Photon-assisted resonant Andreev reflections: Yu-Shiba-Rusinov and Majorana states

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Photon-assisted tunneling frequently provides detailed information on the underlying charge-transfer process. In particular, the Tien-Gordon approach predicts that the sideband spacing in bias voltage is a direct fingerprint of the number of electrons transferred in a single tunneling event. In this talk I consider photon-assisted tunneling into subgap states in superconductors in the limit of small temperatures and bias voltages where tunneling is dominated by resonant Andreev processes and does not conform to the predictions of simple Tien-Gordon theory. A systematic Keldysh calculation of the subgap conductance and provides a detailed analytical understanding of photon-assisted tunneling into subgap states, in excellent agreement with a recent experiment. We focus on tunneling from superconducting electrodes and into Yu-Shiba-Rusinov states associated with magnetic impurities or adatoms and extend our results other types of subgap states in superconductors. In particular, we argue that photon-assisted Andreev reflections provide a high-accuracy method to measure small but nonzero energies of subgap states which can be important for distinguishing conventional subgap states from Majorana bound states.