# Magnetic Circular Dichroism Spectroscopy of III-V Ferromagnetic Semiconductors

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## Introduction

In ferromagnetic semiconductors the spin splitting of the bands, especially the valence bands, are strongly influenced by the spontaneous magnetization and the exchange interaction between localized magnetic moments and the carriers. The difference of the splitting in the valence and the conduction bands reflect itself in different refractive indices for left and right circularly polarized components of the linearly polarized incident laser light. Magnetic circular dichroism (MCD) is used to investigate the evolution of ferromagnetism in several ferromagnetic semiconductors. In GaMnAs, Mn and holes produced two spectroscopically distinct contributions revealing an antiferromagnetic Mn-hole alignment in the ferromagnetic state. Our earlier measurements at the NHMFL provided insights into the interband transition in the InMnAs structures and the results were published in Phys. Rev. B 85, 125313 (2012). In this project we probed the MCD response of InMnSb structures with the Curie temperature of 300 K, using the 25 T split helix magnet at high magnetic fields.

## Experimental

We performed MCD measurements as a function of temperature and external magnetic on two InMnSb films to probe the band structure. A Tungsten lamp, Spectrometer, and a PEM were used to probe the MCD responses.

## Results and Discussion

Figure 1a demonstrates the MCD response has strong temperature and wavelength dependences and figure 1b shows the oscillations in the MCD signal (at 15K, but this trend is the same between 190K and 15K) increasing in energy as the field is increased for the range of energies of energies corresponding to the transitions between the conduction band and the heavy hole and split-off hole bands. For all of the transitions, dips in the MCD signal, the energy increase as the temperature decreases.

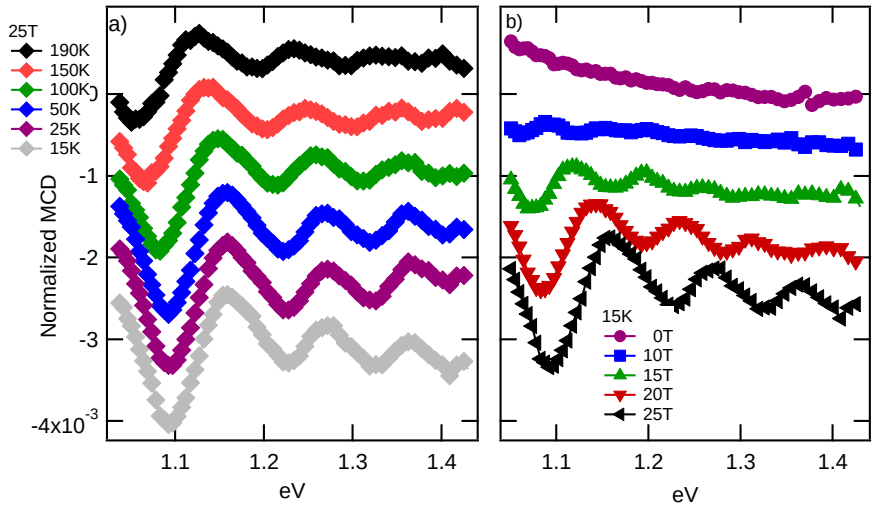


**Fig 1**: a) The normalized MCD as a function of wavelength and temperature for a fixed magnetic field of 25 Tesla. The oscillations in the absorption can be from several transitions from the valence band. b) Normalized MCD as a function of energy and magnetic field at 15 K showing multiple transitions between the hole bands and the conduction band.

## Conclusions

We are modeling the observations to understand the magneto-absorption, determine the g-factor, and ultimately the band structure in this ferromagnetic structure. The change in energy of the oscillations demonstrates that the ferromagnetism continues up to 190 K. This result fits in with previous magneto transport measurements that suggest that ferromagnetism in InMnAs continues above room temperature [2].

## Acknowledgements

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## References

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