
449 Homework #4

1-2) Look up the function $\xi(r)$ in the spin-orbit Hamiltonian $H_{\text{so}} = \xi(r) \mathbf{L} \cdot \mathbf{S}$ for hydrogen. Be sure to write it in atomic units. Calculate the matrix $H_0 + H_{\text{so}}$ using the $2p \dots 5p P_j$ states as a basis. Find the $2pP_{3/2} - 2pP_{1/2}$ energy splitting. Compare to what you get by simply calculating $\langle H_{\text{so}} \rangle$ and subtracting.

3-5) Townsend 11.1, 5, 7.

6) Use appropriate Clebsch-Gordan coefficients to calculate the g_j factors for a 2D_j state.

7) The $97d\ ^2D_j$ states of Rb have a fine-structure splitting of $h \times 12.2$ MHz. Calculate the energy levels as a function of magnetic field, and make a plot showing both the exact results and the approximate answers from 5).