Scattering Gate Interferometry at a Quantum Point Contact

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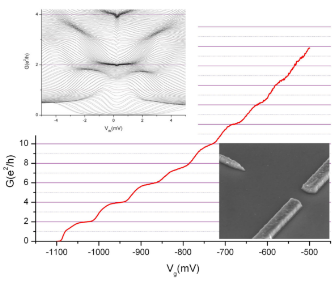
Electron-electron interactions are widely considered to explain the puzzling 0.7 anomaly [1] in Quantum Point Contacts (QPCs). Motivated by the theory developed in Ref. [2], we are interested to see if we can measure the scattering of electrons in the QPC due to Friedel oscillations generated by a distant perturbative potential. Since this experiment will also produce single particle interferences, the more subtle interaction effects will appear as deviation from the single particle models used to analyze the data.

Pioneering Scanning Gate Microscopy (SGM) experiments have already revealed such single electron interferences superimposed to the electron streams imaged in real space [3]. Inspired by SGM technique, we designed a new type of interferometer where an additional sharp gate is designed in front of the QPC to act as a tunable perturbative back-scattering potential for electrons towards the QPC. The negative voltage (Vg3) applied on this gate allows us to move the scattering region towards the QPC and generate interferences.

Additionally to this interferometry study, we performed SGM on a QPC, at base temperature of 20 mK. We observed usual single particle interferences (red dashed line 1) Fig. 2), and compared it to what can be obtained with our interferometers. We studied contrast and phase of these oscillations as the QPC opens, and discovered surprising effects. The interferences are more contrasted on the QPC plateaus and at the 0.7 anomaly than in the crossover regions between the plateaus, and they show sharp phase shifts between each plateau and noticeably at the 0.7 anomaly.

Finally, we observed a new type of fringes in our SGM experiment (blue dashed line 2) Fig.2), exhibiting an increasing wavelength as the tip is moved away from the QPC, and more contrasted below the first plateau. These new oscillations are not due to interferences but to the direct tuning of a self-organized many-particle state inside the QPC channel. These observations shine a new light on the puzzling many-body effects underlying QPCs' physics.



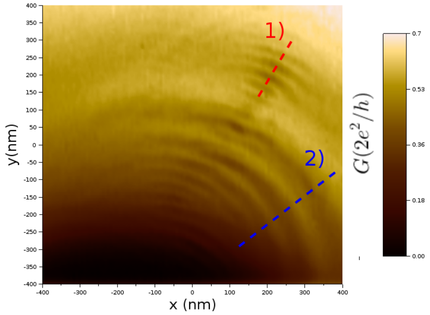


Fig.1 *(left): G(Vg) of the QPC. Insets: SEM image of the device and DC spectroscopy.*
Fig.2 *(right): SGM image showing interferences (line 1) and new oscillations (line 2)*

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