Model for spontaneous frequency of an Alfven wave in a toroidal plasma

Ge Wang , H.L.Berk

Institute for Fusion Studies , University of Texas at Austin

Abstract:

We study the frequency chirping signals that arise from a spontaneously excited toridial Alfven eigenmode(TAE) waves due to an energetic particle distribution function with free energy that can be released as described by a model particle/wave resonance interaction. Initially a wave is excited within the Alfven gap at the frequency predicted by the linear tip model of Rosenbluth, Berk and Van Dam(RBV). The instability, driven together with the dissipation in the background plasma, allows for the formation of phase space hole/clump structures that proceed to chirp towards lower energetic particle states that keep the wave-particle trapping region in synchronism with the wave. We find that the chirping signal enters the Alfven continuum where a larger amplitude and more rapidly chirping signal then develops. The accuracy of an adiabatic approximation for the evolution of the mode is tested and verified by the demonstration that a WKB-like decomposition of the time response for the phase and amplitude agrees with the data. Plots of the phase space structure reproduce the chirping dependent shape of the separatrix structure that partitions the trapped and passing particles. From the separatrix portrait, the chirping and field amplitude relations are inferred and shown to agree with a direct simulation measurement.