The Resonance Absorption of Slow Neutrons in Indium*

It is known that In^{115} exhibits a strong absorption for neutrons of about two ev energy giving rise to two β-active periods of 13 sec. and 54 min. In order to investigate the nature of the level responsible for this absorption we have determined the self-absorption curve for thicknesses of indium up to 1.3 g/cm^2 using the 54-min. activity of a thin (0.08 g/cm^2) indium foil indicator.

Before it is possible to determine the neutron absorption coefficient at resonance ($n\sigma_0/\rho$ cm^2/g) from such a curve, it is necessary to know the β-ray absorption of the indicator. We have observed the electronic absorption curve for this case to be exponential over the detector thickness used. The coefficient is 20 cm^2/g. With this value and the same type of analysis as applied to rhodium,[1] the neutron absorption curve has been calculated for various values of $n\sigma_0/\rho$. We find that any value $n\sigma_0/\rho \gtrsim 100$ cm^2/g gives a satisfactory fit. This indicates a cross section $\sigma_0 \gtrsim 20{,}000 \times 10^{-24}$ cm^2.

From the results it is evident that present data do not provide enough sensitivity for determining a unique value of σ_0; hence the neutron and radiation widths cannot be determined. Additional observations and calculations are now in progress.

J. H. Manley

Department of Physics,
University of Illinois,
Urbana, Illinois.

H. H. Goldsmith
Julian Schwinger

Department of Physics,
Columbia University,
New York, New York,
December 5, 1938.

* Publication assisted by the Ernest Kempton Adams Fund for Physical Research of Columbia University.

[1] J. H. Manley, H. H. Goldsmith and J. Schwinger, in this issue.

A Precise Measurement of the Mass Difference $_4Be^9 - _4Be^8$; The Stability of $_4Be^8$

The energy of the deuterons from the reaction $_4Be^9(p,d)_4Be^8$ has been measured with the electrostatic analyzer previously described.[1] Our most reliable curves have been taken at proton energies of 258 and 262 Kev; A and C of Fig. 1 are curves of this type. C shows the alpha-particle limit at 1.412 Mev from the concomitant reaction $_4Be^9(p,\alpha)_3Li^6$ and the surprisingly sharp deuteron limit at 0.628 Mev. Curve A is a separate investigation of the immediate region around the deuteron limit. The results of three determinations of the upper limit of the deuteron energy (thick target) shows that Q_3 for the deuteron reaction is 0.557 Mev.

Curve B, at 351 Kev, shows both limits close together. X shows the expected location of the deuteron limit obtained by conservation of energy and momentum from the limit as it appears at 262 Kev in curve C. The shift of the limits identifies the upper one as representing the alpha-particles; that of the lower limit agrees with the assumption of deuterons. The hump at the low energy end of B represents scattered protons from the target.

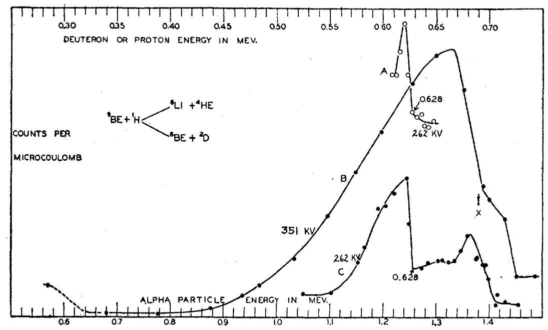

FIG. 1. The energy spectrum of particles from a thick target of beryllium under proton bombardment.

Using $D = 2.01473 \pm 2$ and $H = 1.00813 \pm 2$ after Livingston and Bethe,[2] we obtain

$$_4Be^9 - _4Be^8 = _1D^2 - _1H^1 + Q_3 = 1.00720 \pm 0.00003.$$

From their neutron mass, 1.00897 ± 6, the binding energy of the odd neutron in $_4Be^9$ is 1.65 ± 0.05 Mev, which should be the threshold for photodisintegration of $_4Be^9$.

The stability of $_4Be^8$ may now be expressed entirely in terms of measured reaction energies and the mass spectroscopic value of the difference

$$2\,_1H^2 - _2He^4 = K = 0.02561 \pm 0.00004.^3$$

Using the values Q_1 of $_4Be^9(d,\alpha)_3Li^7$ and Q_2 of $_3Li^7(p,\alpha)_2He^4$ which have been measured with an accuracy comparable to our work, we obtain

$$_4Be^8 - 2\,_2He^4 = Q_1 + Q_2 - Q_3 - K = 0.00033 \pm 0.00006$$

with $Q_1 = 6.95$ Mev,[4] $Q_2 = 17.13$ Mev.[5] Thus $_4Be^8$ is stable with respect to two alpha-particles by 0.31 ± 0.06 Mev. The fact that the deuteron limit is sharp in our curves shows that the deuteron in this reaction recoils from a single nucleus of $_4Be^8$.

Using the above Q values in connection with the atomic weights of hydrogen, deuterium, and helium, and Q_4 of $_4Be^9(p,\alpha)_3Li^6$ as 2.152 ± 0.04 Mev,[1] we can write

$$_4Be^8 = Q_1 + Q_2 - Q_3 - K + 2\,_2He^4 = 8.00739$$
$$_4Be^9 = Q_1 + Q_2 - _1D^2 + 3\,_2He^4 - _1H^1 = 9.01459$$
$$_3Li^6 = Q_1 + Q_2 - Q_4 + 2\,_2He^4 - _1D^2 = 6.01655.$$

A more detailed report of our experiments will be submitted to the *Physical Review* in the near future.

Samuel K. Allison
Elizabeth R. Graves
Lester S. Skaggs
Nicholas M. Smith, Jr.

Ryerson Physical Laboratory,
University of Chicago,
Chicago, Illinois,
November 30, 1938.

[1] S. K. Allison, L. S. Skaggs and N. M. Smith, Phys. Rev. **54**, 171 (1938).
[2] M. L. Livingston and H. Bethe, Rev. Mod. Phys. **9**, 246 (1937).
[3] K. T. Bainbridge and E. D. Jordan, Phys. Rev. **51**, 384 (1937).
[4] J. H. Williams, R. O. Haxby, and W. G. Shepherd, Phys. Rev. **52**, 1031 (1937).
[5] M. L. E. Oliphant, A. E. Kempton, and Lord Rutherford, Proc. Roy. Soc. **149**, 406 (1935) corrected by M. L. Livingston and H. Bethe, reference 2.