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Strange behavior of bouncing drops demonstrates pilot-wave dynamics in action (w/ Video)

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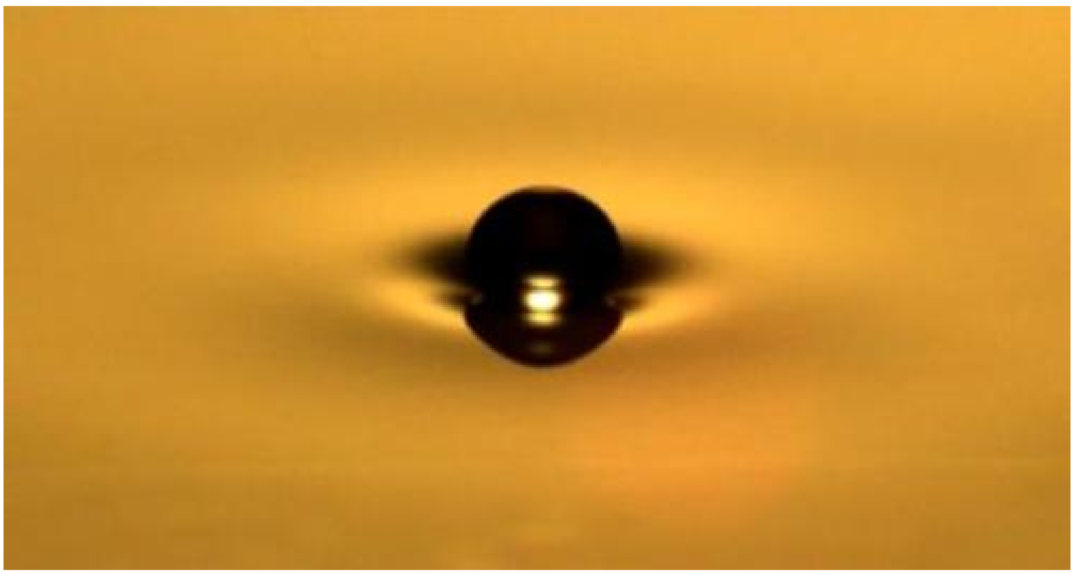

A research team led by Yves Couder at the Université Paris Diderot recently discovered that it's possible to make a tiny fluid droplet levitate on the surface of a vibrating bath, walking or bouncing across, propelled by its own wave field. Surprisingly, these walking droplets exhibit certain features previously thought to be exclusive to the microscopic quantum realm.

This finding of quantum-like behavior inspired another team of researchers, at the Massachusetts Institute of Technology (MIT), to examine the dynamics of these walking droplets. They describe their findings in the journal *Physics of Fluids*.

"This walking droplet system represents the first realization of a pilot-wave system. Its great charm is that it can be achieved with a tabletop experiment and that the walking droplets are plainly visible," explained John Bush, professor of applied mathematics in the Department of Mathematics at MIT. "In addition to being a rich, subtle dynamical system worthy of interest in its own right, it gives us the first opportunity to view pilot-wave dynamics in action."

The dynamics of the walking droplets are reminiscent of the pilot-wave dynamics proposed by Louis de Broglie in 1926 to describe the motion of quantum particles, in which microscopic particles such as electrons move in resonance with an accompanying guiding wave. Pilot-wave theory wasn't widely accepted and was superseded by the Copenhagen Interpretation of quantum mechanics, in which the macroscopic and microscopic worlds are philosophically distinct.

"Of course, if we ever hope to establish a link with quantum dynamics, it's important to first understand the subtleties of this fluid system," said Bush. "Our recent article is the culmination of work spearheaded by my graduate student, Jan Molacek, who developed a theoretical model to describe the dynamics of bouncing and walking droplets by answering questions such as: Which droplets can bounce? Which can walk? In what manner do they walk and bounce? When they walk, how fast do they go?"

In the team's article, Molacek's theoretical developments were compared to the results of a careful series of experiments performed by Øistein Wind-Willassen, a graduate student visiting from the Danish Technical

University, on an experimental rig designed by Bush's graduate student, Dan Harris.

"Molacek's work also led to a trajectory equation for walking droplets, which is currently being explored by my graduate student Anand Oza," Bush said. "Our next step is to use this equation to better understand the emergence of quantization and wave-like statistics, both hallmarks of quantum mechanics, in this hydrodynamic pilot-wave system."

The researchers will now seek and explore new quantum analogs, with the ultimate goal of understanding the potential and limitations of this walking-droplet system as a quantum analog system.

More information: The paper, "Exotic states of bouncing and walking droplets," authored by Øistein Wind-Willassen, Jan Molacek, Daniel M. Harris, and John W. Bush, appears in the journal *Physics of Fluids*. dx.doi.org/10.1063/1.4817612

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