Moving in the in-between: locomotion strategies at intermediate Reynolds numbers and across environmental interfaces

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12:30 PM
Bowen Hall Room 222

MAE Seminar Series

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Animals must use different swimming strategies at very small lengthscales and slow speeds (where viscosity plays a primary role) versus larger scales and speeds (where inertial forces dominate). Studies have historically focused on organisms that move at the limits of these two regimes; however, many animals move in such a way that both inertia and viscosity play an important role. We will examine two different groups of animals who swim at intermediate Reynolds numbers, from both marine and freshwater environments. Comb jellies (ctenophores) are a group of marine zooplankton who are among the oldest animals on the planet; they are also the largest animals on Earth which use cilia to swim. These flexible hair-like structures typically occur at the scale of microns, but in ctenophores their length is on the order of a millimeter. We will explore the hydrodynamic scaling of cilia from the viscous- to inertia-dominated flow regime, and discuss implications for bioinspired devices, sensors, and vehicles. Second, we will examine two aquatic insects in the infraorder Nepomorpha: water boatmen and backswimmers. These insects are unique not only because they swim at intermediate Reynolds numbers, but because they are trimodal: they can swim, walk, and fly, transitioning quickly and easily between locomotor modes. Here we will focus on the role of fluid mechanics in mediating the organism-environment interactions which permit and promote these transitions.

Margaret L. Byron is an Assistant Professor of Mechanical Engineering at Penn State University, where she directs the Environmental and Biological Fluid Mechanics (EBFM) Laboratory. She received her B.S.E. from Princeton University in Mechanical and Aerospace Engineering (2010), and her M.S. and Ph.D. from the University of California Berkeley (2012/2015). From 2015 – 2017 she was an NSF Postdoctoral Fellow in Biology at the University of California Irvine. She is a recipient of the American Chemical Society Doctoral New Investigator Award (2019), the Arnold and Mabel Beckman Foundation Young Investigator Award (2021), and the NSF CAREER Award (2022). Dr. Byron's group studies the interactions between organisms and particles in environmental flows, with a particular focus on intermediate scales where inertial and viscous fluid forces are both important. She is interested in how animals control their position and orientation in turbulence, how their swimming strategies scale with size and speed, and what this implies for their overall behavior and distribution in aquatic environments. She is also exploring the effects of inertial particles' size, shape, and mass properties on their kinematics in environmental flows; particular application areas include the transport of microplastics and the formation and settling of marine aggregates.

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