

# Mathematics Department Colloquium

Organizer: Nicolai Reshetikhin

Thursday, 4:10–5:00pm, 60 Evans

Dec. 6     **Hari Manoharan**, Stanford, Physics, Geballe Laboratory for Advanced Materials

## *A Wrinkle in Space: Quantum Isospectral Nanostructures*

At the juncture of geometry and wave mechanics lurks a subtle yet far-reaching spectral ambiguity. There exist drum-like manifolds that resonate at identical frequencies but possess different shapes, making it impossible to invert a measured spectrum of excitations into a unique physical reality. An ongoing mathematical quest has recently compacted this conundrum from higher dimensions to planar geometries. Inspired by these isospectral domains, we introduce a class of quantum nanostructures characterized by matching electronic structure but divergent physical structure. We perform quantum measurements (scanning tunneling spectroscopy) on these “quantum drums” (degenerate two-dimensional electrons confined by individually positioned molecules) to reveal that isospectrality provides an extra topological degree of freedom enabling the reconstruction of complete electron wavefunctions—including internal quantum phase information—from measured single-eigenmode probability densities. These methods are general and extensible to other nanostructures and fabrication techniques.

In these experiments we utilize the exciting technology of atomic and molecular manipulation: a custom-built scanning tunneling microscope, operating at low temperature in ultrahigh vacuum, is used to assemble nanostructures atom-by-atom to generate versatile quantum laboratories at the spatial limit of condensed matter.

