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Does quark-gluon plasma feature an extended hydrodynamic regime?

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In the view that the short wavelength response can be important in small colliding systems and at early-times of a heavy-ion collision, we investigate the response of the near-equilibrium quark-gluon plasma (QGP) to perturbation at non-hydrodynamic gradients. We propose a conceivable scenario under which sound mode continues to dominate the medium response in this regime. Such a scenario has been observed experimentally for various liquids and liquid metals. We further show this extended hydrodynamic regime (EHR) indeed exists for both the weakly-coupled kinetic equation in the relaxation time approximation (RTA) and the strongly-coupled $N=4$ supersymmetric Yang-Mills (SYM) theory. We construct a simple but nontrivial extension of Müller-Isareal-Stewart (MIS) theory, namely MIS*, and demonstrate that it describes EHR response for both RTA and SYM theory. Finally, we discuss the possible connection between the extended hydrodynamic regime and observed collectivity in small colliding systems.

Ref: Weiyao Ke and Yi Yin, ArXiv: 2208.01046, Phys.Rev.Lett in press

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