# Collective Dynamics of Walking Droplets

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## I. ABSTRACT

Millimetric liquid droplets which self-propel along the surface of a vertically vibrating bath have many properties analogous to those of quantum particles, such as orbital quantization [1, 2]. Experiments with these 'walkers' have historically been limited to scenarios in which there is either only one walker or in which there are multiple walkers limited to wavefield interaction because free walkers will quickly collide and coalesce. This restriction has been a significant obstacle to developing more robust analogs to quantum systems. We aim to eliminate this coalescence to enable experiments with freely interacting walkers. We begin by characterizing this droplet-on-droplet collision in terms of an air lubrication layer between two droplets which drains as the droplets approach. Lubrication theory suggests that increasing the density of this air layer by increasing ambient air pressure will widen an interval in which droplets colliding neither too fast nor slow may collide without coalescing. We then confirm this in a pressurized chamber wherein walkers are created and held until the pressure has been raised, and then are released to freely interact. While at ambient pressure, coalescence will happen within seconds of the droplets' release, we show that under certain configurations of droplet size and forcing, increased pressure prevents coalescence indefinitely, which will enable an entire future family of experiments with collections of walking droplets to represent entire quantum systems, not just quantum particles.

## II. REFERENCES

[1] Bush, John W, and Anand U Oza. "Hydrodynamic Quantum Analogs." *Reports on Progress in Physics*, vol. 84, no. 1, 2020, p. 017001., doi:10.1088/1361-6633/abc22c.

[2] Fort, Emmanuel, et al. "Path-Memory Induced Quantization of Classical Orbits." *Proceedings of the National Academy of Sciences*, vol. 107, no. 41, 2010, pp. 17515–17520., doi:10.1073/pnas.1007386107.