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# On the Origin of Magnetization and Polarization

## Standard Model

In the standard model magnetization and polarization are incorporated into the inhomogeneous Maxwell Heaviside field equations (IMH):

$$\underline{\nabla} \cdot \underline{D} = \rho \quad -(1)$$

$$\underline{\nabla} \times \underline{H} = \frac{\partial \underline{D}}{\partial t} + \underline{J} \quad -(2)$$

Electromagnetic radiation in free space is described by the homogeneous Maxwell Heaviside field equations:

$$\underline{\nabla} \cdot \underline{B} = 0 \quad -(3)$$

$$\underline{\nabla} \times \underline{E} + \frac{\partial \underline{B}}{\partial t} = \underline{0} \,. \quad -(4)$$

Here:

$$\underline{D} = \epsilon_0 \underline{E} + \underline{P} \quad -(5)$$

$$\underline{H} = \frac{1}{\mu_0} \underline{B} - \underline{M} \,. \quad -(6)$$

Here:

$\underline{B}$ = magnetic flux density (tesla)

$\underline{E}$ = electric field strength $(V m^{-1})$

$\underline{D}$ = electric displacement $(C m^{-2})$

$\underline{H}$ = magnetic field strength $(A m^{-1})$

$\underline{P}$ = polarization $(C m^{-2})$

$\underline{M}$ = magnetization $(A m^{-1})$

$\epsilon_0$ = $8.854188 \times 10^{-12} \; J^{-1} C^2 m^{-1}$

$\mu_0$ = $4\pi \times 10^{-7} \; J s^2 C^{-2} m^{-1}$.

This is the classical description of electrodynamics.

This description is Lorentz covariant only, <u>and</u> <u>is not</u> <u>a theory</u> of <u>general</u> relativity. It is not therefore unified with the theory of gravitation. In eqn. (1)

$$\rho = \text{charge density } (C\,m^{-3})$$

$$\underline{J} = \text{current density } (A\,m^{-2})$$

Eqn (1) is the Coulomb Law; eqn (2) is the Ampère Maxwell Law; Eqn. (3) is the Gauss Law applied to magnetism; Eqn. (4) is the Faraday Law of induction.

In differential form notation eqns (3) and (4) can be combined into:

$$d \wedge F = 0 \quad -(7)$$

where:

$$F = d \wedge A. \quad -(8)$$

In eqn (7) $F$ is the electromagnetic field two-form and in eqn (8) $A$ is the electromagnetic potential two-form. In the absence of polarization and magnetization eqns (3) and (4) can be combined into:

$$d \wedge \tilde{F} = \mu_0 J \quad -(9)$$

where $\tilde{F}$ is the Hodge dual of $F$ and where $J$ is the charge current density three-form. In the presence of polarization and magnetization eqn. (9)

can be written as:

$$d \wedge \tilde{G} = J \qquad (10)$$

where $G$ is the field two-form written in terms of electric displacement and magnetic field strength instead of electric field strength and magnetic flux density.

In the standard model $\underline{P}$ and $\underline{M}$ are introduced empirically through the constitutive equations (5) and (6).

<u>Evans Field Theory</u>

This is a correctly covariant theory of general relativity and so is an objective theory of physics as required by the principle of general relativity. The correctly covariant eqn. (8) is:

$$\begin{aligned} F^a &= D \wedge A^a \\ &= d \wedge A^a + \omega^a{}_b \wedge A^b \end{aligned} \qquad (11)$$

and the correctly covariant eqn. (7) is:

$$\begin{aligned} d \wedge F^a &= -A^{(0)} \left( q^b \wedge R^a{}_b + \omega^a{}_b \wedge T^b \right) \\ &= \mu_0 j^a \\ &\sim 0 \end{aligned} \qquad (12)$$

where

$$A^a = A^{(0)} q^a \qquad (13)$$

$$F^a = A^{(0)} T^a . \qquad (14)$$

Here $\omega^a{}_b$ is the spin connection of the Palatini variation of general relativity, $q^a$ is the tetrad field, the fundamental field of general relativity in the Palatini variation; $R^a{}_b$ is the Riemann form and $T^a$ is the torsion form. Eqs (13) and (14) describe the Evans Ansatz where:

$$\phi^{(0)} = c A^{(0)} \quad -(15)$$

is a primordial, universal, influence with the units of volts. Eq. (12) is the homogeneous Evans field equation (HE) and $j^a$ is the homogeneous current. Under laboratory conditions this is zero within contemporary instrumental precision. Using eqs. (13) and (14):

$$T^a = D \wedge q^a \quad -(16)$$

$$d \wedge T^a = -\left(q^b \wedge R^a{}_b + \omega^a{}_b \wedge T^b\right). \quad -(17)$$

Eq. (17) can also be written as:

$$D \wedge T^a = R^a{}_b \wedge q^b. \quad -(17a)$$

Eq. (16) is the first Maurer Cartan structure equation and eq. (17) is the first Bianchi identity of standard differential geometry.

In the Evans field theory a laser beam, for example, is described by eqs. (11) and (12):

5)

$$\boxed{\begin{aligned} F^a &= d \wedge A^a + \omega^a{}_b \wedge A^b \\ d \wedge F^a &= 0 \end{aligned}}$$

— (18)

— (19)

The first term in eq. (18) describes the visible part of the beam, and the second term in eq. (18) describes spacetime swirling around the beam. This is the spacetime magnetization:

$$\boxed{M^a = \frac{1}{\mu_0} \omega^a{}_b \wedge A^b} \quad -(20)$$

Therefore:

1) Visible light is defined by $d \wedge A^a$, i.e. by spatial and temporal derivatives of the potential field $A^a$.

2) The spacetime magnetization $M^a$ is invisible but gives rise to the Aharonov Bohm effects. (AB)

The laser beam can be thought of as a stirring rod, and this causes a whirlpool of spacetime around the beam. The AB effects occur in regions where:

$$d \wedge A^a = 0, \quad -(21)$$

but where:

$$M^a \neq 0 \quad -(22)$$

6) Similarly, in the Chambers experiment, the magnetic field is defined by eqn (18) and the well known Chambers effect is due to the $M^a$ set up by the magnetic field in regions where eqn. (21) applies.

3) It is seen that the origin of magnetization (and polarization) is differential geometry, the existence of spinning or swirling spacetime.

We may define:

$$M^a = \frac{1}{\mu_0} B^a \quad \text{— (23)}$$

where $B^a$ is the Evans spin field:

$$B^a = \omega^a{}_b \wedge A^b \quad \text{— (24)}$$

observed in the inverse Faraday effect.

Evidently both $M^a$ and $B^a$ are missing entirely from the standard model, yet both $M^a$ and $B^a$ are experimental observables. This is a clear demonstration that the standard model is not correctly objective.

Field-Matter Interaction

When there is field-matter interaction

$$\boxed{\begin{aligned} \omega^a{}_b &\rightarrow \Omega^a{}_b \\ F^a &\rightarrow G^a \end{aligned}} \quad \text{— (25)}$$

so eqn. (18) becomes:

$$G^a = d \wedge A^a + \Omega^a{}_b \wedge A^b \quad -(26)$$

and $\Omega^a{}_b$ is the origin of the magnetization and polarization of matter by an electromagnetic field.

The inhomogeneous Evans field equation (IE) is then:

$$\boxed{d \wedge \tilde{G}^a = \cancel{\mu_0}\, J^a} \quad -(27)$$

where:

$$J^a = -\frac{A^{(0)}}{\mu_0}\left(q^b \wedge \tilde{R}^a{}_b + \Omega^a{}_b \wedge \tilde{T}^b\right) \quad -(28)$$

Eq. (27) is the correctly covariant form of eq. (10).

A concise and logical description of the origin of magnetization and polarization is therefore given in differential geometry.