Homework #5, PHY 215C

Due: May9, 2017

Problem 1. Scattering from a square well potential. 20 points.

Consider of particle of mass μ and wavevector $\vec{k}$ impinging on a "square well" (actually, spherical) of constant depth V_o and range r_o.

(i) Calculate the scattering amplitude in the Born approximation.

(ii) Obtain and describe the low energy and high energy behavior.

Problem 2. Maximum partial wave. 15 points.

(i) Show that for a 100 MeV (kinetic energy) neutron incident on a fixed nucleus, the maximum partial wave is $\ell_{max} \approx 2$. You can use: the range of the nuclear force is roughly one F (fermi) $= 10^{-5} \mathring{A}$. Also, $\hbar c \approx 200$ MeV F is useful in nuclear physics.

(ii) Repeat this exercise for a Higgs boson moving at a velocity of $c/2$. This may give some insight into the mass and velocity dependence of ℓ_{max}.

Problem 3. Cross section for a hard sphere potential. 15 points.

The "hard sphere" potential is defined by Shankar: $V(r)$ is $+\infty$ for $r < r_o$, and is zero outside; the space inside the sphere is not accessible. Show that $\sigma_{\ell=0}(k \to 0) = 4\pi r_o^2$. Can you think of a reason the "effective radius" seems to be $2r_o$ instead of simply r_o?

Problem 4. Optical Theorem. 10 points.

In term of equations in Shankar, derive Eq. (19.5.18) and provide the missing steps leading to the optical theorem, Eq. (19.5.21).