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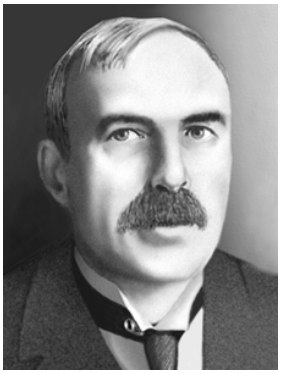
10D Ernest Rutherford

Ernest Rutherford initiated a new and radical view of the atom. He explained the mysterious phenomenon of radiation as the spontaneous disintegration of atoms. He was the first to describe the atom's internal structure and performed the first successful nuclear reaction.

Ambitious immigrants



Ernest Rutherford was born in rural New Zealand on August 31, 1871. His father was a Scottish immigrant, his mother English. Both valued education and instilled a strong work ethic in their 12 children. Ernest enjoyed the family farm, but was encouraged by his parents and teachers to pursue scholarships. He first received a scholarship to a secondary school, Nelson College. Then, in 1890, after twice taking the qualifying exam, he received a scholarship to Canterbury College of the University of New Zealand.

Investigating radioactivity

After earning three degrees in his homeland, Rutherford traveled to Cambridge, England, to pursue graduate research under the guidance of the man who discovered the electron, J. J. Thomson. Through his research with Thomson, Rutherford became interested in studying radioactivity. In 1898 he described two kinds of particles emitted from radioactive atoms, calling them *alpha* and *beta* particles. He also coined the term *half-life* to describe the amount of time taken for radioactivity to decrease to half its original level.

An observer of transformations

Rutherford accepted a professorship at McGill University in Montreal, Canada, in 1898. It was there that he proved that atoms of a radioactive element could spontaneously decay into another element by expelling a piece of the atom. This was surprising to the scientific community—the idea that atoms could change into other atoms had been scorned as alchemy.

In 1908 Rutherford received the Nobel Prize in chemistry for “his investigations into the disintegration of the elements and the chemistry of radioactive substances.” He considered himself a physicist and joked that, “of all the transformations I have seen in my lifetime, the fastest was my own transformation from physicist to chemist.”

Exploring atomic space

Rutherford had returned to England in 1907, to Manchester University. There, he and two students bombarded gold foil with alpha particles. Most of the particles passed through the foil, but a few bounced back. They reasoned these particles must have hit denser areas of foil.

Rutherford hypothesized that the atom must be mostly empty space, through which the alpha particles passed, with a tiny dense core he called the nucleus, which some of the particles hit and bounced off. From this experiment he developed a new “planetary model” of the atom. The inside of the atom, Rutherford suggested, contained electrons orbiting a small nucleus the way the planets of our solar system orbit the sun.

‘Playing with marbles’

In 1917, Rutherford made another discovery. He bombarded nitrogen gas with alpha particles and found that occasionally an oxygen atom was produced. He concluded that the alpha particles must have knocked a positively charged particle (which he named the *proton*) from the nucleus. He called this “playing with marbles” but word quickly spread that he had become the first person to split an atom. Rutherford, who was knighted in 1914 (and later elevated to the peerage, in 1931) returned to Cambridge in 1919 to head the Cavendish Laboratory where he had begun his research in radioactivity. He remained there until his death at 66 in 1937.

Reading reflection

1. What are alpha and beta particles? Use your textbook to find the definitions of these terms. Make a diagram of each particle; include labels in your diagram.

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2. The term “alchemy” refers to early pseudoscientific attempts to transform common elements into more valuable elements (such as lead into gold). For one kind of atom to become another kind of atom, which particles of the atom need to be expelled or gained?

3. Make a diagram of the “planetary model” of the atom. Include the nucleus and electrons in your diagram.

4. Compare and contrast Rutherford’s “planetary model” of the atom with our current understanding of an atom’s internal structure.

5. Why did Rutherford say that bombarding atoms with particles was like “playing with marbles”? What subatomic particle did Rutherford discover during this phase of his work?

6. Choose one of Rutherford’s discoveries and explain why it intrigues you.