HIGH-FREQUENCY MICROWAVE RESPONSE OF 2D ELECTRON GAS

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Introduction

In systems with spin-orbit (SO) interactions, spin can be a good quantum number even in zero applied magnetic field. The ability to store information in spin-states and manipulate these spins without needing to apply a magnetic field may enable computer chips to be reduced in size.

The 2D electron gas (2DEG) formed at the interface of InGaAs and InP experiences a SO interaction. Electron spin resonance (ESR) should occur in such materials even with no applied field, and this has been called the 'chiral spin resonance' (CSR) because the spin-split states are characterized by their chirality [1].

Experimental

We used the quasi-optical homodyne and heterodyne spectrometers in the EMR facility to study the microwave response of $In_{0.53}Ga_{0.47}As$/InP heterostructures [2]. The CSR is predicted to occur between 300 and 500 GHz for this material. We applied 240 (334, 455) GHz radiation transmitted along waveguides delivering about 20 (5, 1) mW of power. We modulated the back gate of the sample at 50-100 Hz and recorded the microwave absorption as the magnetic field was swept from -8 to 8 T. The temperature used was between 2 and 4 K.

Results and Discussion

We observed cyclotron resonance (CR) and quantum oscillations, as well as traditional ESR from spins outside of the 2DEG. The CR could be suppressed or enhanced by applying radiation with the circular polarization that is appropriate for the direction in which the static field is applied. Simultaneous observation of SdH in transport measurements backs up our interpretation of the data. By applying gate voltage bias of up to -600 V it was possible to linearly shift the position of the quantum oscillations by up to 20%.

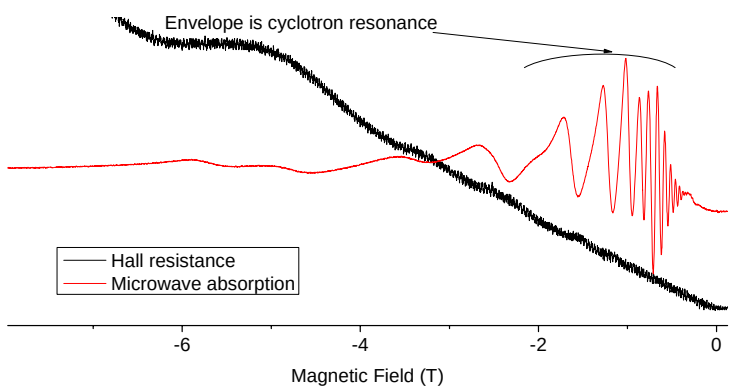

Figure 1. Field sweep at 3 K with circularly polarized 334 GHz radiation. The change from Hall resistance to diagonal resistance at zero field is due to the geometry of the sample and contacts.

Acknowledgements

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References

[1] Shekhter *et al.*, PRB **71**, 165329 (2005).
[2] Wei *et al.*, Appl. Phys. Lett. **45,** 666 (1984).