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CORRIGENDUM

Nonlinear evolution of vortical disturbances entrained in the entrance region of a circular pipe – CORRIGENDUM

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In our recent work Zhu & Ricco (2024), the nonlinear unsteady boundary-region equations (2.15)–(2.18), governing the formation and evolution of the perturbation flow in the entrance region of a circular pipe, are derived.

For the case of nonzero spanwise wavenumber $m \neq 0$ in § 2.3.1., the pressure $\hat{p}_{m,n}$ and the azimuthal velocity $\hat{w}_{m,n}$ are eliminated from the r-momentum equation for convenience of the numerical calculations, resulting in equation (2.27) in Zhu & Ricco (2024). However, one nonlinear term in equation (2.27) is missing. The correct version of equation (2.27) is

$$\begin{aligned}
&\widehat{V}\hat{v}_{m,n} + \widehat{V}_r \frac{\partial \hat{v}_{m,n}}{\partial r} + \widehat{V}_x \frac{\partial \hat{v}_{m,n}}{\partial \bar{x}} + \widehat{V}_{rr} \frac{\partial^2 \hat{v}_{m,n}}{\partial r^2} + \widehat{V}_{xr} \frac{\partial^2 \hat{v}_{m,n}}{\partial \bar{x}\partial r} + \widehat{V}_{rrr} \frac{\partial^3 \hat{v}_{m,n}}{\partial r^3} + \widehat{V}_{xrr} \frac{\partial^3 \hat{v}_{m,n}}{\partial \bar{x}\partial r^2} \\
&\quad + \widehat{V}_{rrrr} \frac{\partial^4 \hat{v}_{m,n}}{\partial r^4} + \widehat{U}\hat{u}_{m,n} + \widehat{U}_r \frac{\partial \hat{u}_{m,n}}{\partial r} + \widehat{U}_x \frac{\partial \hat{u}_{m,n}}{\partial \bar{x}} + \widehat{U}_{rr} \frac{\partial^2 \hat{u}_{m,n}}{\partial r^2} + \widehat{U}_{xr} \frac{\partial^2 \hat{u}_{m,n}}{\partial \bar{x}\partial r} \\
&\quad + \widehat{U}_{xrr} \frac{\partial^3 \hat{u}_{m,n}}{\partial \bar{x}\partial r^2} = \boxed{r_t \frac{2r}{m^2} \frac{\partial \hat{\mathcal{X}}_{m,n}}{\partial \bar{x}}} + r_t \frac{r^2}{m^2} \frac{\partial^2 \hat{\mathcal{X}}_{m,n}}{\partial \bar{x}\partial r} + r_t \hat{\mathcal{Y}}_{m,n} + \frac{i r_t}{m} \frac{\partial \left(r \hat{\mathcal{Z}}_{m,n} \right)}{\partial r},
\end{aligned} \tag{0.1}$$

where the missing term is boxed.

Numerical simulations were repeated with the missing term included and its contribution to the results was found to be very small. The discussion of the results and the conclusions in Zhu & Ricco (2024) are therefore unaffected. We have reproduced figures 3–6, 7(c) and 7(d) in Zhu & Ricco (2024) with our corrected solver. The following figures present a comparison between the original results (shown in blue) and the corrected results (shown in black and red). Figure 16 is also reproduced, with different values of ϵ chosen to achieve a better agreement with the experimental data.

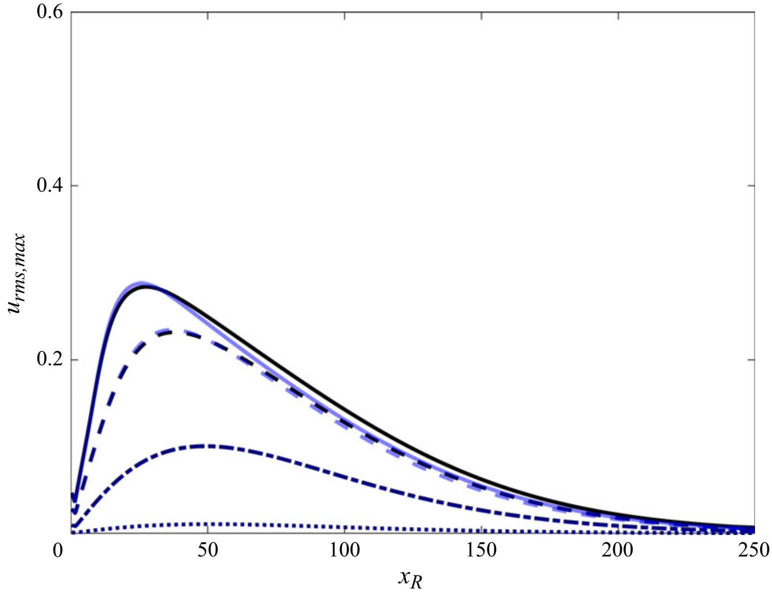

Figure 3. Comparison between the original results (blue lines) and the corrected results (black lines). Only the nonlinear results are presented as the linear results are unaffected.

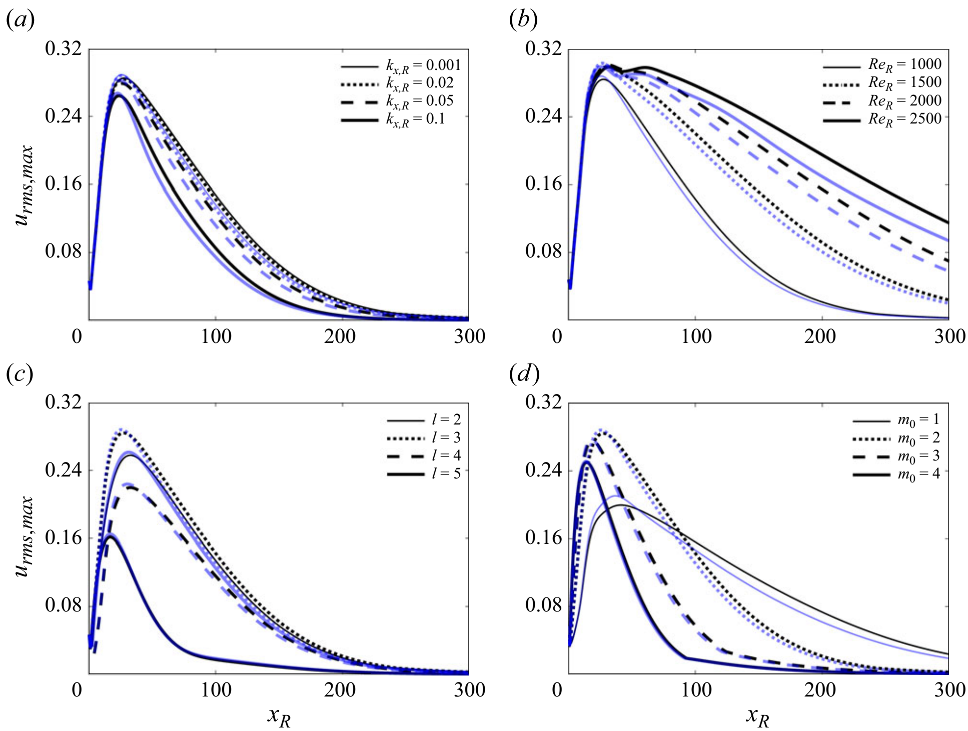

Figure 4. Comparison between the original results (blue lines) and the corrected results (black lines).

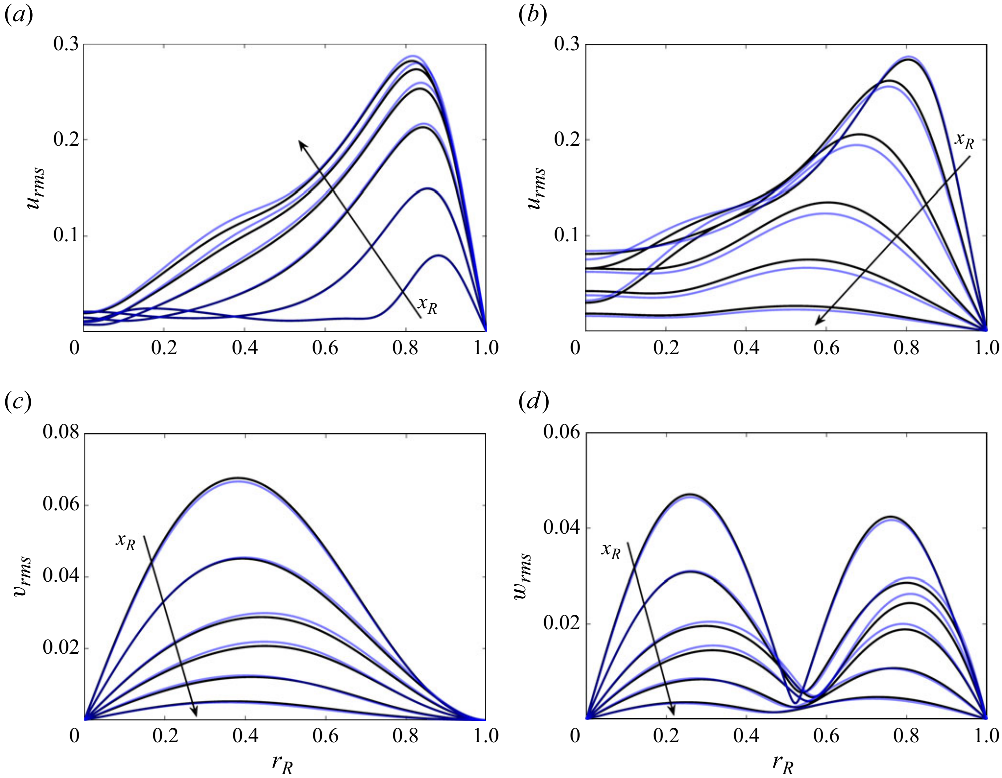

Figure 5. Comparison between the original results (blue lines) and the corrected results (black lines).

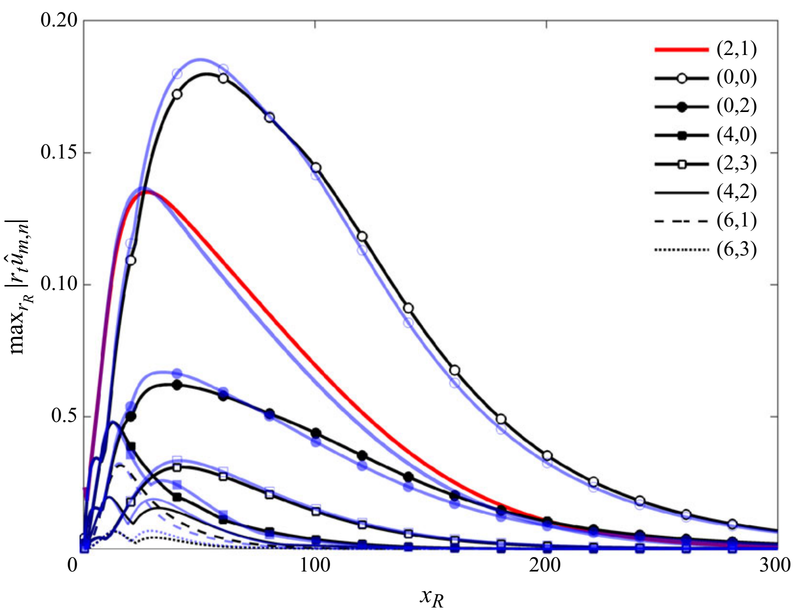

Figure 6. Comparison between the original results (blue lines) and the corrected results (black and red lines).

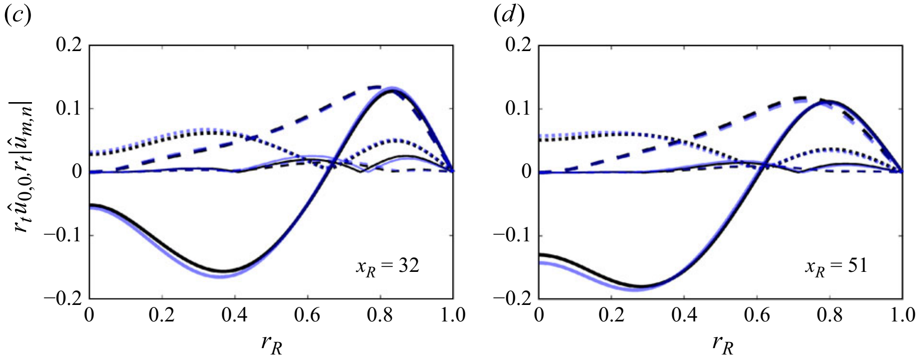

Figure 7. (c) and (d) Comparison between the original results (blue lines) and the corrected results (black lines).

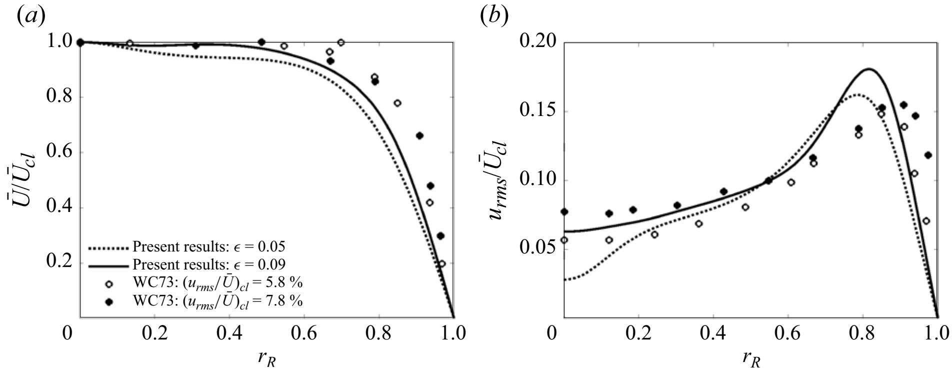

Figure 16. Comparison of (a) the mean flow and (b) the perturbation flow between the experimental measurements (circles) and our numerical results (lines). Open and solid circles: experimental data measured by Wygnanski & Champagne (1973) (refer to as WC73 in the figure) with $(u_{rms}/\bar{U})_{cl} = 5.8\,\%$ and $7.8\,\%$. Dotted and solid lines: present results with the new values $\epsilon = 0.05$, 0.09. The other parameters are unvaried: $Re_R = 1200$, $x_R = 30$, $k_{x,R} = 0.118$, $l = 2$ and $m_0 = 2$.

References

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