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## 449 Homework #2

- 1) Write the function  $f = \sin^3 \theta \cos \theta \sin(3\phi)$  as a series of spherical harmonics.
- 2) Write  $z = r \cos \theta$  in terms of spherical harmonics. Likewise for  $x$ . Show how to get the same result by applying a rotation operator about the  $y$ -axis.
- 3) Calculate  $\int d\Omega Y_{1,-1}(\theta, \phi) Y_{2,1}(\theta, \phi) Y_{3,0}(\theta, \phi) Y_{2,0}(\theta, \phi)$  by expanding each pair of  $Y$ 's as a series of spherical harmonics and using the orthogonality of the  $Y$ 's.
- 4) Find the lowest 8 energy levels (and their degeneracies) for the potential  $V = br$ .
- 5)  $S(n_2, l_2, n_1, l_1) = \sum_{m_1, m_2} \langle n_2 l_2 m_2 | r_i | n_1 l_1 m_1 \rangle \langle n_1 l_1 m_1 | r_i | n_2 l_2 m_2 \rangle = ? \int_0^\infty dr r P_{n_2 l_2} P_{n_1 l_1}$
- 6-7) Exercises 10&11 in the Supersymmetry handout.
- 8) Hydrogen:  $S(3p, 2s) = ?$
- 9) How many radial zero crossings are there for the 5p  $m=1$  state of hydrogen? Plot the probability distribution in the  $x$ - $z$  plane. (Use ContourPlot)