

Canonical and phenomenological formulations of spin hydrodynamics

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Two formulations of relativistic hydrodynamics of particles with spin $1/2$ are compared. The first approach, dubbed the canonical one, uses expressions for the energy-momentum and spin tensors that have properties that follow a direct application of Noether's theorem, which yields a totally antisymmetric spin tensor. The other one is based on a simplified form of the spin tensor and is commonly used in the current literature under the name of a phenomenological approach. We show that these two frameworks are equivalent, i.e., they can be directly connected by a suitably defined pseudogauge transformation, only if the first framework is initially improved by a suitable modification of the energy-momentum tensor (addition of a divergence-free term that cannot be interpreted as a pseudogauge). Our analysis uses arguments related to the positivity of entropy production. The latter turns out to be equivalent for the improved canonical and phenomenological frameworks.

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