H-mode edge rotation in W7-AS

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In W7-AS three regimes of improved confinement exist which base on negative radial electric fields at the plasma edge resulting there from ion-root conditions of the ambipolar radial fluxes. Experimental control besides the magnetic configuration is given via the edge density profile i.e. the recycling and fuelling conditions. However, the ordering element seems to be the radial electric field profile (respectively its shear) and its interplay with the gradients of ion temperature and density.

At low to medium densities the so called optimum confinement regime occurs with maximum density gradients located *well inside the plasma boundary* and large negative values of E_r extending deep in the bulk plasma. For a large inner fraction of the bulk the ion temperature can be sufficiently high that ion transport conditions already can be explained by neoclassics. This regime delivers maximum values of T_i , τ_e and $n \tau_e T_i$.

Density gradients located *right inside the plasma boundary* result in the classical H-mode phenomena reminiscent to other toroidal devices with the capability of an edge layer with nearly complete suppression of turbulence either quasi stationary (in a quiescent H-mode) or intermittently (in between ELMs).

At even higher densities and highly collisional plasmas with the maximum of ∇n shifted to or even *out of the plasma boundary* the High Density H-mode (HDH) opens access to steady state conditions with no measurable impurity accumulation.

These improved confinement regimes are accessed and left via significant transitions of the transport properties albeit these transitions occur on rather different timescales.

A comprehensive picture of improved edge confinement regimes in W7-AS is drawn based on the assumption that a weak edge bounded transport barrier resulting from the ion root conditions (thus E_r <0) is the ground state of the (turbulent) edge plasma and already behaves as a barrier for anomalous transport. On top of that the classical H-mode develops as an additional spin-up of $E \times B$ rotation with the capability for a sudden and nearly complete suppression of transport carrying turbulence.