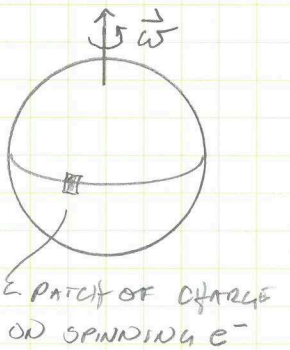
9.8) Model e^- as spinning ball of charge with $r_c = 10^{-18}$ m and find the speed of the equator from the angular momentum and quantum spin.



For a spinning ball, the spin angular momentum is

$$|\vec{S}| = |I\vec{\omega}| = \left(\frac{2}{5}MR^2\right)\frac{v}{R} = \frac{2}{5}MRv$$

where v is the speed at the equator.

Taking the quantum value of $|S| = \sqrt{s(s+1)}\,\hbar$

$$|S| = \frac{\sqrt{3}}{2}\hbar$$

Equating these and solving for v,

$$\frac{2}{5}MRv = \frac{\sqrt{3}}{2}\hbar$$

$$\Rightarrow v = \frac{5\sqrt{3}\,\hbar}{4MR} = \frac{5\sqrt{3}}{4}\frac{\hbar}{m_e r_c} \quad \text{for the } e^-$$

Using mks units

$$v = \frac{5\sqrt{3}}{4}\frac{(1.05\times10^{-34})}{(9.11\times10^{-31})(1\times10^{-18})} = \boxed{2.495\times10^{14}\ \text{m/s} = v_{\text{equator}}}$$

Zippy!

Compare to c

$$v = 2.495\times10^{14}\frac{\text{m}}{\text{s}}\left(\frac{c}{3\times10^{8}\ \text{m/s}}\right) = 8.3\times10^{5}\,c!$$

Ridiculous!

$\Rightarrow$ This is <u>Not</u> a good model of electron spin!