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A Natural Event of Radioactivity

Abstract

Natural radioactivity was first discovered in 1896 by the French physicist Beck Kerelem. As a result of recent research, Pierre and Marie Curie discovered that the nucleus of atoms of some elements spontaneously transforms into the nucleus of atoms of other elements, and during this, the radiation of particles occurs. Most naturally occurring radioactive elements form a radioactive family in which each radioactive element originates from the preceding radioactive element and in turn transforms into the next radioactive element. The transformations continue until the end product is an isotope of a stable element. In nature, there are also radioactive elements that this transformation occurs only once .

In 1934, French scientists Irene and Fredrik Joluo-Curie irradiated aluminum, boron and manganese with particles and obtained isotopes of phosphorus, nitrogen and silicon elements, which do not exist in nature. This type of radioactivity is called artificial radioactivity. Later, by irradiating various elements with proton, deuteron and neutron particles, they obtained isotopes of all chemical elements in the Mendeleev table.

Keywords: *natural, radioactivity, partticles, irradiated, elements*

Introduction

In January 1896, the French physicist A. Poincaré at a meeting of the Academy put forward a hypothesis about V. K. Roentgen and the connection of this radiation with the phenomenon of fluorescence – a non-thermal glow of a substance under the influence of ultraviolet radiation.

Physicist A. A. Becquerel at the meeting. He was interested in this hypothesis because he had long studied the phenomenon of fluorescence using samples of uranite nitrite and other uranium salts. These substances glow with a bright yellow-green light under the influence of sunlight, but the uranium salts stop glowing in less than a hundredth of a second as soon as the sun's rays stop. It was founded by A. A.'s father. Becquerel was also a physicist (Yaroshinskaya, 1996).

Research

After listening to A. Poincaré's report, A. A. Becquerel said that uranium salts that stop glowing can continue to emit another radiation that passes through an opaque material (Crameri & Burkart, 1989). The researcher's experience proved it. The scientist placed grains of uranium salt on a photographic plate wrapped in black paper and exposed it to sunlight. Developing the plate, he noticed that the grains were darkened where they were located. A. A. Becquerel concluded that the radiation emitted by the uranium salt was stimulated by the sun's rays. But the research process was again invaded by a disaster.

Once A. A. Becquerel had to postpone another experiment due to cloudy weather. He placed the photographic plate he had prepared in a drawer of the table and placed a copper cross covered with uranium salt on it (Tanner, 1978). After some time, he again prepared the board, and on it was shown the outline of a cross. Since the cross and tablet were in a place inaccessible to sunlight, it was left to think that uranium, the last element in the periodic table, spontaneously emitted invisible radiation (Schery et al., 1988).

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Figure 1. Radioactive element-uranium salt

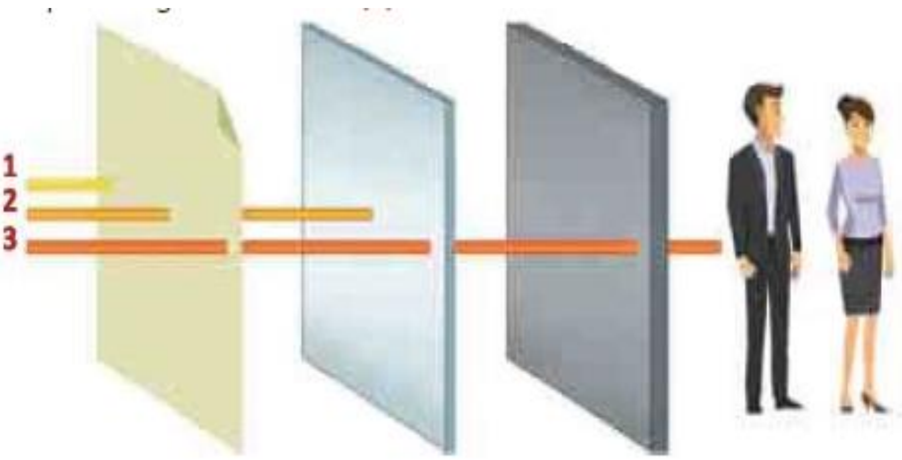

Figure 2. The spread of radioactive rays

The study of this phenomenon was taken up by A. A. Becquerel, his spouses Pierre and Marie Curie. They found that two other elements they discovered have this property. One of them was called polonium – in honor of Marie Curie's native Poland, and the other was called radium, from the Latin word radius – radium. At the suggestion of Marie Curie, this phenomenon was called radioactivity (Schery et al., 1988).

The spontaneous transformation of one radioactive nucleus into another nucleus is called radioactive transformation. There are two types of radioactive transformation: radioactive α-transformation and radioactive β-transformation.

• In α-transformation, the charge number of the nucleus decreases by 2 units, and the mass number decreases by 4 units. As a result, the element changes its place two places towards the beginning of the periodic table:

• In β-transformation, the charge number of the nucleus increases by 1 unit, while the mass number does not change. As a result, the element changes its position one cell towards the end of the periodic table:

E. Rutherford experimentally established that the penetration capabilities of radioactive rays are also different. So, while one type of these rays (1) could not even pass through a sheet of paper, for

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the other (2) an aluminum plate with a thickness of 3 mm became an impenetrable barrier. The third type of rays (3) cannot be resisted by a lead wall with a thickness of several centimeters (Figure 2).

The concept of "radioactivity" is a mystery. Despite the fact that radionuclides are currently used in all areas of the economy, the phenomenon of radioactivity is still treated with caution. Some scientists see the phenomenon of radioactivity as the result of human manipulation of nature. But this is not so. The phenomenon of radioactivity is a completely natural phenomenon that has been inherent in matter since the beginning of mankind. It just happened that some light elements became stable, and heavier ones became unstable. Currently, there is a controversial hypothesis that all known elements are radioactive, but they decay at different rates: heavier ones faster, lighter ones more slowly, and this slow decay occurs so that existing instruments cannot detect their radioactivity. This hypothesis has not yet been confirmed (Schery & Whilstone, 1989).

It is because of their nature that radioactive elements and isotopes are stored in the Earth's crust and its mantle (Schery & Wasiolek, 1993). This applies not only to the widely known elements uranium and thorium (all isotopes of these elements are radioactive), but also to some isotopes of stable elements, for example, the isotope potassium-40, which is included in all substances on Earth. Interestingly, potassium-40 and its other radionuclides are called relic (ancient). This name is given to them because their decay rate is very small (or, in other words, because their half-life is very long) and because they have been around since the formation of the Solar System.

What is the role of potassium-40 in our planet? It is believed that the Earth's mantle is kept in a liquid state thanks to it, that is, the mantle heats up due to the heat of radioactive decay of potassium-40 and other radionuclides. On the other hand, the effect of potassium-40 (and its "colleagues") on the background of natural radiation is very significant, that is, life on Earth arose and developed under the constant influence of radiation (Chi-Yu King, 1980). Experiments show that when animals are isolated from natural radiation, their activity decreases (lethargy occurs), reproductive functions decrease. For this reason, natural radioactivity is very important for human life, it is enough to think about the benefits of radon baths for human health (Hotzl & Winkler, 1994).

The reason why so much attention is paid to the potassium-40 isotope is that its chemical properties are exactly the same as non-radioactive potassium - the biogenic element in our bodies! An adult human body contains 170 g of potassium, 20 mg of which is radioactive potassium-40. Thanks to this radionuclide alone, 300,000 radioactive decays occur in the human body every minute!

Such an event happened at one of the exhibitions. In one of the pavilions, a device measuring the radioactivity of the human body was placed, and strangely enough, it showed a relatively high level of radioactivity in men. The explanation for this phenomenon is that potassium accumulates more effectively in muscle tissues, and muscle tissues are more abundant in men (Porstendorfer, Butterweck, & Reineking, 1994).

The mass of the nucleus of heavy radioactive elements exceeds the mass of the nucleons in its composition. This is the reason for the radioactivity of heavy elements, because it is known from Einstein's formula that mass and energy are equivalent. The excess energy of radioactive nuclei causes the decay of heavy nuclei. For light elements, the total mass of nucleons exceeds the mass of their nucleus. Therefore, fusion of light elements – thermonuclear fusion – causes the release of energy from the nucleus. During fission or fusion reactions, the release of energy leads to the transformation of nuclei (Ogorodnikov, 1995).

Unlike radioactive decay, stable nuclei and nuclei of new elements can be synthesized. Such transformations of nuclei are called nuclear reactions. Protons are usually high energy to cause nuclear reactions

The neutron's lack of electric charge makes it extremely easy for it to enter atomic nuclei. Therefore, the neutron is considered the most effective "projectile" to achieve nuclear transformation. Low-speed neutrons are more useful than high-speed neutrons, so fast neutrons need to be slowed down first. Heavy water (D2O), graphite, etc. are used as coolants. It should be

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noted that when the same nucleus is bombarded with different fast particles, the reaction product is also different (Zimmermann et al., 1989).

The splitting of the nuclei of heavy elements under the influence of neutrons constitutes a type of nuclear reaction. During nuclear fission, two nuclear-shells receive 2-3 neutrons and a large amount of energy.

As a result of nuclear fission occurring in different variants, the mass numbers of nuclear fragments can vary from 72 to 161. Each of the 2-3 neutrons released during nuclear fission splits a neighboring nucleus, and each fission produces 2-3 new neutrons that can split other nuclei, and so on. Thus, the number of dividing nuclei increases very rapidly and causes a chain reaction.

Radioactive nuclei can decay, interact with other particles, and synthesize them. In all cases retention laws are followed.

Conclusion

Numerous experiments have shown that the property of natural radioactivity is only related to the composition and structure of the atomic nucleus of the element. External factors (mechanical pressure, temperature, electric and magnetic fields, etc.) do not affect this property.

In 1899, the physical nature of radioactive radiation was studied under the guidance of English physicist Emest Rutherford. It has been established that radioactive radiation consists of a stream of various particles. So, when a flood of these particles passes through a magnetic field, some of them are affected by the Lorentz force:

- part of the rays consists of a stream of uncharged particles, they are not inclined in the magnetic field - they were called λ-radiation;
- since the other part of the rays consists of a flood of positively charged particles, they tend to the direction of the thumb of the left hand from their previous direction (according to the left hand rule) - this radiation was called π-radiation.

The third part called β-radiation is a flood of negatively charged particles, so they tend in the opposite direction of α-radiation. Later, the property of radioactive transformation was discovered in radioactive substances.

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