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Chiral transport and its dependence on collision beam energy

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Chirality is a fundamental element in the construction of the Standard Model and a key feature for understanding non-perturbative aspects of Quantum Chromodynamics (QCD). Chiral Magnetic Effect (CME) provides a unique access for experimental probe of chirality in heavy ion collisions. Recent measurements from Beam Energy Scan II data by the STAR Collaboration demonstrate very interesting beam energy dependence of CME observables. In particular, robust CME signals are extracted between 10 to 20 GeV energies while a disappearance of such signal is found for even lower energy region. This talk reports results providing theoretical interpretations of those measurements. First, we develop a data-driven approach to decipher the implications of these data. Utilizing machine learning methods based on large scale simulations of AVFD (anomalous-viscous fluid dynamics) framework, we are able to extract, for the first time, the values of key input parameters from the inclusive gamma and delta correlators at 19.6GeV, including the initial axial charge density, the magnetic field lifetime, and the local charge conservation (LCC) strength. The results unambiguously confirm both a dominance of LCC and a robust presence of CME transport. Second, we perform a theoretical calculation of axial charge dynamics with an effective model for QCD chiral dynamics. We demonstrate that with decreasing temperature and density, the spontaneous breaking of chiral symmetry leads to an increased chiral condensate that causes significant damping effect on any initial axial charge. This result supports the interpretations of the CME disappearance at very low collision energy as the indication of QCD chiral symmetry breaking.

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