

Solutions to Assignment 7, UCSD Physics 130b

Sebastian Dietze

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1. PDG

The mass of the proton ($1.672621777(74) \times 10^{-27}$ kg) can be found in the physical constants on pg 4 or under Baryons on pg 142. The Spherical harmonics can be found on pg 299. The radial wavefunction for central potential are not in the PDG booklet see Griffith second editon pg 154. Notice that hydrogen-like wave function are equivalent to this except with the Bohr radius modified to include appropriate constants for the specific nucleus. 10GeV WIMPS have cross sections appropriate for the weak interaction strength and is give to be on the order of 0.1 pb (see pg 233).

2. Scattering

The mean free path is given by

$$\lambda_{mfp} = (\sigma\eta)^{-1} \quad (1)$$

The number density is related to the mass density approximately by the number of scatteres (neutron and proton). We take the neutron mass the same as the proton mass. The number density is given by,

$$\eta = \frac{\rho}{m_p} \quad (2)$$

Thus for neutrino, in water $\lambda_{mfp} \approx 10^{17}$ m and in lead $\lambda_{mfp} \approx 10^{16}$ m. For WIMP, in water $\lambda_{mfp} \approx 10^{11}$ m and in lead $\lambda_{mfp} \approx 10^{10}$ m, assuming a cross secton of 0.1 pb.