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From hydro, quark coalescence to jet quenching, the coupled approach to solving the RAA-v2 puzzle in high-energy heavy-ion collisions

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Hydrodynamic expansion and jet quenching are responsible for the production of low and high transverse-momentum (p_T) particle in heavy-ion collisions, respectively. However, it is still a challenge to simultaneously describe hadron nuclear modification factor and elliptic flow v_2 , especially in the intermediate p_T region of $2 < p_T < 10$ GeV/c. In this talk, we combine hydrodynamics, quark coalescence and jet quenching as well as the hadron cascade, and study their effects on hadron spectra and flow. We find the key to solving the $R_{AA}-v_2$ puzzle is the incorporation of quark coalescence into the state-of-the-art event-by-event simulations of heavy-ion collisions. Specifically, our new theoretical framework combines 1) the Coupled Linearized Boltzmann Transport and Hydrodynamic (CoLBT-Hydro) model, 2) a hadronization model including Cooper-Frye sampling, quark coalescence and string fragmentation, and 3) a hadron cascade model. For the first time, we can consistently describe and understand the experimental data on R_{AA} and v_2 along with their flavor dependence and hadron chemistry (proton-to-pion and kaon-to-pion ratios) from low to intermediate p_T and high p_T in heavy-ion collisions at both RHIC and LHC energies. Our prediction is an example of high-precision tests of the quark coalescence model in nuclear collisions.

[1] Wenbin Zhao, Weiyao Ke, Wei Chen, Tan Luo and Xin-Nian Wang, arXiv:2103.14657 [hep-ph].

[2] Wenbin Zhao, Che-Ming Ko, YuXin Liu, Guangyou Qin and Huichao Song, Phys. Rev. Lett. 125, 072301 (2020).

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