

PHYS4702 Atomic, Nuclear, & Particle Physics Fall 2015 HW #4

Due at the start of class on Thursday 17 Sept 2015

- (1) Derive an expression for the density of states dN/dE for a free particle in *two* dimensions, normalized to periodic boundary conditions inside a box of side length L . Comment on the energy dependence.
- (2) The isotropic harmonic oscillator in three dimensions is defined by the potential energy function $V(r) = \frac{1}{2}m\omega^2r^2$ for a particle of mass m . Solve this problem in *Cartesian* coordinates using separation of variables, and what you know about the one dimensional simple harmonic oscillator. What are the degeneracies of the ground, first excited, and second excited states? Choose one of the first excited states, and write the wave function in spherical coordinates to show that it is proportional to a spherical harmonic. What is the angular momentum quantum number ℓ for the state you chose?
- (3) A particle is confined to a “spherical box” of radius a . Find the lowest three energy eigenvalues for $\ell = 0$. Then find the lowest three energy eigenvalues for $\ell = 1$. Express your answers numerically in units of $\hbar^2/2ma^2$. You’ll need a computer for the $\ell = 1$ case.