00 630 Circa 2000

DERIVATION OF THE $\underline{B}^{(3)}$ FIELD AND CONCOMITANT VACUUM ENERGY DENSITY FROM THE SACHS THEORY OF ELECTRODYNAMICS

by

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KEYWORDS: $\underline{B}^{(3)}$ Field; Vacuum Energy Density, Sachs theory of electrodynamics.

ABSTRACT

The archetypical and phaseless vacuum magnetic flux density of O(3) electrodynamics, the $\underline{B}^{(3)}$ field, is derived from the irreducible representation of the Einstein group and is shown to be accompanied by a vacuum energy density which depends directly on the square of the scalar curvature R of curved space-time. The $\underline{B}^{(3)}$ field and the vacuum energy density are obtained respectively from the non-Abelian part of the field tensor $F_{\mu\nu}$ and the non-Abelian part of the metrical field equation. Both these terms are as given by Sachs {1}.

KEYWORDS : $\underline{B}^{(3)}$ field, Sachs theory of electrodynamics, motionless electromagnetic generator.

1. INTRODUCTION

In higher symmetry electrodynamics the electromagnetic sector is considered to have a symmetry different from the received U(1). In O(3) electrodynamics {1-3} the sector symmetry is described by the O(3) group and field components appear which do not exist in U(1) symmetry electrodynamics. One of these components is the phaseless $\underline{B}^{(3)}$ field, first introduced in 1992 {4} and developed since then {1-3}. The $\underline{B}^{(3)}$ component is defined by the cross product of two circularly polarized and complex conjugate potentials, $\underline{A}^{(1)} = \underline{A}^{(2)*}$, and through the proportionality factor $g = \kappa / A^{(0)}$:

$$\underline{B}^{(3)*} = -ig\,\underline{A}^{(1)} \times \underline{A}^{(2)} \qquad (1)$$

where κ is the wavenumber and $A^{(0)}$ the magnitude of $\underline{A}^{(1)} = \underline{A}^{(2)*}$. In this Letter the fundamental definition of $\underline{B}^{(3)}$ in the vacuum is derived from the non-Abelian component of the field tensor in the Sachs theory of electrodynamics { 5 }, which is based on a consideration of irreducible representations of the Einstein group in general relativity, and which is therefore the most general theory of electrodynamics currently available, and the fundamental definition used to produce the electromagnetic energy in the vacuum due to $\underline{B}^{(3)}$, and observable in a reproducible and repeatable device such as the motionless electromagnetic generator (MEG) {5}.

2. NON-ABELIAN TERM IN THE FIELD TENSOR OF SACHS' THEORY

This term is:

$$F_{\mu\nu} = \frac{1}{8}\left(q_\mu q_\nu^* - q_\nu q_\mu^*\right) RQ \qquad -(2)$$

where q_μ etc. are quaternion valued metric components, where R is the scalar curvature and where Q is the charge { 5 }. In the flat space-time limit the quaternion valued components q_μ etc. reduce to σ_μ etc., the relation between which is:

$$\begin{aligned}
\sigma^0\sigma^1 - \sigma^1\sigma^0 &= 0 \\
\sigma^0\sigma^2 - \sigma^2\sigma^0 &= 0 \\
\sigma^0\sigma^3 - \sigma^3\sigma^0 &= 0 \\
\sigma^1\sigma^2 - \sigma^2\sigma^1 &= 2i\sigma^3 \\
\sigma^2\sigma^3 - \sigma^3\sigma^2 &= 2i\sigma^1 \\
\sigma^3\sigma^1 - \sigma^1\sigma^3 &= 2i\sigma^2 .
\end{aligned} \qquad -(3)$$

A product such as $q^\mu q^{\nu *}$ is non-commutative but not antisymmetric in μ and ν.

The asterisk here denotes quaternion conjugation, which changes the sign of the time component.

There are generally covariant components such as:

$$\begin{aligned}
q_X &= q^1 = (q^{10}, q^{11}, q^{12}, q^{13}) \\
q_Y &= q^2 = (q^{20}, q^{21}, q^{22}, q^{23}) \\
q_Z &= q^3 = (q^{30}, q^{31}, q^{32}, q^{33}) \\
q_0 &= q^0 = (q^{00}, q^{01}, q^{02}, q^{03})
\end{aligned} \qquad -(4)$$

and the row vector column vector product:

$$[0, \sigma_X, 0, 0]\begin{bmatrix} 0 \\ 0 \\ \sigma_Y \\ 0 \end{bmatrix} = 0 \qquad -(5)$$

results in zero. The quaternion product therefore cannot be interpreted in this way. This result leaves possibilities such as:

$$q_x^1 q_y^{2*} - q_y^2 q_x^{1*} = 2 i q_z^3 \qquad (6)$$

$$\downarrow$$

$$\sigma_x \sigma_y - \sigma_y \sigma_x = 2 i \sigma_Z .$$

Also q_x^1 and q_y^{2*} must be one valued, and be 2 x 2 matrices, so:

$$q_x^1 = \begin{bmatrix} 0 & q_x^1 \\ q_x^1 & 0 \end{bmatrix} ; \quad q_y^{2*} = \begin{bmatrix} 0 & -i q_y^2 \\ i q_y^2 & 0 \end{bmatrix} . \qquad (7)$$

The metric q^μ must be a function of x^μ, whose space part is represented by ((1), (2), (3)),

therefore it is possible to define scalar components:

$$q_x^{(1)} := A_x^{(1)} / A^{(0)} ; \quad q_y^{(2)} = A_y^{(2)} / A^{(0)} . \qquad (8)$$

So

$$\underline{q}^{(3)*} = -i \underline{q}^{(1)} \times \underline{q}^{(2)} = q^{(0)} \underline{k} \qquad (9)$$

$$(10)$$

represents O(3) electrodynamics in this vector basis, and:

$$q_x^{(1)} = \begin{bmatrix} 0 & \frac{i}{\sqrt{2}} e^{i\phi} \\ \frac{i}{\sqrt{2}} e^{i\phi} & 0 \end{bmatrix} ; \quad q_y^{(2)*} = \begin{bmatrix} 0 & -\frac{i}{\sqrt{2}} e^{-i\phi} \\ \frac{i e^{-i\phi}}{\sqrt{2}} & 0 \end{bmatrix}$$

where ϕ is the (Wu Yang) electromagnetic phase. The $\underline{B}^{(3)}$ field is therefore defined by:

$$\underline{B}^{(3)*} = -i g A^{(0)2} \underline{q}^{(1)} \times \underline{q}^{(2)} = -i B^{(0)} \underline{q}^{(1)} \times \underline{q}^{(2)} \qquad (11)$$

with metric components:

$$\underline{q}^{(1)} = \frac{1}{\sqrt{2}}(i\underline{i} + \underline{j})e^{i\phi} = \underline{q}^{(2)*} \quad -(12)$$

3 FIELD EQUATIONS AND ENERGY IN THE VACUUM.

The definition of $\underline{B}^{(3)}$ is therefore obtained from the field equations given by Sachs { 5 }, in particular form the non-Abelian part of:

$$\frac{1}{4}\left(K_{\rho\lambda}q^{\lambda} + q^{\lambda}K^{+}_{\rho\lambda}\right) + \frac{1}{8}Rq_{\rho} = kT_{\rho} \quad -(13)$$

a part which can be written in the circular basis ((1), (2), (3)) as:

$$k\underline{T}^{(3)} = \frac{1}{8}R\underline{q}^{(3)} \quad -(14)$$

etc.

This vanishes in flat space-time, where R is zero. So the energy concomitant with the $\underline{B}^{(3)}$ field also vanishes in flat space-time and is given by:

$$En = \int B^{(0)2}\,dV = \int\left(\frac{1}{8}QR\right)^{2}dV = \int (Qk)^{2}\,\underline{T}^{(3)}\cdot\underline{T}^{(3)*}\,dV \quad -(15)$$

Here $K_{\mu\nu}$ is the curvature tensor { 5 } and k the Einstein constant. It is concluded that the energy due to $\underline{B}^{(3)}$ can be expressed in terms of components of the energy momentum tensor, or in terms of the scalar curvature. In both cases the energy is expressed in terms of fundamental quantities in general relativity, and from the irreducible representations of the Einstein group is fundamentally non-zero.

4. MOTIONLESS ELECTROMAGNETIC GENERATOR.

This result can be applied to explain the basic principle of the motionless electromagnetic generator (MEG), in that the energy (1), i.e.:

$$En = \int \underline{B}^{(3)} \cdot \underline{B}^{(3)*} \, dV \qquad -(16)$$

is taken from curved space-time and changed into the energy:

$$En_S = \int \underline{B} \cdot \underline{B} \, dV \qquad -(17)$$

where $\underline{B}$ is a static magnetic field component of the core of the MEG. The latter is a considerably more complicated device { 6 } than this simple principle would seem to allow, but nevertheless the principle applies to all static magnetic field components of any repeatable and reproducible device. The basic idea is that electromagnetic energy is taken from Riemannian space-time and changed into electromagnetic energy in usable form. This procedure is sometimes known as "free energy" or "taking energy from the vacuum".

In summary we have derived and defined the $\underline{B}^{(3)}$ component of O(3) electrodynamics from the Sachs theory of electrodynamics, which considers irrreducible representations of the Einstein group of general relativity. This $\underline{B}^{(3)}$ component is then used to explain the working principles of the motionless electromagnetic generator (MEG).

ACKNOWLEDGMENTS

The U. S. Department of Energy is acknowledged for the web site http//www.ott.doe.gov.electromagnetic which is reserved for papers and articles by the AIAS and the advanced electromagnetic working group of the DoE.

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