Optical Pumping

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- Atom state preparation.
- Laser cooling and trapping.

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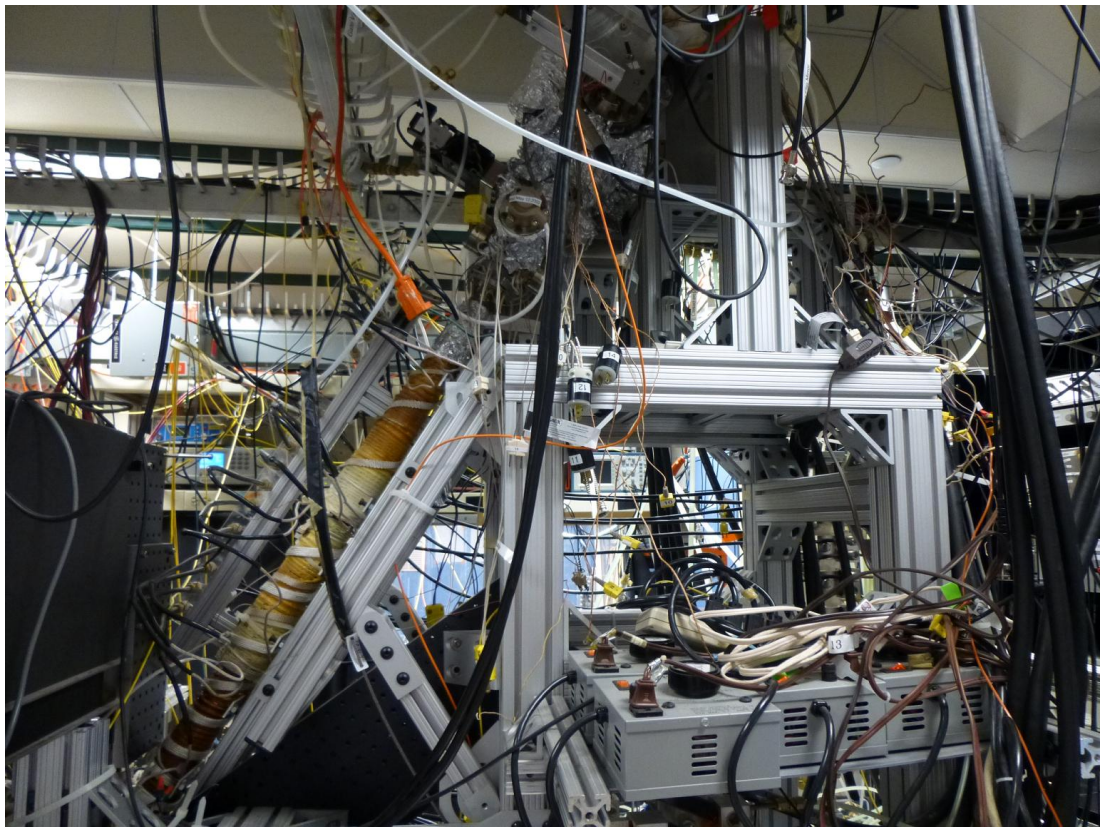


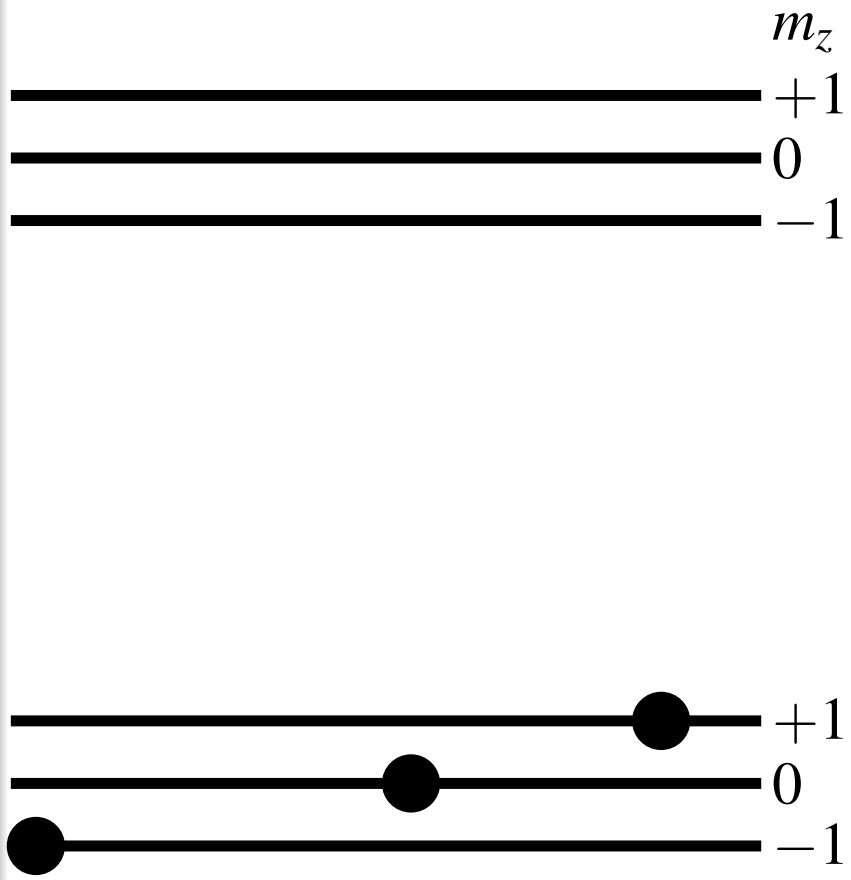
1. Atom energy levels and optical pumping.
2. Apparatus and measurement.
3. Data and result.
4. Conclusion.

- Fine, hyperfine structure, Zeeman splitting.

$$n \propto \mathbf{e}^{-\beta E}$$

- Optical pumping in m_z states.
  Circular polarization light,
  $\Delta m = +1$.
  Spontaneous emission,
  $\Delta m = 0, \pm 1$.
- Dark state.
- Depolarization using RF signal.

$$\mu B = hf$$



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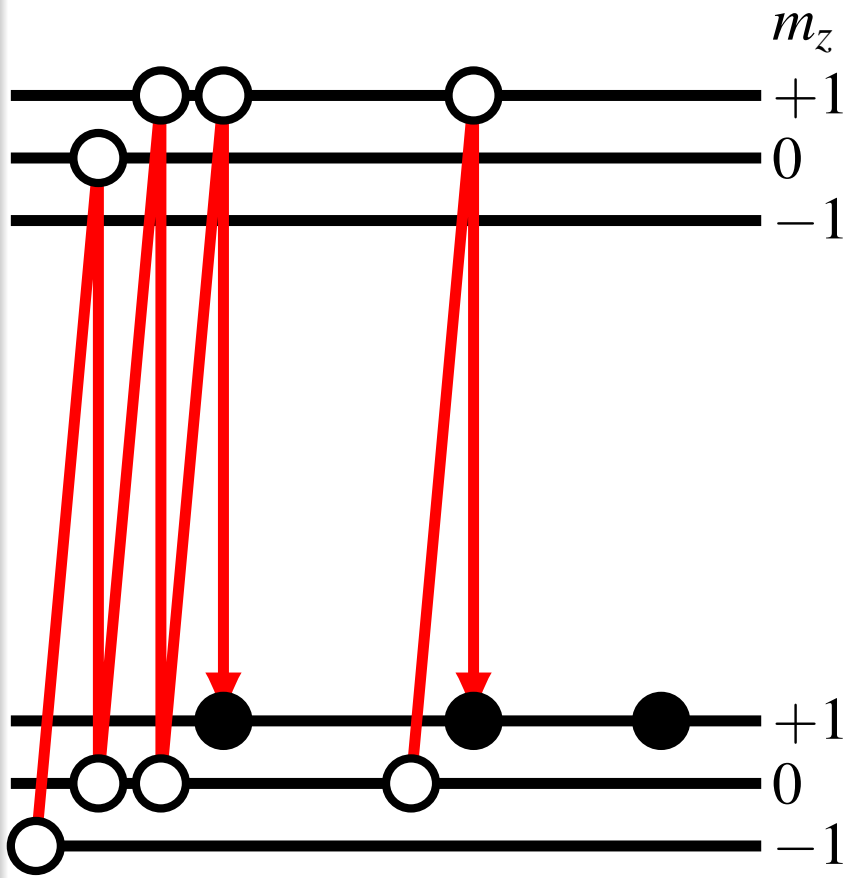

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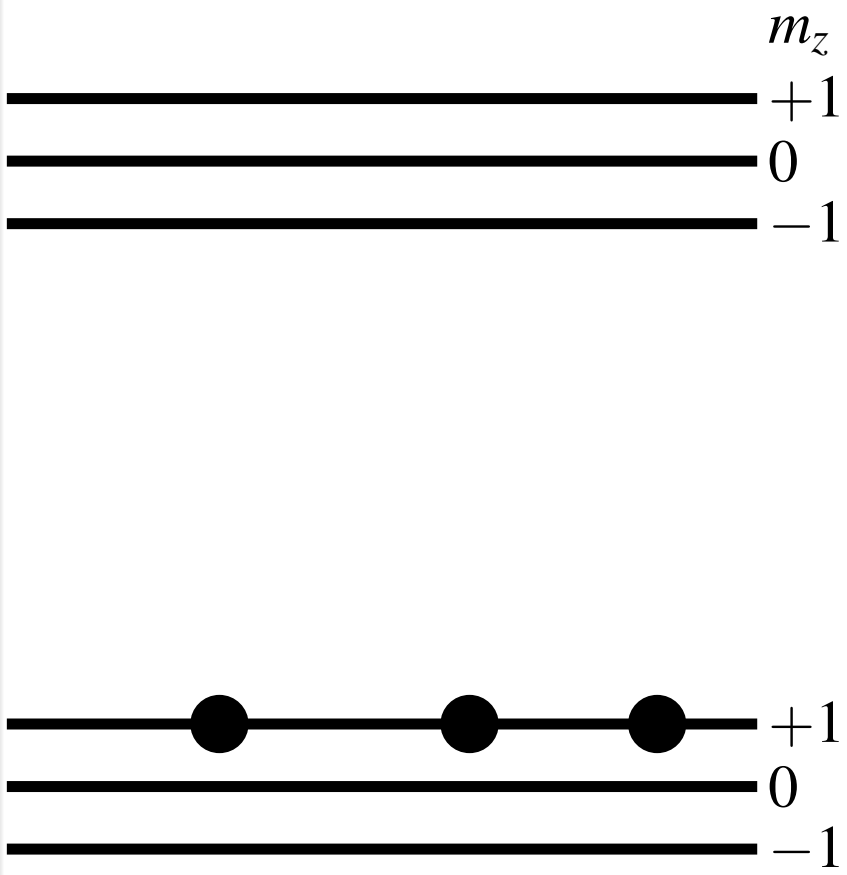

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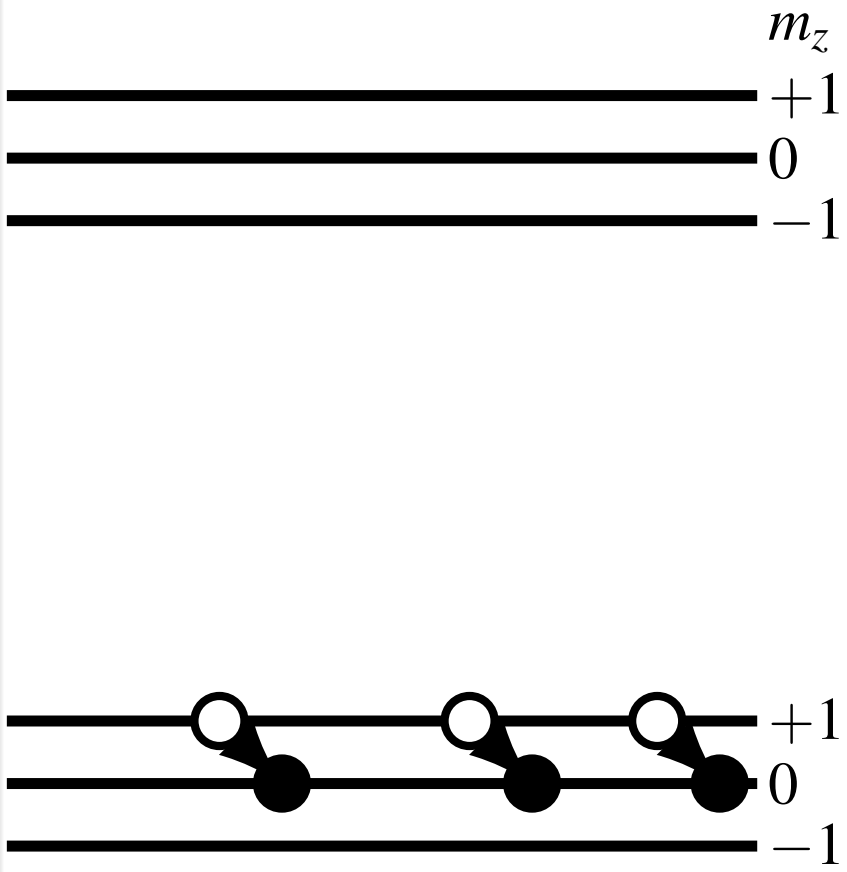

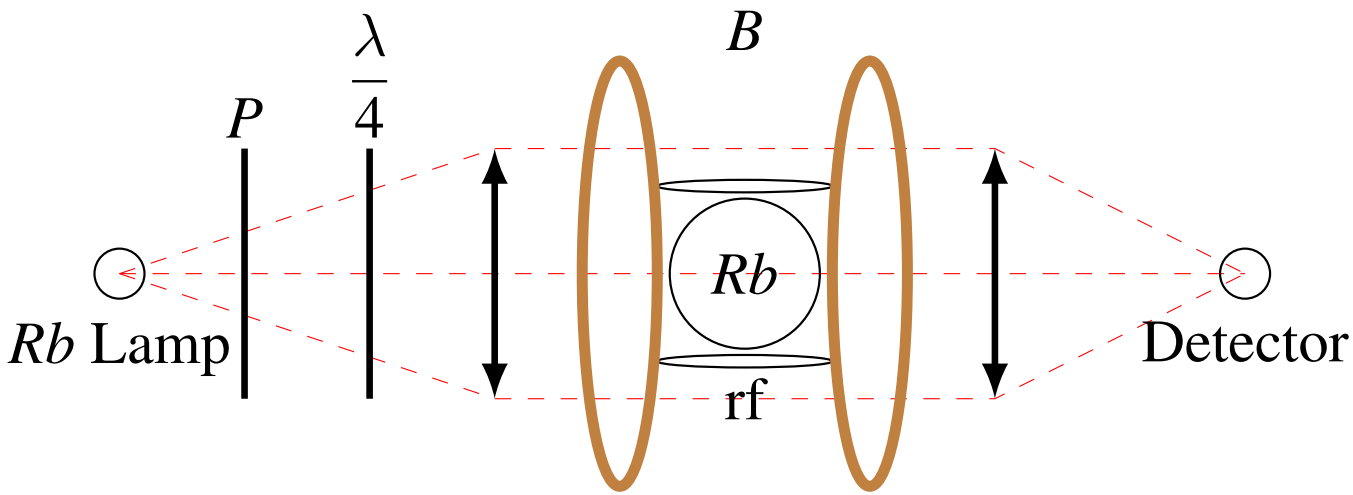

- Circular polarization.
- ^{85}Rb and ^{87}Rb

$$f_{RF} = \frac{g_F \mu_B}{h} \sqrt{(B_x + B_{x0})^2 + (B_y + B_{y0})^2 + (B_z + B_{z0})^2}$$

- Scan RF frequency.
- Scan B field.
- Switch B field.

$$f_{RF} = \frac{g_F \mu_B}{h} \sqrt{(B_x + B_{x0})^2 + (B_y + B_{y0})^2 + (B_z + B_{z0})^2}$$

- Scan RF frequency.
- Scan B field.
- Switch B field.

Scaning RF frequency at different B field.

- Measure/cancel earth magnetic field.
- Absorption strength (Natural Abundance).

$$I_{absorb} \propto NA \cdot g_F^2$$

$$f_{RF} = \frac{g_F \mu_B}{h} \sqrt{(B_x + B_{x0})^2 + (B_y + B_{y0})^2 + (B_z + B_{z0})^2}$$

- Scan RF frequency.
- Scan B field.
- Switch B field.

Scan B field at different RF frequency.

- Measure resonance frequency.

$$f_{RF} = \frac{g_F \mu_B}{h} \sqrt{(B_x + B_{x0})^2 + (B_y + B_{y0})^2 + (B_z + B_{z0})^2}$$

- Scan RF frequency.
- Scan B field.
- Switch B field.

Switch B at different light intensity.

- Measure pumping rate.

$$R \propto I_{light}$$

Conclusion.