Contribution ID: **333** Type: **Oral report**

Spin hydrodynamics of Dirac fermions consistent with entropy principle

Wednesday, 14 August 2024 14:55 (15 minutes)

In this study, the canonical formulation of the spin hydrodynamics of Dirac fermions is examined within a power counting scheme, where the spin variables are considered to be at the same order as the conventional hydrodynamic variables. An entropy-current analysis with a general spin potential reveals the importance of incorporating both the three components of spin density associated with spatial rotation symmetry and the other three components linked to boost symmetry to uphold the entropy principle. It is found that the boost variables have to be included in the stress-energy tensor, along with a totally antisymmetric spin tensor for Dirac fermions. The constitutive relations is chosen to be related to the phenomenological formulation of spin hydrodynamics by pseudogauge transformation. Upon linear-mode analysis, it is observed that the spin and hydrodynamic modes in this canonical formulation exhibit the same dispersion relations as the phenomenological formulation up to the relevant order.

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Session Classification: 分会场三

Track Classification: 重离子物理