# Effect of interactions in quantum point contacts

**Hermann Sellier**
*Institut Néel, CNRS et UJF, 25 rue des Martyrs, F-38042 Grenoble, France*
e-mail: hermann.sellier@grenoble.cnrs.fr

Quantum point contacts (QPCs) are well known for their wave-guide properties, but they also show a rich physics of electron interactions. Applying a negative voltage on split-gates patterned on a two-dimensional electron gas (2DEG) creates a quasi one-dimensional electron channel connecting two large reservoirs [1]. Each wave-guide mode carrying one conductance quantum $2e^2/h$, the conductance curve versus gate voltage shows a series of quantized plateaus which are well reproduced by a simple saddle potential model [2]. However, a shoulder-like feature is commonly observed at a conductance around $0.7 \times 2e^2/h$ which can not be explained by single-particle theory [3]. With lowering temperature, this "0.7 anomaly" shades off and a "zero-bias anomaly" emerges [4]. Although the link between these structures remains an open question, both are thought to arise from strong Coulomb interactions in the small 2DEG region forming the QPC where the electron density is low. Different theoretical models have been proposed to explain these anomalies, but no consensus could be reached so far on their interpretation [5].

After a brief review of experimental observations and theoretical models, I will present recent experiments [6,7] that indicate the presence of self-consistently localized charges in QPCs. In particular, I will focus on our experimental approach [7] using a Scanning Gate Microscope (SGM) [8-10] to change in-situ the shape of the QPC potential. The SGM tip is used as a movable gate in a more flexible and less invasive way than what could be achieved with several fixed surface gates. Approaching the tip towards the QPC produces an oscillatory splitting of the zero-bias anomaly, correlated with simultaneous appearances of the 0.7 anomaly, thereby revealing that both features share a common origin. These repetitive changes are interpreted in terms of a many-body localized state, induced by the strong Coulomb repulsion in this low density region, and forming a small one-dimensional Wigner crystal [11-13]. The number of charges in this crystal is controlled by the tip position and produces different Kondo screenings from the leads depending on charge parity, with a conductance peak either at zero, or at finite bias [14,15].

The SGM technique is also proposed as a way to probe electron interactions in QPCs by back-scattering the electrons towards the QPC with the SGM tip and produce interference fringes [16,17]. I will describe the properties of the interferences observed in SGM experiments and show that disorder in the reservoirs is usually the main source of interferences observed on conductance plateaus [18,19]. Signatures of interactions may be visible in transitions between plateaus and in particular around the 0.7 anomaly.

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