1150: Relative size of atomic nucleus and atom

(Recognize that atoms and the matter they are made of have a huge amount of empty space.)

Key words: Relative size of atomic nucleus and atom; matter is sparse; neutrino

In the schematic diagram of an atom, the nucleus and electrons look close to each other, but the size of the atom is very large compared to the size of the nucleus. Let's consider the case of a hydrogen atom. The diameter of the proton, which is the atomic nucleus, is said to be 10^{-15}m. The electron is located about 0.53Å from the atomic nucleus. 0.53Å is 0.53×10^{-10}m.

If you expand the proton to 10cm, the electron is "orbiting" 5.3km away. (As you will see later, "orbiting" is incorrect.) The space between the electron and the atomic nucleus is empty (vacuum). The atom is sparse.

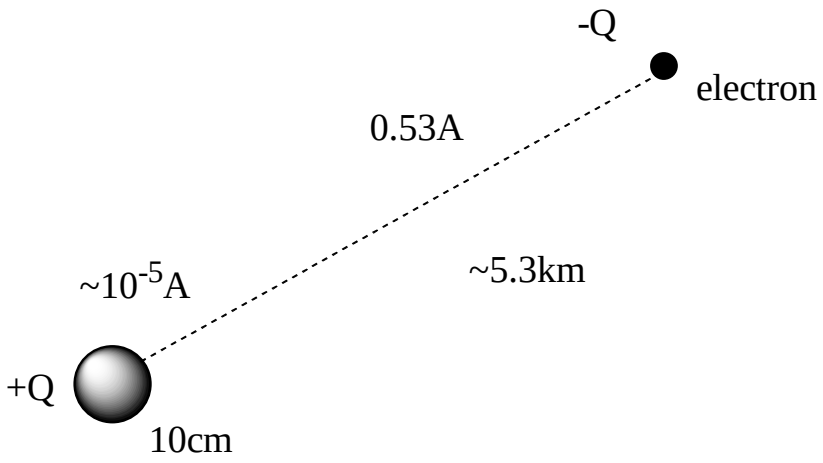

Figure 1-5. The relative sizes of the nucleus and atoms. If the nucleus is enlarged to 10 cm, the electron is 5.3 km away. Q is the elementary charge, 1.6022×10^{-19} Coulombs [C].

[Relative size of atomic nuclei and molecules]

The distance between the nuclei of H_2 molecules is 0.741 Å. If one nucleus is enlarged to 10 cm, the other nucleus is 7.4 km away. This means that matter is very sparse.

As an aside, neutrinos, which do not interact with electrons or nuclei, can easily pass between atoms of matter. Although the probability is very low, neutrinos can sometimes collide with atomic nuclei. When this happens, light is emitted. Neutrinos can be detected by observing this light.