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ITR/P1-37: A Model for the Power Required to Access the H-mode in Tokamaks and Projections for ITER

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We describe a new model for the L-H transition which, in common to other models, determines the physics requirements to stabilize turbulent transport by ExB shear but also derives the required edge power flow to achieve these physics requirements. Plasma transport in the L-mode plasma edge (typically from Psi = 0.95 to 1.0 is assumed to be dominated by resistive ballooning turbulence. Because of the access of an H-mode transport barrier, the scale length of the edge plasma density (Ln) is expected to be set by ionization balance and to be smaller than that of the temperature (LT). The power out flux from the core plasma is transported through the edge by conduction, convection and part of it is also radiated by impurities in this edge region before reaching the separatrix. Under the assumptions of dominant resistive ballooning transport the edge power balance is derived.

Suppression of resistive ballooning transport is assumed to occur when the ExB rotational shear exceeds the typical autocorrelation time of the turbulence. This condition is used to evaluate the H-mode power threshold. It is shown that the H-mode power threshold for the existing tokamaks found to be in reasonable agreement with the measurements and predictions for ITER is shown. Power threshold can also be used to identify the physics processes leading to the increase of the H-mode threshold at low density: a) the scale length of density profile becomes longer than that of the temperature and b) the ratio of ion to electron temperature decreases for electron heated plasmas because of the inefficiency of equipartition at these densities as found in experiments.

Country or International Organization of Primary Author

India

Primary author: Mr SINGH, Raghvendra (India)

Co-authors: Dr LOARTE, Alberto (ITER Organization); Dr CAMPBELL, David (ITER Organization); Prof. BORA, Dhiraj (ITER Organization); Dr NORDMAN, Hans (Department of Earth and Space Sciences, Chalmers University of Technology, SE-412 96 Gotebörg, Sweden); Prof. KAW, Predhiman (Institute for Plasma Research)

Presenter: Mr SINGH, Raghvendra (India)

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