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Photoabsorption and Photofission of Nuclei

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The interaction of baryon resonances in the nuclear medium has not been studies extensively. Although the delta resonance strength appears to be conserved over a wide range in mass number, the higher lying baryon resonances at E_γ=0.7 GeV and 1.0 GeV (mainly the D_{13}(1520) and F_{15}(1680) resonances) are clearly seen only in the photon absorption spectra of free protons and deuterons. This phenomenon might be explained by the shadowing effect or possibly by the damping of the excitation or propagation of deformed resonances in the nuclear medium.

This experiment will measure the total photabsorption cross section for C. A1, Cu, Sn, and Pb nuclei to study the interaction of baryon resonances in the nuclear medium. These measurements will be performed with photons in the energy range from 0.4 to 1.9 GeV using the Hall B photon tagger to produce the photons and measure their energies. The total absorption cross section will be measured using the photo-hadronic method. A cylindrical shell of Na1 detectors will be used to measure the photoproduction rate of hadronic events, and a lead-glass shower detector downstream will provide a veto for the vast preponderance of purely electromagnetic events. This experiment does not require the CLAS detector and is expected to run with the photon tagger prior to final commissioning of the CLAS.

For heavier mass nuclei in the actinide region with fissility nearly equal to one, specifically ^{238}U, measurement of the photofission cross section is a useful technique to measure the total photoabsorption cross section. This experiment will measure the photofission cross sections in the same energy range, from 0.4 to 1.9 GeV, for the nuclei ^{238}U, ^{232}Th, and ^{237}Np.

Data on ^{238}U show that the photofissility has a constant value consistent with one over a large energy region, from the quasideuteron region well into the resonance region, up to 1.2 GeV. This is expected to be valid at higher energy as well. If this is not the case, however, several interesting questions would be raised: what is the branching ratio of non-fission events, what type of processes leave the residual nucleus cold, are these surface events, and are strong many-body forces important?

The photofission of ^{232}Th shows a behavior different from the heavier actinide nuclei. This nucleus appears to have a photofissility between 0.6 and 0.8, and increases with energy from 0.25 GeV to 1.2 GeV. (Other actinide nuclei reach a fissility of nearly 1.0 at much lower energies.) This behavior has been attributed to a smaller transparency of ^{232}Th, although the explanation could be that the fissionability Z^2/A is simply too small. The ^{237}Np nucleus, on the other hand, has reported fissilities exceeding that for ^{238}U by 20-40% from 0.07 to 0.24 GeV. This behavior is quite surprising, and needs to be checked. Therefore, this experiment will measure the fissility of ^{237}Np as well.

The photofission measurements will be made using tagged protons from 0.4 to 1.9 GeV in energy. The fission products will be detected in parallel plate avalanche detectors (PPADs) in which the nuclear target is internal, forming one of the electrode planes. This measurement does not require the CLAS and can be performed prior to CLAS commissioning as well; in fact, this measurement would constitute an ideal commissioning experiment for the photon tagger. However, further study with the CLAS is desirable, in order to determine the character of the non-fission events.