A trajectory equation for walking droplets

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Yves Couder and coworkers have demonstrated phenomena reminiscent of quantum
mechanics in a macroscopic hydrodynamic system. Specifically, they have discovered
that millimetric droplets walking on a vibrating fluid bath exhibit wave-particle phe-
nomena previously thought to be peculiar to the microscopic quantum realm, includ-
ing single-particle diffraction and tunneling. Orbital quantization may be observed
by placing a walking drop on a rotating fluid bath, which suggests a correspondence
between the drop’s quantized orbits and the Landau levels of an electron in a uni-
form magnetic field. We here develop an integro-differential trajectory equation for
these walking droplets with a view to gaining insight into their subtle dynamics. We
present an exact formula for the walking speed and compare it to experimental data.
We also analyze the stability of the walking solution to infinitesimal perturbations.
The trajectory equation is used to model the walking drop in a rotating fluid bath,
which allows us to rationalize the observed orbital quantization. We predict the ex-
istence of self-orbiting or “spin” states and a mechanism reminiscent of the Zeeman
effect in quantum mechanics.

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