Two-phase L-H transitions in unfavorable configurations in Alcator C-Mod

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In the 'unfavorable' configuration, with the ion B×∇B drift pointing away from the active x-point, it is well known that the power threshold for the L-H mode transition is higher than with the 'favorable' configuration with drifts toward the x-point. The edge temperature and gradients have also been found on several experiments to be higher. Flow and rotation measurements on C-Mod have suggested that this difference may be related to a dependence of SOL flows on magnetic configuration[1]. We report here on recent observations of the edge profiles and fluctuations in the phase leading up to, and during, the L-H transition. Edge electron and ion temperatures begin to rise well (> 100 ms) before the transition in density, and the classic D_α drop, often showing a 'break-in-slope' about 30 ms ($\sim\tau_E$) before the L-H transition. Strong T_e and p_e gradients develop in this period, with $\nabla P_e/n_e$ reaching -200 keV/m over the outer 2-3 mm of the plasma; power balance analysis confirms significant decreases in thermal conductivity. At the same time, subtle changes in broadband fluctuations occur. These are most clearly observed by magnetic probes, with fluctuations decreasing in the 50-100 kHz band. The causality and origin of these changes is not yet clear. Enhanced measurements of the plasma rotation and electric field may help to understand these effects. This transition regime will be compared with those observed elsewhere, including the broadly similar 'improved L-mode' on ASDEX Upgrade[2], and the 'IM-mode' on DIII-D[3]. Most importantly, it is hoped to stimulate discussion of what these slow, 'two-phase' transitions, in which the particle and energy transport channels appear to respond differently, reveal about the mechanism for the L-H transition and the origin of the configuration dependence.

[1] B. LaBombard, J. E. Rice, A. E. Hubbard, J. W. Hughes, et al, Phys. Plasmas **12** 056111 (2005).
[2] F. Ryter, W. Suttrop, B. Brusehaber *et al*, Plasma Phys. Control. Fusion **40**, 725-729 (1998).
[3] R. J. Colchin, M. J. Shaffer, B. A. Carreras *et al*, Phys. Rev. Lett. **88** (25), 255002-1 (2002).