The intrinsic structure of fields, Part II

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Abstract

This paper is a continuation of the UFT Paper 447, in which the question of what physical fields comprise was addressed. The answer was found at the microscopic level, which considers spacetime itself. In that paper, static electric fields were shown to consist of aether currents, internally. Gravitational fields were shown to be electromagnetic return currents that must balance the aether currents emitted by matter. Both are electromagnetic in nature.

In this paper, we extend the investigation to magnetic fields, which possess an internal rotational structure, as shown by ECE theory. This causes magnetic field lines to run helically rather than rectilinearly.

We show that the two types of currents in the field equations (electric current densities and potential current densities) are subject to two different continuity equations. The one for the electric current density satisfies charge and energy conservation within the framework of classical electrodynamics. The continuity equation for the potential current, however, is a pure flux equation. The flowing potentials (in units of volt-seconds) are supplied by the "aether", and are not a conserved quantity when considering matter alone. Thus, extended electrodynamics describes the interaction with the spacetime background. This is a completely new and unexpected finding.

Keywords: Unified field theory; electromagnetism; magnetic field; continuity equation; aether structures.

1 Introduction

In classical physics, forces are described by fields that "interact at a distance". The effects of electromagnetic and gravitational forces are described by field equations, but what these fields intrinsically comprise remains an open question. Many speculations exist on this subject, and most of them require a deep-level understanding of quantum mechanics. In contrast, ECE theory [1–5] gave an answer to this question, in UFT Paper 447 [6], that did not require leaving the classical level. The key point was that, in the ECE approach, the vacuum

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or "aether" structure is equivalent to the curvature and torsion of spacetime itself. It turned out that the electric field is intrinsically a linear flow of aether particles. Since each gravitating body consists of charges, there are electric fields that send out aether particles. For continuity reasons, these losses have to be refilled from outside, and this flow is what we experience as gravitation.

The question left open in Paper 447 was the intrinsic structure of the magnetic induction field **B**. That question is answered in this paper, using the same method as before. When we consider the definition of the **B** field in terms of potentials, we see that the spin connection provides a rotational structure, unlike in the electrical case. Therefore, the field lines will not be rectilinear as in the electrical case, but will show a helical structure.

We will find that both the electric and magnetic fields are flux structures of the aether, and that this structure will also be relevant to both types of currents (electric and potential current densities), because currents and fields are coupled by the ECE field equations. To see the differences between the currents, we will derive the continuity equations for both and compare them. We will see that there is a fundamental difference in the flux behavior of these currents.

2 Structure of electric and magnetic fields

2.1 Electric field

We start with a brief review of how the intrinsic structure of the electric field was derived in Paper 447 [6]. The electric field of ECE theory is defined as

$$\mathbf{E} = -\boldsymbol{\nabla}\phi - \frac{\partial \mathbf{A}}{\partial t} - c\omega_{0e}\mathbf{A} + \boldsymbol{\omega}_e\phi, \tag{1}$$

with scalar potential ϕ, vector potential $\mathbf{A}$, scalar spin connection ω_{0e} and vector spin connection $\boldsymbol{\omega}_e$. In the ECE interpretation, $\mathbf{A}$ is proportional to an aether flow velocity. The spin connections are missing in classical electrodynamics theory, which is based only on special relativity.

The field constituents underlie the antisymmetry condition

$$-\frac{\partial \mathbf{A}}{\partial t} + \boldsymbol{\nabla}\phi - c\omega_{0e}\mathbf{A} - \boldsymbol{\omega}_e\phi = \mathbf{0}, \tag{2}$$

which allows one of the variables to be elimianted. We write the antisymmetry condition in the form

$$-\boldsymbol{\nabla}\phi = -\frac{\partial \mathbf{A}}{\partial t} - c\omega_{0e}\mathbf{A} - \boldsymbol{\omega}_e\phi \tag{3}$$

and insert this into Eq. (1), which then gives us

$$\mathbf{E} = -2\frac{\partial \mathbf{A}}{\partial t} - 2c\omega_{0e}\mathbf{A}. \tag{4}$$

Note that the term $\boldsymbol{\omega}_e\phi$ has canceled out. When restricted to the static case, this equation simplifies further to

$$\mathbf{E} = -2c\omega_{0e}\mathbf{A}. \tag{5}$$

We see that the electric field is essentially an aether flow in the $\mathbf{A}$ direction, multiplied by the scalar spin connection. This spin connection has units of inverse meters, and when it is multiplied by the vacuum speed of light c, it becomes a time frequency:

$$\omega_{0t} = c\ \omega_{0e}. \tag{6}$$

We can then write

$$\mathbf{E} = -2\omega_{0t}\mathbf{A}, \tag{7}$$

which shows that $\mathbf{E}$ has an intrinsic structure that is connected with time, even though we considered only the static case. When the vector potential is time-dependent, the term $-2\frac{\partial \mathbf{A}}{\partial t}$ has to be added, according to Eq. (4).

A result corresponding to Eq. (7) was derived for the gravitational field $\mathbf{g}$:

$$\mathbf{g} = -2c\omega_{0g}\mathbf{Q}, \tag{8}$$

(Eq. (11) in [6]), where ω_{0g} is the gravitational spin connection. $\mathbf{Q}$ is the gravitational vector potential, and it corresponds to the electrical one. In [6], it was shown that gravitation is a backflow process to electromagnetic matter, and that it is also electromagnetic in nature. In other words, these are aether currents.

2.2 Magnetic field

In [6], we restricted our investigation to the electric field and did not explore the internal structure of the magnetic field (more precisely: the magnetic induction field or flux density), because this is a bit more complicated, but we will do so now. According to Eq. (4.212) of [5], the magnetic field is written as

$$\mathbf{B} = \boldsymbol{\nabla} \times \mathbf{A} - \boldsymbol{\omega} \times \mathbf{A}, \tag{9}$$

where $\boldsymbol{\omega}$ is the electromagnetic vector spin connection. In principle, this spin connection is a rotation axis of spacetime. According to the ECE axioms, the vector potential is the vector consisting of the space components of the tetrad, times a scale factor. For magnetism, the vector potential has a rotational structure. Therefore, we can identify $\boldsymbol{\omega}$ with the rotation axis of the vector potential, as depicted in Fig. 1. All vectors related to $\mathbf{A}$ are in a plane perpendicular to $\boldsymbol{\omega}$ (blue plane).

The second term of the $\mathbf{B}$ field in Eq. (9) is the cross product of $\boldsymbol{\omega}$ and $\mathbf{A}$, and is a vector perpendicular to both. As can be seen from Fig. 1, it is in the plane of the $\mathbf{A}$ field. Therefore, it describes a deviation from the curl of $\mathbf{A}$ (see Fig. 2).

So far, the description of the $\mathbf{B}$ field has been given only for one point of space. The vector spin connection describes a rotation in space and, therefore, the rotation angle will vary from point to point. This is graphed in Fig. 3. The displacement from the perpendicular curve $\boldsymbol{\nabla} \times \mathbf{A}$ rotates around this axis. This leads to a rotating $\mathbf{B}$ field flux in space; the field lines represent a helical curve. In Fig. 3, only one field line is shown. We have to imagine that many of them exist, like many straight field lines exist around an electric pole.

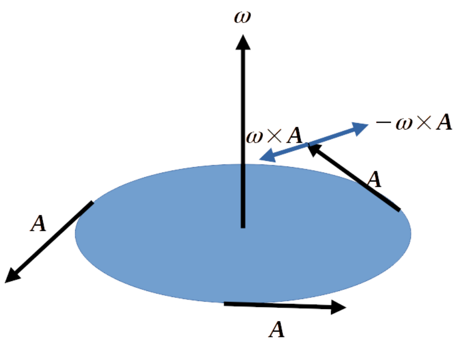

Figure 1: Structures of a rotational vector potential.

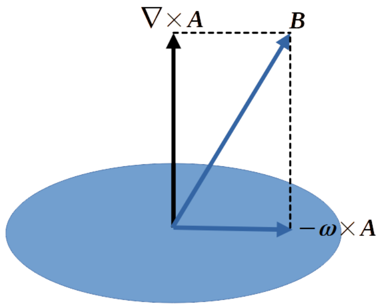

Figure 2: ECE components of the magnetic induction field **B**.

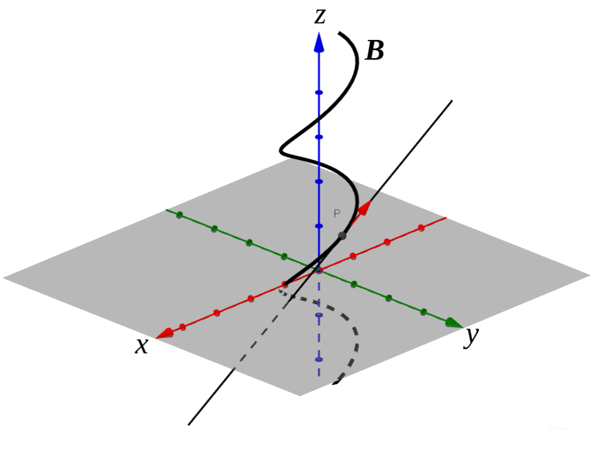

Figure 3: Helical structure of the magnetic field lines (image source: [8]).

3 Flow properties of fields

When considered on a microscopic scale, the electric field represent an aether flux, as described in Section 2.1. The magnetic field has an internal rotational structure and is described by a helical aether flow, in contrast to the electric field, where the aether flux is linear. From a macroscopic perspective, both fields have flux sources. For the conventional current density **J**, electrically charged particles, e.g., electrons, are known to be sources of the fields. The conventional current density has the units of $A/m^2 = As/(m^2 s)$. As discussed in UFT Paper 456 [7], all quantities containing the Ampère as a unit have to be considered as magnetic quantities for consistency reasons. Consequently, **J** is a magnetic current rather than an electric one. In contrast, the potential density **V** has units of $V/m^2 = Vs/(m^2 s)$, which contains the electric flux element Vs. This changes **V** to an electric quantity. The flux sources are "flowing potentials", in contrast to charged particles in the case of **J**. For both types of currents, flux continuity has to be guaranteed. To find the difference between their characteristics, we will consider their continuity equations.

The physical principle that charges and current densities are conserved has been derived with ECE theory for a spacetime with curvature and torsion (see Section 5.3.2 of [5]). The approach was to apply an additional derivative to the second field equation in tensor form, which contains the Ampère-Maxwell law. The result is the well-known continuity equation for the charge and current densities. The same can be done with the first field equation, which contains the Faraday law. This will give us the continuity equation for the potential density and current, which is not known in standard electrodynamics. Instead of deriving this law using tensor calculus, we will use vector calculus. Using the field equations in vector form will give the same results and they will have equal validity. Before doing this for the potential density and current, we will repeat the earlier derivation from [5] for the standard electric case, but in vector form, so that the reader can compare all steps and see the differences between the continuity equations of both types of currents.

3.1 Continuity equation for the electric current J

We start with the Ampère-Maxwell law:

$$\boldsymbol{\nabla} \times \mathbf{B} - \frac{1}{c^2}\frac{\partial \mathbf{E}}{\partial t} = \mu_0 \mathbf{J}, \tag{10}$$

and rewrite it, dividing by the constant μ_0:

$$\boldsymbol{\nabla} \times \mathbf{H} - \frac{\partial \mathbf{D}}{\partial t} = \mathbf{J}. \tag{11}$$

Then, we take the divergence of this form of the Ampère-Maxwell law, which gives us

$$\boldsymbol{\nabla} \cdot (\boldsymbol{\nabla} \times \mathbf{H}) - \boldsymbol{\nabla} \cdot \frac{\partial \mathbf{D}}{\partial t} = \boldsymbol{\nabla} \cdot \mathbf{J}. \tag{12}$$

Because the divergence of a curl is zero, the equation simplifies to

$$-\frac{\partial}{\partial t}(\boldsymbol{\nabla} \cdot \mathbf{D}) = \boldsymbol{\nabla} \cdot \mathbf{J}. \tag{13}$$

Using the Coulomb law,

$$\nabla \cdot \mathbf{D} = \rho_e, \tag{14}$$

where ρ_e is the (time-dependent) charge density in the system, it follows that

$$\frac{\partial \rho_e}{\partial t} + \nabla \cdot \mathbf{J} = 0. \tag{15}$$

This is the well-known continuity equation of electrodynamics, which states that a change in charge density leads to a divergence of the current density, so that the total charge is conserved.

3.2 Continuity equation for the potential current V

Now we will do the same with the symmetrized Faraday law,

$$\nabla \times \mathbf{E} + \frac{\partial \mathbf{B}}{\partial t} = \mathbf{V}, \tag{16}$$

where $\mathbf{V}$ is the potential current density per area. Applying the divergence to the Faraday law gives us

$$\nabla \cdot (\nabla \times \mathbf{E}) + \nabla \cdot \frac{\partial \mathbf{B}}{\partial t} = \nabla \cdot \mathbf{V}. \tag{17}$$

Again, because div curl = 0, we obtain

$$\frac{\partial}{\partial t} (\nabla \cdot \mathbf{B}) = \nabla \cdot \mathbf{V}. \tag{18}$$

Next, we apply the Gauss law of extended electrodynamics,

$$\nabla \cdot \mathbf{B} = \rho_p, \tag{19}$$

where ρ_p is the volume density of electric "flow units" in $V s$, as explained in section 2.2 of UFT Paper 456 [7]. It then follows that

$$\frac{\partial \rho_p}{\partial t} - \nabla \cdot \mathbf{V} = 0. \tag{20}$$

This is the continuity equation for the potential density and current, which is dual to Eq. (15) from the of conventional current case. Please notice that the signs of the divergence terms differ between the cases. This difference is of fundamental importance and will be explained in the next section.

3.3 Interpretation

To understand the difference between the continuity equations (15) and (20), we first have to know that a positive divergence of a vector field means that there is a production of flux elements. We start with the current density $\mathbf{J}$. Assuming a reservoir of flux elements (see Fig. 4), this means that there is an outflow of flux elements from the reservoir. According to Eq. (15), the level of the reservoir has to decrease so that the continuity equation is satisfied:

$$\nabla \cdot \mathbf{J} > 0, \tag{21}$$

$$\frac{\partial \rho_e}{\partial t} < 0. \tag{22}$$

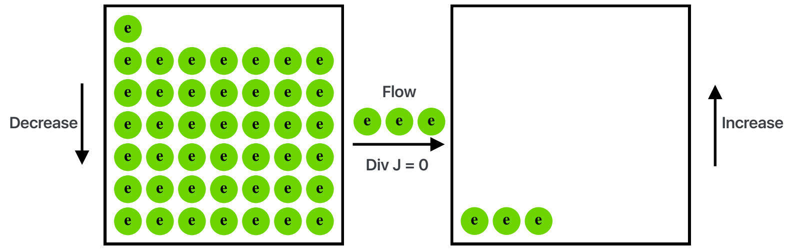

Figure 4: Flow structure of the electric current density.

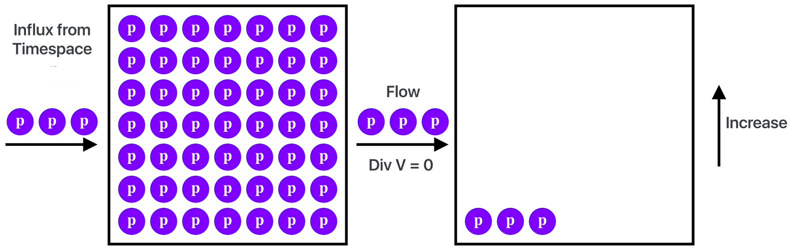

Figure 5: Flow structure of the potential current density.

During this process, the number of flux elements is conserved, which means that no such elements are added or removed except those that flow from the reservoir.

The situation is quite different for Eq. (20) where, for a positive production rate, we have:

$$\boldsymbol{\nabla} \cdot \mathbf{V} > 0, \tag{23}$$

$$\frac{\partial \rho_p}{\partial t} > 0. \tag{24}$$

The reservoir does not run empty, but is refilled from "elsewhere", because the content ρ_p increases when flux elements leave the reservoir (see Fig. 5). Physically, this means that the source of the flux elements that have untis of Vs cannot run empty. The only possible resolution is that these flux elements are being provided by the surrounding vacuum or spacetime. We know from ECE theory (and even from quantum mechanics) that the vacuum is not empty. Thus, the source of the **V** current is spacetime itself.

4 Discussion and conclusions

The continuity equation for **V** shows us that, for extended electrodynamics, there is a direct connection to spacetime. Systems using the **V** current appear like perpetua mobilia from the perspective of standard electrodynamics, but actually they connect to the surrounding vacuum. This is a fundamental insight into the nature of such systems. To gain this insight, it was not even necessary to use general relativity: the symmetrized Maxwell equations were sufficient. These equations can be derived from special relativity, as has been done using

Clifford algebra [9], for example. Nevertheless, the fact that the symmetrized Maxwell equations are derived from ECE theory shows that the results are valid even in the context of general relativity.

Examples of the currents **J** and **V** are the conductance of electronic currents in metallic conductors and the transmission of light in fiber optics. Electronic currents of higher frequencies tend to flow on the surface (skin effect). They produce ohmic losses in the conductor and radiate them as heat. This effect transfers energy from the inner to the outer region of the conductor and is governed by conventional thermodynamics. In contrast, optical waves in fibers transfer energy to the center of the fiber, which is a concentrative mechanism. This mechanism is also present around conventional conductors. The electrical conductivity is practically zero outside of the conductor, but the conductivity for the **V** current is quite high in this region. This leads to the Heaviside flow of energy, which has already been described in UFT Paper 456 [7]. This flow is not subject to the laws of conventional thermodynamics.

We conclude that extended (i.e., symmetrized) electrodynamics describes the interaction with the spacetime background. This new result is more significant than we had anticipated. The fundamental cause is expressed through the duality of the field equations. This duality leads to the sign difference between the time derivatives in the Ampère-Maxwell and Faraday laws, Eqs. (10) and (16). A tiny sign change can have fundamental effects!

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