DEVELOPMENT OF HIGH FIELD MAGNETIC RESONANCE OF OPTICALLY EXCITED STATES

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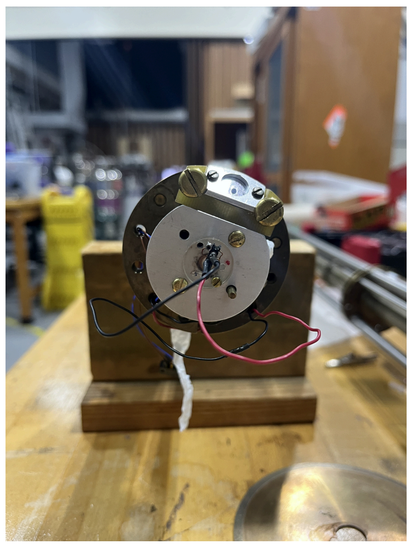
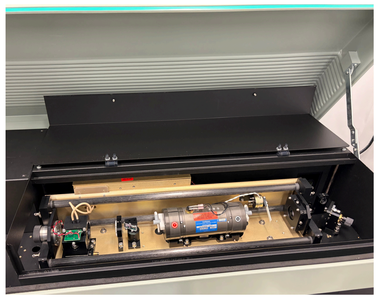
INTRODUCTION

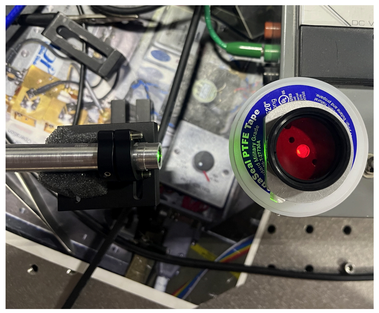
- Have you ever wondered how fireflies and jellyfish glow in the dark? A certain configuration of electrons known as a triplet state makes it hard for electrons in high energy states to become unexcited for longer than normal, which causes them to absorb and emit light. A triplet state is a state with three seperate spin components at +1, 0, and -1.
- Pentacene is a type of crystal which exhibits short-lived triplet states which can be achieved in combination of laser excitation and the influence of a magnetic field. In our research specifically, we want to optimize our experiment setup to improve optical excitation and reduce the noise we see in our results.
- Triplet states are primarily utilized in the development of Organic Light-Emitting Diodes (OLED's) as well as relevant applications in bioimaging and physical chemistry. These studies focus on controlling energy transfer to improve material usage.

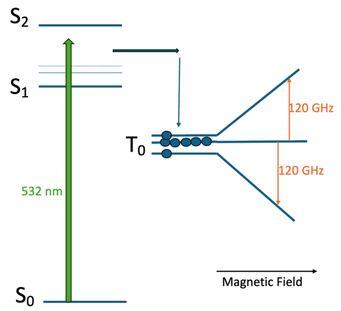


METHODS

- Set up the sample holder by attaching two 12 mm focal point lenses, a reflective crystal, and the rotation device, as well as inserting a crystal rod to guide the light and the pentacene itself. The orientation of the sample can be adjusted for each trial.
- Align the laser for optimal focus onto the lenses and set it up to release pulsed green light at a 562 nm wavelength. The pulsation rates will vary between 110, 120, 140, and 160 microseconds, as well as with different intensities between 13 and 113 mJ for each trial.
- Set up a superconducting magnet to sweep through a magnetic field range, which varied depending on the trial, as well as the helium dewar which will cool the sample holder to 20 degrees.
- Let the magnet run through the entire field value range, first by going up in value to the maximum and then returning back down to the desired minimum field value.
- Analyze the changes in the sample's absorption of the 120 GHz microwaves to determine if a triplet state was achieved and gauge the efficiency of the current orientation of the sample, the pulsation rate, intensity, and magnetic field range.







RESULTS

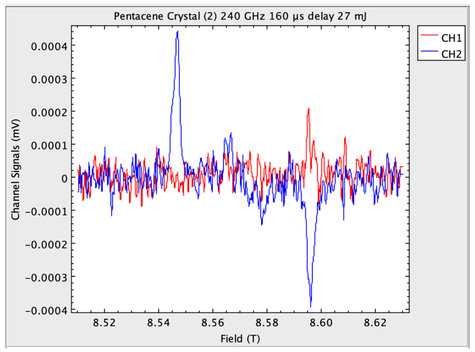


Figure A) Continuous Wave Detection, First trial on 10/21/2025

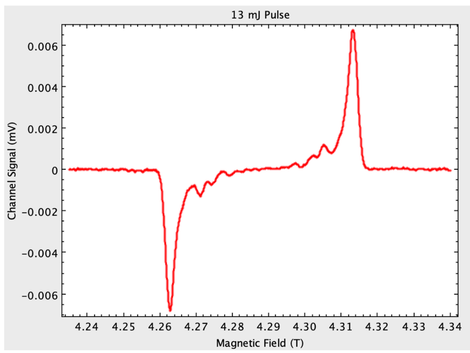


Figure B) Echo Detection, Trial on 2/13/2026

Our first trial (a) demonstates results with a large quantity of noise, likely caused by a less than ideal orientation of the sample or unfavorable conditions. We ran the sample through a magnetic field which swept from 8.50-8.63 T, with a 160 microsecond pulse delay rate and an intensity of 27 mJ. The most optimal set up thus far (b) has been at the magnetic field range of 4.23 to 4.34 T, the laser intensity of 13 MJ, and a pulsation delay rate of 120 microseconds. This yielded minimal noise and two sharp signals clearly indicating the absorption and emission of light from the achieved triplet state. We have yet to perform a trial with our 12 mm lenses and rotation device, and further testing must be done to determine their effects on the efficiency.

CONCLUSION

- We expected our pentacene sample to show sharp signaling for both absorption and emission of light (peaks shown in figures A and B). We ran multiple trials at different energy levels to verify that our results were not due to chance and ensure that we could find the best set up for the current sample.
- Our data exhibits displays clear trends of absorption and light emission during its triplet state. We believe further testing and continued improvement of the experimental set up and trials would provide ground for further study. It's also of note that this is the first time that pulsed (echo) detection has been used at these frequencies by the maglab.
- A constraint we faced was our inability to run repeated trials for each energy level separately.

REFERENCES

SCAN HERE FOR LIST OF REFERENCES USED

ACKNOWLEDGEMENTS

Johan van Tol, National High Magnetic Field Laboratory