FINAL REPORT: CONSTRUCTION OF AN APPARATUS TO STUDY FAST ATOMIC RECOMBINATION IN ULTRACOLD PLASMAS

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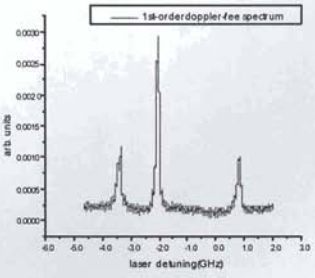
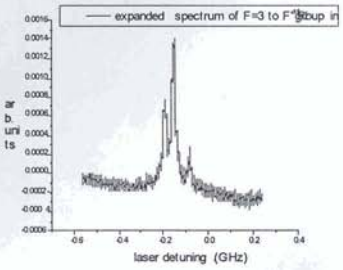
Thanks to the support of the SPS Undergraduate Research Award, we have constructed a narrowband external cavity diode laser and used it to perform saturated absorption spectroscopy on atomic rubidium vapor. A picture of the apparatus is shown below, along with two spectra collected with the complete saturated absorption setup.





With the Doppler effect suppressed to first order, the first curve shows the gross structure of the ground state to first excited state transition for rubidium-85, and one of two similar components for rubidium-87 (the feature on the right of the first plot). The second plot shows the expanded spectrum for the F=3 to F' group in rubidium-85.

We have also been able to frequency-stabilize the laser, which is a necessary step for laser-cooling rubidium. This is done with an acousto-optic modulator that dithers the laser frequency over the atomic absorption lines. A lock-in amplifier converts the oscillating signal at the photodiode to an electronic error signal that is fed back to the laser. We are still working on optimizing the frequency-locking setup.

$1,863.87 of the grant funds have been spent on electronic components, used lock-in amplifiers and an oscilloscope, laser diodes and hardware for the laser mount, optics mounts, and other materials (acrylic sheet, metal stock, etc.) used in construction of the device. The remainder of the budget will be used to purchase a few additional optical components.

We continue to work toward the goal of a complete system to laser cool rubidium atoms, for use in ultracold plasma experiments. Initial observations are expected by mid-2005.