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Medium modifications of event shape in high-energy nuclear collisions

Summary

Event shape observables, such as transverse sphericity $S_\perp$, have long been proposed to study geometrical properties and patterns of the energy flow, and provide a probe of multi-jet topologies in an interaction. For example, the event is pencile-like when transverse sphericity $S_\perp \to 0$, whereas the event is sphere-like when $S_\perp \to 1$. It is well-known that jet quenching in the QGP may lead to the suppression of hadron and jet spectra in heavy-ion collisions, but how jet quenching effect modifies the global geometrical proporties of jet productions in high-energy nuclear collisions is still an unexplored problem. In this talk, we show the first theoretical results of the medium modification of transverse sphericity distribution due to jet quenching effect in heavy-ion collisions. In our investigation, POWHEG+PYTHIA is employed to provide the p+p baseline up to the next-to-leading order (NLO) accuracy with rusummation by the matched parton shower. The Linear Boltzmann Transport (LBT) model of the parton energy loss is implemented to simulate the in-medium evolution of jets. We calculate the event normalized medium modification factor as a function of transverse sphericity distributions in the overall region. An enhancement at small transverse sphericity region and a suppression at large transverse sphericity region are observed in A+A collisions compared to their p+p references, which implies that the event in heavy-ion collisions becomes more pencile-like relative to that in p+p.

We further explore the underlying reasons of the medium alteration of transverse sphericity distribution $S_\perp$. Our numerical results show that the parton energy loss effect on multiple jet events ($n_{jet} \geq 3$) may cause the event more pencil-like, because in this kind of process jets usually have relatively s maller energies and may fall off the jet selection kinematic cut after their energy loss in the medium. Furthermore, we plot the event normalized azimuth angle correlation factor ($\Delta\phi_{j1,j2}$) between the two leading jets for the full events both in p+p and A+A collisions. We demonstrate that jet quenching effect will enhance the fraction of events in back-to-back region ($\Delta\phi_{j1,j2} \sim \pi$) and naturally lead the full events to be more "jetty". Therefore, even though medium-induced gluon radiation may lead to a more isotropic event, the disappearing of less energetic jets and the enhanced fraction of back-to-back ($\Delta\phi_{j1,j2} \sim \pi$) reaction are more pronounced and thus give rise to an overall more pencil-like event in high-energy nuclear collisions with respect to that in p+p.

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