CMP Seminar
Michigan State University

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Level Correlation and Conformal Invariance in 3D Disordered Topological Superconductors

We numerically investigate critically delocalized wavefunctions in models of two-dimensional Dirac fermions, subject to vector potential disorder. These describe the surface states of three-dimensional topological superconductors, and can also be realized through long-range correlated bond randomness in artificial materials like molecular graphene. A “frozen” regime can occur for strong disorder in these systems, wherein a single wavefunction presents a few localized peaks separated by macroscopic distances. Despite this rarefied spatial structure, we find robust correlations between eigenstates at different energies, at both weak and strong disorder. The associated level statistics are always approximately Wigner-Dyson. The system shows generalized Chalker (quantum critical) scaling, even when individual states are quasilocalized in space. We confirm analytical predictions for the density of states and multifractal spectra. For a single Dirac valley, we establish that finite energy states show universal multifractal spectra consistent with the integer quantum Hall plateau transition. A single Dirac fermion at finite energy can therefore behave as a “Quantum Hall critical metal.” For the case of two valleys and non-Abelian disorder, we verify predictions of conformal field theory. Our results for the non-Abelian case imply that both delocalization and conformal invariance are topologically protected for multi-valley topological superconductor surface states. The interplay of disorder and interactions upon the multi-valley gapless surface states will be discussed briefly at the end of the talk.

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4:10 PM
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Prof. Levchenko - Host