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The work of the eighteenth and nineteenth century chemists had given to the world some eighty-odd elements, and it was quite clear that the atoms of the elements were very stable structures. But though the old ideas of transmutation were exploded, the problem still existed, and indeed had been clearly formulated by Faraday. The discovery of radioactivity showed that elements such as uranium and thorium were undergoing spontaneous transformation, and a large number of new elements were brought to light. Moreover, the property was shown to exist in a very slight degree in elements such as potassium and rubidium, the remainder of the normal elements being stable under ordinary conditions over periods to be reckoned in millions of years.

It was in 1911 that the nuclear structure of the atom was clearly evidenced, and a little later that Bohr's masterly interpretation of the movements of electrons gave an explanation of spectral regularities. It soon became evident that outer electrons played no major part in transmutations, that the changes produced by stripping off electrons were only temporary in character, and that the structure of the nucleus must be changed if we wished to institute any permanent atomic transmutation. Moreover, evidence had accumulated to show that the nucleus was a very small entity.

If an α-particle were fired at a nucleus, the enormous forces developed in a head-on collision might be expected to disturb the structure of the nucleus, and it was in 1919 that decisive experiments were made. When α-particles were fired in oxygen, no effect was produced, but when they were fired in nitrogen, a new type of particle appeared—the *proton*.

If we assume that the proton originated from a transformation of the nitrogen nucleus, the question of the rationale of the transmutation becomes urgent. Photographic evidence showed the *capture* by the nucleus of an α-particle accompanied by the *emission* of a proton. If then a nitrogen nucleus of mass 14 and charge 7, assimilates an α-particle of mass 4 and charge 2, with the *emission* of a proton of mass 1 and charge 1, we are left with a nuclear structure of mass 17 and charge 8—an isotope of oxygen, in fact. In a similar manner, other transmutations may be checked, remembering that all such changes must obey what may be termed *general* energy conditions, that is, we must take into account not only kinetic energy, but also the masses involved, remembering that, in some sense, mass and energy are convertible terms. It will be seen that in the instance considered, the new element has a mass three units higher and a charge one unit higher than that of the element which has suffered transmutation.

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It is not difficult to picture the changes which ensue when neutrons are fired into oxygen or nitrogen with the consequent emission of an α-particle, and indeed it is certain that future experiments will show that the neutron is a very powerful weapon of research. Five years ago it became evident that the methods of attack developed must be supplemented by the use of other types of fast particle if more information were to be forthcoming, and it was found possible to obtain from an electric discharge large supplies of particles the speeds of which might be raised by travel through an electric field. This demand has resulted in the development of laboratory methods for the production of high potentials. Lately, assistance has been given by developments of wave mechanics which have shown that particles which could not surmount a potential barrier might yet get through, so that there is a possibility of successful attack by using intense streams of particles at low voltages. One timely word of warning was issued to those who look for sources of power in atomic transmutations—such expectations are the merest moonshine.

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