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The fluctuation-enhanced jet quenching in d-Au collisions at $\sqrt{s_{\rm NN}}$ = 200 GeV

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PHENIX experiment group points out that in the measurements of the π^0 nuclear modification factor $R^{\pi^0}_{dAu}$, $\langle N_{\rm coll}\rangle$ can be biased by the event-selection [1], which can be effectively reduced by using the direct γ yield at large $p_{\rm T}$ to determine the $\langle N^{\gamma}_{\rm coll}\rangle = {\rm Y}^{\gamma^{\rm dir}}_{dAu}/{\rm Y}^{\gamma^{\rm dir}}_{pp}$ [2]. Utilizing the $\langle N^{\gamma}_{\rm coll}\rangle$ provided by PHENIX, the π^0 suppression is studied within a next-to-leading-order perturbative QCD parton model [3] incorporating the medium-modified parton fragmentation functions [4]. This study is under the assumption that the quark-gluon plasma (QGP) is produced, and its evolution can be described by hydrodynamics in d-Au collisions at $\sqrt{s_{\rm NN}}$=200 GeV. The initial conditions and space-time evolution of the matter created in d-Au collisions are provided by the superSONIC hydrodynamic model simulations [5,6] and parton energy loss in such a small medium is described by the high-twist (HT) approach [7]. The jet transport coefficient $\hat{q}/T^3(T)$ in this HT approach is extracted with the information field (IF)-Bayesian inference approach from all existing experimental data on single-inclusive hadron, dihadron, and γ-hadron spectra in heavy-ion collisions at RHIC and the LHC energies [8,9]. When only including the cold nuclear matter effect, the $\langle R^{\pi^0}_{dAu}\rangle$ averaged over $7.5 < p_{\rm T} < 18$ GeV is almost unity. When accounting for the jet energy loss and using the smooth hydro profile, the π^0 production has a suppression of about 15% in 0-5% d-Au collisions. While with the event-by-event (EbyE) hydro profiles, the π^0 production is suppressed by about 25%, which is consistent with the experimental measurement [2]. We find that the fluctuation enhances the jet quenching in d-Au collisions at $\sqrt{s_{\rm NN}} = 200$ GeV. The elliptic anisotropy v_2 is further studied with the EbyE hydro, and it is about 0.05 with a large uncertainty caused by fluctuation. Such suppression and elliptic anisotropy may suggest the formation of QGP in d-Au colliding small system.

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