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Shear and bulk viscosities of gluon plasma across the transition temperature

Shear and bulk viscosities are two key transport coefficients that characterize the fundamental properties of quark-gluon plasma.They quantify the response of the energy-momentum tensor to shear flow and divergent flow,serving as crucial input parameters for the phenomenological and transport models that interpret experimental data, such as the elliptic flow v_2.
However, calculating these inherently non-perturbative viscosities within lattice QCD presents challenges due to strong ultraviolet fluctuations in the relevant operators. The traditional approach using the multi-level algorithm is highly effective in suppressing UV fluctuations but is limited to the quenched approximation. Recently, the gradient flow method was introduced to address this issue [1], opening the path to full QCD studies. However, Ref. [1] examined only a single temperature, $1.5T_c$.
This work extends the Ref. [1]'s results to a wide temperature range from $0.76T_c$ to $2.25T_c$, focusing on the high-temperature regime while also probing the system's behaviour across the phase transition. The former enables a fair comparison with the next-to-leading-order perturbative estimates which become more reliable at high temperatures, while the latter allows us to study the system's critical dynamics—a topic of wide community concern. The methodology developed in this work provides the foundation for future full QCD calculations.

Reference

[1] L. Altenkort, A.M. Eller, A. Francis, O. Kaczmarek, L. Mazur, G.D. Moore, and H.-T. Shu, Phys. Rev. D 108, 014503 (2023).

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