Non-resonant particle Acceleration in strong turbulence: comparison to kinetic and MHD simulations

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Abstract: In high energy astrophysical sources, stochastic particle acceleration by turbulence is one of the promising candidates for the generation of non-thermal particles. By means of 2D and 3D PIC, as well as 3D (incompressible) magnetohydrodynamic (MHD) simulations, we tested a recent model of non-resonant particle acceleration in strongly magnetized turbulence, hence beyond the domain of quasilinear theory. That extended model ascribes the energization of particles to the continuous interaction with the random velocity flow of the turbulence in the frame of ideal MHD. In the frame where the electric field vanishes, we followed the evolution of the particle momentum to relate the sources of energy gains and losses to the gradient of the velocity field. Overall, we find a clear correlation between the model prediction and the numerical experiments, indicating that this non-resonant model can successfully account for the bulk of particle energization through stochastic Fermi processes. More specifically, we observe that in PIC simulations the shear acceleration along the direction of motion of the particle (along the field line) provides the dominant contribution to particle energization. Contrariwise, in MHD simulations, the projections of the shear velocity parallel and perpendicular to the magnetic field provide about equal contributions to acceleration.