Dipartimento di Fisica e Astronomia Galileo Galilei

1222·2022 800 ANNI — Università degli Studi di Padova

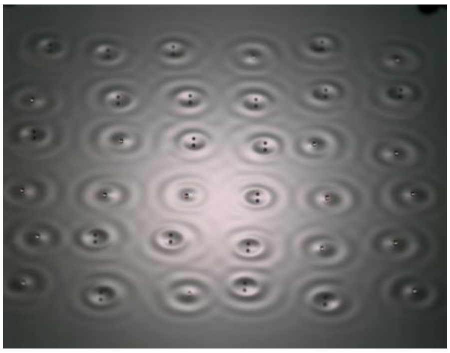
Lunedi 27 settembre 2021 ore 15.00 – aula "Voci"

Giuseppe Pucci, PhD

CNR-Nanotec, Rende (CS), Calabria

Wave-driven particles at a fluid interface: quantum analogs and active dynamics

I present two experimental systems consisting of particles driven by self-generated waves at a fluid interface: walking droplets and capillary surfers. These systems will be reviewed by analyzing their potential and limitations as quantum analogs and active systems.



Spin lattice of walking droplets.

About fifteen years ago, Yves Couder, Emmanuel Fort and collaborators in Paris discovered a form of macroscopic wave-particle duality. A liquid droplet can "walk" by bouncing on the surface of a vibrating liquid bath, propelled by its self-generated wavefield [1]. These "walkers" exhibit a number of quantum analogs, including wavelike statistics in cavities and quantization of orbits and angular momentum [2]. Collections of walkers have been arranged to form hydrodynamic spin lattices that exhibit various non-equilibrium symmetry-breaking phenomena, including transitions from antiferromagnetic to ferromagnetic order [3].

More recently, we have introduced capillary surfers: highly-tunable solid particles that self-propel on a vibrating liquid surface due to the asymmetric radiation pressure of their self-generated surface waves [4]. Two surfers interact via these surface waves and self-organize into multiple interaction modes, while multiple surfers exhibit collective behaviors. Generally, our results suggest that capillary surfers hold promise as a platform that bridges the gap between dissipation- and inertia-dominated active systems.

Two interacting capillary surfers.

[1] Y. Couder, S. Protière, E. Fort and A. Boudaoud. Walking and orbiting droplets. Nature 437, 208 (2005).
[2] J. W. M. Bush and A. U. Oza. Hydrodynamic quantum analogs. Rep. Prog. Phys. 84, 017001 (2020).
[3] P. J. Sáenz, G. Pucci, S. Turton, A. Goujon, R. R. Rosales, J. Dunkel and J. W. M. Bush. Emergent order in hydrodynamic spin lattices. Nature 596, 58-62 (2021).
[4] I. Ho, G. Pucci, A. U. Oza and D. M. Harris. Capillary surfers: wave-driven particles at a fluid interface. arXiv:2102.11694 (2021).