Massachusetts Institute of Technology
Department of Physics

Condensed Matter Theory Seminar

" Topological and strong correlation physics in the px/py-orbital bands of the honeycomb lattice – from solid states to optical lattices"

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Abstract: Different from graphene which is orbitally inactive, the p_x/p_y-orbital bands in the 2D honeycomb lattice are orbitally active, which apply to both optical lattices and several classes of solid state systems including organic materials, fluoridated tin film, BiX/SbX(X=H, F, Cl, Br). The interplay between the orbital structure and spin-orbit coupling gives rise to the 2D quantum spin Hall state and quantum anomalous Hall state with large topological gaps. The gap magnitudes are equal to the spin-orbit coupling strength at the atomic level, and thus are much larger than those based on the *s-p* band inversion. The energy spectra and eigen-wavefunctions are solved analytically based on the Clifford algebra, which greatly facilitates the topological analysis. Flat bands also naturally arise and the consequential non-perturbative physics includes Wigner crystallization and ferromagnetism. In the Mott-insulating state, orbital exchange is highly frustrated described by a quantum 120° model which is similar to but different from the Kitaev model. An f-wave Cooper pairing arises if the band is filled with spinless fermions exhibiting boundary zero energy Andreev modes. Although the pairing mechanism is conventional, the unconventional pairing symmetry is driven by the non-trivial band structure.

12:00noon
Wednesday, November 19, 2014
***Low Seminar Room (6C-333)**

Host: Liang Fu