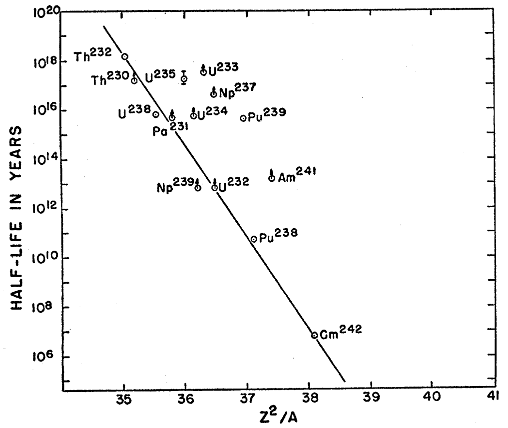

FIG. 1. Plot of spontaneous fission rates (ô signifies lower limit to half-life).

the rate of spontaneous fission is controlled by a Boltzmann, type factor in which the required activation energy for fission depends on Z^2/A; the form of the plot would suggest that this might be a linear dependence with a negative coefficient for Z^2/A. However, another type such as an inverse dependence on Z^2/A in the exponential term also fits nearly as well over the range of data plotted. In any case it is interesting to note that extrapolation of the line in Fig. 1 to the region of instantaneous rate of spontaneous fission (that is, half-life of order of 10^{-20} seconds) gives a value of about 47 for Z^2/A, which corresponds with the predicted limiting value[1] for Z^2/A.

The data seem also to indicate that on the average for a given value of Z^2/A, the rate is greater for an even-even nuclide than one with an odd number of nucleons. Since Z^2/A is a representation of Z^2/r^3, where r is the nuclear radius, the slower rates for the odd-nucleon nuclides may be related to their expected larger radii; on this basis the largest departure of an odd-nucleon nuclide from the line in Fig. 1 corresponds to the order of one percent larger radius than for the "hypothetical" corresponding even-even nuclide. On this picture an important contributing factor to the slower rates may result from the lower zero-point energy of the modes of vibration which lead to fission associated with the nuclei with the larger radii.

Similar considerations may be useful in interpreting some of the results from the study of slow neutron fission probabilities. The slow neutron fission probabilities of the even-even nuclides in the transuranium region seem to be lower than expected on the simple theory.[1] For example, a nucleus like Cm^{242} has a slow neutron fission cross section of less than 5 barns[7] in spite of the fact that the critical fission energy of the intermediate Cm^{243} is of the order of 4 Mev, much less than the estimated 6 Mev of neutron binding energy. It is possible that the time for fission is lengthened for such an odd-nucleon intermediate nucleus to the point where the (n, γ) reaction is able to compete more successfully than is the case for even-odd nuclides like U^{235}, Pu^{239}, etc., where the intermediate fissioning nuclei are of the even-even type.

The effect of an odd nucleon in slowing the fission process may also explain the photofission results of Koch, McElhinney, and Gasteiger[8] who found, for example, higher effective energetic thresholds for U^{235}, U^{233}, and Pu^{239} than for U^{238}, contrary to expectations from existing theory.[5,6]

It will be interesting to see whether even-even nuclei with abnormally small nuclear radii due to closed sub-shells will have especially high rates of spontaneous fission. Thus, a nucleus such as 100^{248} which would have two closed sub-shells on the Mayer picture,[9] 100 protons and 148 neutrons, might be expected to exhibit such an abnormally high rate. Similarly, the large slow neutron fission cross section[7] of a nuclide like Am^{242} might be connected with the sub-shell of 148 neutrons in the intermediate Am^{243}.

The above considerations may make it possible to predict with a fair degree of confidence, especially for the even-even nuclides, the spontaneous fission rates for undiscovered nuclides and hence make it possible to plan experiments more intelligently for their detection.

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The Melting Pressure of He^3

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THE previously reported measurements[1] on the melting pressure of He^3 between 1.51° and 1.02°K have been extended to 0.16°K. The lower temperatures were obtained by adiabatic demagnetization of ferric ammonium alum, which surrounded the capillary (0.16 mm i.d. cupro-nickel) containing the He^3. In order to enhance the thermal contact between the capillary and the salt, copper vanes were soldered to the capillary, and the salt chamber was filled with He^4 to a pressure of one atmosphere at liquid nitrogen temperature. The He^3 apparatus external to the cryostat was the same as in the earlier measurements.

The melting pressures were again obtained by the blocked capillary technique. Magnetic temperature measurements were made with a ballistic galvanometer and a secondary coil around the salt as described elsewhere.[2] Corrections were made for the difference between the magnetic and thermodynamic temperatures on the basis of the results of Kurti, Simon, and Squire.[3]

The results of all the measurements are shown in Fig. 1. The solid circles represent the previous results,[1] obtained with the capillary immersed directly in the He^4 bath, and the open circles represent the present results, obtained with the capillary im-

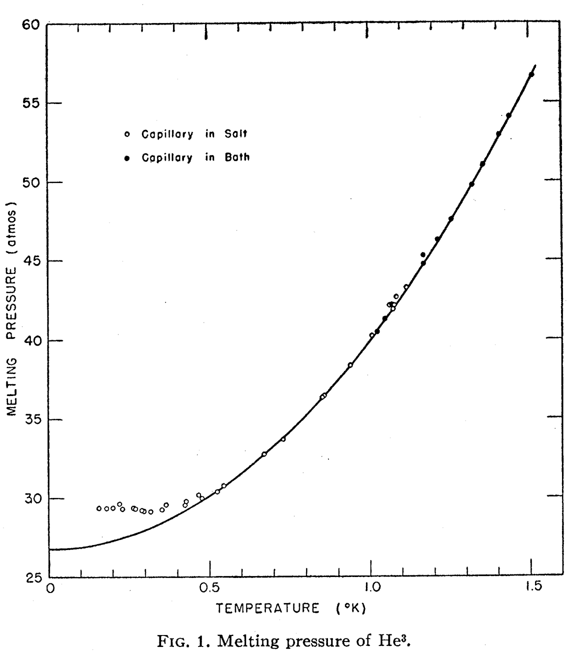

FIG. 1. Melting pressure of He^3.

mersed in the paramagnetic salt. From 0.5° to 1.5°K the data are represented by the equation,

$$P = 26.8 + 13.1T^2 \text{ atmos},$$

which is shown as a solid line in the figure. Below 0.5°K the experimentally determined pressures rapidly approach a constant value of 29.3 atmos.

If the horizontal portion of the observed melting curve is correct, the entropy difference between liquid and solid becomes zero near 0.5°K, which implies a transition in the liquid near this temperature. However, another possible explanation is that below 0.5°K the thermal contact between the capillary and the salt may become so poor that no part of the capillary is cooled below 0.44°K, at which temperature the melting pressure from the equation is 29.3 atmos. Further experiments are planned in which an attempt will be made to improve the thermal contact between the salt and the capillary.

It is clear that the melting pressure at absolute zero is positive, and therefore that the liquid is the stable condensed phase of He^3 at absolute zero.

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Nuclear Interactions of the Decay Products of a Neutral V-Particle*

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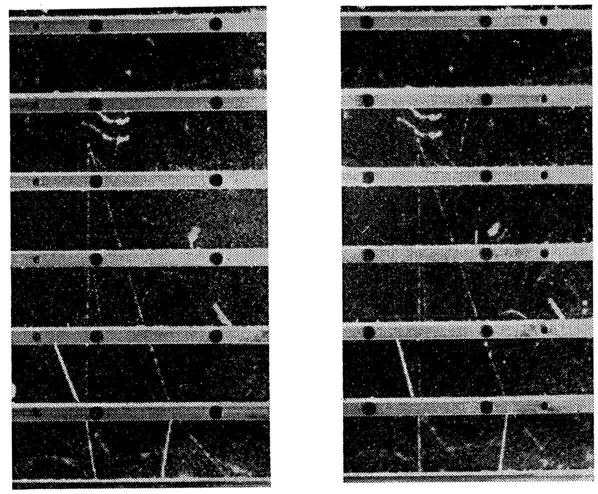
In a series of pictures taken with a large multiple-plate cloud chamber at 10,600 feet, we have observed several decays of neutral V-particles. In one such event, both charged secondaries from the V-particle decay interact in one of the 0.25-inch lead plates, each producing a low energy star.

Two of the three views of this event are reproduced in Fig. 1. Analysis of the three views shows that the electron track between the second and third plates below the point of decay is unrelated to the decay event.



(a) (b)

Fig. 1. Stereoscopic cloud-chamber pictures of a V^0-particle decay.

There is very little doubt that both secondary particles actually undergo nuclear interactions. The event takes place entirely within the well-illuminated region of the cloud chamber. Stereoscopic analysis shows that, in each case, the tracks of the incident particle and of the secondary products intersect at one point. Moreover, the right-hand particle scatters 20° in the plate, and the left-hand particle appears to lose a large amount of energy, becoming heavily ionizing after the traversal.

From recent work[1] it appears fairly certain that either there are two different kinds of V^0-particles with the decay schemes:

$$V^0 \rightarrow (\text{proton}) + (\text{negative meson}), \quad (1)$$

$$V^0 \rightarrow (\text{positive meson}) + (\text{negative meson}); \quad (2)$$

or that the V^0-particle has two alternate disintegration schemes:

$$V^0 \rightarrow (\text{proton}) + (\text{negative meson}) + (\text{neutral meson}), \quad (3)$$

$$V^0 \rightarrow (\text{neutron}) + (\text{negative meson}) + (\text{positive meson}). \quad (4)$$

Under the assumption of a two-body decay, one can decide between the disintegration schemes (1) and (2) from a knowledge of the momenta of the two secondary particles and of the angle enclosed by their trajectories. In our picture, the angle is 19° and the observed scattering corresponds for both particles to momenta of the order of 500 Mev/c. However, the determination of the momenta is not sufficiently precise to permit discrimination between processes (1) and (2). All that can be said is that if the event is of the type (1), the meson is a π-meson rather than a μ-meson, and that if the event is of the type (2), both particles are π-mesons. This is so, of course, because π-mesons (as well as protons) have cross sections for nuclear interactions of the order of the geometrical cross sections of the nuclei; whereas the cross sections for nuclear interactions of μ-mesons are exceedingly small. For the same reason, one can conclude that if the V^0-particle disintegrates according to schemes (3) or (4), the mesons involved must be of the π-variety.

Lastly, it should be pointed out that the disintegration scheme recently suggested by T. D. Lee,[2] $V^0 \rightarrow (\text{proton}) + (\mu^-\text{-meson}) + (\text{neutrino})$, could not explain the observed event.

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