**TEMPLE UNIVERSITY**
Department of Mathematics

# Applied Mathematics and Scientific Computing Seminar

Room 617 Wachman Hall

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## Mathematical Models for Walking Drops

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**Abstract.**

Yves Couder and coworkers (Paris) have discovered a macroscopic particle-wave system exhibiting many features previously thought to be peculiar to the microscopic quantum realm. A small liquid droplet placed on the vibrating surface of a fluid bath, can be made to bounce (essentially indefinitely) provided that the amplitude and frequency of the oscillations is in the "correct range", i.e.: (1) The frequency must be high enough that the "impact time" is too short to allow the air layer between the drop and bath to drain to the critical distance at which merging is initiated by van der Waals forces; (2) The maximum vertical acceleration of the free surface must exceed gravity (so the drop can lift off after landing); (3) The driving amplitude must be below the Faraday instability threshold, so the liquid surface remains (essentially) "flat".

Couder's experiments involve a millimeter sized droplet on a vibrating bath of highly viscous silicone oil. There, the drop may bounce indefinitely, generating a localized field of surface waves that decays with distance from the drop. The drop interacts with this wave field, and undergoes several bifurcations in its behavior as the driving amplitude grows: from bouncing in place at the same frequency as the fluid bath, to a period-doubling bifurcation, to spontaneous "walking" on the surface. Walking drops exhibit quantum-like effects: diffraction, interference, orbit quantization in rotating frames, etc. Multiple bouncers communicate through their wave fields, and can orbit each other forming "atoms", "crystal" lattices, etc.

In this talk I will introduce an integral equation that describes the wave-induced force that acts on walking droplets. From this we can write a new guidance equation for walking droplets, that provides insight into their observed quantum behavior. In particular I will consider the behavior of single and two-particle systems (away from boundaries) in both inertial and rotating frames, as well as in the presence of a central harmonic potential.

(This is joint work with Anand Oza, and John W. M. Bush)