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University of Miami, Physics Department Colloquium

Date: Friday, Oct 11, 2024
Time: 4:00 pm – 5:00 pm
Location: Wilder Auditorium – Rm 112, Knight Physics Building

Cracking Neural Computations of a Simple Brain

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Abstract

How do brains compute? The Drosophila (fruit fly) larva is a small, semi-transparent crawling organism with about 10,000 neurons, compared to 100 billion in humans and 100 million in mice. Despite this simplicity, the larva carries out information-processing tasks, including navigation – moving towards a favorable location based on information from its senses. When facing increases in aversive stimuli, such as light or CO2, larvae on average respond by often changing their direction of movement. However, behavior of each larva can vary when subjected to the same stimulus presentation, and a larva may not respond with same fidelity to different sensory modalities. This intrinsic variability may reflect the differences in the neural implementation of their navigational algorithms to a range of sensory inputs. To quantify the variability in larva's information-processing algorithms, we presented larvae with two aversive stimuli, alone and in combination. We categorized the variability of their behavioral responses to light and fictive odors, and determined the conditions under which they elicit a reliable response to presentations of aversive stimuli. These approaches allowed us to hypothesize the basic underlying mechanisms that larvae engage to a combination of sensory cues.

Because the larva is almost clear, it has been a long-standing goal to use a microscope to "read the larva's mind" as it navigates its surroundings. However, the 3D brain movements generated by the larva's complicated locomotion have prevented optical recording of neural activity in behaving larvae. During my postdoc, we developed a two-photon microscope capable of tracking single neurons moving rapidly in 3D while using a second beam to scan and image from the volume around the tracked neuron. In this way we achieved motion-corrected volumetric imaging in a freely-behaving animal. This allowed us to image correlated activity of motor and pre-motor neurons from a significant portion of larva's "spine" in a completely unrestrained crawling animal. I will use these techniques to follow information flow through the larva's circuits during sensory-motor transformations and achieve a neuron-level understanding of how a simple brain implements fairly complex calculations.