Detection of coexisting electron and hole Landau levels in magnetic graphene via charge transport

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The graphene-CrSBr stack is a novel van der Waals material system with great potential in 2D electronics. It combines the magnetic ordering of CrSBr with the long spin-relaxation length and good conductivity of graphene through exchange interaction at the interface. As has been demonstrated by previous research, the Dirac cones of the spin-down and spin-up electrons are shifted up and down in energy and the graphene becomes effectively magnetised. Non-local 4 terminal spin diffusion experiments using magnetic contacts have shown spin-dependent conductivity in such systems.
Here we fabricated the graphene-CrSBr into the Hall bar configuration with gold contacts, and measured its response in the quantum Hall regime.
We saw non-monotonous behaviour in the transverse resistance where the slope of the resistance changed sign as the magnetic field was changed.
We believe this indicates the coexistence of electron Landau levels and hole Landau levels, corresponding to a Fermi level placed in between the Dirac points of the spin up and down bands. The electron and hole Landau edge channels carry charge currents in opposite lateral directions, but they should also create a transverse spin current, and our aim is to make reliable observation of this charge to spin signal using non-magnetic contacts.