Physics AT QUEENS COLLEGE

Colloquium Notice

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Detecting Bound Spins Using Coupled Quantum Point Contacts

For many years now, there has been ongoing interest in the manifestations of many body phenomena in the conductance of strongly-confined, one-dimensional (1D) electron systems. One important aspect of this research has centered on the study of the so-called 0.7 feature in the low-temperature conductance of 1D conductors known as quantum points (QPCs). There have been numerous reports in the literature suggesting that the 0.7 feature should be related to some kind of spontaneous spin polarization in the QPCs, which persists even at zero magnetic field. In this presentation, we review the results of our recent work on this problem, in which we make use of coupled QPCs to probe the properties of transport very close to pinch-off. We observe a resonant interaction between two QPCs whenever one of them pinches off, which we believe is associated with the binding of a single spin to the QPC that is pinching off. A phenomenological theoretical model is developed that relates the observed resonance to a tunnel-induced correlation that arises from the interaction between a presumed bound spin on one QPC and conducting states in the other. Building on these ideas, we use this measurement technique to probe the microscopic properties of the bound spin, finding it to be robustly confined and to show a Zeeman splitting in a magnetic field. The spin binding occurs for stronger gate confinement than the 0.7 feature, and we therefore suggest an alternative scenario for understanding the formation of this feature. In this, one considers the evolution of the self-consistent bound state as the gate potential is weakened from pinch off to allow for electron transmission through the QPC. The suggestion of this work is that a QPC may serve as a naturally-formed single-spin system with electrical readout, a finding that may be useful for the development of future generations of single-spin electronics.

J. P. Bird and Y. Ochiai,Electron spin polarization in nanoscale constrictions, Science 303, 1621 (2004).
Y. Yoon, L. Mourokh, T. Morimoto, N. Aoki, Y. Ochiai, J. L. Reno, and J. P. Bird, Probing the microscopic structure of bound states in quantum point contacts, Phys. Rev. Lett. 99, 136805 (2007).

Work performed in collaboration with: Y. Yoon, T. Morimoto, L. Mourokh, N. Aoki, Y. Ochiai, and J. L. Reno

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