Electromagnetic global gyrokinetic simulation for the analysis of MHD instabilities and turbulence

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Sustaining burning plasmas requires good confinement of energetic particles produced by fusion reaction and of bulk plasmas heated by these particles. In order to achieve good confinement of them simultaneously, we need to understand turbulent transport of bulk plasma and transport of energetic particles due to macro-MHD instability such as toroidal Alfven eigen-modes. The electromagnetic turbulence dominates bulk plasma transport at finite beta [1] and interacts with MHD instabilities, and their saturation levels depend on their mutual interactions [2], and thus understanding interaction between MHD instabilities and turbulence is one of the critical issues.

Our study is aim to understand MHD instabilities in burning plasmas, which are influenced by high energy particles produced from fusion reaction. In addition, we will study the MHD instabilities interacting with micro-turbulence through multi-scale nonlinear interactions. We are constructing a first principle simulation code of magnetically confined plasmas to evaluate the transport of energetic particles and of bulk plasmas simultaneously and self-consistently by means of numerical simulations of the MHD instabilities and micro-turbulence.

The code is developed by extending GKNET [3] which is a global electrostatic gyrokinetic simulation code, so that the new code is applicable to the analysis of electromagnetic instabilities. The code enables us to investigate electromagnetic drift-wave instabilities such as the electromagnetic ion temperature gradient (ITG) modes mode and electromagnetic trapped electron modes (TEM) as well as MHD instabilities such as kinetic ballooning modes (KBM) and the tearing mode. We will evaluate the transport of energetic particles and bulk plasmas due to MHD instabilities and micro-turbulence, and invesitigate nonlinear interaction between them by using the new code.

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