Study of the strong interaction with baryon femtoscopy in pp collisions at 7 TeV with ALICE*

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Motivation

The understanding of the hyperon-nucleon interaction is an important ingridient for the description of various physical systems. On the one hand side, it helps to better understand the mechanism of the binding of Λ hyperons inside of nuclei, which is an important test bed for studying the interaction in laboratory systems. On the other side, the information about the strength of the interaction is of importance to describe heavy astronomical objects like neutron stars. It is expected that in the interior of heavy neutron stars hyperons are produced, since this leads to an energetically more favoured configuration. This appearance leads in various model calculations often to a strong softening of the equation of state, usually that strong that the models have a hard time to describe such heavy objects. Since the scattering data on the Λ-p interaction is rather scarce it would be benefitial to study it in more details.

With help of the femtoscopy technique one can access such pair interactions. Femtoscopy is based on the measurement of a two-particle correlation function at low relative momenta. Experimentally it is constructed by a ratio of pairs from the same $A(k^*)$ and from mixed event $B(k^*)$. The mixed event sample does not contain correlations from femtoscopic origin and is thus just an uncorrelated yield of pairs [1]:

$$C(k^*) = \frac{A(k^*)}{B(k^*)}\,, \qquad (1)$$

where $k^* = \frac{1}{2}|\mathbf{p}_1^* - \mathbf{p}_2^*|$ is the momentum of the particles in the rest frame of the pair $\mathbf{p}_1^* + \mathbf{p}_2^* = 0$. At small relative momenta $k^* < 150$ MeV/c the correlation function deviates from unity if the pairs are correlated due to e.g. strong final state interactions. The size of the emission region can be reconstructed with this method.

Analysis strategy

For the femtoscopy study, the pp 7 TeV ALICE data sample was analyzed, which was recorded in 2010. The events are selected with the minimum bias trigger condition. The z-position of the primary vertex was required to lie within 10 cm of the center of the ALICE detector. The goal was to obtain the correlation function among proton pairs as well as p-Λ pairs, where the p-p correlation function serves as benchmark to extract the source size of the pp collision system. Protons are identified with the TPC for momenta below p<0.75 GeV/c. Above this threshold also the TPC is required to reject contaminations from other species. The hyperons were identified by their decays involving charged particles $\Lambda \rightarrow p\pi^-$ using the invariant mass technique. To reject contributions from combinatorial background, several topological cuts were applied to reduce the source of particles not stemming from the hyperon decay. Around 6M Λ hyperons ($S/B \sim 20$) were reconstructed.

The goal was to investigate the sensitivity of the measured p-Λ correlation function when it is compared to model calculations, which use as input predictions of various scattering parameter. As an example we tested parameters predicted by chiral effective field theory calculations at leading order (LO) and next-to-leading-order (NLO) expansion [3]. The p-p and p-Λ correlation functions were fitted simultaneously using the NLO parameters for p-Λ. After the fit converged the LO parameters were plugged in to investigate the difference. This is displayed in Fig. 1. One can

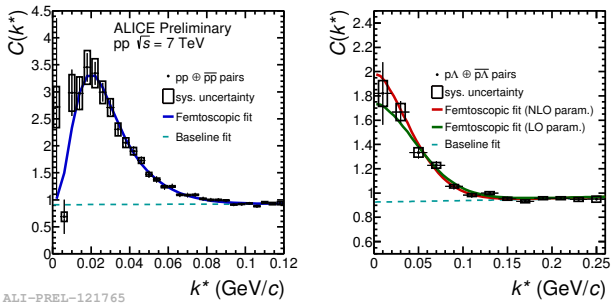

Figure 1: Simultanous fit of the p-p and p-Λ pair. The p-Λ pair was fitted using the NLO parametrization. Afterwards the LO parametrization was plugged in.

see that the p-Λ correlation function develops a sensitivity on the input of the parameters. However, the current statistics is not enough to perform a clear separation of the two parameter sets.

References

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