On the wanderings of a ludion in a corral : in search of a quantum analogy

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We have recently described the resonance of the vertical oscillations of a ludion (or Descartes diver) in a stably stratified fluid together with the internal gravity waves it emits and its bifurcation to horizontal swimming [1]. Now, in search of a quantum hydrodynamic analogy and possible associated pilot wave dynamics [2,3], we analyze the motions of a ludion in a cylindrical container (a corral) in the hope of revealing an interaction between its swimming and its own internal gravity wave field. According to the ratio of the forcing frequency to the Brunt-Väisälä frequency, the ludion can chaotically explore the horizontal cylindrical section where it is constrained on average. Although the statistical study would have required recordings over days, the analysis of the trajectories recorded during several hours seems to show that certain radii of curvature are well privileged, a phenomenon reminiscent of Couder walkers. For a particularly long record (16 hours) of the ludion dynamics in a corral of 30 cm in diameter, the color coding of the chaotic trajectory proportional to the instantaneous horizontal speed of the diver reveals as expected a faint but real target pattern (see Figure 1) with a slightly lower speed along a first yellowish rings at the periphery of the corral and another one at a radius $\approx 5cm$. This pattern may indeed be the ghost of one of the eigenmodes of the corral. In line with these results, a Proper Orthogonal Decomposition (POD) of the synthetic Schlieren images of the waves emitted by the ludion during its chaotic excursion shows large-scale gravity eigenmodes of the cylindrical corral. Without drawing any definitive conclusions from this study, we are hopeful that a wave-driven or a wave-influenced particle dynamics exists also in our system and hence opens the way to a new hydrodynamic quantum analogy.

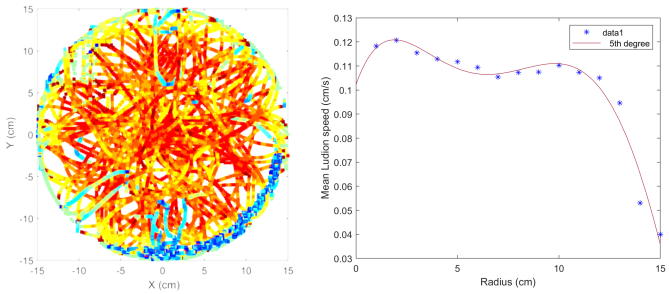

Figure 1. Left : Trajectory of the ludion in a corral 30 cm in diameter, where the color coding is proportionnal to the instantaneous horizontal speed. A faint target pattern which may be the ghost of one of the eigenmodes of the corral, can be detected. Right : Mean speed of the ludion averaged along the azimuth direction.

Références

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3. Bush J., Pilot-wave hydrodynamics, *Ann. Rev. Fluid Mech*, **47**, 269—292 (2015).