Space-Time Resonances in the Ampère-Maxwell Law

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Abstract

The engineering model of Einstein Cartan Evans (ECE) theory allows the design of electro-magnetic devices under inclusion of resonance effects from space-time. The resonance is enabled by means of the spin connection which is not present in the standard model of electrical engineering (Maxwell-Heaviside theory). In this paper models for solving the Ampère-Maxwell law are developed. Results show that resonances of conventional Euler-Bernoulli type may be missing but sharp undamped resonances of other type occur. Some examples for practical realization are proposed.

Keywords: Einstein Cartan Evans (ECE) field theory; spin connection resonance; ECE field equations; simulation model.
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1 Introduction

After its introduction in 2003, Einstein Cartan Evans (ECE) theory [1]- [3] has opened a new view on physics. This new paradigm can be developed by combining the ideas of Einstein's general relativity with addition spacetime torsion. A main benefit of this method is that it is not purely of theoretical and hypothetical nature but can be applied to real-world problems. The most urgent problem currently is finding new sources of energy. ECE theory offers to construct new electro-mangetic energy devices and therefore is of utmost importance for applied physics and engineering. The ECE field equations have been developed into an easily comprehensible form, the so called ECE engineering model [4]. It has been shown in several papers of the ECE series [5] how coupling between the background potential of space-time and electrical or magnetical devices can be established. This is by resonance effects which appear in full analogy to enforced oscillations. This has already been worked out for the Coulomb law in other papers [6, 7]. In this article we derive resonance effects from the Ampère-Maxwell law which is one of the four fundamental field equations of ECE theory.

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2 The resonant Ampère-Maxwell law

The field equations of the ECE engineering model are formally identical to the Maxwell-Heaviside equations, with the difference that the latter hold only for a flat space of special relativity, while the ECE equations are valid for any curved and twisted space-time. The Ampère-Maxwell law is one of these equations and reads

$$\boldsymbol{\nabla} \times \mathbf{B} - \frac{1}{c^2}\frac{\partial \mathbf{E}}{\partial t} = \mu_0 \mathbf{J}. \tag{1}$$

where $\mathbf{E}$ and $\mathbf{B}$ denote the electric and magnetic field, c is the vacuum velocity of light, μ_0 the vacuum permeability and $\mathbf{J}$ an external current density. The electric and magnetic field are related to the magnetic and electric space-time potentials $\mathbf{A}$ and ϕ by the equations

$$\mathbf{E} = -\frac{\partial \mathbf{A}}{\partial t} - \boldsymbol{\nabla}\phi - \omega_0 \mathbf{A} + \boldsymbol{\omega}\phi, \tag{2}$$

$$\mathbf{B} = \boldsymbol{\nabla} \times \mathbf{A} - \boldsymbol{\omega} \times \mathbf{A} \tag{3}$$

where $\boldsymbol{\omega}$ is the vector spin connection and ω_0 the scalar spin connection. These appear due to the space-time torsion and curvature of Cartan geometry. Without this, the above equations would be identical to those of Maxwell-Heaviside.

In this paper we restrict consideration to the electric case, i.e. we assume

$$\mathbf{A} = 0. \tag{4}$$

Then the magnetic field disappears and from Eq. (1) we obtain

$$\frac{\partial}{\partial t}\left(\boldsymbol{\nabla}\phi - \boldsymbol{\omega}\phi\right) = \frac{1}{\epsilon_0}\mathbf{J}. \tag{5}$$

In the following we assume that all quantities are time dependent. This leads to (with denoting the time derivative by a dot)

$$\boldsymbol{\nabla}\dot{\phi} - \dot{\boldsymbol{\omega}}\phi - \boldsymbol{\omega}\dot{\phi} = \frac{1}{\epsilon_0}\mathbf{J}. \tag{6}$$

Taking an additional time derivative on both sides of the equations then gives

$$\boldsymbol{\nabla}\ddot{\phi} - \ddot{\boldsymbol{\omega}}\phi - 2\dot{\boldsymbol{\omega}}\dot{\phi} - \boldsymbol{\omega}\ddot{\phi} = \frac{1}{\epsilon_0}\dot{\mathbf{J}}. \tag{7}$$

Now we further simplify the problem by omitting the space dependence. Then the gradient term disappears and we obtain an ordinary differential equation with non-constant coefficients of the form

$$\boldsymbol{\omega}\ddot{\phi} + 2\dot{\boldsymbol{\omega}}\dot{\phi} + \ddot{\boldsymbol{\omega}}\phi = -\frac{1}{\epsilon_0}\dot{\mathbf{J}} \tag{8}$$

whose Z component is

$$\omega_Z\,\ddot{\phi} + 2\dot{\omega}_Z\,\dot{\phi} + \ddot{\omega}_Z\,\phi = -\frac{1}{\epsilon_0}\dot{J}_Z. \tag{9}$$

The equation is symmetric in ω and ϕ. We restrict consideration to one component and the Z index will be omitted from here. To obtain a solution for the potential, we need a model ansatz for the spin connection. As a first try we define

$$\omega := \omega_0 e^{\alpha t} \tag{10}$$

with a characteristic decay time $1/\alpha$ which may be positive or negative. Then we get

$$\dot{\omega} = \omega_0\, \alpha\, e^{\alpha t}, \tag{11}$$

$$\ddot{\omega} = \omega_0\, \alpha^2\, e^{\alpha t} \tag{12}$$

and Eq. (9) simplifies to

$$\ddot{\phi} + 2\alpha\,\dot{\phi} + \alpha^2\,\phi = -\frac{1}{\epsilon_0\,\omega_0}\dot{J}. \tag{13}$$

This is an equation for a damped resonance with constant coefficients. The standard form [8] of such an equation is for a function φ:

$$\frac{\partial^2\varphi}{\partial x^2} + 2\beta\frac{\partial\varphi}{\partial x} + \kappa_0^2\varphi = f(x) \tag{14}$$

with a damping constant β and a resonance frequency κ_0 of the undamped oscillation. By comparison with (13) we have

$$\beta = \alpha, \tag{15}$$

$$\kappa_0 = \alpha. \tag{16}$$

The resonance frequency is given in general [8] by

$$\kappa_R = \sqrt{\kappa_0^2 - 2\beta^2} \tag{17}$$

which in this case is

$$\alpha_R = \sqrt{\alpha^2 - 2\alpha^2} = \alpha\sqrt{-1}. \tag{18}$$

Obviously the resonance frequency is imaginary, i.e. there is no resonance. The damping is too high, transducing the system into an overcritically damped state. One would have to find a different ansatz (10) for ω to find a real resonance of the potential.

This example was to show the nature of the resonance equation (13). Now we return to the original equation (6) which reads when neglecting any space dependence:

$$\dot{\omega}\phi + \omega\dot{\phi} = -\frac{1}{\epsilon_0}J. \tag{19}$$

This equation can be solved analytically by computer algebra. The general solution is

$$\phi = \frac{c - \frac{1}{\epsilon_0}\int J dt}{\omega} \tag{20}$$

with a constant c. The solution ϕ diverges for instances of time where ω has zero crossings and the numerator of (20) does not go to zero at the same time. For practical applications of resonance it is required to realize this condition, for example by a harmonic choice

$$\omega = \omega_0 \cos\left(\alpha t\right). \tag{21}$$

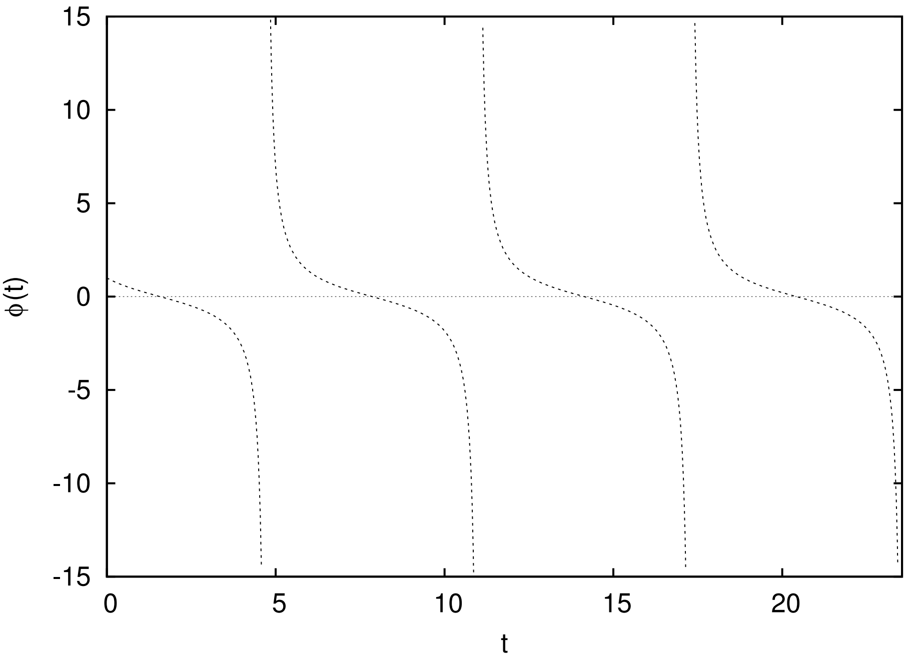

Figure 1: Resonances of potential of Eq.(20) with all constants set to unity.

If ω is created by a current of the same phase, we have

$$J = J_0 \cos(\alpha t), \tag{22}$$

leading to a potential

$$\phi = \frac{c - \frac{1}{\epsilon_0 \alpha} J_0 \sin(\alpha t)}{\omega_0 \cos(\alpha t)}. \tag{23}$$

This is plotted in Fig. 1.

As a second analytic example we define a current and a spin connection in form of a Gaussian function:

$$J \propto \omega \propto \exp(\alpha(t - t_0)). \tag{24}$$

Then J and the integral over J have the form as graphed in Fig. 2. The potential goes to infinity since the denominator of (20) approaches zero, see Fig. 3 (note the logarithmic scale). The constant c in Eq. (20) significantly impacts the form of ϕ, in particular it determines whether there are zero crossings or not. The constant represents a voltage preset for the timing behaviour of J and ω. This must be chosen carefully in experiments.

3 Proposed Realizations

In this paper we made a rough approximation by neglecting the space dependence of all physical quantities. Despite of this, a resonant behaviour was found for the time dependency of a predefined spin connection ω and a current J. To find experimental realizations of this situation we have to

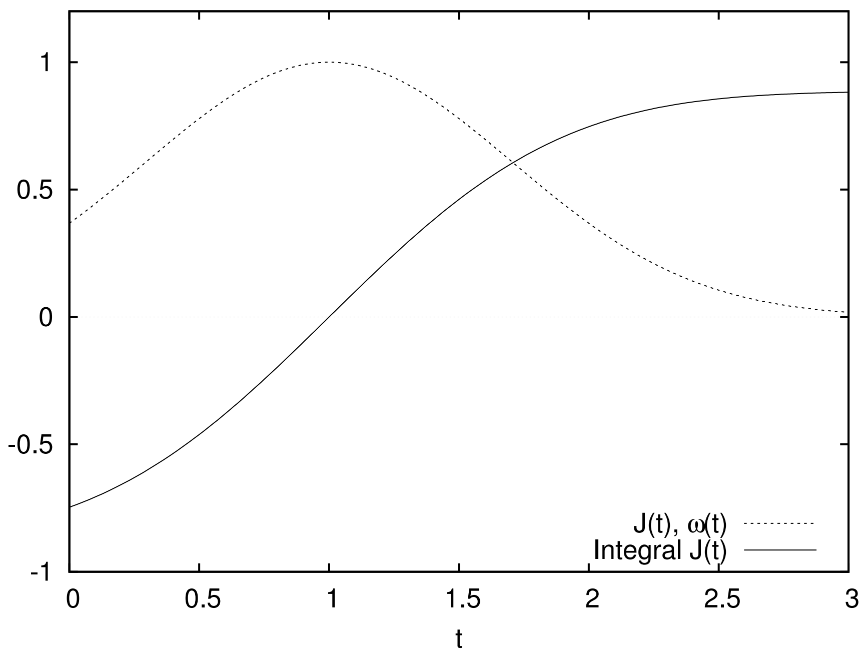

Figure 2: Gaussian current and spin connection, current integral.

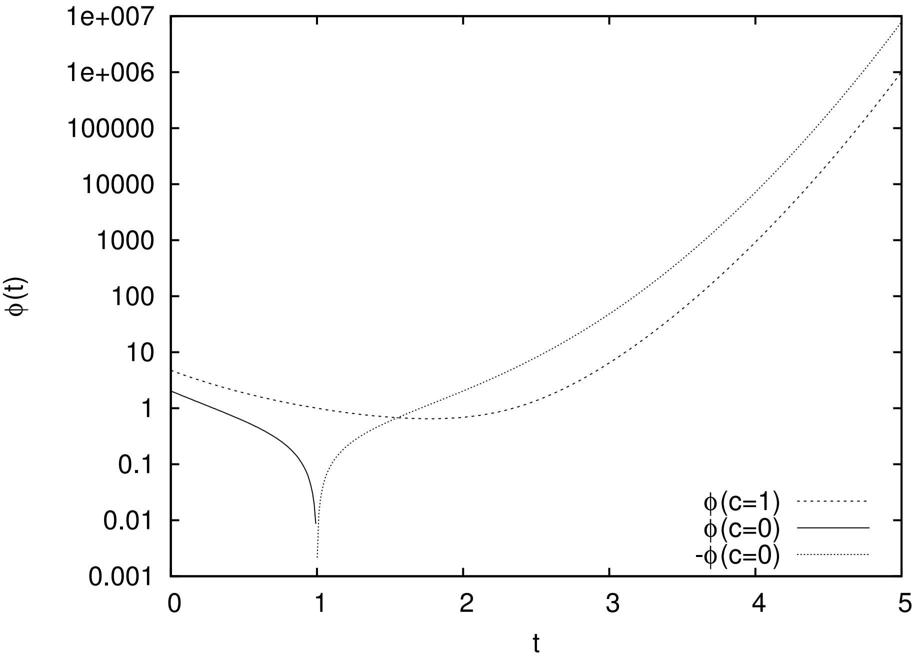

Figure 3: Resonant potential for Gaussian current/spin connection.

1. define a spin connection
2. define a current
3. provide a voltage collector

within the same location of space. How these have to be arranged to be optimal, will be subject of future FEM studies of the full vector equation (5) for the Ampère-Maxwell law. Here we present some ideas how the conditions can be met.

A spin connection in space can be created by a toroidal magnetic field [7]. This can be made time dependent by appying for example an AC voltage to the toroidal coil. The spin connection will follow the current (more precisely: the vector potential of the magnetic field) instantaneously. An AC current with the same phase can be conducted through an ohmic resistor in the center of the toroid, see Fig. 4. It is not clear where to place the electrodes for receiving the resonant voltage. In the simplest case the voltage is induced in parallel to the current J, this would give a boost in the circuit of J. Alternatively one could try to take off the voltage from conducting plates outside the conductor. Some possibilities are shown in Fig. 4.

Another, quite elegant, experimental setup could be a flat Tesla coil (Fig. 5). As already shown in an earlier paper [7] the magnetic field of a Tesla coil is inhomogeneous, leading to a non-vanishing spin connection. In this case the driving current of the coil is identical with the external "driving force" J. It is expected that this current can be enhanced by resonance effects.

4 Acknowledgments

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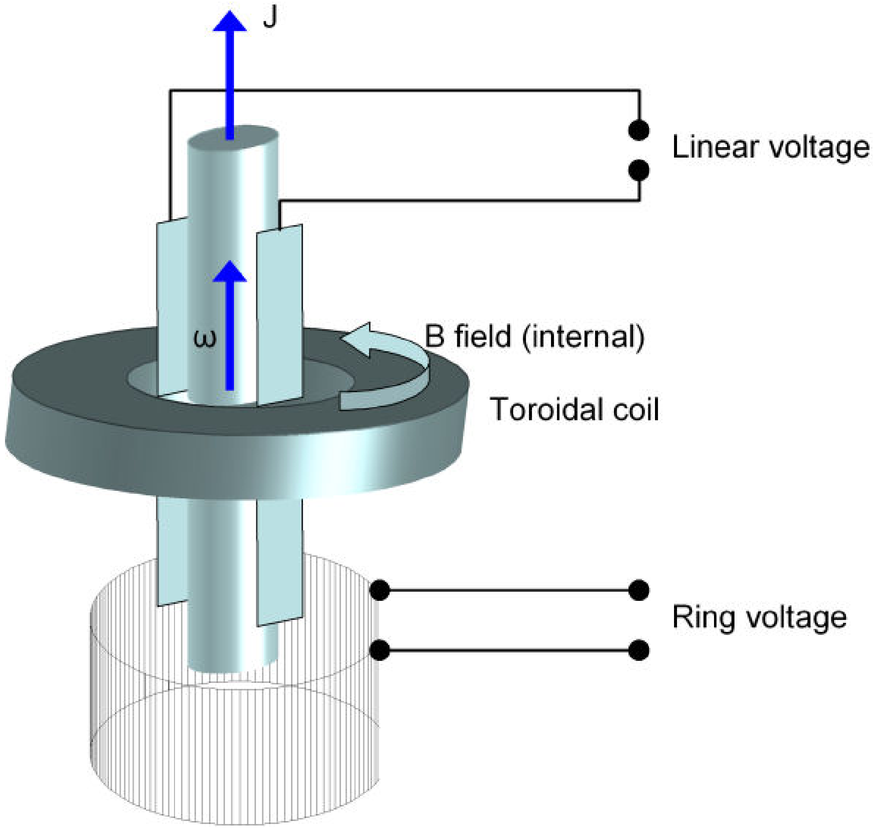

Figure 4: Realization proposition with toroidal coil, with several voltage collectors.

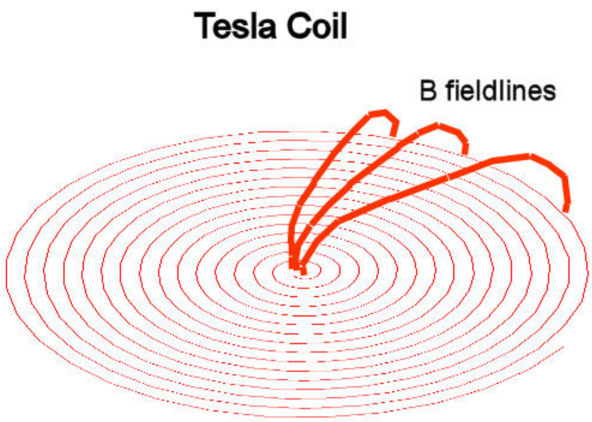

Figure 5: Tesla coil with magnetic field lines.

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