# FRACTIONAL QUANTUM HALL EFFECT AND WIGNER CRYSTALLIZATION IN SUSPENDED CORBINO GRAPHENE DISK

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We report our experimental studies on suspended monolayer graphene in Corbino disk geometry [1]. Our fabrication process resulted in samples with residual impurity charge density down to $6 \times 10^9$ 1/cm$^2$ after current annealing at millikelvin temperatures. We employ conductance and transconductance measurement techniques for probing quantum Hall states (interger and fractional) in these samples at high magnetic fields.

When a perpendicular magnetic field $B$ is introduced, electrons in graphene undergo quantum Hall effect at certain charge carrier densities $n$, noted by integer values of filling factor $\nu = \frac{hn}{eB}$ ($h$ is the Plank constant and $e$ the electron charge). This leads to vanishingly low conductance through the bulk of the device, which is a very convenient way to identify integer (IQHS) and fractional quantum Hall states (FQHS, $\nu \neq$ integer). Indeed, we observe the sequence $\nu$ = 2, 6, 10,... expected for graphene, as well as the lowest so called broken symmetry states $\nu$ = 0, 1, 3,... (broken valley and spin symmetries). Between $\nu$ = 0 and 1 we observe a sequence of FQHS, $\nu = \frac{p}{2p\pm1}$ ($p$ is a positive integer), centred around $\nu$ = 1/2 that corresponds to the sequence predicted by the theory of composite fermions [2]. Additionally, we observe non-linear IV-characteristics at low filling factors ($\nu$ = 0.12-0.2) that are consistent with presence of a Wigner crystal phase [3].

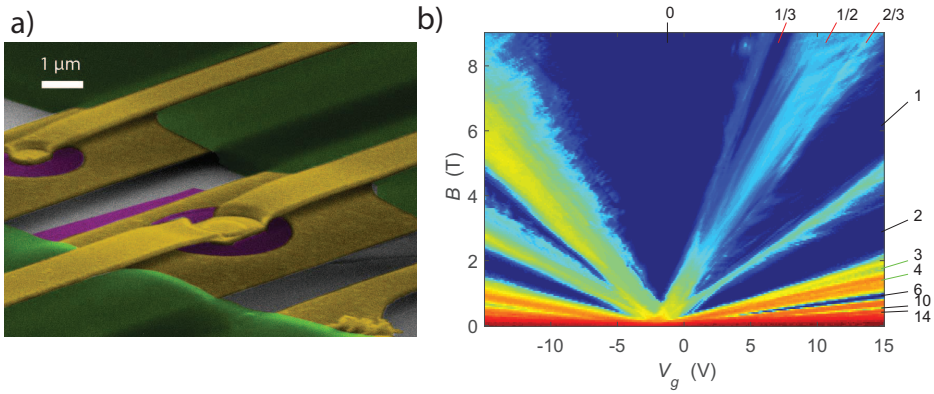


Figure 1: a) a false coloured SEM micrograph of a suspended graphene Corbino sample (graphene purple, gold yellow). b) Conductance through the device as a function of perpendicular magnetic field and back gate voltage used to tune the charge carrier density. Dark blue denotes QH-states with low conductance ($G << 10^{-6}$ S).

[1] M. Kumar, A. Laitinen, P. J. Hakonen, arXiv:1611.02742 (2016).
[2] J. K. Jain, Phys. Rev. Lett. 63 (1989) 199.
[3] H. W. Jiang, el al., Phys. Rev. Lett. 65 (1990) 633.