

Bhaumik Luncheon Young Scientists Seminar (BLYSS)

Friday, May 31st @ 12PM in Physics & Astronomy Building (PAB) 4-330

The Mani L. Bhaumik Institute of Theoretical Physics is pleased to present the Spring 2019 Bhaumik Luncheon Young Scientist Seminar (BLYSS). The goal of this Seminar series is to learn about exciting new ideas from young scientists in the department and around the world through short talks and discussions.



Carl Goodrich

Designer assembly of designer proteins: from equilibrium statistical mechanics to machine learning

How will future technology produce materials with the complexity, hierarchy, and function of biological materials? Recent advances in DNA nanotechnology, protein engineering, and polymer chemistry now allow for the design of nanoscale systems with highly nontrivial interactions, but we do not understand the physical principles that determine what larger scale structures these building blocks can form. Focusing on a class of de novo proteins, I will present two directions that we are pursuing to understand the autonomous assembly of microscopic building blocks into functional structures. First, we consider the case of small collections of proteins in equilibrium, where we can take a quasi-analytical statistical mechanics approach. Second, we consider bulk disordered collections out of equilibrium, where we can use machine learning to study the connection between the initial protein structures and the resulting bulk material properties. Both these directions are in their very early stages, and so my talk will be more of an informal discussion of these approaches rather than a fully flushed-out research talk.



Janaki Sheth

Fluctuation analysis of non-equilibrium dynamics in the inner ear and Mapping speech-inducing neural signals onto underlying phonemes

An important topic in current sensory neuroscience research is studying the audition and production of speech. One of the early stages in the auditory detection of sound is the inner ear. It is an active non-linear system capable of parsing pressure waves ranging over several orders of magnitude in frequency and amplitude. The extremely sensitive mechano-electrical transducers of the inner ear - bundles of stereocilia protruding from hair cells - can even detect sounds that result in Ångstrom-scale displacements. While a significant body of work indicates that an internal active mechanical process serves to amplify the incoming signal, biophysical mechanisms behind this acute sensitivity are not fully understood. Our lab amongst many others seeks to tackle this problem through computational and experimental approaches. However, present-day theoretical inner ear models are complex and expansive compared to experimental observations which are restricted to only a few of the variables. In this talk I suggest a framework to test and enhance the fidelity of these models through fluctuation analysis of the inner ear active mechanism. Additionally I briefly allude to my contribution in an ongoing brain-computer interface project, wherein using recurrent neural networks we map features of speech-inducing neural signals to underlying phonemes. We propose this to be the first part of a future assistive device aiding in speech production.