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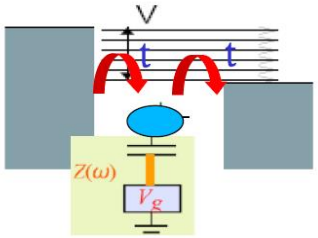
Quantum Phase Transitions, Non-equilibrium Transport, Kondo effect, Quantum Dots, Topological Insulators/Superconductors

We are "Strongly Correlated Quantum Many-Body Theory" group of Department of Electrophsics, NCTU. We study novel quantum phases and phase transitions in solid state systems with strong electron correlations. Topics include:

(i). Exotic Quantum Phase Transitions (QPTs) in Correlated Electron Systems: We have developed novel theoretical techniques based on renormalization group (RG) approaches to address exotic QPTs. New universal scaling properties near quantum critical points are explored. Examples are: non-equilibrium quantum phase transition in dissipative quantum dot (Figure 1); exotic new QPT between one-channel (1CK) and two-channel (2CK) Kondo states in Kondo impurity embedded in interacting edge states of 2D topological insulators (2DTI) (Figure 2).



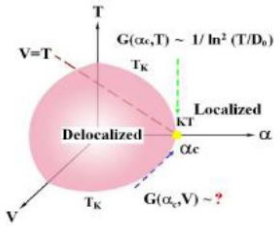


Figure 1 (PRL102, 216803, (2009))

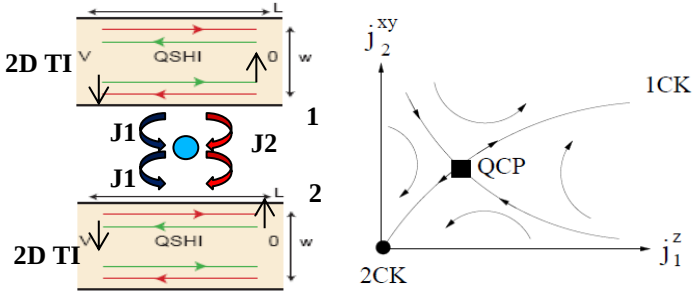
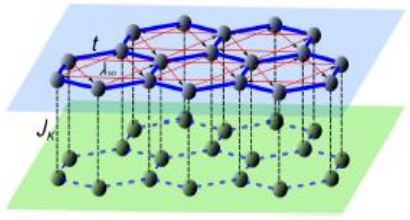


Figure 2 (NJP 17, 013005, (2015))

(ii). Search for topological materials: We look for new correlated materials which show non-trivial topology in electronic structure due to strong spin-orbit couplings, which lead to metallic surface (or edge) states. Examples are topological Kondo insulators where surface states emerge in insulating heavy-fermions with Kondo correlations (Figure 3), and topological superconductors where exotic low-energy excitations called "Majorana zero modes" or "Majorana fermoionis" (charge-neutral and self-conjugate fermions), exist in doped correlated quantum spin-Hall insulators.



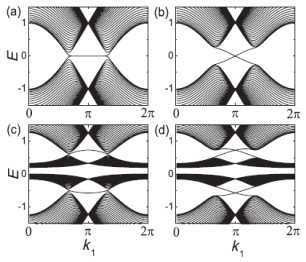


Figure 3 (PRL, 111, 016402 (2013))

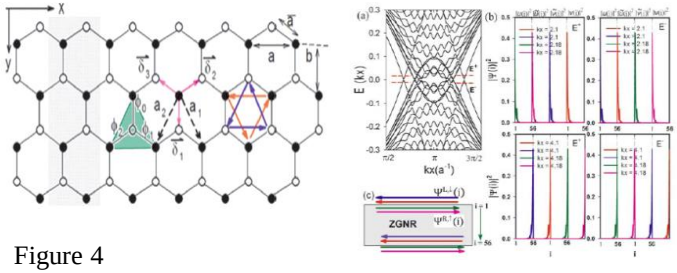


Figure 4