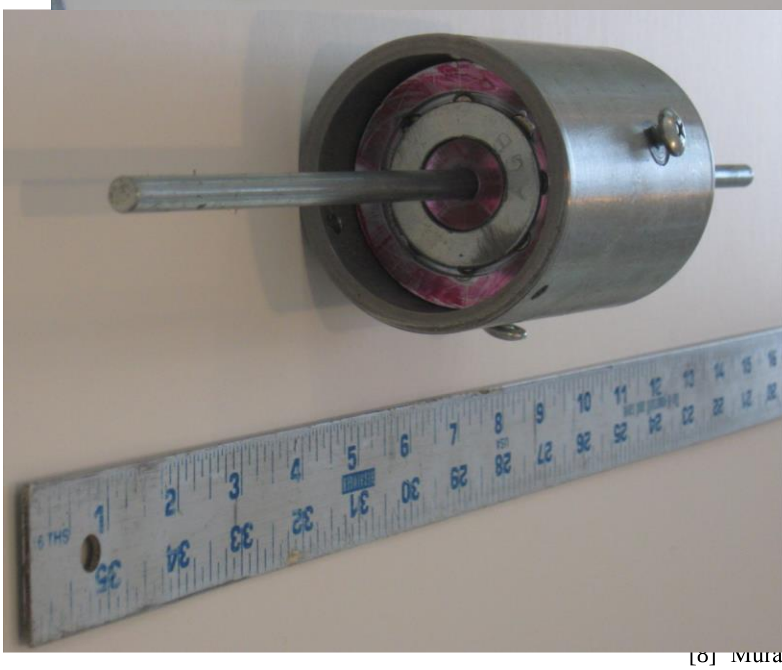


Figure 1. The basic armature structure.





5. Conclusions

Two different perspectives were identified that define conservation for the Poynting field. This equation creates a wave partial differential equation that should be an obvious consequence of both the electric and magnetic fields. The results also provide some possibilities where a coupling exists with the Poynting field combined with either a gravitational or a torsional field. Although Gertsenshtein implies that the coupling of E-M fields and gravity exists, different formulations using the Poynting field conservation also show details that has some more granularity to define gravitational coupling directly as a function of either

es or currents. Moreover, the use
have important consequences for
ithout treating an electrical or

---

wledgment

dges and thanks Dr. Ioannis M.
tus, The Bradley Department of
Engineering Virginia Polytechnic
versity at Blacksburg, VA for
d corrections in the arithmetic in
r.

ERENCES

, M. J., Brandenburg, J. E., McCabe,
e Morningstar Energy Box," AIAA-
A Aerospace Sciences Meeting,
12 January 2012.

Brandenburg, J. E., "The Murad-
lenburg Equation- A Wave Partial Differential
ssion for the Poynting Vector/Field Conservation",
50th Aerospace Science Meeting, AIAA Paper 2012-
Nashville, Tennessee, Jan 9-12, 2012.

ing, J. H., "On the Transfer in the Electromagnetic
" (1884) Philosophical Transactions of the Royal
ty of London, Volume 175, pp. 343-361.

er, E., Florian, M., Henneberger, K., "Poynting's
em and energy conservation in the propagation of light
ounded media", (2008) *Europhysics Letters* **81** (6):
.

h Edminister, *Schaum's Outline of theory and problems
lectromagnetics*. (1995) New York: McGraw-Hill
ssional. p. 225. ISBN 0070212341.

Gertsenshtein, Sov. Phys. JETP 14, 84 (1962)

ard, R. L., "Guidelines to Antigravity", *American
al of Physics*, Vol. **31**, pp166-170, (1963).

[8] Murad, P. A., Baker, jr., R. M. L., "Gravity with a Spin: Angular Momentum in a Gravitational-Wave Field", co-authored with R. M. L. Baker, Jr.: Presented at the First International High Frequency Gravity Wave Conference, Mitre Corporation May 6-9, 2003

[9] Murad, P. A., "Hyper-Light Dynamics and the Effects of Relativity, Gravity, Electricity and Magnetism", IAF Paper No. 99-S.6.02 presented at the 50th International Astronautical Congress in Amsterdam, the Netherlands, Oct. 4-8, 1999, Acta Astronautica, vol. 47, no. 2-9, July-November, 2000, pp. 575-588.

[10] Murad, P. A., "Hyper-Light Dynamics, Relativity, Gravity, Electricity, and Magnetism", AIAA Paper No. 99-2696, to be presented at the 35th AIAA/ASME/ SAE/ASEE Joint Propulsion Conference in Los Angeles, Calif. 20-23 June 1999.

[11] Tombe, D. F., "The Double Helix Theory of the Magnetic Field," The General Science Journal, 15, February 2006, Philippine Islands.

[12] Pinheiro, M., "Do Maxwell's Equations need Revisions? – A Methodological Note," IST/CFP 2.2006-M J Pinheiro, Lisbon, Portugal, Feb 2, 2008.

Appendix A

The derivation depends upon using Maxwells' equations initially mentioned. The curl of the curl of the electric field and using known vector identities results in:

$$-\nabla\cdot(\nabla\cdot\boldsymbol{E})+\nabla^2\boldsymbol{E}=\frac{1}{c^2}\frac{\partial^2\boldsymbol{E}}{\partial t^2}+4\pi\left[\nabla\times\boldsymbol{J}_m+\frac{1}{c}\frac{\partial\boldsymbol{J}_e}{\partial t}\right]. \quad (A\text{–}1)$$

The vector proof is:

$$\nabla\times\nabla\times\boldsymbol{E}=\nabla\cdot(\nabla\cdot\boldsymbol{E})-\nabla^2\boldsymbol{E}. \quad (A\text{–}2)$$

With proper substitutions, this results in a wave equation for the electric field:

$$\frac{1}{c^2}\frac{\partial^2\boldsymbol{E}}{\partial t^2}-\nabla^2\boldsymbol{E}=-4\pi\left[\nabla\rho_e+\frac{1}{c}\frac{\partial\boldsymbol{J}_e}{\partial t}+\nabla\times\boldsymbol{J}_m\right]. \quad (A\text{–}3)$$

The magnetic field results in:

$$\frac{1}{c^2}\frac{\partial^2\boldsymbol{B}}{\partial t^2}-\nabla^2\boldsymbol{B}=-4\pi\left[\nabla\rho_m+\frac{1}{c}\frac{\partial\boldsymbol{J}_m}{\partial t}-\nabla\times\boldsymbol{J}_e\right]. \quad (A\text{–}4)$$

Using the definition for the Poynting vector and taking the gradient:

$$\mu_o\nabla\cdot\boldsymbol{S}=\nabla\cdot(\boldsymbol{E}\times\boldsymbol{B})=\boldsymbol{B}\cdot\nabla\times\boldsymbol{E}-\boldsymbol{E}\cdot\nabla\times\boldsymbol{B}$$
$$=-\frac{1}{2c}\frac{\partial}{\partial t}\left[B^2+E^2\right]-4\pi\left[\boldsymbol{B}\cdot\boldsymbol{J}_m+\boldsymbol{E}\cdot\boldsymbol{J}_e\right] \quad (A\text{–}5)$$

Taking the gradient of this equation yields:

$$\mu_o\nabla(\nabla\cdot\boldsymbol{S})=-4\pi\left[-\boldsymbol{B}\cdot\nabla\boldsymbol{J}_m-\boldsymbol{E}\cdot\nabla\boldsymbol{J}_e+\rho_m(-\nabla\times\boldsymbol{E}-4\pi\boldsymbol{J}_m)+\right.$$
$$\left.+\rho_e(\nabla\times\boldsymbol{B}-4\pi\boldsymbol{J}_e)+4\pi(\rho_m\boldsymbol{J}_m+\rho_e\boldsymbol{J}_e)+\boldsymbol{B}\cdot\nabla\boldsymbol{J}_m+\boldsymbol{E}\cdot\nabla\boldsymbol{J}_e\right]$$
$$\mu_o\nabla(\nabla\cdot\boldsymbol{S})=-4\pi(\rho_e\nabla\times\boldsymbol{B}-\rho_m\nabla\times\boldsymbol{E}) \quad (A\text{–}6)$$

This becomes:

$$\mu_o\nabla^2\boldsymbol{S}=-4\pi(\rho_e\nabla\times\boldsymbol{B}-\rho_m\nabla\times\boldsymbol{E})-\mu_o\nabla\times\nabla\times\boldsymbol{S} \quad (A\text{–}7)$$

To do this we need to use the following mathematical identities:

$$\frac{\partial^2}{\partial t^2}(\boldsymbol{E}\times\boldsymbol{B})=\frac{\partial}{\partial t}\left[\frac{\partial\boldsymbol{E}}{\partial t}\times\boldsymbol{B}+\boldsymbol{E}\times\frac{\partial\boldsymbol{B}}{\partial t}\right]=$$
$$\mu_0\frac{\partial^2\boldsymbol{S}}{\partial t^2}=\left[\frac{\partial^2\boldsymbol{E}}{\partial t^2}\times\boldsymbol{B}+2\frac{\partial\boldsymbol{E}}{\partial t}\times\frac{\partial\boldsymbol{B}}{\partial t}+\boldsymbol{E}\times\frac{\partial^2\boldsymbol{B}}{\partial t^2}\right] \quad (A\text{–}8)$$

For these terms, we have:

$$\frac{\partial^2\boldsymbol{E}}{\partial t^2}\times\boldsymbol{B}=-4\pi c^2\left[+\frac{1}{c}\frac{\partial\boldsymbol{J}_e}{\partial t}\times\boldsymbol{B}+\nabla\times\boldsymbol{J}_m\times\boldsymbol{B}\right],$$
$$2\frac{\partial\boldsymbol{E}}{\partial t}\times\frac{\partial\boldsymbol{B}}{\partial t}=-2c^2\nabla\times\boldsymbol{B}\times\nabla\times\boldsymbol{E}-8\pi c^2\left[\nabla\times\boldsymbol{B}\times\boldsymbol{J}_m-\boldsymbol{J}_e\nabla\times\boldsymbol{E}\right]+$$
$$+32\pi^2c^2\boldsymbol{J}_e\times\boldsymbol{J}_m,$$
$$\boldsymbol{E}\times\frac{\partial^2\boldsymbol{B}}{\partial t^2}=-4\pi c^2\left[+\boldsymbol{E}\times\frac{1}{c}\frac{\partial\boldsymbol{J}_m}{\partial t}-\boldsymbol{E}\times\nabla\times\boldsymbol{J}_e\right]. \quad (A\text{–}9)$$

Simplifying terms:

$$\frac{1}{c}\left(\frac{\partial J_e}{\partial t}\times B+E\times\frac{\partial J_m}{\partial t}\right)=\frac{1}{c}\frac{\partial}{\partial t}\left(J_e\times B+E\times J_m\right)-\frac{1}{c}\left(J_e\times\frac{\partial B}{\partial t}+\frac{\partial E}{\partial t}\times J_m\right),$$
$$=\frac{1}{c}\frac{\partial}{\partial t}\left(J_e\times B+E\times J_m\right)-\frac{1}{c}\left(J_e\times\left(-\nabla\times E-4\pi J_m\right)\right.$$
$$\left.-\left(\nabla\times B-4\pi J_e\right)\times J_m\right). \quad (A\text{–}10)$$

This is substituted into the expression for the second derivative and takes the other cross-products:

$$\frac{\mu_0}{c^2}\frac{\partial^2\boldsymbol{S}}{\partial t^2}=-2c^2\nabla\times\boldsymbol{B}\times\nabla\times\boldsymbol{E}+$$
$$-4\pi\left[\frac{1}{c}\frac{\partial}{\partial t}(\boldsymbol{J}_e\times\boldsymbol{B}+\boldsymbol{E}\times\boldsymbol{J}_m)+\boldsymbol{B}\cdot\nabla\boldsymbol{J}_m+\boldsymbol{E}\cdot\nabla\boldsymbol{J}_e+\right.$$
$$\left.-\nabla(\boldsymbol{J}_e\cdot\boldsymbol{E}+\boldsymbol{J}_m\cdot\boldsymbol{B})\right]. \quad (A\text{–}11)$$

Recall using a vector relationship:

$$\nabla(\boldsymbol{u}\cdot\boldsymbol{v})=\boldsymbol{u}\cdot\nabla\boldsymbol{v}+\boldsymbol{v}\cdot\nabla\boldsymbol{u}+\boldsymbol{u}\times(\nabla\times\boldsymbol{v})+\boldsymbol{v}\times(\nabla\times\boldsymbol{u}),\ \text{or}$$
$$\boldsymbol{u}\times(\nabla\times\boldsymbol{v})+\boldsymbol{v}\times(\nabla\times\boldsymbol{u})=\nabla(\boldsymbol{u}\cdot\boldsymbol{v})-\boldsymbol{u}\cdot\nabla\boldsymbol{v}-\boldsymbol{v}\cdot\nabla\boldsymbol{u}. \quad (A\text{–}12)$$

Substituting:

$$\mu_0\frac{1}{c^2}\frac{\partial^2 S}{\partial t^2}=-2\nabla\times B\times\nabla\times E-4\pi\left[+\frac{1}{c}\frac{\partial}{\partial t}\left(J_e\times B+E\times J_m\right)\right.$$
$$\left.-\nabla\left(J_e\cdot E+J_m\cdot B\right)+J_e\cdot\nabla E+E\cdot\nabla J_e+J_m\cdot\nabla B+B\cdot\nabla J_m\right]. \quad (A\text{–}13)$$

Which becomes:

$$\mu_0\frac{1}{c^2}\frac{\partial^2 S}{\partial t^2}=-2\nabla\times B\times\nabla\times E-4\pi\left[+\frac{1}{c}\frac{\partial}{\partial t}\left(J_e\times B+E\times J_m\right)\right.$$
$$\left.-\nabla\left(J_e\cdot E+J_m\cdot B\right)+4\pi\left(\rho_e J_e+\rho_m J_m\right)+E\cdot\nabla J_e+B\cdot\nabla J_m\right]. \quad (A\text{–}14)$$

Using the terms for the Poynting vector components with $4\pi(\rho_e J_e+\rho_m J_m)$, this becomes:

$$\mu_0\left[\frac{1}{c^2}\frac{\partial^2 S}{\partial t^2}-\nabla^2 S\right]=\mu_0\nabla\times\nabla\times S-2\nabla\times B\times\nabla\times E+$$
$$-4\pi\left[+\frac{\rho_e}{c}\frac{\partial E}{\partial t}+\frac{\rho_m}{c}\frac{\partial B}{\partial t}+\frac{1}{c}\frac{\partial}{\partial t}\left(J_e\times B+E\times J_m\right)\right.$$
$$\left.+E\cdot\nabla J_e+B\cdot\nabla J_m-\nabla\left(J_e\cdot E+J_m\cdot B\right)\right]. \quad (A\text{–}15)$$

This becomes the final results:

$$\mu_0\left[\frac{1}{c^2}\frac{\partial^2 S}{\partial t^2}-\nabla^2 S\right]=\mu_0\nabla\times\nabla\times S-2\nabla\times B\times\nabla\times E+$$

$$-4\pi\left[-\frac{1}{c}\frac{\partial}{\partial t}\left(\rho_e E+\rho_m B\right)+\frac{1}{c}\frac{\partial}{\partial t}\left(J_e\times B+E\times J_m\right)\right.$$

$$\left.-\nabla\left(J_e\cdot E+J_m\cdot B\right)\right]. \qquad (A\text{–}16)$$