wave-particle interaction analysis in one dimensional Faraday wave

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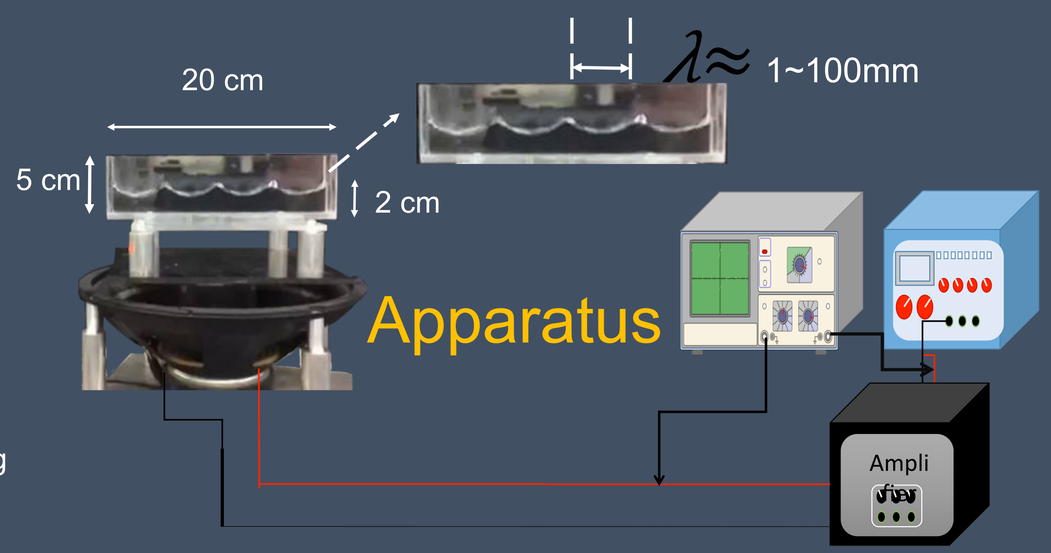
Background

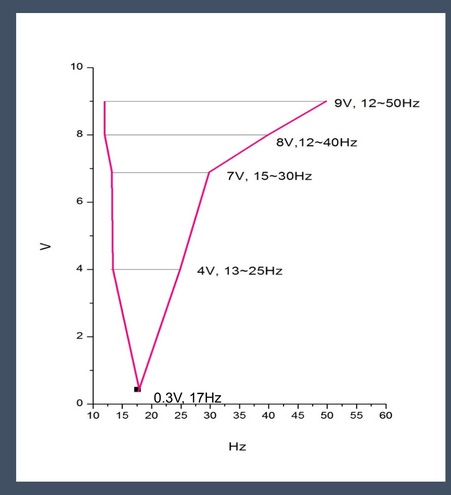
Wave view: Faraday wave is a nonlinear system
- Restoring force: gravity and surface tension
- Scale(wavelength): close to centimeter
- Order state: close to linear system
- One dimensional: simple wave-particle interaction

Our work

Particle view
- Mushroom powder: close to water particle
- Asymmetric of the restoring force in a period
- Complete cycle motion according to the restoring force



Arnold tongue



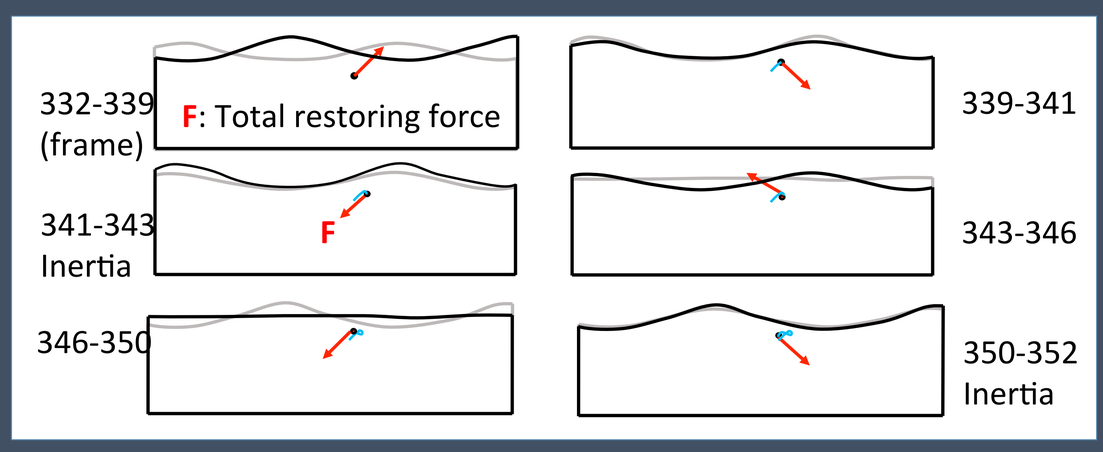
Ordered state particle motion in one wave period

- How do we analyze the flow from a particle view?

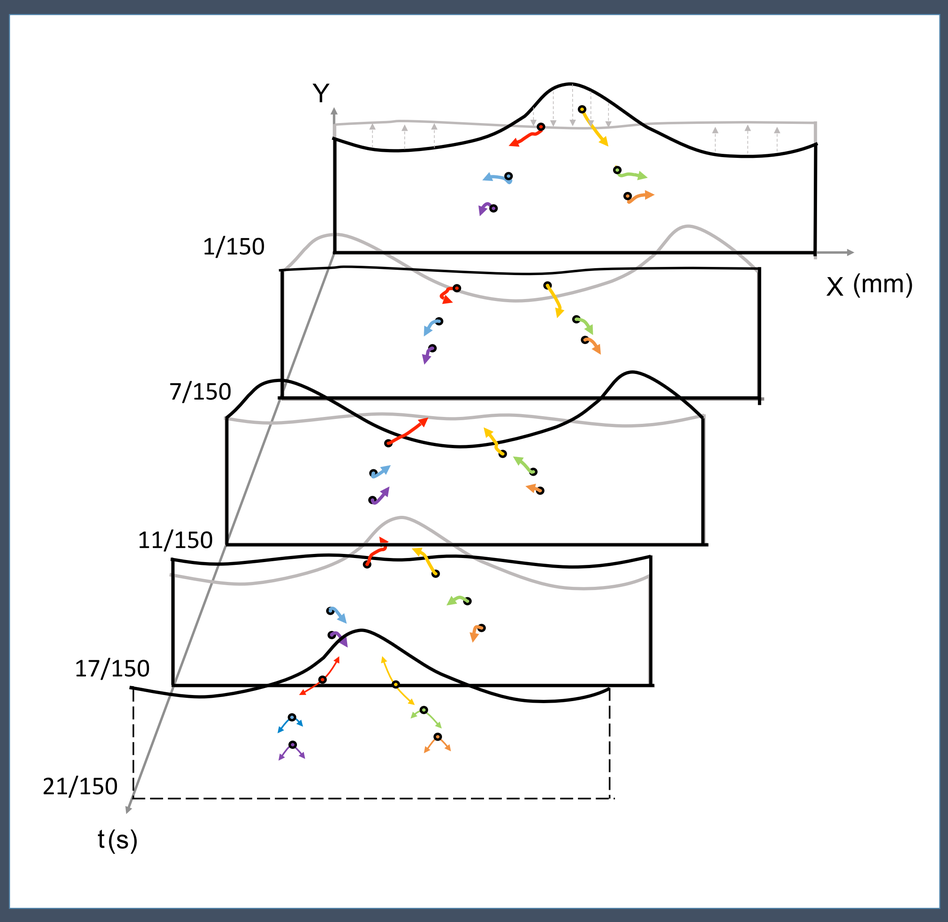
1. We focus on particle motion in one wave period.
2. We divide the trajectory of particles into three parts:(a) On the surface (b) In the middle (c) At the bottom

- The particle motion construct the flow of Faraday wave.
- Particles can move horizontally although we only apply vertical force.

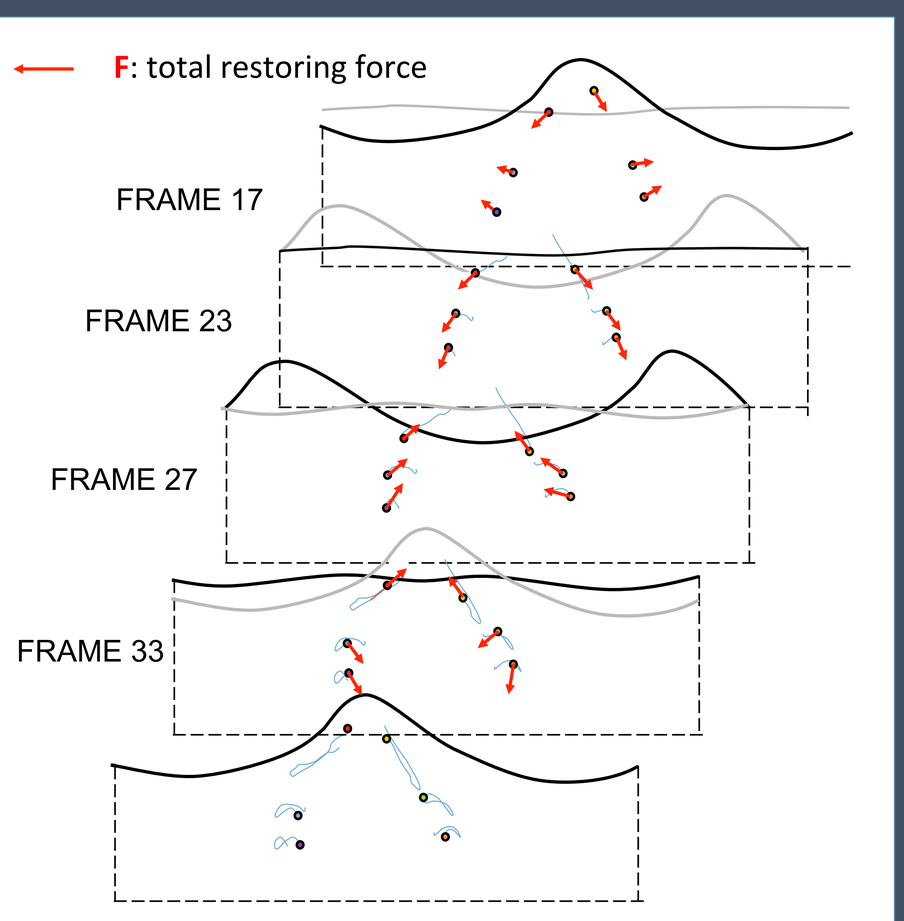
Symmetric wave



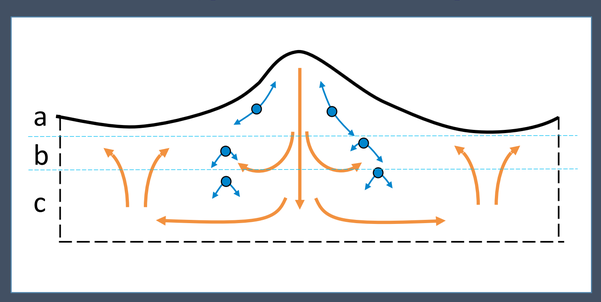
Particle trajectory



Asymmetric wave



Flow (particle cycle)



The magnitude of the total restoring force is the same but the distance between the particle and the surface will dominate which side of the surface tension dominate the restoring force. What's more, it will also effect the propagation time of the force.

A complete cycle of particle motion

Symmetric

Asymmetric

If we conclude the particle motion of each period, we can get a complete cycle.
- Symmetric wave:

1. The restoring force isn't symmetric and cause the drift and vertical motion of particles.
2. The only source for the drift is the restoring force.

- Asymmetric wave:

1. Bigger asymmetric restoring force
2. Cycle drift between oscillons

Conclusion

- The real flow in Faraday wave obey the principle of continuity equation.
- The flow is constructed by particles and according to asymmetric restoring force, it will generate the drift of particles. The asymmetric means the position between different oscillons and the surface.
- Even the symmetric wave will generate asymmetric force.

Reference

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