F-I9 AAPPS-DPP2020

4th Asia-Pacific Conference on Plasma Physics, 26-31Oct, 2020, Remote e-conference

Potential Vorticity Mixing in a Tangled Magnetic Field[1]

Chang-Chun Chen[1], Patrick H. Diamond[1], Steve M. Tobias[2]

[1]University of California, San Diego, USA

[2]University of of Leeds, Leeds, UK

Recent experiments[2] indicate that RMP fields can reduce fluctuation-driven Reynolds forces and so inhibit the initiation of the L-H transition. We present a theory of vorticity flux decoherence and its implications for zonal flow evolution. This theory builds upon recent fundamental work on vorticity mixing in a tangled magnetic field[3].

We calculate the decoherence of the vorticity flux due to stochastic magnetic field scattering in presence of a strong toroidal field. The three relevant rates are: (1) the bandwidth of the ambient electrostatic micro-instabilities ($\Delta\omega$), (2) the bandwidth of Alfvén waves excited by Drift-Alfvén coupling ($v_A|\Delta k_{||}|$), and (3) the stochasticity-induced decorrelation rate ($1/\tau_c = max(k_\perp^2 D, (k_\theta^2 V_A^2 D/Ls^2)^{1/3})$, where D accounts for scattering by the stochastic field). Decoherence requires $1/\tau_c > \Delta\omega$, as well as $1/\tau_c \geq |\Delta k_{||} v_A|$ (i.e. Kubo number $Ku \geq 1$). These inequalities define the critical value of $\langle(\delta B)^2/B^2\rangle$ for an effect on the transition. The analysis proceeds by considering the Elsässer population responses. The implications for decoherence of the particle and heat flux are discussed, as well.

---

[1] This work is supported by the U.S. Department of Energy under Award No. DE-FG02-04ER54738

[2] Kriete, D. M., McKee, G. R., Schmitz, L., Smith, D. R., Yan, Z., Morton, L. A., & Fonck, R. J. (2020). Effect of magnetic perturbations on turbulence-flow dynamics at the LH transition on DIII-D. *Physics of Plasmas*, *27*(6), 062507

[3] Chen, C. C., & Diamond, P. H. (2020). Potential Vorticity Mixing in a Tangled Magnetic Field. *The Astrophysical Journal*, *892*(1), 24.