Emergent Research:
The PIMS Postdoctoral Fellow Seminar

Pacific Institute for the Mathematical Sciences

Oct 13, 2021 | 9:30am Pacific

High-Order Accuracy Computation of Coupling Functions for Strongly Coupled Oscillators

ABSTRACT:

We develop a general framework for identifying phase reduced equations for finite populations of coupled oscillators that is valid far beyond the weak coupling approximation. This strategy represents a general extension of the theory from [Wilson and Ermentrout, Phys. Rev. Lett 123, 164101 (2019)] and yields coupling functions that are valid to higher-order accuracy in the coupling strength for arbitrary types of coupling (e.g., diffusive, gap-junction, chemical synaptic). These coupling functions can be used to understand the behavior of potentially high-dimensional, nonlinear oscillators in terms of their phase differences. The proposed formulation accurately replicates nonlinear bifurcations that emerge as the coupling strength increases and is valid in regimes well beyond those that can be considered using classic weak coupling assumptions. We demonstrate the performance of our approach through two examples. First, we use diffusively coupled complex Ginzburg-Landau (CGL) model and demonstrate that our theory accurately predicts bifurcations far beyond the range of existing coupling theory. Second, we use a realistic conductance-based model of a thalamic neuron and show that our theory correctly predicts asymptotic phase differences for non-weak synaptic coupling. In both examples, our theory accurately captures model behaviors that weak coupling theories can not.

For more information and registration:
https://www.pims.math.ca/seminars/PIMSPDF

Youngmin Park
PIMS PDF, UManitoba

SPEAKER BIO:

Youngmin Park, Ph.D., is currently a PIMS Postdoc at the University of Manitoba under the supervision of Professor Stéphanie Portet. He received his PhD in Mathematics from the University of Pittsburgh in 2018, where he applied dynamical systems methods to problems in neuroscience. His first postdoc involved auditory neuroscience research at the University of Pennsylvania in the Department of Otorhinolaryngology, before moving on to his next postdoc researching molecular motor dynamics in the Department of Mathematics at Brandeis University. He is now at the University of Manitoba, continuing to apply dynamical systems methods to biological questions related to molecular motor transport and neural oscillators.

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PIMS ongoing lecture series featuring our Postdoctoral Fellows every three weeks. You will have the opportunity to connect with emerging research in the mathematical sciences from a PIMS Postdoctoral Fellow. PIMS PDFs are amongst the top young researchers in Canada, and this is an excellent opportunity to learn about them, and their work.