LASERS

Light Amplification

by

Stimulated Emission of Radiation

Consider two energy states of an atom

Upper state with energy \( E_2 \)

Lower state with energy \( E_1 \)
Figure 10.11 in Thornton and Rex, Page 342
If atom is in the upper state it can transition spontaneously to lower state and give off a photon.

Or

If the atom is in the upper state and remains for a long time – photon with energy \( (E_2 - E_1) \) can cause **stimulated emission**

An energy state where atom remains for a long time is called a
METASTABLE STATE

(After quantum mechanics we will give a better definition.)

_____________________ $E_1$

_____________________ $E_2$ (metastable)

_____________________ $E_3$
a. Flood material with photons with energy \((E_3 - E_1)\)

b. Atoms go immediately to \(E_3\) state.

c. Atoms fall immediately to \(E_2\) state where they remain for a long time.

d. Photon with energy \((E_2 - E_1)\) interacts with atom causing atom to go to state \(E_1\) giving off photon with energy equal to \((E_2 - E_1)\).

e. Now there are two photons with energy \((E_2 - E_1)!\)

One photon \((E_2 - E_1)\) \(>>>\) two photons \((E_2 - E_1)\)

AMPLIFICATION
Have material with properly spaced energy states and make transition happen many times you have LASER - light with photons all with energy \((E_2 - E_1)\)

1 photon gives 2

2 photons gives 4

4 photons gives 8

8 photons gives 16

etc.

Question: Consider chess board. If you put one marble on 1st square, 2 on second, 4 on third, 8 on forth, etc. How many will you need for the 64th
square?
LASER LIGHT CHARACTERISTICS

**DIRECTIONAL** – Only photons traveling parallel to axis of cylinder will contribute to laser light.

**MONOCHROMATIC** – All photons have same energy and thus same frequency.

**COHERENT** – Each photon is in phase with all other photons.

Some lasers produce light that is

**POLARIZED** – The E vector is in only one plane.