Corner Flow : a Classical Problem with a New Twist

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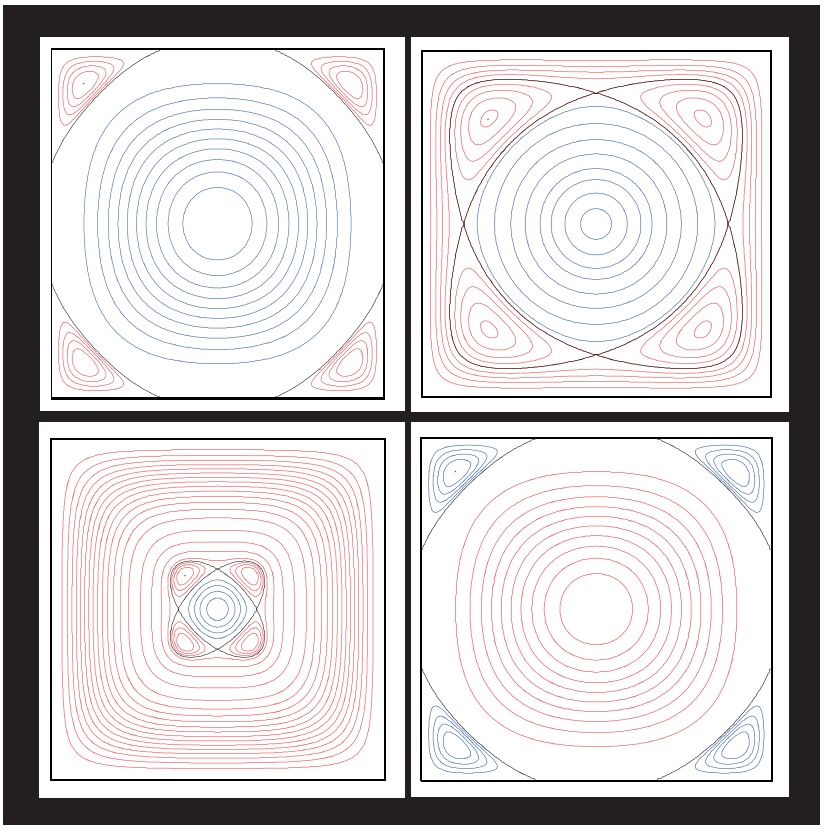
MERCREDI 28 MARS 2007 à 10h30
Amphithéâtre Nougaro
INSTITUT DE MECANIQUE DES FLUIDES
allée du Professeur Camille Soula, Toulouse

Stokes flow of a viscous fluid in a cylindrical container driven by time-periodic forcing, either at the boundary or through oscillation of the cylinder about an axis parallel to its generators, is considered. The behaviour is governed by a single dimensionless frequency parameter Γ and by the geometry of the cylinder cross-section. Attention is focused on the asymptotic behaviour near any sharp corners on the boundary. For small (a regular perturbation expansion reveals the manner in which local flow reversal proceeds during each half-cycle of the flow. The behaviour depends on the corner angles, and different regimes are identified for both types of forcing. For example, for an oscillating square domain, eddies grow symmetrically from each corner and participate in the subsequent flow reversal in the interior. For large (, the corner eddies merge into Stokes-type boundary layers which drive the interior flow-reversal process. In general, the local corner analysis provides the key to an understanding of the global flow evolution.



Succession of streamline patters showing the changes of topology that occur during a half-cycle of the torsional oscillation of a square domain. Red indicates positive sense, blue negative. Eddies emerge from the four corners, then dividing streamlines detach from the walls forming heteroclinic connexions which contract towards the centre, ultimately annihilating the central eddy. At this stage new eddies of the opposite sense emerge from the corners, and the next flow reversal progresses in the same way.