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Observation of Majorana fermions in the vortex on topological insulator-superconductor heterostructure $Bi_2Te_3/NbSe_2$

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Majorana fermion (MF) zero modes have been predicted in a wide variety of condensed matter systems and proposed as a potential building block for fault-tolerant quantum computer. Signatures of the MFs have been reported in the form of zero-energy conductance peak in various systems. As predicted, MFs appear as zero-energy vortex core modes with distinctive spatial profile in proximity-induced superconducting surface states of topological insulators. Furthermore, MFs can induce spin selective Andreev reflection (SSAR), a unique signature of MFs. We report the observation of all the three features for the MFs inside vortices in $Bi_2Te_3/NbSe_2$ hetero-structure [1-4], in which proximity-induced superconducting gap on topological surface states was previously established [2,3]. Especially, by using spin-polarized scanning tunneling microscopy/spectroscopy (STM/STS), we observed the spin dependent tunneling effect, and fully supported by theoretical analyses, which is a direct evidence for the SSAR from MFs [4]. 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 non-Abelian 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).