Massachusetts Institute of Technology
Department of Physics

Condensed Matter Theory Seminar

"Modern semiclassical theory of magnetic quantum oscillations and Landau-level degeneracies"

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Abstract: The modern semiclassical theory of a Bloch electron in a magnetic field now encompasses the orbital magnetic moment and the geometric phase. These two notions are encoded in the Onsager-Lifshitz quantization rule as a phase (λ) that is subleading in powers of the field; λ is measurable in the phase offset of the de-Haas-van-Alphen oscillation, as well as of fixed-bias oscillations of the differential conductance in tunneling spectroscopy. In some solids and for certain field orientations, λ/π are robustly integer-valued owing to the symmetry of the extremal orbit, i.e., they are the topological invariants of magnetotransport. Our comprehensive symmetry analysis identifies solids in any (magnetic) space group for which λ is a topological invariant, as well as identifies the symmetry-enforced degeneracy of Landau levels. The analysis is simplified by our formulation of ten (and only ten) symmetry classes for closed, Fermi-surface orbits. In the absence of crystalline point-group symmetries, three tunable real parameters are needed to attain a spin-degeneracy between two Landau levels; we have exhaustively identified all symmetry classes of orbits for which this number is reduced from three. In particular, only one parameter is needed for rotational-symmetric orbits; this parameter may be the magnitude \textit{or} orientation of the field, or the bias voltage in tunneling spectroscopy.

Case studies are discussed for 3D Weyl and Dirac metals, crystalline and $\Z_2$ topological insulators, and the Rashba 2DEG subject to an arbitrarily-oriented magnetic field.

12:00pm noon
Friday, October 5, 2018
Duboc Room (4-331)

Host: Liang Fu