Nonlinear Gyrokinetic Particle Simulation of Beta-induced Alfvén Eigenmode

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Abstract.

The beta-induced Alfvén eigen mode (BAE) is studied using the global gyrokinetic particle code GTC[1]. BAE linear excitation by energetic particles shows that the BAE propagates in the ion diamagnetic direction and the frequency has a little downshift. We also find that the BAE frequency is related to the wavelength and the plasma beta while the growth rate is sensitive to the energetic particle properties. By analyzing the wave-particle resonance phase space, it is found that both the passing and trapped energetic particles can contribute to the BAE excitation through transit and drift-precessional resonance, respectively. By taking into account the kinetic nonlinearity, BAE saturates when reaching a large amplitude. The energetic particle nonlinearity plays a dominant role in BAE saturation. Nonlinear oscillations along with frequency chirping are observed in the BAE nonlinear stage. The wave-particle resonance in (ζ, ω_d) (ζ and ω_d are the toroidal angle and precessional frequency, respectively.) phase space for trapped energetic particles is also presented. Turbulence simulation of multiple modes with wave-particle and wave-wave nonlinearity and associated EP transport will be reported.

This work is in collaboration with I. Holod, Z. Lin, X. Wang,Y. Xiao, W. L. Zhang and supported by SciDAC GEEP Center.

[1] H. S. Zhang et al, *Phys. Plasmas* **17**, 112505 (2010).

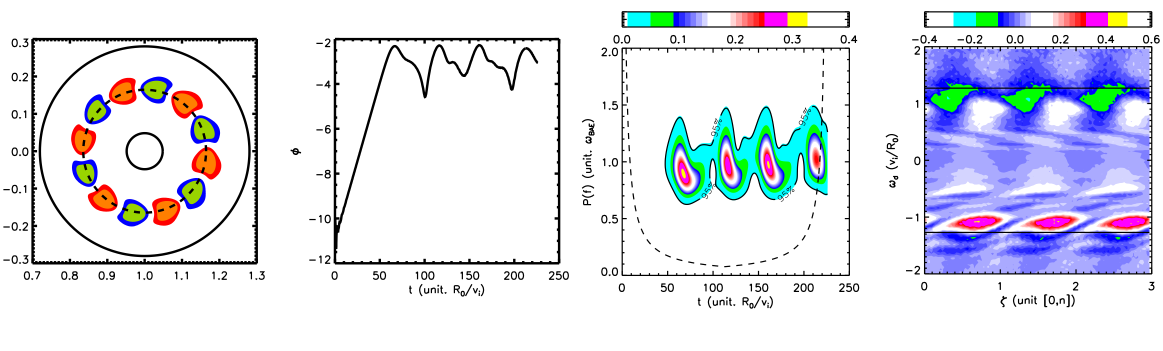

Fig. 1: GTC nonlinear simulation of BAE. (a) Linear poloidal mode structure; (b) Time history of mode amplitude; (c) Wavelet analysis showing frequency chirping; (d) Perturbed distribution function showing wave-particle resonance in phase-space (toroidal precession frequency vs. toroidal angle).