Analysis of magnetic perturbation in BOUT runs for NSTX

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Magnetic perturbation in BOUT turbulence simulations comes from fluctuating $j_{||}$

- $\nabla_{\perp}^{2} A_{||} = -\frac{4\pi}{c} j_{||}$ **=> no $\delta B_{||}$ is kept in BOUT model**

- **Magnetic perturbation is important for theoretical understanding of regimes of turbulence**

- **Magnetic perturbation induces anomalous transport**

$$\Gamma_r = \left\langle \tilde{\Gamma}_{||} \tilde{b}_r \right\rangle, \qquad q_r = \left\langle \tilde{q}_{||} \tilde{b}_r \right\rangle$$

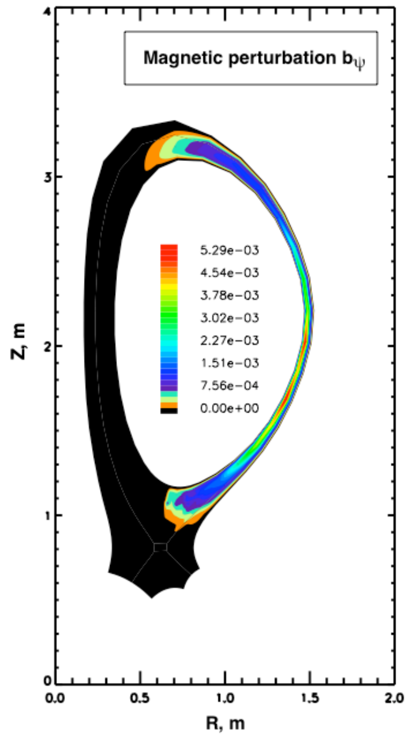
Magnetic perturbation computational data are analyzed for recent BOUT runs for NSTX

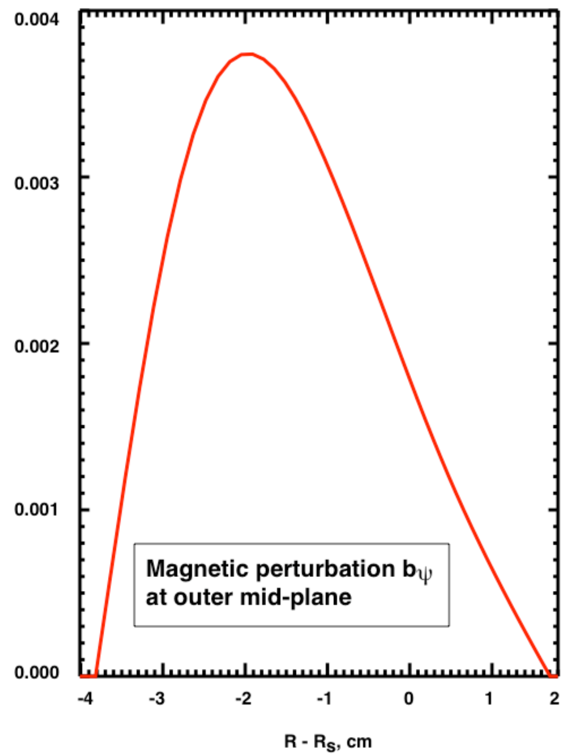
- **Solving for** $\tilde{N}_i, \tilde{V}_i, \tilde{j}_{||}, \tilde{\phi}_i, \tilde{A}_{||}$
- **Using realistic parameters & geometry NSTX**
- **Matching the spatial scale of turbulence with GPI**

BUT

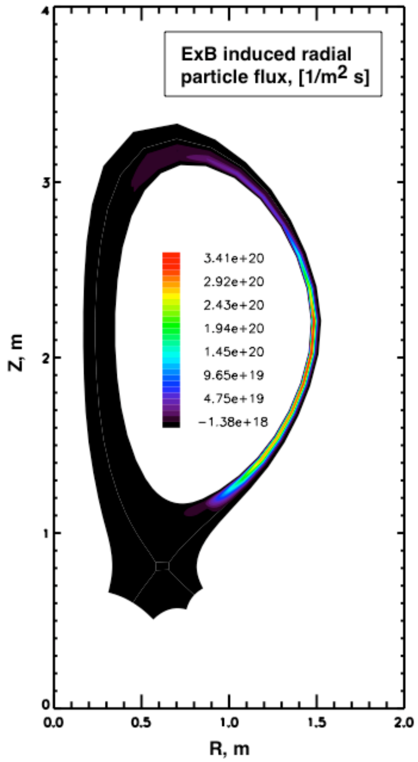
- **Not including temperature fluctuations**
- **Assuming cold ions for background plasma**
- **Not all terms of the form** $\tilde{b} \bullet \nabla$ **are included**

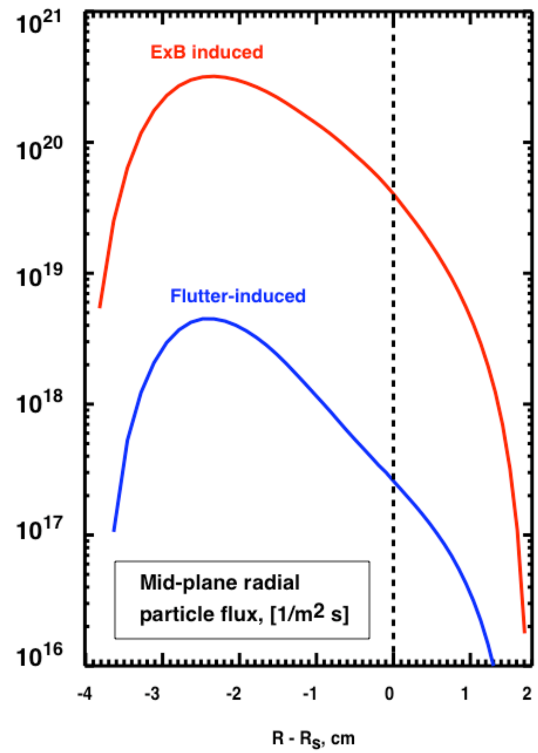
Magnetic perturbation is below 1% level, with ballooning-like poloidal dependence





Flutter induced transport is at least an order of magnitude below ExB flux, both are mainly at outer mid-plane





Conclusions

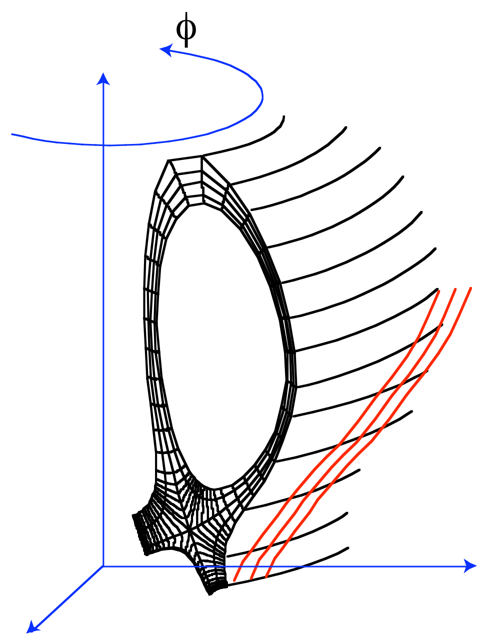
- Based on recent BOUT runs for NSTX
  - δb is below 1% level
  - magnetic flutter induced radial particle flux is at least an order of magnitude below ExB flux
- These BOUT runs for NSTX still miss some physics, however present findings are consistent with previous BOUT experience,

Backup slides

BOUT (BOUndary Turbulence) is a unique modeling tool for tokamak edge plasma turbulence*

- **Fluid equations based on Braginskii equations for N_i, T_e, T_i, $V_{||e}$, $V_{||i}$, and ϖ**
- **Spatial discretization on 3D mesh in real geometry**
- **Time integration by implicit ODE solver PVODE**
- **Parallel implementation with MPI**

Field following grid



$*$Xu et al, Contrib. Plasma Phys. 38, 158 (1998)

Convective part of turbulent heat flux can be extracted from these BOUT runs, no conductive part present (no δT are used)

$$q_r = \frac{5}{2}\Gamma_r T_0$$

- **Convective heat flux is very small, to match the heat flux need to use T fluctuations - this is a high priority**