Physics 570B, Spring 2011
Assignment 02
Due Tuesday, Feb. 1

- Find the energy levels and energy eigenstates for a charged particle in crossed electric and magnetic fields. Specifically, take $\vec{B} = (0, 0, b)$ and $\vec{E} = (0, E, 0)$. Explain why your answers make sense. (Or, if you are unlucky, why they don't make sense.)
  Hints: Use the obvious (time independent choice for the scalar electric potential. Then consider what translational invariance the problem has, and make a choice of gauge for the vector potential which preserves this invariance. Finally, since we are using the symbol 'E' for the electric field magnitude, you should probably use some other symbol for the energy, or you will get confused.

- *Baym* problem chapter 6 number 5 (page 167). This is so you can use the results in the next problem.

- Now add a magnetic field in the $\hat{z}$ direction to the two-dimensional oscillator problem above. Since the problem has rotational symmetry, choose a gauge which has that symmetry. Use lowest order (stationary state) perturbation theory to find the approximate shifts in the energy levels due to the magnetic field.
  Hint: remember that $L = -i\hbar\frac{\partial}{\partial\theta}$