Differential cross section of $\gamma\, n \rightarrow K^+ \Sigma^-$ on bound neutrons with incident photons from 1.1 to 3.6 GeV

A major goal of hadron physics is to study the structure of the nucleon and its excited states. However, understanding nucleon resonance excitation is a serious challenge due to the non-perturbative nature of QCD at low energies. This makes the situation for the excited states of the nucleon (*N* and *Δ* resonances) still unclear: many more states are predicted than observed and states with certain quantum numbers appear at energies much lower than predicted. This has been known for a long time as the ``missing resonance'' problem.

Experimentally, most of our present knowledge of baryon resonances comes from reactions involving pions in the initial and/or final states. For increasing masses, both the energy overlap of the resonances and meson production make it more difficult to separate the resonance contributions. A possible explanation for the missing resonance problem could be that pionic coupling to the intermediate N^* or Δ^* states is weak and that many of the missing states only become visible in other reaction channels. Photoproduction of non-strange resonances detected via decay into strange particles offers two benefits: (1) two-body *KY* (where *Y* denotes any hyperon) final states are easier to analyze than the three-body $\pi\pi N$ final states that dominate the decays at higher masses resonances; (2) couplings of nucleon resonances to *KY* final states are expected to differ from those to πN and $\pi\pi N$ final states. Therefore, looking in the strangeness sector casts a different light on the resonance excitation spectrum, and thus, may emphasize resonances not revealed in πN scattering. To date, however, the PDG compilation gives poorly known $K\Lambda$ couplings for only five well-established resonances, and no $K\Sigma$ couplings for any resonances.

Mapping out the spectrum of excited states that decay into *KY* particles is therefore crucial to provide a deeper insight into the underlying degrees of freedom of the nucleon and to discriminate among different models.

In this situation the necessity of more data and from different channels is evident. In particular, for *Y*-photoproduction on the neutron, one can take full advantage of the isospin symmetry, adding significant constraints on the γKNY coupling constants. Unfortunately, data of hyperon photoproduction on neutrons are very scarce, with the only available data from LEPS, covering a limited photon energy range at very forward kaon angles.

In this paper high-precision cross sections of the reaction $\gamma\, n \rightarrow K^+\, \Sigma^-(p)$ in a broad kinematic range are presented. An example of our results is shown as full circles in Fig. 1. For energies up to $E\gamma$ = 2.1 GeV, the results are shown in linear scale while for higher energies, logarithmic scale has been chosen in order to make more readable the behavior at the backward angles. The error bars represent the total (statistical plus systematic) uncertainties. This is the first high-precision determination of Σ^- photoproduction on the neutron covering a broad kaon-angle and photon-energy range. At a photon energy above ~1.8 GeV, a clear forward peak starts to appear and becomes more prominent as the photon energy increases. This behavior, that is typically attributed to contributions from *t*-channel mechanisms, is not observed at lower energies, where the dominant contributions appear to be from *s*-channel mechanisms. Above ~2.1 GeV there are indications of a possible backward peak, which might suggest the presence of *u*-channel mechanisms. Also shown in are the theoretical results of a Regge-based calculation (Regge-3 model).

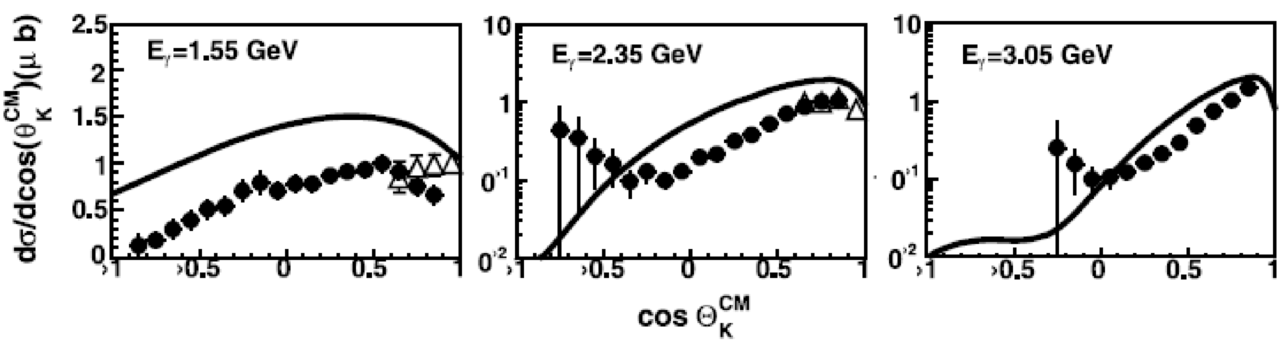

FIG. 1: Differential cross sections for only three E_γ bins of the reaction $\gamma\, n \rightarrow K^+\, \Sigma^-(p)$ obtained by CLAS (full circles). The error bars represent the total (statistical plus systematic) uncertainty. LEPS data (empty triangles) and a Regge-3 model prediction (solid curve) are also shown. Notice the logarithmic scale for high energy plots.