THE ISOVECTOR QUADRUPOLE RESONANCE IN ^{16}O

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Cross sections and analyzing powers for radiative proton capture into ^{16}O have been measured to deduce the distribution of isovector electric quadrupole strength above the region of the giant dipole resonance. While only about 20% of the energy-weighted E2 sum rule has been observed[1] at lower energies, microscopic calculations[2] predict that the dominant resonant contribution should occur near 35 MeV, and extend to nearly 50 MeV of excitation.

Through simultaneous measurements of the angular distributions of both cross section and analyzing power, the low partial-wave quadrupole strength can be accurately determined. We have measured these distributions at proton beam energies of 20.3, 24.3 and 28.7 MeV, corresponding to excitation energies in ^{16}O of approximately 31, 35 and 39 MeV.

Gamma-rays were detected in a NaI spectrometer built at the University of Kentucky and consisting of a core element 8" diameter x 10" deep, which is surrounded by a NaI annulus of 1.75" thickness. Background-free spectra were obtained by the combined use of TOF rejection of fast neutrons and cosmic-ray rejection with the active annular shield. The detection efficiency for the ~30 MeV gamma-rays of interest was increased by approximately 100% by resumming the measured energy distribution as observed in the core and annular detectors.[3]

Gamma-ray angular distributions were recorded at 8 angles extending from 23° to 155° in the lab. Interestingly, the measured analyzing powers at the limits of this angular range assumed their maximal values, where typically $|A_y| \sim 0.6 \to 0.7$. These data provide tight constraints on the parameters which describe the complexity of the angular distribution and on the extent of E1-E2 mixing which appears in interference terms. Our first analysis of these data indicates that the E1-E2 interference is strong. This will allow an accuate extraction of the magnitude and phase associated with the capture partial-waves $^3S_1$ and $^3D_1$ for dipole radiation and the capture partial-wave $^3P_2$ for electric quadrupole radiation.

Replay and further analysis of these data are in progress.

1) S.S. Hanna et al., Phys. Rev. Lett. 32, 114 (1974).

2) K.F. Liu and N. Van Giai, Phys. Lett. 65B, 23 (1976).

3) M.A. Kovash, Proceedings of the LAMPF Workshop on Photon and Neutral Meson Physics, H. Crannel ed. (1987).