Nuclear reaction

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Suggested reviewer: Carmeljcaruana

Radioactivity refers to the particles, which are emitted from nuclei as a result of nuclear instability. Because a nucleus is made of protons, which naturally, due to there positive charge repel each other, there has to be a nuclear force to keep them together, the strong nuclear force (1). Neutrons in the nucleus also help reduce repulsion between protons, since they have no charge, they keep the protons far apart from each other. But when there are too many protons, the proton-proton repulsions builds and the nucleus becomes unstable. It carries more energy than it can manage. To achieve less energy (and more stability), they undergo radioactive decay, ejecting small nuclear fragments and high-energy radiation. That's why it should not be surprising that many nuclear isotopes (2) are unstable and emit some kind of radiation. An atom of a radioactive isotope will spontaneously decay into another element through one of three common processes: Alpha decay Beta decay Spontaneous fission In the process, four different kinds of radioactive rays are produced: Alpha rays, Beta rays, Gamma rays, Neutron rays (3)

ALPHA DECAY Alpha decay is one of the processes by which unstable atoms can become more stable. During alpha decay, an atom nucleus ejects two protons and two neutrons in a single packet called alpha particle This alpha particle is a fast moving helium nucleus carrying a +2 charge. It is the largest radiation particle. Because of its very large mass and its charge, it has a very short range, and can strongly interact with matter, meaning that they have a limited ability to penetrate materials. They travel only a few centimeters through air so they can easily be stopped by skin, thats why external exposure is not hazardous, although they becomes dangerous if inhaled or swallowed, proceeding directly into the lungs and causing cancer.

BETA DECAY In beta decay a neutron becomes a proton by producing an electron. A neutron in the nucleus spontaneously turns into a proton, an electron, and a third particle called an antineutrino. The nucleus ejects the electron and antineutrino, while the proton remains in the nucleus. The ejected electron is referred to as a beta particle. This electron that is released was not present before the decay occurred, but was actually created in the decay process itself. Basically, a Beta particle can be an electron (4) with a charge of -1, or a positron (5) with a charge +1, (particle equal in mass but opposite in charge to the electron considered a positive electron). Unlike alpha particles, these ones are able to penetrate skin so large amounts of beta radiation may cause skin burns, (when taken internally beta emitters can cause tissue damage and increase the risk of cancer). It takes aluminum or even wood (as we saw during our experiments) to stop a beta particle. In the other hand, although beta radiation is more penetrating than alpha radiation it lacks of the kinetic energy of alpha particles

SPONTANOEOUS FISSION To understand Gamma rays we have to acknowledge the fact that radioactive decay is a type of nuclear fission (6) (being the other type nuclear reaction). During the process of fission the atom actually splits instead of throwing off an alpha or beta particle. "For example Fermium 256 atom which is really heavy may split into Xenon140 atom and one palladium 112 atom, and in the process sheds 4 neutrons. These 4 neutrons may crash into other atoms and cause various reactions." (7) Neutron radiation can be used to make nonradioactive atoms become radioactive. In many cases, a nucleus that has undergone alpha decay, beta decay or spontaneous fission will be highly energetic and therefore unstable. It will eliminate its extra energy as an electromagnetic pulse known as a gamma ray. A gamma ray is a packet of electromagnetic energy photon with short wave length and therefore more energy. Gamma photons are the most energetic photons in the electromagnetic spectrum. Gamma rays have no effect on either mass or charge, they only stabilize the nucleus by releasing some of the excess energy. Gamma rays are the most damaging rays being able to penetrate kilometers of dense material (8) (like thick lead). Because of the gamma ray's penetrating power and ability to travel great distances, it is considered the primary hazard to the general population, large exposures in short time periods, cause severe damages. To summarize the above we may say that many nuclei are radioactive. This means they are unstable, and will eventually decay by emitting a particle, transforming the nucleus into another nucleus, or into a lower energy state. A chain of decays takes place until a stable nucleus is reached. During radioactive decay, principles of conservation apply. Some of these are: Conservation of energy, Conservation of momentum (linear and angular), Conservation of charge, Conservation of nucleon number We may mention as well, that when unstable nuclei undergo radioactive decay, their decay rate is not steady. Instead, they have a half-life (t1/2), which is the amount of time required for half of the reactant to disappear.

(1) The strong nuclear force is created between nucleons by the exchange of particles called mesons. We can imagine this exchange as a ping-pong ball constantly hit back and forth. As long as this meson exchange can happen, the strong force is able to hold the participating nucleons together.

(2)Recall, isotopes are variants of a particular element, with the same number of protons but different Lumber of neutrons. The chemical properties of the different isotopes of an element are identical, but they will often have great differences in nuclear stability

(3)Neutron rays will not be discussed in this essay due to its complexity

(4) Unlike electron they are not created outside the nucleus but inside it.

(5) Note that the mass number is unchanged and a new element is formed. So what was the effect of this Beta particle production? It actually changed a neutron into a proton.

(6) The splitting of the nucleus of an atom into nuclei of lighter atoms, accompanied by the release of energy. http://dictionary.reference.com/browse/fission

(7)The Hunger Games Companion: The Unauthorized Guide to the Series. Lois H. Grresh. Macmillan edition. 2011

(8)High energy gamma rays are known as cosmic rays

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