Fractional Quantum Hall Effect in the Upper Spin Branch of the Second Landau Level

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Introduction

Electron physics in the second Landau level has attracted a great deal of current interest due to the exciting proposal of using non-Abelian fractional quantum Hall effect (FQHE) states in fault-resistant topological quantum computation. Unlike the lower spin branch of the second Landau level between $2 < \nu < 3$, however, much less studies have been carried out in the upper spin branch of this Landau level between $3 < \nu < 4$.

Experimental

The high quality 2D electron system was achieved by an LED illumination at ~ 4K. The transport properties have been measured for two current directions (perpendicular to each other), and were carried out using a slow magnetic field sweep (0.02 m Tesla /sec) while the temperature was kept constant.

Results and Discussion

Magneto-transport coefficients R_{xx} and R_{xy} between ν=3 and ν=4 is shown in Figure 1. Four features are noteworthy. (1) The 7/2 FQHE state is well developed [1] for both current directions and is thermally activated. (2) Four re-entrant interger quantum Hall effect (RIQHE) states are observed, consistent with previous work [1,2]. (3) The 3+1/3 and 3+2/3 states are not fully developed, even down to the lowest temperature of 8 mK. At the present time, it is not known whether this is due to a spin transition. (4) The 3+1/5 and 3+4/5 states are better developed than the 3+1/3 or 3+2/3 states.

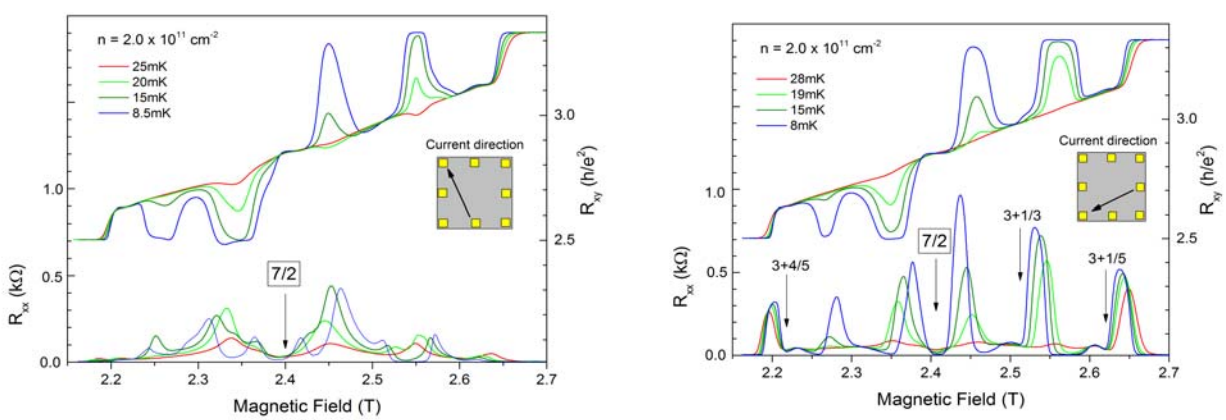

Figure 1. Observed temperature dependence of R_{xx} and R_{xy} for different current directions.

Conclusions

We have made detailed measurements of the temperature dependence of 2D electron system in the Landau level of $3 < \nu < 4$. Fully developed ν=7/2 FQHE state and four RQIHE states are observed. However, the 3+1/3 and 3+2/3 states are not fully developed. More measurements are needed to clarify the nature of these states.

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References

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