Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Generalized rheotaxis of active particles in confined Stokes flow WILLIAM USPAL, University of Hawai'i at Manoa, Dept. of Mechanical Engineering — We consider spherical active particles exposed to shear flow near a planar surface. The swimming activity of a particle gives rise to interactions (e.g., hydrodynamic or chemical interactions) with the surface that couple back to the motion of the particle. Via a dynamical systems approach, we show that a robust directional response can emerge from the interplay of external flow and near-surface swimming activity. For instance, depending on the external flow strength and the character of the swimming activity of the particle, the particle can align against the flow direction (upstream rheotaxis) or nearly perpendicular to it (cross-stream rheotaxis). As an instructive and analytically tractable example, we apply our findings to the squirmer model of a mechanically actuated microswimmer. Using far-field approximations, lubrication theory, and exact numerical calculations, we identify the conditions on the squirming mode amplitudes to obtain the various steady states. Finally, we discuss collective rheotaxis of a group of squirmers. Overall, our findings demonstrate that microswimmers can exhibit surprisingly rich behavior when operating in confined flows, which occur in many of their envisioned applications.

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Date submitted: 31 Jul 2019 Electronic form version 1.4