

ID de Contribution: 172

Type: Talk

## Spin polarization of fermions at local equilibrium: second order gradient expansion

*mercredi 5 juin 2024 09:30 (20 minutes)*

Relativistic heavy-ion collisions provide a unique opportunity to study spin polarization of fermions. In the past decade, a lot of progress has been made regarding the spin polarization of  $\Lambda$  hyperon, both at experimental and theoretical level. Polarizations induced by first order gradient quantities, such as the thermal vorticity tensor, have been widely discussed and successfully explained the  $\Lambda$ 's global polarization. However, the  $\Lambda$ 's polarization along the beam direction still remains a puzzle, which is known as the "spin sign puzzle" in heavy-ion collisions. In this work, we focus on fermions at local equilibrium in a relativistic fluid. We derive, for the first time, the spin polarization induced by second order derivatives of the four-temperature vector. As a consequence, gradients of the thermal vorticity and the thermal shear tensor also have sizable contributions to the polarization, which may provide a solution of the spin sign puzzle.

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**Classification de Session:** Track4-Bulk&Phase

**Classification de thématique:** Bulk matter phenomena, QCD phase diagram and Critical point