Effect of Variation of Charge Carrier on 5/2 Fractional Quantum Hall Effect

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Introduction

Among all the observed fractional quantum Hall effect (FQHE) states, the nu=5/2 FQHE state in the second Landau level remains the most exotic one. This state has been at the center of current quantum Hall research due to the possibility of its being non-Abelian and, thus, having potential applications in fault-tolerant topological quantum computation. Given the non-Abelian character of this state, more studies are needed to fully characterize the 5/2 state.

Experimental

The magneto-resistance of a very high mobility hetero-junction insulated gate field-effect transistor (HIGFET) with variable electron densities up to 4 x 10^{11} cm $^{-2}$ was measured at very low temperatures down to 10 mK and in applied magnetic fields up to 6T. The electron densities were varied by changing the gate voltage of the field-effect transistor. The sample was cooled by immersing the sample in liquid ^{3}He which was in thermal contact with a plug of sintered silver that was an integral part of a solid silver rod extending from a copper nuclear refrigerator.[1]

Results and Discussion

Figure 1a shows the variation of the transverse magneto-resistance as a function of carrier density at a fixed magnetic field and as a function of temperature.

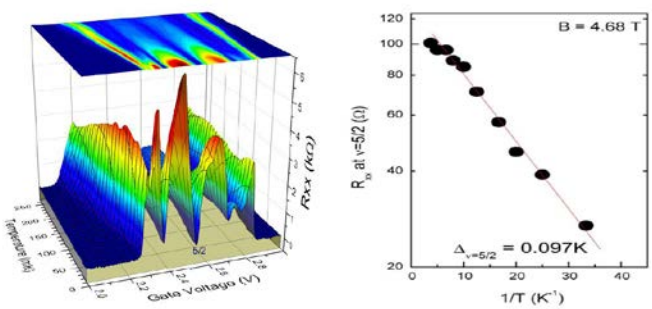

Figure 1. (a) Variation of the longitudinal resistance of the high mobility heterojunction as a function of gate voltage for temperatures 10<T<300 mK. (b) Temp-erature dependence of the value of R_{XX} at 4.68 T. (From ref. [2])

Figure 1b displays the Rxx value at nu=5/2 as a function of 1/T, demonstrating that Rxx is activated at B = 4.68T. From this temperature dependence an energy gap was deduced for the 5/2 state. The density dependence of the energy gap is consistent with the 5/2 state being spin polarized.

Conclusions

Clear evidence for a spin polarized 5/2 fractional quantum Hall state is observed in high mobility 2D electron systems in a very high mobility hetero-junction insulated gate field-effect transistor.

Acknowledgements

The work at Sandia was supported by the DOE under DE-AC04-94AL85000, and the NHMFL High B/T facility is supported by the NSF – DMR-0654118 and the State of Florida.

References

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[2] Pan, W. *et al*., Phys. Rev. Lett. **106**, 206806 (2011).