High Frequency Magnetotransport in High-Mobility n-AlGaAs/GaAs/AlGaAs Heterostructures in the Fractional Quantum Hall Regime

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Introduction

High frequency (ac) conductivity in the single 65nm quantum well AlGaAs/GaAs/AlGaAs structure with the concentration of n=5×10^{10} cm^{-2} and with high mobility μ=8.5×10^{6} cm^{2}/Vs was studied by acoustic methods in the fractional quantum Hall effect regime in perpendicular and tilted magnetic fields of up to B=18 T and temperatures down to 0.1 K. We studied the dependence of ac conductivity on temperature, and the magnetic field tilt angle.

Experimental Results and Discussion

In the experiments we used the "hybrid" configuration of the contactless acoustic method: a guide of the surface acoustic wave (SAW), a plate of lithium niobate, was located in the vicinity of the 2D channel. The electric field produced by the SAW interacts with the carriers. Thus, the attenuation Γ and velocity $\Delta v/v$ of the acoustic wave are affected by the conductivity of the 2DEG [1]. In contrast to "usual" configuration when the SAW is propagating on the GaAs sample surface [2], in the "hybrid" setup no deformation is transmitted into the sample. The complex ac conductivity $\sigma^{ac}=\sigma_1-i\sigma_2$ was calculated from the attenuation and velocity of SAW measured in the experiment, performed in the frequency range of 30-300 MHz, over the temperature range of 0.1-1 K, and in the fields of up to 18 T. One can see that magnetic field induces oscillations of the absorption coefficient and the velocity change as well as the ac conductivity with a rich FQHE states pattern as illustrated in Fig.1. As expected the temperature change impacts the oscillation amplitudes, saving that the amplitude at ν=1/2 seems to be temperature independent for the domain of 0.1-0.5 K. Introducing a larger SAW amplitude has also no effect on the 1/2 state, at least at 100 mK, while damping the amplitudes of other oscillations. We also carried out measurements of the acoustoelectric effects and calculated σ_1 in a tilted magnetic field, being focused mainly on the 1/3 and 2/3 states. Fig. 2 shows a slight increase of the amplitude of the ac conductivity oscillation at ν=2/3 with the tilt angles increase. We measured the temperature dependence of the Γ and $\Delta v/v$ in the range from 0.3 K to 1 K for each tilt angle. The activation energy ΔE is to be derived by constructing the Arrhenius plot lnσ_1 against 1/T. This procedure will result in dependence of ΔE on magnetic field. Analysis of the latter can give information on the character of the spin polarization.

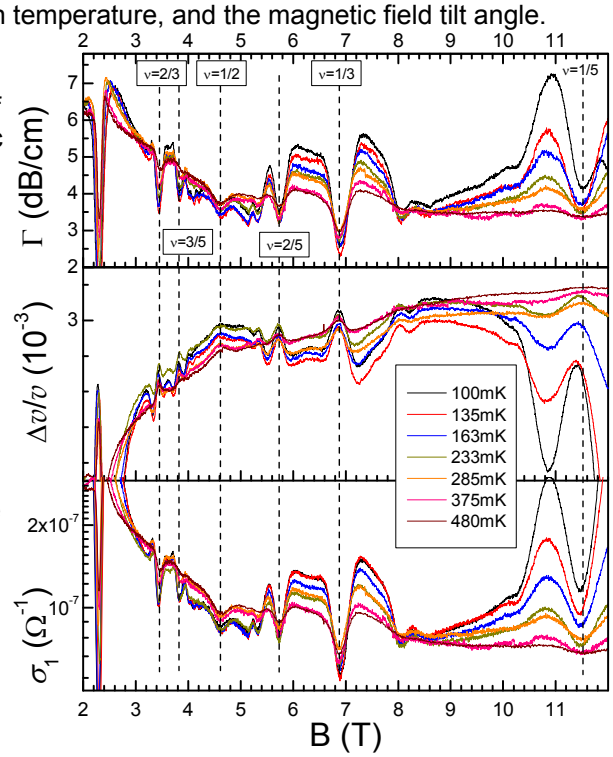

Figure 1. Temperature evolution of the SAW attenuation and velocity shift as well as the real part of ac conductivity in the FQHE regime, f=86 MHz.

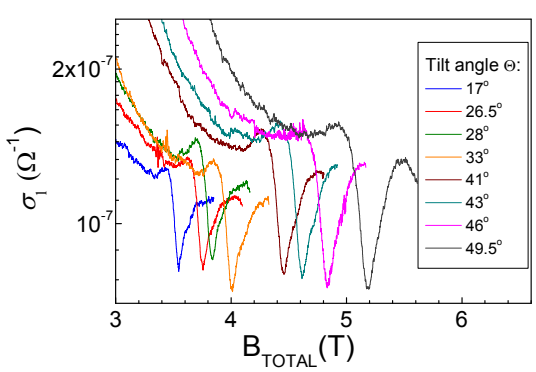

Figure 2. The real part of ac conductivity at ν=2/3 at different tilt angles, f=86 MHz, 0.35K.

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References

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