# RUNAWAY SOLUTIONS OF THE LEHNERT EQUATIONS: THE POSSIBILITY OF EXTRACTING ENERGY FROM THE VACUUM


## ABSTRACT

It is shown that the Lehnert equations possess runaway solutions which, in theory, result in infinite positive and negative vacuum energy in thermodynamic equilibrium. If this equilibrium is locally disturbed, an excess of potential energy and an excess rate of doing work by the vacuum is generated in theory. This can be converted into thermal or mechanical energy without violating Noether's theorem or the laws of thermodynamics.


## INTRODUCTION

Lehnert {1-5} and Lehnert and Roy {6} have recently introduced equations of electrodynamics which allow for the existence of vacuum charge density and current density, concept which are similar to Maxwell's displacement current. It has been shown recently {7} that the structure of the Lehnert equations emerges if the Lorenz condition is discarded. In this paper, it is suggested that there may exist runaway solutions of the Lehnert equations in which the vacuum takes on the attributes of infinite positive and negative energy which are in thermodynamic equilibrium, giving the appearance of zero vacuum energy as in the received classical view {8}. If this equilibrium is locally disturbed, however, there may exist the possibility of extracting energy and rate of doing work from the vacuum, and converting it into thermal or mechanical energy. This does not violate the laws of thermodynamics and Noether's theorem, because in this view, the classical vacuum possesses energy. In the received view, the classical vacuum has no energy, so no energy can be extracted from the vacuum. The reason for this is that there are no vacuum charges or currents present in the received view, apart from the Maxwell's displacement current. This point of view is compatible with the application of the Lorenz gauge. It has been shown {7} that if the Lorenz gauge is discarded, the possibility of vacuum charge/current appears. The equations of electrodynamics then become structured identically with the Lehnert equations, although the latter were introduced empirically using the Lorenz condition.

## BASIS FOR RUNAWAY SOLUTIONS: THE MAXWELL DISPLACEMENT CURRENT

Firstly , consider the method Maxwell used to introduce his famous displacement current using 1) the received equations of electrostatics:

$$\nabla \cdot \boldsymbol{D} = \rho; \qquad \nabla \cdot \boldsymbol{B} = 0$$
$$\nabla \times \boldsymbol{H} = \boldsymbol{J}; \qquad \nabla \times \mathrm{E} + \frac{\partial \boldsymbol{B}}{\partial t} = \boldsymbol{0} \tag{1}$$

and 2) the continuity equation:

$$\nabla \cdot \boldsymbol{J} + \frac{\partial \rho}{\partial t} = 0 \tag{2}$$

Here, $\boldsymbol{D}$ is the displacement current; $\rho$ is the charge density; $\boldsymbol{B}$ is the magnetic flux density; $\boldsymbol{H}$ is the magnetic field strength; $\boldsymbol{J}$ is the current density; and $\boldsymbol{E}$ is the electric field strength. We are using S.I. units and the above equations are for field-matter interaction. Using the continuity equation in the Coulomb law gives:

$$\nabla \bullet \left( \boldsymbol{J} + \frac{\partial \boldsymbol{D}}{\partial t} \right) = 0. \tag{3}$$

Maxwell then replaced $\boldsymbol{J}$ by $\boldsymbol{J} + \frac{\partial \boldsymbol{D}}{\partial t}$ to give:

$$\nabla \times \mathrm{H} = \boldsymbol{J} + \frac{\partial \boldsymbol{D}}{\partial t} \tag{4}$$

which is the Ampère-Maxwell law as still used in the contemporary received view {8}.

**THE LEHNERT VACUUM EQUATIONS**

If the Lorenz condition is discarded, {7} or if we use the vacuum Lehnert equation {6}, a charge density and current density appears in the classical vacuum. The structure of the equations of electrodynamics in the classical vacuum is then {6}:

$$\begin{aligned} &\nabla \bullet \boldsymbol{D} = \rho; && \nabla \bullet \boldsymbol{B} = 0 \\ &\nabla \times \boldsymbol{H} = \boldsymbol{J} + \frac{\partial \boldsymbol{D}}{\partial t}; && \nabla \times \mathrm{E} + \frac{\partial \boldsymbol{B}}{\partial t} = \mathbf{0}. \end{aligned} \tag{5}$$

and is part of the structure of non-Abelian or O(3) electrodynamics {9-12} in the vacuum. In the latter equations, vacuum charge and current densities appear from first principles. In addition to developing the Lehnert equations extensively, Lehnert and Roy {6} have shown that the vacuum charge and current obey the continuity equations in the vacuum:

$$\nabla \bullet \boldsymbol{J} + \frac{\partial \rho}{\partial t} = 0. \tag{6}$$

Using the vacuum continuity equation in the vacuum Coulomb law, following Maxwell's method, we find:

$$\boldsymbol{J} \rightarrow \boldsymbol{J} + \frac{\partial \boldsymbol{D}}{\partial t} \equiv \boldsymbol{J}_1 \tag{7}$$

$$\nabla \times \mathrm{H} = \boldsymbol{J}_1 + \frac{\partial \boldsymbol{D}}{\partial t} \tag{8}$$

$$\nabla \bullet \boldsymbol{J}_1 + \frac{\partial \rho_1}{\partial t} = 0. \tag{9}$$

Repeating this procedure gives:

$$
\begin{aligned}
J_1 &= J + \frac{\partial D}{\partial t} \\
&\vdots \\
J_n &= J + n\frac{\partial D}{\partial t}; \quad n \to \infty
\end{aligned}
\tag{10}
$$

$$
\rho_n = \pm \int \nabla \cdot J_n dt; \qquad n \to \infty,
\tag{11}
$$

and theoretically, there are two infinitely large charge densities in the vacuum, given by:

$$
\begin{aligned}
\rho_n &= \int \nabla \cdot J_n dt; \qquad n \to \infty \\
-\rho_n &= -\int \nabla \cdot J_n dt; \quad n \to \infty
\end{aligned}
\tag{12}
$$

because charge density can be either negative or positive. In this process, $\boldsymbol{B}$ and $\boldsymbol{E}$ are unchanged, so the vector and scalar potentials defined by:

$$
\boldsymbol{B} = \nabla \times \boldsymbol{A}; \qquad \boldsymbol{E} = -\frac{\partial \boldsymbol{A}}{\partial t} - \nabla \phi
\tag{13}
$$

remain unchanged.

Therefore, the vacuum potential energy difference is given by:

$$
\Delta V = \pm \int J_n \cdot A d^3 x
\tag{14}
$$

and the rate of doing work by the vacuum is given by:

$$
\frac{dW}{dt} = \pm \int J_n \cdot E d^3 x.
\tag{15}
$$

In thermodynamic equilibrium, the net result is zero in both cases, but locally, there may be a non-zero rate of doing work by the vacuum on a device, creating thermal or mechanical energy. This process conserves energy in the universe (vacuum and matter) and is consistent with the laws of thermodynamics.

## DISCUSSION

Recently, at least one working device has been patented {13} which outputs about thirty times more energy than inputted. This paper is a very simple suggestion how this can be possible. There is a local disturbance of the balance between positive and negative potential energy difference and rate of doing work being extracted from the vacuum. If this simple hypothesis is accepted, it is another piece of evidence for the Lehnert equations and O(3) electrodynamics, and is potentially very useful, because energy can be drawn from the vacuum, replacing the need to burn fossil fuels.

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