Department of Biomathematics Seminar Series:
Frontiers in Systems and Integrative Biology

Neural Bursts, Averaging and Canards

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ABSTRACT:
Bursting behavior in neurons has been the focus of significant theoretical attention due to both its mathematical complexity and its central role in driving repetitive actions such as respiration and hormone release. A wide variety of forms of bursting that arise in fast-slow single-neuron models are well understood based on fast-slow decomposition, identification of fast subsystem bifurcation structures, and averaging, and these methods also can be used to explain transitions between quiescence, bursting, and tonic spiking in single neurons. Transitions between such activity patterns in neuronal network models, however, are much less well understood.

In this talk, we identify generic bifurcation scenarios corresponding to transitions between bursting and tonic spiking solutions in a model for a coupled pair of burst-capable neurons, and we elucidate the central role of folded singularities in these scenarios. The folded singularities in our work arise in the context of fast-slow averaging (see, e.g., [Cymbalyuk, Shilnikov (2005), J. Comp. Neurosci. 18, 255-263]) and hence our results link with the study of torus canards, a recently identified class of solutions featuring oscillatory excursions along repelling structures in phase space [Burke et al (2012), J. Math. Neurosci. 2, 3]; in particular, our work extends this study to systems featuring two slow variables and symmetry and goes significantly beyond the analysis presented in [Best et al (2005), SIADS 4, 1107-1139].

This is joint work with Kerry-Lyn Roberts (University of Sydney) and Jonathan Rubin (University of Pittsburgh).

Host: Tom Chou, Ph.D.

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