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Advancing the predictive capability for pedestal structure through experiment and modeling[1]

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Prospects for predictive capability of the edge pedestal in magnetic fusion devices have been dramatically enhanced due to recent research, which was conducted jointly by the US experimental and theory communities. Studies on the C-Mod, DIII-D and NSTX devices have revealed common features, including an upper limit on pedestal pressure in ELMy H-mode determined by instability to peeling-ballooning modes (PBMs), and pedestal width which scales approximately as $\beta_{\mathrm{pol}}^{1/2}$. The width dependence is consistent with a pedestal regulated by kinetic ballooning modes (KBMs). Signatures of KBMs have been actively sought both in experimental fluctuation measurements and in gyrokinetic simulations of the pedestal, with encouraging results. Studies of the temporal evolution of the pedestal during the ELM cycle reveal a tendency for the pressure gradient to saturate in advance of the ELM, with a steady growth in the pedestal width occurring prior to the ELM crash, which further supports a model for KBMs and PBMs working together to set the pedestal structure. Such a model, EPED, reproduces the pedestal height and width to better than 20% accuracy on existing devices over a range of more than 20 in pedestal pressure. Additional transport processes are assessed for their impact on pedestal structure, in particular the relative variation of the temperature and density pedestals due, for example, to differences in edge neutral sources. Such differences are observed in dimensionlessly matched discharges on C-Mod and DIII-D, despite their having similar calculated MHD stability and similar edge fluctuations. In certain high performance discharges, such as EDA H-mode, QH-mode and I-mode, pedestal relaxation is accomplished by continuous edge fluctuations, avoiding peeling-ballooning instabilities and associated ELMs. Progress in understanding these regimes will be reported.

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