Ballooning limit of spherical tokamak pedestals using a novel Gyro-Fluid System model

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Abstract

The EPED model [1] had success in describing type-I ELM and QH mode pedestals in conventional tokamaks, by combining calculated peeling-ballooning (PB) and kinetic ballooning mode (KBM) constraints. The KBM constraint, calculated via the ballooning critical pedestal (BCP) technique [1], takes an approximate form $w_{ped} \sim c_1\left(\beta_{p,ped}\right)^{c_2}$, with $c_1 \sim 0.07 - 0.10$ and $c_2 \sim 0.5$ [2] at moderate aspect ratio. However, it is both experimentally observed, and calculated via BCP, that typical values of c_1 and c_2 are higher at low aspect ratio [2][3][4]. It has also been noted that quantitative differences between local MHD and gyrokinetic (GK) ballooning stability can be larger at low aspect ratio [5]. KBM critical pedestals (including kinetic effects) are consistent with observation in initial studies on conventional and spherical tokamaks.

In this work, the application of a reduced model for the calculation of the ballooning stability boundary is presented based on a novel and newly developed Gyro-Fluid System (GFS) [6]. The impact of geometry and impurities is examined and compared to MHD ballooning stability. The geometry affects the ballooning stability due to its effect on the bad/good curvature region and trapped particle contribution, while impurities have an impact on the pedestal temperature. The applicability of the model is examined on NSTX-like pedestals. GFS is observed to capture kinetic ballooning modes and the wide pedestal scaling of NSTX opening the route for the integration of this reduced model to EPED.

References

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