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General equilibrium second-order hydrodynamic coefficients

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The quark-gluon plasma created in heavy ion collisions is a relativistic fluid with extremely large acceleration and vorticity, as demonstrated by the recent STAR measurement of Lambda polarization.
In local equilibrium conditions, the standard hydrodynamic stress-energy tensor expression is expected to receive corrections proportional to the square of acceleration and vortiicty.

We show how these corrections can be obtained in a systematic way by performing a perturbative expansion around the homogeneous global equilibrium condition as long as the ratio between acceleration, vorticity and temperature are small. The relevant coefficients can be expressed in terms of Euclidean correlators of the stress-energy tensor operator and the generators of the Lorentz group.

We also consider massless fermions with net chirality enforcing a thermal equilibrium with a conserved axial charge. We show that parity-odd collective behavior induced by the interplay between vorticity and chirality, like for instance the Chiral Vortical effect, can be systematically derived within this thermal equilibrium approach.

All these correlators can in principle be estimated for QCD with lattice computations. We present analytic results obtained for a free scalar charged field and a free Dirac field, both massive and massless.

Content type

Theory

Collaboration

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