# A reduced transport model for microtearing modes in tokamak H-mode pedestal

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In magnetic confinement fusion research, the prediction of turbulent transport tokamak edge plasma and its effect on fusion devices operation is crucial in the determination of the confinement properties. In order to understand the causes and the evolution of the electron heat transport in tokamak discharges a quasilinear transport model has been developed for use in integrated predictive modeling studies. Analysis of conventional tokamak plasmas [1] suggests that small-scale instabilities localized near the rational surface, such as microtearing modes (MT), have a significant effect on confinement in tokamak. MT draws on the electron temperature gradient as a free-energy source and rearranges magnetic topology through the creation ion-Larmor-radius-scale magnetic islands and thereby playing some role in determining the pedestal characteristics.

The stability of MT modes has been extensively studied theoretically, showing that a slab current sheet is stable in the absence of collisions [2]. Here, we develop a reduced kinetic transport model for MT, using an electromagnetic quasilinear theory, in order to evaluate the parametric dependencies of MT and determine new saturation rules. This reduced model is a derivation of a current sheet model by solving the Vlasov and Maxwell equations and its evaluation inside the resistive layer is obtained from a system of two equations linking the vector potential and the electric potential. This system of equations is solved numerically using an eigenvalue code. This reduced transport model is tested and compared with gyrokinetic simulations using JET experimental data showing a good agreement. Analysis of nonlinear gyrokinetic simulations shows that this quasilinear transport model for microtearing transport reproduces gyrokinetic trends for a variety of parameter regimes. The impact of the electric potential on nonlinear saturation is examined using this simplified model. The electric potential plays a key role in microtearing destabilization by boosting the growth rate of this instability in the presence of collisions. Instability and saturation physics are examined for different pedestal cases and radial positions, with a special focus on the role of electric field fluctuations and the role of zonal flows and fields. In the saturated state, it is found that removing electrostatic fluctuations causes a flux increase, whereas linearly stabilization had been observed. This is consistent with a change in saturation mechanism from temperature corrugations to zonal-field and zonal-flow based energy transfer. After the determination of a new saturation rule, the quasilinear heat fluxes calculated by Solve AP will be directly compared with gyrokinetic simulations. In future work, this model will be coupled to a neural network for sweeping parameter scans, working towards real-time transport modeling in particular of the tokamak pedestal.

## References

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