Probing charge neutrality in InAs/GaSb coupled quantum wells

Megan E. Kelly
Abhirami Saminathan, Mark C. Rosamond, Thomas A. Moore, Lianhe H. Li, Edmund H. Linfield, Christopher H. Marrows

University of Leeds, Leeds, United Kingdom

py17mk@leeds.ac.uk

Abstract

The quantum spin Hall effect (QSHE) defines a two-dimensional topological insulating state [1,2]. The characteristic spin-momentum locked helical edge states offer potential for novel spintronic devices. Evidence for the QSHE in coupled InAs/GaSb quantum wells (QWs), a III-V semiconductor grown by conventional molecular beam epitaxy methods, has been demonstrated [3,4]. Here, we report the fabrication and transport characteristics of dual gated InAs/GaSb QW devices, where electron and hole populations have been tuned to charge neutrality (a necessary condition for the QSHE to manifest itself). Fig. 1 shows an example, where the sheet resistance peak accompanied by a change in sign of the Hall coefficient indicates a crossing of the charge-neutral point. This may correspond to the topologically non-trivial insulating band gap of the QSHE.
Fig. 2 shows further gate voltage sweeps at varying B-fields, with integer QH features highlighted, again converging at the charge-neutral point.

References

[1] Kane et al., PRL, 95 (2005) 226801
[2] Bernevig et al., PRL, 96 (2006) 106802
[3] Knez et al., PRL, 107 (2011) 136603
[4] Knez et al., PRL, 112 (2014) 026602

Figures

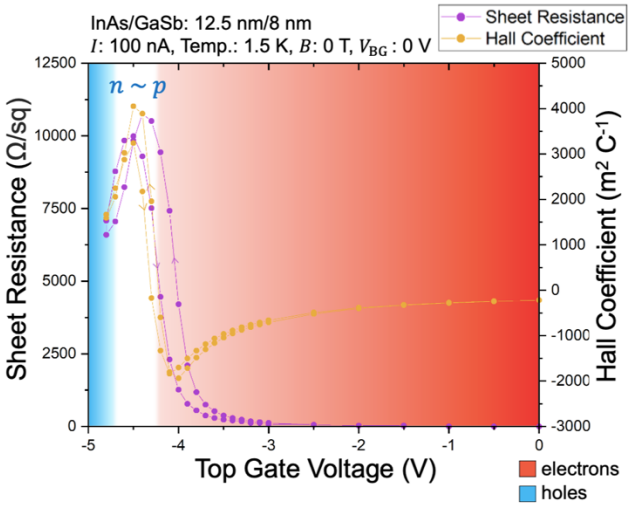

Figure 1: Sheet resistance and Hall coefficient with varying top gate voltage. The carrier dominance is switched from electrons to holes, with a charge neutrality resistance peak consistent with a change-of-sign of the Hall coefficient.

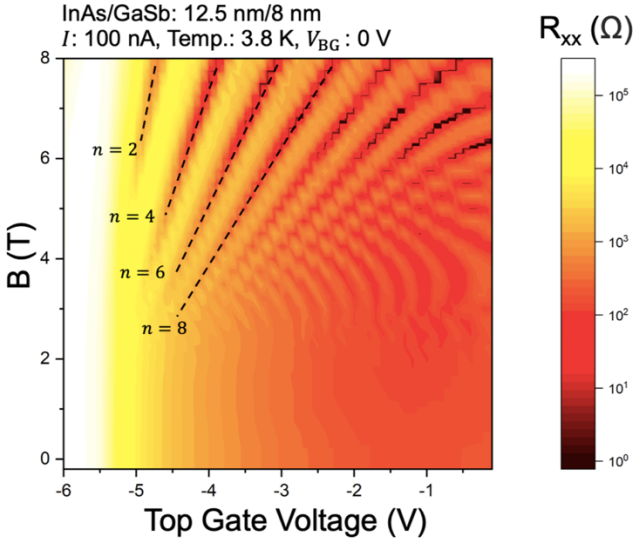

Figure 2: Sheet resistance response to -6 to 0 V top gate voltage sweep, at various B-field values. The ridges of resistance minima correspond to the Landau level filling factors, as determined from the Hall resistance.