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Energy Levels in Be^8 from the Reaction $Li^6(He^3, p)Be^8$

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The energy spectrum of protons from the breakup of B^9 following He^3 capture by Li^6 has been obtained by means of a NaI crystal spectrometer. The energy range of the spectrum which corresponds to a range of excitation in Be^8 up to 11 Mev, shows two groups of protons. Because of systematic errors known to be present, the energy determinations are preliminary. With an uncertainty of about 0.25 Mev, the energy difference between proton peaks corresponds to an energy interval in Be^8 of 2.87 Mev.

UP to an excitation energy of 17 Mev the energy levels in Be^8 have been determined principally from α-particle spectra following the breakup of C^{12} and Be^8, from neutron spectra following the capture of deuterons by Li^7, and from γ-ray spectra following proton capture by Li^7. The breakup of B^9 into Be^8 and a proton following He^3 capture by Li^6 releases 16.77 Mev. This reaction therefore provides protons as a means of studying levels in Be^8. The competing reactions in the breakup of B^9 are as follows:

$$He^3+Li^6 \to B^9+\gamma+16.58 \quad \text{(a)}$$
$$Be^8+p+16.77 \quad \text{(b)}$$
$$B^8+n-1.805 \quad \text{(c)}$$
$$Be^7+H^2+0.106 \quad \text{(d)}$$
$$Be^6+H^3-\approx 5 \quad \text{(e)}$$
$$He^4+Li^5+15.06 \quad \text{(f)}$$
$$He^4+He^4+p+16.86. \quad \text{(g)}$$

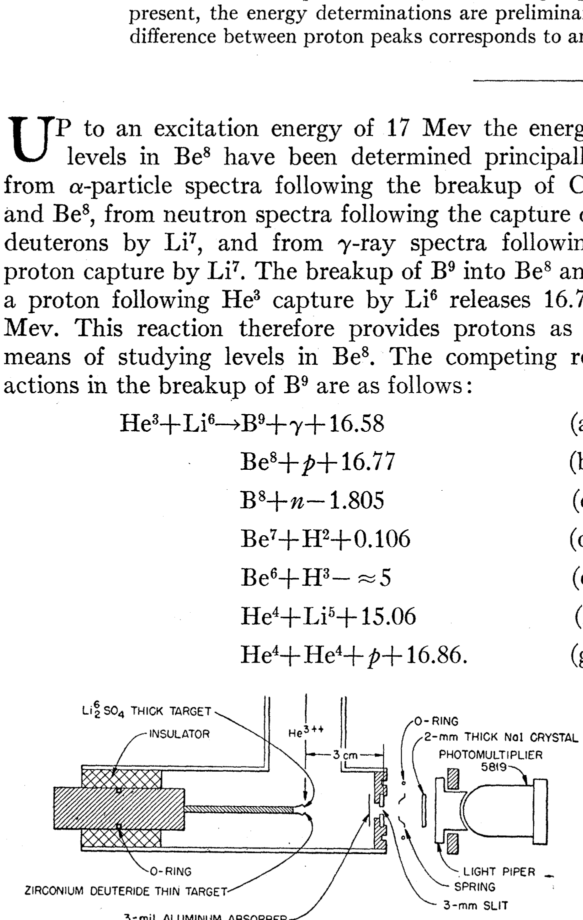

FIG. 1. Schematic diagram of target arrangement for studying the energy spectrum of the decay products accompanying Li^6+He^3.

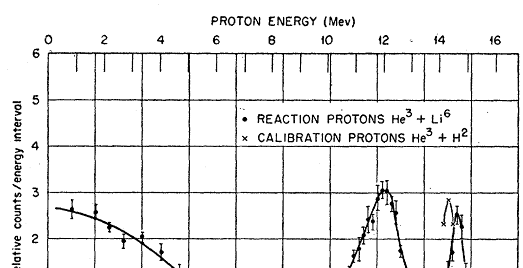

FIG. 2. Pulse spectrum in NaI of protons from the reactions $Li^6(He^3, p)Be^8$ and $Li^6(He^3, p\alpha)\alpha$.

It appears that only α particles and protons will be present at energies above 0.5 Mev. The α particles, having lower energies and being more readily stopped than protons, are easily removed by a few mils of aluminum.

The experimental arrangement is shown schematically in Fig. 1. The accelerator for producing the He^3 ion beam is a 400-kev Cockcroft-Walton. In order to suppress the conflicting $He^3(d, p)He^4$ contamination reaction, the 800-kev He^{3++} beam was used. This beam is present in amount a few parts per thousand. The proton spectrum was obtained by means of a NaI crystal and differential pulse-height selector. The manner of mounting the crystal is illustrated in Fig. 1. Because count rates were small, some rapid means of spectrometer calibration was required. This rapid calibration was achieved by interposing a deuterium target as shown, and checking the pulse height of the reaction protons.

The proton spectrum for 720-kev He^{3++} bombarding energy is shown in Fig. 2. The peak of the ground-state transition corresponds to a Q of 16.60 Mev, agreeing within the present experimental accuracy with 16.77 Mev from mass values.[1] The peak corresponding to the transition to the first excited state in Be^8 gives a Q of 13.73 Mev. The difference in positions of the two proton peaks represents 2.87 Mev energy spacing between ground and first excited states in Be^8. Systematic errors still present in the experiment make this value uncertain by not more than 0.25 Mev. The rise in the spectrum below 5 Mev observed proton energy is caused by breakup of the recoiling Li^5's from channel (f). The experiment is being refined to minimize systematic errors before applying detailed analysis to determine nuclear parameters. The data, however, show evidence for only two levels in Be^8 up to an excitation of about 11 Mev. A recent study of the $B^{10}(d, \alpha)Be^8$ α-particle[2] spectrum shows only two groups of α-particles. Thus, the only experiments indicating more than one level between ground state and 11 Mev in Be^8 are those on the $Li^7(d, n)Be^8$ neutron spectrum.

[1] F. Ajzenburg and T. Lauritsen, Revs. Modern Phys. 24, 395 (1952).
[2] P. B. Treacy, Phil. Mag. 44, 326 (1953).