Intrinsic momentum transport in up-down asymmetric tokamaks

J. Ball[1,2], F.I. Parra[1,2], M. Barnes[3], W. Dorland[4], G.W. Hammett[5], P. Rodrigues[6], and N.F. Loureiro[6]

[1] Rudolf Peierls Centre for Theoretical Physics, Oxford University, Oxford, OX1 3NP, UK

[2] CCFE, Culham Science Centre, Abingdon OX14 3DB, United Kingdom

[3] Institute for Fusion Studies, University of Texas, Austin, TX 78712, USA

[4] Department of Physics, University of Maryland, College Park, MD 20742, USA

[5] Princeton Plasma Physics Laboratory, Princeton University, P.O. Box 451, Princeton, NJ 08543, USA

[6] Instituto de Plasmas e Fusão Nuclear, Instituto Superior Técnico, Universidade de Lisboa, 1049-001 Lisboa, Portugal

E-mail: `Justin.Ball@physics.ox.ac.uk`

Recent work demonstrated that breaking the up-down symmetry of tokamaks removes a constraint limiting intrinsic momentum transport, and hence toroidal rotation, to be small [1]. We show, through MHD analysis, that ellipticity is most effective at introducing up-down asymmetry throughout the plasma. Then, we detail an extension to GS2 [2], a local δf gyrokinetic code that self-consistently calculates momentum transport, to permit up-down asymmetric configurations. Accordingly, tokamaks with tilted elliptical poloidal cross-sections were simulated to determine nonlinear momentum transport. The results are consistent with TCV experimental measurements [3] and suggest that this mechanism can generate rotation with an Alfvén Mach number in excess of 1% in a tilted elliptical ITER-like machine. It appears that up-down asymmetry is the most feasible method to generate rotation in reactor-sized devices.

Work funded by the RCUK Energy Programme, the EU's Horizon 2020 research and innovation programme, and the US Department of Energy.

References

[1] F.I. Parra, M. Barnes, and A.G. Peeters. Up-down symmetry of the turbulent transport of toroidal angular momentum in tokamaks. *Phys. Plasmas*, 18(6):062501, 2011.

[2] M. Kotschenreuther, G. Rewoldt, and W.M. Tang. Comparison of initial value and eigenvalue codes for kinetic toroidal plasma instabilities. *Comput. Phys. Commun.*, 88(2):128, 1995.

[3] Y. Camenen, A. Bortolon, B.P. Duval, L. Federspiel, A.G. Peeters, F.J. Casson, W.A. Hornsby, A.N. Karpushov, F. Piras, O. Sauter, et al. Experimental evidence of momentum transport induced by an up-down asymmetric magnetic equilibrium in toroidal plasmas. *Phys. Rev. Lett.*, 105(13):135003, 2010.