Re-Measurement of the Energies Released in the Reactions Li^7 (p, α) He^4 and Li^6 (d, α) He^4

The energies released in the reactions Li^7 (p, α) He^4 and Li^6 (d, α) He^4 were measured in 1935 by Oliphant, Kempton, and Rutherford.[1] They used a variable pressure air absorption tube which was calibrated with the precisely measured natural alpha-particles from ThC′. They obtained 17.06 ± 0.06 Mev for the Li^7 reaction and 22.06 ± 0.07 Mev for the Li^6 reaction. These values, slightly revised by Livingston and Bethe,[2] have been used by Allison,[3] together with the precise results on the beryllium-proton reactions, obtained by electrostatic analysis,[4,5] to set up masses for several of the lightest atoms.

Recently Bethe[6] has reinterpreted the 1935 Cavendish result on Li^6, raising it to 22.21 Mev, and Oliphant[7] has stated that the correct value may well lie outside the limits specified in the Cavendish result.

We have therefore repeated the earlier work, using an absorption cell in much the same manner. The use of thin collodion windows on the cell instead of mica, the use of thin instead of thick targets, and the prevention of the formation of oil films on the targets differentiated our work from the earlier attempts. Also the higher voltage available for the bombarding beam gave higher yields of disintegration particles and made possible the use of smaller apertures through which they were counted. Several runs were made on different targets of LiF for a period extending over several weeks. In the case of Li^6 a separated target produced in the mass spectrograph by L. H. Rumbaugh was used and gave results no different from the LiF targets. We obtained 17.28 ± 0.03 Mev for the Li^7 reaction and 22.20 ± 0.04 for the Li^6 reaction.

These new values may now be used in connection with our electrostatic analyzer results to give $Li^6=6.01682\pm0.00011$, $Li^7=7.01784\pm9$, $Be^8=8.00766\pm15$, $Be^9=9.01486\pm13$. These are based on the usual values of H, D and He^4.

Our results confirm Bethe's revision of the Li^6 reaction energy release, and our masses agree closely with those of Bethe-Barkas.[8] The question of the stability of Be^8 is now undecided by these masses, but on the Gamow theory of alpha-particle decay we may predict a minimum lifetime of 10^{-16} second for this nucleus.[9]

A detailed account of this investigation is being submitted for publication by one of us. The progress of this work was greatly aided by a grant from the American Philosophical Society.

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[1] M. L. E. Oliphant, A. R. Kempton, Lord Rutherford, Proc. Roy. Soc. London **A149**, 406 (1935).
[2] M. S. Livingston and H. A. Bethe, Rev. Mod. Phys. **9**, 371 (1937)
[3] S. K. Allison, Phys. Rev. **55**, 624 (1939).
[4] S. K. Allison, L. S. Skaggs and N. M. Smith, Jr., Phys. Rev. **54**, 171 (1938).
[5] L. S. Skaggs, Phys. Rev. **56**, 24 (1939).
[6] H. A. Bethe, private communication. See also W. H. Barkas, Phys. Rev. **55**, 691 (1939), reference 13.
[7] M. L. E. Oliphant, private communication.
[8] W. H. Barkas, Phys. Rev. **55**, 691 (1939).
[9] H. A. Bethe, Rev. Mod. Phys. **9**, 71 (1939), Table XXX, p. 167.

Investigation of Boron by Slow Neutrons

A cloud chamber investigation[1] of the B^{10} (n, α) disintegration appeared to indicate an asymmetrical distribution with respect to the plane perpendicular to the incident neutron direction. In these preliminary observations only 75 disintegrations were observed, of which 45 occurred in the forward direction and 30 in the backward. A fuller investigation has now been made by means of an ionization chamber, and the results demonstrate that the distribution is symmetrical.

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[1] Goldhaber, Hill, Kruger and Stallman, Phys. Rev. **55**, 1117 (A) (1939).

Disintegration of Deuterium by Protons and p-n Reactions in Light Gaseous Elements

Neither of the homologous reactions,

$$H^1+H^2\rightarrow 2H^1+n^1, \quad (1)$$

$$n^1+H^2\rightarrow H^1+2n^1, \quad (2)$$

have heretofore[1] been observed, in spite of the importance to be attached to such simple disintegrations which may be treated theoretically with considerable rigor, and consequently may provide additional information concerning nuclear interactions.

The binding energy of the deuteron[2] is 2.17 Mev and therefore the threshold of the reactions (1) and (2) should be reached with protons or neutrons of 3.25 Mev. The present report is to record an experiment designed to detect reaction (1).

A chamber was constructed so that gases could be used as targets for the proton beam from the Princeton cyclotron. The lead lining of the chamber was electrically insulated so that it could also be used as a Faraday collector for the protons which entered through a one-mil aluminum window. Steps were taken to minimize the neutron background caused by bombardment of internal parts of the cyclotron itself. Neutrons generated by disintegrations in the chamber were slowed down in paraffin and measured with a silver detector. Observations were taken when the target was deuterium under one atmosphere pressure, and also normal hydrogen under the same conditions. With the normal hydrogen in the chamber the average initial activity of the detector was 0.238 ± 0.004 div./sec. per microampere. When the chamber contained deuterium the activity was 0.623 ± 0.004 div./sec. per microampere.

With the same geometrical arrangement the neutrons produced in O_2, N_2, CO_2 and A, at one atmosphere pressure in each case, were also observed. Some experiments on the efficiency of the collector in the presence of the various gases indicated that in some cases the apparent proton current was affected somewhat by ionization in the gas. Except for the isotopes of hydrogen the comparison between gases can therefore be only semi-quantitative. Consequently it can only be said that from O_2, N_2 and C the neutron emission is