Quantum entanglement detection in quantum transport

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The creation and detection of entangled particle in a mesoscopic system constitutes an important field of research in both experiment and theory. While sources of spin-entangled electrons are readily available in the form for Cooper pairs in superconductors, to controllably separate the two electrons and detect the entanglement is still a challenge. Experimentally carbon nanotube quantum dots are promising systems to spatially separate Cooper pairs [1,2]. However the detection through current cross correlations presents a challenge, in particular to theory [3]. The reason is that usual schemes like violation of the Bell inequality are not applicable due to the continuous character of the current signal [4]. In this talk I will critically review proposals like entanglement detection through the measurement of current noise correlators, non-local conductances or so-called entanglement witnesses. They all have in common that they cannot exclude in general dephasing induced "detanglement", while still signalling entanglement. In the end I will propose how entanglement can be unambiguously detected and discuss novel schemes to detect controlled entanglement in a Cooper pair splitter pump.

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