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Experimental Observation of Plasma Response to Resonant Magnetic Perturbation and its Hysteresis in LHD

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Dynamics of magnetic islands in helical plasmas has been studied by means of an externally imposed resonant magnetic perturbation (RMP) to clarify its effect on the MHD stability and confinement in the Large Helical Device (LHD) plasmas. It has been reported that spontaneous healing and growth of magnetic islands can be clearly separated on the space of plasma beta, collisionality and poloidal flow. The dependence on the magnetic configuration has been also reported, in which the ramping-up RMP is likely to penetrate for the low magnetic shear and mitigated magnetic hill. This study clarifies configuration effect on healing/growth transition of magnetic islands for the first time. Dynamical response of island has been investigated for various magnetic configurations with different magnetic axis position ranging $R_{ax} = 3.55 - 3.80\text{m}$. To clarify the effect originated from magnetic configuration, plasma parameters are kept approximately constant during the discharge. In case the RMP is ramped up during the discharge, the magnetic island shows healing at the beginning of the discharge. At that period, the plasma response field compensates the RMP field to shield it. When the RMP reaches a threshold, it penetrates into the plasma and makes the magnetic island. On the other hand, in case the RMP is ramped down during the discharge, the RMP initially penetrates into the plasma and makes the magnetic island. When the decreasing RMP reaches a threshold, it is shielded and the magnetic island disappears. It is observed that thresholds of the amplitude of RMP for the healing/growth transition of magnetic island depend on magnetic axis position R_{ax} . The RMP threshold increases as the magnetic axis position R_{ax} increases. Furthermore, it was found that the threshold of RMP for healing is smaller than that for growth, which means hysteresis in the critical RMP at a healing/growth transition. The magnetic island response to RMP and its hysteresis have been identified in LHD. The experimental observation shows (1) the threshold of RMP increases with the R_{ax} of the magnetic configuration. (2) The hysteresis is seen in the critical RMP at a healing/growth transition.

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