IAP-Seminar

Referent: Dr. Eduardo J.H. Lee
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Thema: Subgap Andreev states in hybrid superconductor-semiconductor nanowire structures

Zeit/Ort: Montag, 06.11.2017, 11:00 Uhr
Hermann-Krone-Bau, Hörsaal KRO 1.11 A+B (1. OG), Nöthnitzer Str. 61

Leiter: Dr. Thales de Oliveira

Biographie: Dr. Eduardo Lee did his PhD in Physics at the Max Planck Institute for Solid State Research in Stuttgart, Germany, working on scanning photocurrent microscopy of carbon nanostructures. He then moved to the French Alternative Energies and Atomic Energy Commission (CEA), in Grenoble, France as a Marie Curie Fellow. There, his research focused on quantum transport in nanodevices. After spending a year at the Institute Neel in Grenoble as a postdoctoral researcher, he finally joined the Condensed Matter Physics Center (IFIMAC) at the UAM (Madrid) as a tenure-track researcher. Dr. Lee has been awarded the prestigious ERC Starting Grant 2016, with which he is setting up his own independent research team to investigate superconducting quantum dot arrays as a platform for engineering topological superconductors.
Kurzfassung:

The interaction of a magnetic impurity and a superconductor yields localized subgap states known as Andreev or Yu-Shiba-Rusinov (YSR) states. In recent years, there has been a growing interest in this type of system owing to the close relation that exists between such states and the Majorana zero modes of a topological superconductor. Indeed, it has been theoretically shown that Andreev states are precursors of Majorana modes. Accordingly, it has been proposed that chains of magnetic impurities could be engineered, under appropriate conditions, into a topological superconductor [1-3]. A semiconductor quantum dot coupled to a superconductor constitutes a versatile platform to investigate, in a controllable and quantitative manner, the physics of the corresponding single-impurity limit. Here, we have studied the Andreev states of single quantum dots defined in an InAs nanowire and coupled strongly to a superconductor, by tunneling spectroscopy. First, we exploit the ability to electrically tune the hybridization of the quantum dot and the superconductor to quantitatively investigate their energy scaling. We further leverage the electrical control over device parameters to obtain an experimental phase diagram of the possible ground states: a spin singlet or a magnetic doublet. Our experimental results show remarkable quantitative agreement with numerical renormalization group calculations [4]. In parallel, we have studied the spin texture of the Andreev states in the presence of an external magnetic field. We demonstrate that the Zeeman effect results in a splitting of the subgap states only when the ground state is a spin singlet. In this case, the applied magnetic field can also lead to a quantum phase transition to a spin-polarized ground state [5]. The herein demonstrated electrical tuning of Andreev levels as well as their spin-polarization could be harnessed to pursue proposals of realizing a topological superconductor using quantum dot arrays [3].


[4] Lee et al., PRB (2017),