Andre Nachbin

Wave-mediated spontaneous synchronization of bouncing droplets

Couder and Fort (Nature 2005, PRL 2006) discovered that a fluid droplet bouncing on the surface of a vertically vibrating silicon oil bath, forms a wave-particle association referred to as a hydrodynamic pilot-wave system. Such an object was only imagined in the quantum realm. Much research has been done since this discovery. The main theme of this talk regards nonlinear oscillators which can be correlated at a distance. The dynamics of each droplet/particle is mediated by the surface Faraday wave, which acts as a potential. We present several regimes where two oscillating droplets are confined to separate wells. Through numerical simulations we detect “coherence” when the trapped droplets spontaneously synchronize, phase-locking as in the celebrated Kuramoto model. We then discover a new regime where “coherence” emerges in a statistical fashion (Chaos, 2018). Recently we found a regime of cooperative tunneling leading to a hydrodynamic analogue of superradiance (Nature, Comm. Phys. 2022). Also, we studied the effect of isolation on two droplets which previously interacted and were correlated. The dynamics and statistics are quite different had the two droplets been isolated at the onset (Phys. Rev. Fluids, 2022). Information of the pre-existing correlation is somehow stored in the wave-field. Additional very recent results will be presented if time permits.