CORRELATION ANALYSIS BASED MAGNETIC KUBO NUMBER ESTIMATION DURING PEDESTAL COLLAPSE IN BOUT++ SIMULATION

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Reproduced from [Jaewook Kim, Wonjun Lee, Hogun Jhang, S.S. Kim, H.H. Kaang and Y.-c. Ghim, Evolution of magnetic Kubo number of stochastic magnetic fields during the edge pedestal collapse simulation, Physics of Plasmas 25, 082306 (2018)], *with the permission of AIP Publishing [1].*

Kubo number is estimated from a numerical simulation of pedestal collapse generating stochastic magnetic fields in toroidally confined plasmas.

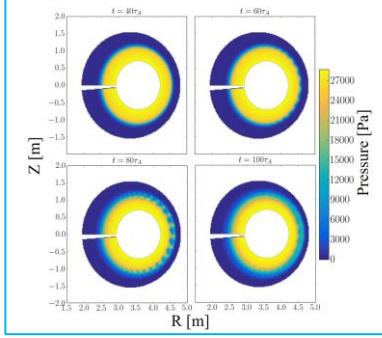
$$\mathcal{R} = \frac{\delta B}{B_0}\frac{l_{\parallel}}{l_{\perp}}$$

Kubo number determines a type of cross-field diffusion model in stochastic magnetic fields. [2]

We use numerical simulation which is performed within BOUT++ framework to solve a set of three-field reduced MHD model. [3,4]

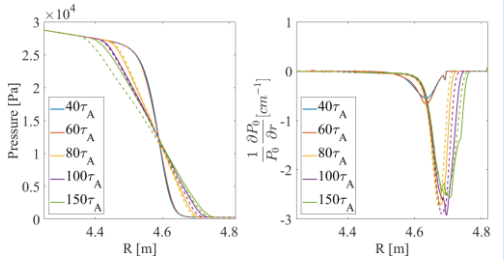
[2] G. Zimbardo et al,, Physical Review E 61, 1940 (2000)
[3] T. Rhee *et al*., Nucl. Fusion 55, 032004 (2015)
[4] H. Jhang et al,, Nucl. Fusion 57, 022006 (2017)

Simulation Results



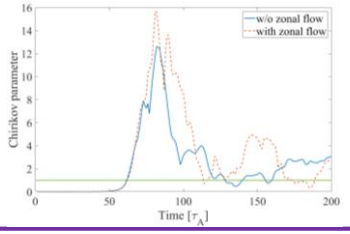
Poloidal cross section of total pressure contours at $t = 40, 60, 80, 100\tau_A$

Pressure gradient is relaxed while ballooning modes grows and destabilized



a) Equilibrium pressure profiles at $t = 40, 60, 80, 100, 150\ \tau_A$.
b) Normalized pressure gradient profile, i.e., $\nabla \ln P_0$ at $t = 40, 60, 80, 100, 150\ \tau_A$.
An abrupt edge pedestal collapse occurs in between $60 < \tau_A < 80$.

Chirikov parameter $\mathcal{C}$ at the location of the maximum pressure gradient.



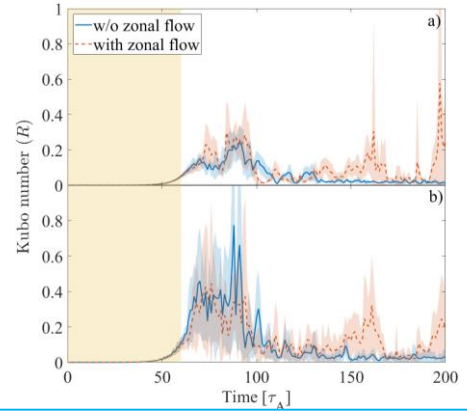
$$\mathcal{C} = \frac{W_m + W_{m+1}}{\Delta\psi_{m,m+1}}$$

Chirikov parameter C larger than 1 indicates there is stochastic magnetic fields

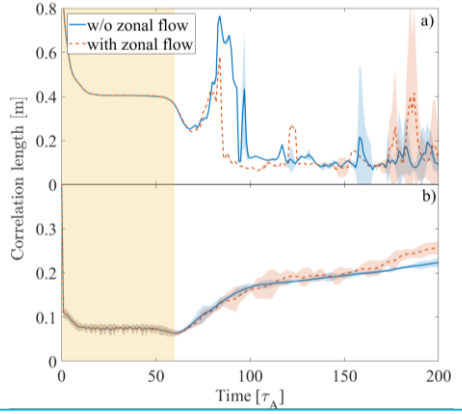
Kubo number and correlation length estimation

- Kubo number is found to be always less than one during the edge pedestal collapse.
- The fact that $R < 1$ implies that the percolation theory may not be applicable to describe the radial transport process during an edge pedestal collapse.

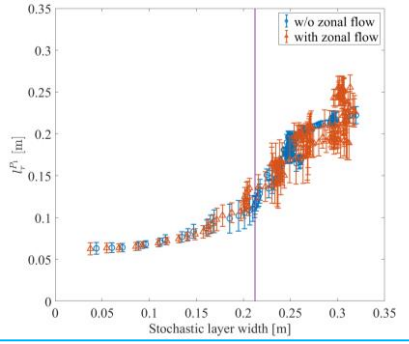
temporal evolutions of the magnetic Kubo number using (a) poloidal and (b) radial correlation length as a measure for the perpendicular one, $l_{\perp}$.



(a) Poloidal and (b) radial correlation lengths. Temporal evolution of poloidal correlation length resembles those of the Chirikov parameter and the Kubo number.



Radial correlation length $l_r^{P_1}$ vs. stochastic layer width showing that they well correlated to each other.



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