Probe-configuration dependence of charge-fluctuation induced dephasing in a mesoscopic interferometer

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In a recent experiment Kobayashi et al.[1] have studied dephasing in a ballisitic mesoscopic ring with four terminals. The decoherence rate was extracted from a measurement of the four-terminal resistance[2] and was found to be very sensitive to the measurment configuration. In addition, the amplitude of the coherent Aharonov-Bohm oscillations[3] observed in the four-terminal resistance was also found to be strongly configuration dependent. In the non-local probe configuration (see Fig. 1) where the dephasing rate is smaller, the typical oscillation amplitudes were an order of magnitude larger than in the local probe configuration (see Fig. 1).

In both configurations, a decoherence rate linear in temperature was observed in agreement with a previous experimental investigation of dephasing in ballistic rings by Hansen et al. [4]. We have shown before[5] that a linear dependence of the dephasing rate on temperature is obtained if scattering of electrons from charge fluctuations in the arms of the ring is taken into account. In our model the arms of the ring were each described by a single internal

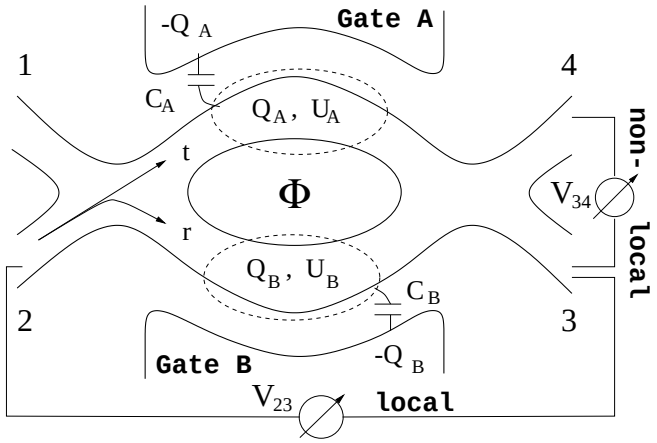

FIG. 1: Arm i $(i = A, B)$ of the ring is coupled to a side-gate via a capacitance C_i . An internal potential $U_i(t)$ and a charge $+Q_i(t)$ belong to each arm of the ring. Here, $t = \sqrt{T}$ is the amplitude for transmission through the intersection and $r = i\sqrt{1-T}$ is the amplitude for being deflected. There is no backscattering in the intersections. The local and non-local voltage-probe configuration are indicated.

potential $U_i(t)$, $(i = A, B)$ and a charge $Q_i(t)$. To understand the results of Kobayashi et al. [1] we have extended this model to take into account the effect of an external circuit. We have demonstrated[6] that charge fluctuations induced through the fluctuations of the voltages applied to the voltage probes can account for the difference of the decoherence rates for the local and non-local configuration.

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