Study of the spin triplet proton-lambda interaction with the COSY-11 detector

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The YN interaction is not very well known compared to the *NN* system and even for the best studied Λp hyperon nucleon system the scattering length has large uncertainties. Elastic Λp scattering data are available for relative momenta above about 120 MeV/c which requires an extrapolation to zero energy with large experimental uncertainies to determine the scattering length. Data from production reactions with multiparticle final states including a Λp subsystem allow the selection of event samples with relative momenta down to zero. However, in this case the theoretical treatment for the extraction of the scattering length where effective range expansions are applied determine the error which is not under control.
Improvements in the theoretical consideration of these processes by the Jülich group [1, 2] with a well controlled error in the derivation of the scattering length from exprimental observables of below 0.3 fm will allow to extract more precise results from reactions like $pp \rightarrow pK^+\Lambda$.
For a detailed analysis a separation of spin singlet and spin triplet scattering lengths is required and measurements with polarised beam and target are necessary. The spin triplet scattering length only is measurable by studying the cross section combined with the analysing power if kaon emission around 90 $^\circ_{cm}$ is selected which needs only a polarised beam.
At the COSY-11 detection system Λ hyperon production via $\vec{p}\,p \rightarrow pK^+\Lambda$ has been measured at an excess energy of 40 MeV with a transverse polarised proton beam in order to extract the spin triplet Λp scattering length. With the asymmetric detection setup only one side can be measured and therefore the spin has to be flipped to get the analysing power. The COSY operation procedure was injection, acceleration to 2.457 GeV/c and measurement with stochastic cooling for 10 minutes with a fixed polarisation direction. Every second cycle the polarisation direction was flipped. The luminosity was monitored by additional detector components detecting elastic pp scattering in polarisation direction which is insensitive to the orientation of the polarisation. The polarisation of the beam is determined by a comparison of the measured asymmetry of elastic pp scattering in the plane perpendicular to the beam polarisation direction to the known asymmetry from EDDA data [3]. Elastic scattering events were selected by requesting one charged particle track with an additional entry in the Si-pad detector from the second proton and can be well identified around the kinematical ellipse expected for elastic pp scattering in the distribution of transverse versus logitudinal proton momentum. The mean polarisation during the measurement was around 50%.
The $pK^+\Lambda$ -events were separated by selecting events with one proton and one kaon both identified by the invariant masses of the two measured particles, and a Λ in the missing mass spectrum. In fig. 1 the missing mass distribution is shown where a clear Λ peak is seen. The angular distribution of the kaons resulting from $pK^+\Lambda$ -events covers the full range including the 90 $^\circ_{cm}$ region which is required for the extraction of the spin triplet scattering length. But unfortunately the preliminary analysis indicates a very small analysing power for kaon emission around 90 $^\circ_{cm}$ and therefore the observable which includes only spin triplet contributions ($A_y \cdot \sigma$) will be also very small with large error bars. The data are checked carefully and will be analysed once more with improved calibrations before the final results will be extracted.

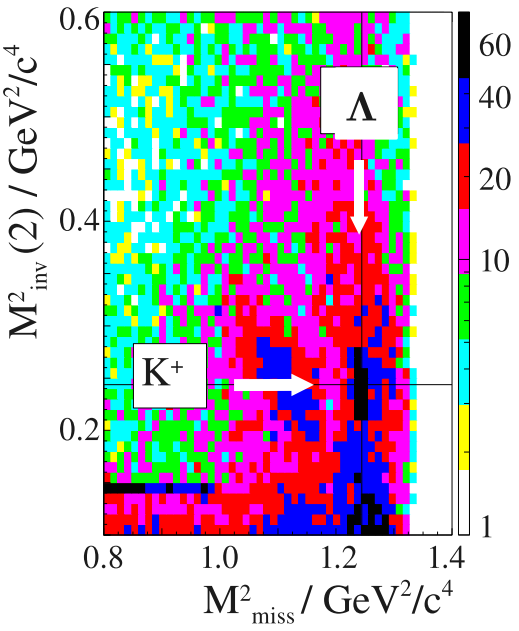

Fig. 1: Invariant mass squared of the second detected particle versus missing mass squared for events with an identified proton.

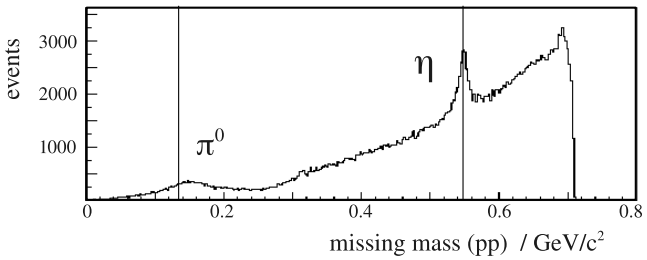

Fig. 2: Missing mass distribution for two proton events.

Besides the $pK^+\Lambda$ reaction also other reaction channels like $pp \rightarrow pn\pi^+$ and $pp \rightarrow pp\pi^0/\eta$ are included in the data. Fig. 2 shows the missing mass distribution with 2 identified protons where a clear η signal shows up. The analyses of the data will also include the study of the η production which will result in cross section and analysing power data for an excess energy of 164 MeV.

References:

[1] A. Gasparyan et al., *Phys. Rev.* **C69**, 034006 (2004).
[2] A. Gasparyan et al., *Phys. Rev.* **C72**, 034006 (2005).
[3] M. Altmeier et al., *Phys. Rev. Lett.* **85**, 1819 (2000).