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Vortices by design in pipe flow by a mechanism of Langmuir circulation[1] SIMEN ÅDNØY ELLINGSEN, Norwegian Univ Tech (NTNU), ANDREAS HOLM AKSELSEN, SINTEF Ocean, LEON CHAN, University of Melbourne — Using DNS we study a mechanism for creating secondary flow by design in the form of longitudinal vortices in pipe flow. By furnishing the pipe wall with a pattern of crossing waves, vorticity already present in the wall boundary layer is rotated into the streamwise direction by a resonant kinematic mechanism known in oceanography as 'CL1' (Craik Leibovich's 1st mechanism), one of the drivers of Langmuir circulation. CL1 is strongest when the wall waves cross at an acute angle of $\varphi \sim 10^\circ$ to 20° (a 'contracted egg carton' pattern), vanishes in the vicinity of 45° and is weak and oppositely directed for larger angles ('protracted egg carton'). The results are compared to a simple theory in the vein of Craik (1970).

CL1 co-exists with a dynamic mechanism of secondary motion due to the asimuthally varying wall rougness caused by the pattern. For the 'contracted' pattern the two effects oppose each other with CL1 prevailing, whereas the dynamic effect dominates at 45° and above, causing a reversal of circulation. Flow reversal also results with increasing amplitude due to flow separation.

We presently report only laminar simulations; the effect on turbulent pipe flow is a potentially important question for the future.

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