Experimental study of the vortex rings generated by an oscillating disc

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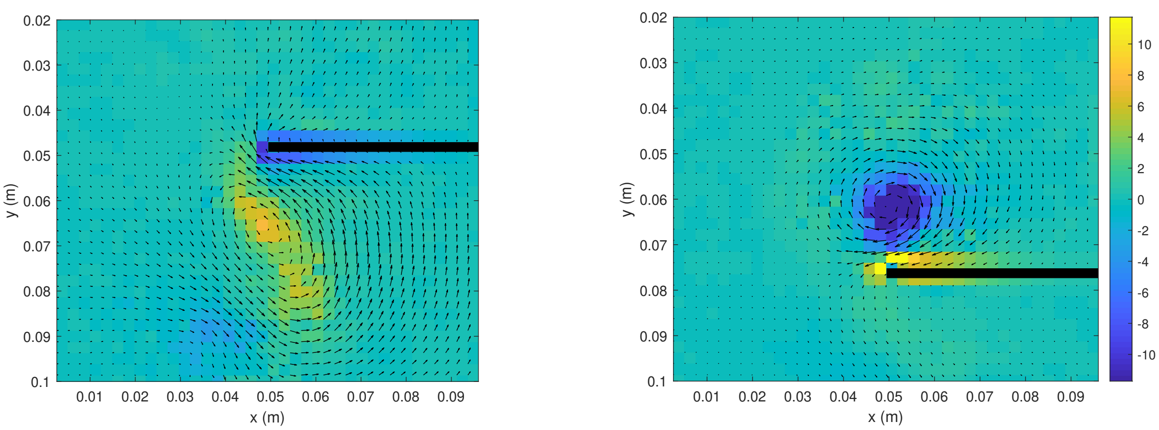
A better understanding of the vortices generated by a moving body can have many applications, such as optimizing the propulsion of an object. Here, we investigate experimentally the periodic generation of vortices by a disc of diameter D and thickness e subject to a sinusoidal oscillation of frequency f and amplitude A in an initial quiescent fluid. The roll-up of the boundary layer produced at the edge of the disc generates a vortex ring at each half-oscillation which interacts with the vortex ring generated in the previous half-cycle.

We describe the different flow regimes observed by flow visualizations depending on the disc diameter, the amplitude, and the frequency of oscillation. We mainly identify four regimes. The asymmetry between the vortex rings generated at each half-oscillation characterizes one of these regimes where a circular core vortex ring generated during one half-oscillation prevents the creation of the vortex ring at the next half-oscillation (figure 1).

We characterize by PIV the features of the circular core vortex ring in this asymmetric regime. The characteristics of the vortex ring, *i.e.*, its size, position, and circulation, can be fitted to scaling laws accounting for the parameters of the experiment.



(a) (b)

Figure 1. Velocity fields (arrows) and vorticity fields ω (color scale) for $A = 1.4$ cm, $D = 10$ cm, $f = 0.3$ Hz and $e = 0.2$ cm. The fields are obtained by phase-averaging PIV results over 20 oscillations. The vortex rings created at the bottom of the disc (a) and the top (b) are asymmetric. We only show half of the disc as the flow is considered axisymmetric around the axis of the disc.

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