EXPERIMENTAL STUDY OF VORTEX DISTORTION BY THE CRAIK-LEIBOVICH FORCE

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In a seminal paper aimed at providing a realistic theoretical model of Langmuir circulations [1], A. Craik and S. Leibovich introduced the mean force that a surface wave field exerts on the underlying flow. We report an experimental study on the influence of such a wave field on a single vortex: how is the wave field refracted by the vortex, and more importantly, how are the vortex structure and intensity affected by the waves?

We drive a steady circular vortex by running electrical current in an electrically conducting fluid, in the presence of magnetic field. A paddle generates waves propagating towards the vortex, with controlled amplitude and frequency. The surface velocity field is measured through Particle Tracking Velocimetry.

Coherent averaging of the surface velocity at the wave frequency allows us to extract the surface wave field, while long-time average leads to the vortex structure. In the top panels of figure 1, we show the base flow without waves, and the pure surface waves in absence of the vortex. The interaction between the two leads to the bottom panels of figure 1, that clearly display wave refraction, together with vortex recoil. A simple analytical model describing the balance between the driving force, the Craik-Leibovich one and turbulent viscosity leads to scaling laws that are verified experimentally.

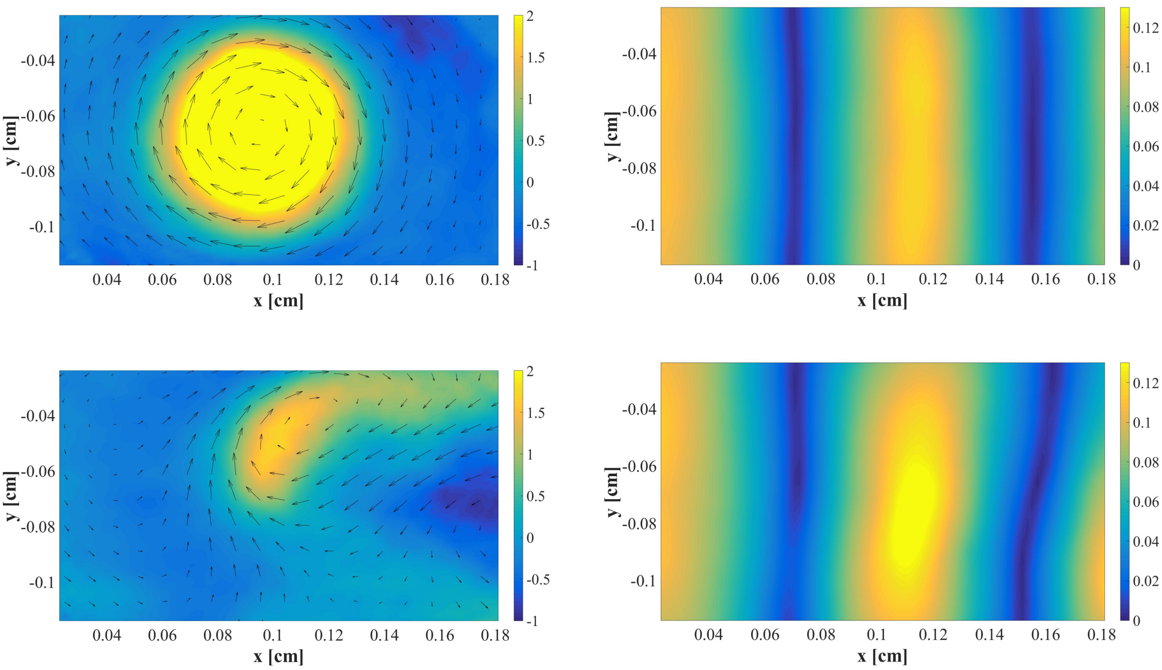

Figure 1. Top-left: vorticity map of the steady vortex without waves, in inverse seconds. Top-right: surface waves in the absence of the vortex (color codes for the magnitude of velocity, in m/s). The interaction between these two ingredients leads to refracted wavefronts (bottom-right panel) and vortex recoil (bottom-left panel).

References

[1] A. D. D. Craik, S. Leibovich, *A rational model for Langmuir circulations.* J. Fluid Mech. **73(3)**, 401-426 (1976).
[2] O. Bühler, *Waves and mean flows.* Cambridge University press (2009).
[3] O. Bühler, M.E. McIntyre, *Remote recoil: a new wave-mean interaction effect.* Journal of Fluid Mechanics, **492**, 207-230 (2003).