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STRUCTURE OF THE ATOM

ADVANCES INTO A NEW WORLD

THE WORK OF LORD RUTHERFORD

FURTHER LIGHT ON SOLAR HEAT

RESEARCH AND THE FUTURE

BY PROFESSOR E. N. da C. ANDRADE, Ph.D., D.Sc., F.R.S.
Quain Professor of Physics in the University of London

On Monday last was published the address prepared by Lord Rutherford for delivery at the Indian Science Congress, of which he was to have been president. It serves to remind us of the tragic suddenness of his death, following a surgical operation, on October 17 last year, but it also brings before us a brief survey of the astonishing results which constitute the crown of Lord Rutherford's life work.

The experiments themselves are scarcely more surprising than the fact that they should have been thought possible. When we consider that those of us who are middle-aged can remember a time when nothing was known of the structure of atoms—when, in fact, to speak of a possible structure of the atom was sufficiently daring—it is remarkable to reflect that to-day we are deep in investigations of the atomic nucleus, which is minute compared to the atom itself, and are building up atoms and taking them to pieces almost as routine work.

AN "ATOM GUN"

These advances into a new world—for the atomic nuclei offer as much space for intellectual adventure and speculation as the world of stellar universes which Herschel threw open to us—were due, as far as any great advance can be due to one man, to Rutherford alone. This is not to undervalue the services of his collaborators and colleagues—men like C. T. R. Wilson, who invented the cloud chamber, which renders visible, as a trail of minute droplets, the path of a single atom, or like E. O. Lawrence, who has invented the ingenious cyclotron, an atom gun which, with its fifty-ton magnet, fires a stream of particles with energies corresponding to several million volts.

It was Rutherford who first made clear the behaviour of the unstable atoms which we call radioactive, and who in this way elucidated one kind of atomic transmutation; it was Rutherford who first proved that the atom had a nuclear structure, the nucleus being the controlling centre which determines the mass and chemical behaviour of the atom; it was Rutherford who first clearly demonstrated the importance of alpha particles, the single atoms of helium fired off by certain radioactive bodies, as agents for attacking the nucleus, and who by this means effected the transmutation of nitrogen atoms into oxygen atoms; it was Rutherford who insisted on the necessity for producing swift atoms artificially, that is, without using radioactive substances as a source, and who initiated the building of high voltage installations to fire charged particles with high energy, in much greater numbers than we can get with radium.

In Rutherford's laboratory Cockcroft and Walton effected the first transmutation by the help of these artificially accelerated projectiles. The whole history of the new alchemy, the changing of one kind of atom to another, may be written in terms of Rutherford's work.

THE NEW CHEMISTRY

With these experiments of Cockcroft and Walton in 1932, carried out under Rutherford's guidance and inspiration, a new branch of science was begun, which

Continued on page 16, Col. 1.

STRUCTURE OF THE ATOM

Continued from page 15, Col. 7.

I have ventured to call the New Chemistry. In ordinary chemistry we change one kind of molecule into another kind of molecule at will; that is, certain combinations of atoms into other combinations of atoms, the atoms themselves being unchanged.

In the New Chemistry we change one kind of atom into another, the old dream of the alchemists. Gold has not so far been changed into lead, but magnesium has been changed into sodium. The quantities involved are minute, far too small to be weighed, but the identification of the atom, by modern methods, is no less certain than it would be with larger quantities. The work of atom building has been particularly vigorously and successfully pursued in America, especially by Lawrence and his school, with the cyclotron.

A discovery essentially connected with Rutherford's work is that of artificial radioactive substances. In 1934 Curie and Joliot produced artificially, by the kind of bombardment already mentioned, cer-

tain types of atoms which did not have permanent nature, but spontaneously changed, giving out a radiation in the process, just like ordinary radioactive bodies. These atoms transform in a relative short time, the process being practically over in a day or so, so that they are found in nature, for any formed at the beginning of the world have disappeared long ago. They may, of course, be constant process of formation in the

STABLE AND UNSTABLE ATOMS. The general idea of experiment is to produce small to have any immediate importance. The scientific significance of this atomic work can, however, be exaggerated. By investigating various transmutations we may discover the laws that make one atom common, and another very rare kind of heavy atom (lead or gold, stable, and another kind of heavy atom (uranium or radium, say) unstable. We may also hope to learn why the different isotopes of one element, that is, the atoms of different mass which have the same chemical properties, occur in such different proportions. We may hope to obtain further light on solar physics and on the origin of solar heat. The possibilities are, in fact, too numerous to be mentioned here.

Even to the statement that the experiments have no immediate practical importance we must make an exception. Lawrence, using his cyclotron, has made a radioactive isotope of sodium, which reverts to magnesium, giving out radiation in the process. The quantity which is made is nothing like that in which radium can be obtained, but the transformation is so rapid compared to that of radium (15 hours compared with 2,000 years) that the activity, while it lasts, is comparable. Already the manufacture of radionadium in quantities sufficient for medical purposes, to which it seems particularly adapted, is in sight. It may well be that producing artificial radioactivity, a branch of the new science of atom building, will soon be a practical undertaking.

To the Hills

I have stayed too long in the lowlands,
Lapped in their murmurous dreams;
I have drunk my fill of their beauty,
Their lovely lingering streams;

With ever the lull of contentment
And never the sting of fears,
With ever the languor of slumbers
And never the hush of tears.

Let me go to the uplands straightway
With the winds of heaven on my cheek,

And the strength of the hills shall absolve me,
The voice of the hills shall speak.

ARTHUR L. SALMON.

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TIMES SATURDAY JANUAR

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FUNDAMENTAL BASIS OF LIFE

PROFESSOR BALY ON THE ACTION OF LIGHT

FROM OUR OWN CORRESPONDENT

CALCUTTA, JAN. 7.

This morning saw great activity in all Sections of the Indian Science Congress. The Indian Chemical Society and the Department of Psychology held their annual meetings and gave a luncheon for the oversea delegates. In the afternoon there was a party and convocation at Government House.

Professor E. C. C. Baly, of Liverpool University, gave a notable sectional address on the mechanism of photo-synthesis.

The fundamental basis of all life, he said, was the process whereby, in the leaves of plants, carbohydrates, including certain sugars, were produced by carbon dioxide and water only. Since the process was carried out by means of light, it was known as photo-synthesis. Its mechanism had for many years remained undiscovered, owing to the difficulty of explaining how the large quantity of energy necessary was supplied. There were in sunlight no rays capable of promoting photo-synthesis as a single reaction.

As a result of protracted investigation in Liverpool, however, the explanation of this mystery had been found. It had been proved that the photo-synthesis of carbohydrates was achieved in two successive stages, each of which was promoted by light. The first stage was promoted by blue light, and the product of this process, when acted on by red light, gave carbohydrates. The sum of the two amounts of light energy thus supplied was exactly equal to the total amount of energy required.

When the surface of pure nickel oxide was irradiated with white light in the presence of carbon dioxide and water, carbohydrates were produced. The first product formed was a complex carbohydrate similar to starch, which, when acted on by diastase, gave simple sugars similar to those produced in the leaves of plants. The laboratory process appeared similar in every way to that in the living plant, the only difference being that in the former nickel oxide took the place of chlorophyl.