Course proposal for Ph.D. students
in Physical, Chemical, Materials Sciences and Technologies of the University of Calabria

Macroscopic quantum analogs

3 CFU

About fifteen years ago, Yves Couder, Emmanuel Fort and collaborators in Paris discovered that a droplet may “walk” by virtue of a resonant interaction with the wavefield that it generates by bouncing on the surface of a vibrating liquid bath. This *walker* is a classical system that couples a particle and a wave at the macroscopic scale and exhibits a number of quantum-like behaviors.
I will present the quantum analogs observed with these walking droplets and we will approach the following question: to what extent can a *classical* wave-driven system reproduce phenomena that are thought to be peculiar to the quantum realm?

<u>Tentative plan of the lectures</u>
(may change along the way by following the students’ and the teacher’s curiosity)

- **Introduction to the walker system.** Discussion of analogies and differences with de Broglie’s pilot-wave theory and Bohm’s pilot-wave theory.
- **Quantum analogs with walkers**: tunnelling, level splitting, quantization of orbits and angular momentum, wavelike statistics in cavities, Friedel-like oscillations, diffraction and interference.
- **Hydrodynamic spin lattices** (non-quantum).
- **Current research and future directions**: what is really quantum?

<u>Classes will start on Thursday June 24th, 2021, 11.30am-1.30pm.</u>

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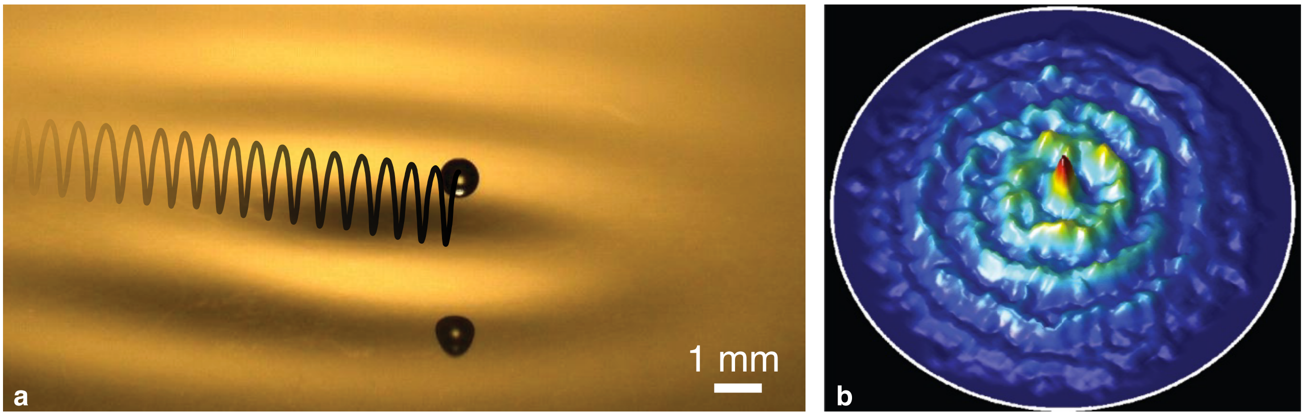

(a) Oblique view of a walking droplet (picture from J. Bush’s group at MIT). (b) Long-term statistical distribution of the droplet position in a circular cavity (D. M. Harris *et al. Phys. Rev. E* 88:011001(R), 2013).

<u>References</u>
J. W. M. Bush and A. U. Oza. Hydrodynamic quantum analogs. *Rep. Prog. Phys.* **84**, 017001 (2020) and references therewith.