TABLE I. Nuclear quadrupole coupling of iodine in ICN determined from the $F_1 \rightarrow F_1+1$ transitions of the eighth rotational line, ($J=7\rightarrow 8$). Here $F_1=J+I_1, J+I_1-1, \cdots |J-I_1|$, where I_1 is 5/2, the nuclear spin of iodine.

$F_1 \rightarrow F_1+1$	Separation from $\frac{15}{2}\rightarrow\frac{17}{2}$ line $\Delta\nu$ in mc	Nuclear quadrupole coupling in mc $eQ\frac{\partial^2 V}{\partial z^2}$
$\frac{9}{2}\rightarrow\frac{11}{2}$	−9.98	−2388
$\frac{11}{2}\rightarrow\frac{13}{2}$	−17.46	−2401
$\frac{13}{2}\rightarrow\frac{15}{2}$	−11.98	−2430
$\frac{15}{2}\rightarrow\frac{17}{2}$	—	—
$\frac{17}{2}\rightarrow\frac{19}{2}$	+9.58	−2488
$\frac{19}{2}\rightarrow\frac{21}{2}$	+5.10	−2563

cause the observed variations in the coupling coefficients listed in Table I. The probable error in the measurements is less than 1 percent.

Further studies of these effects are being made.

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[1] J. W. Simmons and W. Gordy, Phys. Rev. (in press).

Delayed Neutrons from U^{235} After Short Irradiation

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February 6, 1948

DURING the spring of 1945 we investigated the delayed neutrons from U^{235} after very short neutron irradiation of about 10-millisecond duration. The decay curve of the delayed neutrons, from 0.2 second to 10 minutes after irradiation, could be resolved into 5 periods and the relative initial activities of these 5 groups of delayed neutrons determined. When these activities are extrapolated, in the conventional manner, to the case of infinite irradiation time, the rate of delayed neutron emission (on the basis of unit initial activity) is given by the following formula,[1] where t is in seconds:

$$N(t)=0.076e^{-t/0.52}+0.279e^{-t/2.5}+0.297e^{-t/7.9}+0.294e^{-t/32.4}+0.054e^{-t/79.9}.$$

By following the neutron activity during the irradiation and for a period of about 50 milliseconds thereafter we obtained indications of a delayed neutron period of approximately 6 milliseconds. This 6-millisecond period delayed neutron group accounts for only 2 percent of the total yield of delayed neutrons, when the U^{235} is irradiated to saturation. We hope to publish a full account of the above measurements in this journal in the near future.

This letter is based on work performed at the Los Alamos Scientific Laboratory of the University of California under Government Contract No. W-7405-eng-36, and the information contained therein will appear in Division V of the National Nuclear Energy Series (Manhatten Project Technical Section) as part of the contribution of the Los Alamos Laboratory.

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[1] When these results are compared with the work of Hughes, Dobbs, Cohn, and Hall, Phys. Rev. **73**, 111 (1948), there is substantial agreement in the delayed neutron periods. There are, however, discrepancies in the relative intensities which may be due to the fact that our results are not corrected for the varying efficiency of our neutron counters with the various energies of the different delayed neutron groups.

Perturbation of Steady Uniform Flow by Localized Sources of Heat*

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January 29, 1948

THE configuration of steady diabatic flow is affected by heat addition in ignition and combustion. For the one-dimensional approximation these effects have been described in the literature.[1] For uniplanar flow a study of diabatic inviscid patterns can be based in the incompressible approximation on the previously developed equations,[2]

$$\nabla^2\varphi=q,\quad \nabla^2\psi=-\omega,\quad u=\varphi_x+\psi_y,\quad v=\varphi_y-\psi_x$$

where

$$\bar{W}=\bar{V}/V_t=u\bar{\imath}+v\bar{\jmath},\quad \omega=|\nabla x\bar{W}|,\quad q=Q/V_t^3,$$

Q is heat added per unit mass and time, and V_t = limiting velocity (local value). We consider here uniform flow $\bar{W}=u_0L$ slightly perturbed by a localized heat source q which is coupled to ω through the equation $q_y=\omega_x$.

Solutions of these equations will be discussed for various simple heat source functions, $q(x, y)$. Upon the characteristics of $q(x, y)$ depend the continuity of the perturbation field $\bar{W}'$ and the distribution of vorticity produced. It appears that sources of heat are inherently more complicated in their structure and effects than sources of fluid. In general, a localized heat source will produce an accelerated jet of fluid downstream of the source, and more or less sharply defined regions of vorticity trail downstream from the edges of the source.

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* This communication was submitted to the American Physical Society as an abstract for the New York meeting, but because of an oversight it was not included in the bulletin for that meeting.

[1] B. L. Hicks, D. J. Montgomery, and R. H. Wasserman, J. App. Phys. **18**, 891 (1947).

[2] Article accepted for publication in Quart. App. Math.

Excited States of B^{10}

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February 2, 1948

THE neutron spectrum from the reaction $Be^9(d, n)B^{10}$ has been studied by Bonner and Brubaker,[1] Staub and Stephens,[2] and Powell and Fertel,[3] all of whom observed transitions to states in B^{10} at 0.6, 2.0, and 3.5 Mev, in addition to the ground state. The accompanying γ-radiation has been measured by Crane, Halpern, and Oleson[4] as consisting of a line at 3.45 Mev and one or more below 1 Mev. Kruger, Stallman, and Shoupp,[5] on the other hand, report 31 γ-ray lines attributed to this reaction. In work on the reaction $Li^7(\alpha, n)B^{10}$, Haxel and Stuhlinger[6] found evidence for levels at ~0.8, 1.3, and 2.1 Mev. (The energy available in their experiment was not sufficient to excite higher levels.) Cascade transition in the capture radiation from $Be^9(p, \gamma)B^{10}$ through a level at ~0.8 Mev has been reported by Fowler, Lauritsen, and Lauritsen.[7] In the latter work it was found that the radiation emitted from the 4-kev wide state which occurs at a proton energy of 1.077 Mev is appreciably softer than that from the 94-kev wide resonance at 0.988 Mev, and the existence of additional radiation of 0.8 Mev from the higher level was indicated.

Using a large aperture magnetic lens spectrometer, we have studied the γ-radiation from several reactions leading to states in B^{10}. Figure 1 shows the result of measurements made on the $Be^9(p, \gamma)B^{10}$ radiation from a 12-kev target bombarded by 1.08-Mev protons (at the narrow resonance) and from a thick target with 1.04-Mev protons (just below the narrow resonance). The curves indicate the number of photo and Compton electrons from a thick lead converter as a function of momentum. Because of the low intensity of the radiation, it was necessary to utilize a large solid angle in the spectrometer, with considerable sacrifice in resolution. Nevertheless, it is clear that a component at 0.72±0.1 Mev exists at the higher resonance, which does not appear at the lower bombarding voltage. By comparison with the distribution of electrons from the 0.511-Mev annihilation radiation from N^{13}, taken with the same geometry, one can make a reasonable fit to the observed curve by superposition of K, L, and Compton electron distributions. The general background is due to Compton electrons from the higher energy radiation (6.7 Mev from the narrow resonance; 7.4 Mev from the broad resonance).

In the study of the γ-radiation from the reaction $Be^9(d, n)B^{10}$, it was possible to use much improved resolution, and the several lines can be clearly resolved into K, L, and Compton components (Fig. 2). The targets in this case were suspended inside the spectrometer and were bombarded by 0.840-Mev deuterons. To distinguish between Compton and photoelectrons, runs were made with various converters. The location of K and L electron lines for each γ-ray energy is indicated by arrows: a correction of 10 kev has been made for the shift in peak due to the converter thickness. The γ-ray energies are (in kev) 420±10, 480±10, 715±10, 1025±20, 1460±30. Higher energy lines exist, but could not be reached with the present spectrometer.

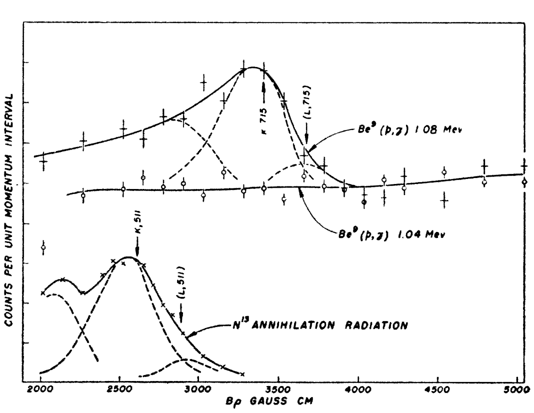

FIG. 1. Secondary electron spectra from Be^9+p gamma-radiation.

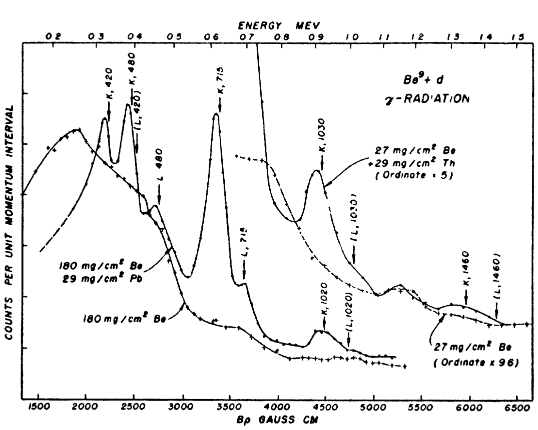

FIG. 2. Secondary electron spectrum from Be^9+d gamma-radiation.

The radiation at 0.715 Mev is identical with that observed in the $Be^9(p, \gamma)B^{10}$ reaction and hence is clearly to be associated with a level at 0.715 Mev above the ground state. It is suggested that the lines at 0.420, 1.025, and 1.46 indicate levels at 0.420 and 1.46 Mev, with the 1.025-Mev radiation arising from cascade transitions from the upper level. That the line at 0.480 Mev is due to $Be^9(d, \alpha)Li^{7*}$ was ascertained by a direct comparison with the radiation from $Li^7(p, p')Li^{7*}$, using the same geometry.

In a search for non-capture radiation we have bombarded B^{10} in the form of isotopically enriched $B_2O_3(B^{10}:B^{11}=24:1)$[*] with protons. Radiation at 0.420 Mev was observed with a bombarding energy of 0.9 Mev, with a sharply rising yield, suggesting a threshold process, to 1.4 Mev. No evidence of the expected 0.715-Mev radiation was found at 1.4 Mev. It seems reasonably clear that the 0.420-Mev radiation arises from non-capture excitation of the lowest level in B^{10}; the absence, or low probability of excitation of the next level, may indicate that this level differs radically in character from the ground state, as is also suggested by its behavior in the $Be^9(p, \gamma)B^{10}$ reaction. This work was assisted by the Office of Naval Research.

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[6] Haxel and Stuhlinger, Zeits. f. Physik **114**, 178 (1939).

[7] Fowler, Lauritsen, and Lauritsen, Phys. Rev. **73**, 181 (1948).