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First-principle simulations of cosmic-ray transport in the self-confinement regime

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Cosmic-rays (CRs) have been recognized to play an important role in the galactic ecosystem through CR feedback. The key underlying microphysics lie in the CR gyro-resonant instabilities, which trigger the growth of Alfv' en waves that lead to energy and momentum exchange between the CRs and the background plasmas, as well as CR self-confinement. I will present simulations of the CR gyro-resonant instabilities using the magnetohydrodynamic-particle-in-cell (MHD-PIC) method in a variety of simulation settings. By designing a streaming box and an expanding box framework, our simulations achieve the steady-state balance between wave growth and damping, as well as between driving CR streaming/anisotropy and isotropization via wave scattering. It allows us to measure the CR transport coefficients from first principles as a function of background environment, which will offer reliable subgrid prescriptions for macroscopic studies of CR feedback and transport.

Summary

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