Abstract for an Invited Paper
for the DPP07 Meeting of
The American Physical Society

Spontaneous Plasma Rotation Scaling in the TCV Tokamak

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Predicting intrinsic plasma rotation that helps stabilize various plasma instabilities that can adversely affect the plasma performance is important for prospective fusion grade devices. ITER-like scenarios have been extrapolated from measured experimental plasma rotation data but little is understood about the underlying mechanisms governing either the generation or dissipation of momentum in a Tokamak plasma. On ITER, rotation is expected to be dominated by intrinsic plasma processes whereas most experimental observations use strong momentum injection sources such as heating Neutral Beams. With a Diagnostic Neutral Beam, driving negligible toroidal velocity, CXRS in TCV provides a high quality direct measurement of the intrinsic plasma toroidal and poloidal rotation profiles for Ohmic and EC-heated plasmas in diverted and limited configurations for a wide range of plasma shaping. The plasma behavior can be separated by the core and edge regions. For limited configurations, core counter-current toroidal rotation scales inversely with plasma current (Scarabosio PPCF 2006) and exhibits a reproducible direction inversion with a <10% rise in plasma density (Bortolon PRL 2006). In diverted configurations, a co-current toroidal velocity reverses direction with a <10% rise in plasma density. Edge toroidal rotation is strongly frictional for limited configurations whereas an edge velocity scaling with core density is observed for diverted configurations. Core toroidal momentum is strongly distributed by sawteeth but the rotation torque evolves and inverts separately from the edge. The behavior of the rotation and deduced radial electric field profiles are shown as a function of plasma shape and compared to changes in other plasma parameters.