Condensed Matter Physics Seminar Series

Topological Superconductivity, Majorana Zero Modes and Quantum Algorithms in Magnet-Superconductor Hybrid Systems

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In tMagnet-Superconductor Hybrid (MSH) systems have proven to be versatile platforms for the engineering of topological superconductivity and the ensuing Majorana zero modes (MZMs), an important step towards the realization of topological quantum computing. In particular, the experimental ability to create MSH system with widely varying magnetic structures -- from ferromagnetic and skyrmion-like to antiferromagnetic and spiral – has provided an unprecedented opportunity to manipulate and explore topological phases.

In this talk, I will review some recent progress in the theoretical prediction and experimental realization of novel topological superconducting phases – ranging from strong and higher order topological superconductors to topological nodal-point superconductivity -- in MSH systems. Moreover, I will show how the atomic scale manipulation of the magnetic structure in MSH systems provides a new path to braiding MZMs. This, in turn, allows us to successfully demonstrate the first real time simulation of topologically protected quantum algorithms, such as the Bernstein Vazirani algorithm, in MSH systems.

Professor Morr's research in theoretical condensed matter physics focuses on the abundance of interesting phenomena in strongly correlated electron systems. He has worked on a wide range of topics, ranging from quantum phase transitions, and optical and electronic properties of magnetic systems to the interplay of magnetism and superconductivity and related resonance phenomena. He has developed a series of theoretical models to explain the results of nuclear-magnetic resonance, angle-resolved photoemission, tunnelling spectroscopy, Raman spectroscopy, and neutron scattering experiments. Among his more recent work is the prediction of an unconventional, current-carrying phase in the pseudo-gap regime of the high-temperature superconductors. He has shown that the existence of a magnetic resonance peak in Sr2RuO4 is tied to the symmetry of its superconducting state. Professor Morr's recent work has also addressed the effects of impurities in magnetic systems and superconductors, as well as quantum interference effects between impurities.

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