248(6): Development of the Dirac $\hat{H}_2$ Hamiltonian to Give Magnetic Effects

This well known development can now be applied to particle theory and low energy nuclear reactions. The Hamiltonian is developed as follows:

$$\hat{H}_2\psi = \frac{1}{2m}\left(\underline{\sigma}\cdot(-i\hbar\underline{\nabla} - e\underline{A})\underline{\sigma}\cdot(-i\hbar\underline{\nabla} - e\underline{A})\right)\psi$$

$$= \frac{1}{2m}\left[\underline{\sigma}\cdot(-i\hbar\underline{\nabla})\underline{\sigma}\cdot(-e\underline{A}) + \underline{\sigma}\cdot(-i\hbar\underline{\nabla})\underline{\sigma}\cdot(-i\hbar\underline{\nabla}) + \underline{\sigma}\cdot(-e\underline{A})\underline{\sigma}\cdot(-i\hbar\underline{\nabla}) + \underline{\sigma}\cdot(-e\underline{A})\underline{\sigma}\cdot(-e\underline{A})\right]\psi \quad -(1)$$

$$= \frac{1}{2m}\left[ie\hbar(\underline{\nabla}\cdot\underline{A} + i\underline{\sigma}\cdot(\underline{\nabla}\times\underline{A})) - \hbar^2(\nabla^2 + i\underline{\sigma}\cdot\underline{\nabla}\times\underline{\nabla}) + e^2(A^2 + i\underline{\sigma}\cdot\underline{A}\times\underline{A}) + ie\hbar(\underline{A}\cdot\underline{\nabla} + i\underline{\sigma}\cdot(\underline{A}\times\underline{\nabla}))\right]\psi$$

Assuming that $\underline{A}$ is real valued, then:

$$\underline{A}\times\underline{A} = \underline{0} \quad -(2)$$

Also,

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

2) So:

$$\hat{H}_2 \psi = \frac{1}{2m}\Big[-\hbar^2 \nabla^2 \psi + e^2 A^2 \psi + ie\hbar \underline{\nabla} \cdot (\underline{A}\psi)$$

$$- e\hbar \underline{\sigma} \cdot \underline{\nabla} \times (\underline{A}\psi) + ie\hbar \underline{A} \cdot \underline{\nabla}\psi$$

$$- e\hbar \underline{\sigma} \cdot \underline{A} \times \underline{\nabla}\psi \Big] \quad -(4)$$

There are many effects present in general, all of which occur in particle collision theory and low energy nuclear reactions,

The most famous effect is given by:

$$\hat{H}_2 \psi = -\frac{e\hbar}{2m} \underline{\sigma} \cdot \left(\underline{\nabla} \times (\underline{A}\psi) + \underline{A} \times \underline{\nabla}\psi \right) + \ldots \quad -(5)$$

$$= -\frac{e\hbar}{2m} \underline{\sigma} \cdot \left((\underline{\nabla} \times \underline{A})\psi + \underline{\nabla}\psi \times \underline{A} + \underline{A} \times \underline{\nabla}\psi \right) + \ldots$$

$$= -\frac{e\hbar}{2m} \underline{\sigma} \cdot (\underline{\nabla} \times \underline{A})\psi + \ldots$$

$$= -\frac{e\hbar}{2m} \underline{\sigma} \cdot \underline{B} + \ldots$$

where

$$\underline{B} = \underline{\nabla} \times \underline{A} \quad -(6)$$

is the magnetic flux density in tesla of the standard physics. The hamiltonian $\hat{H}_2$ gives the Zeeman effect, so the Landé factor, the g factor of the electron, ESR, NMR and MRI.

In ECE physics the spin connection enters into eq. (6), giving the possibility of new physical effects. It is now known that these magnetic effects also enter into particle collision theory and LENR.