SPLITTING OF THE CYCLOTRON RESONANCE LINE IN GATED ALGAAS/GAAS QUANTUM WELLS

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Introduction

A pronounced splitting of the cyclotron resonance (CR) line in two-dimensional electron systems (2DES), first observed in 1984,[1] remains unexplained . This splitting resembles a level-anticrossing of the CR with a second, unidentified, mode, with the magnitude of the splitting showing a monotonic increase with impurity density in the 2DES.[2] An apparent dependence of the splitting energy on $\sqrt{n_{2D}}$, where n_{2D} is the 2D electron density, has led to speculations that the second mode is a roton-like minimum in the magnetoplasmon dispersion of the interacting 2DES.[1,3] However this is based on data from a variety of samples with a wide range of n_{2D} and impurity densities, and thus a clear correlation is difficult to establish. Here, we have made the first study of the splitting as a function of varying n_{2D} in samples with fixed disorder.

Experimental

Our experiments were performed on three gated AlGaAs/GaAs quantum wells, each with a different density of acceptor impurities (carbon) intentionally incorporated into the quantum well, but were otherwise identical. The quantum wells were patterned into Hall bars and gated with a 12 nm thick, infrared-transparent titanium film, which allowed us to vary n_{2D} from 0.8×10^{12} to 2.3×10^{12} cm^{-2}. Far-infrared transmission spectra were recorded for a range of electron densities and magnetic fields, with all data taken at 4K in an 18T superconducting magnet at the NHMFL.

Results and Discussion

Fig. 1 shows the critical energy, E_{crit}, at which the splitting is most clearly developed, as a function of electron density in each sample. It appears that the data, rather then following a $\sqrt{n_{2D}}$ dependence, lie along a line for which the Landau level filling factor, ν, is equal to 2. Thus the unknown second mode seems to be related to an excitation of the filled first Landau level. A single point from a CR line at $\nu = 4$ further suggests the level anti-crossing may occur for other full Landau levels.

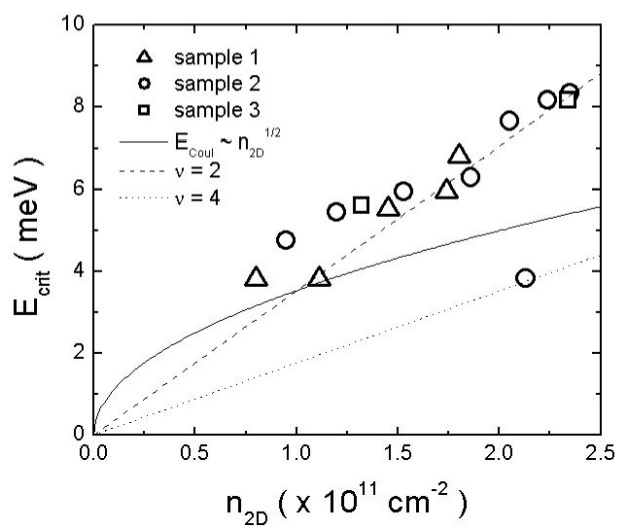

Fig.1 Splitting energy vs. 2D electron density.

Conclusions

The critical energy of the CR splitting in 2DES exhibits an almost linear dependence on n_{2D}, close to filling factor $\nu = 2$. Thus the second, unidentified mode interacting with the CR may be related specifically to excitations of filled Landau levels.

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References

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