Self-consistent MHD modelling of ELMs control by resonant magnetic perturbations

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In the past three years, DIII-D experiments have proven the ability of Resonant Magnetic Perturbations (RMPs) to control type I ELMs reliably [1]. Work is now underway to study the possibility of applying the same method to ITER [2]. However, the physics of ELMs control by RMPs remains not fully understood. In particular, the density pump-out caused by the RMPs is unexplained. Another open question is to know if the RMPs are modified by a plasma reaction or if they are just like in vacuum.

We present here a modelling work which attempts at understanding the physics of ELMs control by RMPs better. The plasma is modelled as a single fluid that evolves according to the resistive MHD equations, which are solved by the JOREK non-linear code [3]. The geometry is the realistic DIII-D one and the RMPs are imposed through the boundary conditions for the poloidal magnetic flux. Several effects are observed in the simulations. First of all, the RMPs are seen to cause the appearance of steady-state electric potential structures to which is associated a plasma convection by the electric drift velocity. The possibility for this mechanism to play a role in the experimentally observed pump-out is discussed. Then, scanning the bootstrap current, one finds that the plasma can enhance significantly the RMPs if the bootstrap fraction is large enough. Finally, adding toroidal rotation, a screening of the RMPs is observed if the rotation frequency is large enough, as predicted by theory [4].

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