Atomic Trails

More Details

Secret traces in the mist

Elementary particles are invisible. However, with the cloud chamber you can show that these smallest particles are omnipresent! The cloud chamber is filled with cold, supersaturated ethanol vapour, which immediately condenses to droplets when the opportunity arises. Elementary particles can trigger this "rain": The most noticeable among them are electrically charged and travel with a fair amount of energy. They speed through between the ethanol molecules and occasionally bump into them. This causes electrons to be catapulted out of the molecules. The now positively charged molecules can merge with neighbouring molecules to form a visible drop. In this way a trail of mist traces the path of the particle.

The particle producers

Where do the elementary particles come from? With the formation of the Earth, elements with an extremely unstable atomic nucleus also developed. Their nucleus of protons and neutrons stabilises by "throwing away" parts – it is radioactive.

The most important radioactive elements in nature are uranium, thorium and potassium^{40}. Their decay produces other radioactive elements (Fig. 1, 2), which in turn decay until finally a stable element – mostly lead – is formed. The intermediate stages are stable for different lengths of time: Bismuth^{209} only decays to half its original state after 19 quintillion years, plutonium^{239} after about 24 thousand

years, radon^{222} has a half-life of only about 4 days and polonium^{212} even only 0.3 microseconds!

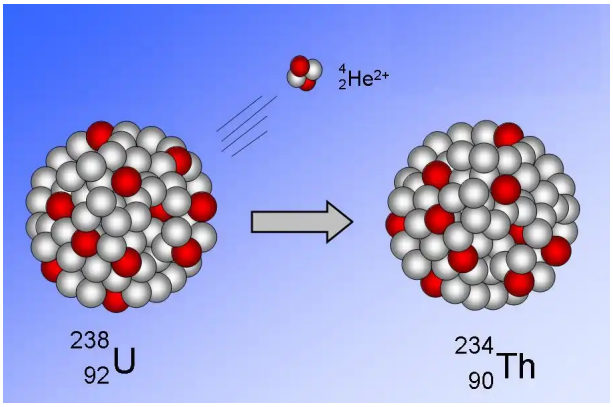

Fig. 1: Radioactive nuclei decay into other elements, e.g. uranium into thorium, by emitting radiation. In alpha decay, the heavy alpha particle is made up of two protons and two neutrons.

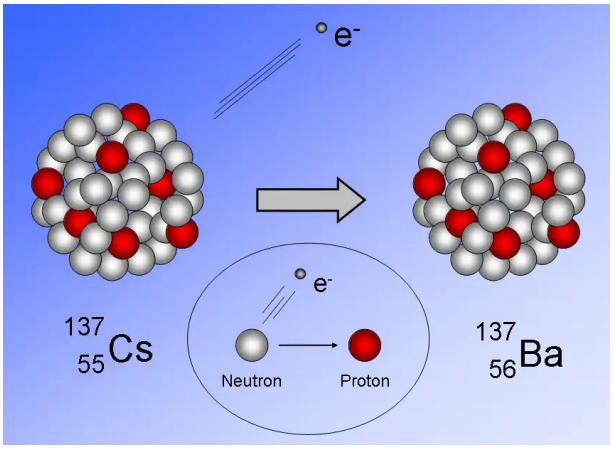

Fig. 2: Radioactive nuclei decay into other elements, e.g. caesium into barium, by emitting radiation. In beta decay, the lighter beta particle is made up of electrons or positrons.

The noble gas radon has the greatest effect on humans, because you inhale it, potassium^{40} you take in with your food. While the body is usually able to cope with radiation damage caused by small amounts of radioactivity, larger amounts can be fatal. Natural radioactivity also influences evolution: it changes the genetic make-up – sometimes to our advantage, sometimes to our disadvantage.

Natural radiation protection

The Earth's natural radiation is tiny compared to what stars emit. Our Earth protects us very effectively against this hail of particles from space: firstly, with the Van Allen belt, a kind of huge, ring-shaped particle trap that is held in shape by the Earth's magnetic field. On the other hand by the atmosphere, in which the most diverse processes slow down or convert almost all radiation.

Cloud chamber inventor

Scottish physicist Charles Wilson studied this so-called secondary cosmic radiation, which is produced by the collisions of radiation from stars with atoms in the atmosphere. In 1911, he developed the cloud chamber and proved that natural radiation consists of particles.