Towards Majorana bound states at the edges of spin chains on superconductors

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Scanning tunneling microscopy (STM) has proved to be a mature technique for the study of magnetic impurities on different substrates as quantum sensors and as building blocks for quantum information. Building arrays of spins is of great interest because of their inherent quantum properties [1]. On an s-wave superconductors, Majorana bound states are expected to appear.

I will show recent experimental results with the STM, using single Cr atoms to assemble a 1-D spin chain on a Bi_2Pd surface. Depending on the arrangement of the atoms, different spin orderings can be achieved leading to closing the superconducting gap and approaching a topological quantum phase transition [2]. Our calculations using Bogoliubov-de Gennes theory [2,3] lead us to the conclusion that clear Majorana bound states should appear for relatively small chains in one of the arrangements.

References

[1] Colloquium: Atomic spin chains on surfaces. Review of Modern Physics 91, 041001 (2019)

[2] Atomic Manipulation of In-gap States on the β-Bi2Pd Superconductors, Physical Review B 104 (4), 045406 (2021).

[3] Calculations of in-gap states of ferromagnetic spin chains on s-wave wide-band superconductors, Physical Review B 104 (24), 245415 (2021).

Figures

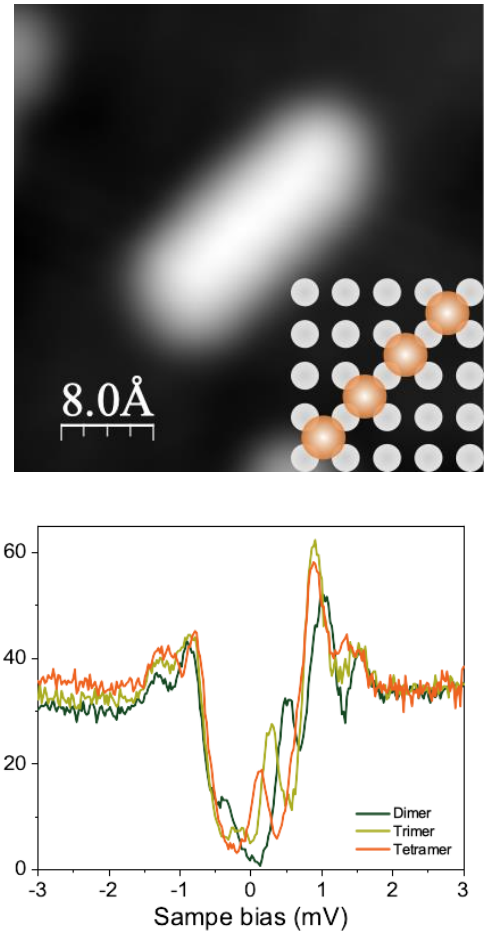

Figure 1: (Top) STM topography of a 4-atom spin chain of Cr on Bi_2Pd. (Bottom) Differential conductance on the edge atom of dimer, trimer and tetramer of Cr on the same surface. As the Cr structure approaches a spin chain, in-gap states approach zero energy [2].