

# OPT - Optical Pumping

## Pre- and Mid-lab questions

Student's Name \_\_\_\_\_ Partner's Name \_\_\_\_\_

### Pre-Lab Discussion Questions

It is your responsibility to be ready to discuss *all aspects* of the lab during a dedicated appointment with a member of the course teaching staff before starting the lab work. Moreover, you will explicitly be asked to answer the following pre-lab questions during that appointment:

1. What is the general principle of optical pumping? Go over your derivation of the Breit-Rabi formula (see reference **Nuclear Moments**) and the values of the Lande g-factors of the hyperfine energy levels of  $^{85}\text{Rb}$  and  $^{87}\text{Rb}$ . Draw qualitative energy-level diagrams for  $^{85}\text{Rb}$  and  $^{87}\text{Rb}$  showing the fine, hyperfine, and Zeeman splittings. How do the Lande g-factors affect the ordering of the Zeman levels? Show the transitions between these levels that are important to this experiment. Include these drawings in your write-up. For our rubidium system, what is the pumping process? Where is the pumped level? Where is the RF transition?
2. Why do we modulate (vary sinusoidally) the external magnetic field? How would we take data if the magnetic field were not modulated?
3. In this experiment, how will we determine the resonance frequency? How can we best estimate the error? Will the modulation amplitude affect our result? What data will we take, and what plots will you make?

Staff member with whom you completed the pre-lab questions: \_\_\_\_\_

Date and time of pre-lab appointment: \_\_\_\_\_

### Mid-Lab Discussion Questions

1. Produce a plot of frequency vs. current for at least one rubidium isotope, and, also, make your first estimate for the ambient magnetic field strength.
2. Explain how exactly the resonance condition was found experimentally. For example, explain how a Lissajous figure was viewed during the experiment, and what was the meaning of this figure. What features of that figure told you that you were precisely at resonance vs. a little bit off? By examining that figure while changing various settings at the experiment, how can you come to a reasonable estimate of the statistical and systematic error in determining the resonance condition?

Staff member with whom you completed the mid-lab questions: \_\_\_\_\_

Date and time of mid-lab appointment: \_\_\_\_\_