The meaning of signals in pΛ deviation spectra*

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Motivation for the analysis

The announcement of a signal of the kaonic nuclear cluster "ppK^-" in p+p reactions (M= 2267 MeV/c^2, Γ= 118 MeV/^{2}) has raised a lot of interest and controversy [1]. The signal appeared in a so-called deviation spectrum (DEV) in IM$_{p\Lambda}$ ($p\Lambda$ invariant mass) from the $pK^+\Lambda$ final state which was produced from a p(2.85 GeV)+p collision system. A DEV spectrum is a division of the measured event distribution by a simulated event distribution. Any signal not included in the simulation which is present in the data will appear in this spectrum as a deviation from unity. Large criticism was raised towards this analysis as the simulations to which the data were compared to contained simple phase space production of the three particles $pK^+\Lambda$. As several experiments have shown that this is not a good assumption for the production dynamics of this final state, the interpretation of the DEV spectrum in Ref. [1] is questionable. The $pK^+\Lambda$ final state is dominated by final-state-interaction between the $p\Lambda$ pair, the cusp-structure at 2.13 GeV in the $p\Lambda$ invariant mass spectrum and the evident presence of N* resonances as a source for the $K^+\Lambda$-pair. This knowledge leads to the assumption that measured data that are divided by phase space simulation will a priory never lead to a DEV spectrum which coincides with unity.

To clarify that point we have repeated the analysis of Ref. [1] on data measured by the HADES detector.

The deviation analysis

The data used for that purpose is a set of events specifically selected to contain mainly the final state of $pK^+\Lambda$ [2, 3]. This final state was obtained from p(3.5 GeV)+p collisions and consists of about 20.000 events. The observable that may contain interesting information whether the kaonic cluster "ppK^-" has left its fingerprints in the data is the invariant mass of $p\Lambda$; these are the decay products of the latter. To cross check the results of Ref. [1], we have also produced phase space simulations of the discussed final state that contain no specific dynamics between the three particles. The simulations were filtered by the HADES acceptance and the event selection procedure. Figure 1 shows the result when the measured data are divided by the phase space simulation (red histogram). As the experimental data can not be described by phase space simulations, as was shown before [3], the spectrum deviates from unity. The very crucial point which we want to stress in this analysis is that further applied cuts do act differently on the data and the simulation, in case the simulations do not describe the data properly. This causes the DEV spectrum to change under varying cut conditions as it is nicely illustrated by the additional histograms in Fig. 1. The long-dashed histogram shows the DEV spectrum under the same cuts as applied for Ref. [1] ($|cos\theta_p| < 0.6$ and -0.2$< cos\theta_{K^+} <$0.4). The stricter restriction of the proton angle ($|cos\theta_p| < 0.4$) leads to the green histogram. While a selection of data under the condition $M_{K^+\Lambda} >$1810 MeV/c^2 is shown in short dashed. Evidently, structures appear which have nothing to do with an additional physics signal in the data. This questions the interpretation of the structure in Ref. [1]. This result will be the topic of a forthcoming publication.

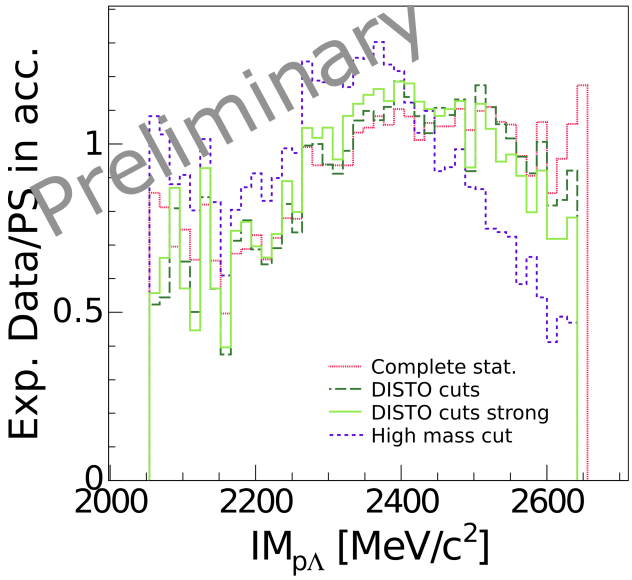

Figure 1: Different deviation spectra, obtained by dividing the reconstructed $pK^+\Lambda$ statistic by phase space simulations in the HADES acceptance.

References

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