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Quantum Hall Stripes in High-Density GaAs/AlGaAs Quantum Wells

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Introduction

Quantum Hall stripes (QHSs) [1] in GaAs are usually aligned along [110] crystal direction, for yet unknown reason, but are expected to align along [1-10] when the carrier density exceeds $n_e \approx 3\times10^{11}$ cm^{-2} [2]. While an in-plane magnetic field $B_{||}$ is expected to orient QHSs perpendicular to it [3], recent experiments [4] have shown that $B_{||}$ can also favor QHS alignment parallel to it. In particular, it was found that $B_{||}$ applied parallel to QHSs cannot alter their orientation above certain n_e. It is thus interesting to investigate higher density quantum wells to see (i) if QHSs are aligned [1-10] and (ii) if QHSs, regardless of their initial alignment, can be reoriented by $B_{||}$.

Experimental

Experiments were performed in SCM-1 on 24-25 nm-wide GaAs quantum wells with densities up to 4.3×10^{11} cm^{-2}.

Results and Discussion

Surprisingly, we have found [5] that native QHSs are still oriented along conventional [110] direction even at the highest density studied and that $B_{||}$ applied along QHSs *does* render them perpendicular to it at $B_{||} \sim 1$ T . Upon further increase of $B_{||}$, the resistance anisotropy diminished but no second reorientation was detected [R_{xx} and R_{yy} vs. filling factor ν are shown in Fig.1 at different tilt angles], meaning that $B_{||}$ favors QHSs perpendicular to it, as in the early studies [2].

Conclusions

Our experiments establish that electron density is not a decisive factor for either abnormal native orientation of QHSs or their ultimate alignment with respect to $B_{||}$. We conclude that quantum confinement plays an important role in determining QHSs alignment with respect to $B_{||}$ and that the recently identified mechanism which favors QHSs along $B_{||}$ is ineffective in narrower quantum wells, despite their considerably higher carrier density.

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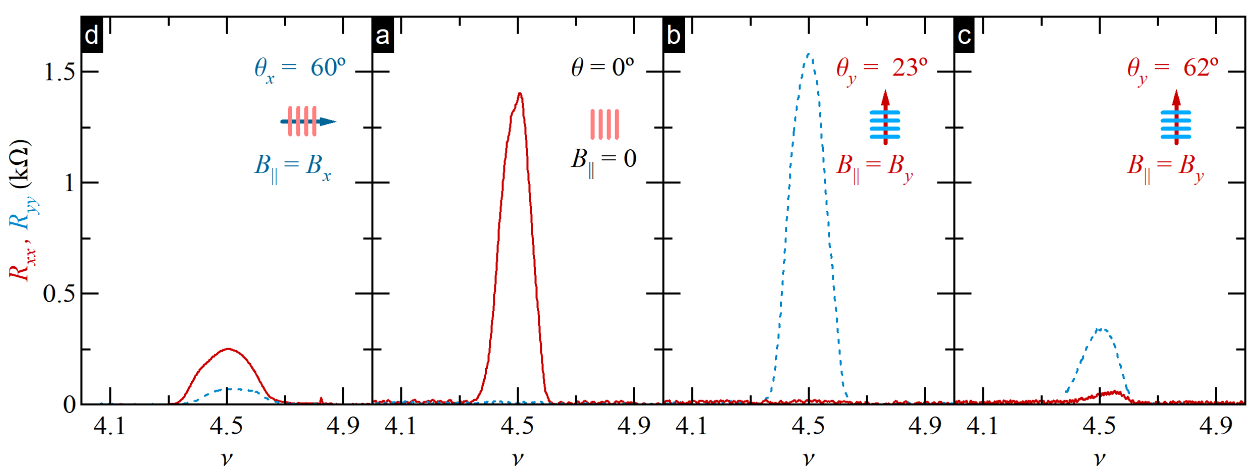

Fig.1 (a) R_{xx} (solid line) and R_{yy} (dotted line) vs. filling factor ν in a 24 nm-wide quantum well with $n_e = 4.1\times10^{11}$ cm^{-2} at (a) $B_{||} = 0$, (b) $B_{||} = B_y$, $\theta_y = 23$ degrees, (c) $B_{||} = B_y$, $\theta_y = 62$ degrees, and (d) $B_{||} = B_x$, $\theta_x = 60$ degrees.