Mapping dissipation in a quantum dot device

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Characterization of quantum devices relies primarily on electric current through the device. It is usually assumed that all parts of the device remain at the same temperature. However, the inevitable presence of local dissipation can lead to significant deviations [1]. Measurements of dissipation or heat transport are more involved and therefore less prominent in the literature [2].

Here, we present a device capable of mapping the dissipation generated by a quantum dot junction in its complete operational range. To this end, we thermally isolate the drain contact of an epitaxially defined quantum dot in an InAs nanowire (Fig. 1a). The electron temperature of the drain is measured via the zero-bias conductance of a proximitized tunnel junction [3]. As a striking consequence of Coulomb blockade, we find regimes where the dissipation can be tuned by the gate voltage, while the charge current remains constant (Fig. 2c,d).

The presented device therefore promises to study heat injection in the steady-state, as well as in calorimetric operation when the system is driven out of equilibrium.

References

[1] Philips, S.G.J. et al., *Nature* **609**, (2022) 919-924

[2] Majidi, D et al., *Applied Physics Letters* **124**, (2024) 140504

[3] Karimi, B & Pekola, J.P., *Phys. Rev. Applied* **10**, (2018) 054048

Figures

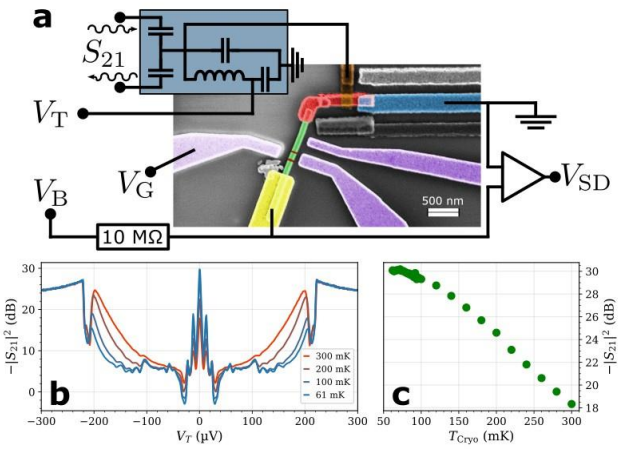

Figure 1: (a) The bolometer (red) acts as the drain of the quantum dot within the InAs nanowire (green). Superconducting contacts (brown, blue) provide thermal isolation. (b) Spectra of the tunnel junction vs. cryostat temperature. The zero-bias anomaly (ZBA) provides a sensitive, non-invasive temperature readout. (c) Calibration curve of the ZBA signal as a function of the cryostat temperature.

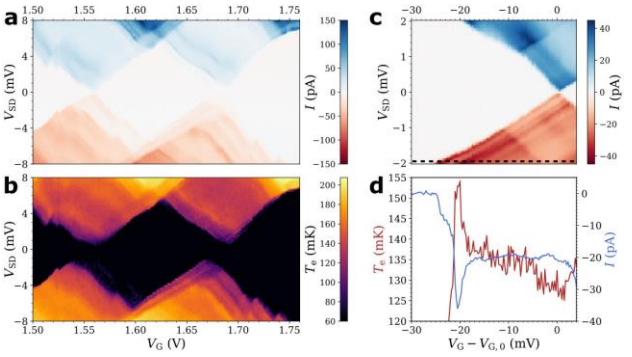

Figure 2: Extended map of the charge current I (a) and the drain temperature T_e (b) in the V_G-V_{SD} plane. (c) Coulomb diamond around $V_{G,0} \approx -1.53$ V. (d) Drain temperature T_e (red) and current I (blue) as a function of V_G at $V_{SD} = -2.0$ mV along the dashed line in (c).