Concentration of He³ by Evaporation of Liquid Helium at Temperatures Below the λ-Point

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IN measurements made by Fairbank, Lane, Aldrich, and Nier[1] on the distribution of He³ between the liquid and vapor phases in a dilute solution of He³ in He⁴, it was found that the concentration of He³ in the vapor dropped to zero at a temperature just below the λ-point of He⁴.

It is important to determine whether this represents a new property of solutions of He³ in He⁴ or whether it is a consequence of the fact that He³ does not take part in superfluid flow.[2] The difficulty is to determine whether the gas sample collected has been evaporated from the main bulk of the liquid or from liquid transported up the connecting tube by the film phenomenon.[3] Fairbank, *et al.* calculated the contribution caused by evaporation from the film by using published values for the rate of film flow and concluded that film transport was insufficient to explain the observed results. However, it has been found that film effects may be very different with different experimental arrangements, and we have therefore thought it worth while to carry out experiments under conditions where it was quite certain that an appreciable fraction of the gas sample collected had been evaporated from the bulk liquid.

The cryostat consisted of two small vessels A and B in thermal contact, situated in an evacuated enclosure. About 1 cc of ordinary liquid helium was introduced into vessel A, while in vessel B we condensed about 0.1 cc of liquid helium from gas in which the He³ content had been enriched by thermal diffusion to 0.15 percent.

The temperature of the cryostat was reduced to 1.3°K by pumping on A, and the evaporation rate from A was then 11 cc of gas at N.T.P. per minute. Heat was now supplied by a heating coil wound round B until the evaporation rate was doubled, and vessel B, the effective dead-volume of which (reduced to room temperature) was 600 cc, was connected with an external volume of 600 cc. The pumping of A was stopped and the vapor pressure in B increased slowly. When the pressure had risen to 5 mm, the external volume was cut off from vessel B which was then connected with a sampling bulb of 500 cc volume. The sampling bulb itself was closed off when the pressure in it had risen to 5 mm. The time taken in the flushing process was 80 seconds and the subsequent sampling occupied 1 minute.

Analysis of the gas sample showed it to contain 1.5 percent of He³, representing a tenfold enrichment over the original concentration. The true enrichment factor for vapor in equilibrium with the liquid must be considerably greater than 10, because our sample was certainly diluted with He⁴ as a result of the film effect and also because the concentration in the liquid was considerably depleted by the flushing and sampling processes.

It is possible that the discrepancy between this result and those obtained by Fairbank, *et al.*[1] is due to a fundamental difference between the properties of dilute and concentrated solutions of He³ in He⁴, as suggested by London and Rice.[4] However, it seems possible to us that the results of Fairbank, *et al.* may have been obscured by a predominance of the film effect.

Our result shows that by evaporation at very low temperatures, when the He³ concentration is relatively high and when there is appreciable heat inflow, the He³ tends to be concentrated in the vapor rather than in the residual liquid as suggested by Fairbank, *et al.*

¹ H. A. Fairbank, C. T. Lane, L. T. Aldrich, and A. O. Nier, Phys. Rev. **73**, 729 (1948).
² J. G. Daunt, R. E. Probst, H. L. Johnston, L. T. Aldrich, and A. O. Nier, Phys. Rev. **72**, 502 (1947).
³ B. V. Rollin and F. Simon, Physica **6**, 219 (1939).
⁴ F. London and O. K. Rice, Phys. Rev. **73**, 1189 (1948).

Beta-Beta-Coincidence Curves for Ir¹⁹² and Ta¹⁸²*

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THE writers have recently reported[1] on beta-beta-coincidence curves in the disintegration of Ir¹⁹² and Ta¹⁸². These data were obtained by placing aluminum absorbers before *both* of the beta-ray counters. In discussing the curves it was remarked that in studying Ir¹⁹², we did not observe the maximum in the region of low energy which was reported by Wiedenbeck and Chu.[2] It turns out that although the internal conversion coefficients of Table II of their paper were determined by placing absorbers before *both* counters, the curves shown for Ir¹⁹² and Au¹⁹⁸ were obtained by inserting foils before only *one* of the two beta-ray counters. The comparison of curve shapes made by the writers was therefore without meaning. Dr. Wiedenbeck has kindly advised us of this oversight in a recent communication.

Beta-beta-coincidence rates for Ir¹⁹² and Ta¹⁸² are shown in Figs. 1 and 2 as a function of the aluminum absorber thickness placed before *one* of the beta-ray counters. Figure 1 shows that the "peculiar hump" is indeed present in the case of Ir¹⁹². In Fig. 2, the beta-beta-coincidence rate of Ta¹⁸² remains constant at 1.2×10^{-3} coincidence per beta-
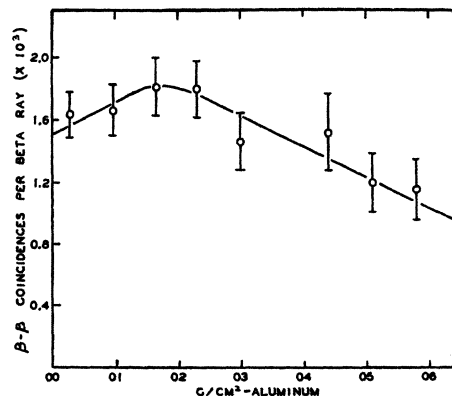

FIG. 1. Beta-beta-coincidences in the disintegration of Ir¹⁹².