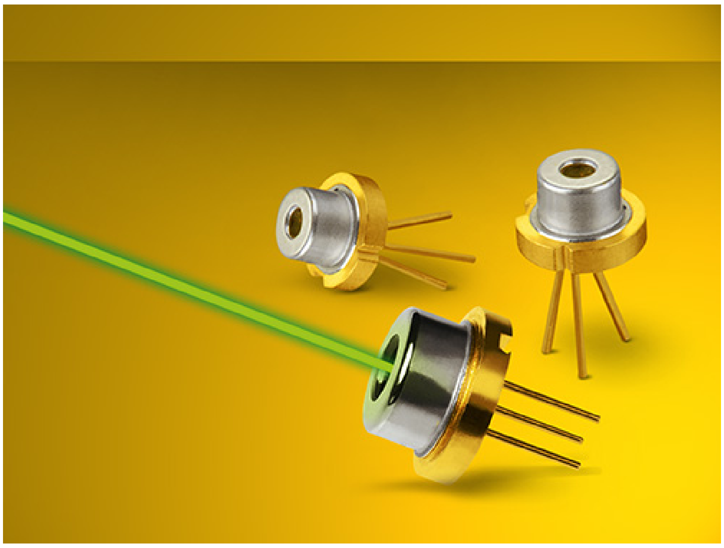
جامعة الملك فهد للبترول والمعادن
King Fahd University of Petroleum & Minerals

Physics Department

PHYS-403: Experimental Physics-II

LASER DIODES



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To
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1 INTRODUCTION

1.1 Objectives

Laser diodes are a type of light source that emit an intense beam of coherent light, making them useful in many applications such as eye surgery and spectroscopy. They are also used in barcode readers and laser pointers. Laser diodes are semiconductor devices which produce laser light when forward-biased current is applied to them. They have a number of advantages over other types of lasers, including high power output in comparison, smaller size and lower cost.
Saturated absorption spectroscopy is a popular and easy method of measuring narrow atomic spectral lines that are no wider than the natural line width resulting from intense Doppler broadening of around one-GHz in an atom-filled vapor. With the addition of a diffraction grating, the wavelength stability, frequency range as well as any interruption due to sudden shifts can be assessed.
A cell containing rubidium vapor was passed through by a frequency swept laser light and the transmitted light analyzed; the broad absorption peaks which were observed from this approach were attributed to transitions between the ground state S1/2(a) and excited state P3/2(b). The second part where a the laser will go directly through the vapor and to detector 1 and part of it will reflect toward detector 2.

2 EXPERIMENTAL SET-UP

Here is the main components of the set-up:
1. Grating Feedback External Cavity Diode Laser - Sanyo DL7140-201
2. Holographic Grating
3. Piezo Stack & Thermo-electric Cooler
4. External Cavity Length and Laser Polarization
5. Absorption Cell Assembly & Current Control
6. Laser Temperature Controller & Cell Temperature Control
7. Ramp Generator & Piezo Controller
8. Detector Control & Photodiode Detectors

2.1 PROCEDURE

We have followed the next procedure:
1. Position the camera in order for it to aim into the Rb cell from the side hole in the cell heater
2. Oscilloscope is provided for signaling

3. Adjustments for the related parameters are done as to be mentioned next (see Figure.1)

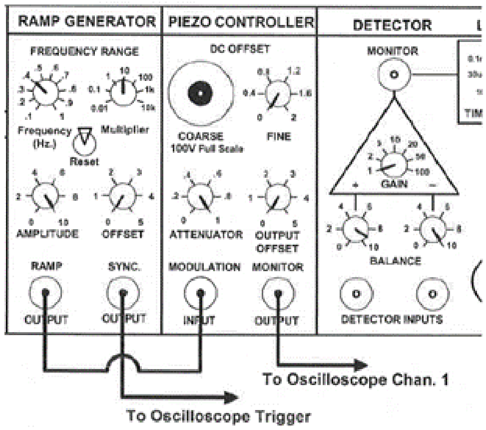


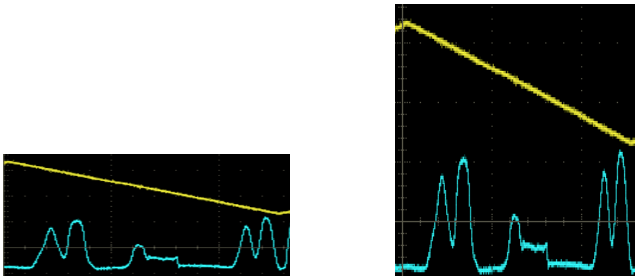
Figure 1: Adjustable nobs

2.2 Carrying out The experiment

Background signal embedded

At 50° C:

1. Set the laser current to the value listed on your data sheet, you will see a flashing streak of light within the cell on the TV monitor. This is rubidium fluorescence, atoms of Rb in the cell, absorb laser light at the atomic resonance frequency and re-emitting it in all directions.
2. Now adjust the laser current to make the fluorescence as bright as possible
3. Connect a photo diode detector to channel 2 of the oscilloscope, and place it to intercept the laser beam coming through the Rb cell.
4. Set channel 2 input coupling to DC, the gain 5 Volts/div. The signal from the photodiode detector is negative and saturates at about -11 V, so you might invert the signal in the display
5. Assemble the glass neutral density filter in a fixed mirror holder
6. Adjust the PD gain so you can observe something on the scope showing that light is hitting the PD
7. Scope signal is

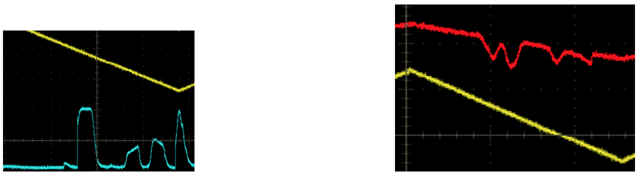


(a) Three absorption lines are shown

(b) Four absorption lines are shown (wider scan)

Figure 2: For temperature at 50°C

At 100° C:



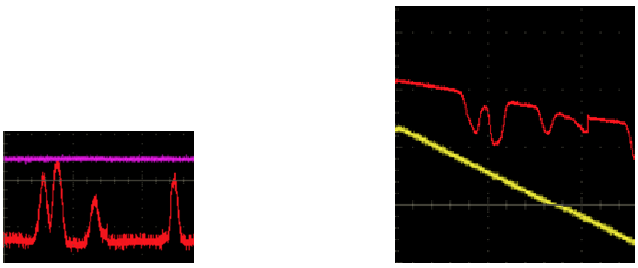
(a) Four absorption lines are shown

(b) Four absorption lines are shown (wider scan)

Figure 3: For temperature at 100°C

Background signal not embedded:

At 50° C:

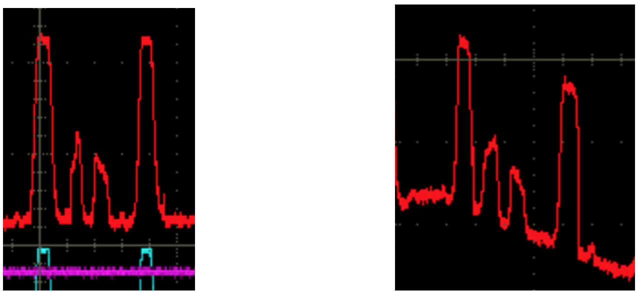


(a) Four absorption lines are shown at 50°C

(b) Four absorption lines are shown at 50°C (wider scan)

Figure 4: For temperature at 50°C

At 100° C:



(a) Four absorption lines are shown

(b) Four absorption lines are shown (wider scan)

Figure 5: For temperature at 100°C

3 CONCLUSION

The experiment was split into two parts: the first examined the absorption lines for Rubidium without any background noise, at both temperatures 50°C and 100°C. The second recorded the absorption lines incorporating background noise, which was then subtracted from the initial signal, again at temperatures of 50°C and 100°C. The results of this laser diode spectroscopy experiment were documented in this report. All in all, Laser diodes represent an important branch of modern photonics and they pave the way for many current and future technologies. Their compact size, low cost and high efficiency makes them ideal for a variety of applications such as surgery, communication, bar-code scanning and photography. With proper handling precautions, laser diodes can be very beneficial in many fields.

4 REFERENCES

[1] LAB MANUAL: - Leybold physics leaflets – Atomic and nuclear physics