Polymer Program

INSTITUTE OF MATERIALS SCIENCE

Seminar: 11:10 am Friday, March 29, 2024

Science 1: Room 1002

Host: Anson Ma

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Mechanical Phase Transitions and Rheology of Fiber Networks

Abstract: The mechanics of cells and tissues are largely governed by scaffolds of filamentous proteins. Particularly common examples of these are the collagen fiber networks of extracellular matrices. There is now increasing evidence that the mechanics of such fibrous structures are governed by underlying mechanical phase transitions reminiscent of the rigidity transition identified by Maxwell for macroscopic engineering structures: networks of struts or springs exhibit a continuous, second-order phase transition at the isostatic point, where the number of constraints imposed by connectivity just equals the number of mechanical degrees of freedom. By contrast, fibrous networks in 3D exhibit a line of critical transitions as a function of strain rather than connectivity. These transitions have shown remarkable richness, including non-mean-field critical behavior. We will present recent theoretical predictions and experimental evidence for such strain-controlled mechanical phase transitions in biopolymer networks, as well as some of the elastic signatures and anomalies such as unexpectedly large Poisson ratios and inverse Poynting effect governed by these transitions.

Bio: Fred MacKintosh received his PhD in Theoretical Physics from Princeton University. Following a postdoc at Exxon Corporate Research, he joined the Physics Department at the University of Michigan as Assistant, then Associate Professor. In 2001, Fred joined the Vrije Universiteit in Amsterdam as Professor of Theoretical Physics of Complex Systems. Since 2016, he has been the Abercrombie Professor of Chemical and Biomolecular Engineering at Rice University, as well as a member of the Center for Theoretical Biological Physics, with additional appointments in the Departments of Chemistry and Physics and Astronomy. His primary research interests include the physics of biopolymers and their networks, mechanobiology and non-equilibrium aspects of active soft matter.

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