Abstract Submitted
for the DFD16 Meeting of
The American Physical Society

Towards designing miniature surfing robots SAEED JAFARI KANG, VAHID VANDADI, HASSAN MASOUD, University of Nevada, Reno —
We theoretically study the surfing motion of chemically and thermally active particles located at a flat liquid-gas interface that sits above a liquid layer of finite depth. The particles' activity creates and maintains a surface tension gradient resulting in the auto-surfing. It is intuitively perceived that Marangoni surfers propel towards the direction with a higher surface tension. Remarkably, we find that the surfers may propel in the lower surface tension direction depending on their geometry and proximity to the bottom of the liquid layer. In particular, our analytical calculations for Stokes flow and diffusion-dominated scalar (i.e. chemical concentration and temperature) fields indicate that spherical particles undergo reverse Marangoni propulsion under confinement whereas disk-shaped surfers always move in the expected direction. We extend our results by proposing an approximate formula for the propulsion speed of oblate spheroidal particles based on the speeds of spheres and disks. Overall, our findings pave the way for designing microsurfers capable of operating in bounded environments.

Hassan Masoud
University of Nevada, Reno

Date submitted: 26 Jul 2016

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