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Kinetic equilibrium for an asymmetric tangential layer with rotation of the magnetic field

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Finding kinetic equilibria for tangential current layers is a key issue for modeling plasma phenomena such as magnetic reconnection instabilities, for which theoretical and numerical studies have to start from steady-state current layers. Until 2012, all theoretical models –starting with the most famous "Harris" one- relied on distribution functions built as mono-valued functions of the trajectories invariants. For a coplanar anti-symmetric magnetic field and in absence of electric field, these models were only able to model symmetric variations of the plasma, so precluding any modeling of “magnetopause-like” layers, which separate two plasmas of different densities and temperatures.
Recently, the "BAS" model was presented (Belmont et al., 2012), where multi-valued functions were taken into account. This new tool is made necessary each time the magnetic field reversal occurs on scales larger than the particle Larmor radii, and therefore guaranties a logical transition with the MHD modeling of large scales. The BAS model so provides a new asymmetric equilibrium. It has been validated in a hybrid simulation by Aunai et al (2013), and more recently in a fully kinetic simulation as well. For this original equilibrium to be computed, the magnetic field had to stay coplanar inside the layer. We present here an important generalization, where the magnetic field rotates inside the layer (although restricted to a 180° rotation hitherto). The tangential layers so obtained are thus closer to those encountered at the real magnetopause. This will be necessary, in the future, for comparing directly the theoretical profiles with the experimental ones for the various physical parameters. As it was done previously, the equilibrium is presently tested with a hybrid simulation.

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