

ATOMS AND NUCLEI: SOME BASIC FACTS

(This is the same as the first part of the notes for section 9, and is covered in more detail in section 3.1 of the textbook.)

Basic constituent of all everyday matter.

Nucleus made of protons and neutrons. Surrounded by a “cloud” of electrons.

The diameter of the nucleus is roughly 100,000 times smaller than the diameter of the electron cloud. (!)

The mass of a proton is 1.67×10^{-27} kg. (In other words, it takes 6×10^{26} — 600 trillion-trillion — protons to get 1 kg.)

The mass of a neutron is almost exactly the same as a proton, larger by just 0.14%.

The mass of an electron is 1/2000 of the proton mass.

Protons have positive electric charge. Electrons have negative electric charge. Neutrons have no electric charge (they are “electrically neutral”).

Opposite charges attract, like charges repel.

Electrons are held in an atom by electrical attraction to the protons of the nucleus.

The nucleus is held together by the *strong nuclear force*, which overcomes the electrical repulsion of the protons.

Typically an atom is electrically neutral, with the same number of protons and electrons.

However, electrons can sometimes be stripped off an atom (by atomic collisions, for example) to create an electrically charged *ion*. Under some conditions an atom can acquire an extra electron to create a positively charged ion.

Atoms form bonds by sharing electrons, making molecules.

The chemistry of an atom is thus determined by its number of protons, which determines the number of electrons the atom would “like” to have.

There are only about 90 stable chemical elements because electrical repulsion makes nuclei with more than 100 protons unstable. (And some nuclei with less than 100 protons are unstable enough that they don’t live long.)

Typically, the number of neutrons is similar to the number of protons. An exception is hydrogen, whose nucleus consists of a single proton.

However, many chemical elements have *isotopes*, nuclei with the same number of protons (hence the same chemistry) but different numbers of neutrons (hence different mass).

Deuterium is an isotope of hydrogen that has one proton and one neutron in the nucleus. (Tritium has one proton and two neutrons.)

Protons and neutrons are themselves made of particles called quarks. Electrons (and quarks) appear to be fundamental particles, not “made of” anything else.