Weak measurements and quantum paradoxes in quantum transport

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The difficulty in measuring non-commuting quantum mechanical observables is one of the most fascinating consequences of the quantum mechanical postulates, relevant for correlation measurements of the electric current [1]. Hence, the investigation of quantum measurement and projection is a fundamentally interesting topic. We study the concept of a weak measurement of non-commuting observables using a quasiprobabilistic description [2] relevant for mesoscopic transport experiments, resembling the Wigner function or other quasiprobabilities [3]. The possible negativity of a quasiprobability is a fundamental quantum mechanical property and can be tested by violation of classically derived inequalities. We discuss as first example how to detect nonlocal quantum correlations (entanglement) in mesoscopic junctions, which do not permit detection of single events [4]. Furthermore we discuss how non-classical correlations similar to squeezing in quantum optics can be observed in a current fluctuation measurement scheme using a detector at a lower temperature [3].

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[1] A. Bednorz and W. Belzig, Phys. Rev. Lett. 101, 206803 (2008)

[2] A. Bednorz and W. Belzig, Phys. Rev. B 81, 125112 (2010)

[3] A. Bednorz, C. Bruder, B. Reulet and W. Belzig, Phys. Rev. Lett. 110, 250404 (2013)

[4] A. Bednorz and W. Belzig, Phys. Rev. B 83, 125304 (2011)