

your name(s) \_\_\_\_\_

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*Physics 852 Quiz #12 - Friday, Feb. 7th*

Consider a harmonic oscillator, which you will fill up with neutrons. The single-particle levels are originally separated by energies  $\hbar\omega$ . A spin-orbit interaction is then added,

$$H_{s.o.} = -\frac{\beta}{\hbar^2} \vec{L} \cdot \vec{S} = -\beta[j(j+1) - \ell(\ell+1) - 3/4]/2,$$

and a final term is added that depends only on  $\ell$ ,

$$H_L = -\frac{\alpha}{\hbar^2} |\vec{L}|^2 = -\alpha[\ell(\ell+1)].$$

Choose  $\beta = 0.12\hbar\omega$  and  $\alpha = 0.02\hbar\omega$ . Let  $N$  refer to the original quantum excitation in the absence of the the spin-orbit and  $\ell$ -dependent interactions, i.e.  $E = \hbar\omega(N + 3/2)$ .

Make an energy-level diagram for all levels with  $N \leq 7$ . Plot the energies  $E_i$  in units of  $\hbar\omega$  (set  $\hbar\omega = 1$ ). Label each level by  $N, j, \ell$  and  $E_i$ . The level diagram should consist of a short horizontal line for each level, where the height is proportional to  $E_i$ .