

Two-dimensional model of the ion-temperature-gradient instability

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A simple, analytically tractable kinetic model for the perpendicularly-propagating branch of the electrostatic ion-temperature-gradient instability is discussed. It assumes two-dimensional dynamics perpendicular to the magnetic field, hence the parallel derivatives are zero. The ions are described with a drift-kinetic equation for mode wavelengths much larger than their Larmor radii and the electrons are treated as adiabatic. Two different geometrical models are considered. The first one assumes a Cartesian geometry with the time-independent magnetic field aligned in the z -direction, having a magnitude dependent on the x -coordinate. Here the magnetic curvature is zero and the only kinetic resonance is the one associated with the grad-B particle drift. The second model assumes a cylindrical geometry with the magnetic field in the azimuthal direction, having a magnitude inversely proportional to the r -coordinate. Now this model includes the effect of the magnetic curvature and the kinetic resonance associated with both the grad-B and magnetic curvature particle drifts. The analysis is carried out within the linear local framework. The local dispersion relations depend on the ion and electron temperatures, and the gradients of the ion density, the ion temperature and the magnetic field magnitude, through two independent dimensionless parameters in the Cartesian case and three independent parameters in the cylindrical case. Such dispersion relations are expressed in a form that allows a straightforward analytic determination of the resonant and non-resonant parts of the instability thresholds in parameter space. The fluid model that corresponds to the assumptions made in the kinetic model is also discussed, with a fluid closure hypothesis that best approximates the kinetic result.