Radiobromine

Don C. De Vault and W. F. Libby[1] and E. Segrè, R. S. Halford and G. T. Seaborg[2] have shown that the 4·5-hr. radiobromine transforms into the 18-min. isotope which is β-active, by the emission of soft γ-rays. Le Roux, Lu and Sugden[3] find that this is the method of disintegration of at least 90 per cent of 4·5-hr. radiobromine. Segrè, Halford and Seaborg[2] predicted that the γ-rays would be soft, and a large proportion would be internally converted.

These considerations are in agreement with observations made in a Wilson chamber of the disintegration of 4·5-hr. radiobromine. Measurement of tracks starting from thin foils which had been activated with radiobromine, and from active ethyl bromide introduced as a vapour into the chamber, show homogeneous energy groups of electrons due to the K and L conversion of this γ-ray, superimposed on a background of the continuous β-ray spectrum of the β-active isotope.

In those experiments in which tracks start in the gas of the chamber, half the electrons produced by the internal conversion of the γ-rays in the K level are accompanied by short tracks starting from the same atom and due to the Auger conversion of the K X-rays of bromine. The existence of these X-rays was reported by Philip Abelson at the December meeting of the American Physical Society at Los Angeles. The Auger electrons accompanying L conversion would not be observed.

These experiments show that the γ-rays have an energy of 43,000 electron volts. The coefficient of internal conversion in the K shell is of the order of 0·30, and that in the L shell much smaller.

Since Le Roux, Lu and Sugden effected a 90 per cent separation of the isotopes, the loosening of the bond discussed by Segrè, Halford and Seaborg must be due to this low-energy γ-ray alone.

In even so brief a summary as this, I would like to make twofold acknowledgments. For advice and discussion on the physical side I must thank Prof. P. M. S. Blackett, Prof. J. D. Bernal and Dr. L. Simons; I wish also to thank Prof. S. Sugden for help and advice, especially on chemical matters.

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[1] *Phys. Rev.*, **55**, 322 (1939).
[2] *Phys. Rev.*, **55**, 321 (1939).
[3] NATURE [**143**, 517 (1939)].

Formation of Helium of Mass 3 in an Excited State

AN excited state of helium of mass 3 (^{3}He) has been previously suggested by me to explain a second low-energy group of neutrons from the deuteron-deuterium reaction[1]. Since present theory does not predict such an excited state[2] in ^{3}He, it is important to establish definitely whether such a state actually exists. This note gives the results of some cloud chamber experiments which were made in order to investigate this point.

In the present experiments, the D-D reaction was studied with a cloud chamber filled with either methane or helium. The neutrons were detected by means of the recoil protons or recoil helium nuclei. The ranges of those recoil particles were measured which were projected in the forward direction (0–10°). Three series of experiments were made. In the first experiment methane was used in the cloud chamber and the neutrons were observed at 90° to the direction of the 0·9 Mv. deutrons. In the second experiment the conditions were the same except that helium was used in the cloud chamber. In the third experiment the neutrons were observed at an angle of 0° to the 0·5 Mv. deuterons. A summary of the results is given in the accompanying table.

Type of recoils	Deuteron energy (Mv.)	Angle of observ-ation	Neutron energies (Mv.)	Relative intensity of recoil groups		Relative intensity of neutron groups	
				low energy	high energy	low energy	high energy
H	0·90	90°±8°	1·5 ; 2·8	0·28	1·00	0·17	1·00
He	0·90	90°±15°	1·5 ; 3·0	0·92	1·00	0·1–0·2	1·00
H	0·50	0°±9°	1·93 ; 3·55	0·19	1·00	0·12	1·00

In each of the experiments a second low-energy group of neutrons was observed as well as the high-energy group. A significant feature is the increase in the energy of the low-energy neutron group when the bombarding voltage was reduced to 0·5 Mv. and the neutrons were observed in the same direction as the deuterons (0° ± 9°). In this case, although the maximum energy of the neutrons produced in the target is reduced from 4·07 Mv. to 3·55 Mv., the low-energy group of neutrons has more energy. This definitely shows that they are not produced by scattered neutrons. Furthermore, the increase in energy is just what one should expect from the reaction

$$^2\text{H} + {}^2\text{H} \rightarrow {}^3\text{He} + {}^1n.$$

The Q values of the reaction were calculated from the data obtained at 0·5 Mv. The disintegration values are $Q^0 = 3·32 \pm 0·04$ Mv. and $Q^1 = 1·48 \pm 0·04$ Mv. These agree within the experimental error with those I obtained previously with quite a different experimental arrangement. The relative intensities of the two neutron groups as given in the table were computed by means of the known relations between collision cross-section and energy, for neutrons[3].

These experiments show that the ^{3}He nucleus is left in an excited state at 1·84 Mv. in approximately 15 per cent of the disintegrations. At the present time it is not clear what happens to the excited ^{3}He. Experiments on the gamma rays from this reaction seem to give too small an intensity[4]. However, the transition to the ground-state may be strongly forbidden as in the case of the 1·426 Mv. gamma ray of radium C′, and so there may be a high internal conversion of the gamma rays. Another possibility is that the excited ^{3}He emits a positive electron with an energy of about 0·8 Mv.

A more complete description of these experiments will be published elsewhere.

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