Edge E_r Structure and the ∇B Drift Effect on the L-H Transition*

T.N. Carlstrom,[1] J.A. Boedo,[2] K.H. Burrell,[1] R.J. Colchin,[3]
R.J. Groebner,[1] A.W. Leonard,[1] R.A. Moyer,[2] T.H.Osborne,[1]
D.M. Thomas,[1] and M.J. Schaffer[1]

[1]*General Atomics, P.O. Box 85608, San Diego, California*
[2]*University of California, San Diego, California*
[3]*Oak Ridge National Laboratory, Oak Ridge, Tennessee*

For many years, experimentalist have searched for a critical edge parameter at the L-H transition by slowly raising the input power until a transition occurred. Since many plasma parameters are correlated with the input power, it is difficult to identify parameters that are changing due to power balance from those that may be related to the L-H transition. We have adopted a different approach by changing the proximity to the L-H threshold while keeping the input power constant. In DIII–D, the H–mode power threshold changes from approximately 1 MW when the ion ∇B drift is toward the X–point, to over 5 MW when the ion ∇B drift is away from the X–point. By comparing plasma conditions at fixed power for both directions of the ion ∇B drift direction, we can more clearly identify conditions related to the transition and not just those associated with power balance.

Measurements of the edge E_r from charge exchange recombination spectroscopy (CER) and Langmuir probe measurements indicate that for low power L–mode plasmas, E_r changes sign when the toroidal field direction is changed. The L–mode edge E_r is positive at 5–10 keV/m when the ion ∇B drift is toward the X–point, and is negative at about the same value when the ion ∇B drift is away from the X–point. At fixed power, all the other measured edge parameters, including the edge temperature, the temperature gradient, the density, and the density fluctuation level, remain approximately the same. Therefore, the sign and structure of E_r may be important in determining the power threshold. These results also indicate that additional physics, other than those involving the local edge profiles of n_e, T_e and T_i near the plasma midplane, are needed to describe the L-H transition.

We also find that changes in the power threshold are correlated with changes in the plasma conditions near the X–point and divertor region. When the ion ∇B drift is toward the X–point, we find a larger electron density just below the X–point, a larger electron temperature along the outer divertor leg, and a larger electron pressure above the X–point than when the ∇B drift is away from the X–point. Physics associated with the X–point region may play a key role in determining the edge E_r and the H–mode power threshold.

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