Identified Two-particle Correlations and Quantum Number Conservation in p-p, p-Pb and Pb-Pb Collisions at LHC Energies

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INTRODUCTION

We investigate the effect of quantum number conservations during parton fragmentation and hadronization in p-p, p-Pb, and Pb-Pb collisions at LHC energies [1, 2]. The strength of the conservation effects are studied by identified two-particle correlations in Monte Carlo generated events in the mid-rapidity region ($\langle \eta \rangle < 1$). The extracted identified associated hadron spectra for charged pions, kaons, and protons show identified trigger-hadron dependent splitting between oppositely charged associated particle species in any nuclear-nuclear collisions. The Pb-Pb data exhibits a peculiar splitting pattern as a function of the transverse momentum of the associated particle $p_{T,assoc}$, both on the near and away side that is different from the patterns observed in p-p and p-Pb collisions. The splitting shows smooth evolution with collision energy and event multiplicity in p-p collisions while in Pb-Pb collisions different trend observed for kaons and protons.

THE PID-ASSOCIATED SPECTRA

Quantum number conservation can be tested by plotting the identified associated spectra $dN_{PID}/dp_{T,assoc}$ for identified trigger hadrons. We have investigated the PID-associated spectra using $\pi^+$, $K^+$, $p$, $\bar{p}$, and charged hadron $b$-triggered, selected from the transverse momentum range 2 GeV/c < $p_{T,assoc}$ < 25 GeV/c. The yields of the PID-associated spectra significantly decrease with the selection of charged pion, kaon and proton triggers, respectively.

Monte Carlo data sets and analysis cuts

To extract and enhance the expected quantum number conservation effects, the ratio of the PID-triggered-to-charged hadron-triggered associated spectra have been plotted:

$\frac{dN_{PID}/dp_{T,assoc}}{dN/dp_{T,assoc}} = \frac{dN_{PID}/dp_{T,assoc}}{dN/dp_{T,assoc}} (+/\pm) / \frac{dN_{PID}/dp_{T,assoc}}{dN/dp_{T,assoc}} (+/\pm)$

which is the PID-triggered to charged hadron-triggered ratio of the PID-associated particle spectra (see Fig. 2).

The splitting effect can be observed for any of the trigger species both in p-p and Pb-Pb collisions. The splitting is larger on the near-side than on the away-side. Qualitative observations show that the strength of the quantum number conservation effects increases in the order of charge ($c$), strangeness ($\bar{c}$) and baryon number ($B$) respectively. The largest splitting effect can be seen for unlike-sign correlations of protons and antiprotons.

RATIO OF PID-TRIGGERED ASSOCIATED SPECTRA

By plotting the differences between the $(+/\pm)$ and $(+/\pm)$ like-sign trigger/associated particle pairs for the PID-triggered-to-charged hadron triggered yields:

$\frac{dN_{PID}/dp_{T,assoc}}{dN/dp_{T,assoc}} (+/\pm) / \frac{dN_{PID}/dp_{T,assoc}}{dN/dp_{T,assoc}} (+/\pm) = \frac{dN_{PID}/dp_{T,assoc}}{dN/dp_{T,assoc}} (+/\pm) / \frac{dN_{PID}/dp_{T,assoc}}{dN/dp_{T,assoc}} (+/\pm)$

we can have a more detailed insight into the magnified splitting as plotted on Fig. 3. The splitting effect is independent of $p_T$, in the studied region of 2 GeV/c < $p_{T,assoc}$ < 25 GeV/c.

The PID-triggered associated spectra for the like-sign and unlike-sign trigger/associated particle pairs for pions in p-p, p-Pb and Pb-Pb collisions. In contrast, there is a clear difference between the p-p, p-Pb and Pb-Pb systems for kaons and protons.

REFERENCES / ACKNOWLEDGEMENT / CONTACT


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PIDs TRIGGERED LIKE SIGN ASSOCIATED SPECTRA RATIOS IN P-P AND P-PB COLLISIONS

Summary

The observed splitting effect of the PID-triggered-to-charged hadron-triggered associated spectra shows a peculiar pattern which:

- is the most prominent for $p$-unlike-sign associated particle pairs (compared to $K^+$/$K^-$, $\pi^+$/$\pi^-$ pairs) on the near- and away-side;
- has a reverse behaviour in Pb-Pb and in p-Pb on the away-side and remains unchanged on the near-side in Pb-Pb;
- has similar behaviour in the p-p, peripheral Pb-Pb and minimum bias p-Pb on the near-side in terms of the conservation of baryon numbers;
- decreases towards higher event multiplicity in p-p;
- decreases with increasing collision energies from RHIC to LHC in p-p.