Search for a "ppK$^-$" bound state in p+p collisions*

E. Epple[1,2], *L. Fabbietti*[1,2], *and the HADES collaboration*[1]
[1]Excellence Cluster 'Universe', München, Germany; [2]Physik Department E12, Technische Universität München

We report, here, on the progress in our analysis of data taken with the HADES detector. As described in last year's GSI Scientific report [1], we have reconstructed ~20.000 $pK^+\Lambda$ events that were produced in p+p reactions at a beam kinetic energy of 3.5 GeV. To describe the measured observables we have employed a PWA analysis [2]. In this analysis several transition amplitudes, including the production of the $pK^+\Lambda$ final state via the decay of various N* resonances, were fitted to the events. A good description of the data was obtained and presented in [1]. We have now performed a more refined statistical analysis of the experimental event yield.

The main motivation for the presented analysis is the possibility of a kaonic nuclear bound state production via:

$$p + p \rightarrow K^+ + "ppK^-" \rightarrow p + K^+ + \Lambda \qquad (1)$$

If the kaonic cluster would be abundantly produced and fairly narrow the $p\Lambda$ invariant mass distribution could show a signal of the latter. Due to the intense debate if the state is deeply or shallow bound and whether it is narrow or broad, experimental data are needed to clarify the theoretical situation. In the following the methods and results of the analysis procedure are presented.

No new signal but an upper limit

A signal in the data would manifest itself as a deviation of the data from a model which does not contain such a signal. This type of model is called a null hypothesis H_0 and is, in our case, constructed by the PWA solutions that were obtained by a fit to the experimental data. The H_0 hypothesis is illustrated in the upper panel of Figure 1 as gray band overlaid to the experimental data points. The solution includes the systematic variation of the transition waves included in the PWA fit. The lower panel of Figure 1 illustrates the local p-value as a function of the $p\Lambda$ invariant mass. The p-value was calculated from a Pearson χ^2-variable and expresses the agreement between data and model. This agreement can be translated into an equivalent significance (nσ). The equivalent significance also presented in the lower figure shows that the data are in agreement with the model within a range of 3σ. There is no significant deviation from the H_0 hypothesis and, thus, an additional signal is not required to describe the data. The mass point at M=2600 MeV/c^2 shows a deviation larger than 3σ. This is, however, a downward fluctuation of the data in respect to the model.

* This research was supported by VH-NG-330 and the DFG cluster of excellence 'Origin and Structure of the Universe'

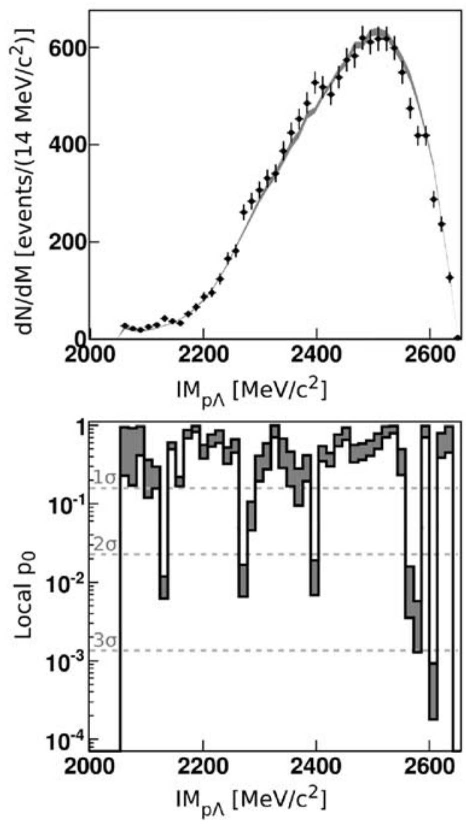

Figure 1: Upper panel: subset of the data shown together with the PWA solution including systematic uncertainties. Lower panel: local p_0-value of the H_0 hypothesis.

The last step in the data analysis is to include an additional signal to the PWA solution to obtain a new hypothesis H_1. This was done for several masses, widths, transition properties and production strengths of the kaonic cluster. The new hypothesis H_1 was compared to the data and only those values of H_1 were accepted that lie within a certain confidence limit. The values of production strength rejected by this test build the upper limit of the production strength of a "ppK^-" in p+p collisions at 3.5 GeV. The results will be presented in an upcoming publication.

References

[1] E. Epple and L. Fabbietti, GSI Report 2012 (2013), p. 13.
[2] A.V. Anisovich et al., Eur.Phys.J. A34, (2007), p. 129.