Abstract. We analysed the theoretical point of view the consequences of certain finite temperature effects on the description of magnetic reconnection in a non-dissipative regime. We considered a two-field model for a collisionless plasma in a slab geometry with a strong guide field, where isotropic electron and ion pressures are included by means of an isothermal thermodynamic closure for both the species. We evidenced in particular the difference between the role played by Finite Larmor Radius (FLR) and ion-sound Larmor radius effects. The latter were already known [1,2] to control the transition from a turbulent to a laminar regime inside the reconnection layer, and various arguments suggested that ion gyro-radius effects remain minute beyond a finite Larmor radius [3,4]. We found that both ion and electron temperature effects regularize the gradients of the ion density with respect to the cold regimes, by means of internal energy variations in the energy balance, which result related to mechanical work. Nevertheless, for values of the Larmor radii that are not asymptotically small, the two temperature effects are no longer interchangeable, in contrast to what is expected from linear theory, and the differences are measurable in the numerical growth rates, in the nonlinear evolution of the density layers and in the different behaviour of fields around the “x” and “y” points [5,6].

The Problem: -Reconnection: effects at macroscopic scales (e.g. fluid models). In high temperature/low density magnetized plasmas occur kinetic regimes
-Need for including temperature effects
-Consistent accounting would require a kinetic approach
-Some effects can be included also in fluid models. In this work: parallel electron compressibility (ion sound Larmor radius)
-finite Larmor radius effects (ion Larmor radius).

The Model: -2-fluid model with strong guide field approximation, single-helicity perturbation
-slab geometry: z along guide field, y along perturbation wave vector, x along shear direction (chosen perpendicular to the wavenumber and such that a point F exists where the shear field goes to zero)
-limit case of RMHD if k_y << k_z, exact configuration with single elcity perturbation, if the mode direction is almost perpendicular to total magnetic field

Equations:
\[ B = \psi \times \hat{e}_y + B_y \delta \]
\[ \psi' = \psi' = 0 \]
\[ \nu = \nu' = 0 \]
\[ \chi = \chi' \]
\[ \gamma = \gamma' \]

Numerical setup: -2D fluid code [2] upgraded to include FLR effects
-Advances cell averaged P & U via finite volume technique
-Reconstruct grid point values via Fourier transform
-Advances time via explicit 3rd order Adam-Bashforth scheme
-Check on conserved quantities (energy, topological invariants)
-Static equilibrium profile
-Linear growth
-Plot times normalised to the numerical growth rate calculated for each simulation

Energy Balance
\[ \psi = \psi' = 0 \]
\[ \chi = \chi' \]
\[ \gamma = \gamma' \]

References:

Ion Finite Larmor Radius and Ion-Sound Larmor Radius effects in slab collisionless reconnection

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14th European Fusion Theory Conference

Frascati, September 26th-29th, 2011