PHYSICS AND ASTRONOMY COLLOQUIUM

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Universal transport at the edge: Disorder, interactions, and topological protection

Topological insulators and superconductors provide condensed matter realizations of the holographic principle: a global property of the bulk translates into an anomalous time-reversal symmetry at the material surface. This symmetry underlies "topological protection" of the edge or surface states. Protection from disorder effects (Anderson localization) is particularly nontrivial, because surfaces are low dimensional. While this was previously understood for noninteracting models of edge and surface states, the more complicated problem of combined disorder and interaction effects had not been addressed until recently. I will discuss two different examples of universal edge or surface transport that arise in the presence of both. First, I will consider the edge states of 2D topological insulators with Rashba spin-orbit coupling (RSOC). With RSOC, disorder induces a backscattering term in the edge theory. We have shown that transport remains perfectly ballistic in a model that incorporates this term and interactions. The solution involves a mapping to a spin 1/2 moment that executes perfect adiabatic evolution in a random magnetic field. Second, I will discuss the surface states of 3D topological superconductors, and explain why we predict universal surface thermal and (if conserved) spin conductivities. The solution exploits methods originally developed in string theory, combined with A. Finkelstein's theory of interacting, disordered electrons.

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