Observation of Majorana bound states and conductance plateau in an iron-based superconductor

By

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Abstract

Majorana bound states (MBSs) in condensed matter systems have attracted tremendous interest owing to their non-Abelian statistics and potential applications in topological quantum computation. A MBS is theoretically predicted to emerge as a spatially localized zero-energy mode in certain $p$-wave topological superconductors in one and two dimensions. Two-dimensional topological superconductors have been predicted to host MBSs as zero-energy modes in vortex cores. In this lecture, I will present an observation of a sharp zero-bias peak inside a vortex core that doesn’t split when moving away from the vortex center by using 400 mK-high magnetic field (11 T) scanning tunneling microscopy/spectroscopy (STM/STS) on superconducting Dirac surface state of an iron-based superconductor FeTe$_{0.35}$Se$_{0.45}$ with a superconducting transition temperature of 14.5 K. The evolution of the peak under varying magnetic field, temperature, and tunneling barrier is consistent with the tunneling to a nearly pure MBS, separated from non-topological bound states. Furthermore, I will talk about the observation of the Majorana conductance plateau in vortices on the FeTe$_{0.55}$Se$_{0.45}$ surface by using 40 mK-(9 2 2) T STM/STS. These observations offer a potential platform for realizing and manipulating MBSs at a relatively high temperature.

Short Biography

Prof. Hong-jun Gao was born in 1963. He obtained his Ph.D. from Peking University in 1994. He is now a Professor and Group Leader in Institute of Physics, Chinese Academy of Sciences, Academician of the Chinese Academy of Sciences, and Academician of the Developing-country Academy of Sciences (TWAS). He serves as editorial board member for several international journals and was an Associate Editor for Appl. Phys. Lett. He was the Vice-President of the University of Chinese Academy of Sciences (U-CAS) and Chair of the U-CAS Advisory Committee of Sciences. He was the Scientific Secretary of the International Union of Vacuum Science, Technology, and Applications (IUVSTA) in the triennium 2004-2007, and the Chairman of the NSTD, IUVSTA (2010-2013). From 1997 to 2000, he worked at the Oak Ridge National Laboratory (ORNL) as a Guest Scientist.

His research interests are in construction and physical properties of quantum nanostructures and scanning tunneling microscopy/spectroscopy (STM/STS). He has 8 international books/chapters, more than 350 journal publications including Science, Nature series, Physical Review Letter, J. of Amer. Chem. Soc., and Adv. Mater., more than 90 invited talks. The total citation is more than 18000 and the H-index>70. His research works have been highlighted by the American Physical Society—physics, Physical Review Focus, Science News, Nature Materials, and Nature Nanotechnology, etc.