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

N. Carlevaro[1,2], G. Montani[1,3], F. Zonca[1,4]

[1] *ENEA, Fusion and Nuclear Safety Department, C. R. Frascati, Via E. Fermi 45, 00044 Frascati (Roma), Italy*

[2] *LTCalcoli Srl, Via Bergamo 60, 23807 Merate (LC), Italy*

[3] *Physics Department, "Sapienza" University of Rome, P.le Aldo Moro 5, 00185 Roma (Italy)*

[4] *Institute for Fusion Theory and Simulation and Department of Physics, Zhejiang University, Hangzhou 310027, China*

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.

** *Work carried out within the framework of EUROfusion as Enabling Research Projects: NLED (AWP15-ENR-01-ENEA-03) and NAT (AWP17-ENR-MFE-MPG-01)* **

References

[1] L. Chen, F. Zonca, Rev. Mod. Phys. **88**, 015008 (2016)

[2] N. Carlevaro, M.V. Falessi, G. Montani, F. Zonca, J. Plasma Phys. **81**, 495810515 (2015)

[3] T.M. O'Neil, J.H. Winfrey, J.H. Malmberg, Phys. Fluids **14**, 1204 (1971)

[4] N. Carlevaro, A.V. Milovanov, M.V. Falessi, G. Montani, D. Terzani, F. Zonca, Entropy **18**, 143 (2016)