Quench dynamics in superconducting nanojunctions: metastability and dynamical Yang-Lee zeros

Rubén Seoane Souto*†[1,2,3], álvaro Martín-Rodero[1,2,3], and Alfredo Levy Yeyati[1,2,3]

[1]Universidad Autonoma de Madrid (UAM) – Spain
[2]Condensed Matter Physics Cente (IFIMAC) – Spain
[3]Instituto Nicolás Cabrera (INC) – Spain

Abstract

The shot noise and the higher order cumulants contain valuable information about interactions and quantum correlations between electrons in nanodevices. While these studies have traditionally been restricted to the stationary case, recent technological advances in the direction of the single electron detection have attracted an increasing interest in the time resolved full counting statistics. On the other hand, superconducting nanodevices are of central interest as building blocks in quantum technologies. In this kind of devices, an unexplained excess of quasiparticles has been observed, which set the limit for possible applications. In superconducting atomic junctions these quasiparticles can decay to the Andreev bound states, giving rise to long lived odd parity states [1].
In this presentation I will focus in the dynamics of the charge transfer through nanojunctions coupled to superconducting electrodes. Under rather general conditions, the system gets trapped in a metastable state, characterized by a non-equilibrium population of the Andreev bound states. Although the trapped quasiparticles lead to a peculiar time dynamics, the quantum state of the system cannot be inferred from the evolution of the single particle observables. Instead, the information provided by the full counting statistics (FCS) is needed to fully characterize the state [2,3].

Finally, I will also demonstrate that the evolution of the roots of the FCS generating function, recently measured experimentally for the first time in a superconducting nanojunction [4], contain all the information about the system transport properties. Their evolution also allows to identify dynamical quantum phase transitions, much in the same way as the Lee Yang zeros of the partition function are connected to phase transitions in the equilibrium mechanics [5]. I will also discuss when a simplified description of the system dynamics based on the "dominant" zeros is possible.

M. Zgirski, L. Bretheau, Q. Le Masne, H. Pothier, D. Esteve, and C. Urbina, Phys. Rev. Lett. **106**, 257003 (2011).

R. S. Souto, A. Martín-Rodero, and A. L. Yeyati, Phys. Rev. Lett. **117**, 267701 (2016).

R. S. Souto, A. Martín-Rodero, and A. L. Yeyati, in preparation.

*Speaker
†Corresponding author: ruben.seoane@uam.es

K. Brandner, V. F. Maisi, J. P. Pekola, J. P. Garrahan and C. Flindt, Phys. Rev. Lett. **118**, 180601 (2017).

C. N. Yang and T. D. Lee, Phys. Rev. **87**, 404 (1952). T. D. Lee and C. N. Yang, Phys. Rev. **87**, 410 (1952).