CO.CO.MAT

SFB/TRR 21 - Seminar

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Quantum Dynamics of a nanoscale Josephson junction probed by scanning tunneling microscopy

Over the past 50 years, the Josephson effect has evolved from a controversial theoretical idea to a metrological standard defining the volt with unprecedented precision as well as the central mechanism in superconducting qubits, just to name a few examples. In the voltage standard, the ac Josephson effect is exploited, while the superconducting qubits rely on the dissipationless currents provided by the Josephson effect. Because a Josephson junction is very sensitive to the environmental impedance, its properties can be tuned by changing the external environment surrounding the junction, which leads to the possibility to actually design the Hamiltonian describing the Josephson junction. In this sense, a scanning tunneling microscop (STM) is an ideal tool to directly tune the properties of a Josephson junction. Using a superconducting vanadium tip as well as a superconducting vanadium sample, we create a Josephson junction, where the Josephson energy can be tuned over about two orders of magnitude by changing the tunneling resistance. In this way, the different regimes of a Josephson junction from sequential charge tunneling towards phase tunneling can be tuned continuously. In this presentation, I will present the nanoscale Josephson junction in an STM operating at a base temperature of 15mK. I will discuss the influence of the environmental impedance on the Josephson junction by demonstrating that the tip acts as a monopole antenna with periodic resonances. Further, I will address the dynamics of these extremely hysteretic Josephson junctions by looking in detail at their switching and retrapping behavior. As an outlook, I will propose how the Josephson junction can be exploited as alternative means to study superconductivity on the atomic scale.

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