2018 Annual Meeting of the Society for Mathematical Biology & the Japanese Society for Mathematical Biology

Contribution ID: **395** Type: **Oral Presentation**

The emergence of neuromechanical resonance in jellyfish locomotion

Wednesday, 11 July 2018 15:00 (30 minutes)

In order for an organism to have an robust mode of locomotion, the underlying neuromuscular organization must be maneuverable 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. When turning, pacemakers induce an asymmetrically timed contraction with the bell musculature. In this work, we explore the control of neuromuscular activation 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 solved 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.

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Session Classification: Modelling the neuromechanics of swimming, flying and pumping systems

Track Classification: Minisymposium: Modelling the Neuromechanics of Swimming, Flying and Pumping Systems