The GHz Frontier of Nano-electronics

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Recently the team of C. Glattli succeeded in measuring both the real and imaginary part of the admittance of a small quantum coherent capacitor for frequencies in the GHz range [1]. A small cavity is coupled via a single scattering channel to an electron reservoir and is capacitively coupled to a back gate. The cavity forms one plate of the capacitor and the back gate represents the other plate. The channel is formed with the help of a quantum point contact. Thus the channel can be tuned from pinch-off to perfect transmission via dc-voltages applied to the gates forming the quantum point contact. Over a decade ago, theory [2] made the counter-intuitive prediction that the charge relaxation resistance of a cavity connected via a single quantum channel to an electron reservoir is independent of the transmission probability of this channel and quantized at half of a resistance quantum. The essential condition is that electron motion in the cavity remains quantum coherent. The experiment of Glattli et al. confirms this prediction. I discuss the original theoretical considerations [2] which combines scattering theory with a Hartree theory [2]. I go on to discuss treatments which exclude self-interactions and permit to treat charge quantization effects [3]. At low magnetic fields the spin degree of freedom is important and we suggest additional experiments.

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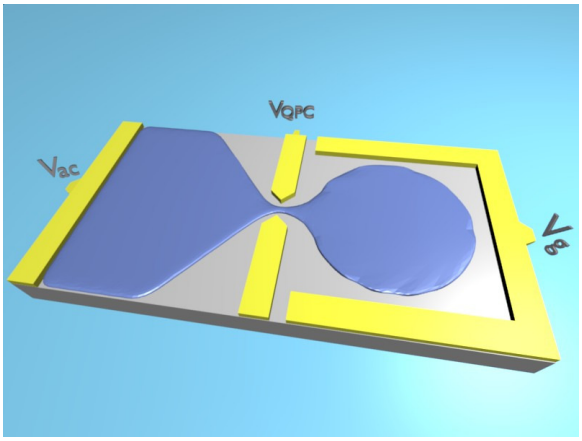

Fig. 1. Quantum coherent capacitor. A small cavity is connected via a single quantum channel through a quantum point contact (at voltage V_QPC) to an electron reservoir. The cavity is capacitively connected to a back-gate at voltage V_g. An ac-voltage V_ac is applied to the electron reservoir. After Ref. [4].

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