357(1): Meaning of the g Factor of the Electron.

In the old electrodynamics, the minimal prescription is defined by:

$$\underline{p} \rightarrow \underline{p} + e\underline{A} \quad -(1)$$

in a textbook such as Atkins, "Molecular Quantum Mechanics". Therefore the kinetic energy becomes:

$$T = \frac{1}{2m}\left((\underline{p} + e\underline{A}) \cdot (\underline{p} + e\underline{A}) \right) \quad -(2)$$

$$= \frac{p^2}{2m} + \frac{e}{m} \underline{A} \cdot \underline{p} + \frac{e^2}{2m} A^2$$

In the usual treatment, $\underline{A}$ is expressed in terms of a uniform magnetic field $\underline{B}$:

$$\underline{A} = \frac{1}{2} \underline{B} \times \underline{r} \quad -(3)$$

Therefore:

$$H^{(1)} := \frac{e}{m} \underline{A} \cdot \underline{p} = \frac{e}{2m} \underline{B} \times \underline{r} \cdot \underline{p} = \frac{e}{2m} \underline{B} \cdot \underline{r} \times \underline{p} \quad -(4)$$

The orbital angular momentum is:

$$\underline{L} = \underline{r} \times \underline{p} \quad -(5)$$

so

$$H^{(1)} = \frac{e}{2m} \underline{B} \cdot \underline{L} \quad -(6)$$

This is responsible for the Zeeman effect. Traditionally in molecular physics, the gyromagnetic ratio is defined as:

$$\gamma_e = -\frac{e}{2m} \quad -(7)$$

so $$H^{(1)} = -\gamma_e \underline{B} \cdot \underline{L} = -\underline{m} \cdot \underline{B} \quad -(8)$$

where $$\underline{m} = \gamma_e \underline{L} \quad -(9)$$

is the magnetic dipole moment.

In the Dirac theory the hamiltonian is developed into:

$$H^{(1)} = \frac{e}{2m} \left(\underline{L} + 2\underline{S} \right) \cdot \underline{B} \quad -(10)$$

where $\underline{S}$ is the spin angular momentum of the electron. This has no classical counterpart.

The g factor of the electron in the Dirac theory is the factor 2 premultiplying $\underline{S}$. It is exactly 2.

Experimentally, however, the electron g factor is

$$g = 2.002319314 \quad -(11)$$

to nine decimal places, and is known with much greater precision. The experimental value (11) is considered to be the result of the effect of spacetime, or aether or vacuum.

In ECE2 theory the vector potential is denoted $\underline{W}$. In addition to the vector

3) potential $\underline{W}$ of the magnetic field:

$$\underline{W} = \frac{1}{2} \underline{B} \times \underline{r} \quad -(12)$$

there is a vacuum or spacetime or aether vector potential:

$$\underline{W}(vac) = \underline{v}(vac) \quad -(13)$$

where $\underline{v}$ is the fluid velocity field of the spacetime. This induces the material potential

$$\underline{W}_1 = \frac{m}{e} \underline{W}(vac) \quad -(14)$$

so the minimal prescription becomes:

$$\boxed{\underline{p} \rightarrow \underline{p} + e\underline{W} + m\underline{W}_1} \quad -(15)$$

The Dirac theory must therefore be recalculated to account for $\underline{W}_1$ and compared with the experimental g of eq. (11).

This will be the subject of the next note.