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Fast-ion loss simulation with MEGA code in the Large Helical Device

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The evaluation of fast-ion confinement is indispensable for the prediction of the heating efficiency in fusion reactor. The fast-ion confinement depends not only on the collisional transport but also on the fast-ion driven magnetohydrodynamics (MHD) instabilities such as Alfvén eigenmodes (AEs) which induce the fast-ion transport and losses. Therefore, it is an important issue to identify the fast-ion driven MHD instabilities and clarify the lost fast-ion distribution due to the instabilities.
In the Large Helical Device (LHD), which is one of the largest heliotron/stellarator devices with non-axisymmetric three-dimensional magnetic configuration, the fast-ion driven MHD instabilities such as the toroidal Alfvén eigenmodes (TAEs) were observed[1]. In addition, the AE-induced fast-ion losses were measured by a scintillator-based fast-ion loss detector (FILD)[2]. The relationship between the amplitude of the instabilities and the fast-ion losses are investigated.
On the other hand, since there is a toroidal dependence of fast-ion loss in the LHD even with no AE instabilities, it is difficult to achieve an overall understanding of fast-ion loss process only by the local measurements. A computer simulation is a powerful tool to investigate the interaction between fast ions and fast-ion driven AE instabilities leading to the fast-ion losses.
A hybrid simulation code for nonlinear MHD and fast-ion dynamics, MEGA, has been developed to simulate recurrent bursts of fast-ion driven AE instabilities including the fast-ion source, collisions, and losses in non-axisymmetric three-dimensional magnetic configuration like the LHD[3]. In order to validate a reproducibility of AE, the MEGA code was applied to the LHD experiment[1]. It was found that two groups of AEs with frequencies close those observed in the experiment are destabilized alternately. The alternate appearance of multiple AEs is similar to the experimental observation[3].
In order to validate the hybrid simulation on the interaction between fast ions and AEs, we apply the MEGA code to the LHD experiment with the AE-induced fast-ion losses measured by the FILD. A numerical fast-ion loss detector with Lorentz orbit (Numerical FILD) has been developed in the MEGA code. The velocity space region of lost fast-ions measured by the Numerical FILD is similar to the FILD measurements during the AE bursts. The fast-ion losses brought about by the AE bursts are proportional to the square of the AE amplitude, which reproduces well the LHD experiment. In addition, the characteristics of the AE induced fast-ion loss are clarified.

[1] M. Osakabe, et al., Nucl. Fusion 46, S911 (2006).
[2] K. Ogawa, et al., Nucl. Fusion 52 (2012) 094013.
[3] Y. Todo, R. Seki, et al., Physics of Plasmas 24, 081203 (2017).

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