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# Nonlinear Interaction of Neo-classical Tearing Modes in Tokamak Plasmas

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Plasma perturbations from the core and/or boundary regions of tokamaks can provide seed islands for the excitation of neo-classical tearing modes (NTMs) with the negative linear instability parameter of the classical tearing mode. In this work, by means of reduced magnetohydrodynamic simulations, we numerically investigate the nonlinear evolution of multi-helicity NTMs in tokamak plasmas with these two types of plasma perturbations with different boundary conditions. In the first case of initial plasma perturbations from the core region with zero boundary condition, the meta-stable property of seed-island triggered NTM with negative instability parameter is verified in the single helicity simulation. In the second case of initial plasma perturbations from the boundary region with nonzero boundary condition, as the amplitude of plasma perturbations on the boundary increases, the mode with negative instability parameter gradually changes from the driven-reconnection state to the NTM state, accompanying with an enhancement of magnetic island width in the single helicity simulation. Nevertheless in the multi-helicity simulation, the spontaneous NTM can make the driven-reconnection triggered NTM transfer from the NTM state back to the driven-reconnection state again. The underlying mechanism behind these transitions is analyzed step by step. Effects of fixed and unfixed poloidal rotations on the nonlinear interaction processes are also investigated in detail in the second case. The appearance and disappearance of the magnetic stochasticity resulting from the nonlinear coupling among the multi-helicity NTMs are discussed in the second case. In addition, The effects of differential rotations and ECCD on the interaction of multi-helicity NTMs are investigated as well. The underlying mechanism behind these transitions is analyzed step by step.

References

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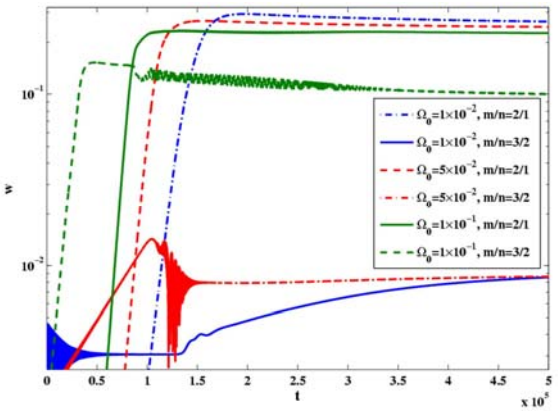


Figure 1 Interaction of 2/1 and 3/2 NTMs in the presence of poloidal rotation.

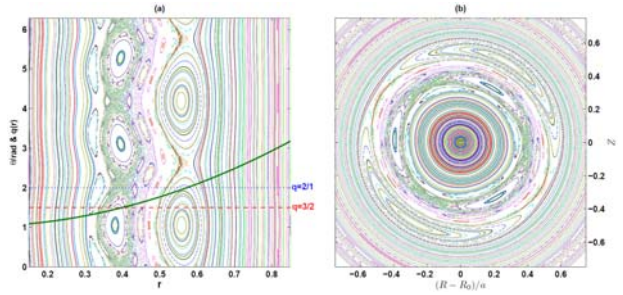


Figure 2 Poincaré plots of magnetic field lines in a poloidal cross section.