7^{th} International Workshop on 2D Materials

Title of the Presentation: Evidence of Majorana zero mode in 2D high Tc interface superconductors

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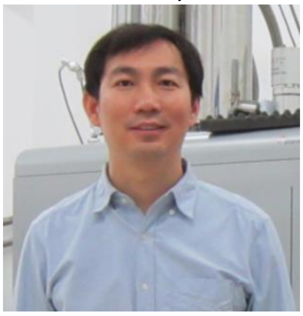

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Short Biography:
Jian Wang, Professor of Physics, received his bachelor's degree in Physics from Shandong University in 2001, and PhD degree in condensed matter physics from Institute of Physics, Chinese Academy of Sciences in 2007. From 2006 to 2011, he worked as a Postdoc and Research Associate at Penn State University, USA. He was promoted to Professor at Peking University in 2017. He won Sir Martin Wood China Prize in 2015 and Outstanding Achievement Award for Research in Institutes of Higher Education of China in 2019. His current research interests are quantum transport properties of low dimensional superconductors and topological materials. In recent years, he has authored more than 100 papers including Science, Science Advances, Nature Physics, Nature Materials, Nature Nanotechnology, Nature Communications, PNAS, Physical Review X, Physical Review Letters, etc. Jian Wang's lab at Peking University possesses ultralow temperature-high magnetic field measurement systems and low temperature scanning tunneling microcopy/spectroscopy-molecular beam epitaxy ultrahigh vacuum system. More details: http://faculty.pku.edu.cn/JianWangGroup

Abstract:
The search for Majorana zero modes (MZMs) has been fueled by the prospect of using their non-Abelian statistics for realizing fault-tolerant topological quantum computing. In this work, we discovered the 1D atomic line defects formed by the missing topmost Te/Se atoms on the one-unit-cell-thick high-Tc superconducting $FeTe_{0.5}Se_{0.5}$ films (Tc ~62 K, much higher than that of ~14.5 K in bulk Fe(Te,Se)). The zero-energy bound states (ZEBSs) are detected at both ends of the 1D atomic line defect, while the tunneling spectra in the middle of the long line defect recover to the fully gapped superconducting states. A series of control experiments show that the spectroscopic properties of the ZEBSs are found to be consistent with the MZMs interpretation [1]. Our theoretical analysis suggests that due to the large spin-orbit coupling, the 1D atomic line defect in monolayer $FeTe_{0.5}Se_{0.5}$ film may become an emergent 1D topological superconductor and a Kramers pair of MZMs appearing at both ends protected by time-reversal symmetry. Even without time-reversal symmetry along the line defect, the 1D topological superconductor can also be realized with a single MZM located at each end of the chain. This work, for the first time, reveals a class of topological zero-energy excitations at both ends of 1D atomic line defects in 2D high-Tc superconducting monolayer $FeTe_{0.5}Se_{0.5}$ films. Being a single material, higher operating temperature and zero external magnetic field, the monolayer $FeTe_{0.5}Se_{0.5}$ may offer a new platform to realize applicable topological qubits.

Reference:
[1] Cheng Chen, Kun Jiang, Yi Zhang, Chaofei Liu, Yi Liu, Ziqiang Wang and Jian Wang*. "Atomic line defects and zero-energy end states in monolayer Fe(Te,Se) high-temperature superconductors" Nature Physics 16, 536–540 (2020).