Waiting time distributions in a double qunatum dot in the Andreev blockade regime

A. Jankiewicz,[1] K. Wrześniewski,[1] and I. Weymann[1]

[1] *Institute of Spintronics and Quantum Information, Faculty of Physics and Astronomy, A. Mickiewicz Univeristy, 61–614 Poznań, Poland*

We theoretically investigate the nonequilibrium dynamics of a serial double quantum dot coupled to normal and superconducting electrodes. This type of system is known for occurence of Andreev blockade, which manifests through the suppression of Andreev reflection processes in certain parameter regimes [1]. To describe the system's evolution following a quantum quench, we employ the Gorini–Kossakowski–Sudarshan–Lindblad (GKLS) master equation framework.

Our analysis focuses on waiting time distributions (WTDs) [2] as a tool to identify dynamical signatures of the Andreev blockade. We demonstrate how the time between certain processes varies for different quench protocols. Specifically, we show that enhancing the coupling to the normal electrode significantly shifts the WTD toward shorter timescales. Furthermore, we examine the role of the dot energy levels in determining the synchronicity of opposite-spin events.

Finally, we explore the impact of an external magnetic field, which modifies the energy spectrum and alters the competition between internal interactions. By incorporating time-dependent numerical renormalization group (td-NRG) [3-5] to evaluate transient currents and correlation functions, we reveal complex dynamics emerging from the interplay between strong Coulomb correlations and superconducting proximity effects.

References:

[1] D. Pekker, P. Zhang, and S. M. Frolov, SciPost Phys. 11 (2021) 081
[2] T. Brandes, Ann. Phys. 520 (2008) 477
[3] K. G. Wilson, Rev. Mod. Phys. 47 (1975) 773
[4] F. B. Anders and A. Schiller, Phys. Rev. Lett. 95 (2005) 196801
[5] F. B. Anders and A. Schiller, Phys. Rev. B 74 (2006) 245113

This work was supported by the National Science Centre, Poland from funds awarded through the decision No. 2022/45/B/ST3/02826.