Iron-based superconductors as a new Majorana playground

Hong Ding

Tsung-Dao Lee Institute, Shanghai Jiao Tong University

Majorana zero modes (MZMs) in solid materials and devices have attracted tremendous interest owing to their potential applications in robust quantum computation. Last ten years witness rapid progresses and serious setbacks in searching for MZMs. Recently iron-based superconductors (FeSCs) emerged as a new and promising Majorana platform due to relatively high temperature and high purity. In this talk I will report a series of our discoveries which help to establish this iron-Majorana platform. We have observed a superconducting topological surface state of Fe(Te,Se) by using ARPES, and a pristine MZM inside a vortex core of this material by using STM. We have observed a half-integer level shift of vortex bound states and nearly quantized Majorana conductance in this material, which are hallmarks of MZMs. We have also found that most of iron-based superconductors, including monolayer Fe(Te,Se)/STO, have similar topological electronic structures. Finally, we found that pressure can be used as a good tuning method to control MZMs in FeSCs. The combination of intrinsic topological nature of vortex and large energy spacing among the discreet bound states, all of which can be tuned by pressure, offers compelling evidence for proving the Majorana nature of vortex zero-modes discovered in FeSCs, thus creating an exciting playground for realizing and manipulating Majorana modes.