

# Electromagnetic Productions of $K\Sigma$ on the Nucleons<sup>2</sup>

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## ABSTRACT

The latest experimental data on the differential cross sections, recoil polarizations, beam asymmetries, as well as double polarizations  $C_x$  and  $C_z$  for the  $K\Sigma$  photoproductions [1],

$$\gamma p \rightarrow K^+ \Sigma^0, \quad \gamma p \rightarrow K^0 \Sigma^+, \quad \gamma n \rightarrow K^+ \Sigma^-, \quad \gamma n \rightarrow K^0 \Sigma^0, \quad (1)$$

have been simultaneously analyzed by means of a multipoles model. The background part of the model is constructed from a number of appropriate Feynman diagrams. Hadronic form factors are included in the hadronic vertices in a gauge-invariant fashion. Several important constraints, such as crossing and SU(3) symmetries, are imposed on the background part. The resonance terms are assumed to have the Breit-Wigner form [2,3]

$$A_{\ell\pm}^R(W, Q^2) = \bar{A}_{\ell\pm}^R(Q^2) c_{K\Sigma} \frac{f_{\gamma R}(W) \Gamma_{\text{tot}}(W) M_R f_{KR}(W)}{M_R^2 - W^2 - iM_R \Gamma_{\text{tot}}(W)}, \quad (2)$$

where  $W$  represents the total center-of-momentum energy,  $\ell$  indicates the kaon angular momentum, and  $\ell\pm \equiv \ell \pm 1/2 = j$  shows the total angular momentum. All possible nucleon and  $\Delta$  resonances up to  $\ell = 5$  have been included in this analysis.

For comparison with the results of previous calculations [4], as well as with the PDG values [5], we follow Ref. [3] to define the proton  ${}_p A^{(1/2)}$  and neutron  ${}_n A^{(1/2)}$  helicity photon amplitudes with total isospin 1/2,

$${}_p A^{(1/2)} = A^{(0)} + \frac{1}{3} A^{(1/2)}, \quad {}_n A^{(1/2)} = A^{(0)} - \frac{1}{3} A^{(1/2)}. \quad (3)$$

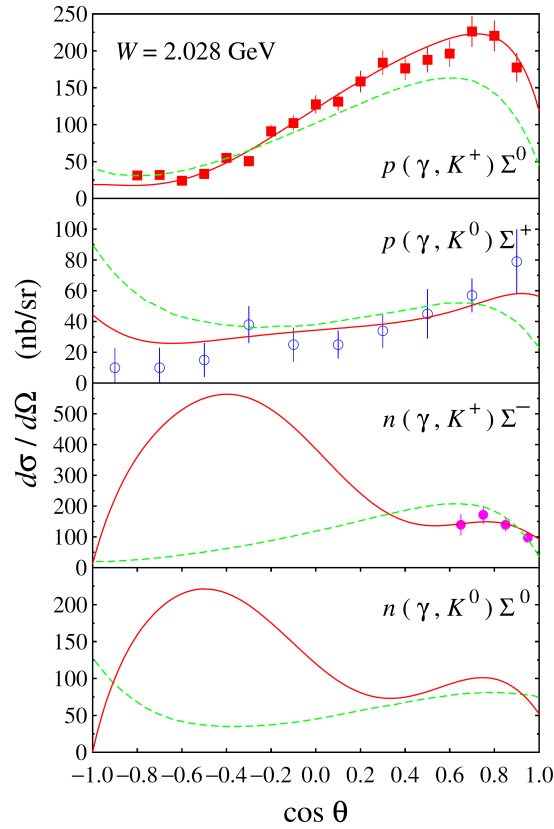
Using this notation, the CGLN amplitudes for the four physical channels of kaon photoproduction can be written as

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$$\begin{aligned}
A(\gamma p \rightarrow K^+ \Sigma^0) &= p A^{(1/2)} + \frac{2}{3} A^{(3/2)} \quad , \\
A(\gamma n \rightarrow K^0 \Sigma^0) &= -_n A^{(1/2)} + \frac{2}{3} A^{(3/2)} \quad , \\
A(\gamma p \rightarrow K^0 \Sigma^+) &= \sqrt{2} \left[ p A^{(1/2)} - \frac{1}{3} A^{(3/2)} \right] \quad , \\
A(\gamma n \rightarrow K^+ \Sigma^-) &= \sqrt{2} \left[ -_n A^{(1/2)} + \frac{1}{3} A^{(3/2)} \right] \quad .
\end{aligned}
\tag{4}$$

Sample of the results is shown in Fig. 1. We found that the model can explain the available data [1] nicely, whereas the extracted masses, widths, branching ratios, and coupling parameters of the resonances are comparable to the PDG limits [5].



**Figure 1:** Differential cross sections for  $K\Sigma$  photoproductions on the nucleons. Solid curves demonstrate the result of the present analysis. Dashed curves show the prediction of KAON-MAID [6]. Experimental data are taken from Ref. [1].

*Keywords :* Kaon photoproduction, multipoles, isospin symmetry.

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