Revealing the fine structure of Andreev levels in hybrid nanowires

Alfredo Levy Yeyati

Universidad Autónoma de Madrid, Campus de Cantoblanco, Madrid, Spain

In atomic physics the fine structure refers to the splitting of the spectral lines due to relativistic effects, leading to the spin-orbit interaction. Analogously, the Andreev bound states in a weak link between two superconducting leads connected through a semiconducting nanowire are expected to exhibit a splitting due to the Rashba spin-orbit interaction in the wire.

In a recent work [1] we provide evidence of this effect through microwave spectroscopic measurements. We have developed a simple model which allows us to fit the transition lines in terms of a few parameters, like the effective junction length and its transparency. A basic ingredient in the model is to account for the nanowire multichannel structure [2]. Our theoretical analysis allows to get an estimate on the size of the spin-orbit interaction in the nanowire, which is found to be in agreement with values reported in the literature. It also allows to describe with high accuracy the effect on the Andreev levels of an applied Zeeman field along an arbitrary orientation.

I shall discuss several open issues connected to understanding the excitation and detection mechanisms of the Andreev transitions in a circuit QED geometry like the one used in the experiments. This knowledge constitutes a basic requirement towards the development of an Andreev spin qubit based on this setup.

[1] L. Tosi, C. Metzger, M.F. Goffman, C. Urbina, H. Pothier, Sunghun Park, A. Levy Yeyati, J. Nygard and P. Krogstrup, Phys. Rev. X 9, 011010 (2019).

[2] Sunghun Park and A. Levy Yeyati, Phys. Rev. B 96, 125416 (2017).