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Effects of the Background Turbulence on the Relaxation of Ion Temperature Anisotropy in Space Plasmas

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Turbulence in space plasmas usually exhibits two regimes separated by a spectral break that divides the so called inertial and kinetic ranges. Large scale magnetic fluctuations are dominated by MHD non-linear wave-wave interactions following a -5/3 or -3/2 slope power-law spectrum. After the break, at scales in which kinetic effects take place, the magnetic spectrum follows a steeper power-law $k^{-\alpha}$ shape given by a spectral index $\alpha > 5/3$. The location of the break and the particular value of α, depend on plasma conditions, and different space environments can exhibit different spectral indices. Despite its ubiquitousness, the possible effects of a turbulent background spectrum in the quasilinear relaxation of solar wind temperatures are usually not considered. In this work, a quasilinear kinetic theory is used to study the evolution of the proton temperatures in a solar wind-like plasma composed by cold electrons and bi-Maxwellian protons, in which electromagnetic waves propagate along a background magnetic field. Four wave spectrum shapes are compared with different levels of wave intensity. We show that a sufficient turbulent magnetic power can drive stable protons to transverse heating, resulting in an increase in the temperature anisotropy and the reduction of the parallel proton beta. Thus, stable proton velocity distribution can evolve in such a way as to develop kinetic instabilities. This may explain why the constituents of the solar wind can be observed far from thermodynamic equilibrium and near the instability thresholds.