Theoretische Physik III
- Quantenmechanik (SoSe 2019) -

Übungsblatt 10 (10 Punkte)
Ausgabe 13.06.19 – Abgabe 18.06.19 – Besprechung n.V.
Aufgaben mit Sternchen sind Klausurisomorph

▷ Aufgabe 1 (Yukawa scattering)* (4 Punkte)

We consider the scattering off a Yukawa potential,

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

and kindly ask you to compute the scattering amplitude, differential and total cross section in first Born approximation. Also, please discuss the limiting cases $\mu, V_0 \to 0$ mit $V_0/\mu = ZZ'e^2/(4\pi\epsilon_0)$, where the Yukawa assumes the form of the Coulomb and gravitational potential, respectively.

▷ Aufgabe 2 (Elektron-atom scattering) (6 Punkte)

We consider the elastic scattering of electrons off a neutral atom. The interaction potential is given by $V = -e_0\Phi$, with $-e_0$ the charge of the electron), and Φ the electrostatic potential of the atom,

$$\Delta\Phi = -e_0[Z\delta(\vec{x}) - \rho(\vec{x})]/\epsilon_0 \tag{5}$$

Here, Z denotes the proton number, ρ the distribution of its Z electrons, i.e. $\int d^3x\rho(\vec{x}) = Z$. Compute the differential cross section in first Born approximation. If necessary, make use of the so called *form factor* of the electronic charge distribution

$$F(\vec{q}) = \int e^{-i\vec{q}\cdot\vec{x}'}\rho(\vec{x}')d^3x' \,. \tag{6}$$

Apply your derivations to the case of scattering of electrons off atomic hydrogen in its ground state. DIscuss the differential cross section in the regimes of high and low energies, respectively.

Hinweis: Don't rush and solve the Laplace equation (5)! Recall, that in first Born approximation, the only thing you need is the Fouriertransform of the potential $\Phi(\vec{x})$ – and for this it is suffient, to simply Fouriertransform the Laplace equation ...