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Rotating polygons : Numerical and experimental study of the base flow

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Rotating polygons, as shown in Fig. 1 (right), have challenged the curiosity of various research groups¹². The flow is induced by a disk rotating at the bottom of a cylindrical tank partially filled with a working fluid. The polygons appear above a threshold that breaks the symmetry of the base flow initially axisymmetric. Instability mechanisms have been proposed based on simplified base flow model³. The aim of our study is to characterize in details the base flow using numerical techniques – computation of steady solutions or mean unsteady two-dimensional and three-dimensional direct simulations – as well as Laser-Doppler Velocimetry measurements.

Numerical results averaged in time and space reveal the structure of the toroidal flow located at the periphery of the central solid body rotation region. When viewed in a meridional plane, this flow cell is found bordered by four layers, in particular by a layer at the free surface leading to a better understanding of the complete flow structure. The Froude number associated to surface deformation and the Reynolds number if sufficiently large are shown to have little effect on the flow structure. Experimental measurements corroborate the azimuthal velocity distribution used in the simplified models. But experimental and numerical results also reveal a large robust modal structure as seen in Fig. 1 (left) with the same azimuthal wave number as the corners' number of the rotating polygon. This structure is observed while the free surface remains almost axisymmetric and thus before the rotating polygon settles in.

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¹Vatistas, *J. Fluid Mech.* **217**, 241 (1990).

²Jansson et al., *Phys. Rev. Lett.* **96**, 174502 (2006).

³Mougel et al., *J. Fluid Mech.* **824**, 230 (2017)

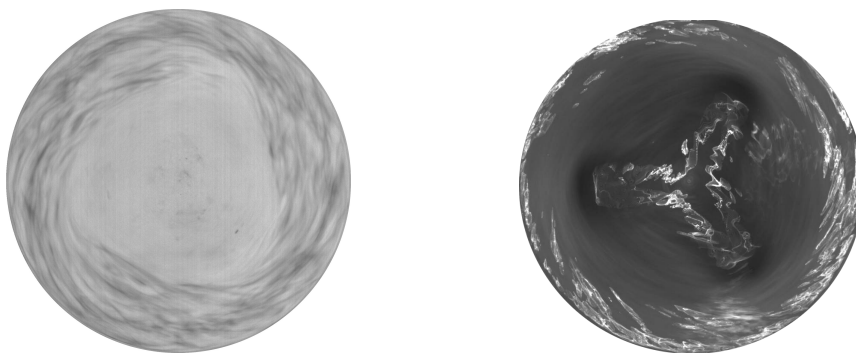


Figure 1: (Left) Visualization with kalliroscope of a mode 3 below threshold for the rotating polygon, (Right) Rotating polygon once it is settled.