Synchronized Surfing of Self-Propelled Particles

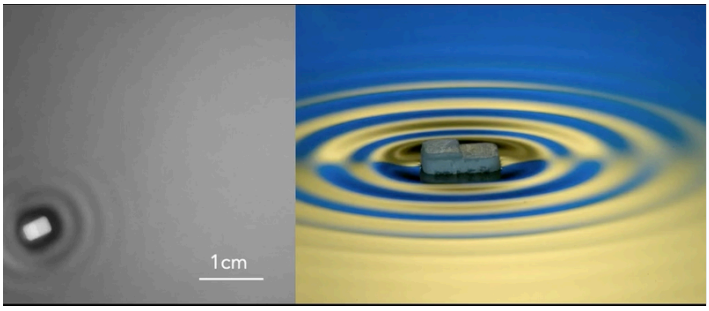
Millimeter-sized "surfers" can self-propel across a vibrating liquid surface, interacting with other surfers to create collective patterns.

By **Maggie Hudson**

Self-propelled objects can move in mesmerizing patterns. The collective movements of groups of such objects typically occur in one of two flow regimes: the inertial regime—think swirling schools of fish in water—or the viscous regime—think swarming colonies of bacteria in mucus. Some self-propelled objects can travel in both flow regimes, a possibility that is less explored. Daniel Harris at Brown University, Rhode Island, and colleagues have studied the motion of a new system of self-propelled objects that move in this intermediate regime, finding that the objects organize into several distinct and tunable motion patterns [**1**]. The researchers say that their surfers may serve as a versatile, accessible model system for developing a detailed understanding of active matter in the intermediate flow regime.

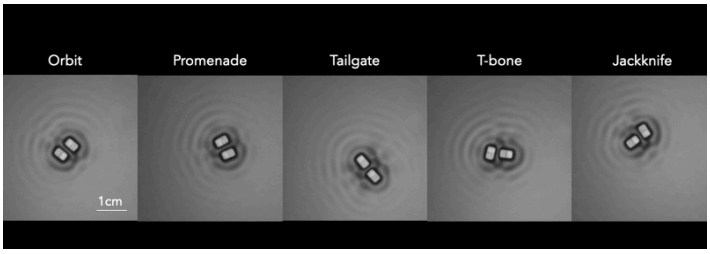
The team considered millimeter-scale plastic "surfers" floating atop a vertically vibrated pool containing a mixture of water and glycerol. The surfers resembled miniature, rectangular boats and had uneven weight distributions across their lengths. With heavier sterns than bows, the surfers bobbed up and down like seesaws when the liquid surface vibrated. The waves that then emanated from the bow and stern of each surfer had unequal amplitudes, with the sterns creating waves with higher amplitudes.

Credit: I. Ho *et al.* [**1**]



Video 1: Hydrophobic plastic objects with a step-like outline surf along a vibrated water–glycerol surface, propelled by self-generated waves.
Credit: I. Ho *et al.* [**1**]

When only one surfer was present, these mismatched amplitudes propelled the surfer in the direction of its bow. When there were two surfers close to each other, interactions among the waves caused the surfers to either repel each other so that they moved in opposite directions or to come together so that they collectively traced one of seven distinct patterns. The team considered groups of up to eight surfers, finding similar collective behaviors. The team also developed a mathematical model that explains this behavior [**2**].



Video 2: Pairs of self-propelled surfers observed by the team move in one of seven different patterns (the video shows five). These include the "orbit," where a pair of surfers rotate around a central point; the "tailgate," where one surfer closely follows another, head to tail in a linear path; and the "jackknife," where a pair of perpendicular surfers rotate stern to stern around their collision point.
Credit: I. Ho *et al.* [**1**]

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REFERENCES

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