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Resummed spin hydrodynamics from quantum kinetic theory

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In the past years, different observables related to the spin polarization of hadrons such as Λ-Baryons have attracted much attention and continue to find new applications.
While some measurements (such as the global polarization) are straightforwardly reproduced by assuming the spins of the particles to be in equilibrium, the explanation of more differential observables (such as the local polarization) remains a subject of active discussion.

A crucial ingredient in a more thorough description of spin dynamics is a formulation of dissipative relativistic spin hydrodynamics that accounts for the finite (and possibly long [1]) timescale of spin relaxation, i.e., of the approach of the spin potential $\Omega_0^{\mu\nu}$ to the thermal vorticity $\varpi^{\mu\nu}$. In such a theory, the spin potential remains a dynamical quantity that follows certain evolution equations, akin to the Bloch equations for the magnetization in the (nonrelativistic) description of spin dynamics.

The main result to be presented are the equations of motion for such a theory, derived from first principles based on quantum kinetic theory [2]. Employing the inverse-Reynolds dominance (IReD) approach [3], a resummation scheme based on a power counting in Knudsen and inverse Reynolds numbers is constructed, leading to hydrodynamic equations that are accurate to second order.
It is found that the spin dynamics can be characterized by eleven equations: six of them describe the evolution of the components of the spin potential $\Omega_0^{\mu\nu}$, while the remaining five provide the equation of motion of a dissipative irreducible rank-two tensor $\mathfrak{t}^{\mu\nu}$. For a simple truncation, all first- and second-order transport coefficients are computed explicitly.

[1] DW, M. Shokri, D. H. Rischke, arXiv: 2405.00533

[2] DW, arXiv: 2409.07143

[3] DW, A. Palermo, V. E. Ambruş, Phys.Rev.D 106 (2022) 1, 016013

Category

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