Contribution ID: **752** Type: **Poster**

EX/2-2: A Unified Explanation of Rotation Reversals, Confinement Saturation and Non-Diffusive Heat Transport in C-Mod Ohmic Plasmas

Wednesday, 10 October 2012 08:30 (4 hours)

Recently, the connection among rotation reversals, energy confinement saturation (the transition between the LOC and saturated Ohmic confinement, SOC, regimes) and changes in underlying turbulence has been demonstrated. Examination of the rotation reversal results and a large body of confinement saturation observations suggests that there is a critical value of the collisionality where these effects transpire. Also occurring with the rotation reversals and the LOC/SOC transition is a saturation of the electron density profile peaking. These results may be unified with the following ansatz: at low collisionality in the LOC regime, the underlying turbulence is dominated by trapped electron modes and the rotation is directed co-current; at high collisionality in the SOC regime, ion temperature gradient modes prevail, the rotation is counter-current and the density profile peaking saturates. There are two other phenomena which appear to be related and occur at the LOC/SOC transition: a transformation from non-diffusive to diffusive heat transport and a change from symmetric up/down edge impurity density profiles to up/down asymmetric. Heat transport was investigated by means of rapid edge cooling from impurity injection by laser blow-off, and following the electron temperature profile evolution from electron cyclotron emission. In the high density in the SOC regime, there is 'normal' diffusive heat transport, with a drop in the core temperature lagging the edge cooling by about an energy confinement time. Also with SOC, the core rotation is counter-current, and there is a significant up/down edge impurity density asymmetry. At low density in the LOC regime, the core electron temperature increases (on a faster time scale) following the edge cooling, indicating the workings of a convective heat pinch or transient ITB. The core rotation with LOC is co-current and the edge impurity density profile is up/down symmetric. Rotation reversal, the transformation from non-diffusive to diffusive heat transport, the switch of edge impurity density profiles from up/down symmetric to asymmetric and changes in turbulence have all been observed dynamically during a single discharge with a density ramp to change the collisionality. These empirical results unify a large body of previously seemingly unrelated phenomena.

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Session Classification: Poster: P3