Turbulent channel flow under large amplitude streamwise travelling waves

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Wall oscillation techniques have received a considerable attention from the turbulence control community due to their capability of producing drag reduction margin as large as 60%[1][2]. Despite the continuous efforts in investigating the various captivating features of these techniques, the mechanism responsible for the observed drag reduction is still far from being fully understood. In the present work, we conducted few direct simulations of a plane turbulent channel flow controlled using streamwise travelling waves of spanwise wall velocity of amplitudes ranging from 0.15 to 1.25 (in outer units) at fixed frequency and wavenumber at friction Reynolds number 180. The resulting analyses show that the effect of large amplitude STW is to annihilate the spanwise vorticity at the wall (figure 1a). The quasi-streamwise vortices (QSVs), which play a key role in the regeneration mechanism, are drifted away from the wall, resulting in their weakened signature at the wall (figure 1b). Using their drift (Δd_s) and other results, a reasonable estimate of DR margin can be made using the model proposed by Orlandi and Jiménez[3].

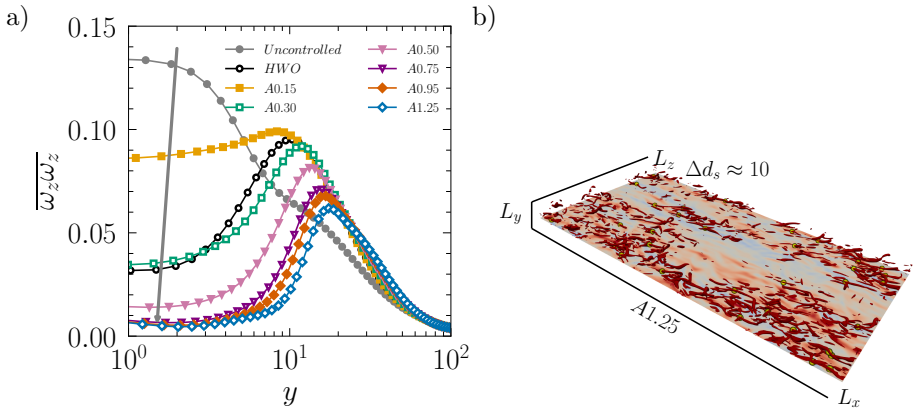

Figure 1: (a) Spanwise turbulent enstrophy. (b) The near-wall quasi-streamwise vortical structures for $A1.25$ case.

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[1]Umair et al., *Phys. Rev. Fluids* **7**(5), 054601 (2022).
[2]Quadrio et al., *J. Fluid Mech.* **627**, 161-178 (2009).
[3]Orlandi and Jiménez, *Phys. Fluids* **6**(2), 634-341 (1994).