Modern Physics Research Topics Related to Optical Pumping

Hyperpolarization – MRI

Frequency Standards – Atomic Clocks

Polarized Nuclear Physics Targets

Precision Magnetometers

Overhauser Polarization

Coherent Population Trapping

Single Particle Spectroscopy

Double Resonance Experiment

High Stability Gas Lasers

Precision Metrology to Study QED

“Slow” Light

Explorations of Atomic Physics Using TeachSpin's Optical Pumping

1. Transient Effects
   - Rabi Oscillations
   - Optical Pumping Times
   - Field Reversal
   - Adiabatic Transients
2. High-Field Spectroscopy
   Determination of Ground State Hyperfine splitting using Quadratic Zeeman Splitting data
3. Pressure Dependence
4. Effects of other Buffer Gases
5. Coherent Population Trapping
6. Pump with both D1 & D2 lines –

All Signals Observed in Optical Pumping Experiments with this apparatus are
CHANGES in Optical Transparency of the Rb Vapor Cell
(either Increases or Decreases)

An Optical Pumping Riddle

Because photon "energies" are often described in wave length units (nm) while RF "energies" are in frequency units (MHz), students easily miss the dramatic difference in scale between the energy of the photons used to "pump" the Rb gas and the RF energy that creates the depumping. And there is no way the energy level diagrams "showing" the Zeeman splittings can indicate the relative magnitudes. A dotted line on the arrow between the $S_{1/2}$ and $P_{1/2}$ levels cannot even infer the dramatic difference in scale.

If we put both "energies" in ev, we get a hint, but there is no way to show this graphically!

Ratio of energies: optical/RF =1.5 ev/3×10^{-9}ev, 10^8 to 10^9

A Whimsical Analogy for the Optical Pumping Phenomenon

Question: How do you derail a freight train with a ping pong ball **?**

Answer: Throw the ping-pong ball at the rail switch.

Explanation: In our case, the freight train "is" the D_1 optical photon ~ 1 ev, and the ping-pong ball is the RF photon ~ 10^{-9} ev. The switch "is" the Zeeman states, and their angular momentum based selections rules.