

Self-propulsion of floating objects driven by the Marangoni flow induced by the presence of multiple species

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Floating objects that release volatile surface active material show self-propulsion by generating the Marangoni flow around the object. Typical example is a camphor particle on a water surface, which shows self-propulsion by the spontaneous fore-aft and/or rotational symmetry breaking around the particle. Interestingly, such surface active material also induces effective interaction between particles that can be nonreciprocal; i.e., the broken action-reaction laws. In such a case with the multiple type of objects, the different types of objects experience nonreciprocal interaction, and they create self-propelling pairs owing to the unbalanced effective force. Here, we show several systems of floating objects with multiple species, and especially talk about the system with binary droplets, PFD and decane droplets, on water. The system showed self-propulsion, as well as the repetitive activity that resembles eruptive motion. We discuss the behavior in terms of the presence of duplex films on the water surface.

Reference:

[1] Yutaka Sumino, Ryo Yamashita, Kazuki Miyaji, Hiroaki Ishikawa, Maho Otani, Daigo Yamamoto, Erika Okita, Yasunao Okamoto, Marie Pierre Krafft, Kenichi Yoshikawa and Akihisa Shioi, "Droplet duos on water display pairing, autonomous motion, and periodic eruption", *Sci. Rep.* 13,12377-1-10 (2023).

[2] Hiroaki Ishikawa, Yuki Koyano, Hiroyuki Kitahata, and Yutaka Sumino "Pairing-induced motion of source and inert particles driven by surface tension", *Phys. Rev. E.* 106,024604-1-11 (2022).

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