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Alignment from spin-1 hydrodynamics

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The spin alignment of vector mesons emitted in heavy-ion collisions has recently been measured by the ALICE and STAR collaborations over a wide range of energies [1, 2]. The alignment is part of the so-called tensor polarization, which is a property that is exclusive to particles of spin 1 and higher. Even though there have been substantial theoretical efforts, a definite explanation for the tensions between theory and experiments does not yet exist.

In this work [3], we derive an expression for the tensor polarization of a system of massive spin-1 particles in a hydrodynamic framework. Starting from quantum kinetic theory based on the Wigner-function formalism, we employ a modified method of moments which also takes into account all spin degrees of freedom. We find that the tensor polarization is independent of the nonlocal part of the collision term and sourced by the usual dissipative quantities of the fluid, i.e., the bulk-viscous pressure, the particle-diffusion current, and the shear-stress tensor. As an example, we compute the relevant transport coefficient in the case of an uncharged fluid, where, neglecting bulk effects, the tensor polarization is determined solely by the shear-stress tensor. In order to quantify this polarization effect, we provide a formula which can be used for numerical calculations of vector-meson spin alignment in relativistic heavy-ion collisions.

[1] S. Acharya et al. (ALICE), Phys. Rev. Lett. 125, 012301 (2020), 1910.14408.
[2] M. Abdallah et al. (STAR), Nature 614, 7947 (2023), 2204.02302.
[3] D. Wagner, N. Weickgenannt, E. Speranza, Phys. Rev. Res. 5, 013187 (2023), 2207.01111.

Category

Theory

Collaboration (if applicable)

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