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Landau-fluid simulations of non-resonant heating in a turbulent magnetized plasma

Thierry Passot, Pierre-Louis Sulem, and Dimitri Laveder
UNS, CNRS, Observatoire de la Côte d'Azur, Laboratoire Lagrange, Nice Cedex 4, France (thierry.passot@oca.eu)

Non-resonant perpendicular ion heating, which plays an important role in the solar corona and the solar wind, has been mostly studied by simulating particle trajectories in a given wave field. This effect originates from the ion stochastic motion due to field perturbations at the scale of the Larmor radius, which breaks the conservation of the magnetic moment. We show that this effect is amenable to a fluid description provided low-frequency kinetic effects such as Landau damping and finite Larmor radius (FLR) corrections are suitably included. This approach provides a self-consistent description where temperatures and wave fields evolve dynamically under the effect of a large-scale random driving of the velocity field, a procedure which does not directly affect the conservation of the space-averaged magnetic moment per unit mass. We here present numerical simulations based on the so-called FLR-Landau fluid model which allows for the identification of the various contributions to the heating process. It turns out that for a fixed beta, the heating is dominantly in the perpendicular direction when the bulk of the wave spectrum is located at relatively small scale, while parallel heating is dominant when there is a sufficient separation between the driving scale and the ion Larmor radius. Fixing the ratio between these two scales, the heating increases as beta is decreased, while the reverse variation takes place when fixing the ratio with the ion inertial length. Perpendicular heating and parallel cooling are enhanced as the magnetic compressibility is increased, for example when getting closer to the mirror threshold. In this case, temperature variation mainly originates from the work of the non-gyrotropic pressure forces. In all the regimes, electrons are dominantly heated in the parallel direction, at a rate that is enhanced when the amplitude of fast waves is larger.