(5): Exact Method of Computation from Observation of $\underline{E}$ and $\underline{B}$ in a Circuit.

This method is based on the experimental observation of the electric field strength $\underline{E}$ in volts per metre and the magnetic flux density $\underline{B}$ in tesla in a circuit. On the one electron level and $\underline{B}$ in a circuit. The electric field strength $\underline{E}$ in volts per metre and the magnetic flux density $\underline{B}$ in tesla contain contributions from the vacuum. On the one electron level the electron g factor contains a vacuum contribution, and so does the H atom in the Lamb shift. The scalar and vector potentials ϕ and $\underline{A}$ also contain vacuum contributions.

The antisymmetry equations are:

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

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

$$\frac{\partial A_Z}{\partial Y} + \frac{\partial A_Y}{\partial Z} = \omega_Y A_Z + \omega_Z A_Y \quad -(3)$$

$$\frac{\partial A_X}{\partial Z} + \frac{\partial A_Z}{\partial X} = \omega_Z A_X + \omega_X A_Z \quad -(4)$$

$$\frac{\partial A_Y}{\partial X} + \frac{\partial A_X}{\partial Y} = \omega_X A_Y + \omega_Y A_X \quad -(5)$$

and the trace antisymmetry equation or Lindstrom constraint:

$$\frac{1}{c^2}\left(\frac{\partial \phi}{\partial t} + \omega_0 \phi\right) = \underline{\nabla} \cdot \underline{A} - \underline{\omega} \cdot \underline{A} \quad -(6)$$

The field equations are the homogeneous equations:

$$\underline{\nabla} \cdot \underline{B} = 0 \quad -(7)$$

$$\underline{\nabla} \times \underline{E} + \frac{\partial \underline{B}}{\partial t} = \underline{0} \quad -(8)$$

) and the inhomogeneous equations:

$$\underline{\nabla} \cdot \underline{E} = \rho / \epsilon_0 \quad -(9)$$

$$\underline{\nabla} \times \underline{B} - \frac{1}{c^2}\frac{\partial \underline{E}}{\partial t} = \mu_0 \underline{J} \quad -(10)$$

From eqs. (1) and (8):

$$\underline{E}(\text{exp}) = -\underline{\nabla}\phi + \underline{\omega}\phi \quad -(11)$$

and

$$\underline{\nabla} \times (\underline{\omega}\phi) + \frac{\partial \underline{B}}{\partial t}(\text{exp}) = \underline{0} \quad -(12)$$

) The quantities $\underline{E}$ (exp) and $\frac{\partial \underline{B}}{\partial t}$ (exp) are measured experimentally in any given circuit or material. From the Faraday law of ECE2, eq. (8), it follows that

$$\underline{\nabla} \times \underline{E}(\text{exp}) + \frac{\partial \underline{B}}{\partial t}(\text{exp}) = \underline{0} \quad -(13)$$

so if $\underline{E}$ (exp) is measured $\partial \underline{B} / \partial t$ (exp) can be found. Alternatively, $\partial \underline{B} / \partial t$ can be measured directly.

Denoting:

$$\underline{a} = \underline{E}(\text{exp}) \quad -(14)$$

$$\underline{b} = \frac{\partial \underline{B}}{\partial t}(\text{exp}) \quad -(15)$$

it follows that:

$$\underline{a} = -\underline{\nabla}\phi + \underline{\omega}\phi \quad -(16)$$

and

$$\underline{\nabla} \times (\underline{\omega}\phi) = \phi\,\underline{\nabla} \times \underline{\omega} + \underline{\omega} \times \underline{\nabla}\phi = -\underline{b} \quad -(17)$$

So ϕ and $\underline{\omega}$ can be found from eqs. (16) and (17), with computer algebra.

3) 2) Having found $\underline{\omega}$, the vector potential $\underline{A}$ is found from the antisymmetry equations (3) to (5).

3) The scalar spin connection ω_0 is found from the trace antisymmetry equation (6).

4) Knowing ω_0, $\underline{\omega}$, ϕ and $\underline{A}$, the charge density is found from

$$\rho = \epsilon_0 \underline{\nabla} \cdot \underline{E} = \epsilon_0 \underline{\nabla} \cdot \left(-\underline{\nabla} \phi + \underline{\omega} \phi \right) = \epsilon_0 \underline{\nabla} \cdot \left(-\frac{\partial \underline{A}}{\partial t} - \omega_0 \underline{A} \right) \quad -(18)$$

and the current density from:

$$\underline{J} = \frac{1}{\mu_0} \left(\underline{\nabla} \times \underline{B} - \frac{1}{c^2} \frac{\partial \underline{E}}{\partial t} \right) \quad -(19).$$

5) Note that ω_0 must obey both eqns (1) and (6) simultaneously, so if ω_0 is found from eq. (6) for example, eq. (16) is used to find $\partial \phi / \partial t$.

From eq. (16):

$$\underline{\nabla} \phi = \underline{\omega} \phi - \underline{a} \quad -(20)$$

so eq. (17) becomes simplified to:

$$\phi \underline{\nabla} \times \underline{\omega} - \underline{\omega} \times (\underline{\omega} \phi - \underline{a}) = -\underline{b} \quad -(21)$$

From eq. (17):

$$\underline{\nabla} \times (\underline{\omega} \phi) = -\underline{b} \quad -(22)$$

and $\underline{\omega}\phi$ may be found in terms of $\frac{\underline{b}}{r_0}$. Having
found $\underline{\omega}\phi$, it can be used in Eq. (16) to find
ϕ. Having found $\underline{\omega}\phi$ and ϕ, $\underline{\omega}$ can be
found from Eq. (21).

Finally if
$$\underset{\sim}{\nabla} \times (\underline{\omega} b) = -\underline{b} \qquad -(18)$$

then
$$\underset{\sim}{\nabla} \times (\underset{\sim}{\nabla} \times (\underline{\omega} b)) = -\underset{\sim}{\nabla} \times \underline{b} \qquad -(19)$$
$$= \underset{\sim}{\nabla} (\underset{\sim}{\nabla} \cdot (\underline{\omega}\phi)) - \nabla^2 (\underline{\omega}\phi))$$

Eq. (19) can be integrated to give $\underline{\omega}\phi$.