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(I) Tunneling processes through Yu-Shiba-Rusinov states of magnetic atoms on superconductors

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Magnetic atoms on superconductors induce an exchange coupling, which leads to states within the superconducting energy gap. These so-called Yu-Shiba-Rusinov (YSR) states can be probed by scanning tunneling spectroscopy at the atomic scale. Here, we investigate single magnetic adatoms on a superconducting Pb surface.

As YSR states are within the superconducting energy gap, their excitation by electrons requires a subsequent inelastic relaxation process. At strong tunnel coupling, thermal relaxation is not sufficiently fast and resonant Andreev processes become the dominant tunneling process [1]. We obtain direct evidence of these two transport regimes by inserting GHz radiation into the STM junction and analyzing the photon-assisted tunneling maps [2,3].

[1] M. Ruby, F. Pientka, Y. Peng, F. von Oppen, B. W. Heinrich, K. J. Franke, *Phys. Rev. Lett.* 115, 087001 (2015).

[2] O. Peters, N. Bogdanoff, S. Acero Gonzalez, L. Meliscek, J. R. Simon, G. Reecht, C. B. Winkelmann, F. von Oppen, K. J. Franke, *Nature Physics* 16, 1222 (2020).

[3] S. Acero Gonzalez, L. Meliscek, O. Peters, K. Flensburg, K. J. Franke, F. von Oppen, *Phys. Rev. B* 102, 045413 (2020).

Primary authors: PETERS, Olof (Fachbereich Physik, Freie Universität Berlin, Germany); BOGDANOFF, Nils (Fachbereich Physik, Freie Universität Berlin, Germany); ACERO GONZALEZ, Sergio (Fachbereich Physik, Freie Universität Berlin, Germany); MELISCHEK, Larissa (Fachbereich Physik, Freie Universität Berlin, Germany); SIMON, J. Rika (Fachbereich Physik, Freie Universität Berlin, Germany); REECHT, Gael (Fachbereich Physik, Freie Universität Berlin, Germany); WINKELMANN, Clemens B. (Université Grenoble, France); VON OPPEN, Felix (Fachbereich Physik, Freie Universität Berlin, Germany); FRANKE, Katharina (Freie Universität Berlin)

Presenter: FRANKE, Katharina (Freie Universität Berlin)

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