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Path-integral formula for local thermal equilibrium

Relativistic hydrodynamics, which successfully describes the quark-gluon plasma created in heavy-ion collisions, is formulated based on the assumption that systems are almost in local thermal equilibrium. However, a quantum field theoretical way to handle such a locally thermalized matter has not been clearly clarified.

In this study, we develop imaginary-time formalism for relativistic quantum field theories under local thermal equilibrium. We show microscopically that the Masseiu-Planck functional, which is a thermodynamic potential for locally thermalized systems, plays a role as the generating functional for the expectation values of conserved current operators such as the energy-momentum tensor and electric current in local thermal equilibrium. We also provide the complete path-integral formulation of the Masseiu-Planck functional from a scalar field [1] to a spinor field [2], in which it is written in terms of the emergent thermally curved spacetime with the notable intrinsic symmetry properties: Kaluza-Klein gauge symmetry, spatial diffeomorphism symmetry, and gauge symmetry for external fields. With the help of the symmetry argument, we can construct the nondissipative part of the hydrodynamic equations including the anomaly-induced transport such as the chiral magnetic effect.

References:

[1] T. Hayata, Y. Hidaka, M. Hongo, T. Noumi, Phys.Rev.D 92, 065008

[2] M. Hongo, in preparation

Preferred Track

New Theoretical Developments

Collaboration

Not applicable

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