The other sample, manufactured on March 2, 1959, showed a very high exposure (170 mr), whereas the corresponding sample arriving by air showed low exposure (13 mr). The reason for this difference has not been determined.

Results show that it is advisable to import nuclear emulsion plates by sea rather than by air, although there is still some chance of excessive exposure. The use of the electron sensitive emulsions in radiation measurements is also shown to be useful for determination of low dosages, particularly as the electron tracks can be distinguished from darkening produced by other means such as exposure to light and chemical fogging due to excess temperatures. Further tests are being carried out with the method on aircraft travelling on different routes in the southern and northern hemispheres.

RELATIVE INTENSITY OF THE 17·2 AND 14·3 MeV GAMMA RAYS FROM THE $^7Li(p,\gamma)^8Be$ REACTION*

By B. Mainsbridge†

Radiation from proton capture in ^7Li is known to consist of two principal components of energy $(17 \cdot 2+\frac{7}{8}E_p)$ and $(14 \cdot 3+\frac{7}{8}E_p)$ MeV, corresponding to transitions to the ground state and first excited state of ^8Be respectively (Walker and McDaniel 1948). Resonances in the reaction are known to exist at E_p=441 keV, 1·03 and 2·1 MeV (Bonner and Evans 1948; Kraus 1954; Price 1954) and the relative intensity of the two γ-rays is known to vary in the neighbourhood of the 441 keV resonance (Campbell 1956). It is not known if the intensity ratio varies in the region of the 1030 keV resonance and this experiment was designed to repeat the measurements of Campbell and extend the investigation to the higher resonance.

Experimental

The detector was a 5 in. diameter by 4 in. long NaI(Tl) crystal mounted, with the cylindrical axis vertical, at 90° to the proton beam and 9·5 in. from a $\frac{3}{16}$ in. diameter natural lithium target. The γ-radiation was collimated into the crystal centre by a conical hole through a lead block 3 in. thick. The collimator was tapered so that the detector observed, through a solid angle of 0·074 steradians, a $\frac{3}{16}$ in. diameter spot at the target. A 5 in. diameter Dumont 6364 photomultiplier was mounted on the crystal and the output was amplified and fed to a 100 channel pulse-height analyser, biased at 6 MeV γ-ray energy.

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† Research School of Physical Sciences, Australian National University, Canberra.

The targets, prepared by the evaporation of natural lithium metal onto silver-plated brass backings, were mounted on a water-cooled holder and inclined at 20° to the proton beam. The deposits were as thin as experimental conditions would allow and were less than 5 keV thick for measurements between $E_p=430$ and 450 keV. Up to $E_p=600$ keV, 5–10 keV thick targets were used and in the remaining energy regions they were 20 keV thick except for the measurements below 300 keV, where the low yield required targets 60 keV thick.

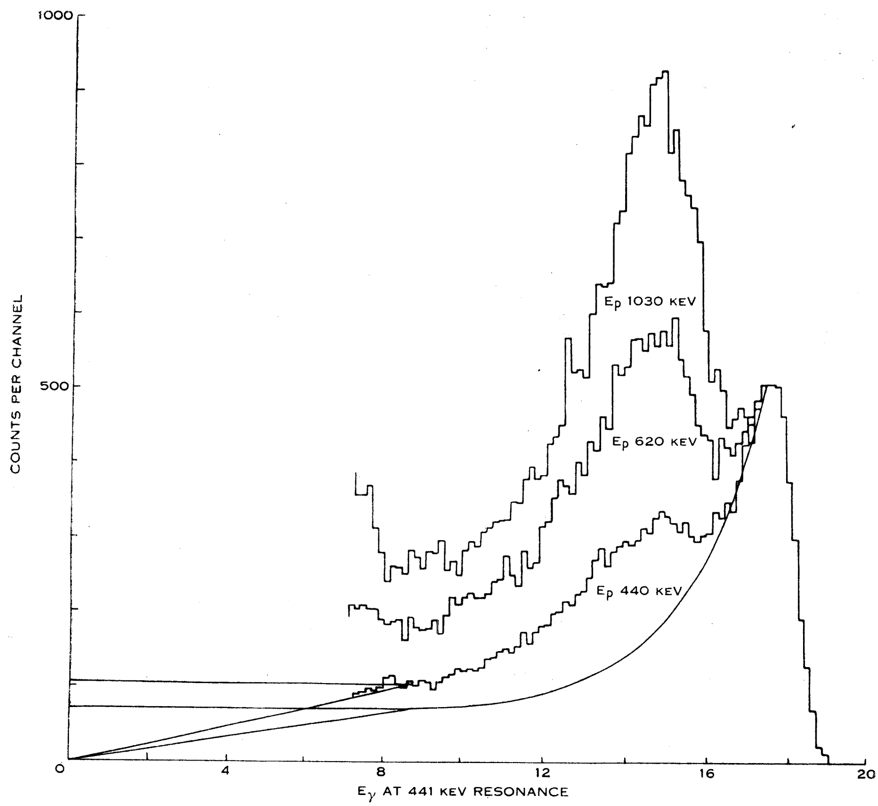

Fig. 1.—Pulse-height distributions of the $^7Li(p,\gamma)^8Be$ radiation at $E_p=440$, 620, and 1030 keV.

Beam currents of 10–15 μA were used and the charge was measured on a current integrator. In the region of the 441 keV resonance, the current was reduced to limit counting rates to 100 p.p.s.

The bias and gain of the pulse-height analyser were fixed during the measurement so that the peak of the $17 \cdot 6$ MeV γ-ray always occurred in the same channel of the display. The cosmic ray background was measured by running the electronics for 2–3 hr with the accelerator switched off.

Figure 1 shows typical spectra obtained in the measurement after correction for cosmic ray background and normalizing to a common peak height at $17 \cdot 6$ MeV.

Pulse-height Distribution of the 17·6 MeV γ-Ray

The pulse-height distributions of the two γ-rays cannot be obtained directly from the spectra of Figure 1 because of the overlap in the two components. The separation is complicated by the 2 MeV width of the 14·8 MeV γ-ray.

The 17·6 MeV component is monochromatic and investigations of the response of 5 in. diameter by 4 in. long NaI(Tl) crystals to monochromatic radiation between 10 and 20 MeV suggest there is little change in the pulse-height distributions in this energy range (Kockum and Starfelt 1959). A comparison of the pulse-height distributions of the 16·6 and 20·3 MeV γ-rays from proton capture in ^{11}B and ^{3}H respectively, measured with the apparatus of the present investigation, showed the line shapes to be identical and it was assumed that the

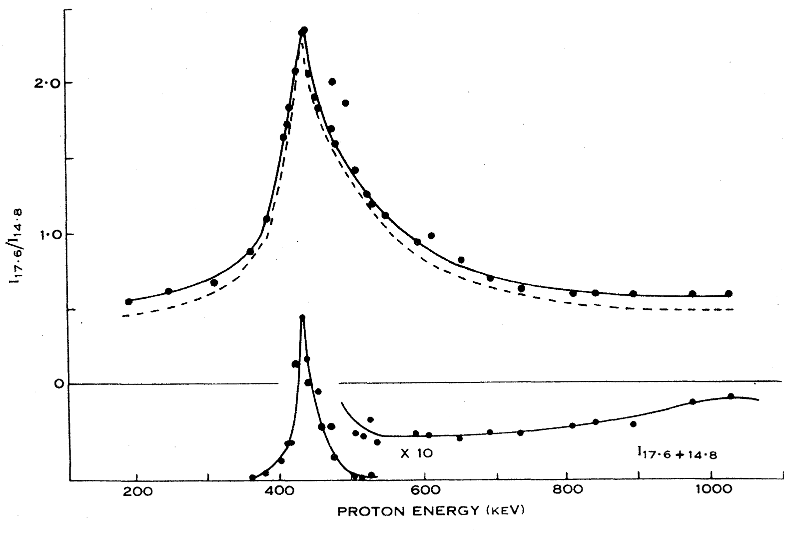

Fig. 2.—Variation of the intensity ratio with proton energy, measured at 90° to the proton beam.

pulse-height distribution of the 20·3 MeV γ-ray could be used to represent that of the 17·6 MeV γ-ray. This was obtained by replacing the lithium target with one of tritium absorbed in zirconium and bombarding with 850 keV protons. The gain of the photomultiplier was altered so that the peak of the 20·3 MeV γ-ray coincided with that of the 17·6 MeV component and the line shape is included in Figure 1.

Line Shape below $E_\gamma = 8·5$ *MeV*

The pulse-height distributions do not indicate the line shape below $E_\gamma = 8·5$ MeV. In this region, contributions from the $^{19}F(p,\alpha,\gamma)^{16}O$ reactions are mixed with low energy γ-rays from scattered radiation. Many of these events arise from scattering material outside the detector and some are due to the escape of a fraction of the incident γ-ray energy from the detector. The actual line shape between 0 and 8·5 MeV depends on the escape loss and is partly determined by the dimensions of the collimator. It was inferred from the investigations of Kockum and Starfelt (1959) that the line shape for the geometry of the present experiment was between the limits in the extrapolations to zero energy in Figure 1.

Calculation of the Intensity Ratio

Each spectrum was summed between $E_\gamma=8\cdot5$ and $19\cdot5$ MeV and the cosmic ray background was subtracted. The assumed pulse-height distribution of the $17\cdot6$ MeV γ-ray was normalized to fit each spectrum and the intensity of the $14\cdot8$ MeV component was obtained by subtraction. Small corrections were made for the calculated efficiency of the detector to $14\cdot8$ and $17\cdot6$ MeV γ-rays, $82\cdot9$ and $84\cdot5$ per cent. respectively. The ratio of the intensity of the two components $I_{17\cdot6}/I_{14\cdot8}$ is shown as a function of proton energy in Figure 2. The excitation function was derived from the ratio of the total number of events between $8\cdot5$ and $19\cdot5$ MeV and the current integrator counts. Four targets of varying thickness were used in the measurements and, since the yield from each target at the 441 keV resonance has been normalized to a common value, the excitation function is only approximate.

Absolute Value of the Ratio

The experimental points in Figure 2 are based on the pulse-height distributions above $E_\gamma=8\cdot5$ MeV. The errors in the absolute values of the ratio, due to the uncertainty in the line shapes below this energy, have been calculated by considering the extrapolations of Figure 1. The absolute value lies between the experimental curve and the broken curve of Figure 2.

TABLE 1

MEASUREMENTS OF THE INTENSITY RATIO AT THE 441 keV RESONANCE

E_p	Target Thickness	Angle	$I_{17\cdot6}/I_{14\cdot8}$	Reference
450	10–20 keV	0°, 90°	$2\pm0\cdot2$	Devons and Lindsey (1950)
460	150 keV	0°	2	Walker and McDaniel (1948)
500	thick	0°, 35°, 70°	$1\cdot7\pm0\cdot2$	Stearns and McDaniel (1951)
441	5	90°	$2\cdot30\pm0\cdot04$	Present work

Discussion

The points at $E_p=480$ and 500 keV show higher values of the ratio than neighbouring points and this effect is attributed to non-uniformity of the target deposit where a small portion may be thick enough to contribute some resonance radiation with a larger cross section and a higher value of the ratio. In this case, the target was discarded and the measurement was repeated. The results are in general agreement with the measurements by Campbell (1956). The improved resolution of the larger detector used in the present investigation limits the errors due to uncertainty in the line shape of the two γ-rays and allows the ratio to be measured directly without reference to measurements by other workers.

At the 441 keV resonance, the value of $2\cdot3\pm0\cdot04$ is higher than values reported by other workers using pair spectrometers (Table 1), but, since those measurements were made with thicker targets, a small contribution from the non-resonant radiation would tend to reduce the value.

Above 800 keV, the ratio remained constant at $0\cdot54\pm0\cdot08$ and no departures from this value were observed at the 1030 keV resonance.

Measurements of the angular distributions of the two γ-rays have shown the intensity ratio to be in addition a function of the angle of observation above and below the 441 keV resonance and in the neighbourhood of the 1030 keV resonance and is the subject of further investigation.

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CONFERENCE ON SOLID STATE PHYSICS

A conference on Solid State Physics was held in Melbourne from 17th to 21st August, 1959, under the auspices of the Australian Branch of the Institute of Physics. This conference was the first of its kind in Australia and attracted an attendance of about 130.

The Institute was assisted financially in holding this conference by grants from the Aeronautical Research Laboratories, Amalgamated Wireless (Australasia) Ltd., the Australian Atomic Energy Commission, the British General Electric Company Pty. Ltd., the Commonwealth Scientific and Industrial Research Organization, Philips Electrical Industries Pty. Ltd., the Rola Company (Australia) Pty. Ltd., Standard Telephones and Cables Pty. Ltd., the Australian Academy of Science, the University of Melbourne, and the University of New South Wales.

Forty-six papers were read and discussed at the conference and a number of the original contributions are being published in this issue. No attempt was made to record the discussion at the conference but many authors have incorporated in their papers the results of such discussion. Brief summaries and notes on all papers presented have been published in the British Journal of Applied Physics (**11**: 137 (1960)).

The conference was organized on behalf of the Institute of Physics by the following Committee: W. Boas, R. I. Garrod, P. G. Klemens, J. F. Nicholas, A. L. G. Rees, and S. E. Williams.