The role of cotunneling processes in Andreev transport through quantum dot coupled to two ferromagnetic leads and one superconducting electrode

Piotr Trocha[1], **Ireneusz Weymann**[1]

[1]*Adam Mickiewicz University, 61-614 Poznań, Poland*

Quantum dot attached to one superconducting electrode and two normal leads allows to study nonlocal Andreev reflection phenomenon. Such a phenomenon has already been reported experimentally in hybrid structures consisting of two normal metal (or ferromagnetic) leads connected via tunnel barriers or point contacts to one common superconducting electrode. [1, 2, 3] In contrast to the direct Andreev reflection, where the hole is reflected back to the electrode from which the incoming electron originates, in nonlocal processes the hole is reflected into a second, spatially separated electrode. Recently, Cooper pair splitting has also been observed in quantum dot systems. [4, 5]

Here, we investigate local and nonlocal Andreev transport through the system consisting of single-level quantum dot coupled to one superconducting electrode and two ferromagnetic leads. We restrict our model to collinear magnetic configurations, i.e., parallel or antiparallel. To calculate basic transport characteristics like Andreev current, local and nonlocal conductance, we employ the real-time diagrammatic perturbation approach assuming weak tunnel coupling of the dot to the ferromagnetic leads. In turn, in the large superconducting gap limit the coupling to the superconductor can be arbitrary strong. The influence of cotunneling processes on the Coulomb blockade has been investigated.

[1] G. Deutscher and D. Feinberga, Appl. Phys. Lett. **76**, 487 (2000).
[2] D. Beckmann, H. B.Weber, and H. v. Löhneysen, Phys. Rev. Lett. **93**, 197003 (2004).
[3] S. Russo, M. Kroug, T. M. Klapwijk, and A. F. Morpurgo, Phys. Rev. Lett. **95**, 027002 (2005).
[4] L. Hofstetter, S. Csonka, J. Nygård, C. Schönenberger, Nature **462**, 960 (2009).
[5] L. G. Herrmann, F. Portier, P. Roche, A. Levy Yeyati, T. Kontos, C. Strunk, Phys. Rev. Lett. **104**, 026801 (2010).