$K^+\Sigma^-$ Photoproduction

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New fits for $K^+\Sigma^-$ channel

P. Bydžovský, A. Cieplý, D. Petrellis, and D. Skoupil, Phys. Rev. C **104**, 065202 (2021)

Fitting procedure

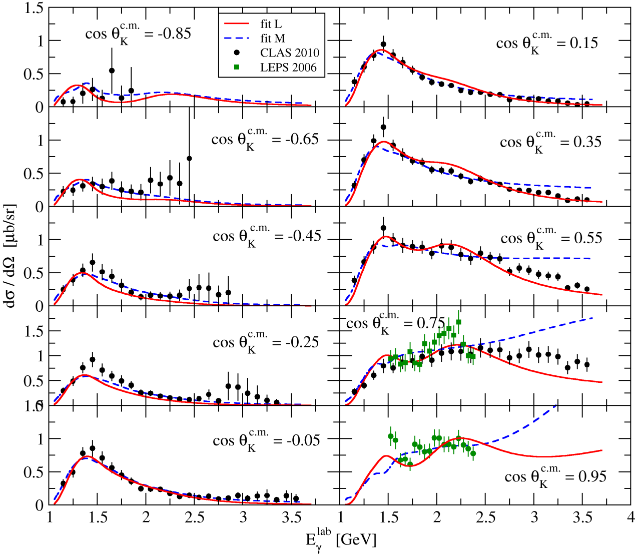
- non resonant part modelled by Born terms and exchanges of K^* and K_1 (t channel) and Σ^* (u channel)
- resonant part modelled by exchanges of nucleon and Δ resonances in the s channel (partly motivated by previous analyses)
- around 600 CLAS (Phys. Lett. B **688**, 289 (2010), arXiv:2106.13957) and LEPS (Phys. Rev. Lett. **97**, 082003 (2006)) data on $d\sigma/d\Omega$ and Σ (restricted up to $E_\gamma^{lab} = 2.6\,\mathrm{GeV}$) utilized to fit ≈ 25 free parameters
- the main coupling, $g_{K^+\Sigma^- n} = \sqrt{2} g_{K^+\Sigma^0 p} = 1.568$, taken from $K^+\Lambda$ channel
- a variant with the smallest $\chi^2/\mathrm{ndf} = 2.3 \rightarrow$ **fit M** (25 parameters, 14 resonances)
- **LASSO method** used: $\chi^2/\mathrm{ndf} = 3.4 \rightarrow$ **fit L** (17 parameters, 9 resonances) (see talk of D. Petrellis for details)

Characteristics of models

- only one Δ resonance introduced
- no hyperon resonances needed for reliable data description
- results in very good agreement with the cross-section and beam-asymmetry data

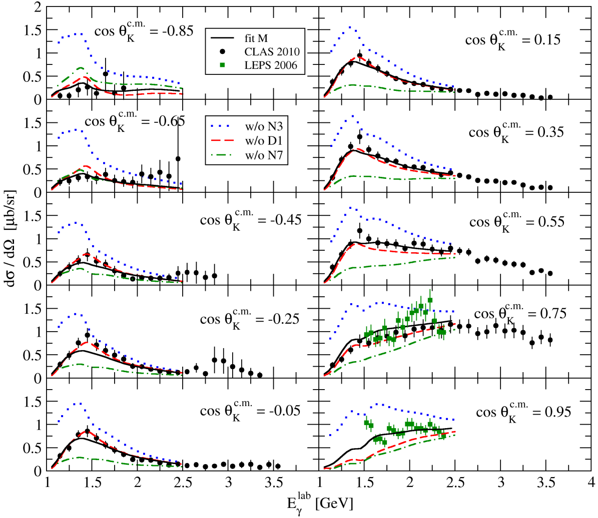
New fits for $K^+\Sigma^-$ channel

Differential cross section in dependence on the photon lab energy



New fits for $K^+\Sigma^-$ channel

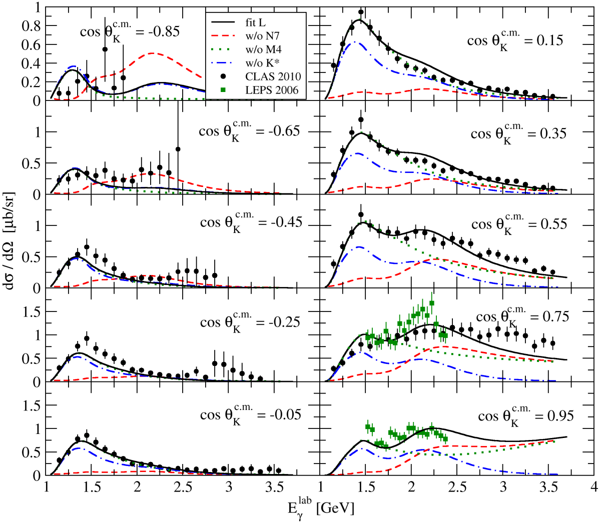
Differential cross section in dependence on the photon lab energy - fit M w/o individual resonances



N3: N(1535)$1/2^-$, D1: Δ(1900)$1/2^-$, N7: N(1720)$3/2^+$

New fits for $K^+\Sigma^-$ channel

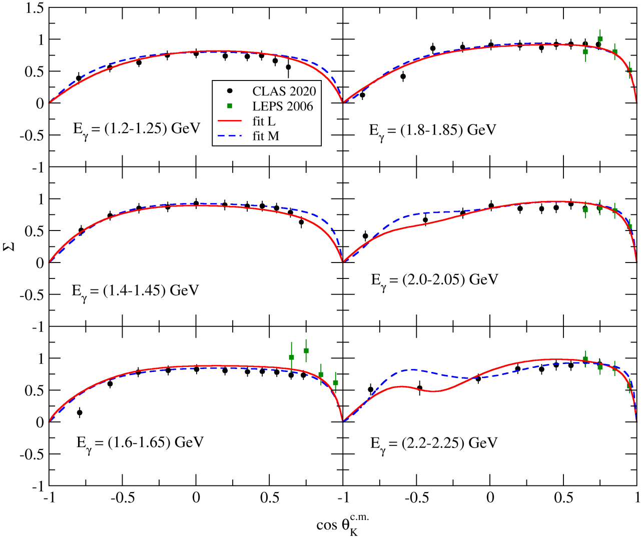
Differential cross section in dependence on the photon lab energy - fit L w/o individual resonances



N7: $N(1720)3/2^+$, M4: $N(2060)5/2^-$

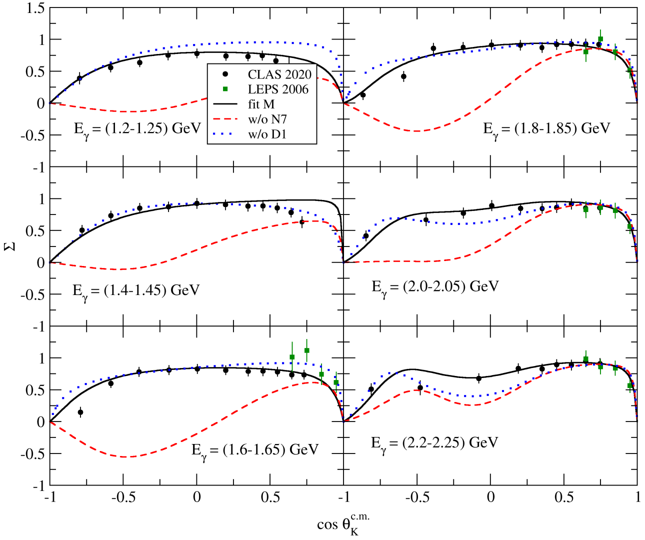
New fits for $K^+\Sigma^-$ channel

Beam asymmetry in dependence on the kaon center-of-mass angle



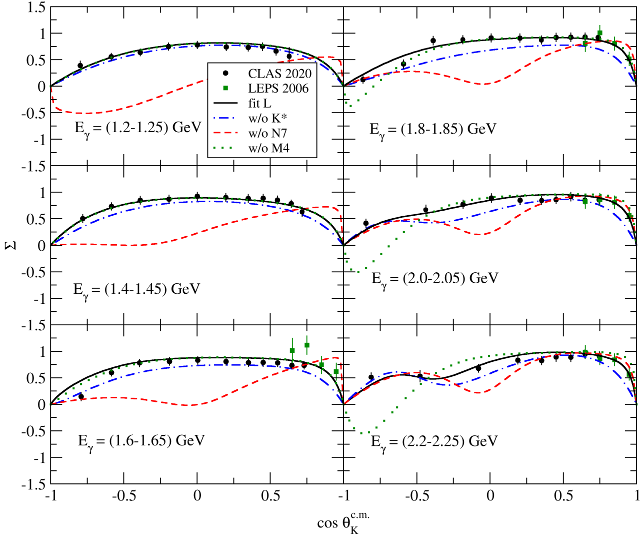
New fits for $K^+\Sigma^-$ channel

Beam asymmetry in dependence on the kaon center-of-mass angle - fit M w/o individual resonances



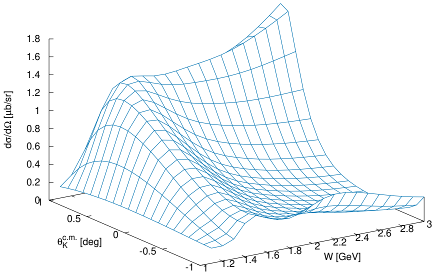
New fits for $K^+\Sigma^-$ channel

Beam asymmetry in dependence on the kaon center-of-mass angle - fit L w/o individual resonances

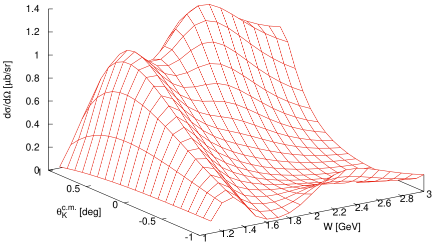


New fits for $K^+\Sigma^-$ channel

Differential cross sections in dependence on energy and kaon angle



Fit M



Fit L

Near-future work: Analysis of Σ production channels

Three-step process

- derive scalar amplitudes $\mathcal{A}_j$ for all channels involved
- use SU(2) isospin symmetry in the strong vertex to relate the couplings
  - isospin symmetry of various meson and baryon multiplets is assumed to be exact
- use known helicity amplitudes for relating electromagnetic couplings
  - the helicity amplitudes for N^*'s are used to determine neutral-to-charge ratio of the electromagnetic coupling constants

$$g^{EM}_{N^*\gamma n}/g^{EM}_{N^*\gamma p}$$

Fit to the data

- $K^+\Sigma^0$ dominates in number of data:
  $\sim$ 92% of Σ photoproduction data concentrated in this channel
- use of Minuit + regularization methods

Mobility Plus: Work plan from the last year

In 2022 we will:

• extend our K+Lambda photoproduction amplitude into the K0 Lambda photoproduction channel
• prepare a framework for the use of DWIA formalism for calculating excitation spectra of hypernuclei
• include the Lambda−Sigma mixing in the YN interaction
• analyze existing experimental data on the p(e,e′K+)Lambda at the forward K+ scattering angle
• analyze existing experimental data on light hypernuclei 9 Lambda Li
• extend the EMPM on hypernuclei with the odd-even nuclear cores by the coupling of the N Lambda Tamm-Dancoff Approximation phonons to the phonon and multiphonon excitations of the nuclear cores

In 2023 we will:

• prepare a formalism for dealing with K0 Lambda photoproduction off the deuteron target using data from CLAS and LNS-Tohoku Collaborations
• extend the EMPM on hypernuclei by the coupling of the N Lambda Tamm-Dancoff Approximation phonons to the phonon and multiphonon excitations of the nuclear cores
• take data of 3,4 Lambda H, 40,48 Lambda K, and 208 Lambda Tl hypernuclei at JLab Hall A by means of electron scattering and analyze the data with the theoretical model
• provide detailed calculation of the structure of 40 Lambda K, 48 Lambda K and 208 Lambda Tl hypernuclei within extended EMPM with various nucleon and baryon potentials


Thank you for your attention!