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Fyzikální ústav Akademie věd České republiky
Institute of Physics of the Czech Academy of Sciences

CELOÚSTAVNÍ SEMINÁŘ
FZU COLLOQUIUM

14. 5. 2019 | 14:00

přednáškový sál | main lecture hall
Pod Vodárenskou věží 1, Praha 8

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Emergence of Majorana States in Atomic-Scale Hybrid Systems

Majorana states in atomic-scale magnet-superconductor hybrid systems have recently become of great interest because they can encode topological qubits and ultimately provide a new direction in topological quantum computation [1,2]. First, it will be demonstrated how well defined 1D atomic chains of magnetic adatoms on superconducting substrates with high spin-orbit coupling can be artificially fabricated using STM-based atom-manipulation techniques. Spin-polarized STM measurements [3] allow to reveal the presence of non-collinear spin textures, i.e. spin spiral ground states, stabilized by interfacial Dzyaloshinskii-Moriya interactions [4,5]. Simultaneously performed scanning tunneling spectroscopy on the magnetic atom chains on the superconductor substrate reveal the evolution of the spatially and energetically resolved local density of states as well as the emergence of zero-energy bound states at the chain ends above a critical chain length. Based on the exact knowledge of the geometrical, electronic, and spin structure of the magnetic chain – superconductor hybrid system, the experimental results can be compared rigorously with ab-initio and model-type tight-binding calculations supporting the interpretation of the spectroscopic signatures at the ends of the chains as Majorana bound states [6]. More recently, the atomic-scale design of more complex network structures for Majorana state manipulation, including braiding operations has been in the focus of our research. Moreover, experimental and theoretical studies of monolayer topological superconductivity and chiral Majorana edge modes in model-type 2D magnetic islands on elemental superconductors will be presented [7]. In particular, it will be demonstrated that interface engineering by an atomically thin oxide layer is crucial for driving the studied hybrid system into a topologically non-trivial state as confirmed by theoretical calculations of the topological invariant, the Chern number. Finally, the prospects for studies of Majorana states in skyrmion – superconductor hybrid systems [8] will be discussed.

References

[1] J. Alicea et al., Nature Phys. 7, 412 (2011).
[2] S. Nadj-Perge et al., PRB 88, 20407 (2013); H.-Y. Hui et al., Sci. Rep.. 5, 8880 (2015).
[3] R. Wiesendanger, Rev. Mod. Phys. 81, 1495 (2009).
[4] A. A. Khajetoorians et al., Nature Commun. 7, 10620 (2016).
[5] M. Steinbrecher et al., Nature Commun. 9, 2853 (2018).
[6] H. Kim et al., Science Advances 4, eaar5251 (2018).
[7] A. Palacio-Morales et al. (2018), arXiv:1809.04503.
[8] N. Romming et al., Science 341, 6146 (2013).

Seminář proběhne v angličtině. Hlavním organizátorem je Fyzikální ústav Akademie věd ČR.
The colloquium will be held in English. Organised by Institute of Physics of the Czech Academy of Sciences.