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Observations of sustained phase shifted magnetic islands from externally imposed m/n = 1/1 RMP in LHD

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New observations in LHD show that the magnetic islands externally imposed by m/n = 1/1 resonant magnetic perturbation (RMP) can be maintained in an intermediate state with a finite phase shift away from the value present in vacuum. The magnetic island is maintained with a deviated phase of around 0.3pi rad from the imposed RMP. The experimental observation implies that the plasma response can provide plasma currents that produce deviations away from the RMP's designed position and can be maintained in the unfavorable phase. Given the previous experimental observation that the saturated magnetic islands show either growth or healing, the intermediate states are realized in the "healing region"in the beta and collisionality space, which implies that the parameter except for beta and collisionality should exist in order to determine the island state. Theories based on the competition between electromagnetic torques and poloidal flow-induced viscous torques provide a prediction for the intermediate state. These two kinds of torques might be balanced to realize the steadily maintained intermediate state whereas the islands are put in growth or healing state in the case in which the balance is broken. The new finding of the intermediate state brings a distinct paradigm shift in which the magnetic island can be moved and maintained in a partial position of the phase. If the poloidal flow can be externally varied, the phase of the magnetic island can be also arbitrarily controlled, which may permit continued utilization of the island divertor concept. The experimental observation shows that there is a possibility for the magnetic island phase to deviate from its designed position. If the parameters are controlled properly, it is possible to control the phase of the magnetic island, which may permit continued utilization of the island divertor concept.

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