Chez Pierre

Presents ...

Monday, November 24, 2025

12:00 pm - 1:00 pm

Duboc Room – 4-331

Chez Pierre Seminar

Anushya Chandran, Boston University

" Moving beyond Born and Oppenheimer for Dynamics, Thermodynamics and Quantum Geometry."

Complex systems often exhibit phenomena on widely differing timescales, which simplifies their description. An everyday example is a swinging bucket of water. When the bucket moves slowly, the water surface remains nearly horizontal, an approximation known as the Born-Oppenheimer Approximation (BOA). The BOA is widely used in quantum chemistry and in quantum condensed matter, where a similar timescale separation arises due to the mass difference between nuclei and electrons. However, as the bucket rotation rate increases, the BOA breaks down, and pseudo forces cause the water to reach a state of new "moving" equilibrium. This in turn feeds back to the bucket motion, for example, through mass corrections and synchronized motion.

I will review the Born-Oppenheimer approximation in several classic (and quantum) contexts, and thus motivate the need to go beyond. I will then introduce a systematic framework, dubbed the Moving-BOA, to go beyond in generic quantum and classical systems. The Moving-BOA reveals rich dynamics; for example, the fast degrees of freedom can get entangled and squeezed, and their motion can synchronize with that of the slow degrees of freedom. It fundamentally modifies the thermodynamics of the slow degrees of freedom, identifying new thermodynamic forces. It also suggests a route to make the quantum geometry of Bloch bands dynamical.