Hypertriton reconstruction in Ar+KCl reactions at 1.756A GeV with HADES*

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In September 2005 the collision system Ar+KCl at a kinetic beam energy of 1.756 GeV per nucleon was measured with HADES. Among other observables, in particular several hadron species carrying strangeness have been reconstructed. Due to the conservation of the strangeness quantum number its production is a highly correlated process. The relative distribution of strange and anti-strange quarks among the hadrons in the final state, including excited states and resonances, can provide important insight into the production and propagation of quarks [1].

In this contribution, we investigate the production of the hypertriton ${}^3_\Lambda H$, the lightest of the so-called hypernuclei. In addition to the nucleons - the proton and the neutron - these nuclei contain at least one hyperon, which is in the explicit case of the hypertriton a $\Lambda-$hyperon.

Hypertritons are most easily reconstructed through their bound decay into a negative pion and a ${}^3He$. The branching ratio for this decay is about 35% [2]. Hence, an important issue of the analysis is a good identification of the two final-state particles π^- and ${}^3He$ via the Time-of-Flight information in the TOF and TOFino walls and the energy loss in the Multiwire Drift Chambers (MDC) as well as in the TOF and TOFino walls.

In order to reduce the background stemming from uncorrelated pairs of negative pions and helium nuclei, secondary-vertex cuts are applied. The procedure is comparable to the $\Lambda \to \pi^- + p$ analysis in Ar+KCl, but since the mass of ${}^3_\Lambda\mathrm{H}$ is significantly higher than that of Λ, the cut on the mean flight distance has to be widened. For the optimization of the applied cuts, the hypertriton decay is simulated in order to observe their effects on the significance of the signal. After generating with Pluto [3] hypertritons produced either thermally or via coalescence processes, the detector response on the analyzed decay channel is simulated with HGeant [4]. The simulated signal is embedded into real data to get a realistic estimate of the uncorrelated background. Then, the distributions of the topology variables from simulations are compared to those of data.

Additionally, the acceptance and reconstruction efficiency of the hypertriton are determined via simulations to $\mathrm{acc} \cdot \mathrm{eff}_{rec} = (0,1031 \pm 0,0054)\%$ for those produced by coalescence and $\mathrm{acc} \cdot \mathrm{eff}_{rec} = (0,14 \pm 0,013)\%$ for those coming from thermal sources.

After subtracting the background, which is obtained via the mixed-event-method and delivers an invariant mass spectrum of uncorrelated π^--^{3}He pairs, from the invariant mass spectrum of the same event, there is no significant hypertriton signal visible.

However, an upper production limit can still be calculated. This can either be done by using the Feldman-Cousins method [5], which only takes underlying statistics of the invariant mass spectrum into account. Another way is to embed simulated hypertritons into the measured data at such a ratio, that a reconstruction becomes just possible. The multiplicities are calculated for the different methods to $\mathrm{Mult}_{FC} = (7,493 \pm 3,371 \pm 0,465) \cdot 10^{-4}$ respectively $\mathrm{Mult}_{embed} = (2,96 \pm 0,93 \pm 0,67) \cdot 10^{-4}$. The obtained values of the different methods are within errors in agreement with each other. Additionally, they agree well with results from former reconstructions on rare, strange particles in Ar+KCl collisions measured with HADES, namely the Ξ^-, which was observed significantly in this collision system [6]. Considering the upper production limit obtained via the second method, the production ratio of hypertritons to the successfully reconstructed Λ-hyperons could be calculated, which provides the limiting value of $N_{{}^3_\Lambda H}/N_\Lambda(embedded) = (7,24 \pm 3,94) \cdot 10^{-3}$.

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