IR Modulated Magneto-Transport of Monolayer Graphene in the Quantum Hall Regime

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Introduction

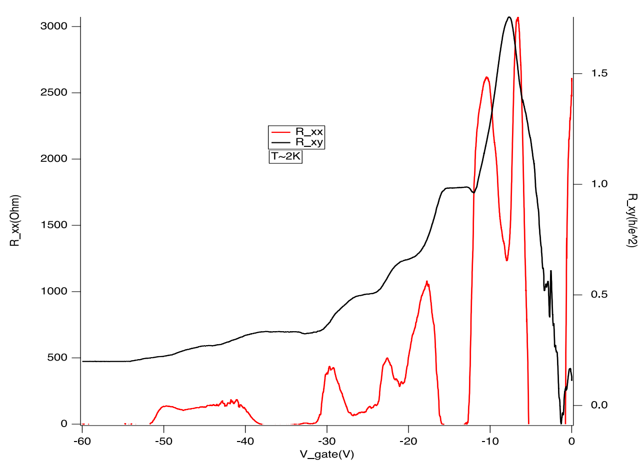
The low energy band structure of graphene displays a linear dispersion and can be expressed by a Dirac hamiltonian for 2D massless electrons. It results in to the non-equidistant separation of Landau levels (LLs) and allows the coupling of two different LLs with resonant optical excitation. According to a recent theoretical work [1], optically induced fractional Quantum Hall States can be realized in monolayer graphene due to interaction between two optically dressed, partially filled Landau levels. Motivated by this prediction, we have been working on experimental realization of new light induced fractional quantum Hall phases.

Experimental

We performed first test experiments on gated h-BN encapsulated monolayer graphene samples with a newly modified probe head that enables magneto-transport measurements on IR illuminated samples at ^{3}He temperatures. A tunable MIR quantum cascade lasers was used as a pump to drive a time periodic excitation and the standard lock-in technique to measure the Hall conductance.

Results and Discussion

The high quality of our hBN/graphene samples allows us to detect some fractional Quantum Hall State at temperatures to approximately 1.8 K (Fig. 1). The goal of this first campaign was to establish the configuration of the experiment that could enable IR photoconductivity measurements under relatively strong IR light modulation at lowest temperatures. Figure 2 shows the temperature log of the probe head when we were condensing and pumping ^{3}He. We found that one could reach temperature as low as 600-700mK under IR illumination of up to 1 mW of power, which is promising for the next experiments.



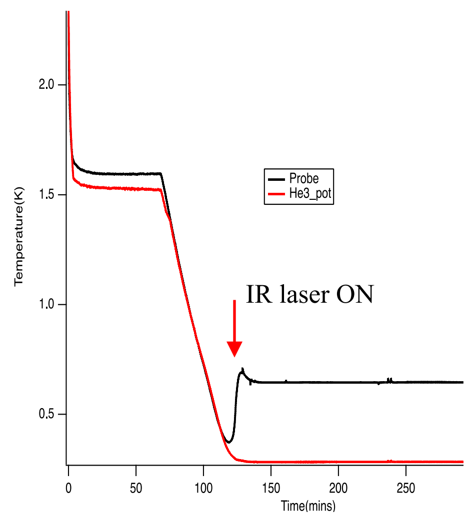


Figure 2. Hall resistance of the sample at 1.8K and 18T

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References

[1] Ghazaryan, A. et al., PRL, **119**, 247403 (2017)