Three-dimensional coherent structures in a curved pipe flow

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This talk will present three-dimensional coherent structures in curved pipes under loose coiling and high-Reynolds-numbers approximation. Two distinct types of solutions bifurcate from the Dean's classic two-vortex solution. The first type arises through a supercritical bifurcation from inviscid linear instability, and the corresponding self-consistent asymptotic structure aligns with the vortex-wave interaction (VWI) theory. The second type emerges from a subcritical bifurcation by curvature-induced instabilities and satisfies the boundary region equations (BRE). Although no connection to the zero-curvature limit has been found, continuing from known self-sustained exact coherent structures in straight pipe flow[1] reveals another family of three-dimensional travelling waves that exist across all Dean numbers.

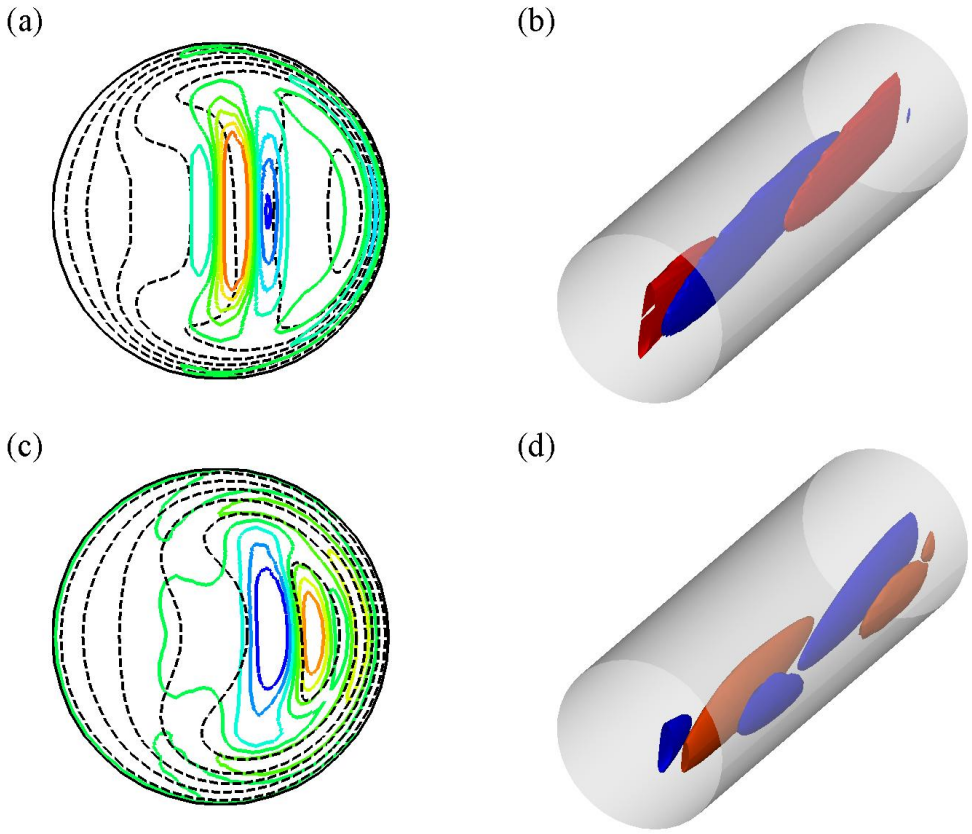

Figure 1: Flow visualisation of three-dimensional coherent structures. (a,b): VWI-type solution; (c,d): BRE-type solution. (a,c) The black dashed curves represent the isocontours of streamwise-averaged flow, while the coloured curves show the isocontours of streamwise vorticity; (b,d): The red/blue surface depicts the positive/negative isosurfaces of streamwise vorticity.

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[1]Pringle, C. C. T., Kerswell, R. R., *Phys. Rev. Lett.* **99**, 074502 (2007)