Radial Localization And Energetic-Particle Excitation of Alfvén-Ballooning Eigenmodes in High-β Toroidal Plasmas

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Radial localization of the αTAE, where α measures the plasma pressure gradient, is investigated in the second ballooning stable regime of toroidal plasmas by applying the WKB approximation in the radial direction. The αTAE is a discrete toroidal Alfvén eigenmode trapped in the α-induced potential well due to the ballooning curvature effect and suffers negligible continuum damping even in absence of the toroidal Alfvén frequency gap [*Hu and Chen*, 2004]. Employing the standard ballooning-mode formulation, the two-dimensional eigenvalue problem is reduced into two nested one-dimensional ones: one along the magnetic field line and the other in the radial direction. It is found that the αTAE can indeed be radially bounded around the maximum α, where the corresponding local real frequency is maximized. Resonant excitations by energetic particles are then demonstrated with gyrokinetic-magnetohydrodynamic (MHD) hybrid simulations. While the radial localization of αTAEs is determined by the background MHD plasma, the energetic particle mode (EPM) has much more complicated features; depending on the wave-particle resonances as well as the strength of kinetic instability drive. The detailed stability properties, including the finite radial wavenumber modifications, of the αTAE and the EPM excited by energetic particles will be presented.

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