PHY420 Tutorial 4

Handed out 05.04.2018, Due 13.04.2018

1. Calculate the total scattering cross-section for an attractive spherical potential

$$U = -|U_0| \quad r \leq a; \quad U = 0 \quad r > a$$

in the Born approximation. What are conditions of validity of this approximation?

2. Calculate the differential cross-section by the method of phase shifts for a repulsive potential $U = \alpha/r^2$.

3. Using the definition of the form factor, obtain the relative magnitudes of the cross-sections in the forward and backward directions for fast electrons scattered from the hydrogen atom.

4. What are the differences between the Rutherford's classical scattering analysis of the alpha particle on a gold foil experiment and the quantum mechanical analysis of the same experiment taking into account the entire atom, not just the nucleus?

5. Show that the scattering amplitude for an electron incident on an hydrogen atom and suffering a momentum change $\vec{q}$, calculated in the first order Born approximation is

$$f = 2\frac{q^2 + 8}{(q^2 + 4)^2}$$