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Probing quantum Hall states with single-electron transistors at high magnetic fields MARTIN GUSTAFSSON, MATTHEW YANKOWITZ, CARLOS FORSYTHE, XIAOYANG ZHU, CORY DEAN, Columbia University —
The sequence of fractional quantum Hall states in graphene is not yet fully understood, largely due to disorder-induced limitations of conventional transport studies. Measurements of magnetotransport in other 2D crystals are further complicated by the difficulties in making ohmic contact to the materials. On the other hand, bulk electronic compressibility can provide clear signatures of the integer and fractional quantum Hall effects, does not require ohmic contact, and can be localized to regions of low disorder. The single-electron transistor (SET) is a suitable tool for such experiments due to its small size and high charge sensitivity, which allow electric fields penetrating the 2D electron system to be detected locally and with high fidelity. Here we report studies of exfoliated 2D van der Waals materials fully encapsulated in flakes of hexagonal boron nitride. SETs are fabricated lithographically on top of the encapsulation, yielding a structure which lends itself to experiments at high electric and magnetic fields. We demonstrate the method on monolayer graphene, where we observe fractional quantum Hall states at all filling factors $\nu = n/3$ up to $n = 17$ and extract their associated energy gaps for magnetic fields up to 31 tesla.

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