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This summer, William Bodron and I implemented and tested a laser frequency stabilization system for a near-infrared laser needed for Faraday rotation measurements of Rb and K done by W. Korsch's research groups. Our primary goal was locking the laser to the D2 transition of Rb (780 nm). We used saturated absorption spectroscopy to distinguish the doppler-free spectrum of Rb. The doppler-free peaks provided narrow linewidth lock points at the frequency we wanted to stabilize. Our work involved the initial set-up and alignment of the spectroscopy system to achieve a doppler-free signal. We tested multiple optical layouts to optimize our signal.

Saturated absorption involves counter-propagating "probe" and "pump" beams interacting with a target gas sample. Only atoms with zero velocity in the direction of the beam interact with both the "probe" and "pump," leading to a decrease in absorption at the frequency absorbed by atoms not experiencing the doppler effect. Many techniques require splitting the laser into a probe and pump beam and directing them through the cell at slightly different angles. We tested this method but found better results with an alternate approach using a quarter waveplate and mirror to use the reflected pump beam as the probe. This method increased the region of overlap between the two beams. The change of polarization from the quarter-wave plate allowed for easy direction of the returning beam to a photodetector with a polarizing beam splitter.

After our signal was aligned, we used the doppler-free peaks as lock points for our laser's lock-in feature. We adjusted the PID gains until we found gains that successfully locked our system. To test if the laser's frequency drifted over time, we measured the change in frequency using a scanning Fabry-Perot interferometer. W. Bodron created extensive programs to collect data from our oscilloscope, laser and, wavemeter. These programs were vital to the assessment of our lock.