Nonlinear wave-particle dynamics in chorus excitation

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Nonlinear wave particle interaction during chorus wave generation has been recently shown to be a non-adiabatic process; that is, the wave-particle trapping time in the resonant phase-space structures, $\tau_{tr}$, is typically of the same order as the characteristic nonlinear time scale $\tau_{NL}$ [1,2]. These results shed new light on the physical processes underlying wave-particle resonance and nonlinear mode evolution with respect to previous analyses assuming $\tau_{NL} \gg \tau_{tr}$. In this work, we present an analytical study of nonlinear evolution of phase-phase space structures in support of our earlier numerical simulation results [1,2].

We adopt a non-perturbative description [3] of the phase-space structures due to the interaction of supra-thermal electrons with the fluctuating fields produced by a quasi-periodic chorus wave. This allows us to derive the renormalized expression of supra-thermal electron distribution function in the form of a Dyson-like equation [3], which illuminates the self-consistent nonlinear evolution of resonance structures in the phase-space. In particular, we demonstrate that frequency sweeping of chorus fluctuations occurs as consequence of maximization of wave-particle power transfer; and discuss the consequence of this on the spatiotemporal features of the fluctuation spectrum.

References

