Physics Colloquium
Learning about Function

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April 7, 10:30-12:00 pm, GRAN 135

We now have ways, at least on the computer, to design simple systems that perform functions inspired by biology, such as the ability of proteins (e.g. hemoglobin) to change their conformations upon binding of an atom (oxygen) or molecule, or the ability of the brain's vascular network to send enhanced blood flow and oxygen to specific areas of the brain associated with a given task. For example, we can design on the computer thousands of different central-force spring networks that all produce a desired strain (change their conformation) in response to an applied strain (approximating the binding of an atom or molecule), or thousands of flow networks that all send enhanced flow to a local region. I will show how we can use these ensembles of networks to understand how function emerges using persistent homology, an analysis developed by mathematicians to identify topologically significant features. We close the loop by applying the analysis to real proteins, showing that how function emerges is remarkably similar in proteins and our designed networks.

Bio: Professor Andrea Liu is a theoretical soft and living matter physicist who received her A. B. and Ph.D. degrees in physics at the University of California, Berkeley, and Cornell University, respectively. She was a faculty member in the Department of Chemistry and Biochemistry at UCLA for ten years before joining the Department of Physics and Astronomy at the University of Pennsylvania in 2004, where she is the Hepburn Professor of Physics. She is known for her work on jamming in granular materials, biopolymers and also more recently in the learning problem, and in using data science methods to understand collective many-body behavior in systems ranging from glasses to biological tissues. She is a Simons Investigator and a Simons Fellow in Theoretical Physics, a Fellow of the American Physical Society (APS), American Association for the Advancement of Science (AAAS) and the American Academy of Arts and Sciences, and a member of the National Academy of Sciences. Liu has served as Speaker of the Council of the APS and Chair of the Physics Section of the AAAS and is a Councilor of the US National Academy of Sciences.