BiophysTO Lunchtime Seminar Series

BIOPHYS TO

Date
Thursday, September 13, 2018
12:00 pm (noon)

Location
McLennan Physical Labs, MP606
60 St George Street

Pizza & refreshments provided

Prof. William Ryu

Department of Physics and Donnelly Centre
University of Toronto

The Physics of Behavior: measuring and modeling the sensorimotor response of *C. elegans.*

The roundworm, *C. elegans* is a relatively simple organism with only 300 neurons but can generate complex adaptive behavioral responses to a wide range of sensations including taste, touch, and temperature. *C. elegans* locomotion consists of a number of stereotyped behavioral states such as forward and reverse, pausing, turning, etc. In general, the worm moves randomly by making stochastic transitions between these states, and in response to sensory measurements it performs adaptive locomotory changes (behaves) by biasing the probability of these transitions. However under certain conditions the worm will respond deterministically with a specific behavioral sequence or motif, such as in the escape response to a "painful" or noxious stimulus. One of the grand goals in science is to understand how neural, genetic, and biochemical circuits produce these behaviors. While a great deal of work has been done in the development of tools to perturb and measure the circuits underlying sensory behavior, advances in the study of behavior itself has lagged behind. Here I will describe some attempts to close this gap with focus on *C. elegans* movement and its response to thermal stimuli. We've developed simple desktop experiments to programmatically stimulate *C. elegans* and quantitatively capture its behavioral response. Using these data we have shown that *C. elegans* moves through a "shape space" that is low dimensional in which four dimensions capture approximately 95% of the variance in body shape. Here I will give two examples of modeling that take advantage of this low dimensionality and stereotypy. In the first we show that stochastic dynamics within this shape space predicts transitions between attractors corresponding to abrupt reversals in crawling direction. With no free parameters, our inferred stochastic dynamical system generates reversal timescales and stereotyped trajectories in close agreement with experimental observations. In the second we use *Sir Isaac*, an algorithm that allows inference of the dynamical equations underlying a noisy time series, even if the dynamics are nonlinear—to analyze the thermal "pain" response of *C. elegans*. Both examples show that it is possible to learn "equations of behavior" of the worm, and that these equations give an interpretable, complementary perspective to traditional biological studies.

Host:
Prof. Sid Goyal

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