Solid particles walking on a vibrating interface:

Towards wave-mediated granular matter

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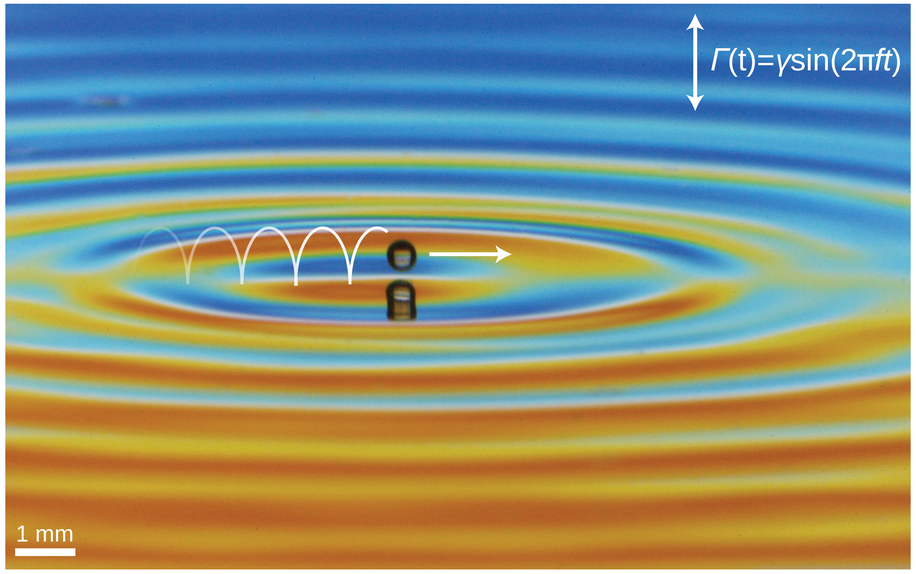
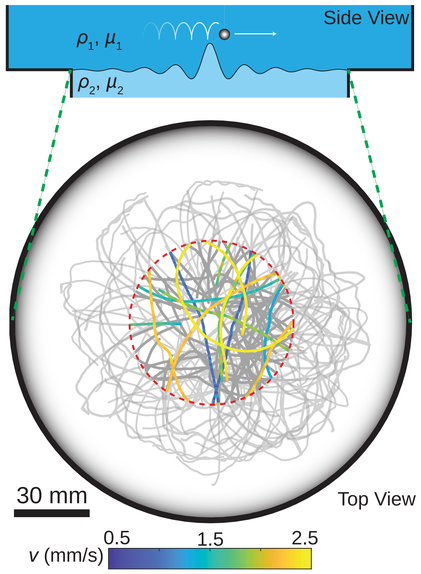
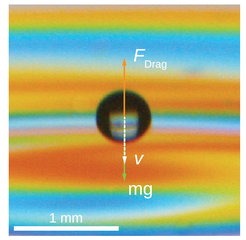
Solid particle walking on a vibrating oil-water interface

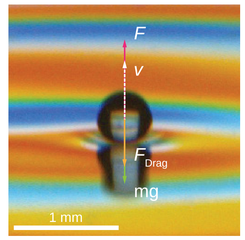


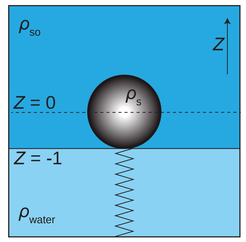


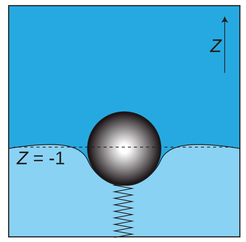
We place a glass particle on a sinusoidally vibrated interface of two liquids and enable the particle bouncing. By carfully tuning the vibration strength and particle size, we find the particle can land on the slope of the self-emanating wave field and performs horizontal motions along the interface, known as "walking".

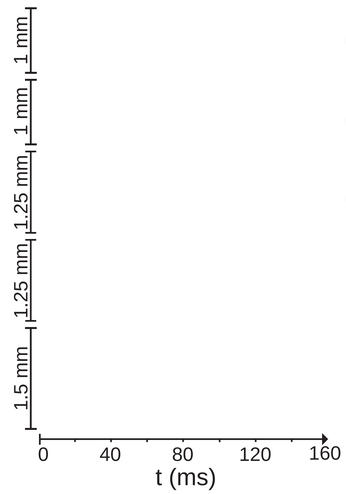
Vertical dynamics of a bouncing particle

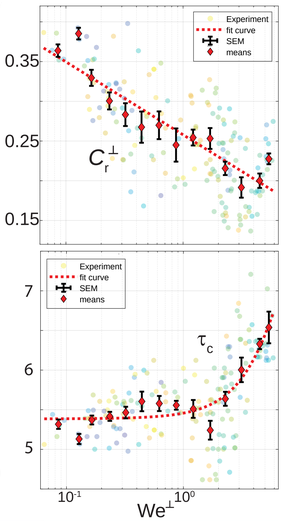


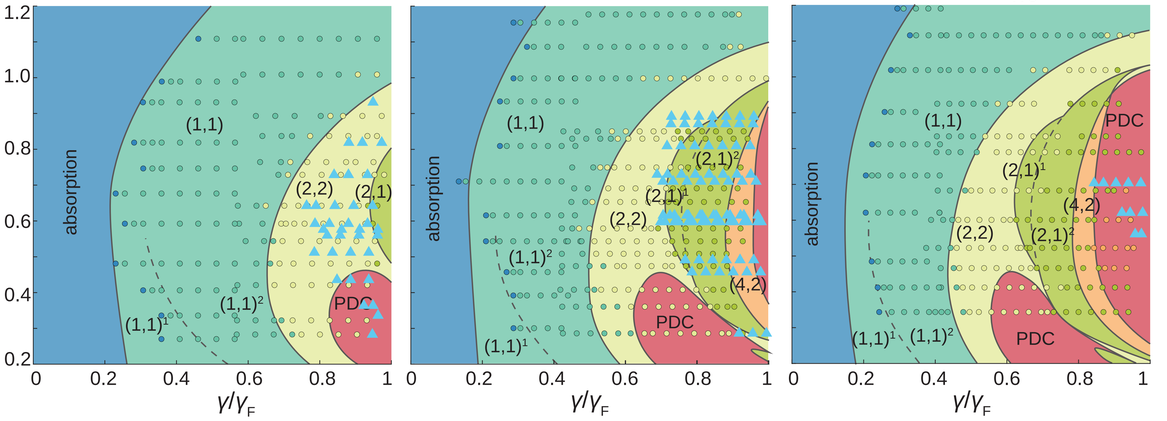


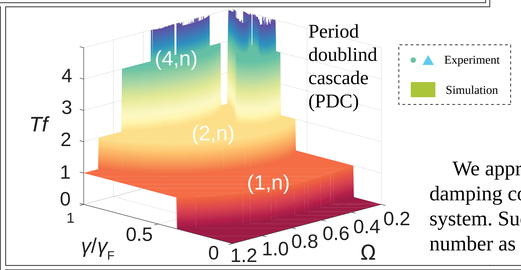










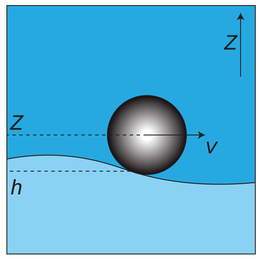


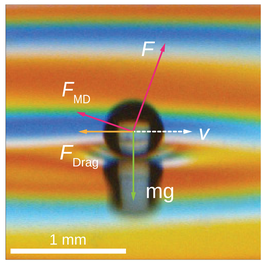
Period doublind cascade (PDC)

Experiment
Simulation

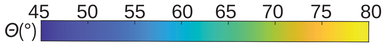
We approximate the vertical interfacial reaction force F by a damped linear-spring. To determine the two physical constants (spring constant and damping coefficient) which characterizes the spring, we introduce the restitution coefficient $C_r^{\perp}$ and contact time τ_c as their new counterparts in our system. Such two physical constants can either be measured by observing a particle's rebound from the quiescent interface; or we may regard the two number as fitting parameters and match with the bouncing modes reported in the experimentally observed phase map. Walking is denoted as ▲.

Horizontal dynamics of a walking particle

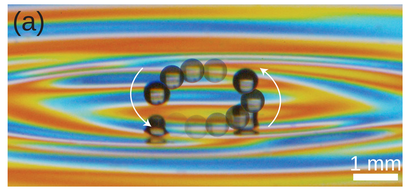


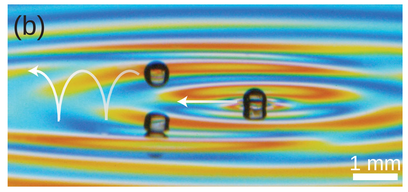


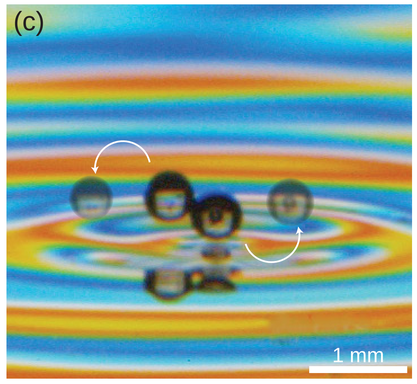
We observed the preferred walking velocity increases and saturates as increasing vibration. We compute the kick F received by the particle during each contact with the wave slope. Such contact not only creates a propulsion but also drag force F_{MD}. Nevertheless, we performed the similar experiment to measure tangential restitution coefficient $C_r^{\top}$ which characterizes the energy loss in the horizontal frame.

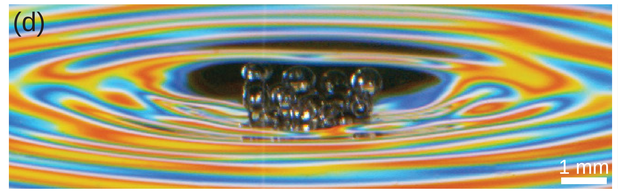


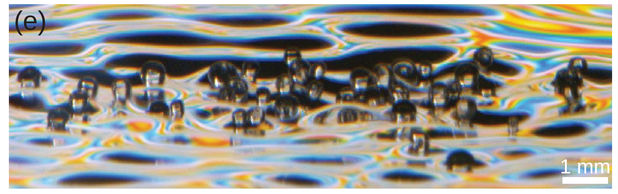
Plethora of particle's dynamics on a vibrating interface

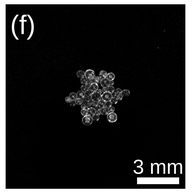


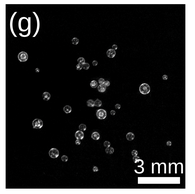












(a) Spin orbital coupling of two solid walkers in which they form a closed rotating orbit with quantized radii. (b) A type of chasing pair in which one solid particle is absorbed at the interface. (c) Particle collision induced by forcing two bouncers closer to each other. (d,e) Side-views of granular particle rafts self-disassemble on vibrating interface with progressively increasing γ. (f,g) Top-views of rafts before and after the self-disassembling.