Topological superconductor and Majorana fermions in the vortex

Jinfeng Jia[1]

[1]*Key Laboratory of Artificial Structures and Quantum Control (Ministry of Education), Department of Physics, Shanghai Jiao Tong University, Shanghai 200240, China*

Majorana fermion (MF) whose antiparticle is itself has been predicted in condensed matter systems. MFs can be used in fault-tolerant quantum computation relying on their non-Abelian braiding statistics, therefore, lots of efforts have been made to find them. Signatures of the MFs have been reported as zero energy modes in various systems. As predicted, MF in the vortex of topological superconductor appears as a zero energy mode with a cone like spatial distribution. Also, MF can induce spin selective Andreev reflection (SSAR), a novel magnetic property which can be used to detect the MFs. Here, I will show you that the $Bi_2Te_3/NbSe_2$ hetero-structure is an artificial topological superconductor and all the three features are observed for the MFs inside the vortices on the $Bi_2Te_3/NbSe_2$. Especially, by using spin-polarized scanning tunneling microscopy/spectroscopy (STM/STS), we observed the spin dependent tunneling effect, which is a direct evidence for the SSAR from MFs, and fully supported by theoretical analyses. More importantly, all evidences are self-consistent. Our work provides definitive evidences of MFs and will stimulate the MFs research on their novel physical properties, hence a step towards their statistics and application in quantum computing.

References:

1. M. X. Wang, et al., Science **336**, 52-55 (2012).
2. J. P. Xu, et al., Phys. Rev. Lett. **112**, 217001 (2014).
3. J. P. Xu, et al., Phys. Rev. Lett. **114**, 017001 (2015).
4. H. H Sun, et al., Phys. Rev. Lett. **116**, 257003 (2016)
5. H.H. Sun, Jin-Feng Jia, NPJ Quan. Mater. **2**, 34 (2017)
6. H.H. Sun, Jin-Feng Jia, SCIENCE CHINA-PHYSICS MECHANICS & ASTRONOMY **60** 057401(2017)