Center for Environmental & Applied Fluid Mechanics

"Active Mixing in Laminar Flows: How is a Swimming Microbe like a Forest Fire?"

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We present experiments on the effects of laminar flows on the motion of swimming microbes and on the motion of the excitable Belousov-Zhabotinsky chemical reaction. This is a topic with applications to a wide range of systems including microfluidic chemical reactors, self-assembly of novel materials, blooms of harmful algae in the oceans, and the effects of moving populations on the spreading of a disease. A universal theoretical framework of active mixing predicts invariant manifolds -- "burning invariant manifolds" (BIMs) for front propagation and "swimming invariant manifolds" (SwIMs) for self-propelled tracers -- that act as one-way barriers for both of these systems. In fact, the problem of front propagation is a special case of the more general, active mixing theory. We present results from several experiments: (a) BIMs blocking reaction fronts in a range of 2-D and 3-D vortex-dominated flows; (b) SwIMs blocking motion of swimming bacteria and eukaryotic microbes in a microfluidic hyperbolic flow in a cross channel; and (c) on-going experiments about the behavior of swimming microbes in vortex flows.

Fall 2023 CEAFM Seminar Series

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