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Loss and redistribution of energetic ions induced by resonant magnetic perturbations for EAST-like tokamak

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Resonant magnetic perturbations (RMPs) can be beneficial for controlling ELM activity, but they could have a detrimental effect on the fast-ion confinement, leading to increased losses and fast-ion redistribution. Many orbit codes have been used to study the energetic ion loss. A numerical code GYCAVA based on the Lie-transform perturbation method has been developed to compute the guiding-center orbits in tokamaks with general electromagnetic field perturbations [1,2]. The gyrocenter Hamilton's equations in terms of exact canonical variables are used in the code. Recently, the orbit code GYCAVA has been upgraded for evaluation of RMP-induced loss and redistribution of fast particles. A module for evaluating the loss and redistribution of fast ion has been incorporated into GYCAVA. To improve the computation efficiency, the GYCAVA code has been parallelized by using OpenMP and MPI. For different initial profiles of fast ion distribution, we have simulated the loss and redistribution of energetic passing ions with and without RMPs for EAST-like tokamak by using the GYCAVA code. Figure 1 shows that the loss fraction for different initial pitches without RMPs is almost proportional to the square root of the initial energy. This is related to the finite orbit width due to the magnetic drift. Both the direction of the parallel velocity and initial pitch can impact on the loss of energetic passing ions with and without RMPs. Figure 2 shows that the loss of energetic and thermal passing ions increases with the perturbation amplitude of RMPs. The change of the distribution of energetic passing ions in the edge is due to the loss induced by the magnetic drift and RMPs.

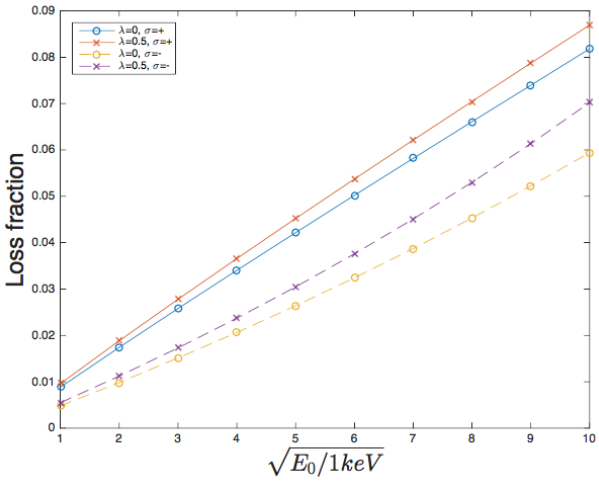

Figure 1. Loss fraction as a function of the initial energy for different initial lambdas and directions of parallel velocity without RMPs.

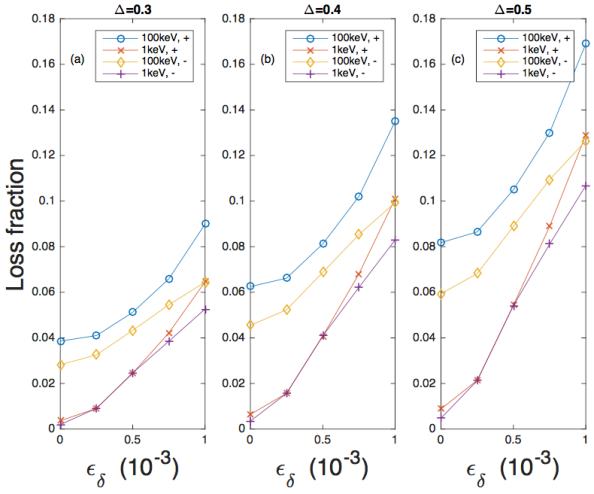

Figure 2. Loss fraction as a function of perturbation amplitude parameter for energetic ions (100keV, pitch=1) and thermal ions (1keV, pitch=1) with the profile parameter of the initial fast ion distribution chosen as $\Delta = 0.3, 0.4, 0.5$.

References

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