Intrinsic momentum transport in tokamaks with tilted elliptical flux surfaces

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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.

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‡ F.I. Parra, M. Barnes, and A.G. Peeters. Phys. Plasmas, 18(6):062501, 2011.

§ Y. Camenen, A. Bortolon, B.P. Duval, et al. Phys. Rev. Lett., 105(13):135003, 2010.