Strangeness Results from HADES ◇

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1. Study of the $\Lambda(1405)$ resonance

The study of the resonance $\Lambda(1405)$ has recently attracted very much attention, especially for a better understanding of the $\bar{K}N$ interaction and therefore important for a prediction of possible kaonic clusters [1]. The p+p reaction system at 3.5 GeV measured in April 2007 with a statistics of $1.2 \cdot 10^9$ reactions with the HADES-spectrometer are now being analyzed to investigate the feasibility of such a measurement. Simulations were performed to estimate the expected yield of $\Lambda(1405)$ and the corresponding background in the measured data. The following reaction was taken into account:

$$p + p \rightarrow \Lambda(1405) + K^+ + p. \quad (1)$$

A cocktail with $6 \cdot 10^6$ events was simulated with the event generator PLUTO [2] and particle tracks have been propagated through the spectrometer with GEANT [3].The background cocktail consists of 21 reaction channels containing at least a K^+p pair. The $\Lambda(1405)$ has been reconstructed using the missing mass technique ΔM_{K^+p}. The result of the simulations is shown in Fig.(1) (red shaded histogram). The spectrum shows the hyperons $\Lambda(1116)$ and $\Sigma^0(1192)$ as well as the sum of the $\Lambda(1405)$ and $\Sigma(1385)$. It is clearly visible that this signal of the $\Lambda(1405)$ is on top of a large background and is completely overlapped by the $\Sigma(1385)$ contribution. Therefore it is necessary to do an exclusive analysis to distinguish between the individual components of the hyperon spectrum. A preliminary analysis of the experimental data has also been carried out. The resulting missing mass spectrum is also shown in Fig.(1). The overlay of the experimental and simulated spectra shows a fair agreement. The differences are due to uncertainties of some cross sections in the simulated cocktail.

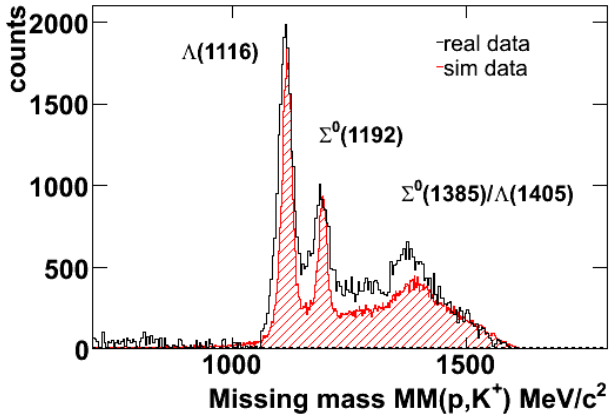

Fig. 1: Missing mass spectra of K^+ and p for simulated data (red shaded histogram) and from a preliminary analysis of measured data (black histogram).

In order to get a pure $\Lambda(1405)$ signal further analysis steps are necessary. If the following decays are considered:

$$\Lambda(1405) \rightarrow \Sigma^- + \pi^+ \rightarrow n + \pi^- + \pi^+ \quad (2)$$

$$\Lambda(1405) \rightarrow \Sigma^+ + \pi^- \rightarrow p + \pi^\circ + \pi^- \quad (3)$$

$$\Lambda(1405) \rightarrow \Sigma^+ + \pi^- \rightarrow n + \pi^+ + \pi^- \quad (4)$$

$$\Lambda(1405) \rightarrow \Sigma^\circ + \pi^\circ \rightarrow \Lambda(1116) + \gamma + \pi^\circ \rightarrow p + \pi^- + \gamma + \gamma + \gamma \quad (5)$$

one can see that the $\Sigma^\circ\pi^\circ$ channel is the best suited to distinguish the $\Lambda(1405)$ from the overlapping $\Sigma(1385)$-resonance. Indeed the $\Sigma(1385)$ decays as well as $\Lambda(1405)$ into $\Sigma\pi$, but due to isospin conservation the decay

$$\Sigma(1385) \rightarrow \Sigma^\circ\pi^\circ \quad (6)$$

is forbidden. This allows to disentangle experimentally the two resonances as already shown in [4].

Including in the simulations the geometrical detector acceptance as well as the efficiency of the trigger and track reconstruction the amount of expected $\Lambda(1405)$ in the decay channel $\Sigma^\circ\pi^\circ$ has been estimated. In the collected statistics for the p+p at 3.5 GeV reaction we expect about 400 counts for this particular channel. These events are going to be reconstructed in an exclusive analysis.

2. ϕ and K^- production below the NN-threshold in Ar+KCl reactions

An analysis of ϕ and K^- mesons has been performed in the reactions system Ar+KCl at a bombarding energy of 1.756 AGeV. The ϕ meson was reconstructed in the decay channel $\phi \rightarrow K^+K^-$. The invariant mass spectrum of K^+ and K^- mesons is displayed in Fig.(2), showing a clear ϕ signal. The ϕ and K^- are produced in the reactions far below the NN-threshold energies which is for both particles around 2.5 GeV. The ϕ/K^- ratio has been deduced from the data and found to be 0.37 ± 0.13, translating into a fraction of $18 \pm 7\%$ of K^- stemming from ϕ decays. This unexpected high value of K^- mesons coming out from ϕ decays may change the importance of other production channels like the so called strangeness-exchange channel [5].

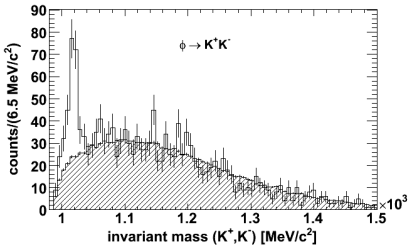

Fig. 2: Invariant mass spectrum of K^+-K^--pairs. The grey shaded are shows the mixed-event background.

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References

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