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EXPLANATION OF THE MOTIONLESS ELECTROMAGNETIC GENERATOR WITH O(3) ELECTRODYNAMICS

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Recently, Bearden *el al.* developed a device which is known as a motionless electromagnetic generator (MEG) and which produces a coefficient of performance (COP) far in excess of unity. The device has been independently replicated by Naudin. In this communication, the fundamental operational principle of the MEG is explained using a version of higher symmetry electrodynamics known as O(3) electrodynamics, which is based on the empirical existence of two circular polarization states of electromagnetic radiation, and which has been developed extensively in the literature. The theoretical explanation of the MEG with O(3) electrodynamics is straightforward: Magnetic energy is taken directly ex vacua and used to replenish the permanent magnets of the MEG device, which therefore produces a source of energy that, in theory, can be replenished indefinitely from the vacuum. Such a result is incomprehensible in U(1) Maxwell-Heaviside electrodynamics.

Key words: motionless electromagnetic generator, O(3) electrodynamics, energy from the vacuum.

1. INTRODUCTION

Bearden *et al.* [1] recently produced a device which they describe as a motionless electromagnetic generator (MEG), which outputs more energy than is input by the operator, and therefore produces a coefficient of performance (COP) well in excess of unity. The device has been replicated independently by Naudin [2] and is therefore reproducible and repeatable, meeting the requirements of scientific rigor. In this communication, a qualitative theoretical explanation is offered for the MEG using a version of higher-symmetry electrodynamics known as O(3) electrodynamics [3,4]. The latter theory has been developed from an empirical basis: the existence of two-circularly polarized states of electromagnetic radiation. In O(3) electrodynamics, there exists a vacuum current and vacuum energy [3,4]

$$En = \frac{1}{\mu_0}\int \mathbf{B}^{(3)} \cdot \mathbf{B}^{(3)} dV, \tag{1}$$

where μ_0 is the vacuum permeability in S.I. units, and where $\mathbf{B}^{(3)}$ is a longitudinally directed and phaseless magnetic flux density which propagates in vacuum with the plane wave $\mathbf{B}^{(1)} = \mathbf{B}^{(2)*}$ in such a way that

$$\mathbf{B}^{(1)} \times \mathbf{B}^{(2)} = iB^{(0)}\mathbf{B}^{(3)*}, \quad \text{et cyclicum,} \tag{1a}$$

where $B^{(0)}$ is the scalar magnitude of $\mathbf{B}^{(3)}$ [3,4]. In this notation, $\mathbf{B}^{(3)}$ is a three vector and the dot denotes the usual scalar product, with the upper star denoting the usual complex conjugate. In Sec. 2, Eq. (1) is derived from the field equations of O(3) electrodynamics, which are in turn derivable from fiber bundle theory, and have the structure of Yang-Mills field equations. In Sec. 3, the fundamental operational principle of the MEG is explained straightforwardly using Eq. (1).

2. DERIVATION OF EQ. (1)

The homogeneous and inhomogeneous field equations of O(3) electrodynamics are, respectively, [3,4]:

$$D_\mu \tilde{\mathbf{G}}^{\mu\nu} \equiv 0, \tag{2}$$

$$D_\mu \mathbf{H}^{\mu\nu} = \mathbf{J}^\nu, \tag{3}$$

where $\tilde{\mathbf{G}}^{\mu\nu}$ is an O(3) field tensor, and D_μ is the O(3) covariant derivative. In Eqs. (2) and (3), the Greek indices assume the standard values of 0, 1, 2, 3. In Eq. (3), the bold symbol $\mathbf{J}^\nu$ denotes a charge current twelve vector defined as:

$$\mathbf{J}^{\nu(i)} := \left(\rho, \mathbf{J}^{(i)}/c\right), \quad i = 1, 2, 3 \tag{4}$$

where c is the speed of light [3]. In O(3) electrodynamics, the field tensor $\mathbf{G}^{\mu\nu}$ is defined in the internal space ((1), (2), (3)) as the sum of three components [3]:

$$\mathbf{G}^{\mu\nu} := G^{(1)}_{\mu\nu}\mathbf{e}^{(1)} + G^{(2)}_{\mu\nu}\mathbf{e}^{(2)} + G^{(3)}_{\mu\nu}\mathbf{e}^{(3)}. \tag{5}$$

The field tensor $\mathbf{H}^{\mu\nu}$, which is a generalization of $\mathbf{G}^{\mu\nu}$ that includes magnetization and polarization, is similarly defined as:

$$\mathbf{H}^{\mu\nu} := H^{\mu\nu(1)}\mathbf{e}^{(1)} + H^{\mu\nu(2)}\mathbf{e}^{(2)} + H^{\mu\nu(3)}\mathbf{e}^{(3)}, \tag{6}$$

and the charge current 12-vector as

$$\mathbf{J}^\nu := J^{\nu(1)}\mathbf{e}^{(1)} + J^{\nu(2)}\mathbf{e}^{(2)} + J^{\nu(3)}\mathbf{e}^{(3)}, \tag{7}$$

where $\mathbf{e}^{(1)}, \mathbf{e}^{(2)}, \mathbf{e}^{(3)}$ are unit vectors in the basis ((1), (2), (3)). Therefore O(3) electrodynamics is a Yang-Mills gauge field theory [3] with internal space ((1), (2), (3)). For further details, see Refs. 3 to 8.

These equations are Yang-Mills equations and as such, are derivable from fiber bundle theory [5]. They form an extended Lie algebra [5] and as such, constitute a valid Lie algebra, meeting all the criteria of such an algebra. An extended Lie algebra is defined [5] as

$$E := L \oplus V, \tag{8}$$

where L and V are two Lie algebras in different spaces.

In vacuum (in the absence of matter), one can develop a special case of Eq. (3):

$$\partial^{\mu}\mathbf{G}^{\mu\nu} = 0, \quad \mathbf{J}^{\nu} = g\varepsilon_0 \mathbf{A}_{\mu} \times \mathbf{G}^{\mu\nu}, \tag{9}$$

where $\mathbf{J}^{\nu}$ is a conserved vacuum current. Here, the tensors $\mathbf{G}^{\mu\nu}$ and $\tilde{\mathbf{G}}^{\mu\nu}$ are dual to each other:

$$\partial^{\mu}\mathbf{G}^{\mu\nu} = 0, \tag{10a}$$

$$\tilde{\mathbf{G}}^{\mu\nu} = \frac{1}{2}\varepsilon^{\mu\nu\sigma\rho}\mathbf{G}_{\sigma\rho}. \tag{10b}$$

This concept is absent from Maxwell-Heaviside electrodynamics, in which the only vacuum current is the Maxwell displacement current. However, Lehnert [6] has developed a theory of electrodynamics based on a concept similar to $\mathbf{J}^{\nu}$ and has replicated the existence $\mathbf{B}^{(3)}$ [6] as one component out of many possible longitudinal components in vacua. Empirical evidence for the the $\mathbf{B}^{(3)}$ field is revised elsewhere [3-5], where it is demonstrated that O(3) electrodynamics explains anomalies that are not explicable with U(1) electrodynamics.

Equation (1) is arrived at by developing Eq. (9) as follows. The vacuum charge-current twelve-vector $\mathbf{J}^{\nu}$ is a physical charge-current density that gives rise to the energy

$$En = -\int \mathbf{J}^{\nu} \cdot \mathbf{A}_{\nu} dV, \tag{11}$$

where V is the radiation volume [3,4]. This equation represents the electromagnetic energy in the vacuum generated by the vacuum current J^3 in a volume V [3] and, when written out in full, is

$$En = -\int \mathbf{J}^{\nu} \cdot \mathbf{A}_{\nu} dV, \tag{12}$$

$$\mathbf{J}^{\nu} = J^{\nu(1)}\mathbf{e}^{(1)} + J^{\nu(2)}\mathbf{e}^{(2)} + J^{\nu(3)}\mathbf{e}^{(3)}, \tag{12a}$$

$$\mathbf{A}_{\nu} = A_{\nu}^{(1)}\mathbf{e}^{(1)} + A_{\nu}^{(2)}\mathbf{e}^{(2)} + A_{\nu}^{(3)}\mathbf{e}^{(3)}. \tag{12b}$$

The analogous term in U(1) electrodynamics is the starting point for the derivation [3] of the Lamb shift in H.

The three-vector magnetic field $\mathbf{B}^{(3)}$ is defined fundamentally in O(3) electrodynamics [3] as

$$\mathbf{B}^{(3)*} := -ig\mathbf{A}^{(1)} \times \mathbf{A}^{(2)}, \tag{13}$$

where g is a proportionality coefficient defined as

$$g = \frac{\kappa}{A^{(0)}}, \tag{14}$$

where κ is the wave-vector and $A^{(0)}$ is the scalar magnitude of $\mathbf{A}^{(1)} = \mathbf{A}^{(2)*}$. For more details, see Refs. 3 and 5.

The energy term can therefore be developed as follows. In Eq. (12b), $A_\nu^{(1)} A_\nu^{(2)}$ and $A_\nu^{(3)}$ are each four-vectors:

$$A_\nu^{(1)} = \left(\phi^{(1)}, -c\mathbf{A}^{(1)}\right), \tag{15}$$

$$A_\nu^{(2)} = \left(\phi^{(2)}, -c\mathbf{A}^{(2)}\right), \tag{16}$$

$$A_\nu^{(3)} = \left(\phi^{(3)}, -c\mathbf{A}^{(3)}\right). \tag{17}$$

From Eq. (9), it follows that:

$$\mathbf{J}^{(1)*} = -ig\varepsilon_0 \mathbf{A}_\mu^{(2)} \times \mathbf{G}^{\mu\nu(3)}, \tag{18}$$

$$\mathbf{J}^{(2)*} = -ig\varepsilon_0 \mathbf{A}_\mu^{(3)} \times \mathbf{G}^{\mu\nu(1)}, \tag{19}$$

$$\mathbf{J}^{(3)*} = -ig\varepsilon_0 \mathbf{A}_\mu^{(1)} \times \mathbf{G}^{\mu\nu(2)}. \tag{20}$$

Equation (11) for the energy is therefore

$$En = -ig\varepsilon_0 \int \mathbf{A}_\nu^{(2)} \times \mathbf{G}^{\mu\nu(3)} \cdot \mathbf{A}_\nu^{(1)} dV + \dots. \tag{21}$$

We now use the vector identity

$$\mathbf{F} \cdot \mathbf{G} \times \mathbf{H} = \mathbf{G} \cdot \mathbf{H} \times \mathbf{F} \tag{22}$$

to obtain the non-zero result

$$En = -ig\varepsilon_0 \int \mathbf{G}^{\mu\nu(3)} \cdot \mathbf{A}_\nu^{(1)} \times \mathbf{A}_\mu^{(2)} dV + \dots, \tag{23}$$

which can be developed as

$$En = c^2 \varepsilon_0 \int \mathbf{B}^{(3)} \cdot \mathbf{B}^{(3)} dV \tag{24a}$$

$$= \frac{1}{\mu_0} \int \mathbf{B}^{(3)} \cdot \mathbf{B}^{(3)} dV \tag{24b}$$

where ε_0 is the vacuum permittivity in S.I. units, defined by

$$c^2 = \frac{1}{\mu_0 \varepsilon_0}. \tag{25}$$

We therefore arrive at Eq. (1), which is the energy from the vacuum due to the vacuum current $\mathbf{J}^\nu$, a current which is absent from Maxwell-Heaviside electrodynamics. The concept is however present in general relativity as shown by Sachs [7]. It has been shown [8] that the structure of the Sachs theory reduces to that of O(3) electrodynamics using a particular choice of metric. Therefore, there exists a foundation for O(3) electrodynamics in general relativity, and O(3) electrodynamics is a theory of conformally curved space-time. The Maxwell-Heaviside theory, on the other hand, is a theory of flat spacetime, in which there is no curvature tensor. Sachs has shown that in the theory of general relativity, the electromagnetic field cannot propagate through the vacuum. This result refutes the Maxwell-Heaviside theory, in which the field is assumed to propagate in a vacuum which is structurally equivalent to flat space-time.

3. QUALITATIVE EXPLANATION OF THE MEG, USING EQ. (24A)

The qualitative explanation of the MEG from Eq. (24a) is that the magnetic energy (24a) is transferred into the magnetic energy

$$En_S = \frac{1}{\mu_0} \int \mathbf{B} \cdot \mathbf{B} dV, \tag{26}$$

where $\mathbf{B}$ is the permanent magnetic field of the core of the MEG [1]. Therefore, the energy (Eq. 26) is continuously replenished from the vacuum, so that in the theory, the MEG takes energy from the vacuum, which is effectively an infinite source of energy. The MEG is therefore an important prototypical device for outputting more power than is inputted by the circuit. The independent replication by Naudin [2] demonstrates that the MEG meets the requirements of reproducibility and repeatability, and so is a working device that cannot be refuted theoretically. It must be explained theoretically, as suggested for example in Sec. 2 of this communication. The fundamental principle of the MEG is that energy is drawn from a permanent magnet and converted into an electric current. The permanent magnetic energy (26) is not depleted because it is continuously replenished by the vacuum magnetic energy (24a).

This description is a simplified synopsis of the MEG, which is fully described elsewhere [1], but suffices to show that a coefficient of productivity much greater than unity can be produced if it is realized that the energy [1] exists in the vacuum itself, and that electromagnetic energy can be taken from the vacuum. There is no vacuum current J^ν in the Maxwell-Heaviside theory, and therefore there is no equivalent of the energy (24a) in that theory. The current J^ν is conserved, and so Noether's theorem is not violated by the explanation offered in this communication. In order for the MEG to operate in conventional Maxwell-Heaviside electrodynamics, a source of electromagnetic energy would have to be inputted into the MEG by this source, and the coefficient of performance could not exceed unity. In a higher-symmetry electrodynamics such as O(3) electrodynamics, or in the electrodynamics developed by Lehnert [6], there is energy inherent in the vacuum *itself*, so no source, or transmitter, is needed in order for the MEG to output current indefinitely. The energy given to the core magnet of the MEG is taken from Eq. (1), and the MEG operates indefinitely in principle, and does not deplete, or run down, as an ordinary battery depletes. In higher symmetry electrodynamics, the positive and negative terminals of a battery act as a receiver of vacuum energy, and an ordinary battery runs down because the chemical energy needed to produce the positive and negative terminals is dissipated.

The MEG does not rely on such chemical energy, and in principle can take energy from the vacuum, via Eq. (1), indefinitely, and without a source, or transmitter, being present. The MEG does not violate Noether's theorem because the current $\mathbf{J}^\nu$ is conserved and acts as a reservoir of energy. The MEG therefore utilizes this energy in the same way as water is drawn from a faucet.

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