Gyrokinetic framework for the Neoclassical Tearing Modes.

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The topology of a magnetic field, which confines plasma in a fusion device is rather complex. For example, a spontaneous formation of a chain of magnetic islands is one of its inner properties. A magnetic island, in its turn, implies formation of stochastic region, in which the electrons transport enhances. In the case when the seed island grows up significantly, i.e. it reaches up to 1 or 2 cm for MAST, it can lead to the loss of confinement and even to plasma disruption.

In order to prevent a potentially harmful influence of a magnetic island to the confinement, it is important to understand how the magnetic island modifies plasma dynamics. A particular interest is related with calculation of perturbed plasma current due to the presence of an island. This question has been already studied by Wilson in [1] in the framework of the drift-kinetic theory, i.e. without accounting for the FLR effects.

The magnetic island is a system, which exhibits multiple spatial scales. In the case of the neoclassically driven tearing modes, the poloidal dimension of an island may reach the size of a machine’s minor radius, while its width varies between few ion Larmor radii and an ionic banana width. Therefore, in order to compute the current modification induced via the presence of such islands, it is important to take into account the FLR effects in a consistent way, at least for the ions dynamics.

The purpose of that work is to derive the set of non-linear gyrokinetic Vlasov-Maxwell equations suitable for description of the self-consistent plasma response to the island perturbation. The gyrokinetic Ampere’s law is then used for calculation of the plasma current modification. We are deriving a set of the electromagnetically perturbed equations, which allow to treat an island as a dynamical perturbation. In previous works, a plasma response to a static island [1],[2] in the electrostatic approach has been considered.

To get a self-consistent description of a plasma dynamics modified by an island will allow to improve our understanding of island’s growth mechanism as well as review the estimation of the minimal seed size necessary for the neoclassically driven tearing instability development.

References
