Fluid theory of gradient-drift instability of partially-magnetized plasmas in $\text{E}_x\text{B}$ fields with finite electron Larmor radius effects

E.A. Sorokina$^{1,2}$, V.P. Lakhin$^1$, V.I. Ilgisonis$^{1,2}$, N.A. Marusov$^{1,3}$

$^1$NRC "Kurchatov Institute", Moscow, Russia
$^2$RUDN University, Moscow, Russia
$^3$Moscow Institute of Physics and Technology, Moscow, Russia

The gradient-drift instability in inhomogeneous partially-magnetized plasmas with transverse current is studied theoretically. Such an instability is typical for plasmas immersed in crossed external electric and magnetic fields (in particular, for Hall ion sources, Penning discharges, closed-drift Hall plasma thrusters) [1, 2] and can be a source of turbulence and anomalous electron mobility in such systems [3-5].

The analysis is performed in the frame of two-fluid theory. The ions are considered to be cold and unmagnetized. The electrons are assumed to be hot and magnetized, and their inertia and gyroviscosity effects are included. Such a model takes into account the finite electron Larmor radius effects (FLR) in Padé approximation. The generalized local dispersion relation is derived, which extends previously known dispersion relations of Refs. [4-8].

The detailed analysis of the dispersion relation is presented for a wide range of plasma parameters. The necessary and sufficient instability condition is analytically derived and the instability threshold is obtained. The growth rates of unstable modes and their frequencies are found. In general, the FLR effects stabilize the short-wavelength perturbations and, therefore, for some ranges of plasma parameters only the long-wavelength, low-frequency (compared to the lower-hybrid frequency) modes are unstable.

References:
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