

Proceedings of the Third International
Conference on High Energy Physics and
Nuclear Structure, Argonne, Illinois,
May 5-7, 1969

UCRL-19348
Preprint

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DOPPLER BROADENING OF THE 6.322-MeV γ -RAY FROM ^{15}N
FOLLOWING μ^- CAPTURE IN ^{16}O

S. N. Kaplan, R. V. Pyle, L. E. Temple, and G. F. Valby

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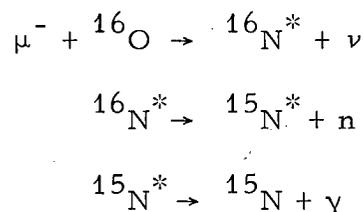
DOPPLER BROADENING OF THE 6.322-MeV γ -RAY FROM ^{15}N
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The very broad, 6.322-MeV ^{15}N line observed¹ following μ^- capture in ^{16}O can be fitted with a simple kinematic model by using the neutron energy spectra predicted in the resonance-capture calculation of Raphael, Uberall, and Werntz.² If we assume complete isotropy in the reaction sequence



and define $\vec{\beta}_1$ as the recoil velocity of the $^{16}\text{N}^*$ from ^{16}O , $\vec{\beta}_2$ as the recoil velocity of the $^{15}\text{N}^*$ from ^{16}N , and E_0 as the γ -ray energy in the $^{15}\text{N}^*$ rest frame, we can easily show that for monoenergetic neutron emission the γ ray will have the trapezoidal line shape shown in Fig. 1.

Summing over the neutron line spectrum of Ref. 2 and folding in detector resolution (12 keV or 2 PHA channels), we obtain the curve in Fig. 2.

The experimental data points can also be fitted by assuming the recoil of a monoenergetic neutron. The quality of this fit as a function of neutron energy (E_n) is indicated in the table.

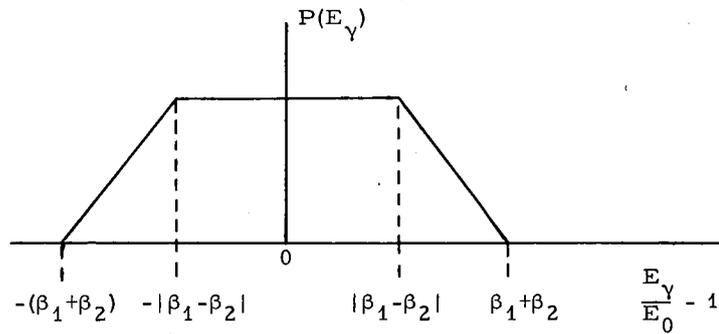


Fig. 1. Calculated line shape for monoenergetic neutron emission.

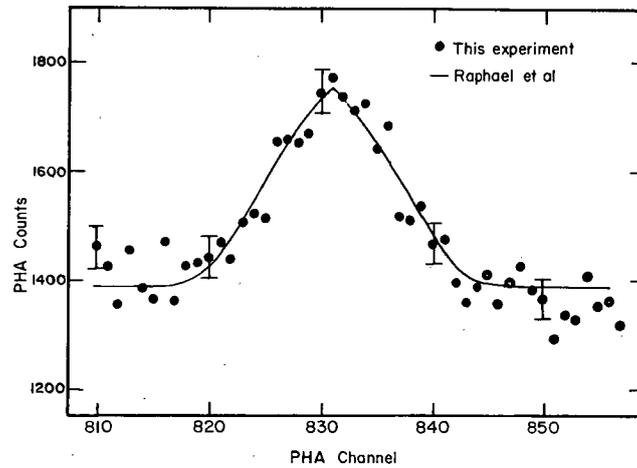


Fig. 2. Experimental data fitted with neutron spectrum of Ref. 2.

E_n (MeV)	χ^2/d	Confidence level (CL) (%)	E_n (MeV)	χ^2/d	Confidence level (CL) (%)
1	70/30	< 0.01	5	25.5/30	> 50
2	47/30	6	6	31.5/30	40
3	28/30	> 50	7	40.8/30	10
4	23.6/30	> 50	8	55.5/30	0.4

The data can, therefore, be well fitted ($CL \geq 50\%$) with any spectrum of neutrons principally in the energy range of 3 to 6 MeV. However, a significant fraction of lower- or higher-energy neutrons would spoil this fit.

These limits imposed on neutron recoil energies are consistent both with the predictions of the resonance model and the μ^- capture

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AEC Contract No. W-7405-eng-48

November 7, 1969

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S. N. Kaplan, R. V. Pyle, L. E. Temple, and
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Please change citation at upper left on cover to read:

"Proceedings of the Third International Conference on High Energy
Physics and Nuclear Structure, New York, September 8-12, 1969."

neutron spectrum measurements reported by Evseev et al.³

It should be pointed out that the assumed isotropy does constitute an oversimplification because of correlation between the nuclear spin axis and the direction of neutrino emission. Therefore some modification of the above result can be expected if detailed account is taken of possible angular correlations.

References:

1. S. N. Kaplan, R. V. Pyle, L. E. Temple, and G. F. Valby, Phys. Rev. Letters 22, 795 (1969).
2. R. Raphael, H. Uberall and C. Werntz, Physics Letters 24B, 15 (1967).
3. Y. Evseev, T. Kozlowski, V. Roganov, and J. Woitkowska (these Proceedings).

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