144(10): Experiment to Detect the E and B Spin Fields

Consider an electron trajectory:

$$\underset{\sim}{r} = \frac{r}{\sqrt{2}}\left(\underline{i} - i\underline{j}\right)\exp\left(i(\omega t - \kappa Z)\right) \quad -(1)$$

where

$$r = |\underline{r}| \quad -(2)$$

As in notes 144(3) this produces the spin velocity:

$$\frac{\underline{v}}{c} = \underline{\nabla} \times \underline{r} \quad -(3)$$

and spin acceleration:

$$\frac{\underline{a}_{spin}}{c^2} = \underline{\nabla} \times (\underline{\nabla} \times \underline{r}) \quad -(4)$$

Thus:

$$\underline{v} = i\omega\underline{r}, \quad \underline{a}_{spin} = \omega^2\underline{r}. \quad -(5)$$

In electrodynamics, eq. (3) translates into:

$$\frac{\underline{A}}{c}(\text{spin}) = \frac{m}{e}\underline{\nabla} \times \underline{r} \quad -(6)$$

i.e.

$$\boxed{\underline{A}(\text{spin}) = i\frac{m}{e}\omega\underline{r}} \quad -(7)$$

In the limit of zero spin connection, and using antisymmetry:

$$\underline{E}(\text{spin}) = -2\frac{\partial \underline{A}}{\partial t}(\text{spin}) \quad -(8)$$

$$= -2i\frac{m}{e}\omega\frac{\partial \underline{r}}{\partial t}$$

$$= 2\frac{m}{e}\omega^2\underline{r} \quad -(9)$$

2)

So:

$$\boxed{\underline{E}(\text{spin}) = 2\frac{m}{e}\omega^2 \underline{r}} \quad -(10)$$

This has an ~~a~~ ω^2 dependence which could be detected experimentally.

However, in the limit of zero spin connection

$$\underline{E}(\text{orb}) = -2\frac{\partial \underline{A}(\text{orb})}{\partial t} \quad -(11)$$

and
$$\underline{A}(\text{orb}) = 2\frac{m}{e}\frac{\partial \underline{r}}{\partial t} \quad -(12)$$

so
$$\underline{E}(\text{orb}) = -4\frac{m}{e}\frac{\partial^2 \underline{r}}{\partial t^2} \quad -(13)$$

For a plane wave such as eq. (1):

$$\boxed{\underline{E}(\text{orb}) = 4\frac{m}{e}\omega^2 \underline{r}} \quad -(14)$$

and
$$|\underline{E}(\text{orb})| = c\left|\frac{\underline{E}(\text{spin})}{c}\right| \quad -(15)$$

The force on ~~an~~ a test electron or charge for eq. (14) is:

$$\boxed{\underline{F} = e\underline{E}(\text{orb}) = 4m\omega^2 \underline{r}} \quad -(16)$$