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TITLE: DIRECT CAPTURE IN THE $^{34}S(n,\gamma)^{35}S$ REACTION WITH THERMAL NEUTRONS

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Direct capture in the $^{34}S(n,\gamma)^{35}S$ reaction with thermal neutrons

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Abstract. The partial capture cross sections for primary γ rays in the $^{34}S(n,\gamma)^{35}S$ reaction with thermal neutrons are in reasonable agreement with the direct capture predictions of Lane and Lynn.

We have studied the $^{34}S(n,\gamma)$ reaction at the Los Alamos Omega West Reactor thermal neutron capture facility. These measurements were made with a 1.09 gram, 78% enriched ^{34}S target. The 26 cm^3 Ge(Li) detector was located approximately 6 m from the internal target. This detector was operated either in the Compton suppression or pair spectrometer mode. Approximately 60 γ rays were observed, several with intensities as low as ≈2 photons per 10,000 neutron captures. All γ rays except 3 weak ones have been incorporated into a level scheme of ^{35}S with 20 excited states. The primary γ rays and the secondary γ rays (feeding the ground state) separately accounted for ≈100% of the measured total capture cross section of 244 mb. The primary E1 γ rays leading to states at 2348, 3802, 4169, 4903 and 4963 keV accounted for 95% of this cross section.

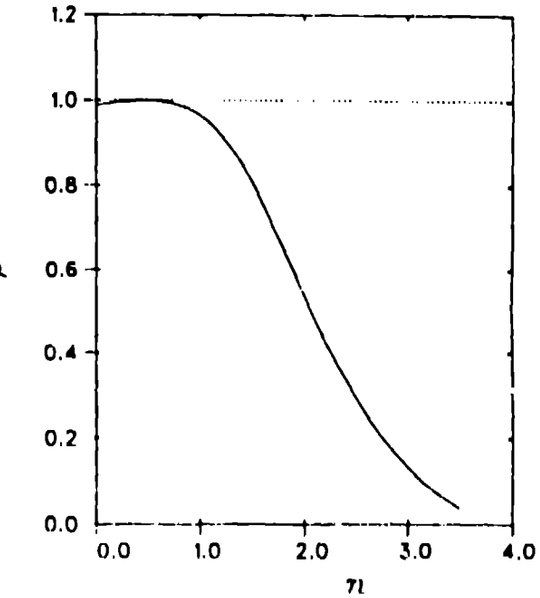

Fig. 1. Correlation coefficient ρ between (d,p) strengths and (n,γ) strengths $I_\gamma E_\gamma^{-n}$ plotted as a function of n.

For several nuclides near A=40, where thermal cross sections are low and non-resonant, Spits and Akkermans (1973) showed that the correlation between thermal (n,γ) intensities and (d,p) spectroscopic strengths is maximized by dividing the primary γ-ray intensities by the appropriate energy to the first power. A similar

result for ^{35}S is shown in Fig. 1. This result a priori suggests direct capture (Kopecky, Spits and Lane 1974) but as emphasized by Mughabghab and Chrien (1979) it is also necessary to quantitatively compare the measured and calculated partial capture cross sections.

The needed expressions for calculating the direct capture cross sections have been derived by Lane and Lynn (1960a, 1960b) and explicitly given by Mughabghab and Chrien (1979). The (d,p) spectroscopic strengths for $1/2^-$ and $3/2^-$ levels in ^{35}S are known (Abegg and Datta 1977). Since the nuclear radius of 4.4 fm is greater than the known scattering length of 3.5 fm (Koester, Knopf and Waschkowski 1979), constructive interference between hard-sphere and channel capture is expected. The resulting predictions are compared with the measured cross sections in Fig. 2. The predictions are $\approx$20% lower than the measurements but well within the uncertainties inherent in the compared quantities.

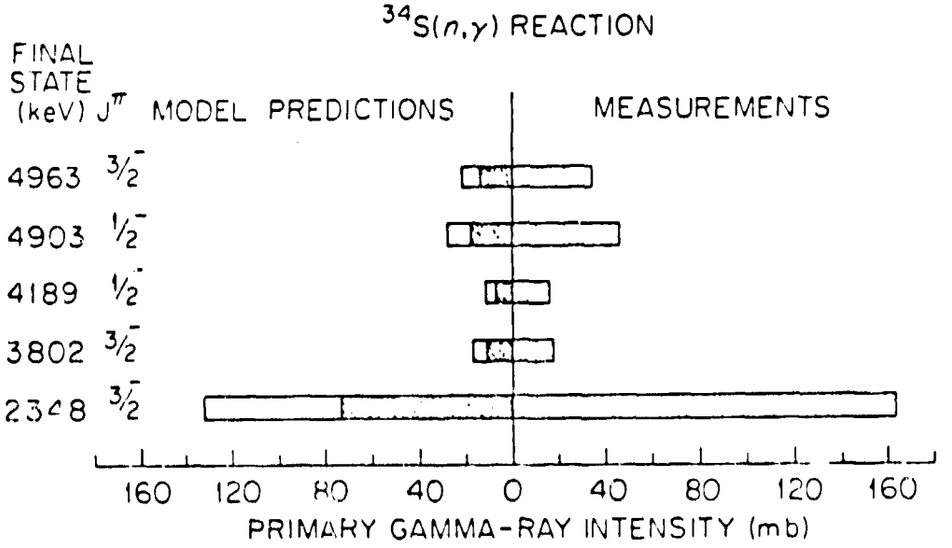

Fig. 2. Comparison of measured and predicted partial cross sections. On the left side, the darkly shaded contribution is due to hard sphere and the remaining due to channel capture

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