Energetic particle transport:
diffusion vs convection and phase-space barriers

N. Carlevaro[1], G. Montani[1,2], M.V. Falessi[1], Ph. Lauber[3]

[1] *ENEA, FNS Department, C.R. Frascati, Via E. Fermi 45, 00044 Frascati (Roma), Italy*

[2] *Physics Department, "Sapienza" University of Rome, P.le Aldo Moro 5, 00185 Roma, Italy*

[3]*Max-Planck-Institut fuer Plasmaphysik, Boltzmannstrasse 2, D-85748 Garching, Germany*

Energetic particle (EP) redistribution due to the interaction with electromagnetic fluctuations is a key issue for magnetic confinement fusion. When multiple Alfvén eigenmodes with overlapping resonances are considered, the commonly used reduced description is based on diffusive quasi-linear (QL) models [1, 2]. In Ref.[3], from the analysis of the ITER 15MA baseline scenario, it is instead pointed out how realistic non-linear simulations are not properly characterized by QL predictions because typical avalanche phenomena are not reproduced. This specific transport feature is instead retained by the 1D reduced description introduced in Ref.[4] illuminating the relevance of the stable part of the fluctuation spectrum.

In this work, using this simplified 1D Hamiltonian method, we investigate the transport character of domino EP redistribution. The relaxation of tracers that interact mostly with the initially linear stable part of the spectrum is shown to have, in the non-linear phase, a temporal quadratic dependency of the mean square path, highlighting the convective nature of transport towards the plasma edge. Meanwhile, tracers dominated by interaction with overlapping unstable modes in the plasma core exhibit a linear dependence, characteristic of pure diffusion. Moreover, the formation of transport barriers in the phase space and their connection with the diffusive/convective transport regimes is studied by means of the Lagrangian Coherent structures technique [5].

Work carried out in the framework of EUROfusion as ENR Project: ATEP (CfP-FSD-AWP21-ENR-03-MPG-01)

References

[1] B. Breizman, S. Sharapov, Plasma Phys. Contr. Fusion **53**, 054001 (2011)

[2] L. Chen, F. Zonca, Rev. Mod. Phys. **88**, 015008 (2016)

[3] M. Schneller, Ph. Lauber and S. Briguglio, Plasma Phys. Control. Fusion **58**, 014019 (2016)

[4] N. Carlevaro et al., Plasma Phys. Control. Fusion **64**, 035010 (2022)

[5] M.V. Falessi et al., J. Plasma Phys. **81**, 495810505 (2015)