The connection between microscopic turbulence and large scale dynamics in L-H and L-I transitions in Alcator C-Mod

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Transitions of tokamak confinement regimes are studied on Alcator C-Mod using gas-puff-imaging (GPI) with a focus on the interaction between the edge drift-turbulence and the local shear flow. Results from the L-to-H transition show that the nonlinear turbulent kinetic energy transfer rate into the shear flow reaches the estimated drift turbulence growth rate just as the turbulence is suppressed in the transition. The net energy transfer is quantitatively compared to the loss of turbulence power and is found sufficient to explain the observed change. A corresponding amount of growth is recorded in the shear flow kinetic energy. Thus a lossless kinetic energy conversion mechanism is shown to mediate the transition into H-mode. The edge pressure gradient is inferred with a fine time resolution and shown to build later and on a slower (1 ms) timescale as it locks in the H-mode state. The result unambiguously establishes the time sequence of the L-H transition: first the the normalized Reynolds power develops, then the turbulence collapses, and finally the diamagnetic electric field shear forms. The I-mode is characterized by a decoupling of heat and mass transport channels such that a relaxed density profile remains while the plasma develops a clear temperature pedestal [1]. Results from this regime proceed from our previous study [2] which found geodesic-acoustic modes (GAM) to play a significant role in shaping the edge turbulence of the regime, while exhibiting a drive–damping characteristic that is expected to scale similarly to the L-I threshold in macroscopic parameters. New analysis of the L-to-I and I-to-H transitions is carried out in a time-resolved sense analogously to that of the L-H transition, clarifying the role of GAM in changes to the broadband, low-frequency component of the edge turbulence. Parametric dependences of the I-mode onset are compared to these results.

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[2] I. Cziegler et al, *Phys. Plasmas* **20**, 055904 (2013)