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The effect of the equation of state on η/s of strongly interacting matter

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The properties of QCD matter produced in ultrarelativistic heavy ion collisions can be determined in a global analysis of LHC and RHIC observables. Bayesian analysis [1] has provided meaningful credibility ranges for the ratio of shear viscosity to entropy density η/s, as well as for key parameters describing the initial state, essentially confirming earlier results like those obtained using the EKRT model [2]. We report here the results of our study [3] where we investigate the temperature dependence of η/s using a piecewise linear parametrization. We perform a global Bayesian model-to-data comparison on Au+Au collisions at $\sqrt{s_{NN}} =$ 200 GeV and Pb+Pb collisions at 2.76 TeV and 5.02 TeV, using a 2+1D hydrodynamical model, with the initial entropy distribution taken as an average of a large number of fluctuating event-by-event EKRT initial states. We provide three new parametrizations of the equation of state (EoS) based on contemporary lattice results and hadron resonance gas. We use these parametrizations, named $s83s_{18}$, $s87h_{04}$, and $s88h_{18}$, along with the earlier $s95p$ parametrization to explore the uncertainties caused by the choice of the EoS. We find η/s most constrained and almost independent of T in the temperature range $T \approx$ 150–220 MeV, where, for all EoSs, $0.08 < \eta/s < 0.23$ when taking into account the 90% credibility intervals. In this temperature range the EoS parametrization has only a small ∼10% effect on the favored η/s value, which is less than the ∼30% uncertainty of the analysis using a single EoS parametrization. Our parametrization of $\eta/s(T)$ leads to a slightly larger minimum value of $\eta/s(T)$ than the previously used parametrizations.

[1] J. E. Bernhard, J. S. Moreland and S. A. Bass, Nature Phys. 15, no.11, 1113-1117 (2019).
[2] H. Niemi, K. J. Eskola and R. Paatelainen, Phys. Rev. C 93, no.2, 024907 (2016).
[3] J. Auvinen, K.J. Eskola, P. Huovinen, H. Niemi, R. Paatelainen and P. Petreczky, arXiv:2006.12499 [nucl-th], to appear in Phys. Rev. C.

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