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Effects of energetic particle on the collisionless trapped-electron-mode instability in tokamak plasmas

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Abstract

Effects of energetic particle (EP) on the microturbulence driven by temperature gradient and/ or density gradient, such as ion temperature gradient mode and trapped electron mode turbulence are important to study for the control of magnetic confinement fusion in tokamak plasmas.[1,2] ICRH driven EP (He-3) has strong stabilizing effects on the ITG linear growth rate as compared to NBI driven fast ions (deuterium).[2] EP has stabilizing effects on ion temperature gradient instability with low magnetic shear in JET-like plasmas.[3] For steep density profile of EP (fusion born alpha particles) with slowing-down distribution, the trapped electron drift waves are stabilized by the presence of EPs.[4] Recent GENE gyrokinetic simulations show slight destabilization of TEM by NBI driven EP.[5] In this work, the influence of EP on collisionless trapped electron mode (CTEM) instability is analyzed using the linear gyrokinetic theory and bounce kinetic theory for tokamak plasmas. The EPs under consideration are fusion born alpha particles. The effects of these EPs on the CTEM instability are investigated by comparing Maxwellian, slowing-down and equivalent Maxwellian distribution functions for the equilibrium EP distribution functions. It is shown that the CTEM instability can be destabilized by the presence of EP, which is mainly attributed to the downshift of real frequency. The difference between the effects of EP on the CTEM instability for Maxwellian, slowing-down and equivalent Maxwellian distribution functions is almost negligible. By increasing the fraction of tritium with fixed EP fraction, the destabilizing effects become stronger.

References

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