PINNING MODE DISPERSION OF 2D WIGNER SOLID PHASES IN HIGH MAGNETIC FIELD

Yong P. Chen, R. M. Lewis (NHMFL and Princeton); L. W. Engel (NHMFL); D. C. Tsui (Princeton); L. N. Pfeiffer and K. W. West (Lucent Bell Labs)

The ground state of a sufficiently clean two-dimensional electron system (2DES) in high magnetic field (above the termination of the fractional quantum Hall state series) is generally believed to be a Wigner solid (WS). Pinned by disorder, such a solid is an insulator and possesses a characteristic pinning mode resonance, due to the solid oscillating within the pinning potential. Recent measurements [1] on very low disorder 2DES realized in GaAs/AlGaAs quantum wells found two different resonances, with one crossing over to the other as Landau filling factor (ν) is reduced, suggesting that there are two different solid phases ("A", dominant at high ν and "B", dominant at low ν).

We have probed the dispersion of the pinning mode of solid A by varying the wave vector $q=\pi/w$ imposed by a planar transmission line that couples to the 2DES in these measurements, as shown in the inset in Fig. 1a. Samples were made from the same wafer (with 2DES in a 65 nm wide quantum well), but with various w's ranging from 20 to 80 µm. Fig. 1 shows that the peak frequency of the pinning mode (f_{pk}) of solid A is lower for larger w. This trend continues at least to w=80 µm, the largest w we measured. This means solid A has some type of *correlation length exceeding ~80 µm*. The q dependence of the peak frequency, shown in the inset in Fig. 1b), is in reasonable agreement with the predicted dispersion [2] for the magnetophonon mode of a disorder-pinned Wigner crystal. In contrast, the resonance in solid B is independent of w.

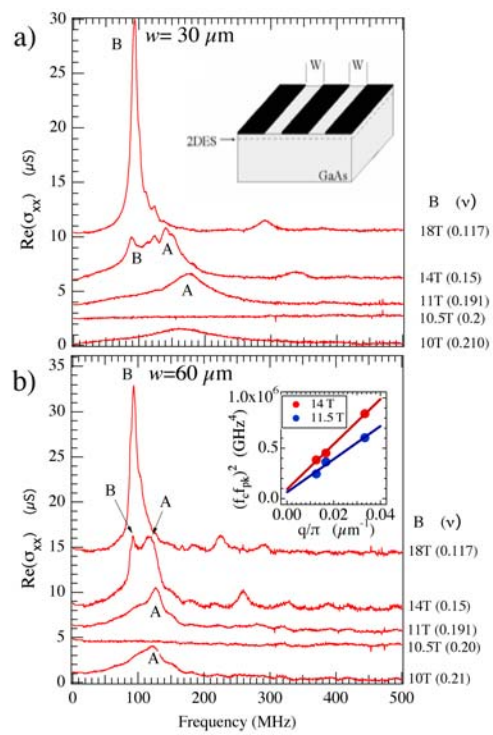

Fig. 1 a) and b): Conductivity spectra for samples with different transmission line widths, w=60 and 30 µm, for various Landau level filling factors ν. Resonances interpreted as due to solids A and B are marked. There is a crossover from the A to the B resonance as ν decreases. The density of both samples was 5.1×10^{10} cm^{-2}, and the measuring temperature was 50 mK. The higher frequency peaks may be due to spatial harmonics.

Inset in a): magnified cross section of transmission line pattern fabricated on top of sample. The transmission line has three conductors, two grounded side planes and a driven center conductor, separated by slots of width w.

Inset in b): Experimentally measured dispersion of solid-A pinning mode at two representative magnetic fields. Solid lines show fits to the theory in [2]. Fit parameter was density: 5.1×10^{10} cm^{-2} (14.5 T data, red), 4.9×10^{10} cm^{-2} (11.5 T data, blue). f_c is the cyclotron frequency; f_{pk} is the measured resonance frequency.

Acknowledgements

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References

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