

**Problem 8.11** Picture the electron as a uniformly charged spherical shell, with charge  $e$  and radius  $R$ , spinning at angular velocity  $\omega$ .

- Calculate the total energy contained in the electromagnetic fields.  $W = W_{B_m} + W_{B_{out}} + W_E$
- Calculate the total angular momentum contained in the fields.
- According to the Einstein formula ( $E = mc^2$ ), the energy in the fields should contribute to the mass of the electron. Lorentz and others speculated that the *entire* mass of the electron might be accounted for in this way:  $U_{em} = m_e c^2$ . Suppose, moreover, that the electron's spin angular momentum is entirely attributable to the electromagnetic fields:  $L_{em} = \hbar/2$ . On these two assumptions, determine the radius and angular velocity of the electron. What is their product,  $\omega R$ ? Does this classical model make sense?

Example 5.11 found  $B = \frac{2}{3} \mu_0 \sigma R \omega$  for this problem (5,68)  
 inside  $r < R$   $\sigma = \frac{e}{4\pi R^2}$  237

Since  $\sigma_{\text{inside}} = 0$ ,  $E(r < R) = 0$

Problem 5.36 found  $B(r > R) = \frac{\mu_0}{4\pi r^3} \left( 2\cos\theta \hat{r} + \sin\theta \hat{\theta} \right)$   
 where  $m = \frac{4}{3} \pi \sigma R^3$ .

Gauss' Law tells us that  $E(r > R) = \frac{1}{4\pi\epsilon_0} \frac{e}{r^2} \hat{r}$

Example 2.8 found the energy stored  $W_E = \frac{e^2}{8\pi\epsilon_0 R}$   
 94 in the electric field

Energy density of the magnetic field INSIDE ( $r < R$ )

$$U_{B_m} = \frac{B_m^2}{2\mu_0} =$$

$$W_{B_m} = U_{B_m} \cdot \frac{4}{3}\pi R^3$$