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Simulating chiral anomalies in a box system

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We have investigated the chiral anomalies with transport simulations in a box system. In the box system with the periodic boundary condition under a uniform magnetic field, the chiral magnetic effect and the chiral magnetic wave were simulated based on the spin kinetic equations of motion (SEOM) and the chiral kinetic equations of motion (CEOM), with the latter derived from the SEOM for massless particles with approximations. We found that the chiral magnetic effect is weaker while the damping of the chiral magnetic wave is stronger from the SEOM compared with that from the CEOM, and they are both weaker than the analytic results. In addition, effects induced by chiral anomalies from the SEOM are less sensitive to the decay of the magnetic field than from the CEOM due to the spin relaxation process. Furthermore, effects of the temperature, the magnetic field, and the specific shear viscosity on the key properties of the chiral magnetic wave with different scenarios are discussed.

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