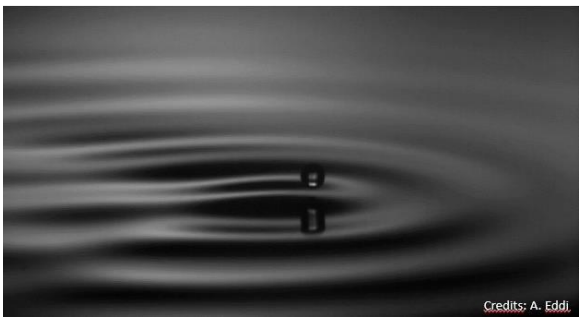
18-month postdoctoral position:

Violation of Bell's inequality with soft matter

Contacts :
Matthieu LABOUSSE
Gulliver, CNRS, ESPCI Paris PSL University
matthieu.labousse@espci.psl.eu
https://blog.espci.fr/matthieulabousse/

During the last decade, a series of works has shown that wave-particle duality is not restricted to the quantum domain. It is possible to create such a system by bouncing a drop of submillimetric siilicon oil off a vertically vibrated bath. The drop is self-propelled by a system of Faraday standing waves while successive impacts renew the wave field. This is an experimental implementation of a wave-pilot system, as imagined by De Broglie, allowing to reproduce effects that were thought to be restricted to the quantum world: diffraction, Young's slits, tunneling, Landau level analogue, quantized and degenerate states in 2D harmonic potential, statistical superposition of states…



So far, this system has reproduced single-particle quantum analogues. The most profound quantum effects, such as non-separability, only manifest themselves with at least two particles. Whether such effects are intrinsic to the quantum world alone is a major scientific and intellectual challenge. Recently, we performed numerical simulations of two drops trapped in coupled underwater cavities that show that the correlations between the two particles may violate Bell's inequalities. This numerical result encouraged us to design an experimental setup to achieve the first violation of Bell's inequalities by coupled classical particles.

In a first phase of exploration, we managed to find some combinations of experimental conditions that violate Bell's inequalities without statistical ambiguity. The objectives of this position are to characterize and rationalize experimentally this violation.

A candidate with an experimental expertise in fluid mechanics with free boundary, interfacial phenomena and flow visualization, is the most welcome. Interested candidates should send a CV, cover letter –and arrange for at least one letter of reference to be sent– to the contact noted above before January 31st 2023. The position is generously funded by the EMERGENCE@INC2023 program.

Selected bibliography

K. Papatryfonos, L. Vervoort, A. Nachbin, M. Labousse, J.W.M. Bush, Bell test in a classical pilot-wave system (submitted), (2022) [preprint: arXiv:2208.08940v1].
K. Papatryfonos, M. Ruelle, C. Bourdiol, A. Nachbin, J.W.M. Bush, M. Labousse, Hydrodynamic superradiance in wave-mediated cooperative tunneling, *Communication Physics*, 5, 142 (2022)