Quasiparticle Properties in Tailored Heterostructures

Recent progresses in condensed matter physics have shed light on creating novel electronic excitations or quasiparticles that mimic many fundamental particles in nature. These quasiparticles include Majorana fermion that is an antiparticle of itself, massless and massive spin-helical fermions on the surface of a topological insulator, and Dirac fermions that obey relativistic physics in charge transport. As they originate from the unique interaction, topology and symmetry of a material, their properties can be tailored experimentally.

In this talk, I will present our approaches in creating quasiparticles and tailoring their properties by building thin film heterostructures, in which proximity effects play an important role. I will describe our experiments in detecting the electronic states of these quasiparticles using tunneling spectroscopy, spin and heat transport. The specific topics of my talk will include:

1. Our effort to confine Majorana fermions in nanowires of (111)-oriented gold/superconductor thin film hetero-layers.
2. The creation of broken symmetry states at the interface between a topological insulator and a ferromagnetic insulator.

These results will not only open up new exciting areas in exploring fundamental physics of the unconventional quasiparticles, but also lead to advancements in the fields of quantum computation, spintronics, etc.