Common Types of Radiation

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Radiation α (alpha) (https://en.wikipedia.org/wiki/Alpha_decay) Alpha radiation is the emission of an α-particles which consist of two protons (https://en.wikipedia.org/wiki/Proton) and two neutrons (https://en.wikipedia.org/wiki/Neutron) (essentially the nucleus of a helium-4 atom). These particles can be imagined as the classical helium atom from which the electron shell He2 + was removed. As it was mentioned above, the alpha particles are made up of two protons and two neutrons, therefore they are positively charged with an electrical charge of + 2e. Beyond that, they have a nonzero rest mass. Radiation α is generated by the radioactive conversion of the the heavy element isotope, in which the α particles are emitted and the energy, corresponding to the mass loss in the system, is released. The nuclide resulting from the alpha decay has, due to the conservation of the nucleon number and the electric charge, a proton number of 2 lower. Consequently, the element is displaced, with respect to the original nucleus, two places to the left in the periodic table. It is clear that the emitted particle has a small weight compared to the mass of the emitting nucleus. The kinetic energy of the nucleus at particle emission is practically negligible. The nucleus of the heavy element returns from the excited state to the state of the energy base emission gamma. Therefore, it is common that this type of radioactive conversion is accompanied by the gamma radiation. Alpha radiation has strong ionizing effects but has a low penetrating power, the speed rate is up to 107 m.s-1 and the radiation penetrates only a few centimeters of air, so you can shade it with a standard sheet of paper. External effects on humans have virtually no effect at all, as radiation is absorbed by the cells of the squamous skin epithelium. However, the internal effect of radiation (eg in the lungs) can damage the genetic material and thus lead to the development of a cancer. Alpha radiation can also be used for healing purposes. Its action in certain doses activates the defense mechanisms of the cells. Uranium, radium or radon belong among the exemplary substances that are regarded as sources of radiation α.

Radiation β (beta) (https://en.wikipedia.org/wiki/Beta_particle)' Beta radiation is the emission of nuclear particles created by beta decay. These particles carry either β+ (positron) or β- (electron) electrical charge. β+ particle is created when a proton transforms into a neutron (and emits electron neutrino), therefore the original nucleus is changed into a nucleus of an element closest to the left in the periodic table. β- particle is created when a neutron transforms into a proton (and emits electron antineutrino). This makes the original nucleus shift into a nucleus of a different element which is closest to the right in the periodic table. β particles have very high speed rate and their penetrating power is also way stronger than α particles. β particles can pass through materials with low density or small thickness such as aluminium foil.

Radiation γ (gamma) (https://en.wikipedia.org/wiki/Gamma_ray) Gamma radiation is electromagnetic radiation with a very short wavelength with great energy and penetrating power of its particles. In contrast to α and β, which are corpuscular, the radiation penetrates into the material better and its perfect shielding is almost impossible (layers of materials containing heavy elements such as lead are used to reduce the intensity of radiation). Radionuclides are unstable nuclides. We distinguish naturally occurring radionuclides (naturally occurring) and artificial radionuclides (generated by nuclear reactions). Accordingly, we distinguish between natural and artificial radioactivity. Natural radioactivity is the spontaneous transformation of unstable nucleus into stable while transmitting radiation. The natural radioactivity was discovered in 1896 by the French physicist H. Becquerel and lately studied by spouses Curie.

Artificial (induced) radioactivity (https://en.wikipedia.org/wiki/Induced_radioactivity) is an atomic transformation that is induced by nuclear reactions. The discovery of artificial radioactivity occurred in 1934 by the process of bombarding aluminum with particles alpha. This study was held by spouses, Fréderic and Irene Joliot-Curie.

Radioactive equilibrium is a condition in which the same number of atoms is converted into the same number of radioactive isotopes per unit of time

A - equilibrium does not occur because the physical half-life time of the parent element (T1) is shorter than the half-life of the daughter radionuclide (T2)

B - a transient (radioactive) equilibrium occurs when T1 is longer than T2

C - a permanent (secular) radioactive equilibrium can occur with a half-life time of the T1 element transformation being much longer than the half-life time of the T2 element

Applications of radiactivity

Nuclear energetics Nuclear energetics utilizes unstable radionuclides and the energy that is released during nuclear reactions. Every nuclear reaction is based on transformation of nucleus with lower binding energy into a nucleus with higher binding energy. The higher binding energy the more stable the atomic nukleus is. The most stable are nuclei with nucleon number between 30 and 130. Nuclear energy is an energy that is released when two atomic nuclei merge together to create a single heavier nucleus or when an atomic nucleus falls apart and creates two lighter nuclei. Using this principle we can distinguish two main kinds of nuclear reactions:

A. Nuclear synthesis (thermonuclear reaction) – synthesis of two lighter atomic nuclei into one heavier nucleus. Huge amount of energy is released during this process. In order for this reaction to work we need extremely high pressure and temperature (these conditions are inside stars).

B. Nuclear fission - occurs when heavy atomic nucleus falls apart and creates two medium heavy nuclei, releases a few neutrons and great amount of energy. These neutrons induce fission of other heavy atomic nuclei. This causes chain reaction that can be either controlled (nuclear reactors) or uncontrolled (atomic bomb).

Radiotherapy Radiotherapy is conservative method that is used for treatment malignant tumours. Affected tissue is exposed to different types of ionizing radiation. The goal is to destroy all affected cells without damaging healthy ones. Depending on the type of tumour we choose different intensity and type of radiation. During teletherapy the tumour is exposed to a radiation coming from a source located outside the body. Brachytherapy on the other hand includes locating the source of radiation on the surface of the tumour or even inside it. Commonly used ionizing radiation is either electromagnetic or corpuscular type. Electromagnetic radiation includes X-ray and gamma radiation, corpuscular radiation includes proton, neutron, alpha particles and electrons. Radiosensitivity is cell atribute that determines how will the cell react when exposed to radiation. Undifferentiated cells are usually more sensitive than cells that are highly differentiated.

Carbon dating To determine the age of some discoveries in archeology, the so-called radiocarbon method is used by many archeologists. Carbon is able to form three basic isotopes - 12C, 13C and 14C. Isotop 14C is a radioactive radionuclide with a decay half-life of 5730 years. In nature, all three isotopes are represented in a constant ratio. When the organism dies or when the carbon supply is stopped, the results in the ratio of isotopes remains the same as in the surrounding nature. Radionuclide then begins to disintegrate and the ratio between isotopes increases. Depending on the number of decays per minute in 1 g of radioactive carbon, it is possible to determine the age of the finding.

sources: https://en.wikipedia.org/wiki/Radiation https://www.mirion.com/introduction-to-radiation-safety/types-of-ionizing-radiation/ http://www.wikiskripta.eu/w/Radioaktivita_(2._LF_UK)