Calculations of impurity transport in Wendelstein 7-X plasmas

A. Mollén[1,†], M. Landreman[2], H. M. Smith[1], J. A. Alcusón[1], P. Xanthopoulos[1],
J. M. García-Regaña[3], A. Iantchenko[4], S. Buller[4], A. Langenberg[1], P. Helander[1]

[1] *Max-Planck-Institut für Plasmaphysik, Greifswald, Germany*

[2] *Institute for Research in Electronics and Applied Physics, University of Maryland, USA*

[3] *Laboratorio Nacional de Fusión, CIEMAT, Madrid, Spain*

[4] *Department of Physics, Chalmers University of Technology, Göteborg, Sweden*

Collisional transport theory has traditionally predicted impurity accumulation in stellarators driven by the inward pointing radial electric field, and impurities are a major concern for the capability of stellarators as a fusion energy source. However, recent advances in analytical [1, 2] and numerical [3, 4, 5] studies suggest that the standard neoclassical theory lack several effects that can be crucial when analyzing the impurity transport, and perhaps the situation is less severe than previously thought. Moreover, initial calculations of impurity transport in the first experimental campaign of the Wendelstein 7-X stellarator indicate that neoclassical theory alone is not capable of explaining the experimentally inferred results and particularly towards the plasma edge turbulent transport can play an important role.

In the present work we perform a kinetic transport analysis of impurities in experimental Wendelstein 7-X plasmas. To calculate the neoclassical transport we employ the SFINCS (Stellarator Fokker-Planck Iterative Neoclassical Conservative Solver) code [4, 6], which solves the time-independent radially local linearized 4D drift-kinetic equation for the perturbed distribution function and calculates fluxes. The code can account for flux-surface variations of the electrostatic potential, the full linearized Fokker-Planck-Landau collision operator, tangential magnetic drifts, an arbitrary number of kinetic species (including non-trace impurities), and it can be run iteratively to find the ambipolar radial electric field. Neoclassical calculations are supplemented by predictions of the turbulent impurity transport using the GENE code [7].

References

[1] P. Helander, et al., *Phys. Rev. Lett.* **118** (2017) 155002.

[2] I. Calvo, et al., *Plasma Phys. Control. Fusion* **59** (2017) 055014.

[3] J. M. García-Regaña, et al., *Nucl. Fusion* **57** (2017) 056004.

[4] A. Mollén, et al., submitted to *Plasma Phys. Control. Fusion* (2017).

[5] J. L. Velasco, et al., *arXiv:1712.03872* (2017).

[6] M. Landreman, et al., *Phys. Plasmas* **21** (2014) 042503.

[7] F. Jenko, et al., *Phys. Plasmas* **7** (2000) 1904.

† albert.mollen@ipp.mpg.de