

Physics 4803  
Homework Assignment 10  
Due Dec 3 at 5:00

- 1) Consider two identical particles in a one-dimensional harmonic oscillator.
  - a) What is the ground state for two bosons?
  - b) What is the ground state for two fermions of the same spin?
  - c) Suppose that there are two fermions in the system, but their spin is not fixed. In the ground state of the system, will the fermions have the same spin or opposite spins? What is the total spin quantum number?
  - d) In addition to the orbital Hamiltonian, we add a spin Hamiltonian  $H = -BS_z$ . Note that  $S_z$  commutes with the total Hamiltonian. Write the energy of the lowest state with opposite spin and the energy of the lowest state with parallel spin for the fermions.
  - e) At what positive value of  $B$  is there a transition in the ground state between opposite spin and parallel spin?
  
- 2) An electron of mass  $m$  and charge  $-e$  moves in a region where a uniform magnetic field  $\vec{B} = \nabla \times \vec{A}$  exists in the  $z$  direction.
  - a) Setup up the Schrodinger equation in rectangular coordinates.
  - b) Solve the equation for all energy levels.