

PHYSIKALISCHES KOLLOQUIUM

Wintersemester 2018/19

Das Kolloquium findet (soweit unten nicht anders angegeben) jeweils montags 17:15 Uhr im Hörsaal P des Physikalischen Instituts auf dem Hubland Campus Süd der Universität Würzburg statt.

05. November 2018

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Emergence of Majorana States in Atomic-Scale Hybrid Systems

Abstract

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, we will also address recent experimental and theoretical studies of monolayer topological superconductivity and chiral Majorana edge modes in model-type 2D magnetic islands on elemental superconductors [7]. Finally, the prospects for studies of Majorana states in skyrmion – superconductor hybrid systems [8] will be highlighted.

- [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. (2018).
- [6] H. Kim et al., Science Advances 4, eaar5251 (2018).
- [7] A. Palacio-Morales et al. (2018), submitted.
- [8] N. Romming et al., Science 341, 6146 (2013).

Für die Dozentinnen und Dozenten der Fakultät für Physik und Astronomie

Frau Prof. Dr. Erdmenger, Prof. Dr. Bode, PD Dr. Behr und Herrn Steppert