

P1.1104 First-principles simulation of plasma fuelling in a tokamak

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See the full abstract here:

<http://ocs.ciemat.es/EPS2019ABS/pdf/P1.1104.pdf>

We study tokamak fuelling by using a first-principles approach, based on turbulent numerical simulations of the plasma periphery. These simulations are carried out by using the GBS code [1, 2]. GBS is a 3D flux-driven turbulence code that advances the drift-reduced two-fluid Braginskii equations, while solving a kinetic equation that describes the neutral dynamics. Neutral and plasma models are coupled via ionization, charge exchange and recombination processes. GBS simulates both the SOL and the edge, the most external region with closed magnetic flux surfaces. For a proper description of the plasma fuelling, a mass-conserving model was recently implemented. This required: a) to take into account the toroidal geometry consistently by including the radial variation of the tokamak aspect ratio; b) to include contributions of gradients parallel to the magnetic field previously neglected in comparison to the perpendicular gradients; c) to implement proper boundary conditions ensuring mass conservation for the plasma recycling occurring at the walls.

Since the plasma continuity equation is exactly satisfied and the simulations conserve the total number of ions and neutrals both globally and locally, GBS now provides a tool for a quantitative assessment of the mechanisms behind tokamak plasma fuelling. Based on our simulation results, we developed a 1D radial model that describes the balance between plasma and neutrals. The first results show that, while the plasma radial flux in the SOL is dominated by an ExB outward-pointing turbulent flow, the radial flux in the edge is determined by the competition between equilibrium ExB and diamagnetic flows. Understanding the physics behind these radial fluxes in the context of the neutral-plasma interplay is a first step to study the fuelling and improve our understanding of the mechanisms determining plasma transport in the edge and SOL.

References

- [1] F. D. Halpern, P. Ricci, S. Joliet, J. Loizu J. Morales, A. Masetto, F. Musil, F. Riva, T.M. Tran and C. Wersal, *Journal of Computational Physics* 315, 388-408 (2016).
- [2] C. Wersal and P. Ricci, *Nuclear Fusion* 55, 123014 (2015).

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