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Co- and Counter Current Rotation in Tore Supra LHCD Plasmas: Neoclassical and Turbulent Transport Processes

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Lower hybrid (LH) wave effect on toroidal plasma rotation in L-mode Tore Supra plasmas has been analyzed in more than 50 plasma discharges, with LH input power P_LH up to 4.8MW, plasma current Ip up to 1.4MA, line integrated density n_l up to 6 × 10ˆ19m−2, B_T = 3.8T, and a significant ripple amplitude (up to 5% at the plasma boundary) which makes ripple-induced momentum non negligible. At low plasma current (Ip < 0.95 MA), the rotation change is in the co-current direction and impacts the whole rotation profile. At higher plasma current, an opposite trend is observed, the core plasma rotation incrementing in the counter-current direction, the profile being affected up to r/a < 0.6 only. In both low and high Ip cases, rotation increments are found to increase with P_LH (Fig. 1). Moreover, when Ip increases, at fixed LH power (P_LH = 4.8MW) and plasma density (n_l = 3.8×10ˆ19 m−2), the rotation increases in the counter-current direction, switching from co- to counter-current direction at Ip ~ 0.95MA. Theoretical investigations show that the rotation evolution results from the competition of different contributions. At high plasma current, the rotation evolution in LHCD plasmas is controlled by the neoclassical friction force due to the trapped ions in banana trajectories through the toroidal diamagnetic velocity. This force results in a counter-current rotation increment as observed in Tore Supra experiments. At low plasma current, the rotation is dominated by momentum turbulent transport when the LH waves are applied. The Reynolds stress grows strongly (through q profile effect) comparing to the high plasma current case, and acts as a co-current force through the residual stress contribution.

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