

# Physics 5403

## Problem Set 9 – due November 13, 2009

### Problem 1

Consider a situation where after scattering the particles are “incoming”. Apply partial wave analysis and find the wave function for spherically symmetric potentials. The incoming solution has the form

$$\psi^{(-)} = e^{ikz} + \psi_{\text{sc}} = e^{ikz} + f^{(-)}(\theta) \frac{e^{-ikr}}{r}$$

whereas the outgoing solution looks like

$$\psi^{(+)} = e^{ikz} + \psi_{\text{sc}} = e^{ikz} + f^{(+)}(\theta) \frac{e^{ikr}}{r} .$$

What relation exists between  $f^{(+)}(\theta)$  and  $f^{(-)}(\theta)$ ?

### Problem 2

Derive the Green's function for one dimensional scattering:

$$\frac{d^2 G(x, x')}{dx^2} + k^2 G(x, x') = \delta(x - x')$$

with the property that

$$G(x, x') \sim f_+ e^{ik(x-x')} \text{ for } (x - x') \rightarrow \infty$$

and

$$G(x, x') \sim f_- e^{-ik(x-x')} \text{ for } (x - x') \rightarrow -\infty .$$

### Problem 3

Let  $V(x, y, z) = 0$  except for the region

$$x^2 < \left(\frac{a}{2}\right)^2, \quad y^2 < \left(\frac{a}{2}\right)^2, \quad z^2 < \left(\frac{a}{2}\right)^2,$$

which is a cube of side length  $a$ . The strength of the potential is  $V_0$  inside this cube. A plane wave  $e^{ikz}$  is incident on the cube. What is the differential cross section  $d\sigma/d\Omega$  as a function of the angles  $(\theta, \phi)$  in the Born approximation?