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BOUT++ nonlinear simulation of divertor heat flux profile width in DIII-D discharges

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Based on the experimental data base from DIII-D quasi steady inter-ELM period, we conducted BOUT++ simulations for a plasma current scan to understand the underlying physics of the parallel heat flux width. The linear BOUT++ simulations suggest the two dominant modes at different radial locations: resistive ballooning modes peak at the largest pressure gradient (∇P) and drift-Alfven wave (DAW) modes peak at the largest inverse electron pressure gradient scale length ($1/L_{pe}$). From the frequency and k_θ spectrum in the nonlinear stage, a quasi-coherent mode, near the separatrix at the normalized $\psi = 1.0$, is found. The parallel electron heat fluxes onto the target from the BOUT++ simulations of DIII-D, EAST and C-mod follow the experimental heat flux width scaling of the inverse dependence on the poloidal magnetic field with an outlier. The simulated radial electron heat turbulent transport coefficients on the separatrix at the outer mid-plane are inversely proportional to poloidal magnetic field, which provides a simple explanation to the experimental scaling law. However, the parallel electron heat fluxes only qualitatively match the experimental measurements with a factor of 3 higher amplitudes for all three cases. Possible reasons are: (1) the lack of radiative energy losses and (2) the choice of flux-limiting parameter α_j. The statistical analysis of the fluctuation suggests the blobs are generated by the resistive-ballooning modes inside the separatrix at peak pressure gradient position. As these blobs *propagate* outward into the low density region through the DAW zone, they will pick up suitable characteristics of DAW and capture the DAW phase between fluctuating potential and temperature.

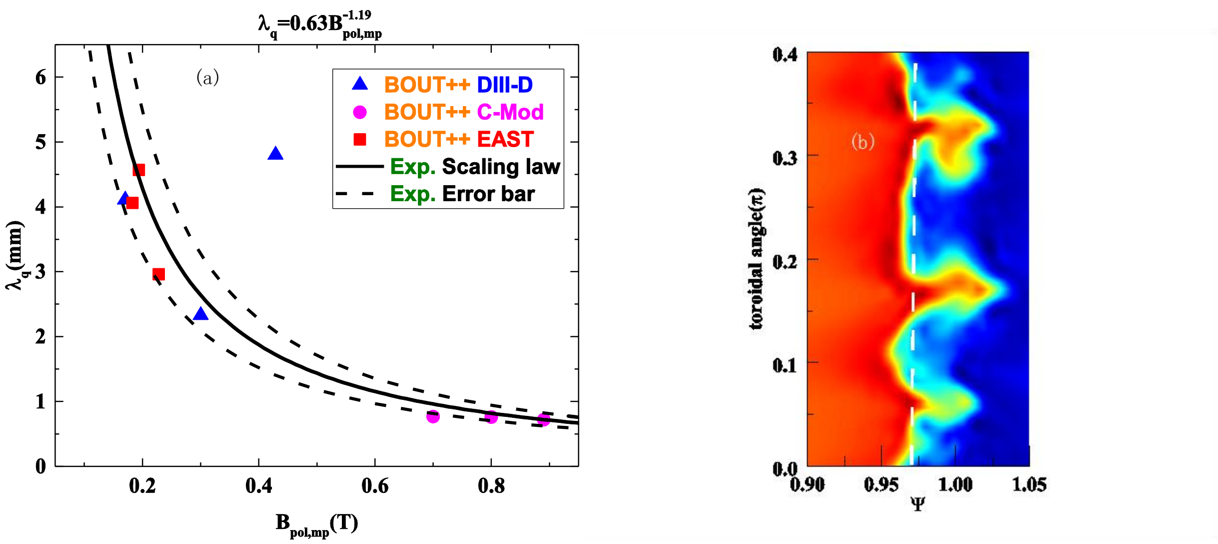

Fig. (a) the simulation results versus the experimental scaling law; (b) the DAW type blobs