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CORRIGENDUM

Turbulent drag reduction through oscillating discs – CORRIGENDUM

Daniel J. Wise, Paolo Olivucci and Pierre Ricco

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Recent progress has uncovered a small but significant error in the paper (Ricco & Hahn 2013), which propagates into the paper (Wise & Ricco 2014). The caption of figure 9 in Ricco & Hahn (2013) should read:

(*a*) Wall-normal profiles of r.m.s. of $\boldsymbol{u_d}$ components and of $\langle u_d v_d \rangle^+$ (the latter multiplied by a factor of $-\mathbf{6}$); the disc-flow boundary layer thickness δ, defined in § 3.4, is shown. (*b*) Wall-normal profiles of r.m.s. of velocity components and Reynolds stresses, where u, v, w are indicated in the legend.

The only difference is the minus sign in front of 6. The Reynolds stresses $\langle u_d v_d \rangle^+$ in the left graph were plotted with the opposite sign to show clearly that their maximum amplitude occurs where the $u^+_{d,rms}$ also peaks. Although the results and the conclusions in the text of Ricco & Hahn (2013) are unaltered, the sign error is also found in the analysis in Wise & Ricco (2014). The effect of this error on the results and conclusions in Wise & Ricco (2014) is addressed below.

Figure 11(*b*) in Wise & Ricco (2014) shows that $\widehat{u_d v_d}^+$ is positive, which implies that it contributes favourably to the drag reduction $\mathscr{R}$, as elucidated by the analysis based on the modified Fukagata–Iwamoto–Kasagi identity (see § 4.3 of Wise & Ricco (2014)). However, figure 11(*b*) in Wise & Ricco (2014) should be corrected as in figure 1(*b*) below because the profiles should instead be multiplied by -6.

The isosurfaces of $\langle u_d v_d \rangle^+$ for $u_d < 0$, $v_d > 0$ displayed in figure 11(*a*) of Wise & Ricco (2014) are corrected in figure 1(*a*) below. Thanks to the modified Fukagata–Iwamoto–Kasagi identity, it emerges that the structures contribute negatively to the total drag reduction.

This is further shown in the diagram of figure 2, where figure 14 on p. 557 of Wise & Ricco (2014) has been corrected: the arrows of the interdisc structures now point upstream and upward as they contribute directly to strengthen the Reynolds stresses.

Figure 15 in Wise & Ricco (2014) is recreated in figure 3 below with the corrected values of $\mathscr{R}_t$ and $\mathscr{R}_d$. The drag reduction contribution from the modification of the turbulent Reynolds stresses, $\mathscr{R}_t$ still scales linearly with the penetration depth of the disc-flow boundary layer, δ^+. $\mathscr{R}_d$ also still scales linearly with the same simple combination of the disc-flow parameters (i.e. $W^m T^n$) and the exponents remain unchanged, i.e. $(m, n) = (2, 0.3)$.

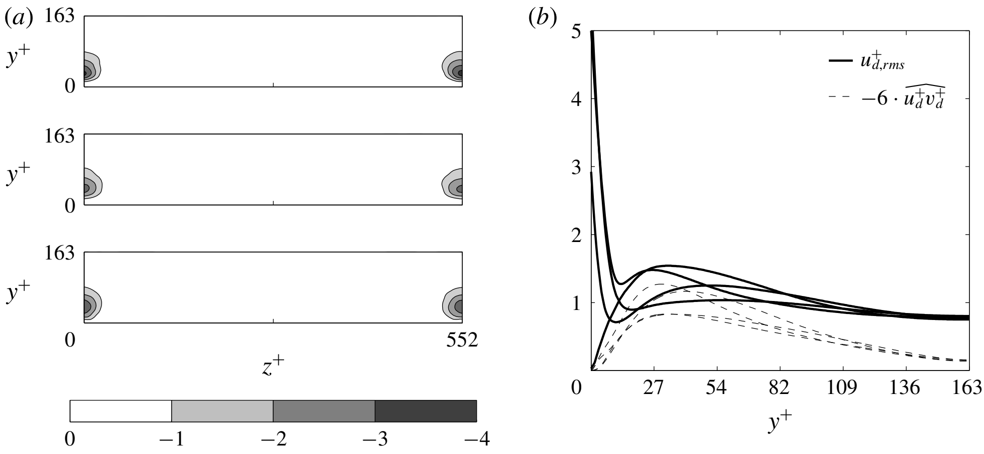

FIGURE 1. (*a*) Isosurfaces of $\langle u_d v_d \rangle^+$ observed from the y–z plane at $x^+ = 0$, $x^+ = 160$, $x^+ = 320$ (from top to bottom). The plots show only $\langle u_d v_d \rangle^+$ for $u_d < 0$, $v_d > 0$ as within the contour range the contributions from other contributions of u_d and v_d are negligible. (*b*) Wall-normal profiles of $u^+_{d,rms}$ (solid lines) and $\widehat{u_d v_d}^+$ (dashed lines). Profiles are shown for phases from the first half of the disc oscillation.

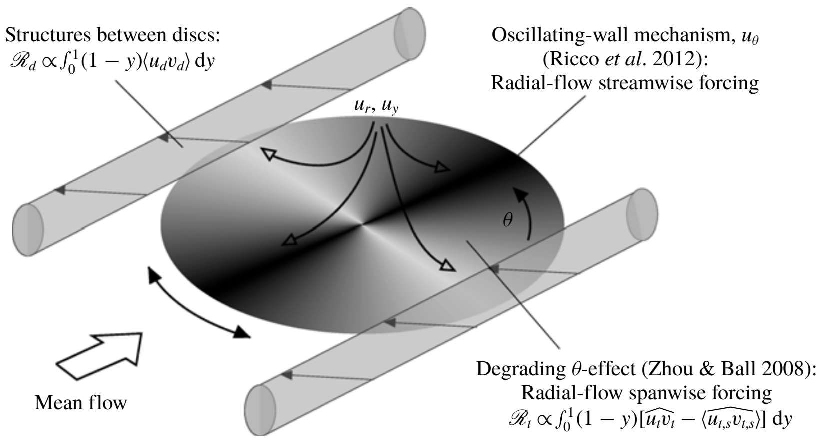

FIGURE 2. Reproduction of figure 14 on p. 557 of Wise & Ricco (2014). Note that the arrows of the interdisc structures now point upstream and upward in the wall-normal direction.

Acknowledgement

We would like to thank one of the referees for pointing out the missing '*g*' subscript of the square parenthesis in equation (4.2) on p. 551 of Wise & Ricco (2014).

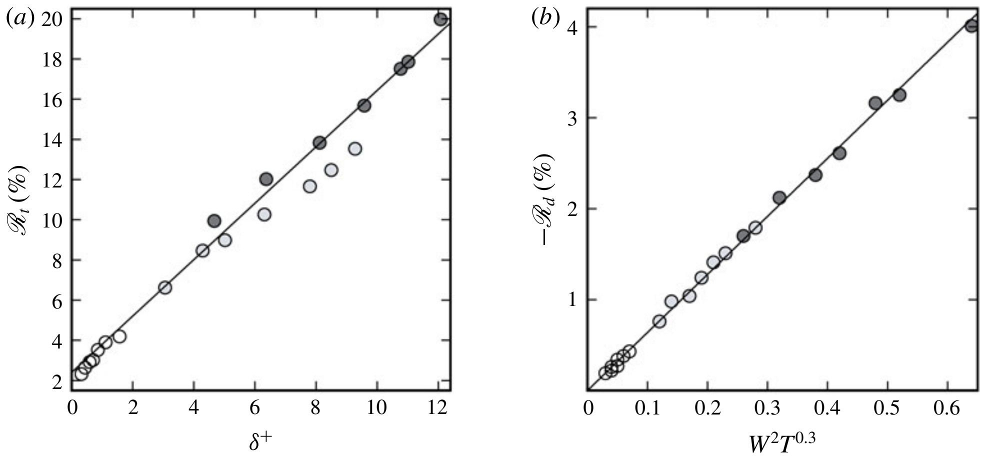

FIGURE 3. (*a*) $\mathscr{R}_t$, the contribution to drag reduction due to the modification to the turbulent Reynolds stresses, versus δ^+, the penetration depth of the disc-flow boundary layer. (*b*) $\mathscr{R}_d$, contribution to drag reduction due to the disc-flow Reynolds stresses, versus $W^2T^{0.3}$. White circles: $W^+ = 3$, light grey: $W^+ = 6$, dark grey: $W^+ = 9$.

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