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Production of chiral anomaly, dynamo instabilities and generation of turbulence

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The standard model of particles predicts the occurrence of a macroscopic quantum phenomenon named the chiral magnetic effect (CME) in plasmas with chiral, electrically charged particles. The CME implies an electric current along a magnetic field, which arises if there is an asymmetry in the chemical potentials of left- and right-handed fermions related to a chiral anomaly. This effect can be incorporated in the framework of magnetohydrodynamics, and leads to chiral dynamo instabilities, which can amplify magnetic energy by many orders of magnitude. The CME and the chiral dynamo instabilities have relevance for the early universe, neutron stars, quark-gluon plasmas, heavy ion collisions, and for quasi-particles in new materials such as graphene and Dirac semi-metals. In this talk, we discuss various effects related to production of a chiral anomaly, the excitation of a chiral dynamo instability, the production of magnetically driven turbulence, and the generation of a large-scale magnetic field via the magnetic alpha effect related to fluctuations of current helicity.

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