Gyrokinetic Theory of Mirror Instability

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Magnetic mirror instability is the slow magnetosonic wave driven unstable by the anisotropic pressure in collisionless plasmas. It plays an important role in low frequency magnetic turbulences in high-β space plasmas, e.g., the Earth's magnetosheath, and also potentially in high-β laboratory mirror or dipole plasmas with large fraction of trapped particles. A quasi-hydrodynamic analysis of kinetic mirror instability in non-Maxwellian plasmas recently found that the maximum growth rate increase swith perpendicular wave number until the perpendicular wavelength becomes comparable to the ion gyroradius[1]. Therefore, the finite Larmor radius effects are important in determining the threshold and the wavelength of the kinetic mirror instability.

In this study, we extend the kinetic theory for mirror instability to the short wavelength regime using the gyrokinetic theory to treat finite Larmor radius effects. Following the gyrokinetic formulation of Ref.[2], we have developed a general dispersion relation of the mirror mode with finite Larmor radius effects and arbitrary distribution functions. In the long wavelength limit of $k_\perp \rho_i = 0$, we recover the results of Ref.[1]. In the short wavelength limit, we find that the finite $k_\perp \rho_i$ has stabilizing effects. The coupling to the slow sound wave is also found to be stabilizing.

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References

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