Perpendicular Currents, Electric Fields and Rotations in Tokamaks

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It is experimentally well established that the electric field profile in tokamaks is given by the neoclassical theory in terms of the plasma density and ion temperatures profiles. The system of equations describing the evolution of the electric field and the plasma profiles accounting for electric field shear suppression of diffusivities due to turbulence yields a scenario for the L- H transition.

However, an emergence of the ergodic layer either due to the external Resonant Magnetic Perturbations or any other reason modifies the transport pattern. Parallel electric currents carried by stochastic electrons must be closed by the perpendicular currents carried by ions due to perpendicular conductivity given by the neoclassical parallel viscosity. The closure of currents results in the pump – out effect implying the flattening of the density profile, thereby contributing to the suppression of ELM´s.

Furthermore, the torque provided by the ion closure currents within the stochastic layer causes the intrinsic toroidal rotation within the entire tokamak.

The profile of the toroidal velocity is predominantly uniform in the inner regions with a pedestal that appears mostly at the edge. Hence, the main reason for the intrinsic rotation is the population of stochastic electrons.