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The thermal neutron absorption cross section of sulfur and the ^{252}Cf nubar problem*

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The thermal neutron absorption cross section for natural sulfur was measured to be 513 ± 15 mb. Any discrepancy between $MnSO_4$-bath and liquid scintillator measurements of $^{252}Cf(\bar{\nu})$ cannot be attributed to a discrepancy in this cross section value.

The need for a more accurate value of the thermal neutron absorption cross section of sulfur has been emphasized in a recent status report on measurements of the average number of neutrons ($\bar{\nu}_T$) emitted in spontaneous fission of ^{252}Cf.[1] The ^{252}Cf $\bar{\nu}_T$ value is used as the standard in measurements of $\bar{\nu}(E)$ for neutron induced fission in all the isotopes of thorium, uranium, and plutonium. It is therefore one of the most important parameters used in reactor design and safety analysis calculations for which its value is requested to an accuracy of 0.25%. The impact of the value of the sulfur absorption cross section on ^{252}Cf $\bar{\nu}_T$ values obtained from $MnSO_4$-bath activation measurements is discussed in Ref. 1. Smith suggests that an increase in the value used for this cross section may relieve the persistent ~ 0.8% systematic difference between the $\bar{\nu}$ value obtained in

manganese bath measurements and those obtained by the other frequently used, precise technique-liquid scintillator. It has been pointed out[1] that the currently accepted value of σ_a (natural sulfur) of 520 ± 30 mb (Ref. 2) was derived from measurements which range from ~ 470 mb to ~ 620 mb and that an increase in the value used for $MnSO_4$-bath corrections of only 30 mb would increase the value of $\bar{\nu}_T$ obtained by 0.25%. Clearly, an independent measurement of the sulfur thermal capture cross section, which constitutes nearly 99% of the absorption, to an accuray of better than 5% would be of great benefit in resolving this question.

We have measured $\sigma(n,\gamma)$ for thermal neutron capture in natural sulfur by summing the intensities in the prompt gamma spectrum. The spectrum was obtained from a 1-g sample of chemically pure natural sulfur placed in the internal target facility of the Los Alamos Omega West reactor. The detector was a 6.1-cm dia by 15.2-cm long NaI scintillator operated in anticoincidence with a NaI annulus. The response function of the detector has been determined over a wide energy range to permit unfolding of the recorded pulse-height spectrum into a superposition of full-energy peaks that correspond to the emitted gamma spectrum (see figure). The gamma spectrum thus determined was normalized in terms of partial capture cross section by measuring the intensity of the single gamma from neutron capture by ^1H from a 46-mg sample of polyethylene placed at the same target position.

The value of the natural sulfur thermal absorption cross section derived from the present measurements, 513 ± 15 mb, is in good agreement with the value 520 ± 30 mb used currently in corrections for $MnSO_4$-bath measurements of $^{252}Cf\ \bar{\nu}_T$. This suggests that other areas must be examined to resolve the discrepancy between $MnSO_4$-bath and liquid scintillator measurements of this important parameter.

The two most precise values of $^{252}Cf\ \bar{\nu}_T$ are 3.764 ± 0.014 from $MnSO_4$-bath measurements[3] and 3.782 ± 0.008 from recent ORELA liquid scintillator measurements.[4]

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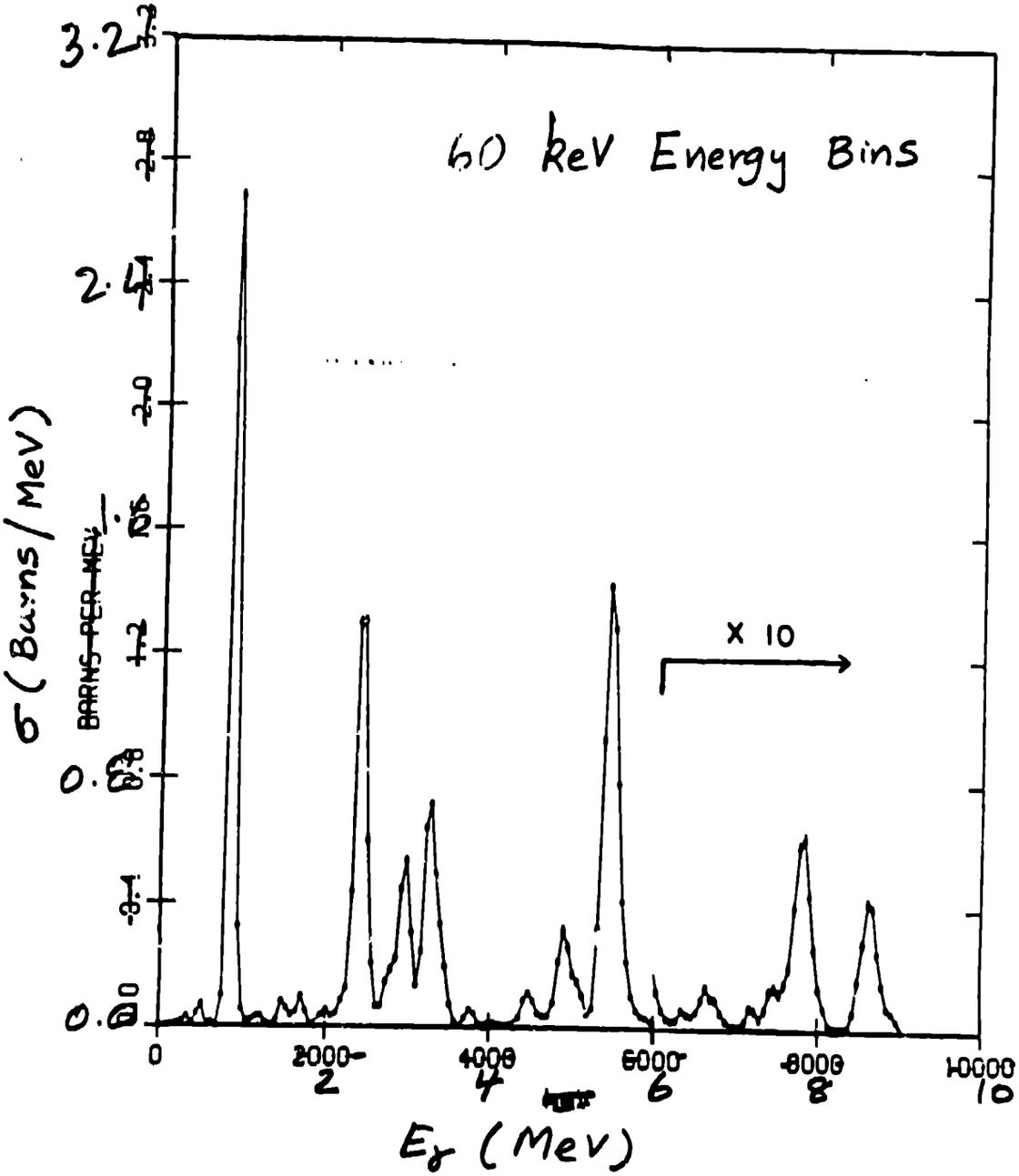
[1]J. R. Smith, "Status of the Quest for $^{252}Cf\ \bar{\nu}$," EPRI NP-1258, December (1979).

[2]S. F. Mughabghab and D. I. Garber, Neutron Cross Sections, BNL-325, Vol. 1, June (1973).

[3]J. R. Smith, S. D. Reeder, and R. J. Gehrke, Trans. of the Amer. Nucl. Soc. and the European Nucl. Soc. 1980 Int. Conf. on World Nuclear Energy, Wash. D. C., 35, 549 (1980).

[4]R. R. Spencer, R. Owin, and R. W. Ingle, (to be published). See also Proc. Int. Conf. on Nuclear Cross Sections for Technology, Knoxville, NBS Special Publication 594, 728 (1980).


60 keV Energy Bins
X 10
σ (Barns/MeV)
BARNS PER MEV
3.2
2.4
1.6
0.8
0.0
0
2000
4000
6000
8000
10000
2
4
6
8
10
Eγ (Mev)