Production of hadronic resonances in p–Pb collisions in ALICE at LHC

A. K. Dash (for the ALICE Collaboration)*

School of Physical Sciences, National Institute of Science Education and Research, Jatni - 752050, India

Introduction

Hadronic resonances serve as a unique tool to study the properties of hot and dense matter produced in heavy-ion collisions. Several observables can be obtained, starting with the measurement of particle spectra, which provide insights into particle production mechanisms. Resonances have very short lifetime, which are comparable with that of the fireball produced in the collision. Considering that $K(892)^{*0}$ decays in $\tau_{K^{*0}} \sim 4\ fm/c$ and $\phi(1020)$ has a lifetime nearly ten times larger than K^{*0}, $\tau_{\phi} \sim 45\ fm/c$, these particles are excellent probes of the hadronic phase of the collision [1, 2]. The ratios of hadronic resonance yields to the yields of longer-lived hadrons can be used to investigate the re-scattering effects and the chemical freeze-out temperature. Measurements in smaller collision systems such as proton-proton (pp) and proton-nucleus (pA) provide a necessary baseline for heavy-ion data. Studies of resonance production rates have been performed in Pb-Pb collisions [3] and have suggested that re-scattering is a key ingredient in describing measurement. There is therefore great interest in studying this observable in smaller systems. p–Pb collisions provide a system whose size in terms of average charged-particle density and number of participating nucleons is intermediate between pp and peripheral Pb–Pb collisions.

Resonance reconstruction

The K^{*0} and ϕ mesons are measured through invariant-mass reconstruction of their identified decay daughters in the charged hadronic decay channels, $K^{*0} \rightarrow K^{+}\pi^{-}(\bar{K}^{*0} \rightarrow K^{-}\pi^{+})$ and $\phi \rightarrow K^{+}K^{-}$. In p–Pb the rapidity range is restricted to $-0.5 < y_{\rm cms} < 0$ in order to ensure the best detector acceptance. The combinatorial background is estimated using an event-mixing technique. After subtraction of the combinatorial background, the resonance signals are fitted by using a Breit-Wigner function for K^{*0} and convolution of a Breit-Wigner function and a Gaussian for ϕ. A second-order polynomial is used to describe the residual background. The raw yields are extracted from the residual background-subtracted resonance signal distribution. To measure the invariant spectra the raw yields are corrected for detector acceptance, efficiency and branching ratio. The data set used in this analysis were collected by the ALICE detector in 2013 at $\sqrt{s_{\rm NN}} = 5.02$ TeV in p–Pb collisions. About 98 million minimum bias events are analysed after applying all event selection cuts.

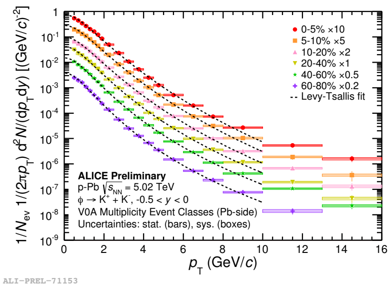

FIG. 1: Transverse momentum spectra of ϕ for different multiplicity event-classes.

Results and discussion

The production of K^{*0} and ϕ has been measured in several multiplicity event-classes in p–Pb collisions at $\sqrt{s_{\rm NN}}$= 5.02 TeV. Fig. 1 shows the transverse momentum ($p_{\rm T}$) spectra for ϕ in different multiplicity event-classes. The $p_{\rm T}$ integrated particle yields (dN/dy) and mean $p_{\rm T}$ ($\langle p_{\rm T}\rangle$) of K^{*0} and ϕ for each multiplicity event class are determined by integrating the $p_{\rm T}$ spectra in the measured range and by using a Levy-Tsallis fit function to extrapolate

*Electronic address: `ajayd@niser.ac.in`

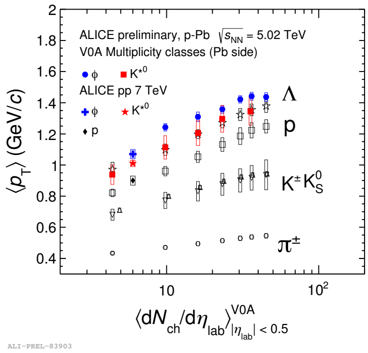

FIG. 2: Mean p_T of $\pi, \mathrm{K}, \mathrm{K}^0_s, \mathrm{K}^{*0}, \mathrm{p}, \phi$ and Λ as a function of the average charged particle multiplicity density in p–Pb at $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV and pp at $\sqrt{s}$ = 7 TeV.

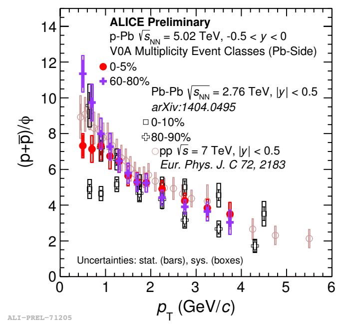

FIG. 3: Ratio p/ϕ as a function of p_T in different centrality and multiplicity intervals in pp, p–Pb, and Pb–Pb collisions.

the yield in the p_{T} range where no measurement is available. Fig. 2 shows the $\langle p_{\mathrm{T}} \rangle$ of K^{*0} and ϕ compared with π, K, $\mathrm{K}^0_{\mathrm{S}}$, p and Λ) [4] as a function of the average charged multiplicity density in p–Pb and pp collisions (K^{*0}, p and ϕ only). The $\langle p_{\mathrm{T}} \rangle$ of resonances increases as a function of the average charged particle multiplicity density, as for other hadrons. The $\langle p_{\mathrm{T}} \rangle$ of long lived hadrons follows mass ordering (particles with higher mass are measured to have larger $\langle p_{\mathrm{T}} \rangle$), while the $\langle p_{\mathrm{T}} \rangle$ of K^{*0} and ϕ are larger than that of protons, even the $\langle p_{\mathrm{T}} \rangle$ of ϕ is larger than Λ. A similar trend is also observed in pp collisions where $\langle p_{\mathrm{T}} \rangle$ of ϕ and K^{*0} is larger than p. The $(\mathrm{p} + \bar{\mathrm{p}})/\phi$ ratio is shown in the Fig. 3 for different centrality and multiplicity intervals. In peripheral p–Pb

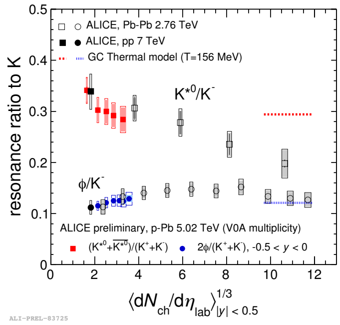

FIG. 4: Ratios K^{*0}/K and ϕ/K as functions of $(\mathrm{d}N_{ch}/\mathrm{d}\eta)^{1/3}$ in pp, p–Pb, and Pb–Pb collisions.

and pp collisions the $(\mathrm{p} + \bar{\mathrm{p}})/\phi$ ratio is quantitatively consistent below 2 GeV/c and decreases steeply with p_{T}, as also observed in peripheral Pb–Pb collisions. The ratio in high-multiplicity (0- 5%) p–Pb is similar to that in 60-80% peripheral Pb–Pb collisions, although for the former a hint of flattening is observed for $p_{\mathrm{T}} <$ 1.5 GeV/c. Fig. 4 shows the K^{*0}/K and ϕ/K ratios measured in p–Pb collisions compared to the measurements in pp and Pb–Pb.The ϕ/K ratio is nearly flat across all systems and multiplicities and it reaches the value predicted by a grand-canonical thermal model with T = 156 MeV [5]. On the other hand, the K^{*0}/K ratio exhibits a decreasing trend towards more central Pb–Pb, where the measured ratio is about 60% of the thermal model value. The decrease in the K^{*0}/K ratio is likely due to re-scattering.

Acknowledgments

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