

# Optical Pumping

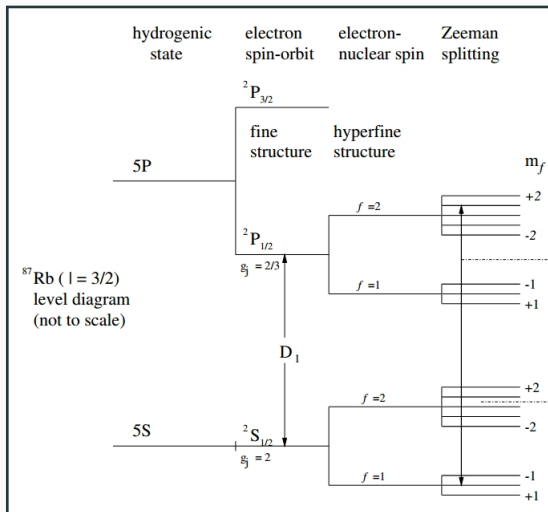
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# Lifting Degeneracy



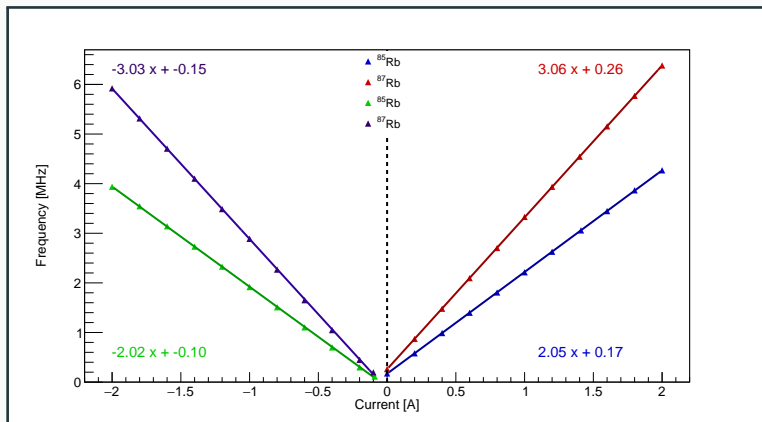
**Figure 1:** The contributions to the energy level splittings of the  $^{87}\text{Rb}$  isotope. Source: <http://web.mit.edu/8.13/www/JLEperiments/JLExp11.pdf>

# Experimental Setup

Main components:

- Circularly polarized light to induce electric dipole transitions.
- Bulb of Rubidium vapor.
- Helmholtz coils to produce magnetic field for Zeeman splitting.
- RF radiation to expedite Zeeman transitions.
- Photodiode to measure relative light absorption.

# Measuring Resonance



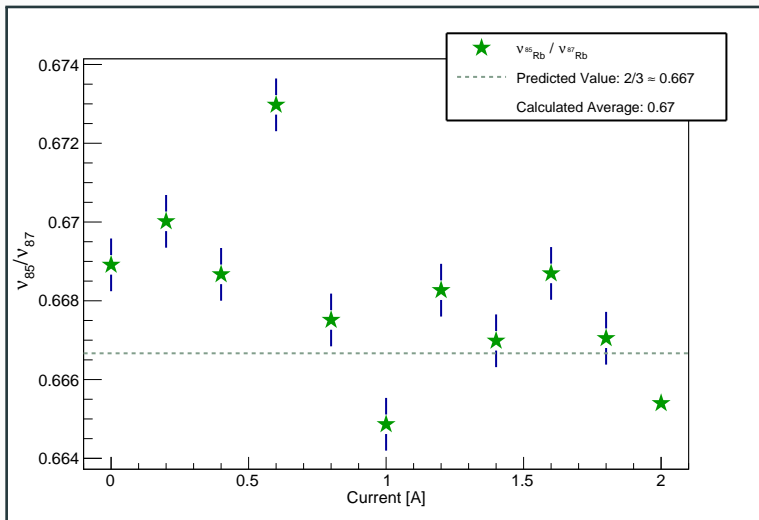
**Figure 2:** Resonant carrier wave radio frequencies as a function of applied coil current.

# Fitting Errors

Isotope	Slope	Intercept	$\chi^2$
$^{85}\text{Rb}$	$m = 2.049 \pm 0.002$	$b = 0.170 \pm 0.002$	$1.2 \times 10^{-4}$
$^{87}\text{Rb}$	$m = 3.061 \pm 0.002$	$b = 0.260 \pm 0.002$	$1.7 \times 10^{-4}$
$^{85}\text{Rb}$	$m = -2.020 \pm 0.006$	$b = -0.098 \pm 0.007$	$1.3 \times 10^{-3}$
$^{87}\text{Rb}$	$m = -3.033 \pm 0.008$	$b = -0.149 \pm 0.010$	$2.7 \times 10^{-3}$

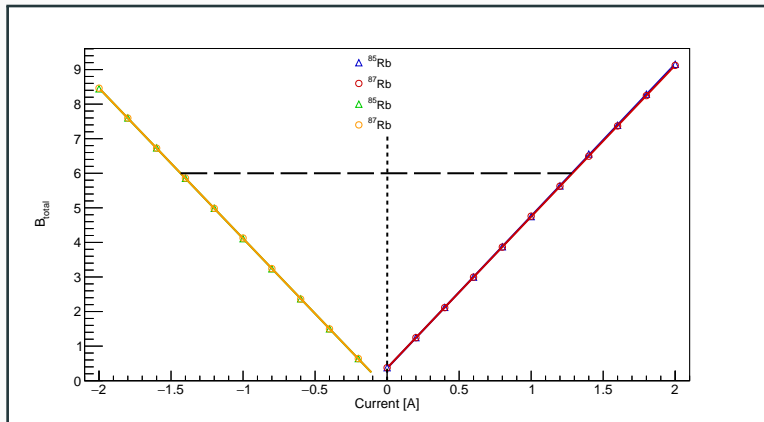
**Table 1:** Values for slope and intercept of linear fits performed in previous slide. The  $\chi^2$  indicate that our estimates are consistent.

# Ratio



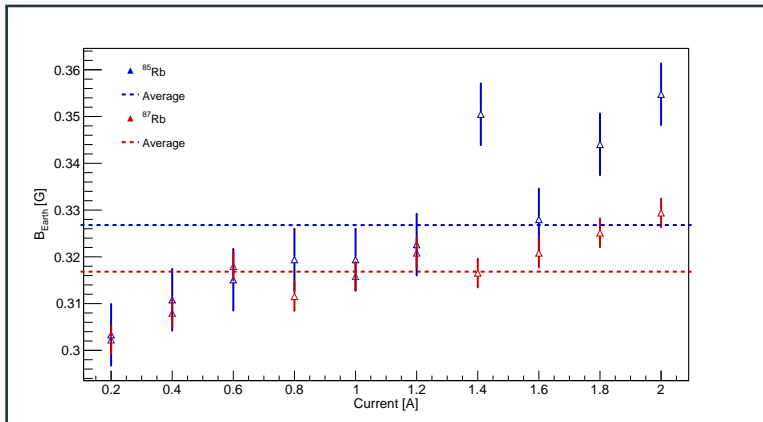
**Figure 3:** Frequency Ratio for  $^{85}Rb$  over  $^{87}Rb$  as a function of current.

# Working Back to the Magnetic Field



**Figure 4:** Total magnetic field through coils as a function of coil current.

# Earth's Magnetic Field

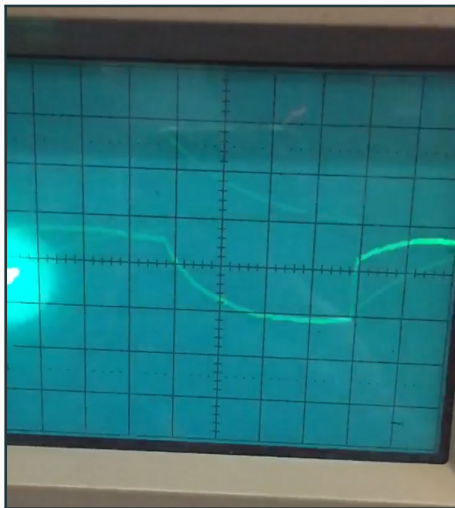


**Figure 5:** Values for Earth's magnetic field using

$$B_E = \frac{1}{2} \left( \frac{|\nu^+ - \nu^-|}{2.799} \right) (2I + 1)$$



# Pumping Time



**Figure 6:** Photodiode output as a function of time. RF radiation input with a modulation rate of 10Hz. 10ms/div scale on horizontal axis.

# Conclusions

- Obtained nuclear spins of two Rubidium isotopes using resonance frequency data.
- Measured magnetic field of Earth with help from Breit-Rabi equation.
- Observed the time scale of Rubidium's pumping time.