# OPT - Optical Pumping

## Pre- and Mid-lab questions

Student's Name _____ Partner's Name _____

Suggested reading to start with (see the end of the manual for more):

1. 111B OPT manual
2. OPT video. Note in order to view this, you must be signed into your berkeley.edu Google account. See the OPT manual for a list of corrections to the video!
3. Rubidium energy level diagrams

### 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. Explain the principle and process of optical pumping. In your explanation, discuss the different types of energy level splitting, the energy level diagrams, and the three legs of the cycle (pumping up, getting stuck, unpumping), including the cause and what specific transition occurs for each leg.
2. Go over your derivation of the Breit-Rabi formula (see reference **Nuclear Moments**). For a given applied magnetic field strength, does $^{85}$Rb or $^{87}$Rb have a higher resonance frequency? Also discuss the values of the Lande g-factors of the hyperfine energy levels of $^{85}$Rb and $^{87}$Rb. How do the Lande g-factors affect the ordering of the Zeeman levels?
3. Why do we modulate (vary sinusoidally) the external magnetic field? How would we take data if the magnetic field were not modulated?
4. 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 Lissijous 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: _____