Extended MHD model and shear flow dynamics in magnetized plasmas

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We present an “extended MHD” model set of equations[1] aimed at studying magnetized
plasma regimes where fluctuations arise at scale lengths comparable to the ion Larmor radius (or
to the ion skin depth), while the characteristic frequencies remain smaller than the ion cyclotron
frequency. This system of equations conserves the total energy explicitly. Our main goal is
the investigation of the multi-scale dynamics resulting from the development of the Kelvin-
Helmholtz instability (KHI) driven by of a shear flow as, e.g., is the case of the interaction
of the solar wind with the Earth’s magnetosphere. Using this model, we have obtained a new
set of equilibria that include finite Larmor radius (FLR) microscopic effects accounting for the
contribution of the pressure tensor that, in such conditions, reacts on the flow itself on a time
scale much smaller than the ideal time scale of the KHI. These equilibria are an extension of
the standard MHD equilibria and are very well suited for fully kinetic simulations[1] where, on
the contrary, standard MHD equilibria generate strong spurious fluctuations and do not relax
towards Vlasov equilibria[2].

References

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