

Topological superconductor and Majorana zero mode in the vortex

Jin-Feng Jia

Key Laboratory of Artificial Structures and Quantum Control (Ministry of Education), School of Physics and Astronomy, Shanghai Jiao Tong University, Shanghai 200240, China

Email: jfjia@sjtu.edu.cn

Abstract: Majorana fermion whose antiparticle is itself has been predicted in the vortex of a topological superconductor, i.e. Majorana zero mode (MZM). MZMs 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 MZM have been reported as zero energy modes in various systems. As predicted, MZM in the vortex of a topological superconductor appears as a zero energy mode with a cone like spatial distribution. Also, MZM can induce spin selective Andreev reflection (SSAR), a novel magnetic property which can be used to detect the MZM. Here, I will show you that the $\text{Bi}_2\text{Te}_3/\text{NbSe}_2$ hetero-structure is an artificial topological superconductor and all the three features are observed for the MZM inside the vortices on the $\text{Bi}_2\text{Te}_3/\text{NbSe}_2$. 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 MZM, and fully supported by theoretical analyses. More importantly, all evidences are self-consistent. Our work provides definitive evidences of MZM and will stimulate the MZM 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)