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Finite Toroidal Flow Generated by Resistive Wall Tearing Modes in a Toroidal Plasma

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The toroidal plasma flow, and/or flow shear, plays a critical role in affecting the macroscopic magnetohydrodynamic (MHD) instabilities (e.g. the resistive wall mode, the tearing mode, etc.) as well as the plasma confinement. A finite toroidal plasma rotation generated without external momentum input is very important for ITER, since its momentum input is expected to be small in relation to the plasma volume. In this work, it is shown that an intrinsic steady-state toroidal rotation can be generated by the neoclassical toroidal viscous (NTV) torque, which results from an unstable tearing mode(TM) in tokamak. The preliminary results show that a toroidal rotation of 17 krad/s (28 km/s) can be reached in the HL2A-like plasma. At the initial state (t=0), the plasma is static. The steady state solution is achieved in about 46ms , during which the initially unstable TM reaches saturation due to the non-linear coupling to the self-generated plasma flow. The above results indicate that a TM may give considerable contribution to the generation of the plasma flow in the absence of the external momentum input.In addition,the achieved steady-state rotation (both amplitude and the rotation profile) is insensitive to the given initial perturbation amplitude (as long as it is small), the ion/electron temperature ratio, and the distance between the resistive wall and plasma surface. On the other hand, the saturated rotation amplitude is significantly increased with increasing the plasma resistivity. We also find that the saturated rotation is much slower than that of the NTV theory predicted off-set rotation, which is comparable in magnitude to the ion diamagnetic flow speed.

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