Shear viscosity of a hot hadron gas

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Last year we have reported on a the extraction of the specific shear viscosity of hot hadron gas using data from the Relativistic Heavy Ion Collider (RHIC) and the Large Hadron Collider (LHC) [1]. That work had been motivated by the paradigm that quark gluon plasma just above the crossover transition to a hadron gas is a strongly coupled liquid [2]. Its specific shear viscosity η/s has been found to be close to the conjectured lower quantum bound of $1/4\pi$. We do not expect any rapid changes of η/s of nuclear matter as a function of temperature T as it is lowered across the crossover temperature into the hot hadron gas phase. However such a rapid change is predicted by several hadronic transport models.

In [1] we had extracted η/s from the distortion $f \rightarrow f + \delta f$ of particle distributions away from equilibrium at freeze-out. These distortions emerge in the presence of shear stress and can be systematically described by a gradient expansion in the Navier-Stokes approximation. We had developed a viscous blastwave for this purpose which is discussed in detail in [1].

In the past year we have improved the values of η/s vs temperature extracted from data by accounting for the systematic bias build into the blastwave approximation in [1]. This was achieved by systematically comparing blastwave fits with relativistic fluid dynamics. Pseudodata generated with viscous fluid dynamics with known freeze-out temperature and specific shear viscosity was compared to

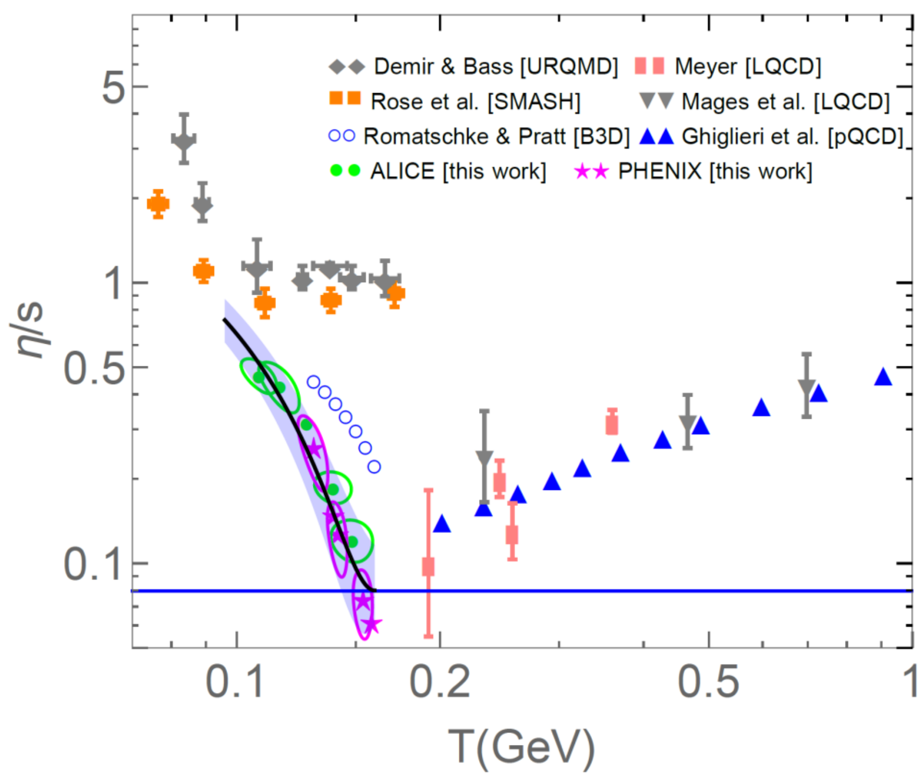

FIG. 1. The specific shear viscosity $\boldsymbol{\eta/s}$ for various temperatures in the hadronic phase extracted from freeze-out data after removal of blastwave bias. Our values are represented by circles and stars with uncertainties indicated by ellipses. For references to the other calculations shown here please see Ref. [1].

the values measured by viscous blastwave fits of the pseudodata. This distortion can be parameterized. Subsequently this map can be used to remove the bias in the temperature and specific shear viscosity extracted from real data using the viscous blastwave [3].

The results of our improved analysis can be seen in Fig. 1 together with values found in the literature calculated by both lattice QCD (for quark gluon plasma) and hadronic transport (for hadron gas). See Ref. [1] for references to the other calculations shown in this figure. We have also improved the analysis of systematic uncertainties in our approach. After removing blastwave bias the specific shear viscosity rises more slowly with dropping temperature.

[1] Z. Yang and R.J. Fries, arXiv:1807.03410.

[2] E. Shuryak, Prog. Part. Nucl. Phys. **62**, 48 (2009).

[3] Z. Yang and R.J. Fries, (in preparation).