Walking droplets interacting with submerged boundaries

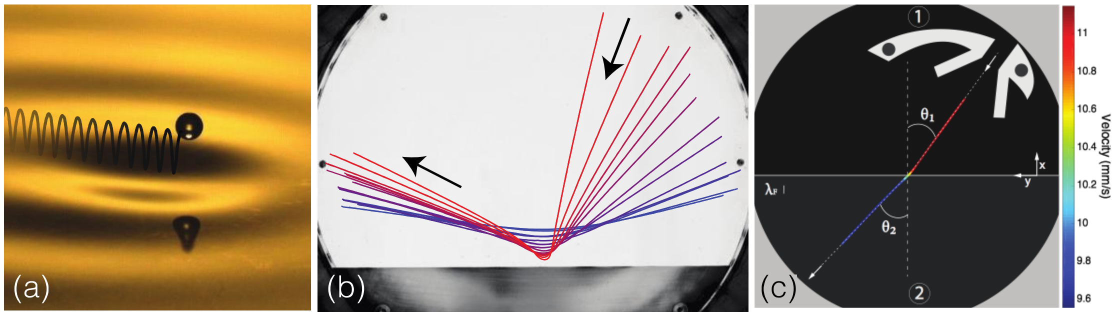
Giuseppe Pucci

Department of Mathematics, Massachusetts Institute of Technology, USA

A decade ago, Yves Couder and Emmanuel Fort discovered that a droplet bouncing on the surface of a vibrating fluid bath can self-propel across the surface through interaction with its own wave field (fig.(a)) [1]. These walking droplets or "walkers" comprise a droplet and its guiding wave, and have been shown to exhibit many features reminiscent of quantum particles [2]. Integrated experimental and theoretical work has rationalized the manner in which chaotic pilot-wave dynamics may give rise to quantum-like statistical behaviour in unbounded geometries, for example, in orbital dynamics as arises when walkers are subjected to an applied body force.

The interaction of walkers with boundaries, as arises in a number of key quantum analogs such as tunneling, motion in a confined circular corral, and diffraction and interference from single- and double-slits, remains relatively poorly understood.

I here present the results of a combined experimental and theoretical investigation of walkers interacting with submerged boundaries. First, we revisit the pioneering experiments of Couder & Fort [1] on diffraction and interference from single- and double-slit geometries, showing that the behaviour of walkers in such geometries is dominated by a wall effect [3]. Motivated by the walker-wall interaction observed in the slit experiments, we explored the non-specular reflection arising when a walker interacts with a planar wall (fig.(b)) [4]. Finally, I will consider the case of walkers crossing a linear step corresponding to a reduction in bath depth. Here the walker is refracted and satisfies an effective Snell-Descartes law in which the component of momentum parallel to the step is conserved (fig.(c)).



[1] Y. Couder and E. Fort. Single-particle diffraction and interference at a macroscopic scale. Phys. Rev. Lett. 97, 154101 (2006).

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[4] G. Pucci, P. J. Sáenz, L. M. Faria and J. W. M. Bush. Non-specular reflection of walking droplets. J. Fluid Mech. 804: R3 (2016).