Identification of Exotic Jet Topologies via Three-Particle Correlations in PHENIX

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Abstract. Modifications of jet properties resulting from the coupling of jets to the strongly interacting matter produced in RHIC collisions are of great current interest. In recent work, the PHENIX collaboration has applied a novel technique to the analysis of two-particle azimuthal correlations which extinguishes the harmonic part of the underlying event revealing the true jet shape. Recent extensions of the method to three-particle correlations allow for a more revealing study of jet topologies in Au+Au collisions at (√s_{NN} = 200 GeV).

Keywords: jets, jet modification, three-particle correlations, sonic boom

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1. Introduction

The energy density achieved in Au+Au collisions at RHIC far exceeds the lattice QCD estimate for creating the QGP. The high matter density gives rise to large pressure gradients which are the driving force for the observed large azimuthal anisotropy (v_2) of particle emission from the collision zone. The value of this anisotropy is close to the predictions of the hydrodynamic model which in turn implies the creation of a strongly interacting medium which undergoes early thermalization [1]. Jets provide good probes of this medium provided one can decompose the jet signal from the collective flow effects. Possible medium associated modifications of the jet topology are a conical emission due to a “sonic boom” effect [2] and deflection induced by interactions with the partonic flow [3]. Two- and three-particle azimuthal correlations can be an effective tool in the study of jet topology.

2. Two-Particle Azimuthal Correlations

To study jet topologies we use two- and three-particle azimuthal correlation functions. For two-particle correlations, the correlation function C(Δφ) is given by
$C(\Delta \phi) = \frac{N_{\text{real}}(\Delta \phi)}{N_{\text{mix}}(\Delta \phi)}$, where $\Delta \phi$ is the difference of the azimuthal angles of the pair. The real distribution ($N_{\text{real}}(\Delta \phi)$) is built from pair members belonging to the same event and the mixed distribution ($N_{\text{mix}}(\Delta \phi)$) is made of pair members belonging to different events. Thus the correlation function is free of geometric acceptance effects and carries only the combined correlations from flow and jets. Decomposition of these correlations into their jet and flow contributions, constitute an important prerequisite for obtaining the jet function and hence, information about jet fragmentation.

Figure 1 shows results from simulations in which strongly distorted away-side jets were studied. Panels (b), (c) and (d) show cases for inclusive, in-plane and out-of-plane correlation functions. The figure clearly shows that our decomposition method retrieves the input jet function in detail, confirming that the decomposition procedure is robust even for unusual di-jet distributions.

Figure 2 shows results obtained from the decomposition of the two-particle correlation measurements. The apparent shape distortions of the away-side jet is consistent with recent conjectures of a strong coupling between such jets and the high energy density matter that they traverse [2, 3].

3. Three-Particle Azimuthal Correlations

Three-particle correlation functions consisting of a trigger hadron from the range $2.5 < p_T < 4.0$ GeV/c (hadron #1) and two associated hadrons from the range $1.0 < p_T < 2.5$ GeV/c (hadron #2 and #3) were also studied (cf. Fig. 2). Correlation surfaces were constructed by way of $\Delta \phi_{1,2}$ and $\Delta \phi_{1,3}$ distributions. The correlation