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Magnetic Island and Plasma Rotation under External Resonant Magnetic Perturbation in T-10 Tokamak

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The experimental comparison of the m=2 mode and plasma rotation velocities at the q=2 magnetic surface in a range of the mode amplitudes is presented in this paper. The phase velocity of the mode rotation is measured with a set of poloidal magnetic field sensors located at the inner side of the vacuum vessel wall. The plasma rotation velocity at the q=2 magnetic surface in the direction of the mode phase velocity is measured with the heavy ion beam diagnostics. In the presence of a static RMP the rotation is irregular that appears as cyclical variations of the mode and plasma instantaneous velocities. The period of these variations is equal to the period of the mode oscillations. In each period the velocities depend on the angular shift between the mode and RMP. A non-monotonic dependence of the mode rotation irregularity on the mode amplitude is observed. The rotation irregularity increases in both cases of sufficiently big and small amplitudes. In the case of big mode amplitude the rotation irregularity of the mode coincides with the rotation irregularity of the resonant plasma layer. On the contrary, the observed rise of the mode rotation irregularity in the case of sufficiently small mode amplitude is not followed by an increase of the rotation irregularity of the resonant plasma layer. It means that a decoupling between the mode and plasma rotations is observed for small islands. The experimental results are simulated with the TEAR code based on the two-fluid MHD approximation. The effects of plasma resistivity, viscosity, RMP and the current induced in the resistive vacuum vessel are taken into account. The calculated irregularities of the mode and plasma rotation depend on the mode amplitude similar to the experimental data. For large islands, the rotation irregularity is attributed to variations of the electromagnetic torque applied to the resonant layer. For small islands, the deviations of the mode rotation velocity from the plasma velocity take place due to the effect of finite plasma resistivity.

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