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Pre-equilibrium dynamics of the chiral magnetic effect and anomalous transport: real-time simulations and chiral kinetic theory

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We investigate the real time dynamics of the Chiral Magnetic Effect and anomalous transport in ultra-relativistic heavy ion collisions. To this end we perform real-time lattice simulations with dynamical (Wilson and Overlap) fermions simultaneously coupled to color and electro-magnetic fields and we show that for light quarks the transport of electric and axial charges is essentially dissipation-less and can be understood from a simple hydrodynamic picture, while for heavier quarks significant derivations arise.
Further we discuss how our studies can be extended to compute the Chiral Magnetic Effect during the pre-equilibrium stage of a heavy-ion collision in order to provide initial conditions for the subsequent kinetic descriptions and anomalous hydrodynamic evolution. We illustrate the need of a consistent formulation of chiral kinetic theory, which we show can be derived from a first-principle world-line approach to quantum field theory. Our work ties in with recent progress towards a unified understanding of the pre-equilibrium dynamics of anomalous and topological effects.

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