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Anomalous Chiral Transport in Heavy Ion Collisions (15' + 5')

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Anomalous chiral transport processes, with the notable examples of Chiral Magnetic Effect (CME) and Chiral Magnetic Wave (CMW), are remarkable phenomena that stem from highly nontrivial interplay of QCD chiral symmetry, axial anomaly, and gluonic topology. The heavy ion collisions provide a unique environment where a hot chiral-symmetric quark-gluon plasma is created, gluonic topological fluctuations generate chirality imbalance, and very strong magnetic fields $|\vec{\mathbf{B}}| \sim m_\pi^2$ are present during the early stage of such collisions. Significant efforts have been made to look for signals of CME and various other anomalous chiral transport effects signals in heavy ion collision experiments. Crucial for such search and for interpretation of data, is the development of quantitative simulations based on hydrodynamics, with realistic initial conditions and properly accounting for possible backgrounds. We report a number of important recent progress toward this direction. Fluid systems with chiral fermions are described by anomalous hydrodynamics. We combine this new framework with the state-of-the-art, data-validated viscous hydro simulations of heavy ion collisions to describe the anomalous chiral transport of various charges in the quark-gluon plasma in a linearized fashion. Furthermore we have used partonic transport tools (AMPT) to simulate realistic initial conditions for each parton flavor, to be then evolved in time using the anomalous hydro. In addition, known background effects are incorporated in the computation of relevant observables for final state hadrons. Such quantitative simulations have allowed us to (1) systematically examine and contrast the transport of conserved charges with and without anomaly effects; and (2) meaningfully compare modeling predictions with experimental measurements related to CME and CMW. We will present these results in details and discuss their implications for the search of anomalous chiral transport effects.
[Refs] Shi, Jiang, Yin, Liao, to appear; Liao, 1601.00381; Kharzeev, Liao, Voloshin, Wang, 1511.04050; Yin, Liao, 1504.06906; Jiang, Huang, Liao, 1504.03201.

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