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Shear and bulk viscosities of gluon plasma across the transition temperature

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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 the shear flow and divergent flow, serving as crucial input parameters for the phenomenological and transport models that interpret experimental data, e.g. 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 has the limitation that it applies only in the quenched approximation, as done in [1, 2]. Recently, the gradient flow method was introduced to address this issue [3], opening the path to studies in full QCD. However, [3] examined only a single temperature, $1.5T_c$.

In this talk, we present results extending [3] to a wide temperature range from $0.76T_c$ to $2.25T_c$ [4], with particular focus on the phase transition region and high-temperature regime. The former helps us to understand how the system behaves under the critical change, a topic of wide concern in the community. The latter allows us to compare against the NLO perturbative estimate, which becomes more reliable at high temperature. The methodology developed in this study positions us well for a full QCD calculation in the near future.

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