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Spontaneous Spin Polarization in Quantum Point Contacts

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Mesoscopic systems exhibit a range of non-trivial spin-related phenomena in the low density regime, where inter-particle Coulomb interactions become comparable to their kinetic energy. In zero-dimensional systems spontaneous polarization of a few-electron quantum dot leads to a spin blockade, a remarkable effect where mismatch of a single spin blocks macroscopic current flow. In two-dimensional hole gases there is an experimental evidence of a finite spin polarization even in the absence of a magnetic field. In one-dimensional systems quantum wires and quantum point contacts - a puzzling so-called "0.7 structure" has been observed below the first quantization plateau. Experiments suggest that an extra plateau in the conductance vs gate voltage characteristic at $0.7 \times 2e^2/h$ is spin related, however, the origin of the phenomenon is not yet understood and is highly debated. We report direct measurements of finite polarization of holes in a quantum point contact (QPC) at conductances $G < 2e^2/h$ [1]. We incorporated QPC into a magnetic focusing device so that polarization can be measured directly using a recently developed spatial spin separation technique [2]. Devices are fabricated from p-type GaAs/AlGaAs heterostructures. A finite polarization is measured in low-density regime, when conductance of a point contact is tuned to $< 2e^2/h$. We found that polarization is stronger in samples with well defined "0.7 structure".

[1] L.P. Rokhinson, L.N. Pfeiffer and K.W. West,"Spontaneous spin polarization in quantum point contacts," Physical Review Letters **96**, 156602 (2006)
[2] L.P. Rokhinson, V. Larkina, Y.B. Lyanda-Geller, L.N. Pfeiffer and K.W. West, "Spin separation in cyclotron motion," Physicsl Review Letters **93**, 146601 (2004)