Intrinsic momentum transport in tokamaks with tilted elliptical flux surfaces

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.$^{‡}$ We show, through MHD analysis, that ellipticity is most effective at introducing up-down asymmetry throughout the plasma. Using GS2, a local $δf$ gyrokinetic code that self-consistently calculates momentum transport, we simulate tokamaks with tilted elliptical poloidal cross-sections and a Shafranov shift. These simulations illuminate both the magnitude and poloidal dependence of nonlinear momentum transport. The results are consistent with TCV experimental measurements$^{§}$ and suggest that this mechanism can generate sufficient rotation to stabilize the resistive wall mode in reactor-sized devices. Furthermore, preliminary linear and nonlinear results indicate that tilting elliptical flux surfaces directly reduces the energy transport at low temperature gradients, but increases it at high temperature gradients.

This work has been carried out within the framework of the EUROfusion Consortium and J.B and F.I.P have received funding from the Euratom research and training programme 2014-2018 under grant agreement No 633053, as well as the RCUK Energy Programme (grant number EP/I501045). The views and opinions expressed herein do not necessarily reflect those of the European Commission.