Current-induced extrinsic contributions in nonlinear transport measurements at the LAO/STO interface

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Electron motion in a solid can arise from the local distribution of the wavefunctions, as encoded in the quantum geometric tensor [1]. This tensor consists of a real part, the quantum metric and an imaginary part, the Berry curvature. Under an oscillating current, transport experiments are an excellent probe to disentangle linear from higher-order nonlinear responses originating from distinct geometrical contributions [2]. However, commonly used control parameters such as electrostatic gating and temperature can themselves be modulated by the applied current, leading to undesired extrinsic nonlinear effects [3].

Here we report a systematic and general procedure one could use to identify and possibly rule out spurious contributions to transport generated by current-induced modulation of gate voltage and temperature. We implement this approach with magneto-transport measurements in the two-dimensional electron gas at $LaAlO_3/SrTiO_3$ interface. This system exhibits Rashba spin-orbit coupling at the origin of nontrivial geometrical features in momentum space and has been shown to host intriguing linear and nonlinear transport phenomena [4,5].

[1] P. Törmä, Phys. Rev. Lett. 131, 240001 (2023).
[2] M. Suárez-Rodríguez et al., Nat. Mater. 24, 1005-1018 (2025).
[3] K. Sobnath et al., in preparation (2026).
[4] G. Sala et al., Science 389, 822-825 (2025).
[5] E. Lesne et al., Nat. Mater. 22, 576-582 (2023).