“Lee-Yang zeros in condensed matter physics: theory and experiment”

Statistical physics provides the concepts and methods to explain the phase behavior of interacting many-body systems. Investigations of Lee-Yang zeros – complex singularities of the free energy in systems of finite size – have led to a unified understanding of equilibrium phase transitions. The ideas of Lee and Yang, however, are not restricted to equilibrium phenomena. Recently, Lee-Yang zeros have been used to characterize non-equilibrium processes such as dynamical phase transitions in quantum systems after a quench or dynamic order-disorder transitions in glasses. In this talk, I give an introduction to Lee-Yang zeros illustrated with a molecular zipper that exhibits a thermal phase transition [1]. I then go on to show how Lee-Yang zeros can be experimentally determined from the high cumulants of thermodynamic observables. This method was recently employed to extract the dynamical Lee-Yang zeros of a stochastic process involving Andreev tunneling between a normal-state island and two superconducting leads [2]. Even for systems that do not undergo a sharp phase transition, the Lee-Yang zeros carry important information about the large-deviation statistics and its symmetry properties.