Optimal orientation of oblique turbulent stripes in planar shear flows

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Subcritical transition to turbulence in wall-bounded shear flows is usually characterised by intermittency, i.e., the coexistence of laminar and turbulent flow regions. While for pipe flow, where the proliferation and interaction of the corresponding localised regions of turbulence (puffs and slugs) are predominantly one dimensional, the dynamics are reasonably well understood[1], in shear flows extended in two dimensions the corresponding processes at play are much more complicated. Such is the case for plane Couette[2 3 4], plane Poiseuille[5 6 7] and Taylor-Couette[8 9 10] flows, where turbulence has been reported to appear in localised patches (spots) which on longer time scales develop into elongated oblique bands (stripes), surrounded by laminar flow.

The probably most curious aspect of the developing stripe patterns is their characteristic tilt angle with respect to the streamwise direction. Consequently, in this study we investigate the angle selection mechanisms. By using suitably tilted narrow orthogonal domains, previously introduced by Barkley and Tuckerman[11 12], we are able to enforce a range of different tilt angles and determine the conditions optimal for stripe sustenance, in order to provide a physical explanation for the angle selection observed in practice.

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[1]Avila *et al.*, *Annu. Rev. Fluid Mech.* **55**, 575-602 (2023).
[2]Duguet *et al.*, *J. Fluids Mech.* **650**, 119-129 (2010).
[3]Duguet *et al.*, *Phys. Rev. Lett.* **110**, 034502 (2013).
[4]Lemoult *et al.*, *Nat. Phys.* **12**, 254-258 (2016).
[5]Tsukahara *et al.*, *Proc. 4th Int. Symp. Turb. Shear Flow Phen.*, 935-940 (2005).
[6]Xiao and Song, *J. Fluid Mech.* **883**, R1 (2020).
[7]Mukund *et al.*, arXiv:2112.06537 (2021).
[8]Coles and Van Atta, *Phys. Fluids* **10**, S120-S121 (1967).
[9]Meseguer *et al.*, *Phys. Rev. E* **80**, 046315 (2009).
[10]Dong, *Phys. Rev. E* **80**, 067301 (2009).
[11]Barkley and Tuckerman, *Phys. Rev. Lett.* **94**, 014502 (2005).
[12]Barkley and Tuckerman, *J. Fluids Mech.* **576**, 109-137 (2007).