

Exercise 1: Yukawa potential

Calculate the scattering amplitude $f(\theta)$ for $V(r) = \frac{\chi}{r}e^{-\alpha r}$ (Yukawa potential) using the 1st Born approximation.

Exercise 2: Optical Theorem

Show that $\text{Im}f(0) = \frac{k}{4\pi}\sigma$ (optical theorem), with σ the scattering cross section, for a central potential. (The theorem is actually true in general.) What is the physical meaning of the theorem?

Exercise 3: Hydrogen atoms

The range of the potential between two hydrogen atoms is approximately $r_0 = 4\text{\AA}$. For a gas in thermal equilibrium, obtain a numerical estimate of the temperature below which the atom-atom scattering is essentially s-wave. (Hint: associated to a given temperature T there is typical kinetic energy $k_B T$ for the particles in the system.)

Exercise 4: Identical particles

Consider spin-1/2 fermions, say electrons. Assume that the electrons are colliding with random spin orientation \uparrow and \downarrow . Derive the differential cross section.