ESPCI
Laboratoire PMMH
10 rue Vauquelin, 75231 Paris Cedex 05

Séminaire PMMH

Salle de réunion du PMMH, Campus Jussieu, Bâtiment Cassan A, 1 er étage

Vendredi 22 juin 2018, 11h00-12h00

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Biomimetic flapping and beating in viscous fluid

We probe interactions of elastic structures with viscous fluids to investigate biomimetic approaches for fluid manipulation. We consider two systems : fish-like elastic fines and artificial cilia. Fish displays incredible agility and speed using oscillating flexible fins. We represent fins as thin elastic plates actuated to oscillate at the leading edge. We explore the effects of fin elasticity and shape on swimming velocity and economy. We show that structural resonance yields faster swimming and that fin tapering enhances swimming economy for a wide range of actuation frequencies. We also probe the propulsion of swimmers actuated by a distributed internal bending moment that mimics fish muscles. We show that swimming performance of such active swimmers greatly benefits from passive elastic attachments at the swimmer trailing edge. In our second example, we probe to design arrays of artificial magnetic cilia that mimic beating of natural cilia. Due to their small size, cilia operate in low Reynolds number regimes, where a non-reciprocal beating is required to produce a net fluid flow. Our artificial cilia formed from thin ferromagnetic films and actuated by a uniformly rotating magnetic field display distinctly different forward and recovery strokes. We probe the utility of such cilia for microfluidic pumping and design arrays of beating cilia that produce metachronal waves. We also show how magnetic cilia can be individually immobilized by integrating electrostatic actuation into a ciliary array.