IPP Garching Contributions to the Application and Development of the non-linear MHD code JOREK

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An overview is given over the contributions of Max-Planck-Institute for Plasma Physics in Garching to physical applications of the non-linear MHD code JOREK and its further development.

The JOREK code, originally written by Guido Huysmans at CEA Cadarache [1,2], is introduced briefly including some aspects of the numerical model, the physical equations implemented, and the steps performed in a typical simulation.

Application: In the first part of the talk, some results obtained with the code are summarized.

ELM studies were performed based on a typical ASDEX Upgrade H-mode equilibrium. On one hand, simulations with a high number of included toroidal modes are shown that reveal a poloidal and toroidal localization of perturbed structures [4]. A similar feature has been observed experimentally at the same time in ASDEX Upgrade discharges and is now called solitary magnetic perturbation [5].

On the other hand, some aspects influencing the growth rate of the modes and their structures have been studied [3]. This includes effects of the ideally conducting wall boundary conditions, of non-linear interactions between the modes, and of background profiles modified by the instability.

Development: The second part of the talk presents some contributions to the code development.

Some scripts have been written for a simplified setup of simulations. New diagnostics were created that, for instance, allow to monitor parameters of a running simulation, perform a 2D Fourier analysis of results or easily extract flux-surface averaged quantities for many different time-steps. A magnetic diagnostic allows to extract artificial Mirnov-coil signals from a JOREK simulation.

In the present version of JOREK, boundary conditions are implemented equivalent to an ideally conducting wall at the boundary of the computational domain. In contrast to that, experiments feature three-dimensional conducting structures with holes and finite resistivity. The STARWALL code [6,7] is able to solve the vacuum field equation in presence of such conducting structures and perform linear stability analysis. Both codes are now being coupled to enable non-linear simulations including resistive wall effects. The current status of the implementation and benchmarking is described [8].

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