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Model selection in electromagnetic production of kaons

Abstract:
We have constructed new models for photo- and electroproduction of kaons on the proton [1, 2] utilizing new experimental data from LEPS, GRAAL, and CLAS collaborations. In these models, the high-spin nucleon (spin-3/2 and spin-5/2) and hyperon (spin-3/2) resonances were included using a consistent formalism and they were found to play an important role in the data description. We paid close attention to model predictions of the cross section at small kaon angles which are vital for accurate calculations of the hypernucleus-production cross section. In order to account for the unitarity corrections at the tree level, we introduced energy-dependent widths of nucleon resonances, which affect the choice of hadron form factors and the values of their cutoff parameters extracted in the fitting procedure.
Once all the ingredients of the model were well prepared, we faced the problem of selecting the appropriate set of resonances. Since a plain $\chi 2$ minimization, which we used in our previous studies [1, 2], could not prevent us from overfitting the data, i.e. introducing more parameters (and thus resonances) than were needed for data description, we opted for a regularization method, the least absolute shrinkage selection operator, and information criteria for avoiding this issue and choosing the best fit. In the analysis of new CLAS $K + \Sigma-$ data [5], we were then able to arrive at a very economical model including only the most needed resonances [6]. Similarly, in our two subsequent studies we focused on the role of hyperon resonances in the $K + \Lambda$ channel, in which we made use of ridge regression to reduce some of the couplings and arrived at much more robust model [7], and developed the amplitude for the $K + \Sigma 0$ channel in order to start systematically analysing Σ photoproduction channels.

References
[1] D. Skoupil, P. Bydžovský, Phys. Rev. C 93, 025204 (2016).
[2] D. Skoupil, P. Bydžovský, Phys. Rev. C 97, 025202 (2018).
[3] E. L. Lomon, Phys. Rev. C 66, 045501 (2002).
[4] L. De Cruz et al., Phys. Rev. Lett. 108, 192002 (2012).
[5] N. Zachariou et al., Phys. Lett. B 827, 136985 (2022).
[6] P. Bydžovský, A. Cieplý, D. Petrellis, D. Skoupil, and N. Zachariou, Phys. Rev. C 104, 065202 (2021).
[7] D. Petrellis, D. Skoupil, Phys. Rev. C 107, 045206 (2023).