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Unravelling the mechanism behind Swirl-Switching in turbulent bent pipes PHILIPP SCHLATTER, LORENZ HUFNAGEL, JACOPO CANTON, RAMIS ÖRLÜ, Linné FLOW Centre, KTH Mechanics, OANA MARIN, ELIA MERZARI, Mathematics and Computer Science Division, Argonne National Laboratory — Turbulent flow through pipe bends has been extensively studied, but several phenomena still miss an exhaustive explanation. Due to centrifugal forces, the fluid flowing through a curved pipe forms two symmetric, counter-rotating Dean vortices. It has been observed, experimentally and numerically, that these vortices change their size, intensity and axis in a periodic, oscillatory fashion, a phenomenon known as swirl-switching. These oscillations are responsible for failure due to fatigue in pipes, and their origin has been attributed to a recirculation bubble, disturbances coming from the upstream straight section and others. The present study tackles the problem by direct numerical simulations (DNS) analysed, for the first time, with three-dimensional proper orthogonal decomposition (POD) as to distinguish between the spatial and temporal contributions. The simulations are performed at a friction Reynolds number of about 360 with a divergence-free synthetic turbulence inflow, as to avoid the interference of low-frequency oscillations generated by a standard recycling method. Results indicate that a single low-frequency, three-dimensional POD mode, representing a travelling wave, and previously mistaken by 2D POD for two different modes, is responsible for the swirl-switching.

Philipp Schlatter
Linné FLOW Centre, KTH Mechanics

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