EXCITATION OF SPIN–ISOSPIN GIANT RESONANCE STATES IN $^{12}C(\gamma, \pi^+)$ ^{12}B USING TAGGED PHOTONS

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The angular distribution of positive pions from the reaction, $^{12}C(\gamma,\pi^+)\ ^{12}B^*$ were measured at five angles (θ_π = 35°, 55°, 90°, 125°, 145°) using the tagged photons in the range $176 \leq E_\gamma \leq 182$ MeV. The π^+ spectra were measured with a system of ΔE–E plastic scintillator telescopes. The separation of π^+ from other particles was achieved by measuring the ΔE vs. E scatter plot and also by observing the delayed decay muons from the stopped π^+ in the E–detector.

The π^+ spectra obtained over the 6 MeV wide tagging range were shifted to, and collected at a centroid photon energy $\overline{E}_\gamma$ = 180 MeV. The results are shown in Fig. 1. Prominent peaks are seen at 0, 4.5, 7.5 MeV and in addition there is an evidence of structure above 10 MeV in the residual nucleus, ^{12}B.

The differential cross sections leading to each of these states (complex of states) were obtained by a fitting procedure using a Monte–Carlo simulated detector response function. The magnitude of the cross sections were determined relative to the known $^1H(\gamma,\pi^+)$ cross sections values[1] in an auxiliary run using a polyethylene target. The results are shown in Fig. 2 as a function of the momentum transfer, q(fm^{-1}). The errors assigned are statistical only. Previous data obtained using a continuous photon source are also included for comparison with our monochromatic, tagged photon data. The results for the 7.5 MeV state in ^{12}B are especially noteworthy. While the previous data[2] using a continuous photon data are subject to large statistical uncertainties, the present data using tagged photons show a definite forward peaking characteristic of low multipole transition, probably E1 or M2. The 7.5 MeV state in ^{12}B is the analog of a 22.5 MeV state in ^{12}C, an energy region where strong spin flip E1[3] and M2[4] states were theoretically predicted, and experimentally observed in (ee')[5,6] and (π,π')[7] experiments.

Since the charged pion photoproduction proceeds dominantly via the Kroll–Ruderman term, all the states observed here are unambiguously T=1 and most likely S=1 ("spin–flip"). Detailed theoretical calculations will be very useful to facilitate our understanding of spin–isospin excitations observed in the present experiment.