Phys 6021: Homework IV

due February 15, 2019

1. Born approximation for Gaussian potential

(a) *(6 pts)* Calculate the differential cross section in first Born approximation for the potential

$$V(r) = V_0 e^{-\mu r^2}. \tag{1}$$

(b) *(6 pts)* In the same approximation calculate the s-wave phase shift.

(c) *(4 pts)* After your explicit calculation of the s-wave phase shift, write down the steps you would follow to obtain the p- and d-wave phase shifts. Be as explicit as needed, so that either you or a friend could go ahead and follow your instructions to write e.g. a computer code to obtain the answers numerically.

2. Breit-Wigner Resonance

(a) *(6 pts)* According to the notes (11.123), close to a resonance, the phase shift is given by

$$\tan \delta_\ell \simeq \frac{1}{E_R - E} \frac{\Gamma_l}{2}. \tag{2}$$

Use this to derive the partial wave scattering amplitude f_ℓ of (11.125). Then verify (11.126) by use of the optical theorem.

(b) *(6 pts)* Plot $\Im m f_\ell$ versus $\Re e f_\ell$ on a so-called Argand plot for a Breit-Wigner resonance. Take $\Gamma = E_R/10$ and plot your points for enough energies to complete a full loop. Mark the (equally spaced) energy values on your diagram. Indicate the point where the phase shift goes through $\pi/2$.