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Gyrocenter shift and H-mode transition

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Since the first observation of the H-mode, there has been much experimental and theoretical work studying the role of boundary neutrals on the L-H transition. In addition, it is believed that turbulence suppression due to ErxB shear can also play an important role in the L-H transition, despite a lack of complete understanding of the origin of the radial electric field. The gyrocenter shift of thermal ions is the basis of a theoretical model that connects these two problems of L-H transition theory: the role of neutrals and the origin of the radial electric field. The radial gradient of the charge-exchange microscopic reaction rate of thermal ions in the presence of a neutral density gradient gives rise to a radial force. This force in turn gives rise to a radial current and electric field, which can be computed by taking the average of the ion velocity at the time of the charge-exchange reaction averaged over the gyromotion. This model can be applied to the interplay between the neutral density gradient and the plasma density gradient, which affects neutral penetration. This paper will integrate the details of the theory and related neoclassical effects with a neutral transport calculation in order to develop a time-dependent picture of the L-H transition, specifically for NSTX. Calculations of the radial electric fields based on this theory show good agreement with experimental results from NSTX and DIII-D.