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Effect of the QCD equation of state and strange hadronic resonances on multiparticle correlations in heavy ion collisions

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The QCD equation of state at zero baryon chemical potential is the only element of the standard dynamical framework to describe heavy ion collisions that can be directly determined from first principles. Continuum extrapolated lattice QCD equations of state have been computed using 2+1 quark flavors (up/down and strange) as well as 2+1+1 flavors to investigate the effect of thermalized charm quarks on QCD thermodynamics. Lattice results have also indicated the presence of new strange resonances that not only contribute to the equation of state of QCD matter but also affect hadronic afterburners used to model the later stages of heavy ion collisions. We investigate how these new developments obtained from first principles calculations affect multiparticle correlations in heavy ion collisions. We compare the commonly used equation of state S95n-v1, which was constructed using what are now considered outdated lattice results and hadron states, to the current state-of-the-art lattice QCD equations of state with 2+1 and 2+1+1 flavors coupled to the most up-to-date hadronic resonances and their decays. New hadronic resonances lead to an enhancement in the hadronic spectra at intermediate p_T. Using an outdated equation of state can directly affect the extraction of the shear viscosity to entropy density ratio, η/s, of the quark-gluon plasma and results for different flow observables. The effects of the QCD equation of state on multiparticle correlations of identified particles are determined for both AuAu $\sqrt{s_{NN}} = 200$ GeV and PbPb $\sqrt{s_{NN}} = 5.02$ TeV collisions. New insights into the $v_2\{2\}$ to $v_3\{2\}$ puzzle in ultracentral collisions are found. Flow observables of heavier particles exhibit more non-linear behavior regardless of the assumptions about the equation of state, which may provide a new way to constrain the temperature dependence of η/s.
[1] Alba, Sarti, Noronha, Noronha-Hostler, Parotto, Vazquez and Ratti, arXiv:1711.05207

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