Exploring the physics of one-dimensional systems by scanning gate microscopy

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In my talk I will present our recent work on quantum point contacts studied by scanning gate microscopy (SGM). The study of low-dimensional ballistic systems has yielded a number of exciting observations and has made it possible to investigate several striking physical phenomena during the last 30 years. Despite the conceptual simplicity of the archetypical device, i.e. a quasi-1D constriction (or quantum point contact, QPC), these systems are still attracting much interest both from the point of view of fundamental electron-transport physics and for possible applications, for instance in spintronics. The origin of the anomalous transport feature appearing in QPCs at conductance $G \sim 0.7 \times (2e^2/h)$ – the so-called 0.7 anomaly – represents a long standing puzzle. Several mechanisms were proposed to explain it, but a general consensus has not been achieved. A key open issue is whether point defects that can occur in these low-dimensional devices are the physical cause behind this conductance anomaly. Here we use the SGM technique to map individual impurity positions in several quasi-1D constrictions and correlate these with conductance characteristics. Our data demonstrate that the 0.7 anomaly can be observed irrespective of the presence of localized defects, and we conclude that the 0.7 anomaly is a fundamental property of low-dimensional systems [1].

In the second part of my talk I will focus on the possible existence of fractional order within integer quantum Hall systems. In fact, integer edge states sometimes behave as monolithic objects with no inner structure, while other experiments clearly highlight the role of fractional substructures. Here we use SGM and demonstrate that fractional features are unambiguously observed in every integer quantum Hall constriction studied. We present also an experimental estimate of the width of the fractional incompressible stripes corresponding to filling factors 1/3, 2/5, 3/5, and 2/3 [2]. Our results compare well with predictions of the edge-reconstruction theory.

[1] A. Iagallo, N. Paradiso, S. Roddaro, C. Reichl, W. Wegscheider, G. Biasiol, L. Sorba, F. Beltram, and S. Heun: *Scanning Gate Imaging of quantum point contacts and the origin of the 0.7 Anomaly*, Nano Research, in press; arXiv:1311.6303 [cond-mat.mes-hall].

[2] N. Paradiso, S. Heun, S. Roddaro, L. Sorba, F. Beltram, G. Biasiol, L. N. Pfeiffer, and K.W. West: *Imaging Fractional Incompressible Stripes in Integer Quantum Hall Systems*, Phys. Rev. Lett. **108**, 246801 (2012).