
2. Problem 11.12, page 416 in Griffith – Total cross-section for Yukawa Potential; Born approximation.

3. Problem 11.13, page 416 in Griffith – Spherical δ-function potential; Born approximation. (For part (c): in problem 11.4 the result for the scattering amplitude is \( f(\theta) = -\alpha \beta / (1 + \beta) \).

4. Comparison of central Gaussian potential with Yukawa potential

   (a) Use the Born approximation to calculate the differential cross section \( d\sigma / d\Omega \) for the scattering of a particle on mass \( m \) and energy \( E \) from a central Gaussian potential of the form
   \[
   V(r) = \frac{V_0}{\sqrt{4\pi}} e^{-r^2/4a^2}.
   \]
   Express your answer in terms of \( \kappa = 2k \sin(\theta/2) \), where \( k^2 = 2mE/\hbar^2 \). Hint: You might want to use the relation
   \[
   \int \sin(ax) f(x) dx = -\frac{\partial}{\partial a} \int \cos(ax) \frac{f(x)}{x} dx.
   \]

   (b) Write down the Born approximation for the differential cross section \( d\sigma / d\Omega \) for the scattering of a particle of mass \( m \) and energy \( E \) from a Yukawa potential
   \[
   V(r) = \frac{V_0 a}{r} e^{-r/a}.
   \]
   Use the results on p. 415 in Griffith for this part of the problem.

   (c) Sketch the differential cross section as a function of \( \kappa a \) for each of the potentials in (a) and (b). For each potential, expand \( d\sigma / d\Omega \) in the quantity \( \kappa a \), including terms up to order \((\kappa a)^2\). Compare \( d\sigma / d\Omega \) for the Gaussian and Yukawa potentials for \( \kappa a \ll 1 \). Compare \( d\sigma / d\Omega \) for the Gaussian and Yukawa potentials when \( \kappa a = 2 \). Give a qualitative explanation for these results.

Due Friday, April 13, in class. Scores for late problem sets will be divided by 2.