Production of Li^8 in Boron-Loaded Photographic Emulsions

E. PICKUP
Division of Physics, National Research Council, Ottawa, Ontario, Canada
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THE disintegration of B^{11} by fast neutrons to give Li^8 and an α-particle is now well known, and was first detected by Lawrance,[1] using an ionization chamber filled with boron trifluoride. The Q of the reaction, estimated from mass values in the Segrè chart is -6.7 Mev. For some time we have been working on the problem of trying to obtain Li^8 disintegrations in the gas in a cloud chamber with the object of getting information about the neutrino recoil. In the course of this work, and to obtain information about the yield of the $B^{11}(n, \alpha)Li^8$ reaction some Ilford C2, boron-loaded, photographic emulsions were exposed to the neutrons from a Li target bombarded with 600 kv deuterons, in the Ottawa ion accelerator. The neutron spectrum from such a target extends up to about 14.5 Mev with several peaks. This is well above the threshold for the B^{11} reaction, and examples of this disintegration have been observed in the emulsions as well as the usual B^{10} disintegrations. Measurements on the tracks are not yet complete, but one good typical case is shown in Fig. 1 below. This is a mosaic of four microphotographs, and shows clearly the recoil Li^8 nucleus together with the α-particle from the B^{11} disintegration, and the two oppositely directed α-particles of about equal range produced by the splitting of the Be^8 nucleus formed after β-decay of Li^8. This is a simple example of the so-called "hammer" tracks sometimes observed in cosmic-ray stars.

The total energy of the pair of α-particles in this particular case is 2.6 Mev, if we use the range energy data of Lattes, Fowler, and Cuer[2] for the emulsion. The energies of the other α-particle and the Li^8 recoil nucleus are 5.4 Mev and 1.7 Mev, respectively, the latter being extrapolated from the data of Lattes, Fowler, and Cuer for α-particles, assuming the Li^8 recoil to obey the range-energy relation $(m/Z^2)\cdot f(v)$, where $f(v)$ is the same as for α-particles in this energy region. Thus, the total energy of the incident neutron, taking into account the threshold energy for the reaction of -6.7 Mev, must have been 13.8 Mev, and this is consistent with its being a neutron from the high energy end of the Li-D spectrum.

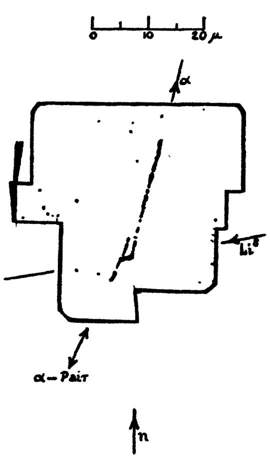

FIG. 1. Mosaic of photomicrographs showing $B^{11}(n,\alpha)Li^8$ reaction in Ilford C2, boron-loaded, photographic emulsion; Li^8 (β-decay; $t=0.88$ sec.; electron not visible in emulsion)$\rightarrow Be^8$; $Be^8\rightarrow\alpha$-pair. The direction of the incident neutron in this particular case was not very well defined because of proximity of neutron source and plate.

The ejection of Li^8 nuclei in cosmic-ray stars has been reported by Occhialini and Powell, and very recently in more detail by Franzinetti and Payne[3] of the Bristol group. In some observations by A. Morrison and myself here, on photographic emulsions exposed to cosmic radiation, which will be reported soon, we have obtained one definite example of a star showing a "hammer" track out of some 500 cosmic-ray stars. The estimated energy of the ejected Li^8 nucleus was 16 Mev, and the energy of the pair of α-particles was 3 Mev, these being about equal in length and oppositely directed.

The above work will be reported in more detail later.

[1] A. M. Lawrance, Proc. Camb. Phil. Soc. 35, 304 (1939).
[2] Lattes, Fowler, and Cuer, Proc. Phys. Soc. 59, 883 (1947).
[3] Franzinetti and Payne, Nature 161, 735 (1948).

Experiments on He^3 at Low Temperatures

J. G. DAUNT, R. E. PROBST, AND S. R. SMITH
The Cryogenic Laboratory, Department of Chemistry and Department of Physics, The Ohio State University, Columbus, Ohio
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THE first experimental indications of a new method of separation of the isotopes He^3 and He^4 were given by us in observing the effects accompanying the superfluid transfer of matter in liquid helium II both in supra-surface film transfer[1] and through channels in the bulk liquid.[2] We established that, within the limits of measurement, He^3 atoms do not partake in superfluid flow, characteristic of liquid helium II, and pointed out that the separation of the isotope He^3 by superfluid flow in the liquid phase is a process which could lead to its eventual isolation.

Repetitions of the preliminary experiments[1] on separation by the method of supra-surface film transfer have been made and have shown, as did the first experiments, that the relative abundances of He^3 in He^4 in the two reservoirs connected by the mobile film could be made to differ in the process by a factor of at least 200. Subsequent experiments, using techniques based on the same principle, have yielded samples with He^3/He^4 concentration of approximately 5.10^{-4}. We conclude, therefore, that this process of separation is satisfactory.

Based on evidence thus provided[1,2] for the non-superfluidity of He^3 in low concentration ranges, Lane and collaborators have adopted an elegant method[3] of concentrating the rare isotope by initiating the superfluid flow in the bulk liquid by thermal means, a technique used by us for initiating the flow through films rather than the bulk liquid. The variation of the results obtained at different temperatures by this method, however, together with some unpublished results obtained by us on separation processes