Impact of X-point geometry and neutrals recycling on edge plasma turbulence

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Key points

- Bridging mean field and turbulence modeling
  - 2 complementary but parallel paths in edge fluid modeling: mean-field ("transport") and turbulence codes

- Experiments: strong interaction between turbulent transport and divertor geometry / density regimes [T. Eich, EPS2019; A. Wynn, NF2018]
  - Predictive capabilities possible only with self-consistent treatment of both facets of physics

- This presentation: overview of recent results with TOKAM3X code to bridge the gap = turbulence in X-point geometry and with neutrals recycling
- Parallel effort: new code checking all the above boxes => see poster 33

The TOKAM3X-EIRENE code package

- 3D fluid-drift equations (see attached slides)
  - arbitrary magnetic geometry (axisymmetric) made possible by domain decomposition method [P. Tamain, JCP (2016)]

- TOKAM3X coupled to EIRENE via same architecture as SOLEEDGE2D-EIRENE 2D transport package [H. Bufferand, NF2015; D.M. Fan, CCP2018]

Turbulent transport in X-point geometry

- Key properties of edge turbulence and flows remain similar to limited plasmas [D. Galassi, NF2017]
  - Large intermittency and fluctuation level increasing with r, k⊥<0, ballooning

- Shaping (flux expansion) plays important role in poloidal distribution of transport level [D. Galassi, NME 12 (2017)]
  - Complex steady ExB flux pattern around X-point [D. Galassi, NF2017]
    - Poloidal shear of radial ExB velocity at X-point as new mechanism for filament disconnection identified [F. Nespoli, submitted to NF]

- Quiescent region systematically observed in X-point vicinity and along the separatrix [D. Galassi, Fluids 4 (2019)]
  - Js, reduced vs limited simulation
  - Mild edge transport barrier even upstream
  - Magnetic shear probably main drive although strong ExB shear also

Turbulence with self-consistent neutrals recycling

- Compare core particle influx with self-consistent fuelling (GP + recycling) [P. Tamain, PSI2018]

- Change in particle source location leads to major reorganization of profiles and heat transport mechanism from convected to conducted

- Response of turbulence very dependent on poloidal position
  - Far from targets: drop of N, increase of T, intermittency and structure unchanged
  - Close to targets: strong increase of intermittency and fluctuation rate, incl. q

X-point turbulent simulation with neutrals?

- X-point geometry enhances source relocation effect
- Turbulence regime strongly impacted
  - Intermittency replaced by quasi-coherent mode
  - Relevance of new regime?

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