in Table I are probably in large part due to compound nucleus formation.

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Bubble Tracks in a Hydrogen-Filled Glaser Chamber*

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GLASER[1] first showed that the boiling of superheated ethyl ether was sensitive to ionizing radiation, and later photographed the bubble tracks in his apparatus. A liquid-hydrogen chamber would have a number of attractive features, and it is therefore not surprising that several groups have been working to produce such a device. At Chicago, Hildebrand and Nagle,[2] working in cooperation with Glaser, have produced superheated liquid hydrogen, and have shown that it boils sooner in the presence of a γ-ray source. We have taken the next step, but with somewhat different technique, and can report the photography of bubble tracks in hydrogen. (See Fig. 1.)

The bulk of the Chicago apparatus was immersed in a bath of hydrogen which was boiling at atmospheric pressure, but the bubble chamber was in the vapor space, and superheated by a coil of resistance wire. This arrangement involves problems of heat transfer and temperature measurement, in addition to some serious problems if photography were to be attempted. We have therefore immersed our bubble chamber in a bath of hydrogen which boils at high pressure; this provides a convenient heat reservoir, whose temperature is easily controlled by a pressure regulator. First, hydrogen is condensed into the bubble chamber at a pressure somewhat higher than that over the bath. After temperature equilibrium has been established, the following cycle is initiated: (1) The pressure in the bubble chamber is suddenly reduced to one atmosphere. (2) At a variable time after the pressure release, an electronic circuit triggers a stroboscopic lamp, which takes a photograph of the chamber, and (3) pressure is reapplied to the chamber to condense any bubbles that may have formed.

We have been unable to duplicate the long times of superheat reported by the Chicago group, but we have been using considerably higher degrees of superheat. We were discouraged by our inability to attain the long times of superheat, until the track photographs showed that it was not important in the successful operation of a large bubble chamber. Tracks have even been observed in cases where the liquid hydrogen was not completely condensed in the chamber prior to expansion.

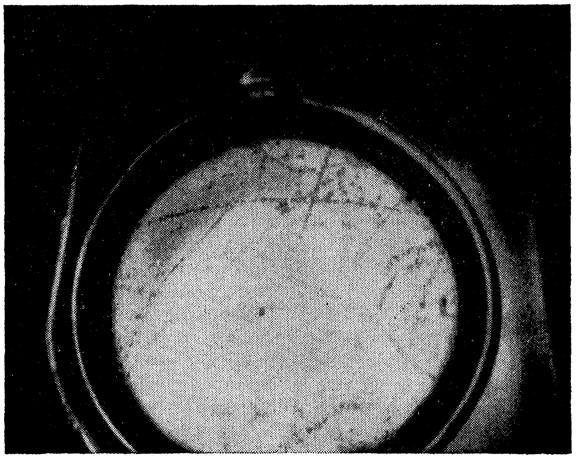

FIG. 1. $1\frac{1}{2}$-inch chamber irradiated with a Po-Be source.

I wish to thank Dr. Luis W. Alvarez, Dr. Frank S. Crawford, Jr., and Dr. M. Lynn Stevenson for their advice and help in these experiments. I am indebted to A. J. Schwemin for help with the electronic circuits, and to H. Powell and T. Robbins for their cooperation with the glass work.

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Angular Distribution of Deuterons from $N^{14}(p,d)N^{13}$†

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BUTLER'S interpretation[1] of the angular distribution of particles from (d,p) and (d,n) stripping reactions has yielded much information on the spins and parities of nuclear states.[2] By the reciprocity theorem,[3] a similar analysis should apply to the inverse processes, (p,d) and (n,d) pickup. Most pickup reactions have Q's which are negative and several Mev in magnitude, so it is necessary to select low-energy deuteron groups in the presence of background caused by relatively high-energy protons. Because of this difficulty, angular distributions from (p,d) reactions have been examined in a few favorable cases[4,5] only.

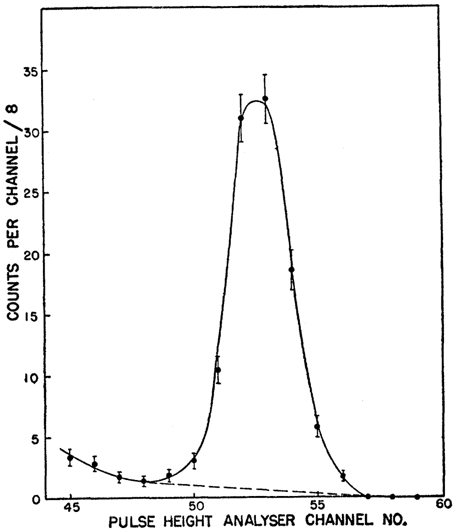

FIG. 1. Gated scintillation counter spectrum at 15° in the laboratory system. The peak consists of $N^{14}(p,d)N^{13}$ ground-state deuterons. Background was estimated from the general shape of the curve and from spectra taken with larger absorbers (which move the deuteron peak to a lower pulse height).

A thin NaI crystal in a scintillation counter may be used to distinguish deuterons from proton background. The maximum possible energy loss of any deuteron passing normally through such a crystal comes from a deuteron whose range in NaI is equal to the thickness T of the crystal. This deuteron *just* stops in the crystal and loses its entire energy E_T. A higher-energy deuteron will pass through the crystal and lose energy $<E_T$ because of the smaller rate of energy loss at higher energy. A similar relation holds for protons, but, since the range of a proton is greater than the range

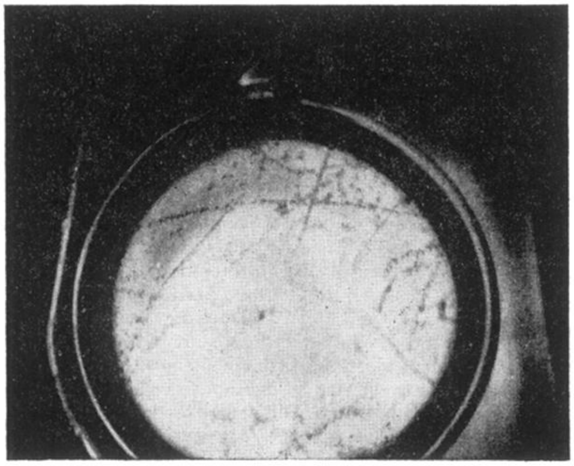

FIG. 1. 1½-inch chamber irradiated with a Po-Be source.