Azimuthal and pseudo-rapidity correlations with strange particles at intermediate-$p_T$ at RHIC

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Abstract. We present results on two-particle azimuthal correlations with strange trigger particles ($K^0_S$, $\Lambda$, $\Xi$, $\Omega$) associated with unidentified charged particles in $d+Au$ and Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV. We investigate, in detail, the near-side associated yield as a function of centrality, $p_T$ and strangeness content in the trigger particle to look for possible flavor and baryon/meson differences. We compare our results to a fragmentation and recombination model, where the study of $\Omega$-triggered correlations is used as a critical test of the validity of the recombination picture.

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1. Introduction

The suppression of inclusive $p_T$ spectra of identified particles in central Au+Au collisions with respect to p+p and peripheral Au+Au collisions [1, 2] and the enhanced baryon/meson ratios [3, 4] show that baryons and mesons behave differently than in p+p collisions for $p_T = 2-6$ GeV/$c$. This indicates that fragmentation is not dominant and parton recombination and coalescence models [5, 6, 7, 8] have been suggested as alternative mechanisms of particle production. Moreover, studies of di-hadron correlations in Au+Au revealed the presence of an additional long-range pseudo-rapidity correlation (ridge) on the near-side [9], which is absent in p+p and d+Au collisions.

In this paper, we discuss the properties of two-particle correlations using strange trigger particles ($K^0_S$, $\Lambda$, $\Xi$, $\Omega$) associated with unidentified charged particles in d+Au and Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV with STAR. We investigate the near-side associated yield as a function of centrality, system size, $p_T$ and strangeness content in the trigger particle, to look for possible flavor and baryon/meson differences. We compare our results to a fragmentation and recombination model.

2. Data analysis

The correlation functions, normalized to the number of trigger particles, are corrected for the reconstruction efficiency of associated particles, elliptic flow ($v_2$) and, unless mentioned otherwise, triangular acceptance in $\Delta \eta$. The near-side yield of associated
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Figure 1. Centrality dependence of the ridge yield (a) and jet yield (b) of associated charged particles for various trigger species in d+Au and Au+Au collisions. The error bands indicate systematic errors on the ridge yield due to the $v_2$ subtraction.

3. Correlations with $K_S^0$, $\Lambda$ and charged trigger particles

Comparing the near-side yields in d+Au and Au+Au collisions, we observe a strong increase by a factor of 3-4 going from d+Au to central Au+Au collisions. Studying separately the jet and ridge contributions to the near-side yield (Fig. 1), we find that the ridge yield rises with centrality and is responsible for the observed strong increase of the near-side yield with centrality. The jet yield is independent of centrality and consistent with that in d+Au collisions. No significant baryon/meson or particle/anti-particle differences are observed.

Next, we study the dependence of the near-side yield on the transverse momentum of the trigger particle, $p_T^{\text{trig}}$, shown in Fig. 2. While the ridge yield increases with $p_T^{\text{trig}}$ and flattens off for $p_T^{\text{trig}} > 3.0$ GeV/c, the jet yield keeps increasing with $p_T^{\text{trig}}$ as expected. The jet yield for $\Lambda$ triggers is systematically below that of charged hadron and $K_S^0$ triggers. Remaining effects of artificial track merging, which are found to affect more V0s than charged tracks, are currently under investigation.

We have also measured the invariant $p_T$ spectra of associated charged particles for
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$p_T^{\text{trig}} = 3-6$ GeV/c (not shown) and extracted the inverse slope, $T$. The ridge spectra have, for all studied trigger species, $T \sim 400$ MeV, close to that of 'the bulk', while the jet spectra have $T \sim 450$ MeV. The 0-10%/40-80% centrality ratio of the near-side yields is about 3 at $p_T^{\text{assoc}} = 1$ GeV/c and decreases with $p_T^{\text{assoc}}$. As shown in Fig. 1, this large ratio is due to the correlations at large $|\Delta \eta|$ because the jet yield is independent of centrality. Our results qualitatively agree with the parton recombination model [10] which points toward a significant role of thermal-shower recombination in Au+Au collisions. To draw quantitative conclusions, the calculation must be done for the same centrality and $p_T^{\text{trig}}$ selection and also reproduce properties of the measured $\Delta \eta$ correlations.

4. Correlations with multiply-strange trigger baryons

Our study of correlations with multiply-strange baryons, especially $\Omega$, has been stimulated by the predictions from the recombination model of [11]. Contrary to the production of $K$ and $\Lambda$, for particles created exclusively from strange quarks, such as $\phi$ and $\Omega$, the contribution from shower $s$ quarks should be negligible for $p_T$ up to 8 GeV/c. Consequently, there should be no associated particles for $\phi$- and $\Omega$-triggered correlations with $p_T > 3$ GeV/c because they cannot be distinguished from background.

Figure 3(a) shows the azimuthal correlations for strange trigger baryons with increasing strangeness content: $\Lambda$, $\Xi$ and $\Omega$. Due to limited statistics, the trigger particles have been selected with $p_T^{\text{trig}} = 2.5-4.5$ GeV/c. Clearly, there is a remaining near-side peak above the elliptic flow contribution for all discussed trigger species. The near-side peak persists even if the larger $v_2$, determined from the event plane method, is used. Moreover, the strength of the near-side peak is, within errors, independent of the strangeness content in the trigger particle. This is further confirmed by the study of
the $p_T^{\text{trig}}$ dependence of the near-side yield shown in Fig. 3(b). Within errors, the yield is consistent for all studied baryon and meson species.

5. Conclusions

We have reported results on two-particle correlations with strange trigger particles at intermediate-$p_T$ at RHIC. The correlations reveal a strong contribution from the long-range $\Delta \eta$ correlations in the near-side. We do not observe any significant baryon/meson differences. The behavior of the central-to-peripheral ratio of the near-side yields agrees qualitatively with a recombination model. However, for the $\Omega$-triggered correlations there exist associated particles in the near-side, which disagrees with the model. Studies of jet and ridge yields for $\Omega$-triggered correlations as well as correlations with identified associated particles are expected to constrain the origin of these correlations.

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