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Yves Couder: Wave-particle duality as it emerges in the dynamics of a classical particle driven by its memory-endowed wave-field

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We have introduced, some time ago, an experimental system in which a droplet bouncing on a vertically vibrated liquid interface can become self-propelled by its interaction with the waves it generates. It thus becomes a self-propelled "walker", a symbiotic object formed by the droplet and its associated wave. A specificity of this system is that owing to the parametric forcing due to the substrate vibration the generated waves are standing Faraday waves that can be sustained in time. In these conditions there is information interplay between the drop and its wave-field so that the latter contains a memory of the recent trajectory of the droplet. Since this wave-field drives the drop a very specific self-organized dynamics emerges. Usually self-organization is a characteristic of the interaction of multiple entities. Here it is observed for a single structure interacting with its own past. I will specifically discuss recent experiments in which a walker, confined in a potential well, has an orbiting motion. Surprisingly, in spite of the classical nature of this system, several quantum-like characteristics emerge with a form of double quantization(1) of the orbits as well as probabilistic behaviors(2).

(1) S. Perrard, M. Labousse, M. Miskin, E. Fort, & Y. Couder, Nature Com. 5, 3219, (2014)
(2) S. Perrard, M. Labousse, E. Fort, Y. Couder, Phys Rev Lett, 113, 104101, (2014).