GENERAL MEASUREMENTS LAB
PHYS 339 – LASER

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Feb 20, 2018

MARKING SCHEME

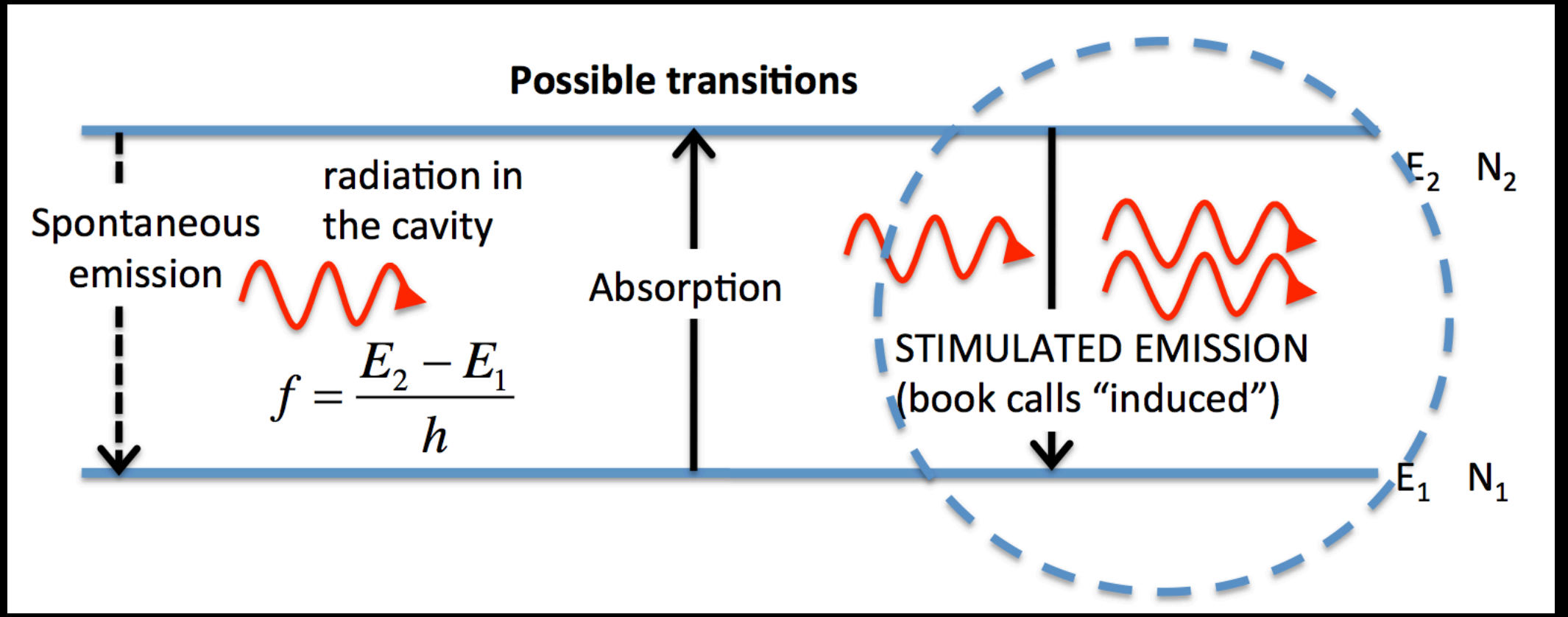
Title	Weight
Introduction to the PC report Counting statistics report Calibration of Arduino microcontroller report Calibration of Arduino microcontroller test **Properties of laser report** Temperature controller report	10% 15% 5% 10% **15%** 15%
Project proposal Project report	5% 20%
Log book	5%

February 26, deadline for project proposal. ONE week to go!

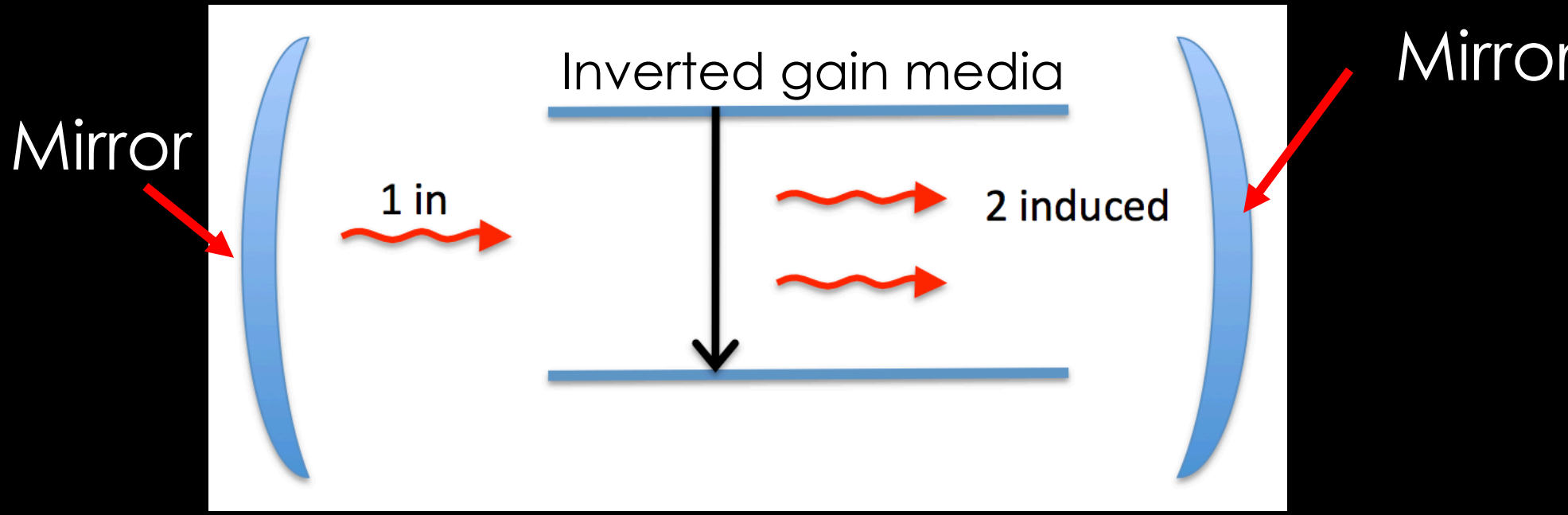
LAB OVERVIEW

- GOAL OF THIS LAB:
  - Measure some properties of a solid state laser.
  - Measure polarization (Malus' Law, Brewster's angle).
- WHY?
  - Control an experiment and acquire a lot of data in an automated fashion.

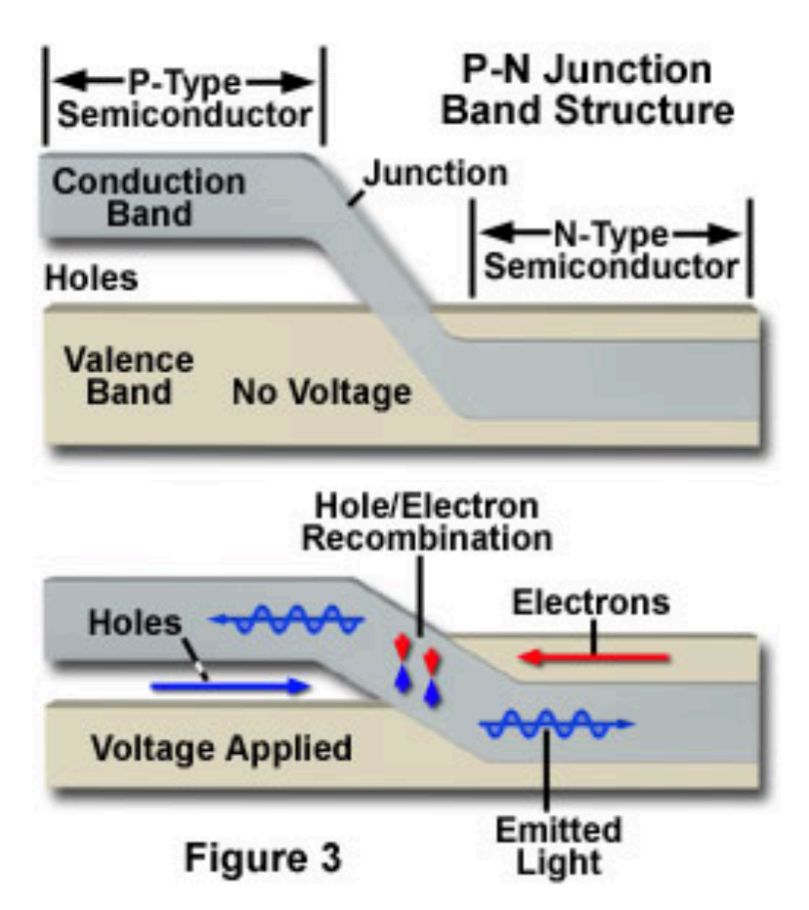
THE LASER

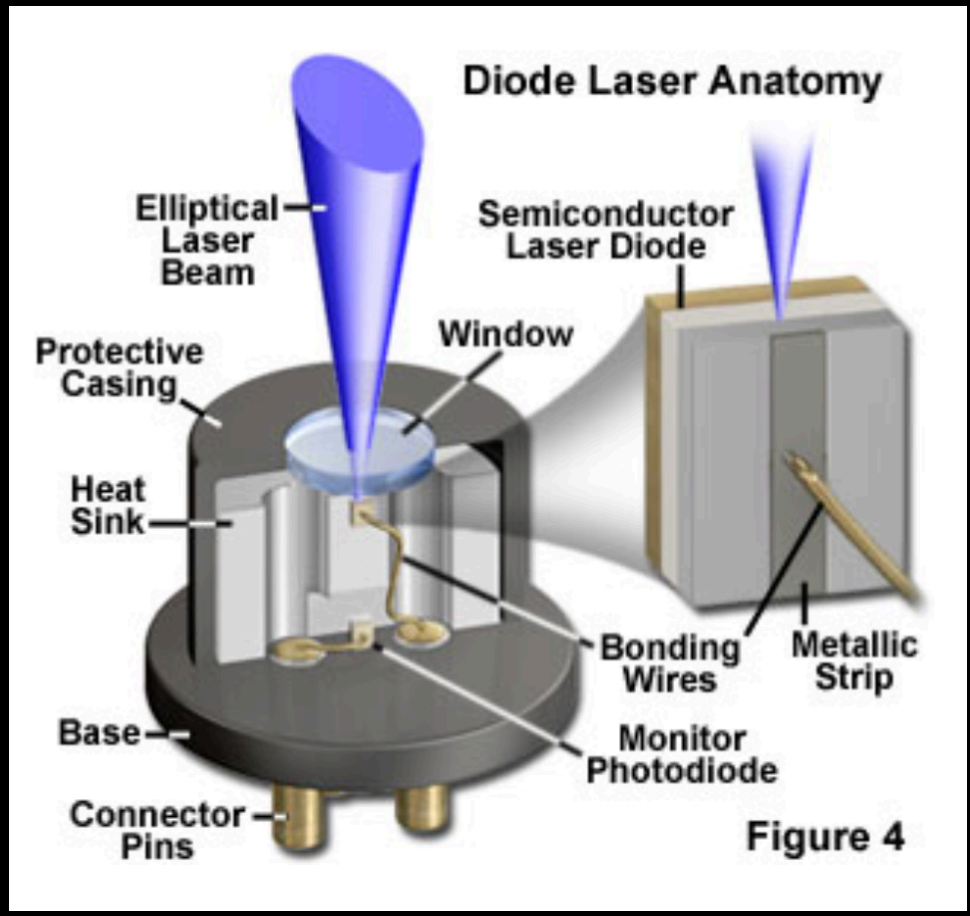

Possible transitions
Spontaneous emission
radiation in the cavity
Absorption
$f = \frac{E_2 - E_1}{h}$
STIMULATED EMISSION
(book calls "induced")
E_2 N_2
E_1 N_1

THE LASER

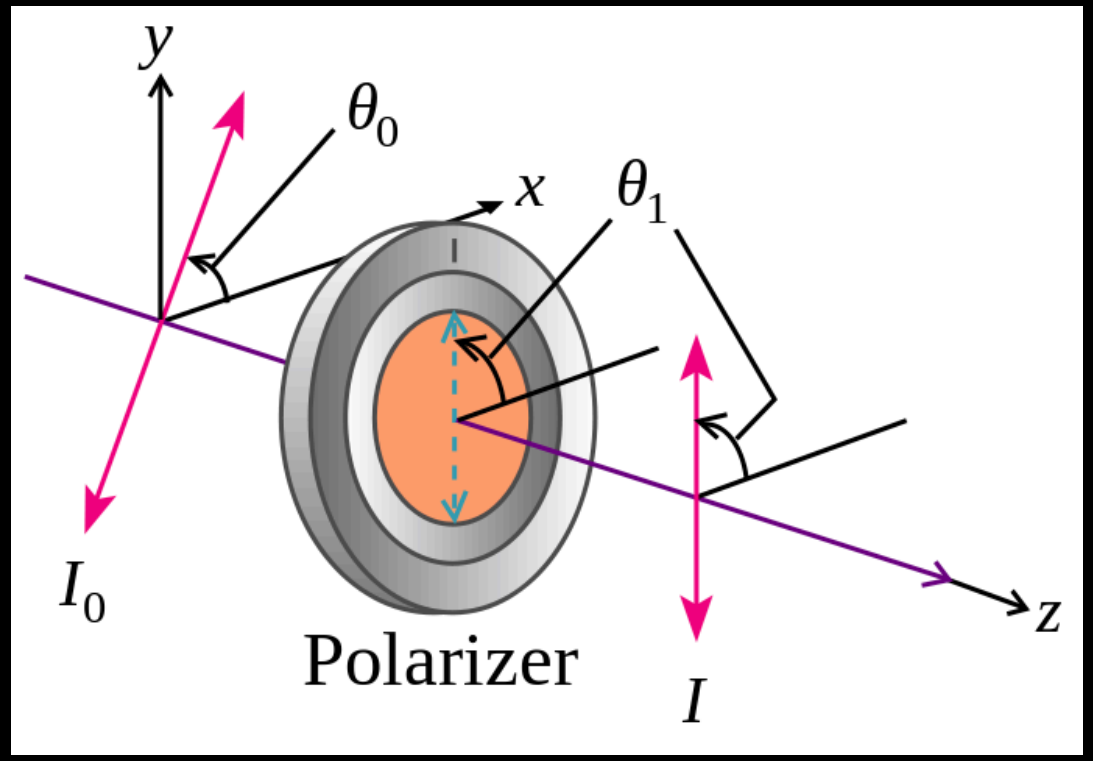


DIODE LASERS





POLARIZATION OF LIGHT

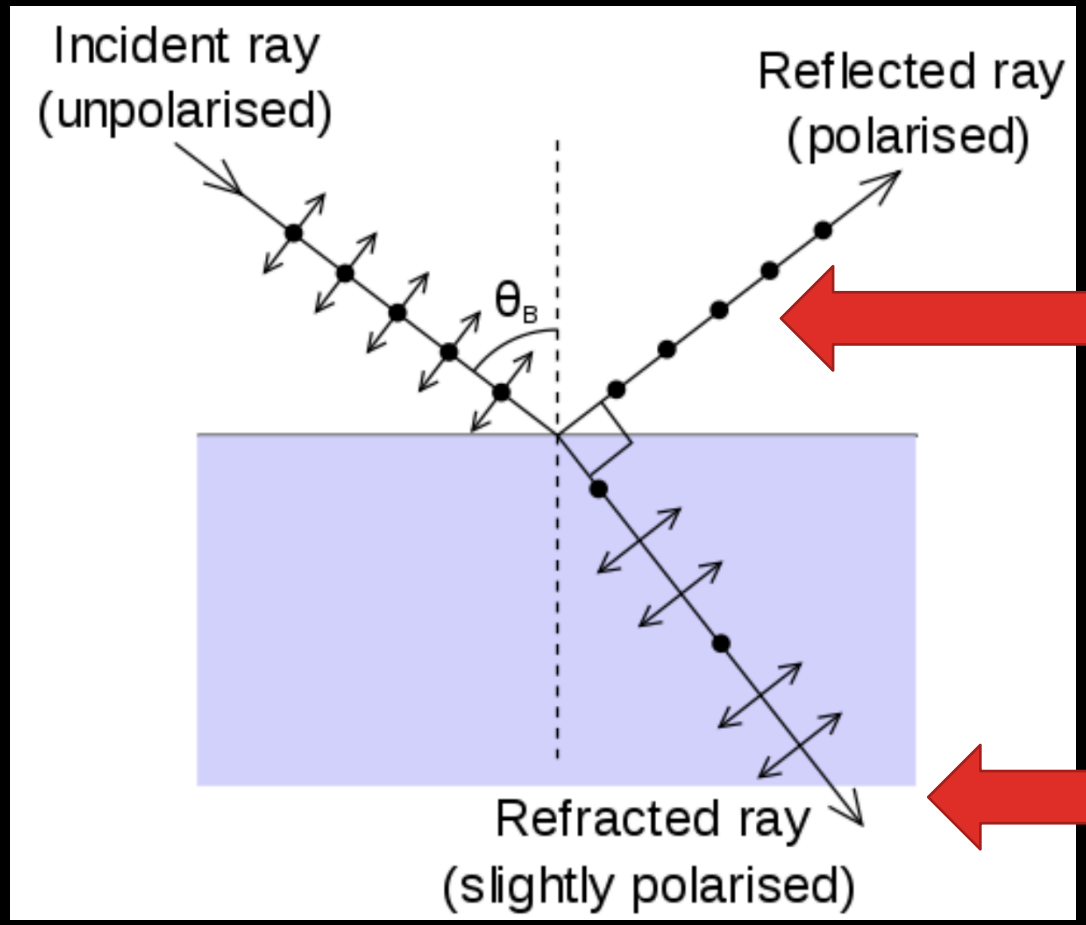


Intensity transmitted through polarizers is governed by Malus' Law.

$$I = I_0 \cos(\theta_i)^2$$

BREWSTER'S LAW

$$\theta_B = \arctan(\frac{n_2}{n_1})$$



s-polarized (senkrecht = perpendicular)

Partially p-polarized = parallel

APPLICATION OF BREWSTER

WHAT YOU'LL BE DOING

- Control stepper motor to rotate a polarizer, 1 pulse per step.
- Examine Malus's Law using a thin film polarizer
  - how will you know the angle…calibrate!
- Read a photodiode whose intensity is proportional to the intensity of light.
  - Is It linear?
- Identify Brewster's angle.

This year we replaced the old stepper motor controller with a new Arduino shield (last week!). Here are some pointers:

- If you set too short of a delay time the reflector might still be shaking quite a bit when the analogRead is done.
- For very short delay times the plot seems to lag behind quite a bit in updating, although the data should still be collected properly, it's just slow on the matplotlib end.
- Aside from long delay times, there are other motor operation modes that can be used to decrease the shaking, mainly 'MICROSTEP' (which can be set in the Arduino sketch). This will result in much smaller steps however, so they will have to calibrate this mode as well if they decide to use it for less 'jittery' results
- play with the `AFMS.begin()` frequency in the Sketch to find a stable frequency for the motor.
- figure out how many degrees the motor rotates per step and change `degsPerStep` in LASER_2018.py accordingly (is the idea that they look at the glass to figure this out or should they figure out the number of steps between two intensity peaks in the readout from the photodiode?)

ARDUINO'S AT HOME

- Poll of class: How many have received their Arduino?
- Steps to Arduino training:
  - Talking to Arduino, uploading a sketch.
  - Getting it to do count, send to computer.
  - Getting it to sense something.
  - Getting it to control something.
  - Feedback/real time analysis
  - Supreme hacker of life

If you haven't already, pick up a LM34 temperature sensor from Mark and demonstrate that it can read a temperature. Can you make it plot live data?
Question: How do you know it's the right temperature? Calibrate!