PY 452: Quantum Physics II Problem Set 10

Due date: **Tuesday**, November 23 by 5:00pm

Reading: Please finish reading chapter 10, and then begin reading chapter 11, sections 11.1 and 2 on a general introduction to scattering theory and the partial wave analysis. We may start scattering theory toward the end of Tuesday's lecture, but definitely by this Thursday.

Problems:

1. Consider the scattering of a uniform beam of point particles that is incident in the z-direction on an immobile spherical obstacle in d dimensions. Show that the ratio of the total backward scattering flux $\Phi_{\rm b}$ to forward scattering flux $\Phi_{\rm f}$ is

$$\frac{\Phi_{\rm b}}{\Phi_{\rm f}} = \frac{\left(\frac{1}{\sqrt{2}}\right)^{d-1}}{1-\left(\frac{1}{\sqrt{2}}\right)^{d-1}}$$

   The forward flux refers to particles that are scattered in a direction with a positive z-component (and vice versa for the backward flux). Notice that there is only backward scattering in one dimension (obvious), predominantly backward scattering in two dimensions, and isotropic scattering in three dimensions, and *only* in three dimensions.

   Hint: This problem involves almost no calculation if use employ the right perspective. First work the problem for $d = 1$, 2, and 3; the case of general d is more ambitious.

2. Text 11.1. In addition to the three parts given in the text, please answer the following additional questions:

   (d) Calculate the fraction of particles that are scattered into the differential cone bounded by θ and $\theta + d\theta$ from a target that is comprised of n scattering centers per unit area?

   (e) From the previous question, calculate the fraction of α particles with incident energy of 5 Mev that are scattered into the differential cone (θ,$\theta + d\theta$), with $\theta = \pi/2$, if the incident beam passes through a gold sheet of thickness 1 μm.