Physics Colloquium

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“Topological superconductors: Boundary fluids, electromagnetic fingerprints, and spectrum-wide fractality”

Topological quantum materials systems exhibit "protected" boundary modes with unusual properties--the quantum Hall effect and topological insulators being the archetypal examples. Topological superconductors (TSCs) could enable a robust form of topological quantum computation; despite progress, ongoing experiments in synthetic platforms (such as semiconductor wire networks) have yet to furnish unambiguous signatures of topology. I will discuss the hunt for an alternative: bulk solid-state TSCs. These can host gapless "Majorana fluids" at the sample boundary, which should provide a host of falsifiable experimental signatures. I will give a broadbrush overview of TSCs, starting with a basic introduction to superconductivity and topology. Then I'll discuss boundary-mediated electromagnetic signatures (Meissner effect, topological anomalous skin effect), which could be used to efficiently screen material candidates. Finally, I'll close with an extremely strange property of TSC boundary fluids. We show that even weak disorder transfigures all boundary wave functions of a TSC into quantum fractals, of the type observed in the Hofstadter butterfly. We explore how this "spectrum-wide criticality" might actually play a key role in a non-topological system of perennial interest: the high-Tc cuprates.

Matthew Foster is a theorist working at the intersections of quantum condensed matter physics, complex systems, high-energy theory, and mathematical physics. He obtained his Ph. D. at the University of California, Santa Barbara and worked as a post-doc at Columbia and Rutgers Universities, before joining Rice University in 2012. He has worked on disorder-driven, interacting ("Anderson-Mott") metal-insulator transitions, the dynamics of Dirac materials such as graphene and topological surface fluids, and electron hydrodynamics in strongly interacting systems. Matthew also works occasionally on far-from-equilibrium quantum dynamics, with applications in ultrafast pump-probe solid-state and ultracold-atom experiments.

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On the regular schedule that starts at 4:25 PM

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(This is an online colloquium)