Gyrokinetic simulation of a fast L-H bifurcation dynamics in a realistic diverted tokamak edge geometry[a)]

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Despite its critical importance in the fusion program and over 30 years of H-mode operation, there has been no fundamental understanding at the kinetic level on how the H-mode bifurcation occurs. We report the first observation of an edge transport barrier formation event in an electrostatic gyrokinetic simulation carried out in a realistic C-Mod like diverted tokamak edge geometry under strong forcing by a high rate of heat deposition. The results show that the synergistic action between two multiscale dynamics, the turbulent Reynolds-stress driven [1] and the neoclassical X-point orbit loss drive [2] sheared ExB flows, works together to quench turbulent transport and form a transport barrier just inside the last closed magnetic flux surface. The synergism helps reconcile experimental reports of the key role of turbulent stress in the bifurcation [3] with some other experimental observations that ascribe the bifurcation to X-point orbit loss/neoclassical effects [4,5]. The synergism could also explain other experimental observations that identified a strong correlation between the L-H transition and the orbit loss driven ExB shearing rate [6]. The synergism is consistent with the general experimental observation that the L-H bifurcation is more difficult with the ∇B-drift away from the single-null X-point, in which the X-point orbit-loss effect is weaker [2].

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