

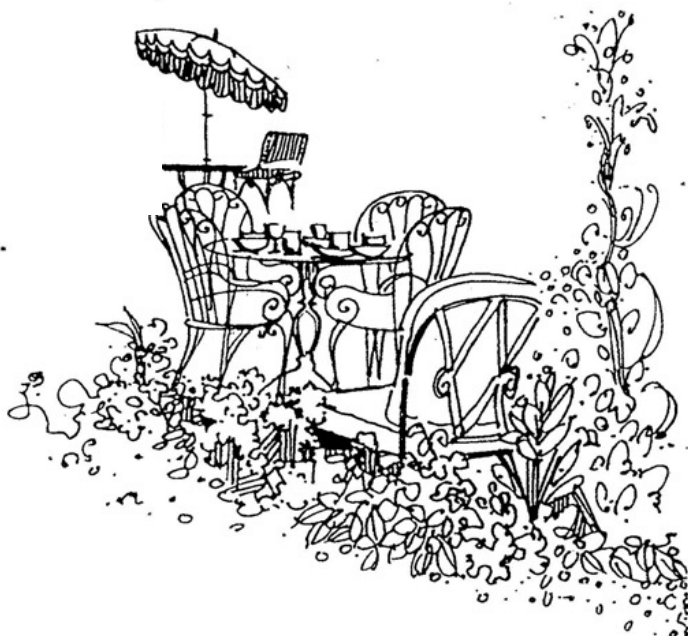
Chez Pierre

Presents ...

Monday, October 26, 2026

12:00pm – 1:00pm

Duboc Room (4-331)



Chez Pierre Seminar

Raquel Pinheiro de Almeida Queiroz, Columbia University

“Quantum geometry, bonding, and natural orbitals in quantum materials.”

Quantum geometry quantifies how Bloch wavefunctions spread across a crystal, encoding the interference patterns that arise from multi-orbital hybridization.

Orbital interference and lattice frustration force electrons to delocalize, producing position fluctuations that connect chemical bonding to optical response. I will introduce Cell Natural Orbitals, the eigenstates of the one-particle density matrix restricted to a single unit cell, as a local basis that accurately captures the geometry of bands. Their eigenvalue spectrum reveals how much of each orbital’s weight is retained by the band subspace, giving a local picture of how electrons are shared across the lattice. I will discuss how this natural-orbital framework provides a starting point for building effective models of multiband and moiré systems. As an application, I will show how the valence bands of semiconducting transition metal dichalcogenides map onto a breathing kagome lattice, and connect this orbital structure to real-space charge-density patterns and the geometry of moiré bands in twisted homobilayers.