



Quantum Hall Effect in a Polarization Induced 2-D Electron Gas in Pulsed Field

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Introduction

Electrons confined to move in two dimensions and placed in a perpendicular magnetic field may exhibit the fractional quantum Hall effect (FQHE), a topologically non-trivial and strongly correlated quantum phase that exhibits fractional charges and anyonic statistics. This exotic state is fragile to disorder, but the energy gap can be increased to make the state more robust by realizing it in a higher magnetic field. The polarization-induced two dimensional electron gas (2DEG) at the $\text{Al}_x\text{Ga}_{1-x}\text{N}/\text{GaN}$ heterojunction can be prepared with sufficiently low disorder simultaneously with high electron concentration needed to study the FQHE in the very high magnetic fields provided by pulsed magnets.

Experimental

The heterostructure, fabricated by molecular beam epitaxy, consists of 3 nm GaN/21 nm $\text{Al}_{0.07}\text{Ga}_{0.93}\text{N}/300$ nm GaN on single crystal GaN. At the four corners of 3 mm square chips, Ti/Al contacts are defined by photolithography and rapid thermal annealing to 500 °C in nitrogen atmosphere.

In Cell 4 of NHMFL-PFF, the 2DEG sample resistances, 2-terminal and longitudinal 4-terminal, are recorded by DC transport at low temperature in pulsed magnetic fields up to 65 T. Applied currents ranging from 3 to 12 uA allow for observation of quantum Hall effect with good signal to noise.

Results and Discussion

Magnetotransport (**Fig.1**) shows well-formed integer quantum Hall effect with vanishing longitudinal resistivity R_{xx} . An additional R_{xx} minimum and a plateau of 2-terminal resistance are seen around $B = 45$ T. Analyzing the resistivity as a function of $1/B$ shows that these features appear when the filling fraction is exactly $2/3$. The features disappear with increasing temperature (**Fig.1**); they are indicative of FQHE, but with non-vanishing R_{xx} we cannot extract the gap size.

Conclusions

We can study the quantum Hall effect in the GaN 2DEG in very high, pulsed magnetic fields. We find features in magnetotransport indicating a $2/3$ fractional quantum Hall state in a $\text{Al}_{0.07}\text{Ga}_{0.93}\text{N}/\text{GaN}$ 2DEG sample at 45 T.

Acknowledgements

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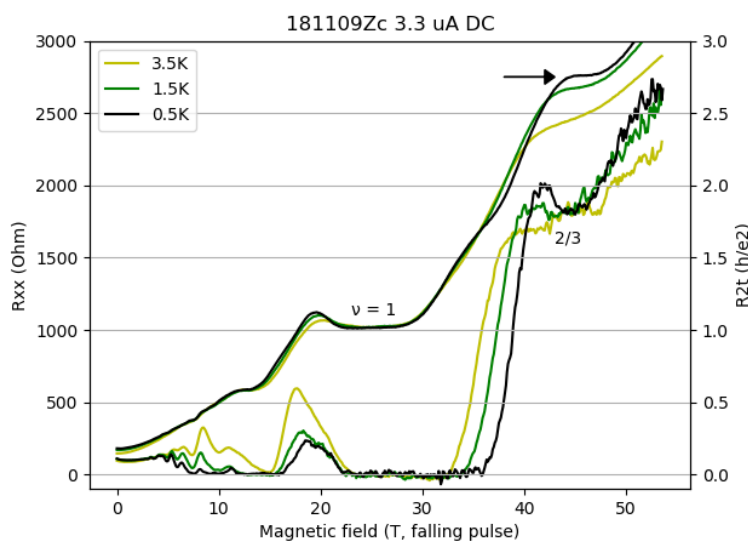


Fig.1 The signatures of fractional quantization at 45 T are a minimum of R_{xx} and a plateau of 2-terminal resistance (arrow)