Edge turbulence in different density regimes in Alcator C-Mod

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The role played by the plasma edge in the Greenwald density limit is studied

Properties of the edge fluctuations:
- poloidal velocity
- radial velocity
- spatial correlation

Properties of the blobs:
- propagation velocity
- birth region
Edge fluctuations of Alcator C-Mod studied with the GPI diagnostic

Phantom 7.3 camera:
- 64x64 pixels
- 250 kHZ
- 120 ms acquisition time

GPI measures $D_\alpha$ fluctuations in the perpendicular plane at the outboard midplane

ANALYZED DISCHARGES

- Discharges with different $n/n_G$ have been analyzed
- $0.2 < n/n_G < 0.8$
- Ohmic L-mode
- Single null magnetic configuration
- Edge fluctuations measured varying normalized density

![Graph showing discharge parameters](image)
2D velocity field of edge fluctuations measured with the cross correlation technique

Two distinct regions separated by the separatrix

Different behavior at **low** and **high** normalized density
SOL VELOCITY SCALING

- SOL Radial velocity increases with increasing $n/n_G$
- Possible increase of the radial transport due to edge fluctuations
- For $n/n_G > 0.3-0.4$ poloidal velocity can invert its sign: from ion to electron diamagnetic drift direction
- Common “density threshold”?
- Same threshold in $n/n_G$ for edge behavior found in MAST and RFX-mod experiments

[P.Scarin et al., JNM 363-365 669 (2007)
G.Y.Antar et al., PoP 12 08253 (2005)]
VELOCITY TIME BEHAVIOR

- SOL velocity fluctuates in time during the discharge
- EDD propagation only for high density plasmas

Inversion in the edge velocity at high density not peculiar of Alcator C-Mod: same observations also in RFX-mod RFP device

Common issues in different magnetic configurations?
SIMILARITY WITH RFX-MOD

- In RFX-mod local inversion of edge velocity at high density plasma
- Velocity inversion leads to local density accumulation in the edge

- Plasma edge cooling
- Increase of resistivity
- Soft landing of the discharge

[M.E.Puiatti et al., NF 49 045012 (2009)]
[G.Spizzo et al., PPCF 52 095011 (2010)]
Spatial Correlation

Spatial correlated fluctuations only outside the separatrix

At high density correlated fluctuations involve larger area of the plasma edge

They involve region inside the separatrix

Similar phenomenology found with Langmuir probes

[B. LaBombard et al., PoP 8 2107 (2001)]
2D CONDITIONAL AVERAGE

- Space-time evolution of average blob measured with conditional average technique
- Blobs birth region and area are measured

Blobs area increases moving into the SOL
Blobs are detected outside the separatrix where autocorrelation time increases
Different density regime means different behavior of the edge coherent structures

At high density blobs birth region moves from SOL to separatrix

**Low density:** blobs birth place is 15 mm outside the separatrix

**High density:** birth region moves near the separatrix

[M.Agostini et al., NF, to be published]
CONCLUSIONS

✓ Properties of the edge fluctuations strongly depend on the normalized density
✓ Density “threshold” at n/n_G = 0.3-0.4

At high density:

✓ SOL fluctuations can change propagation direction: from IDD to EDD
✓ Coherent fluctuations and blobs involve a larger edge area
✓ Blobs birth place close to the separatrix

Perpendicular transport due to edge and SOL turbulence linked with the empirical density limit

Common behavior and similar physics mechanism with other experiments?