Nuclear Physics

THE British Association discussion at Norwich on nuclear physics on September 5 was opened by Lord Rutherford. After a review of progress resulting from the application of high voltages to nuclear transmutation, he passed on to discuss the rapid development of our knowledge of artificial radioactivity and in particular the production of such radioactivity by neutron bombardment. Neutrons, being uncharged, penetrate the heaviest nuclei without difficulty, and radioactive isotopes of the great majority of the elements have already been discovered. The effectiveness of neutrons in producing some types of transmutation is increased largely by slowing them down by passage through paraffin, water or other substances containing hydrogen, the neutrons losing energy by collision with the protons. By slowing them down in this way to thermal velocities, their adsorption by boron is increased 350 times, by cadmium 3,000 times, and by gadolinium 30,000 times, the effective cross-section for capture then being of the order of 10^{-20} sq. cm. A demonstration that neutrons actually obtain thermal velocities is afforded by slowing them down in paraffin wax cooled to liquid air or liquid hydrogen temperatures. This extra cooling reduces the velocity still further, and an increase in the efficiency of disintegration has been observed by P. B. Moon and others.

Lord Rutherford considers that it would be of interest to see whether neutrons reach the upper layers of the atmosphere in appreciable numbers, and whether they can account for any of the cosmic ray phenomena. He hopes that future expeditions to the stratosphere will include apparatus for the detection of neutrons.

He passed next to discuss the new radioactive isotopes. These isotopes must exist in the sun or other hot stars where a natural nuclear bombardment must be constantly proceeding. They would therefore exist in the substance of the earth when it was first flung off from the sun, but in the course of time they would progressively disappear, only those with the longest lives such as radium with its unstable products remaining.

Dr. C. D. Ellis stressed the importance of the accurate measurement of the energies of electrons, γ-rays and protons emitted in related transmutations. Thus aluminium bombarded by α-particles can change into Si^{30} and a proton, or to Si^{30}, a neutron and a positron. An accurate measurement of the kinetic energies in the two alternative modes of transmutation would show whether in all cases the energy liberated in the positron emission is given by the maximum positron energy. It appears that many of the measurements made hitherto were quite unreliable, estimates of maximum positron energies varying by factors so large as two. Dr. Ellis expressed the hope that the exciting work of discovering new radioactive elements would shortly give way to more precise work.

A similar point was raised by Dr. J. D. Cockcroft. It is well known that carbon bombarded by deuterons can either give C^{13} with the emission of a proton or through the production of radionitrogen to C^{13}, a positron and a neutron. The kinetic energy release in the proton reaction has been measured carefully, and is 2·7 million volts. The total kinetic energy available for neutron and positron should thus be only 1·3 million volts. The maximum energy of the positrons on the other hand is at least 1·4 million volts, whilst the neutrons must possess some kinetic energy. A way out of the difficulty might be found by the discovery of other modes of energy liberation in the proton reaction although strong theoretical arguments have been advanced against the possibility of such other modes.

Dr. Cockcroft referred also to the properties of the new radioactive isotopes produced by proton and deuteron bombardment. Radioactive isotopes of lithium and boron have been discovered emitting electrons up to 11 million volts energies. Radiosodium which emits penetrating γ-rays can be produced by voltages so low as 500 kilovolts, but a 10-hour bombardment of a rock salt crystal with 10 microamps will produce a source emitting only 2,000 electrons per second, whereas an increase of voltage to 1·7 million increases the yield by a factor of 10,000. Prof. Lawrence hopes by advances in technique to increase the yield by a further factor of 1,000, and so to produce in a day a source of the same order of activity as a gram of radium. Prof. Lawrence considers that such sources might have great importance in biological work.

Dr. M. L. Oliphant showed how the accurate measurement of the kinetic energy changes in nuclear transmutations has led to a revision of the scale of nuclear masses. Until recently, the mass spectrograph data have been accepted without question, but several serious discrepancies have forced a reconsideration of the position. The mass of Be^{9} has caused the greatest difficulty, for on Aston's and Bainbridge's figures it should be able to disintegrate spontaneously into 2 α-particles and a neutron. It appeared that all

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the difficulties were removed by the assumption that a small error had been made in determining the mass of helium relative to oxygen. Since most of the masses were measured in terms of helium, a complete revision of the mass scale necessarily followed. Dr. Aston has since repeated his mass spectrograph measurements using the more accurate brackets now possible with the use of deuterium, and has confirmed that revision was necessary.

Mr. M. Goldhaber reported the experiment of Dr. J. Chadwick and himself on the γ-ray disintegration of the deuteron. The neutrons resulting from the transmutation have been detected by their action in disintegrating lithium ; the proton energies have been estimated at 240 kilovolts using radium γ-rays.

Dr. N. Feather reported a more accurate determination of this energy by the use of a Wilson chamber filled with 'heavy methane'. 40 proton tracks were measured, the proton energy being about 180 kilovolts. The distribution of tracks was similar to that expected for a photo-electric effect. The new work requires a proton mass of 1·0086 on the revised scale.

Dr. P. B. Moon demonstrated the production of induced radioactivity by neutrons, and in particular showed how enormously the effect with rhodium is increased by slowing down the neutrons by paraffin wax.

News and Views

Demonstration of Firewalking

A DEMONSTRATION of firewalking was given by an Indian, Kuda Bux, before members of the University of London Council for Psychical Research and other men of science at Carshalton, on September 17. The fire was contained in two trenches about 12 ft. long, 6 ft. wide and 8 in. deep. Barefooted, Kuda Bux walked along the trenches twice, and his feet made contact with the burning embers for some five seconds each time. Prof. C. A. Pannett of St. Mary's Hospital sends us the following account of his observations : "Kuda Bux is physically of the typical, slightly built, Indian type. The soles of his feet present no unusual features. The skin is not callous but soft, as the skin of so many individuals who walk barefoot. The feet felt cold to the hand, and a skin thermometer registered 93·2° F. This was about twenty minutes before the attempt, during which time the performer walked about the lawn. A five-eighths inch square of zinc oxide plaster was attached to the sole of the right foot. The skin of the feet was very dry. The feet were washed and dried carefully about fifteen minutes before the walk. After the steps had been taken, with a delay of perhaps ten seconds, the temperature of the soles of the feet was again taken. It was now 93° F. There was no sign of burning of the skin.

"AT the conclusion of the performance, after Kuda Bux had walked twice over the pit, an interval of perhaps forty minutes having elapsed, the feet were again examined. By careful scrutiny could be seen here and there the whitened appearance of the skin which occurs when the very surface of the epithelium is scorched without blistering. Yet with the pigmentation present it was very difficult to be positive of this. There were no signs of hyperæmia or blistering. The patch of plaster was quite unharmed, except that the fluff of the cotton basis at the cut edge looked very slightly scorched. If this were so, these cotton fibres must have reached a temperature approaching 120° C. Mr. Digby Moynagh, who had made an attempt to carry out a firewalk ten days previously, made a second one. The soles of his feet had a number of blisters on them, which were in the healing stage. After two steps he acquired new blisters. The soles of his feet were noticeably moister than those of the Indian, and this factor may be of importance, because at one place the dampness had caused a piece of the charcoal to adhere. Underneath it a burn occurred. Mr. Maurice Sheepen also made two steps on the glowing charcoal. Hyperæmic patches occurred on his soles, which doubtless were the beginning of blisters."

Our Indian Contemporary—*Current Science*

To those who are interested in following from afar the remarkable increase in the appreciation of scientific education and research in India, which has recently become so apparent, our contemporary *Current Science* has been indispensable. This journal, which now enters upon its fourth year, is ably edited by Prof. C. R. Narayan Rao, of Bangalore, with the active co-operation of all the leading men of science in India. It has been their aim to provide India with a periodical similar in its aims to NATURE and in this they have undoubtedly been successful. In the July issue, the future of Indian university education is discussed at length, more especially as it affects the pass degree graduates who are so numerous in India. The problem of finding employment for these is not solely an Indian problem, but there it attains a magnitude not met with elsewhere. It is suggested that the courses of study require modification to meet this difficulty, but we doubt if this would provide more than a partial solution of the problem. We think that much might be done by the introduction of Civil Service examinations for the lower grades of civil servants, which would remove from the colleges many unsuitable students. The question is one well worthy of study by an independent committee.

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