TEMPLE UNIVERSITY

Department of Mathematics

Analysis Seminar

Room 617 Wachman Hall

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Strongly Correlated Topological Insulators

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Abstract: The properties of strongly correlated insulators are described by a model Hamiltonian, which contains two types of electrons: f electrons in partially-filled atomic shells located inside the atoms and conduction electrons in partially-filled shells localized outside the atoms. The quantum mechanical anti-crossing of the two electron bands leads to an opening of a gap in the electronic spectrum that is strongly reduced by Coulomb interactions. At half-filling, the system becomes insulating in the bulk. However, due to the strong correlations, we show that if the insulating materials are close to a magnetic instability they exhibit low frequency, large amplitude magnetic fluctuations.

Topological Insulators are bulk insulators which have metallic states located at the surface of the sample. The surface states of a strongly correlated topological insulator experience strong spin-orbit coupling typically found in f electron systems. The form of the spin-orbit coupling at the surface is different from the form in the interior of the sample due to the breaking of spatial-inversion symmetry at the surface. We show how the resulting surface spin-orbit coupling produces the properties associated with topological insulators including the locking of the electron?s spin to its momentum (which leads to the surface states being protected from scattering by non-magnetic impurities) and also leads to dissipationless transport.

We show that the coupling of the bulk magnetic fluctuations to the surface states, can partially remove the protection of the surface states from scattering even though time-reversal invariance is not broken.