High confinement modes with radial structure

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Since the discovery of the L to H transition, several theoretical models have been proposed. These models involve various mechanisms for the creation of transport barriers including ion orbit losses, critical gradients, Reynolds stress, magnetic shear, and atomic physics. Due to the lack of sufficiently high spatial and temporal resolution, it is difficult to have a clear experimental test to select the dominant mechanisms responsible for the transition. However, recent C-mod experimental results using ECE temperature measurements offer the possibility of improved diagnostics with increased radial resolution during and after the transition [1]. Motivated by this, in this presentation we investigate the radial structure of high confinement modes in the context of phase transition models. In a previous publication [2] we discussed the spontaneous formation of shear flows with nontrivial radial structure in a flow-fluctuation model. By spontaneous we mean that, in this model the radial structures arise as nonlinearly saturated finite-k instabilities, and not as a result of externally imposed inhomogeneities. Here we incorporate to the two-fields model a transport equation for the pressure with the corresponding coupling to the fluctuations via a pressure gradient drive [3]. Of particular interest is the study of pedestal formation resulting from the plasma self-organization driven by the self-consistent interaction of fluctuations, shear and pressure gradients. The model describes the plasma edge with an energy flux coming from the core, which is used as a boundary condition for the pressure transport equation. As the energy flux increases, there is an L-H transition bifurcation which is described near marginal instability using a reduced Ginzburg-Landau model for the shear flow coupled to a transport equation for the pressure. For higher values of the energy flux, a second transition takes place in which the H mode exhibits a finite-k instability. Numerical results show that this instability leads in the nonlinear regime to the spontaneous formation of a pedestal in the pressure profile, where the effective diffusivity exhibits a sharp drop. A further increase of the energy flux leads to multiple pedestals across the simulation domain.

[1] Hubbard A.E, B.A. Carreras, N.P. Basse, D. del-Castillo-Negrete, et. al.,accepted for publication in Plasma Phys. Control. Fusion (2004).
[2] del-Castillo-Negrete D., and B.A. Carreras, Phys. Plasmas, **9**, 118, (2002).
[3] del-Castillo-Negrete D., B.A. Carreras, and V.E. Lynch, submitted to Plasma Phys. Control. Fusion (2004).