Majorana bound states vs. Yu-Shiba-Rusinov states in artificially constructed magnetic Fe atom-chains on superconducting Re(0001)

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A magnetic nanowire with non-collinear spin texture on an s-wave superconducting substrate is a fascinating platform, which has been proposed for observing the emergence of topological superconductivity and Majorana bound states at the ends of the wires. Most recently, evidences for topologically non-trivial end-states were experimentally found for self-assembled ferromagnetic Fe nanowires on the superconducting Pb(110) surface by using scanning tunneling microscopy and spectroscopy (STM/S) as well as non-contact atomic force microscopy methods [1-4]. However, self-assembled nanowires have unavoidable limitations, such as (1) uncontrolled length and orientation, and (2) intermixing of atomic species of the nanowire and the substrate during the annealing process.

Here, we demonstrate the fully-controlled formation of artificial 1D atomic chains from individual magnetic Fe adatoms (Shiba adatoms) on the superconducting Re(0001) surface by utilizing STM-based atom-manipulation techniques at T=350 mK. Spin-polarized STM (SP-STM) measurements indicate the presence of a non-collinear spin texture, i.e. a spin spiral ground state, most likely stabilized by interfacial Dzyaloshinskii-Moriya interactions similar to Fe chains on Ir(001) [5]. Tunneling spectra measured spatially resolved on the Fe-atom chain reveal the evolution of the local density of states (LDOS) inside the superconducting gap as well as the development of edge states at the ends of chain, which are distinguishable from trivial end states by systematically increasing the number of atoms within the Fe-atom chain. The experimental results will be compared with *ab initio* and tight-binding model calculations supporting the interpretation of the spectroscopic signatures at the ends of the chains as Majorana bound states [6].

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