311(3): New Interpretation of ECE2 Theory

Consider the definition of the electric field strength $\mathbf{E}$ (volts per metre) and the magnetic flux density $\mathbf{B}$ (tesla) in ECE2 theory:

$$\mathbf{E} = -\nabla\phi + \boldsymbol{\omega}\phi = -\frac{\partial \mathbf{A}}{\partial t} - \omega_0 \mathbf{A} \quad -(1)$$

$$\mathbf{B} = \nabla \times \mathbf{A} - \boldsymbol{\omega} \times \mathbf{A} \quad -(2)$$

Eqs. (1) and (2) are interpreted as follows:

$$\mathbf{E} := \mathbf{E}(\text{observed}) = \mathbf{E}(\text{material}) + \mathbf{E}(\text{interaction with vacuum}) \quad -(3)$$

$$\mathbf{B} := \mathbf{B}(\text{observed}) = \mathbf{B}(\text{material}) + \mathbf{B}(\text{interaction with vacuum}) \quad -(3a)$$

Here:

$$\mathbf{E}(\text{material}) = -\nabla\phi \quad -(4)$$

$$\mathbf{E}(\text{interaction with vacuum}) = \boldsymbol{\omega}\phi \quad -(5)$$

$$\mathbf{B}(\text{material}) = \nabla \times \mathbf{A} \quad -(6)$$

$$\mathbf{B}(\text{interaction with vacuum}) = -\boldsymbol{\omega} \times \mathbf{A} = \mathbf{A} \times \boldsymbol{\omega} \quad -(7)$$

The spin connection four vector:

$$\omega^\mu = \left(\frac{\omega_0}{c}, \boldsymbol{\omega}\right) \quad -(8)$$

maps the structure of the vacuum and defines the $\mathbf{E}$ and $\mathbf{B}$ fields produced by the interaction with the vacuum

The following is a procedure for computation.
Using the electrostatic equations of ECE2 theory:

$$\underline{\nabla} \times \underline{E} = \underline{0} \quad -(9)$$

$$\underline{\nabla} \cdot \underline{E} = \rho / \epsilon_0 \quad -(10)$$

$$\partial \underline{E} / \partial t = \underline{0} \quad -(11)$$

it is found that

$$\underline{\nabla} \times (\omega_0 \underline{A}) = \underline{0} \quad -(12)$$

$$\underline{\nabla} \cdot (\omega_0 \underline{A}) = -\frac{\rho}{\epsilon_0} \quad -(13)$$

These are solved using FEM methods on a computer to give ω_0 and $\underline{A}$. This is a boundary value problem.

Having determined $\underline{A}$ for electrostatics, the spin connection vector $\underline{\omega}$ for electrostatics is found from the antisymmetry equations:

$$\frac{\partial A_Z}{\partial Y} + \frac{\partial A_Y}{\partial Z} = \omega_Y A_Z + \omega_Z A_Y \quad -(14)$$

$$\frac{\partial A_X}{\partial Z} + \frac{\partial A_Z}{\partial X} = \omega_Z A_X + \omega_X A_Z \quad -(15)$$

$$\frac{\partial A_Y}{\partial X} + \frac{\partial A_X}{\partial Y} = \omega_X A_Y + \omega_Y A_X \quad -(16)$$

using the $\underline{A}$ vector found from eqs. (12) and (13).
The scalar potential ϕ is found from:

$$\phi(\underline{x}) = \frac{1}{4\pi\epsilon_0} \int \frac{\rho(\underline{x}')}{|\underline{x} - \underline{x}'|} d^3x' \quad -(17)$$

) in which ρ is found from:

$$\underline{\nabla} \cdot \underline{E} = \underline{\nabla} \cdot (\omega_0 \underline{A}) = -\frac{\rho}{\epsilon_0} \quad -(18)$$

Finally the electric field strength in volts per metre due to the vacuum is calculated from:

$$\underline{E}\,(\text{vac}) = \underline{\omega}\,\phi \quad -(19)$$

The material electric field strength is:

$$\underline{E}\,(\text{material}) = -\underline{\nabla}\,\phi. \quad -(20)$$

The secondary magnetic flux density $\underline{B}$ associated with the electric field strength of ECE2 electrostatics is:

$$\underline{B} = \underline{\nabla} \times \underline{A} - \underline{\omega} \times \underline{A} \quad -(21)$$

where $\underline{A}$ is the electrostatic vector potential computed from eqs. (9) and (10).

ECE2 magnetostatics is defined by:

$$\underline{\nabla} \cdot \underline{B} = 0 \quad -(22)$$

$$\underline{\nabla} \times \underline{B} = \mu_0 \underline{J} \quad -(23)$$

$$\frac{\partial \underline{B}}{\partial t} = \underline{0} \quad -(24)$$

$$\underline{A}\,(\underline{x}) = \frac{1}{4\pi\epsilon_0} \int \frac{\underline{J}\,(\underline{x}')}{|\underline{x} - \underline{x}'|}\, d^3x' \quad -(25)$$

and

$$\underline{B} = \underline{\nabla} \times \underline{A} - \underline{\omega} \times \underline{A} \quad -(26)$$

where the $\underline{A}$ of magnetostatics is defined by eq. (25).

Using computational methods, $\underline{A}$ can be calculated for any current density $\underline{J}'$ of the material or circuit using eq. (25). Having calculated $\underline{A}$ the spin connection vector of magnetostatics is found from eqs. (14) to (16). The material magnetic flux density is:

$$\underline{B} = \underline{\nabla} \times \underline{A} \quad - (26)$$

and the magnetic flux density due to interaction with the vacuum is:

$$\underline{B}\,(\text{vacuum}) = -\underline{\omega} \times \underline{A} \quad - (27)$$

Finally the secondary electric field strength of ECE2 magnetostatics is:

$$\underline{E} = -\omega_0 \underline{A} \quad - (28)$$

where $\underline{A}$ is the magnetic vector potential calculated from eq. (25). The scalar spin connection ω_0 is the same for electrostatics and magnetostatics and is calculated from eqs. (12) and (13).

It has been shown that ECE2 electrostatics and magnetostatics are rigorously consistent with the ECE2 antisymmetry laws. The structure of the vacuum can be mapped with eq. (8) and the vacuum four current density is:

$$J^\mu(\text{interaction with vacuum}) = \frac{1}{\mu_0}\left(\frac{1}{c}\underline{\nabla}\cdot(\underline{\omega}\phi), -\underline{\nabla}\times(\underline{\omega}\times\underline{A})\right) \quad - (29)$$

The minus sign comes from the definition (7).