Multi-Reaction-Channel Fitting Calculations in a Coupled-Channels Model; Photo-Induced Strangeness Production

O. Scholten[1*] and A. Usov[1,2]
[1]KVI, University of Groningen, Groningen, The Netherlands and
[2]University of Leiden, Leiden, The Netherlands

The approach used in this work is based on a coupled-channels effective-Lagrangian formalism. The coupled-channels aspect is implemented through a K-matrix formulation, allowing for the possibility of a full coupled channels in a rather large model space. All calculations are performed in a partial-wave basis including partial waves up to J=9. The effective lagrangian formalism allows to limit the model dependence to a minimum through the possibility of introducing contact terms. A detailed description of our model can be found in Refs. [1, 2].

The use of the K-matrix formalism allows to generate an infinite, non-perturbative set of loop corrections. A number of basic symmetries like gauge invariance, unitarity and crossing symmetry is conserved in this formalism. The model space used in the present investigation is formed by $K-\Lambda$, $K-\Sigma$, $\phi-N$, $\eta-N$, $\gamma-N$, $\pi-N$ and $\rho-N$ states. All reactions within this model space are calculated consistently.

The parameters in the effective Lagrangian are obtained following a χ^2-minimization procedure were cross sections and spin observables for different strangeness producing reactions are considered simultaneously. The minimization technique we use is similar to the multistage minimization technique described in ref. [3].

We have implemented a number of optimizations to improve the performance of the code. Firstly we have limited the fitting to the kaon sector, which allows to calculate matrix elements for the pion scattering and pion photoproduction channels only once, and reuse them later. Another extremely important optimization concerns the calculation of χ^2 where we have employed an interpolating spline for each partial wave to calculate observables for any specific energy. This approach gives surprisingly good results even for sparse energy grids.

We will show that there are several parameter sets that reproduce the data for the three kaon photoproduction channels ($\gamma+p\to K^++\Lambda$, $\to K^++\Sigma^0$, and $\to K^0+\Sigma^+$) at a comparable level while having significantly different values of coupling constants. We show that even in the case of multichannel analysis there is ambiguity in the extract resonance parameters. A complete set of polarization observables is indispensable to dissolve this ambiguity. An outlook will be presented to the next generation of models that incorporate the constraints imposed by analyticity and which generate molecular resonances.

References

[1] A. Usov and O. Scholten, Phys. Rev. C **72**, 025205 (2005).
[2] A. Usov and O. Scholten, Phys. Rev. C **74**, 015205 (2006).
[3] D. G. Ireland, S. Janssen and J. Ryckebusch, Nucl. Phys. A **740**, 147 (2004).

*Electronic address: scholten@kvi.nl