

FYS-MENA3110 Problem set #2

Problem 2.1:

The wave function of an electron in a hydrogen-like atom with nuclear charge Z is $\psi(r) = Ce^{-r/a}$, where $a = a_0/Z$; $a_0 \approx 0.5 \text{ \AA}$ is the Bohr radius.

- Compute the normalization constant.
- What is the probability that the electron is in the region $x, y, z > 0$?
- If the nucleus number is $A = 173$ and the charge is $Z = 70$, what is the probability that the electron is in the nucleus region? Assume that the radius of the nucleus is $1.2 \times A^{1/3} \text{ fm}$.

Problem 2.2:

- Write the Schrödinger equation for a two-dimensional hydrogen atom. Suppose the potential is $V(r) = -e^2/r$, where $r = \sqrt{x^2 + y^2}$.
- Using separations of variables, find the radial and angular equations.
- Solve the angular equation.
- Describe the quantum numbers that characterize the bound state and find the degeneracies of the system.