Gyrokinetic Constraints In Tokamak Pedestals

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We find the pedestal width-height scaling [0] for multiple tokamaks using a new kinetic ballooning mode (KBM) gyrokinetic threshold model [1]. At tight aspect ratio, we reproduce NSTX's experimental linear pedestal width-height scaling for ELMy H-modes [2], overcoming previous issues with tight aspect ratio pedestal prediction [3]. We reproduce the square root pedestal width-height scaling [0] at regular aspect ratio for previously published DIII-D discharges [4]. Our model uses EFIT-AI [5] to calculate global equilibria with self-consistent bootstrap current and can be applied to any H-mode equilibria. For ELMy NSTX discharges, KBM physics is needed to match the experimental data: we find that infinite-n MHD stability overpredicts pedestal pressure and underpredicts pedestal width. In addition to device-specific results, we report the effect of aspect ratio and plasma shaping on width-height scalings, showing the dependence on various shaping parameters [6]. Combined with peeling ballooning mode (PBM) stability [7,8], our model will calculate a maximum inter-ELM pedestal width and height based on KBM and non-ideal PBM stability. Finally, we incorporate heat and particle transport physics into our stability model, showing how transport can change significantly near the KBM stability boundary [9]. This work is an important step towards a unified predictive capability of pedestal stability and transport for tokamak equilibria across a range of operating space.

This work was supported by US Department of Energy Contract No. DE-AC02- 09CH11466.

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