Phase transition of pinning modes in wide quantum wells

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Recent transport studies of wide quantum wells (WQWs) [1] have revealed a reentrant integer quantum Hall effect (RIQHE) located in Landau filling factor (ν) ranges between 0.80 and 0.87 and interpreted as some type of pinned Wigner solid. The ν of the RIQHE is remarkably sensitive to the carrier density n.

Wigner solids, including those of quasiparticles or -holes, within the ν ranges of the integer quantum Hall effect (IQHE) [2] exhibit a microwave resonance. This resonance is understood as a pinning mode, in which quasiparticles or holes oscillate about their pinned positions. In this study, we investigate the microwave spectra for $0.8 \leq \nu \leq 1$ in WQWs, of width $w = 54$ and $w = 65$ nm with varying n. Fig. 1 (a) shows spectra ($w = 65$ nm and $n = 2.1 \times 10^{11}$ cm^{-2}) where the frequency response of the real part of the diagonal conductivity (Re(σ_{xx})) taken at many ν varying from 0.8 (top) to 1.0 (bottom) with a step of 0.01 is plotted.

On decreasing ν from 1 we observe a resonance peak, labeled A in the figure. A further decrease in ν results in the observation of an additional resonance, marked as B. In Fig. 1 (b) we plot the spectrum at $\nu = 0.9$. For this ν we observe both resonances and the spectrum can be fit to a double Lorentzian, consistent with two Wigner solid phases coexisting. The critical filling factor, ν_c, for crossover between the resonances is plotted as a function of n in Fig. 1 (c) for well widths of $w = 54$ and 65 nm. The phase farthest from $\nu = 1$ can be reasonably identified with the RIQHE of [1], which also moves closer to $\nu = 1$ as n increases. The observed coexistence of phases is consistent with a first order phase transition between two distinct Wigner solid phases.

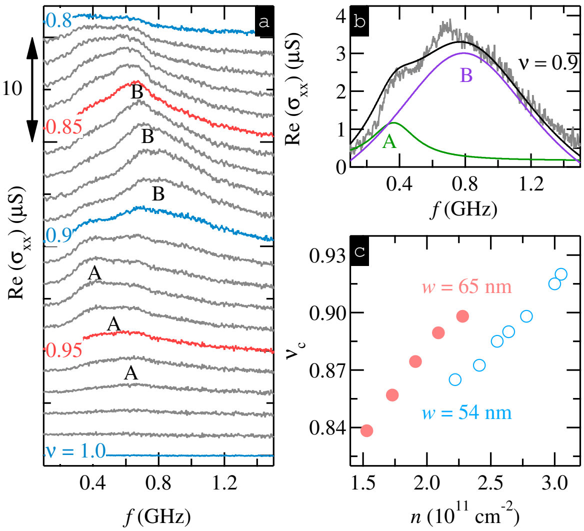

Figure 1: (a) Microwave spectra for $\nu = 0.8$ (top) to $\nu = 1.0$ (bottom) in step of 0.01 normalized to $\nu = 1$. Well width $w = 65$ nm and $n = 2.1 \times 10^{11}$ cm^{-2}. (b) Microwave spectra for $\nu = 0.9$ with double Lorentzian decomposition. (c) ν_c versus carrier density.

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[2] Y. Chen, R. M. Lewis, L. W. Engel, D. C. Tsui, P. D. Ye, L. N. Pfeiffer, and K. W. West, Phys. Rev. Lett. **91**, 016801 (2003).