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Gyrokinetic analysis of tearing modes in a collisionless plasma

ADINARAYAN K SUNDARAM, 917 Shenandoah Way, Greenwood, IN, ABHIJIT SEN, Institute for Plasma Research, Bhat, India — The linear and nonlinear dynamics of tearing instabilities in a collisionless plasma are investigated analytically using a gyrokinetic description. The effects of Landau and ∇B resonances on the linear characteristics of Δ'-driven tearing modes are discussed by including short wavelength variations across the confining magnetic field and long wavelength variations along the field. For a simple case when electrons are adiabatic and ions are fluid-like, the solutions of dispersion relations are obtained for modewidths, x_w, lying between electron and ion excursion lengths, namely, $X_{e,i}$, where $X_{e,i} = \omega L_s/(k_y v_{e,i})$, k_y is the wavenumber, L_s is the magnetic shear length, and $v_{e,i}$ represent electron and ion thermal speeds. It is shown that electron Landau damping effect can drive the tearing mode unstable with growth rate proportional to $(\Delta')^{1/2}$. For this mode, it is further shown that the effects of compressional mode coupling and finite Larmor radius can combine to have a slightly stabilizing effect. In another physical situation, it is demonstrated that the electron ∇B resonance effect can significantly destabilize the gyrokinetic tearing mode with growth rates varying as fractional powers of Δ' and k_y. The nonlinear implications of these effects are investigated by deriving an appropriate Rutherford equation for the magnetic island evolution.

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