# The Bridge of Microscopic and Macroscopic World by Little Droplet

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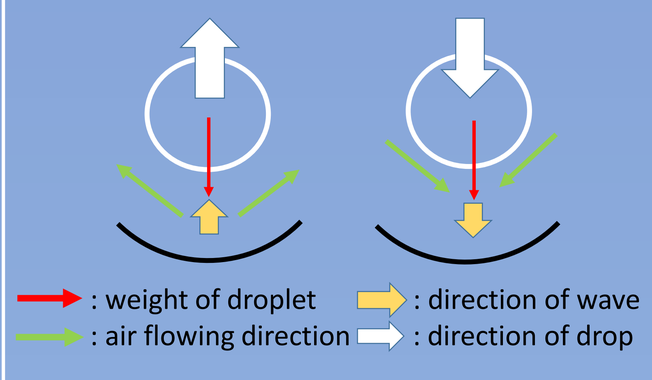
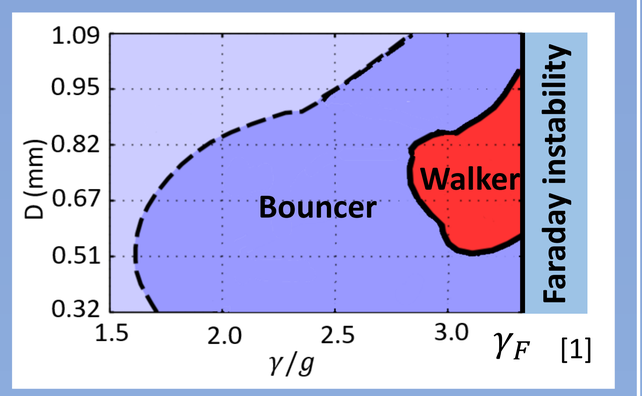
The motion of an oil droplet with the shaking liquid bath can be classified to different types: bouncer, walker and Faraday instability. The bouncer and walker can be propelled along the surface by interacting with wave fields they produced. The movement of walking droplets can seemly analog to the microscopic quantum system and this arouses our interest. In our experiment, different types of walking motion, distribution and other characteristics are discussed and counted in the statistical form.

## Introduction

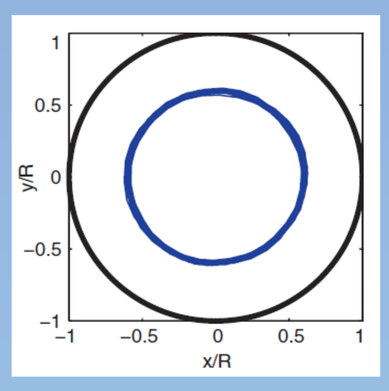
Our system is to simulate a wave - particle system. Waves are generated on the vertical vibrating oil surface. With waves and oil droplets, the quantum system can be mimicked.

A thin air layer is generated between the oil surface and droplets. Therefore, droplets can jump on the oil surface continually. By changing droplet size (D) and vertical acceleration ($\gamma$), different states of droplets can be observed.

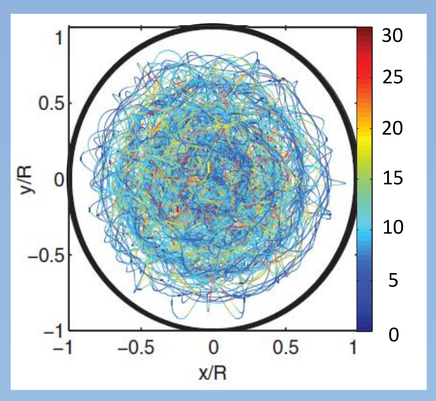



Bouncer always stays at the same position. Walker can be classified into two types, spinning and chaotic walker. Spinning walker forms a trajectory of stable circular orbits. Chaotic walker moves randomly. It is affected by the waves produced previously to cause the trajectory changing significantly.[1,2]

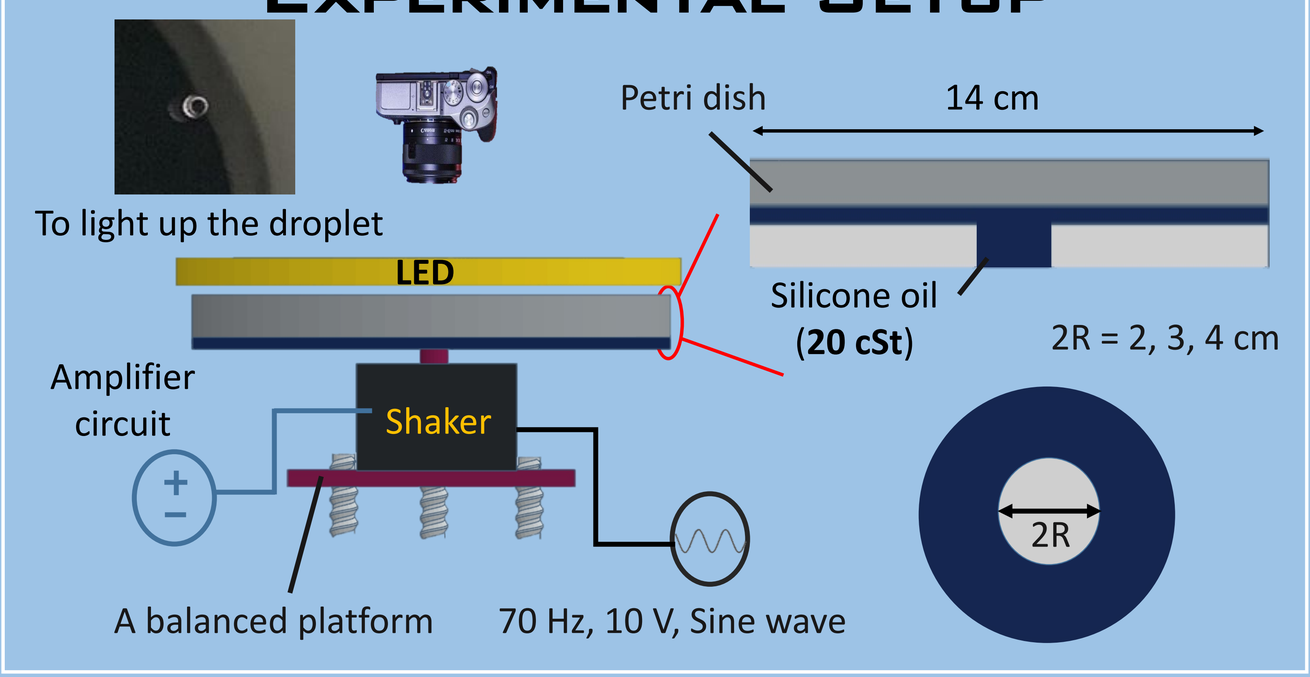



**Spinning walker** [2]



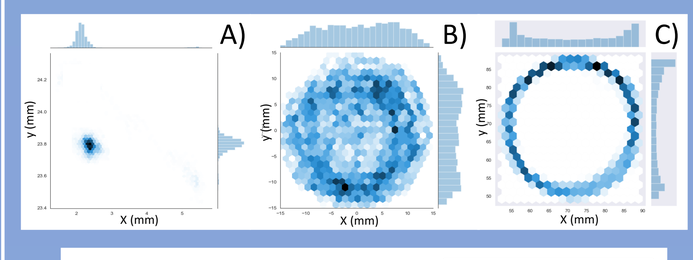

**Chaotic walker** [2]

## Experimental Setup

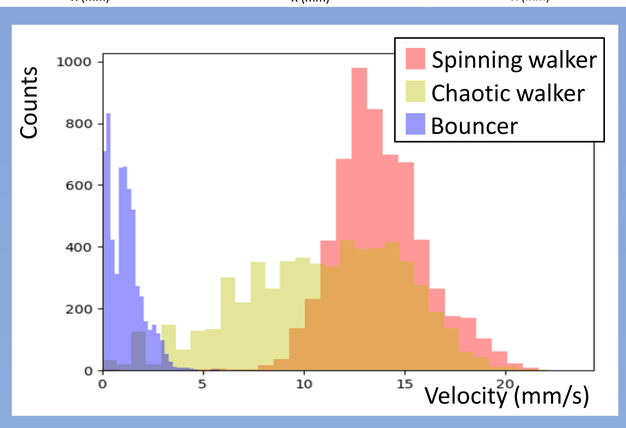



## Results

### Property of the droplet

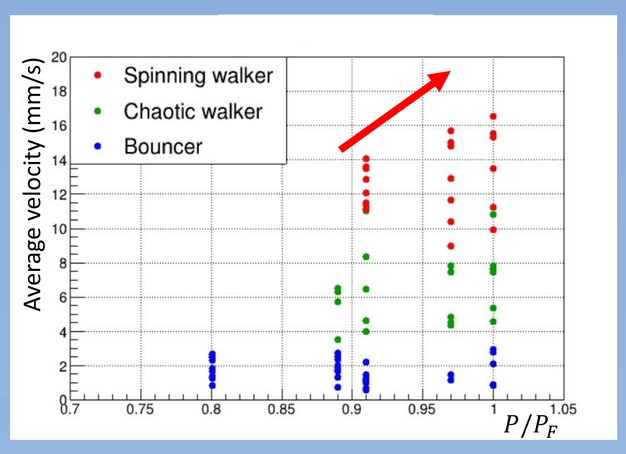



- The distribution of the droplet. A) Bouncer, B) Chaotic walker and C) Spinning walker.




- The velocity of the bouncer closes to 0 mm/s.
- The velocity of the chaotic walker has a wider range comparing to the spinning walker.

### Average velocity of droplet vs. power



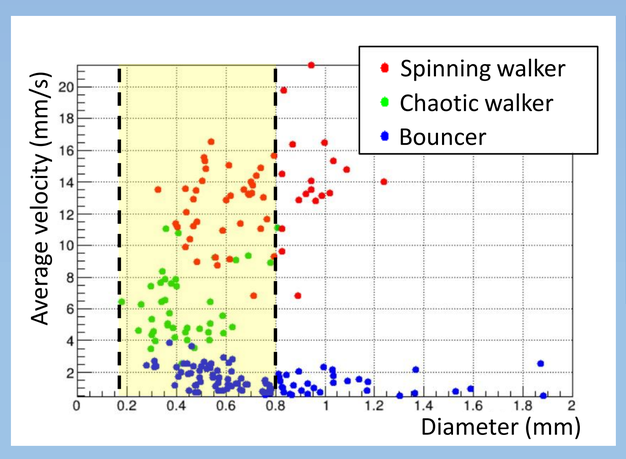

Walker can be observed when $P/P_F \sim 1$.

($P$: the power of the shaker, $P_F$: the power when it just becomes Faraday instability.)

Average velocity shows : spinning walker > chaotic walker > bouncer

The maximum average velocity increases with power.

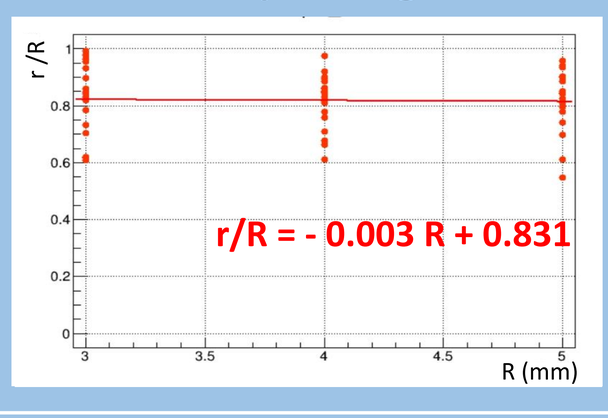
### Average velocity of droplet vs. diameter of droplet




| Type | Diameter |
|---|---|
| Spinning walker | 0.4 ~ 1.2 mm |
| Chaotic walker | 0.2 ~ 0.6 mm |
| Bouncer | 0.2 ~ 2.0 mm |

All types of the droplet can be observed in 0.4 mm ~ 0.8 mm.

### Radius of spinning walker vs. diameter of hole




Spinning radius is always 0.6 ~ 1 R.

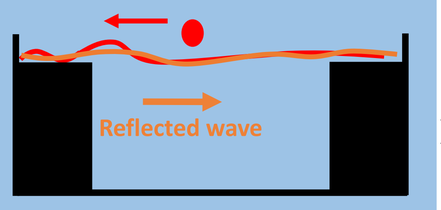
Fit function shows that : r/R is independent of the hole size.

r : spinning radius

R : radius of hole

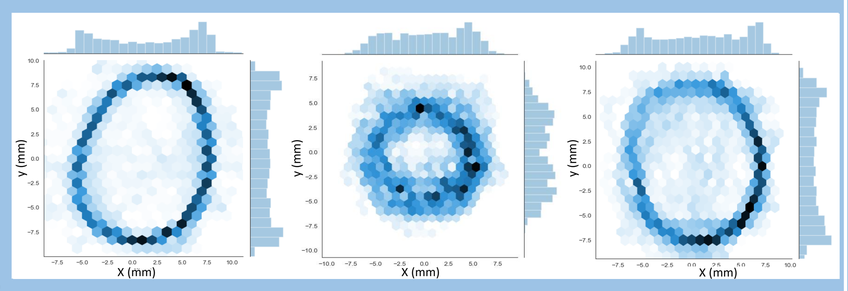
## Boundary condition

To avoid the reflected waves affecting the motion in the deep water zone, the distance between the hole and boundary is studied. The shallow water zone is to reduce the amplitude of wave.




From the measurement, the distance > 20 mm is used.

**15 mm** **20 mm** **30 mm**




$\frac{\Delta y}{\Delta x} = 1.2$ $\frac{\Delta y}{\Delta x} = 1.07$ $\frac{\Delta y}{\Delta x} = 1.06$

## Conclusion

- Distance between the boundary and hole larger than 20 mm is better to prevent the reflected waves.
- Velocity : bouncer ~ 0 mm/s, the chaotic walker has a wider range comparing to the spinning walker.
- Walker happens when $P/P_F$ close to 1.
- The maximum average velocity increases with power.
- Three types of the droplet are observed in diameter of 0.4 mm ~ 0.8 mm.
- The radius of spinning walker is always 0.6 ~ 1 r/R

- [1] J. Fluid Mech. (2013), vol. 727
- [2] PRE 88, 011001(R) (2013)