# L/H transitions and Limit Cycle Oscillations From Mean Field Momentum Transport Equations*

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The momentum transport of the mean field (i.e. low frequency compared to the turbulence) ExB toroidal and ion poloidal velocities are modeled with both collisional and turbulent contributions to the transport equations. The radial and temporal evolution of the edge barrier is modeled. It will be shown that there are both normal one-step L/H transitions to suppressed turbulence and newly discovered limit cycle oscillations (LCO), from this two dimensional system. The results of the new model will be compared with recent high resolution measurements of L/H transitions and limit cycle oscillations, or dithering transitions, which have given unprecedented detail of the dynamics and spatial structure of the plasma velocities and turbulence. The properties that govern which type of transition occurs in the 2-D momentum equations are the collisional poloidal velocity damping force and the Reynolds force (radial derivative of the Reynolds stress). Over a range of ExB velocity shear, the effective momentum diffusivity due to the turbulence is negative, which provides the drive for the instability of the equilibrium. The linear stability of the two dimensional momentum equations admits purely growing and finite frequency instabilities that give rise to the LCO. A distinct characteristic of the limit cycle oscillations is that the poloidal velocity and toroidal ExB velocity contributions to the parallel fluid velocity oscillate with opposite relative signs. The phase shift between the density fluctuation amplitude of the turbulence and the ExB velocity shear can vary depending on the evolution on the linear growth rate of the turbulence. The density dependence of the H-mode power threshold is consistent with the model. The new momentum transport modeling has a mean field ExB velocity and a poloidal velocity that departs from neoclassical values due to the high momentum transport driven by the turbulence. In the H-mode barrier region, the modeling gives mean field ExB and ion poloidal velocities that approach neoclassical levels. These properties compare well with the measured radial structure of the L and H-mode plasmas.

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