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Relativistic spin hydrodynamics with antisymmetric spin tensors and an extension of the Bargmann-Michel-Telegdi equation

We derive a formulation of relativistic spin hydrodynamics with totally antisymmetric spin tensors that satisfy the Frenkel-Mathisson-Pirani condition. In our proposed spin hydrodynamics, the second law of thermodynamics is fulfilled by the spin-induced corrections in the heat flow, the viscous tensor, and the antisymmetric part of the energy-momentum tensor. These corrections are interpreted as the inverse spin Hall effect and the anomalous Hall effect in the nonrelativistic limit. We show that our evolution equation for the spin density is interpreted as an extension of the Bargmann-Michel-Telegdi equation known in relativistic many-body systems, including the Thomas precession term, the spin-rotation term, and new coupling terms between spin and hydrodynamic variables.

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