PCSI

Room Ballroom South - Session PCSI-TuE

Majorana Fermions in Atomic Structures

Moderator: Paul M. Koenraad, Eindhoven University of Technology, Netherlands

7:30pm **PCSI-TuE-1 From Majorana Fermions to Parafermions in Nanowires and Atomic Chains***, **Daniel Loss**,* University of Basel, Switzerland **INVITED**

I will present recent results on Majorana fermions and parafermions which can emerge in one nanowires and atomic chains in the presence of spin orbit interaction or spatially periodic magnetic fields, in RKKY systems forming intrinsic spin helices, and in the presence of superconductivity. I will present candidate materials such as semiconducting Rashba nanowires, ^{13}C nanotubes, and atomic magnetic chains. In contrast to Majorana fermions, parafermions emerge only in the presence of strong electron-electron interactions and have a more powerful braid statistics enabling entanglement and CNOT gates.

8:00pm **PCSI-TuE-7 Probing Atomic Structure and Majorana Wavefunctions inMono-Atomic Fe-chains on Superconducting Pb-Surface***, **Rémy Pawlak**, M Kisiel, J Klinovaja, T Meier, S Kawai, T Glatzel, D Loss, E Meyer,* University of Basel, Switzerland **INVITED**

Motivated by the striking promise of quantum computation, Majorana bound states (MBSs) [1] in solid-state systems [2-3] have attracted wide attention in recent years [4-6]. In particular, the wave-function localization of MBSs is a key feature and crucial for their future implementation as topological qubits [2-3]. Here, we investigate the spatial and electronic characteristics of topological superconducting chains of iron atoms on the surface of Pb(110) by combining scanning tunneling microscopy (STM) and atomic force microscopy (AFM) at low temperature. We demonstrate that the Fe chains are mono-atomic, structured in a linear fashion, and exhibit zero-bias conductance peaks at their ends which we interpret as signature for a Majorana bound state. Spatially resolved conductance maps of the atomic chains reveal that the MBSs are well localized at the chain ends (< 25 nm), with two localization lengths as predicted by theory [7-8]. Our observation lendsstrong support to use MBSs in Fe chains as qubits for quantum computing devices.

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[1] E. Majorana, Nuovo Cimento 14, 171 (1937).

[2] A.Y. Kitaev, Phys.-Usp. 44, 131 (2001).

[3] J. Alicea, Rep. Prog. Phys. 75, 07501 (2012).

[4] V. Mourik, et al. Science 336, 1003 (2012).

[5] S. Nadj-Perge, et al. Science 346, 602 (2014).

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[8] J. Klinovaja, D. Loss, Phys. Rev. B 86, 085408 (2012).

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8:30pm **PCSI-TuE-13 Majoroana Fermions in Atomic Chains: Spin and Charge Signatures***, **Ali Yazdani**,* Princeton University **INVITED**

I will review the platform for realization of topological superconductivity and Majorana fermions in chains of magnetic atoms on the surface of a superconductor. I will describe high resolution studies of spatial mapping of spectroscopic signature of Majorana fermions in spectroscopic experiments with the STM. These will include experiments at lowest possible temperature with the STM, with superconducting tips, as well as those using spin-polarized STM techniques. In each case Majoranas are predicted to leave a distinct signature than other in gap states of a superconductor, which can be diagnosed experimentally.

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[1] S. Nadj-Perge et al. Science 346, 6209 (2014).

[2] J. Li et al. Physical Review B 90, 235433 (2014).

[3] B. Feldman et al. Nature Physics to appear (2016).

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