

## Shot noise of quasiparticles at local fractional quantum Hall states measured by a cross correlation technique

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Edge channels (ECs) along the boundary of fractional quantum Hall (QH) states are regarded as chiral Luttinger liquids (CLLs). Charge tunneling between ECs through a quantum point contact (QPC) reflects fractional charge of quasiparticles [1] and CLL nature of ECs [2] as evidenced in shot noise measurements. On the other hand, measurement of current through a QPC in the QH regime suggested the importance to consider quasiparticle tunneling through the constriction region of a *local fractional QH state* [3]; even when the bulk filling factor ( $\nu_B$ ) is an integer, the local filling factor ( $\nu_{QPC}$ ) can be a fraction, since negative voltage applied to the split gate electrodes modifies the local electron density at the QPC. Here, we report the direct observation of fractional charge of quasiparticles at various  $\nu_{QPC}$  by shot noise measurements. While the previous shot noise measurements have focused on the edge of the bulk fractional QH states, we are motivated to clarify quasiparticle tunneling through the local fractional QH state connected to the integer QH region.

Figure 1 shows the schematic of the device and the measurement setup. We inject DC current ( $I_1$ ) from the Ohmic contact  $\Omega_1$  by applying a source-drain voltage ( $V_{sd}$ ). The current  $I_1$  flows to the QPC and is partitioned to  $I_2$  and  $I_4$ , which are drained at  $\Omega_2$  and  $\Omega_4$ . The current fluctuations  $\Delta I_2$  and  $\Delta I_4$  are converted to voltage fluctuations by cryogenic transimpedance amplifiers and measured with an analog-digital converter. We evaluate the shot noise caused at the QPC by calculating the cross-correlation  $S_{21} = \langle \Delta I_2 \Delta I_4 \rangle$  in frequency band of 300 ~ 700 kHz. Figure 2 shows the typical  $V_{sd}$  dependence of  $S_{21}$  measured at 80 mK at magnetic fields of  $B = 8.8$  T ( $\nu_B = 1$ ) and 4.4 T ( $\nu_B = 2$ ). The transmission probability  $T_1$  of the EC of the lowest Landau level at  $V_{sd} = 0$  is fixed at  $T_1 \cong 1/3$  (Conductance from  $\Omega_1$  to  $\Omega_4$  is  $G_{41} = e^2/3h$  at both bulk filling factors). The obtained  $S_{21}$  is negative due to the binominal distribution of quasiparticles. While the data at  $B = 4.4$  T are well fitted by the calculation for free electrons (tunneling charge  $e^* = e$ : solid line), those at 8.8 T are close to the shot noise of  $e^* = e/3$  at  $V_{sd} > 100$   $\mu$ V (dashed line). Moreover, we observed non-monotonic enhancement of the shot noise near  $V_{sd} = 30$   $\mu$ V, which indicates the CLL nature of ECs at local fractional QH states.

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 [2] D. C. Glatli *et al.*, Physica E **6**, 22 (2000); Y. C. Chung *et al.*, Phys. Rev. B **67**, 201104(R) (2003). [3] S. Roddaro *et al.*, Phys. Rev. Lett. **93**, 046801 (2004).

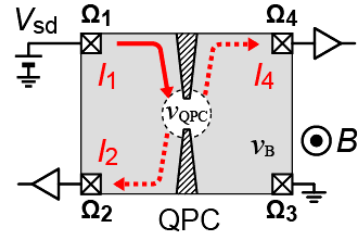


Fig. 1 Schematic of the device and the measurement setup.

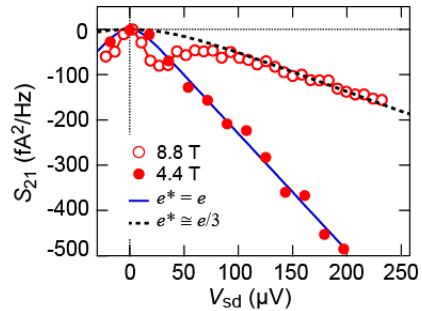


Fig. 2 Source-drain voltage ( $V_{sd}$ ) dependence of  $S_{21}$  at  $T_1 \cong 1/3$  at bulk filling factors of  $B = 8.8$  T (open circles) and 4.4 T (filled circles).

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