Justification of the model for H-mode pedestal and ELMs

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Abstract

A model for the H-mode pedestal and for the triggering of Edge Localized Modes (ELMs) is presented. The model predicts the height, width, and shape of the H-mode pedestal and the frequency and width of ELMs. The model for the H-mode pedestal in tokamak plasmas is based on flow shear reduction of anomalous transport. While the simple model based on the shear flow suppression of the ITG turbulence has been tested before [1, 2], the new model takes into account the fact that different instabilites are suppressed by the flow shear at different rates. In this model, the ion temperature gradient mode, resistive ballooning mode, trapped electron mode, and electron temperature gradient mode have individual flow suppression functions. Turblence driven by these modes contribute to the anomalous thermal transport at the plasma edge. Formation of the pedestal and the L-H transition is the direct result of $E_r \times B$ flow shear suppression of anomalous transport in this model. The periodic ELM crashes are triggered by MHD instabilities. Two mechanisms for triggering ELMs are considered. ELMs are triggered by ballooning modes if the pressure gradient exceeds the ballooning limit or by peeling modes if the edge current density exceeds the peeling mode criterion. The effects of ELM crashes on the H-mode pedestal profiles are discussed. The models for the pedestal and ELMs are used in the ASTRA integrated transport code to follow the time evolution of tokamak discharges from L-mode through the transition from L-mode to H-mode, with the formation of the H-mode pedestal, and, subsequently, to the triggering of ELMs. The reference scenario is based on a DIII-D discharge. Scans with heating power, magnetic field, and plasma density are presented. The resulting dependences are compared with the experimental observations.

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[2] G. Janeschitz, G. W. Pacher, O. Zolotukhin, G. Pereverzev, H. D. Pacher, Y. Igitkhanov, G. Strohmeyer, and M. Sugihara, Plasma Phys. and Controlled Fusion **44**, A459 (2002).