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Double polarisation observables G and E and helicity dependent cross section for single π^0 photoproduction off proton and neutron at MAMI

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The internal structure of the nucleon and the excitation spectra of protons and neutrons have been a central issue for many theoretical models and experiments of nuclear and particle physics since the beginning of the 1960's.

Up to now, most efforts have been devoted to studying proton excitation but, since the electromagnetic excitations are isospin dependent, also measurements of meson-photoproduction off the neutron are required.

The A2@ MAMI collaboration is carrying out a broad and systematic study on these topics, both on the proton and the neutron. The experiments are performed at the tagged photon beam facility of the MAMI accelerator in Mainz, using circularly and longitudinally polarized photons on longitudinally polarized proton and deuteron targets, for energies ranging from the pion production threshold up to 1.6 GeV. Hadronic reaction products are then measured with the large acceptance Crystal Ball spectrometer, complemented by charged particle and vertex detectors for tracking and identification.

In this talk, an overview of the results obtained so far for the double polarization observables G and E on the single π^0 photoproduction off the proton and the neutron will be given. New results on the helicity-dependence of the total inclusive photo-absorption $d\sigma/d\Omega$ cross sections for the π^0 reaction channel on the proton and the deuteron will be presented. These new, high-quality doubly-polarized pion-photoproduction data sets give a valuable input to the study of the nucleon structure and excitation spectra of protons and neutrons, by providing a contribution to the partial wave analysis models and by allowing to constrain the multipole solution of the different analyses.

Furthermore, the helicity dependent observables provide the main ingredient for the verification of the well-known Gerasimov-Drell-Hearn (GDH) sum rule, which relates the helicity-dependent photoasborption process to the main static nucleon properties (mass, charge, spin). For this reason, such a verification is of particular interest in the understanding of the nucleon spin structure, the $\gamma - N$ interaction, as well as the physics of strongly interacting systems. Thanks to the use of polarized deuteron and ^{3}He targets, the A2 experiment can study all the $\gamma N \rightarrow N\pi(\pi)$ partial channels and the total cross sections, for the neutron too.

Moreover, the results obtained on ^{3}He give information not only on the GDH integral on the neutron, but also on the ^{3}He nuclear structure and allow an investigation of the nucleon properties inside this nucleus.

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