Search for exotic dibaryons at LHC-ALICE

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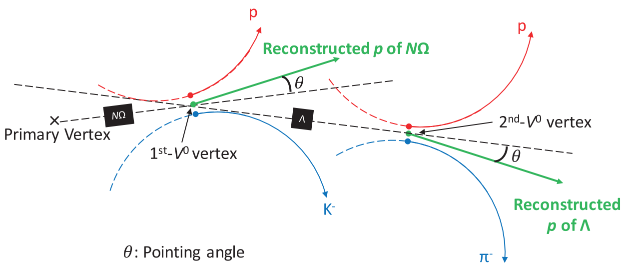

Fig. 1. Decay topology of the $N\Omega$ dibaryon.

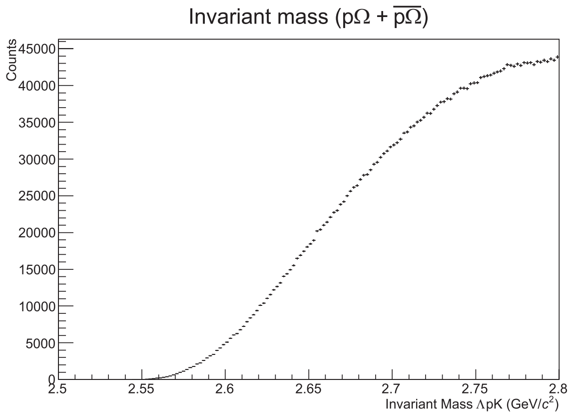

Fig. 2. Invariant mass distribution for ΛpK in Pb-Pb collisions.

H dibaryon (uuddss)[1)] is one of the most investigated dibaryon candidates and its experimental searches were recently carried out in heavy-ion collisions, where various hadrons are produced abundantly [2,3)]. Besides exploring a bound state of dibaryons, the measurements of baryon-baryon correlations provide us with the information on baryon-baryon interactions and equation of the state for dense matter.

ALICE is the dedicated experiment to study Quark Gluon Plasma (QGP), a hot and dense Quantum chromodynamics (QCD) medium, via heavy-ion collisions at LHC. The two main tracking detectors in the central barrel are the Inner Tracking System (ITS) and the Time Projection Chamber (TPC). The ITS consists of six cylindrical layers of silicon detectors for particle tracking and reconstructing the secondary vertex. The TPC surrounds the ITS and comprises a 90 m^3 cylinder filled with $Ne/CO_2/N_2$ (90/10/5). It is also used for particle identification via the energy deposit ($\mathrm{d}E/\mathrm{d}x$) measurement.

As a dibaryon candidate other than H dibaryon, it is predicted by lattice QCD calculations that the $N\Omega$ system has enough attraction to form a bound state[4)]. The analysis strategy for searching $N\Omega$ is based on topological particle identification. The decay pattern is shown in Fig. 1.

Our assumed decay topology of the $N\Omega$ dibaryon is as follows.

(1) $N\Omega$ dibaryon decays into p, K^-, and Λ at the 1st-V^0 vertex.
(2) Λ decays into p and π^- at the 2nd-V^0 vertex.

The reconstruction of a $N\Omega$ candidate via this decay topology starts with the reconstruction of Λ (i.e., the search of the 2nd-V^0 vertex in Fig. 1). The V^0 decays are determined by two tracks that are emitted from a secondary vertex and might come close to each other. The minimum distance between the two tracks is called the Distance-of-Closest-Approach (DCA). The V^0 decay point is determined using DCA. The protons and pions are selected from all 2nd-V^0 candidates and the invariant mass of Λ is calculated. In a similar way, the 1st-V^0 vertex is determined by selecting protons and kaons from all V^0 candidates. A criterion for selecting the appropriate 1st- and 2nd-V^0 candidate is the cut on the pointing angle. It is the angle between the reconstructed flight-path and the reconstructed momentum of the V^0 particle.

Figure 2 shows the invariant mass distribution in the decay channel $N\Omega \to \Lambda\mathrm{pK}$ for Pb-Pb data at $\sqrt{s_{NN}} =$ 2.76 TeV. A 3σ $\mathrm{d}E/\mathrm{d}x$ cut in the TPC is used for the PID of p, K, and π. The invariant mass of Λ at 2nd-V^0 is restricted between 1.111 GeV/c^2 $< m_\Lambda <$ 1.120 GeV/c^2 and is combined with the four-vectors of proton and kaon at the 1st-V^0 vertex. The cuts on the DCA and the cosine of the pointing angle for both V^0 vertex are $<$ 1.0 cm and $>$ 0.9, respectively. There is no significant signal in the invariant mass distribution so far, however the cut optimization is ongoing. Other dibaryon candidates such as ΩΩ, $\Lambda^*\Lambda^*$ will also be evaluated.

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References
1) R. L. Jaffe, Phys. Rev. Lett. **38**, 195 (1977).
2) N. Shah for the STAR Collaboration, Nucl. Phys. A **914**, 410 (2013).
3) ALICE Collaboration arXiv:1506.07499 [nucl-ex] CERN-PH-EP-2015-069.
4) F. Etminan et al. (HAL QCD Collaboration), Nucl. Phys. A **928**, 89 (2014).