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Effects of fast particles on internal modes in reversed field pinches

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Abstract

Fast ion population in tokamaks is found to have a significant influence on the dynamics of global plasma modes. In a normal mode analysis of plasma oscillations the fast particles are described by drift kinetic equation in which the perturbed electric and magnetic fields are evaluated at the position of the particle's guiding center. In this treatment the effects due to spatial variation of perturbed fields within the gyroradius are not considered. In reversed field pinches (RFP) the magnetic field is an order of magnitude smaller than in tokamaks. The Larmor radius of neutral beam injected particles in the 20 KeV energy range in RFPs is a substantial portion of the minor radius. The perpendicular wave length of global plasma modes is comparable to the Larmor radius of fast particles; thus the finite Larmor radius effects mentioned above can be important. In this study we concentrate on these effects only. We apply a simple constitutive relation without drift contributions for the fast particle dielectric response obtained from the linearized Vlasov equation. We consider cylindrical RFP equilibrium and use the resistive MHD model for the description of the plasma bulk. The changes to the internal modes due to the fast particles with large gyroradius are estimated. Analysis shows that the changes are sizable and that fast particles can either stabilize or destabilize plasma within the considered model. The effect depends on the radial distribution of fast particle density.