Effect of externally applied resonant magnetic perturbations on the stability of magnetic island

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The effect of externally applied resonant magnetic perturbations (RMPs) on the stability of magnetic island is investigated based on two-fluid equations. The growth of the m/n=2/1 magnetic island (m and n are the poloidal and toroidal mode numbers), driven by an unfavorable plasma current density profile and bootstrap current perturbation, is found to be suppressed by static RMPs of the same helicity and of moderate amplitude (~ 10^{-4} of the toroidal field), if the local bi-normal electron fluid velocity at the resonant surface is sufficiently large. While without applying RMPs, the 2/1 island saturates at a width of 0.2a (a is the plasma minor radius) in the nonlinear phase even when neglecting the bootstrap current perturbation. A significant change in the local equilibrium plasma current density gradient by small amplitude RMPs is also found for realistic ASDEX Upgrade plasma parameters, which together with the diamagnetic drift and the associated ion polarization current affect the island stability. The two-fluid effects, including the electron inertia, on the island stability are found to be larger for a lower plasma resistivity and expected to be more important for a fusion reactor like ITER. Our results indicate that error field can be stabilizing for the island growth, if the error field amplitude is not too large and the local bi-normal electron fluid velocity is not too low, and that applied rotating RMPs with an appropriate frequency can be utilized to change the local plasma current density gradient around the resonant surface and to suppress the 2/1 island growth in high temperature plasmas even for a low bi-normal electron fluid velocity. It is known that the 2/1 mode can lead to significant decreases in plasma confinement or even disruptions in tokamak discharges and should be stabilized.