Orbital and spin electric and magnetic fields from ECE Theory

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Abstract

The concept of orbital and spin electric and magnetic fields is introduced through a development of the potential field of ECE theory in terms of electronic trajectory. The methods used are an extension of Paper 143 from dynamics to electrodynamics. The four main laws of electrodynamics are developed for the orbital fields and for the spin fields in terms of the electronic or ionic trajectory and the spin connection. In general the electronic trajectory is different for the orbital and spin fields for each of the four laws. The emergence of orbital and spin electric and magnetic fields is the direct consequence of general relativity developed into ECE unified field theory using standard differential geometry.

Keywords: ECE theory, orbital and spin electric and magnetic fields.

1. Introduction

The development of Einstein Cartan Evans (ECE) unified field theory [1-10] has been based on standard differential geometry [11] and has led to numerous new results in 143 source papers to date. Therefore ECE theory should be regarded as the most rigorous test of the philosophy of general relativity devised to date. A large part of ECE has been successfully tested experimentally (www.aias.us and www.atomicprecision.com) and all the main equations of physics have been derived from differential geometry. Many of the fundamental precepts and equations of the old twentieth century physics ("standard model") have been found to be defective or erroneous and in consequence ECE theory is the only rigorously correct physics available at present. The main field and wave equations of physics all emerge from the axioms of differential geometry, thus adhering rigorously to the fundamental philosophy of relativity, that physics be based on geometry.

In this paper, the 144th paper of this series, the methods used in Paper 143 to devise new types of fundamental dynamics are extended systematically to classical electrodynamics. The most fundamental prediction of ECE relativity is that there exist orbital and spin electric and magnetic fields. The four main field equations of classical electrodynamics apply to each type of field. In Section 2 the field equations are developed in terms of the electronic trajectory **r**. The trajectories of the electron for the orbital and spin fields are in general different for each field equation, namely for the Gauss law of magnetism, the Faraday law of induction, the Coulomb law and the Ampere Maxwell law. The spin fields are c times smaller in magnitude (S. I. units) than the orbital fields, so there exists a spin electric field which is c times smaller in magnitude than the orbital electric field strength **E** (in volts per metre). The units of the spin electric field strength are therefore tesla, the units of magnetic flux density **B**. The geometry shows that the spin electric field is defined in the same way exactly as the orbital magnetic flux density **B**. The geometry shows also that there exists a spin magnetic field whose units are those of tesla divided by c.

In Section 3 the four laws of classical electrodynamics are written out in terms of electronic trajectory **r** for both the orbital fields and the spin fields. The **E** and **B** defined conventionally in the textbooks {12} are the orbital types, but in conventional electrodynamics the spin connection is missing and the field is imposed on a Minkowski frame. In ECE electrodynamics there is always a spin connection present and the field is the frame itself.

2. Definition of potentials and fields

The fundamental structure of the theory is simple differential geometry, and the physics is based directly on the geometry, rigorously adhering to the philosophy of general relativity. In the minimal notation [1-10] of this series of papers the basic ECE hypothesis linking the field and potential is:

$$F = D \wedge A \tag{1}$$

where D ^ is the covariant exterior derivative of standard differential geometry. Here F is the electromagnetic field two-form and A is the electromagnetic potential one-form. Following the methods of Paper 143 of this series (www.aias.us) the electromagnetic potential A is developed as follows in terms of the electron trajectory r, a one-form of differential geometry directly proportional to the Cartan tetrad. The minimal prescription is used as follows:

$$p = m\boldsymbol{v} = eA \tag{2}$$

where m is the mass of the electron, $-e$ is the charge of the electron, and $\boldsymbol{v}$ is the velocity two-form defined as in Paper 143 by:

$$v = D \wedge r \quad . \tag{3}$$

Therefore A is expressed in terms of r as follows:

$$A = \frac{m}{e} D \wedge r \quad . \tag{4}$$

In this equation A is a two-form. The scalar valued elements of this two-form (a matrix) are used to define the space-like components of the potential one-form, which in index restored notation [1-10] is denoted A_μ^a. Here a is the index of the complex circular representation and μ the index of any other representation such as the Cartesian, spherical polar, cylindrical polar or any curvilinear. Finally the time-like component A_0^a is introduced, so the potential one-form is:

$$\boldsymbol{A}_\mu^a = (\boldsymbol{A}_0^a \, , -\boldsymbol{A}) \quad . \tag{5}$$

From Eq. (4) the space-like components of $\boldsymbol{A}_\mu^a$ are:

$$\boldsymbol{A}_{orbital}^a = -\frac{m}{e} \left(\frac{\partial \boldsymbol{r}^a}{\partial t} + c \, \nabla r_0^a + c \, \omega_{0b}^a \boldsymbol{r}^b - c \, r_0^b \, \boldsymbol{\omega}_b^a \right) \tag{6}$$

and

$$\boldsymbol{A}_{spin}^a = \frac{m}{e} \left(\nabla \times \boldsymbol{r}^a - \boldsymbol{\omega}_b^a \times \boldsymbol{r}^b \right) \quad . \tag{7}$$

Therefore there are two fundamental types of vector potential in ECE relativity, the orbital and the spin, the latter being c times smaller in magnitude.

The a and b indices in Eqs. (6, 7) may be removed as follows, thus simplifying the structure of the equations to a straightforward vector structure. The a index is removed by summing up over

$$a = (1), (2), (3) \tag{8}$$

so Eqs. (6) and (7) reduce to:

$$\boldsymbol{A}_{orbital}^a = -\frac{m}{e} \left(\frac{\partial \boldsymbol{r}}{\partial t} + c \, \nabla r_0 + c\omega_{0b} r - c \, r_0 \omega_b \right) \tag{9}$$

and

$$\frac{\boldsymbol{A}_{spin}}{c} = \frac{m}{e} \left(\nabla \times \boldsymbol{r} - \boldsymbol{\omega}_b \times \boldsymbol{r}^b \right) \quad . \tag{10}$$

The b index is removed as follows using:

$$c\omega_{0b}\boldsymbol{r}^b = c\omega_{0b} r \boldsymbol{q}^b = c\ \omega_0 \boldsymbol{r} \tag{11}$$

and

$$c\ r_0^b \boldsymbol{\omega}_b = c r_0 q^b \boldsymbol{\omega}_b = c r_0 \boldsymbol{\omega} \tag{12}$$

so the orbital and spin vector potentials become:

$$\boldsymbol{A}_{orbital} = -\frac{m}{e} \left(\frac{\partial \boldsymbol{r}}{\partial t} + c\ \nabla r_0 + c\ \omega_0 \boldsymbol{r} - c\ r_0\ \boldsymbol{\omega} \right) \tag{13}$$

and

$$\frac{\boldsymbol{A}_{spin}}{c} = \frac{m}{e} \left(\nabla \times \boldsymbol{r} - \boldsymbol{\omega} \times \boldsymbol{r} \right) \quad . \tag{14}$$

The orbital vector potential can be simplified further using the antisymmetry law of ECE theory [1-10]:

$$\boldsymbol{A}_{orbital} = -\frac{2\ m}{e} \left(\frac{\partial}{\partial t} + \omega_0 c \right) \boldsymbol{r} \tag{15}$$

so a simple expression for the orbital $\boldsymbol{A}$ is obtained.

Similarly the b indices may be removed as follows in the spin part of $\boldsymbol{A}$:

$$\boldsymbol{\omega}_b \times \boldsymbol{r}^b = r\ \boldsymbol{\omega}_b \times \boldsymbol{q}^b = \boldsymbol{\omega}_b \times (r\boldsymbol{q}^b) = \boldsymbol{\omega} \times \boldsymbol{r} \tag{16}$$

so the spin vector potential is:

$$\frac{\boldsymbol{A}_{spin}}{c} = \frac{m}{e} \left(\nabla \times \boldsymbol{r} - \boldsymbol{\omega} \times \boldsymbol{r} \right) \tag{17}$$

and is defined as being c times smaller in magnitude than the orbital vector potential. In conventional classical electrodynamics [12] the spin vector potential is not considered, and the spin connection in the orbital vector potential is missing.

3. Fields and field equations

From Eq. (1) it is possible to define the orbital and spin electric fields and the orbital and spin magnetic fields. The orbital electric field is:

$$\boldsymbol{E} = -\left(\frac{\partial}{\partial t} + \omega_0 c\right) \boldsymbol{A} - (\nabla - \boldsymbol{\omega})\ c\ A_0 \tag{18}$$

and by antisymmetry simplifies to:

$$\boldsymbol{E} = -2\left(\frac{\partial}{\partial t} + \omega_0 c\right) \boldsymbol{A}\ . \tag{19}$$

So the orbital electric field strength in ECE relativity is:

$$\boldsymbol{E} = \frac{4\,m}{e}\left(\frac{\partial}{\partial t} + \omega_0 c\right)\left(\frac{\partial}{\partial t} + \omega_0 c\right) \boldsymbol{r}\ . \tag{20}$$

The spin electric field is defined as c times smaller in magnitude as follows:

$$\boldsymbol{\epsilon} = \frac{\boldsymbol{E}_{spin}}{c} = -\frac{2}{c}\left(\frac{\partial}{\partial t} + \omega_0 c\right) \boldsymbol{A}_{spin}$$

(21)

and in terms of the spin vector potential:

$$\frac{\boldsymbol{A}_{spin}}{c} = \frac{m}{e}\left(\nabla \times \boldsymbol{r} - \boldsymbol{\omega} \times \boldsymbol{r}\right) \tag{22}$$

So the spin electric field strength is:

$$\boldsymbol{\epsilon} = \frac{2m}{e}\left(\frac{\partial}{\partial t} + \omega_0 c\right)\left(\boldsymbol{\omega} \times \boldsymbol{r} - \nabla \times \boldsymbol{r}\right)\ . \tag{23}$$

The orbital magnetic flux density is defined as:

$$\boldsymbol{B} = \nabla \times \boldsymbol{A}_{orb} - \boldsymbol{\omega} \times \boldsymbol{A}_{orb} \tag{24}$$

in terms of the orbital vector potential:

$$\boldsymbol{A}_{orb} = -\frac{2m}{e}\left(\frac{\partial}{\partial t} + \omega_0 c\right) \boldsymbol{r} \tag{25}$$

so the orbital magnetic flux density in tesla is:

$$\boldsymbol{B} = \frac{2m}{e}\left(\frac{\partial}{\partial t} + \omega_0 c\right)(\boldsymbol{\omega} \times \boldsymbol{r} - \nabla \times \boldsymbol{r}) \tag{26}$$

and is seen to have the same geometrical structure as the spin electric field strength (23). The two concepts are therefore interchangeable.

Finally the spin magnetic flux density is defined as c times smaller than the orbital magnetic flux density:

$$\beta = \frac{1}{c}\boldsymbol{B}_{spin} = \frac{1}{c}(\nabla \times \boldsymbol{A}_{spin} - \boldsymbol{\omega} \times \boldsymbol{A}_{spin}) \tag{27}$$

and in terms of the spin vector potential:

$$\frac{1}{c}\boldsymbol{A}_{spin} = \frac{m}{e}(\nabla \times \boldsymbol{r} - \boldsymbol{\omega} \times \boldsymbol{r}) \tag{28}$$

so the spin magnetic flux density is:

$$\beta = \frac{m}{e}(\nabla - \boldsymbol{\omega}) \times (\nabla \times \boldsymbol{r} - \boldsymbol{\omega} \times \boldsymbol{r}) \ . \tag{29}$$

If it is assumed that there is no magnetic four-current (no magnetic monopoles and no magnetic current) then the four field equations of classical electrodynamics in ECE relativity are the same, mathematically, as the Maxwell Heaviside field equations of conventional theory, but are philosophically field equations of general relativity, not special relativity. The four field equations are therefore:

$$\left.\begin{array}{ll} \nabla \cdot \boldsymbol{B} = 0 & \nabla \cdot \boldsymbol{\beta} = 0 \\ \nabla \times \boldsymbol{E} + \frac{\partial \boldsymbol{B}}{\partial t} = \boldsymbol{0} & \nabla \times \boldsymbol{\epsilon} + \frac{\partial \boldsymbol{\beta}}{\partial t} = \boldsymbol{0} \\ \nabla \cdot \boldsymbol{E} = \rho / \epsilon_0 & \nabla \cdot \boldsymbol{\epsilon} = \rho / (c\epsilon_0) \\ \nabla \times \boldsymbol{B} - \frac{1}{c^2}\frac{\partial \boldsymbol{E}}{\partial t} = \mu_0 \boldsymbol{J} & \nabla \times \boldsymbol{\beta} - \frac{1}{c^2}\frac{\partial}{\partial t}\boldsymbol{\epsilon} = \frac{\mu_0}{c}\boldsymbol{J} \end{array}\right\} \tag{30}$$

in the absence of polarization and magnetization. Here ρ is the charge density, $\boldsymbol{J}$ is the current density, and ϵ_0 and μ_0 are the vacuum permittivity and permeability. These are the Gauss law, the Faraday law of induction, the Coulomb law and the Ampere Maxwell law.

They are derived in ECE theory from geometry, the Cartan identity:

$$D \wedge T := R \wedge q \tag{31}$$

and the Evans identity

$$D \wedge \tilde{T} := \tilde{R} \wedge q \ . \tag{32}$$

Here T is the Cartan torsion, R is the Cartan curvature, and the tilde denotes Hodge duality.
It follows that there are four laws for the orbital fields, and four laws for the spin fields. In summary, the orbital and spin fields are as follows:

$$\left.\begin{aligned}
\boldsymbol{E} &= \frac{4\,m}{e}\left(\frac{\partial}{\partial t} + \omega_0 c\right)\left(\frac{\partial}{\partial t} + \omega_0 c\right)\boldsymbol{r} \;=\; -\,2\,(\nabla - \boldsymbol{\omega})\, \mathrm{c}\, A_0 \\
\boldsymbol{B} &= \frac{2m}{e}\left(\frac{\partial}{\partial t} + \omega_0 c\right)(\boldsymbol{\omega} \times \boldsymbol{r} - \nabla \times \boldsymbol{r}) \\
\epsilon &= \frac{2m}{e}\left(\frac{\partial}{\partial t} + \omega_0 c\right)(\boldsymbol{\omega} \times \boldsymbol{r} - \nabla \times \boldsymbol{r}) \\
\beta &= \frac{m}{e}(\nabla - \boldsymbol{\omega}) \times (\nabla \times \boldsymbol{r} - \boldsymbol{\omega} \times \boldsymbol{r})
\end{aligned}\right\} \quad (33)$$

in terms of the electron trajectory $\boldsymbol{r}$ and spin connection:

$$\omega^{\mu} = (\,\omega_0\,,\,\boldsymbol{\omega}\,)\;. \quad (34)$$

Using computer algebra, it is a straightforward matter to derive the eight laws of classical electrodynamics from the above equations. Some examples are worked out by hand and given as follows.

The Faraday law of induction of the orbital fields is:

$$\left(\frac{\partial}{\partial t} + \omega_0 c\right)\left(\frac{\partial}{\partial t}(\nabla \times \boldsymbol{r} + \boldsymbol{\omega} \times \boldsymbol{r}) + 2\,\omega_0 c\,\boldsymbol{\omega} \times \boldsymbol{r}\right) = \boldsymbol{0} \quad (35)$$

and for the spin fields is:

$$\left(\frac{\partial}{\partial t}(\nabla + \boldsymbol{\omega}) \times + 2\,\omega_0 c\right)(\nabla \times \boldsymbol{r} - \boldsymbol{\omega} \times \boldsymbol{r}) = \boldsymbol{0}\;. \quad (36)$$

The Ampere Maxwell law for the orbital fields is:

$$\left(\frac{\partial}{\partial t} + \omega_0 c\right)\left(\nabla \times (\boldsymbol{\omega} \times \boldsymbol{r} - \nabla \times \boldsymbol{r}) - \frac{2}{c^2}\frac{\partial}{\partial t}\left(\frac{\partial}{\partial t} + \omega_0 c\right)\boldsymbol{r}\right) = \frac{e\mu_0}{2m}\mathrm{J} \quad (37)$$

and for the spin fields is:

$$\left(\nabla \times (\nabla - \boldsymbol{\omega}) + \frac{2}{c^2}\frac{\partial}{\partial t}\left(\frac{\partial}{\partial t} + \omega_0 c\right)\right)(\nabla \times \boldsymbol{r} - \boldsymbol{\omega} \times \boldsymbol{r}) \;=\; \frac{e\mu_0}{2mc}\mathrm{J} \quad (38)$$

The Coulomb law for the orbital electric field is:

$$\nabla \cdot \boldsymbol{E} = \rho / \epsilon_0 \quad (39)$$

where

$$\boldsymbol{E} = \frac{4\,m}{e}\left(\frac{\partial}{\partial t} + \omega_0 c\right)\left(\frac{\partial}{\partial t} + \omega_0 c\right)\boldsymbol{r} \quad (40)$$

and the Coulomb law for the spin electric field is:

$$\nabla \cdot \boldsymbol{\epsilon} = \rho / (c\epsilon_0) \quad (41)$$

with:

$$\boldsymbol{\epsilon} = \frac{2m}{e}\left(\frac{\partial}{\partial t} + \omega_0 c\right)(\boldsymbol{\omega} \times \boldsymbol{r} - \nabla \times \boldsymbol{r}) \;. \quad (42)$$

4. Discussion

The orbital laws given here are the conventional laws of classical electrodynamics written out in terms of the electron trajectory. The spin laws are new to physics and it may be that the spin laws pertain to phenomena in electrodynamics such as cold current and cold electricity which are well observed [2] but not well understood. It is beyond doubt that the conventional classical electrodynamics cannot describe all the phenomena of electricity and magnetism, or of electrodynamics. The spin fields are c times smaller in magnitude than the orbital fields, so may easily have been overlooked in conventional experimentation.

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