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Frequency chirping of an energetic particle driven mode in the presence of kinetic thermal ions

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In the present work, the extended hybrid MHD-gyrokinetic code (XHMGC) [1,2] with both energetic particles and thermal ions treated kinetically is used to study the frequency chirping of a single toroidal number mode. Anisotropic slowing-down distribution with single pitch angles are used to describe the energetic ion velocity space distributions, and isotropic Maxwellian distribution is used to describe the thermal ions. In our simulations, we found mode frequencies can chirp across the shear Alfvén continuum. The down-chirping is dominant. Saturation level scales differently from both resonance detuning and radial decoupling scaling for fixed mode structure and constant frequency modes [3]. During chirping, mode structure is strongly modified. Each poloidal harmonic essentially attaches to its own shear Alfvén continuum branch. As a consequence, large particle redistribution in phase space is observed. By varying thermal ion beta or energetic particle density, modes are found to chirp down to the kinetic thermal ion induced gap. When the mode chirps down, it can transfer energy to thermal ions. Down-chirping modes can transfer energy to thermal ions in an easier way, as the ion Landau damping is more effective at low frequency.

References

[1] S. Briguglio et al., Phys. Plasmas 2, 3711 (1995).

[2] X. Wang, S. Briguglio et al., Phys. Plasmas 18, 052504 (2011).

[3] X. Wang, S. Briguglio et al., Physics of Plasmas 23 (1), 012514, 2016

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