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Control of neoclassical tearing mode by synergetic effects of RMP and ECCD in reversed magnetic shear tokamak plasmas

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Synergetic effects of resonant magnetic perturbation (RMP) and electron cyclotron current drive (ECCD) on stabilizing neoclassical tearing mode (NTM) in reversed magnetic shear (RMS) tokamak plasmas are numerically investigated based on a set of reduced MHD equations. For the moderate separation, it is found that the explosive burst, as shown in figure 1, induced by the fast reconnection of double tearing mode (DTM) in the RMS configuration can be completely suppressed by externally applied RMPs. Zonal flows with strong shear induced by a rotating RMP play an important role in this suppression process. Moreover, turning on ECCD in advance is essential to mitigate the NTM. For the large separation without the explosive burst, two strategies, i.e. a continuous ECCD with static RMP and a modulated ECCD with rotating RMP, are separately investigated. It is shown that when the NTM is decelerated by a relatively slow rotating RMP, the modulated ECCD can have a better stabilizing effect. In addition, the ECCD deposition widths in both radial and helical angle directions, as well as the ECCD on-duty time, are analyzed in detail. The best effectiveness of ECCD is obtained and the relevant physical mechanisms are discussed.

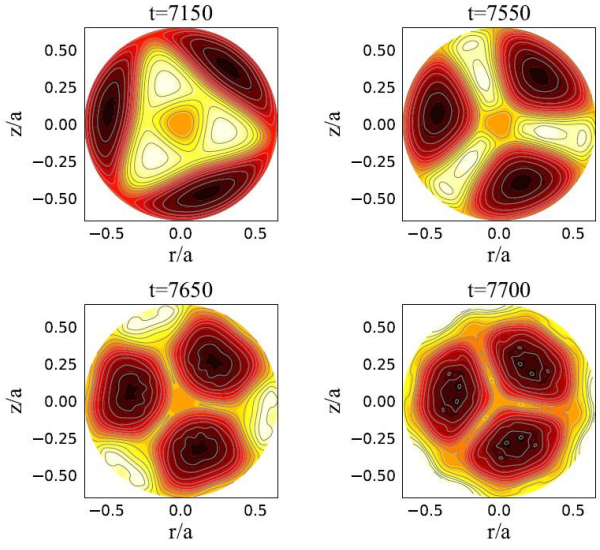

Fig 1. Contour plots of the helical magnetic flux during the explosive burst

Figure 2 gives the nonlinear evolution of the island width with the combination use of the rotating RMP and continuous/modulated ECCD. The rotating RMP is turned on first at the early stage. After the NTM is already locked to the rotating RMP, the continuous/modulated ECCD is then launched. The NTM can be partly mitigated or almost absolutely suppressed once the ECCD is applied.

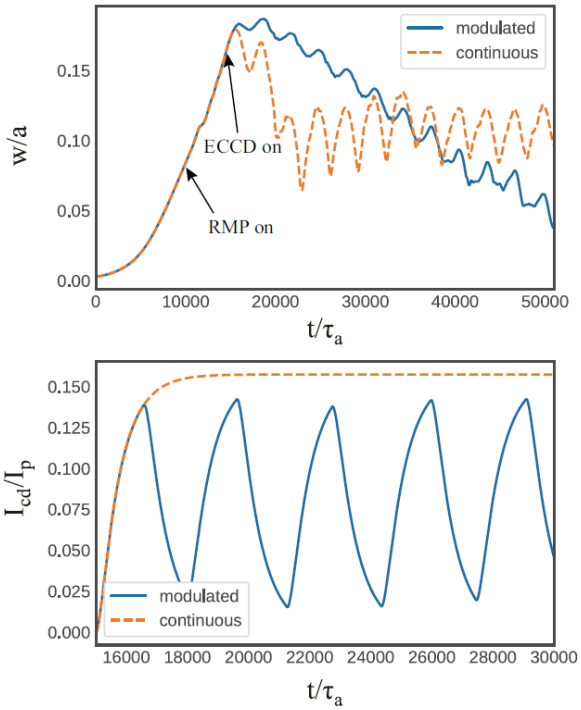

Fig 2. Comparison of the effectiveness for continuous and modulated ECCD.

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