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Exact laminar solutions for flows in channels with sinusoidal walls
SABARISH VADAREVU, ATI SHARMA, BHARATHRAM GANAPATHISUBRAMANI, University of Southampton — We compute exact solutions for steady, incompressible, laminar flows in sinusoidal channels using Newton's method, employing domain transformation with spectral resolution in all spatial directions. Aligning the walls to be in phase has made computations considerably cheap (runtime/case $\sim$ 10 minutes on 1 core); Newton's method has allowed tracing solutions into high Reynolds number ranges, where solutions are temporally unstable. We identify four parameters: the amplitude, maximum slope, and streamwise inclination of the grooves/furrows in the surfaces, as well as the mean pressure gradient that drives the flow. Results are presented for amplitudes ranging from 0.1% to 10% of channel half-height, and maximum slopes ranging from 0.3 to 3.0, for a set of inclinations and Reynolds numbers. We look at the onset and sizes of steady recirculation zones, their effect on the volume flux, and relative contributions of pressure and wall-shear to total drag. The strengths of shear layers and the wall-normal gradients of circulation are considered as indicators for Kelvin-Helmholtz and centrifugal instabilities respectively. Future work will focus on computing other classes of exact solutions and understanding their significance to transition and turbulence.

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