392(7): Electrostatic Limit

Define electrostatics as a subject that considers static charges. In the standard model:

$$\underline{E} = -\underline{\nabla}\phi \quad -(1)$$

where ϕ is the scalar potential and $\underline{E}$ is the electric field strength. So the units of ϕ are volts. $\underline{E}$ is volts m^{-1}.

The scalar antisymmetry law of ECE2 means that

$$\underline{E} = -\underline{\nabla}\phi + \underline{\omega}\phi = -\frac{\partial \underline{A}_E}{\partial t} - \omega_0 \underline{A}_E \quad -(2)$$

where

$$\omega^\mu = \left(\frac{\omega_0}{c}, \underline{\omega}\right) \quad -(3)$$

Eq. (2) is generally covariant, and considers interaction with the vacuum:

$$-\underline{\nabla}\phi(\text{vac}) = \underline{\omega}\phi \quad -(4)$$

$$\frac{\partial \underline{A}_E(\text{vac})}{\partial t} = \omega_0 \underline{A}_E \quad -(5)$$

Eq. (1) is not generally covariant, and does not consider vacuum interaction.

Therefore:

$$\underline{E} = -\underline{\nabla}\phi(\text{total}) = -\frac{\partial \underline{A}_E(\text{total})}{\partial t} \quad -(6)$$

where

$$\underline{A}_E(\text{total}) = \underline{A}_E + \underline{A}_E(\text{vac}) \quad -(7)$$

and

$$\phi(\text{total}) = \phi + \phi(\text{vac}) \quad -(8)$$

It follows from conservation of scalar antisymmetry, that:

2)
$$\underline{A}_E(\text{total}) = \int_{t_1}^{t_2} \underline{\nabla}\,\phi(\text{total})\,dt \quad -(9)$$

Therefore conservation of scalar antisymmetry demands the presence in electrostatics of a vector potential.

If it is considered that $\underline{\nabla}\,\phi(\text{total})$ is time independent, then:

$$\boxed{\underline{A}_E(\text{total}) = (t_2 - t_1)\,\underline{\nabla}\,\phi(\text{total})} \quad -(10)$$

It follows that:

$$\underline{B} = \underline{\nabla} \times \underline{A}_E(\text{total}) = \underline{0} \quad -(11)$$

so this kind of vector potential does not produce a magnetic field. This is self consistent because a magnetic field requires a current of charge, i.e. moving charges. The vector potential needed to define a magnetic field is:

$$\underline{A}_m = \frac{\mu_0}{4\pi} \int \frac{\underline{J}(\underline{x}')}{|\underline{x} - \underline{x}'|}\, d^3x' \quad -(12)$$

where $\underline{J}$ is the current density.

In standard model electrostatics:

$$\phi = \frac{1}{4\pi\epsilon_0} \int \frac{\rho(\underline{x}')}{|\underline{x} - \underline{x}'|}\, d^3x' \quad -(13)$$

where $\rho(\underline{x})$ is the charge density.

3) In ECE2 there is also a vacuum scalar potential:

$$\phi(\text{vac}) = \frac{1}{4\pi\epsilon_0} \int \frac{\rho(\underline{x}')(\text{vac})}{|\underline{x} - \underline{x}'|} d^3x' \quad -(14)$$

where $\rho(\underline{x}')(\text{vac})$ is the vacuum charge density.

The vector antisymmetry law is based on the magnetic vector potential, denoted $\underline{A}_m$:

$$\underline{B} = \underline{\nabla} \times \underline{A}_m - \underline{\omega} \times \underline{A}_m \quad -(15)$$

$$:= \underline{\nabla} \times (\underline{A}_m + \underline{A}_m(\text{vac}))$$

in which

$$\underline{\nabla} \times \underline{A}_m(\text{vac}) := -\underline{\omega} \times \underline{A}_m \quad -(16)$$

so the vector antisymmetry law does not apply to electrostatics.

The experimentally measured scalar potential is $\phi(\text{total})$, because there is always interaction with the vacuum. Similarly, the experimentally measured electric field strength is

$$\underline{E}(\text{total}) = -\underline{\nabla}\phi(\text{total}) \quad -(17)$$

so the electric field strength from the vacuum is always present in any circuit. The spin connection $\underline{\omega}$ is therefore found from:

$$\underline{E}(\text{total}) = -\underline{\nabla}\phi(\text{total}) = -\underline{\nabla}\phi + \underline{\omega}\phi \quad -(18)$$

(4) where ϕ is the Coulomb potential (13) of the standard model. So:

$$\underline{E}\,(\text{experimentally measured}) = -\underline{\nabla}\,\phi\,(\text{Coulomb}) + \underline{\omega}\,\phi\,(\text{Coulomb}) \quad -(19)$$

and $\underline{\omega}$ can be found. On a one electron level:

$$\phi := \phi\,(\text{Coulomb}) = -\frac{e}{4\pi\epsilon_0 r} \quad -(20)$$

so

$$\partial\phi / \partial t = 0 \quad -(21)$$

if $\underline{r}$ is time independent.

Conservation of trace antisymmetry therefore means that:

$$\omega_0\,\phi = c^2\left(\underline{\nabla} - \underline{\omega}\right)\cdot\underline{A}_E \quad -(22)$$

and ω_0 can be found.

Finally $-\partial\underline{A}_E/\partial t$ is found from eq. (17).

As in "Principles of ECE", volume two, page 165 ff., the g factor of the electron is:

$$g = 1 + \gamma = 1 + \frac{\hbar\omega}{mc^2} \quad -(23)$$

where γ is the Lorentz factor and m the mass of the electron. Here ω is the angular frequency of the electron matter wave. For the rest electron:

$$g = 1 + \frac{\hbar\omega_0}{mc^2} = 2 \quad -(24)$$

) from the Dirac theory. Here ω_0 is the rest angular frequency of the electron.

The effect of the vacuum is as follows:

$$\omega_0 \rightarrow \omega_0 + \omega(\text{vac}) \quad -(25)$$

where $\omega(\text{vac})$ is the vacuum frequency. For the rest electron, experimental data on the g factor of the electron give:

$$g = 2 + \frac{\hbar\,\omega(\text{vac})}{mc^2} = 2.002319314 \quad -(26)$$

which is the anomalous g factor of the electron.

The magnitude $|\phi(\text{vac})|$ of the vacuum potential for one electron is therefore:

$$e\,|\phi(\text{vac})| = \hbar\,\omega(\text{vac}) \quad -(27)$$

from the minimal prescription:

$$p^\mu \rightarrow p^\mu - eA^\mu(\text{vac}) \quad -(28)$$

So

$$\boxed{\begin{aligned} |\phi(\text{vac})| &= 0.002319314\,\frac{mc^2}{e} \\ &= 1,185 \text{ volts} \end{aligned}} \quad -(29)$$

at the one electron level.

The vacuum contains voltage.

Following pp. 162 ff. of PECE2:

$$U = e\phi = -\frac{e^2}{4\pi\epsilon_0 r} + \mathcal{L}\omega(vac) \quad -(30)$$

$$-(31)$$

In the Bethe theory:

$$U(vac) = \mathcal{L}\omega(vac) = -\frac{e^2}{4\pi\epsilon_0}\left(\frac{1}{r-\delta r} - \frac{1}{r}\right)$$

and the average value of $\phi(vac)$ is:

$$\langle\phi(vac)\rangle = \frac{e^2}{4\pi\epsilon_0 r^3}\langle(\delta r)^2\rangle \quad -(32)$$

The spin connection for this theory can be found from:

$$\underline{\omega}\phi = -\underline{\nabla}\langle\phi(vac)\rangle \quad -(33)$$

This zitterbewegung or jitterbugging theory can describe the Lamb shift of atomic H.