Resonance overlap and non-linear velocity spread
in Hamiltonian beam-plasma systems

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We analyze in some detail the properties of the beam-plasma instability [1, 2, 3] with respect to both the morphology of the linear dispersion relation, and the non-linear behavior of the particle velocity spread. First, we investigate non-perturbative effects in the dispersion relation, characterizing the linear growth rates and the frequency shift with respect to the plasma frequency where the perturbative inverse Landau damping expression breaks down. Then, we discuss the behavior of the non-linear velocity spread as function of the linear growth rate. We introduce three basic criteria to estimate the non-linear velocity spread, and demonstrate that only the full change of the particle velocity profile is really predictive of resonance overlap. Finally, we discuss aspects of the mode saturation level in the case of a broad fluctuation spectrum [4] and, by the help of an analytical toy model, we illuminate the mechanism responsible for higher saturation intensity with suitable overlapping resonances with respect to the case of single resonance with an isolated mode.

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References