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The dynamics of a solid-body rotation flow in a finite-length pipe[1]

SHIXIAO WANG, University of Auckland, ZVI RUSAK, Rensselaer Polytechnic Institute — The dynamics of a perturbed, incompressible, inviscid and axisymmetric solid-body rotation flow in a finite-length, straight, circular pipe is studied through a theoretical analysis of the steady-state equations and direct numerical simulations. The flow is subjected to non-periodic inlet and outlet conditions where the outlet flow is columnar. The computed bifurcation diagrams from both approaches agree as the pipe length increases. The results show the natural evolution of the flow at incoming swirl levels above critical into either a state with a breakdown (stagnation) zone, centred around the pipe axis, or into a state with a wall separation zone (where there is no axial and radial velocity). Each solution is a result of a different domain of attraction of initial perturbations. The work emphasizes that the solid-body rotation dynamics is dominated by the linear evolution of perturbations.

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