Cleveland State University
College of Science

COLLOQUIUM

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From Nerve Net to Vortex Ring: A Computational Modeling Approach to Medusan Biomechanics

Friday September 20th at 3pm in RT 1516

Bio: Prof. Hoover grew up in the Cleveland region before heading out to complete his PhD in Mathematics at the University of North Carolina at Chapel Hill with Prof. Laura Miller. After completing his doctorate, he held a postdoctoral fellowship at the Tulane University in New Orleans before landing back in Northeast Ohio as an assistant professor at the University of Akron. His research is firmly at the intersection of fluid dynamics, numerical partial differential equations, and mathematical biology. Some of the perks of his research is that he gets to go on research cruises at sea on the hunt for flow fields generated by organisms in the midwater ocean.

Abstract: In order for an organism to have an robust mode of locomotion, the underlying neuromuscular organization must be adaptable in a changing environment. In jellyfish, the activation and release of muscular tension is governed by the interaction of pacemakers with the underlying motor nerve net that communicates with the musculature. This set of equally-spaced pacemakers located at bell rim alter their firing frequency in response to environmental cues, forming a distributed mechanism to control the bell's muscular contraction. The relative simplicity of the jellyfish nervous system presents mathematicians with the opportunity to examine an intriguing multi-scale, multi-physics system with many potential applications to soft-body robotics and tissue-engineered pumps. In this talk, we explore the control of medusan neuromuscular activation in with a model jellyfish bell immersed in a viscous fluid and use numerical simulations to describe the interplay between active muscle contraction, passive body elasticity, and fluid forces. The fully-coupled fluid structure interaction problem is resolved using an adaptive and parallelized version of the immersed boundary method (IBAMR). This model is then used to explore the interplay between the speed of neuromechanical activation, fluid dynamics, and the material properties of the bell.

Refreshments at 2:30pm in RT 1517