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NSTX-U

Simulated heat transport in NSTX via CAE- & GAE-induced electron orbit modification

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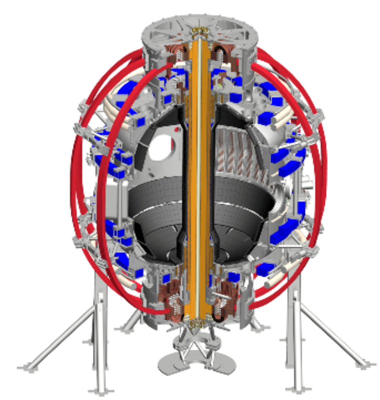
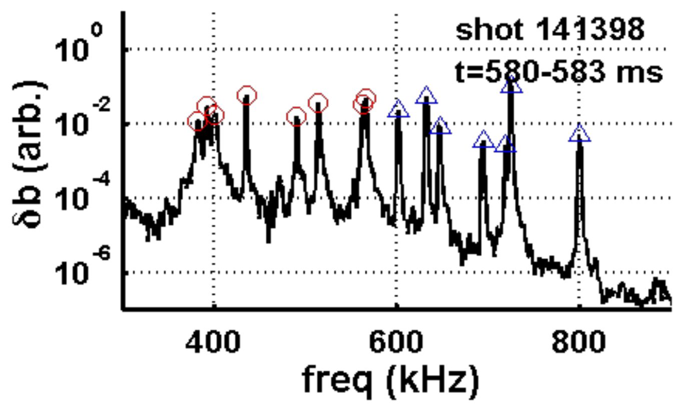
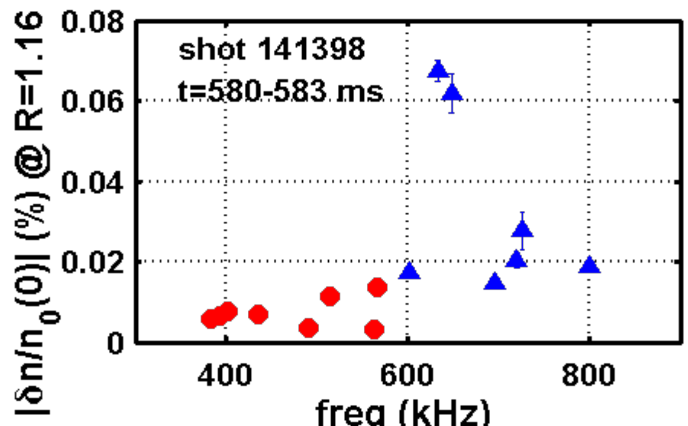
PPPL

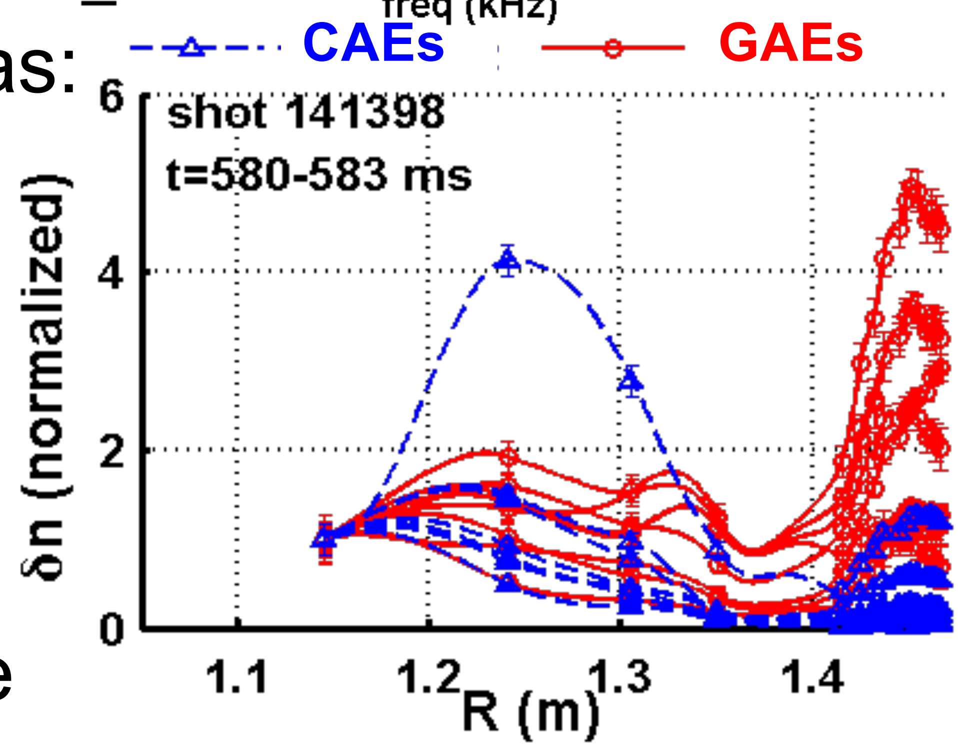


Structure and amplitude of CAE & GAE δn measured in high performance plasma





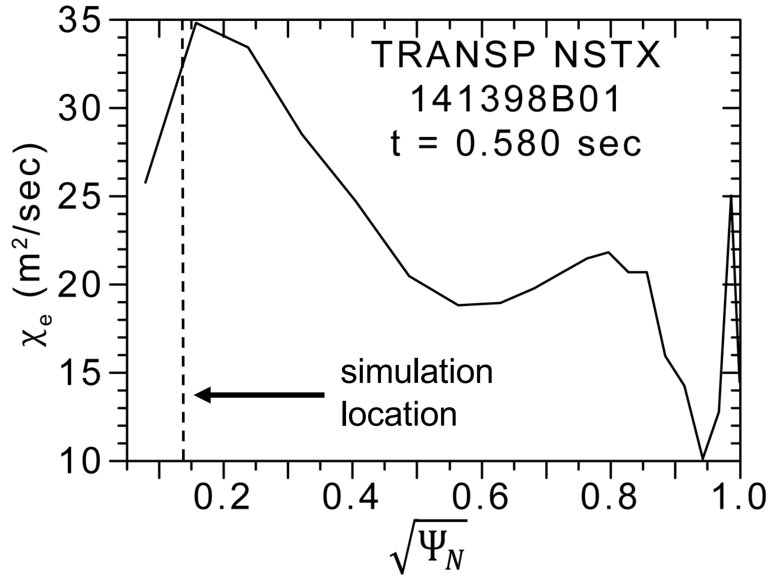
- Observed modes identified as:
  - GAEs: *f < ~ 600 kHz, n = -6 – -8*
  - CAEs: *f > ~ 600 kHz, n = -3 – -5*



- CAEs have larger δn in core
- GAEs have larger δn in edge

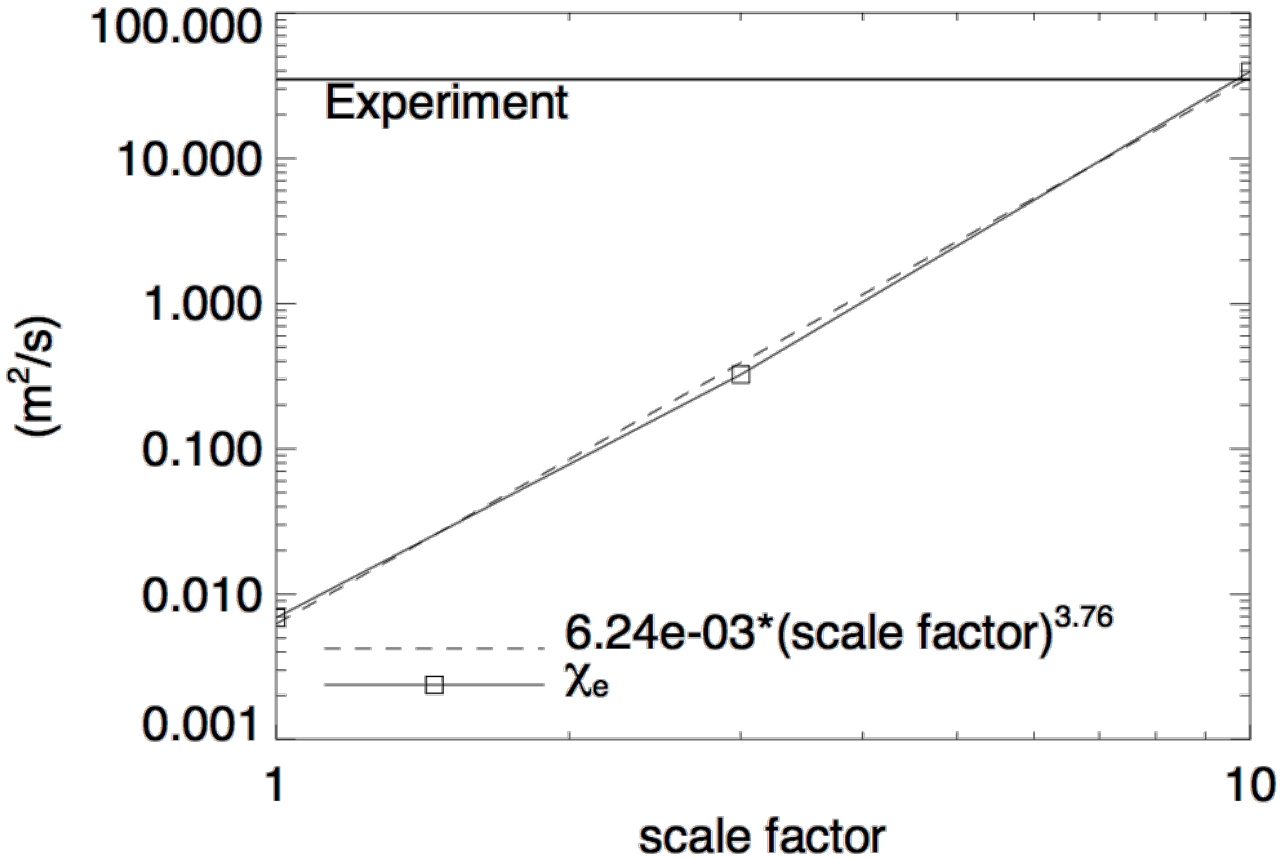
χ_e from GAEs simulated for 6 MW H-mode 141398, t = 0.58 sec

- Anomalous core χ_e (~ 35 m^2/s) in 6 MW H-mode (141398, t = 0.58 sec)
- e^- guiding center orbit spreading simulated by ORBIT => χ_e
  - initial population isotropic thermal (T_e = 1 keV) at $\Psi_N^{1/2}$ = 0.15
  - B-field from experiment (B_{T0}=0.45 T)
  - collisionless
  - spreading => D_e, $\chi_e = \frac{3}{2} D_e$
- 8 GAEs
  - ξ_{rms} ~ 0.4 mm
  - $\omega = k_{||} V_A$ => |m| = 0 – 2
  - poloidal+toroidal Fourier modes used



f (kHz)	*n*	*m*	*ξ* (mm)
383	-8	-2	0.1
393	-7	-1	0.11
401	-8	-2	0.13
436	-7	0	0.12
491	-8	0	0.06
515	-7	1	0.21
563	-6	2	0.05
567	-8	1	0.25

χ_e from GAEs in simulation much less than from TRANSP



- χ_e<< 1 m^2/s at experimental amplitude, ξ_{expt}
- scaling study shows χ_e sensitive to amplitude: $\chi_e \propto \xi^{3.76}$
- need ξ = 10*(ξ_{expt}) for agreement with TRANSP

Inclusion of CAEs as shear modes increases simulated χ_e, but still not enough

- 7 CAEs (15 CAEs+GAEs)
- δn typically much larger for CAEs => much larger ξ need to explain δn
  - ξ_{rms} ~ 1.8 mm (1.9 mm CAEs+GAEs)
- *m* typically much larger for CAEs when $\omega = k_{||} V_A$ assumed
  - $\omega = k_{||} V_A$ => |m| = 4-10
- χ_e = 8 m²/s at $\xi_{\text{expt,CAE+GAE}}$
  - expect 2 m²/s from just GAEs at comparable ξ_{rms}
    - higher $k_{||}$ (or higher *m*) => more effective at breaking adiabatic constants of motion?
    - more modes = more stochastic?
- χ_e = 39 m²/s ~ $\chi_{e,\text{expt}}$ at 3*($\xi_{\text{expt, CAE+GAE}}$)

f (kHz)	*n*	*m*	ξ (mm)
602	-5	4	0.31
633	-4	5	1.23
648	-1	8	1.05
695	-5	5	0.26
720	0	10	0.36
726	-3	7	0.57
800	-4	7	0.32

Future Work

- Implement more physically realistic poloidal strucuture
- CAEs need to be included as compressional modes
  - compressional modes not fully implemented
  - ORBIT is currently being modified
- Simulation with eigenmodes from codes
  - HYM, CAE3B, CAE

UCLA reflectometers operational on NSTX-U

- Example: phase fluctuations ($\propto \delta n$), 42.5 GHz reflectometer, 204636
  - (a) 0 – 3 MHz
    - GAEs at ~ 1.8 MHz
  - (b) 0 – 200 kHz.
    - TAEs and other MHD