Physics 853 Quiz #4 - Monday, October. 4, 2010

1. Consider the Dirac equation for a massless particle in a magnetic field pointed along the z axis, and with momentum eigenvalues $k_y = k_z = 0$.

$$(-i\alpha_x \partial_x - eBx\alpha_y)\,\psi = E\psi.$$

Since the particles are massless, consider only the upper components in the chiral representation,

$$\alpha_x \to \sigma_x = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}, \quad \alpha_y \to \sigma_y = \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix}.$$

Assume the solution is of the form,

$$\psi = \begin{pmatrix} i\beta x \\ 1 \end{pmatrix} e^{-x^2/2R^2}.$$

Solve the Dirac equation for the energy and wave function, i.e., find E, β and R in terms of eB.