Scanning Gate Microscopy Probing of Electron-Hole Interference in a Normal-Superconductor Junction

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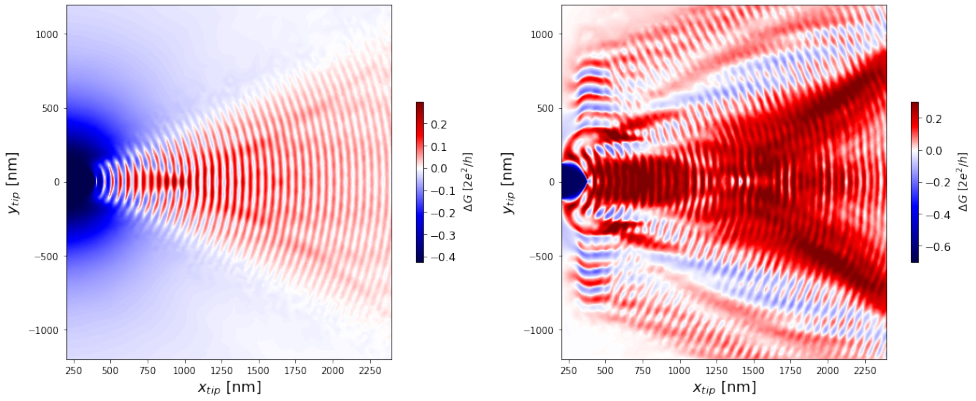
We theoretically investigate Scanning Gate Microscopy (SGM) probing of electron and hole trajectories in a two-dimensional Normal-Superconductor (NS) junction embedding a Quantum Point Contact (QPC). SGM is a well-known technique that has been used to visualize branched electron flow from QPCs [1]. In our work, taking advantage of recent progress in the realization of NS junctions in gated heterostructures [2], we propose to use this method for probing the paths of electrons and Andreev-reflected holes. We find that in an NS junction the conductance probed by the SGM technique exhibits oscillations that are due to the self-interference of electrons and holes. In contrast to ordinary SGM measurements, the interference occurs not only between the QPC and the SGM tip, but also between the tip and the NS interface. Most importantly, we show that for the measurements performed at a non-zero bias, the oscillations exhibit beating with the two periods determined by the two Fermi wavelengths that correspond to the electron and the hole wave-vectors. Finally, we show that at non-zero energy, the hole does not retrace the electron path due to the difference in the incident and reflection angles at the NS interference which, in turn, leads to a pronounced interference pattern in the conductance map [see Fig. 1].



(a) Zero bias. (b) Non-zero bias.

Figure 1: Electron-hole interference in SGM conductance maps.

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