Letters to the Editor

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Transmutation Effects observed with Heavy Hydrogen

WE have been making some experiments in which diplons have been used to bombard preparations such as ammonium chloride (NH_4Cl), ammonium sulphate ($(NH_4)_2SO_4$) and orthophosphoric acid (H_3PO_4), in which the hydrogen has been displaced in large part by diplogen. When these D compounds are bombarded by an intense beam of protons, no large differences are observed between them and the ordinary hydrogen compounds. When, however, the ions of heavy hydrogen are used, there is an enormous emission of fast protons detectable even at energies of 20,000 volts. At 100,000 volts the effects are too large to be followed by our amplifier and oscillograph. The proton group has a definite range of 14·3 cm., corresponding to an energy of emission of 3 million volts. In addition to this, we have observed a short range group of singly charged particles of range about 1·6 cm., in number equal to that of the 14 cm. group. Other weak groups of particles are observed with the different preparations, but so far we have been unable to assign these definitely to primary reactions between diplons.

In addition to the two proton groups, a large number of neutrons has been observed. The maximum energy of these neutrons appears to be about 3 million volts. Rough estimates of the number of neutrons produced suggest that the reaction which produces them is less frequent than that which produces the protons.

While it is too early to draw definite conclusions, we are inclined to interpret the results in the following way. It seems to us suggestive that the diplon does not appear to be broken up by either α-particles or by proton bombardment for energies up to 300,000 volts. It therefore seems very unlikely that the diplon will break up merely in a much less energetic collision with another diplon. It seems more probable that the diplons unite to form a new helium nucleus of mass 4·0272 and 2 charges. This nucleus apparently finds it difficult to get rid of its large surplus energy above that of an ordinary He nucleus of mass 4·0022, but breaks up into two components. One possibility is that it breaks up according to the reaction

$$D_1^2 + D_1^2 \longrightarrow H_1^3 + H_1^1$$

The proton in this case has the range of 14 cm. while the range of 1·6 cm. observed agrees well with that to be expected from momentum relations for an H_1^3 particle. The mass of this new hydrogen isotope calculated from mass and energy changes is 3·0151.

Another possible reaction is

$$D_1^2 + D_1^2 \longrightarrow He_2^3 + n_0^1$$

leading to the production of a helium isotope of mass 3 and a neutron. In a previous paper we suggested that a helium isotope of mass 3 is produced as a result of the transmutation of Li^6 under proton bombardment into two doubly charged particles. If this last reaction be correct, the mass of He_2^3 is 3·0165, and using this mass and Chadwick's mass for the neutron, the energy of the neutron comes out to be about 3 million volts. From momentum relations the recoiling He_2^3 particle should have a range of about 5 mm. Owing to many disturbing factors, it is difficult to observe and record particles of such short range, but experiments are in progress to test whether such a group can be detected. While the nuclei of H_1^3 and He_1^3 appear to be stable for the short time required for their detection, the question of their permanence requires further consideration.

M. L. OLIPHANT.
P. HARTECK.
RUTHERFORD.

Cavendish Laboratory,
Cambridge.
March 9.

Magneto-Caloric Effect in Supraconducting Tin

IN connexion with experiments on persistent currents in spheres, and in continuation of previous work on the energy content of supraconductors[1], measurements were carried out on the adiabatic magnetisation and demagnetisation of supraconducting tin.

We used a cylinder of 2 cm. diameter, 5·5 cm. long, with a phosphor-bronze resistance thermometer which was calibrated both with and without a field. The experiments were carried out in the temperature range 2·5°–4·0° K., and both longitudinal and transverse fields were used. The field strength was always considerably higher than the magnetic threshold values of tin.

We observed a cooling effect on magnetisation and a heating effect on demagnetisation. The heating was always greater than the corresponding cooling, as in both cases, when the field was above the threshold value, an additional heating due to eddy currents was produced. Measurements were mainly carried out on the cooling effect, which was found to increase from zero at the normal transition point (3·7° K.) to the lowest temperatures reached. The effect appeared to be the same for longitudinal and transverse fields within the limits of experimental error.

The cooling observed at the various initial temperature indicated was: 0·05° at 3·3° K.; 0·11° at 3·0° K.; 0·21° at 2·7° K.; 0·33° at 2·5° K. Still greater cooling could be obtained by using a magnetic field exactly equal to the magnetic threshold value corresponding to that temperature, as this would eliminate the heating effect of eddy currents.

The theoretical discussion of these results and their connexion with recent calculations by C. J. Gorter and others may be postponed until further experimental material is available.

Experiments are being carried out to investigate this cooling effect at lower temperatures and with different substances. It will perhaps be possible to use the adiabatic magnetisation of supraconductors as a simple method (as the fields necessary are small) of producing very low temperatures.

K. MENDELSSOHN.
J. R. MOORE.

Clarendon Laboratory,
Oxford.
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[1] *Z. phys. Chem.*, B, 16, 72; 1932.