Two-mode dynamics of phase-space holes and clumps in systems near marginal stability

1 York Plasma Institute, Department of Physics, University of York, York YO10 5DD, U.K.
2 Institute for Fusion Studies, The University of Texas, Austin, TX 78712, U.S.A.

B.J. O. Woods1, B. N. Breizman2, R. G. L. Vann1

Hole-and-clump structures have been shown to have a fast particle distribution function (PDF) in the non-linear phase of the evolution of an energetic particle (EP) driven mode, such as gap TAEs. However, while the concept of toroidal Alfvén eigenmodes (TAE) destabilisation has been observed, the mechanism is not fully understood. Here, we utilise a Berk-Breizman augmented 1D kinetic model; a bump-on-tail distribution function with electric field dissipation captures the key physics.

First, we explicitly derive a Berk-Breizman model that allows us to capture the key physics, applying appropriate approximations and computational methods. Then, we explore the dynamics of single mode, demonstrating stochastic behaviour that we conclude is entirely encapsulated by the evolution of a hole and clump. Finally, we utilise semi-analytic models of single mode dynamics to describe the energy losses observed in the destabilisation of a marginally stable mode (slave mode) by a marginally unstable mode (master mode).

1. Motivation

2. Bump-on-tail model

3. Approximations and code

4. Simulation parameters

5. Single mode burst profile

6. Linear phase: lag and growth

7. Non-linear phase: plateau and decay

8. Mode bifurcation

9. Two-mode destabilisation

10. Destabilised energy loss

11. Point-like model of holes/clumps

12. Extension to multimode systems

References

Acknowledgements

For a given value of \( \Omega \), the energy loss curve features a threshold determined by \( n_p \).

For a set of slave modes shifting \( n_p \), such that they undergo mode flattening when destabilised.

We predict that below the point of quasi-linear transition, comprising at least one energetic particle distribution function, the mode flattening is accompanied by particle loss.