Recent results on hadronic resonance production with ALICE at the LHC

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Introduction

The study of hadronic resonance production serves as a unique tool to understand the properties of matter created in heavy-ion collisions. Due to their short lifetimes ($\sim 10^{-23}$ s), resonance yields and particle ratios are expected to get modified due to the interaction of their decay daughters within the hadronic medium via the regeneration and re-scattering processes. Recent measurements in p–Pb collisions at $\sqrt{s_{\rm NN}}$ = 5.02 TeV and in pp collisions at $\sqrt{s}$ = 7 and 13 TeV as a function of multiplicity have uncovered various bulk properties similar to those seen in heavy-ion collisions [1, 2]. The particle ratio $\mathrm{K}^{*0}/\mathrm{K}$ (resonance to the stable particle) decreases with increasing the charged-particle multiplicity in small systems similar to what is observed in the heavy-ion collisions. Among the various resonances, $\mathrm{K}^*(892)^0$ has a lifetime of ∼4 fm/c and $\phi(1020)$ has a lifetime nearly ten times larger than K^{*0}. Therefore, the systematic comparison of measurements related to these resonances may enable us to investigate the dynamics of the hadronic phase and help to extract the lifetime of the hadronic phase [1]. The nuclear modification factors ($R_{\rm pA}$ and $R_{\rm AA}$) are used to study the parton energy loss and disentangle initial and final state effecs due to cold nuclear matter and the hot dense medium, respectively. Measuring the nuclear modification factor in p–Pb provides the baseline for heavy-ion systems.

Analysis details

The $\mathrm{K}^*(892)^0$ and $\phi(1020)$ vector mesons are reconstructed through the invariant mass analysis using their hadronic decay channels. The signals of $\mathrm{K}^*(892)^0$ and $\phi(1020)$ in different $p_{\rm T}$ intervals are obtained by subtracting the combinatorial background from unlike-sign charged-particle invariant-mass distributions for the various multiplicity classes. The combinatorial background is estimated by using the mixed-event technique. After the combinatorial background subtraction a residual background remains, which mainly arises from other sources of correlated pairs and mis-identified particle decay products. The extracted K^{*0} signal is fitted with a Breit-Wigner function and the ϕ signal is fitted with a Voigtian function (which is a convolution of Breit-Wigner and Gaussian functions). A polynomial function is used to describe the residual background. The raw yields are obtained by integrating the signal and subtracting the residual background in each of the $p_{\rm T}$ intervals for the various multiplicity classes. To measure the transverse momentum ($p_{\rm T}$) spectra the raw yields are corrected for detector acceptance, reconstruction efficiency and decay branching ratio. The recent measurements of K^{*0}, $\mathrm{K}^{*\pm}$ and ϕ mesons in p–Pb collisions at $\sqrt{s_{\rm NN}}$ = 5.02, 8.16 TeV along with K^{*0} and ϕ at $\sqrt{s_{\rm NN}}$ = 5.02, 5.44 TeV in Pb–Pb and Xe–Xe collisions, respectively are presented.

Results and Discussion

Figure 1 shows the mean $p_{\rm T}$ ($\langle p_{\rm T}\rangle$) as a function of charged particle multiplicity for the K^{*0} in different colliding systems and energies. $\langle p_{\rm T}\rangle$ increases from low to high multiplicity classes and seems to be saturated at high multiplicity classes, as was also observed in p–Pb [2].

Figure 2 shows the comparison of the nuclear modification factor ($R_{\rm pPb}$) of K^{*0} and ϕ

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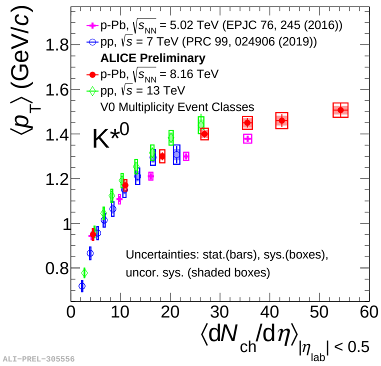

FIG. 1: Mean $p_{\rm T}$ of $\rm K^{*0}$ as a function of $\langle dN_{\rm ch}/d\eta\rangle_{|\eta_{lab}|<0.5}$ in pp collisions at $\sqrt{s}$ = 7 and 13 TeV and in p–Pb collisions at $\sqrt{s}$ = 5.02 and 8.16 TeV.

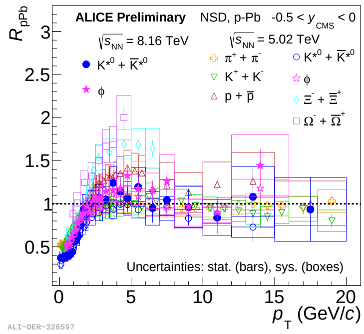

FIG. 2: Nuclear modification factor ($R_{\rm pPb}$) as function of $p_{\rm T}$ of $\rm K^{*0}$, ϕ at $\sqrt{s_{\rm NN}}$ = 5.02 and 8.16 TeV along with π, K, p and heavy strange baryons (Ξ, Ω) at $\sqrt{s_{\rm NN}}$ = 5.02 TeV.

at $\sqrt{s_{\rm NN}}$ = 5.02 and 8.16 TeV along with π, K, p and heavy-strange baryons (Ξ, Ω) at $\sqrt{s_{\rm NN}}$ = 5.02 TeV in p–Pb collisions. It is observed that at low $p_{\rm T}$ (< 2 GeV/c), $\rm K^{*0}$ $R_{\rm pPb}$ is lower in comparison with ϕ, π, K, p, Ξ, and Ω.

At intermediate $p_{\rm T}$ ($2 < p_{\rm T} < 4$ GeV/c), the $R_{\rm pPb}$ values for baryons seem to exhibit mass dependence, whereas all mesons shows similar trend. At $p_{\rm T} > 8$ GeV/c, results for all light flavour particles are consistent within uncertainties, indicating that no flavour dependence of parton energy loss is present. No significant energy dependence in $R_{\rm pPb}$ is also observed for $\rm K^{*0}$ and ϕ at $\sqrt{s_{\rm NN}}$ = 5.02 and 8.16 TeV, respectively.

The ratio of resonance yields to those of long-lived particles is shown in Fig 3, as a function of the cubic root of the average charged particle multiplicity ($\langle {\rm d}N_{\rm ch}/{\rm d}\eta\rangle^{1/3}$) for various resonances in different collision systems and energies measured with the ALICE the detector. A decreasing trend in the ratios ρ/π, $\rm K^{*}(892)^{0}/K$, $\Lambda(1520)/\Lambda$ was seen with the increase in the charged particle multiplicity from peripheral to the most central collisions, whereas the $\Sigma^{*\pm}/\Lambda$, Ξ^{*0}/Ξ and ϕ/K ratios are nearly constant across all systems and centrality classes measured. These results suggest dominance of re-scattering effects over regeneration in the hadronic phase. The results on particle ratios measured in the ALICE at

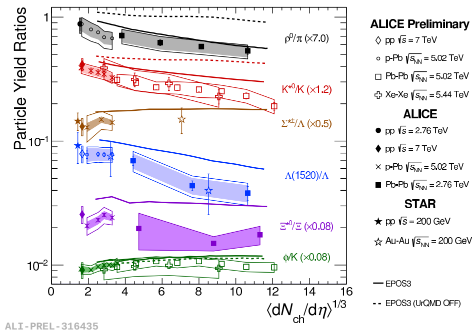

FIG. 3: The particle yield ratios ρ/π, $\rm K^{*0}/K$, $\Lambda(1520)/\Lambda$, $\Sigma^{*\pm}/\Lambda$, Ξ^{*0}/Ξ and ϕ/K as a function of $\langle {\rm d}N_{\rm ch}/{\rm d}\eta\rangle^{1/3}$ in pp, p–Pb, Xe–Xe and Pb–Pb collisions.

the LHC energies are also compared to the EPOS model (with and without UrQMD) [3].

Acknowledgments

I acknowledge financial support from DAE-DST projects.

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