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Kinetic theory for massive spin-1/2 particles from the Wigner-function formalism

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We calculate the Wigner function for massive spin-1/2 particles in an inhomogeneous electromagnetic field to leading order in the Planck constant. Going beyond leading order in $\hbar$ we then derive a generalized Boltzmann equation in which the force exerted by an inhomogeneous electromagnetic field on the particle dipole moment arises naturally. Furthermore, a kinetic equation for this dipole moment is derived. Carefully taking the massless limit we find agreement with previous results. The case of global equilibrium with rotation is also studied. Finally, we outline the derivation of fluid-dynamical equations from the components of the Wigner function. The conservation of total angular momentum is promoted as an additional fluid-dynamical equation of motion. Our framework can be used to study polarization effects induced by vorticity and magnetic field in relativistic heavy-ion collisions.

Authors: WEICKGENANNT, Nora (Goethe University Frankfurt); SHENG, Xin-li (Institute for theoretical physics, Goethe Uni.); SPERANZA, Enrico (Frankfurt University); WANG, Qun (University of Science and Technology of China); RISCHKE, Dirk (University Frankfurt)

Presenter: WEICKGENANNT, Nora (Goethe University Frankfurt)

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