Transport of Magnetized Particles in Random Electric Fields: from Advection to Diffusion

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The study of anomalous transport of particles (as well as momentum and energy) across ubiquitous magnetic field is an important task of plasma physics. One of the causes of anomalous transport is commonly assumed to be an electrostatic turbulence. In the limit of small correlation times of random fields transport is diffusive, and for its description a quasilinear approximation is used. In the opposite limit of large correlation times transport occurs as advection.

We proposed the new closure, and subsequently derived the statistical equations which describe transport of magnetized particles undergoing random isotropic electric fields in a wide range of correlation times (including two limiting cases), without use of free parameters. The evolution of a particle ensemble is considered in terms of the running diffusion coefficient and mean square displacement. Direct numerical simulations were carried out to verify the transport equations. It was shown that statistical characteristics of particle ensemble obtained from simulations are consistent with solutions of transport equations for fields such as frozen one, piecewise frozen field with phase jumps, and set of random waves.

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