Fourth homework assignment tentatively due on Wed 8 April.

1. Apply the variational method to find the ground state of the generic hamiltonian

$$H = H_0 + V \tag{1}$$

using trial states of the form

$$|a_1, \ldots a_n\rangle = \sum_{j=1}^{\infty} a_j |E_j\rangle \tag{2}$$

in which the state $|E_j\rangle$ is an eigenstate of H_0

$$H_0|E_j\rangle = E_j|E_j\rangle \tag{3}$$

with energy E_j. Interpret your result.

2. Suppose two identical spin-one particles are both in s-states in some potential. If they also have the same value of the principal qunatum number n, *i.e.,* they are in the same space state, what are the possible values of the total angular momentum j?

3. Consider two identical spin-one-half particles in an box of side L with a potential V_0 that is zero inside the box and infinite outside it. (a) If the particles do not interact, what are the energies and wave-functions (space and spin)? (b) Suppose now the potential is

$$V(\boldsymbol{r_1}, \boldsymbol{r_2}) = V_0(\boldsymbol{r_1}, \boldsymbol{r_2}) + a^2\, \delta^{(3)}(\boldsymbol{r_1} - \boldsymbol{r_2}) \tag{4}$$

in which $\boldsymbol{r_1}$ and $\boldsymbol{r_2}$ are the positions of the two particles. Show that the triplet states (*i.e.,* those of total spin $\hbar$) are unaffected by the change in the potential.