Session 8 ~ 9. Atomic Structure

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Goal

1. Rutherford scattering & atomic model
2. Bohr atom
3. Energy levels of electrons & atomic spectra

Scenario

✓ People began to wonder if matter has a definite structure on a microscopic level.

✓ The existence of atoms and molecules, the ultimate particles of matter, has been amply demonstrated.

✓ Their ultimate particles, electrons, protons, and neutrons, have been identified and studied well.

✓ Here comes to the structures of atoms, since it is the the structure that is responsible for nearly all the properties of matter that shape the world around us.

✓ How electrons revolve around the nucleus?

✓ Niels Bohr applied quantum ideas to the atomic structures.

- Rutherford scattering

⇒ PPt. file

The Rutherford model of the atom

A tiny, massive, positively charged nucleus surrounded at a relatively great distance by enough electrons to render the atom electrically neutral as a whole.

⇒ The planetry model of the atom

- Electron orbits

✓ Classical model

Centrifugal force : F_c Electric force : F_e

$$F_c = \frac{mv^2}{r} \qquad F_e = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2}$$

⇒ For an orbit to be dynamically stable,

$$F_c = F_e : \frac{mv^2}{r} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2}$$

⇒ $$v = \frac{e}{\sqrt{4\pi\varepsilon_0 mr}}$$

Total energy of the electron : $KE + PE$

$$KE = \frac{1}{2}mv^2, \quad PE = -\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r}$$

$$E = \frac{1}{2}mv^2 - \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r} = -\frac{e^2}{8\pi\varepsilon_0 r}$$

✓ The failure of classical physics

Accelerated electric charges radiates energy in the form of em waves.

⇒ An electron should continuously lose energy, spiraling into the nucleus in a fraction of time. However, atoms do not collapse.