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Spontaneous Toroidal Rotation Profiles and Observations of Momentum Pinch in Alcator C-Mod Plasmas

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Spontaneous toroidal rotation, self-generated in the absence of external momentum input, exhibits a rich phenomenology. In Ohmic L-mode plasmas, the rotation is predominantly in the counter-current direction and varies in a complicated fashion with electron density, magnetic configuration and plasma current. In contrast, the rotation in H-mode plasmas is mainly directed co-current, and has a relatively simple parameter dependence, with the magnitude of the core velocity proportional to the stored energy normalized to the plasma current. The co-current rotation is observed to propagate in towards the center from the plasma edge following the H-mode transition, on a time scale similar to the energy confinement time. The profile shapes, determined with a new imaging x-ray spectrometer system, range from relatively flat to centrally peaked, which in the latter case is indicative of the presence of an inward momentum pinch. The velocity gradient region is typically in the outer 2/3 of the plasma. Addition of LHCD power into ICRF H-mode discharges causes the rotation profile to become hollow in the core region, suggesting that the pinch has changed sign. In pure LHCD plasmas, the rotation is strongly peaked in the counter-current direction in the central half of the plasma, with the strong gradient region near r/a=0.3, demonstrating that the momentum pinch operates on rotation in either direction. Comparisons of these diverse observations of momentum pinches will be compared with a variety of recent theories.