

PHYS 115 Exam 2 StudyGuide

1. Laser

a. Generation of laser light

i. Concepts in **L**ight **A**mplification of **S**timulated **E**xcitation **R**adiation

Population inversion, stimulated radiation, spontaneous radiation, lifetime of energy levels

ii. Parts in lasers and their functions

Lamp - excitation source- pumping-prepare the population inversion (of excited atoms), laser medium– stimulated radiation-generating photons, resonant cavity– amplification-generating the coherence (same phase) of all the photons (waves) , mirrors – feedback-allowing all photons having same property,

2. Wave nature of light (continued)

a. What is wave.

Characters of a wave: Amplitude, wavelength, period, frequency, wave velocity, polarization

They are all independent except that period and frequency are linked to each other.

Behavior of polarization change after light propagate through polarizers.

b. Light as a wave:

interference, diffraction.

c. Wave –view and photon –view

What are the equivalent/related concepts in both views? Amplitude –intensity – photon numbers, frequency – energy per photon,

3. Spectrum

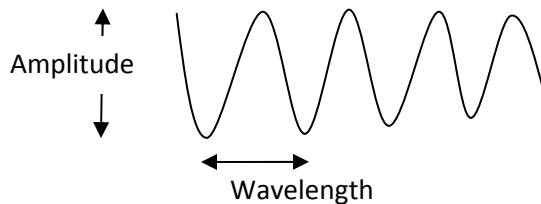
a. What is a spectrum diagram? What are the axes?

b. What does the width of the spectrum related to?

I.a. I. Population inversion is to generate more atoms in an excited state so that the number of photons emitted will overcome the photons being absorbed. This is a critical part to have more photons “out” than “in”. i.e., this is the condition to have “amplification” in the laser. Whether one could achieve population inversion is decided by the energy level structure of a material.

Emission means that when an atom comes to lower energy state, it emits a photon. If this is triggered by a photon of same energy passing by, the atom emits an identical photon in respect of the original “trigger” photon. This is called stimulated emission. Otherwise, it is spontaneous emission. Laser beams are the photons of same property. Therefore, laser has to be achieved from stimulated emission.

II.a. For a wave shown below, all characters are marked in the graph.



Frequency is how many cycles it moves back and forth in a second and period is how long it takes to move one cycle back and forth.

Light with a polarization perpendicular to the direction of a polarizer can not pass through. An unpolarized light or light with some component of polarization aligned along the polarizer can partially get through. The light whose polarization is along a polarizer propagates through completely.

After going through a polarizer, the light **has to be polarized along the direction of the polarizer**.

b. when light passing through an opening with certain size, light will propagate into directions forming a bigger spot, the diffraction phenomenon. This resulted from the wave nature of the light. It is strongest when the opening has a comparable size to the wavelength of the incident light. Poisson’s spot is an evidence to demonstrate the diffraction.

When multiple coherent light meet at same spot, it may superimpose (adding together) and this is called interference. You may need to refer to your lab notes for the interference and diffraction phenomenon.

III.a. spectrum diagram is to show how a light is comprised from various components of colors. The vertical axis is the number of photons and the horizontal axis is the wavelength (or energy/photon, or color, or frequency)

b. For any peak in a spectrum diagram, center position of the peak shows the color of the light, width of the peak shows the coherent length and the saturation of the color and the height of the peak shows

how intense/number of photons of the light. (Please note, this is the number of photons at the peak color, not the total photons, which is the “area” underneath the whole peak.)