



# **SNS COLLEGE OF ENGINEERING**

**Coimbatore-641 107**

**( An Autonomous Institution )**

Accredited by NBA & NAAC with 'A' Grade  
Approved by AICTE, New Delhi & Recognized by UGC  
Affiliated to Anna University, Chennai

## **DEPARTMENT OF PHYSICS**

**COURSE NAME :23PYT101 & ENGINEERING PHYSICS**

**I YEAR / II SEMESTER**

**UNIT 2 – LASER AND FIBER OPTICS**

**TOPIC 1 – SPONTANEOUS AND STIMULATED EMISSION-  
POPULATION INVERSION**





# INTRODUCTION OF LASER

A laser is a device that emits light through a process of optical amplification based on the stimulated emission of electromagnetic radiation.

## Characteristics of laser light Or The properties of laser beam:

- Highly coherence
- Highly monochromatic
- Highly directionality
- Highly intensity



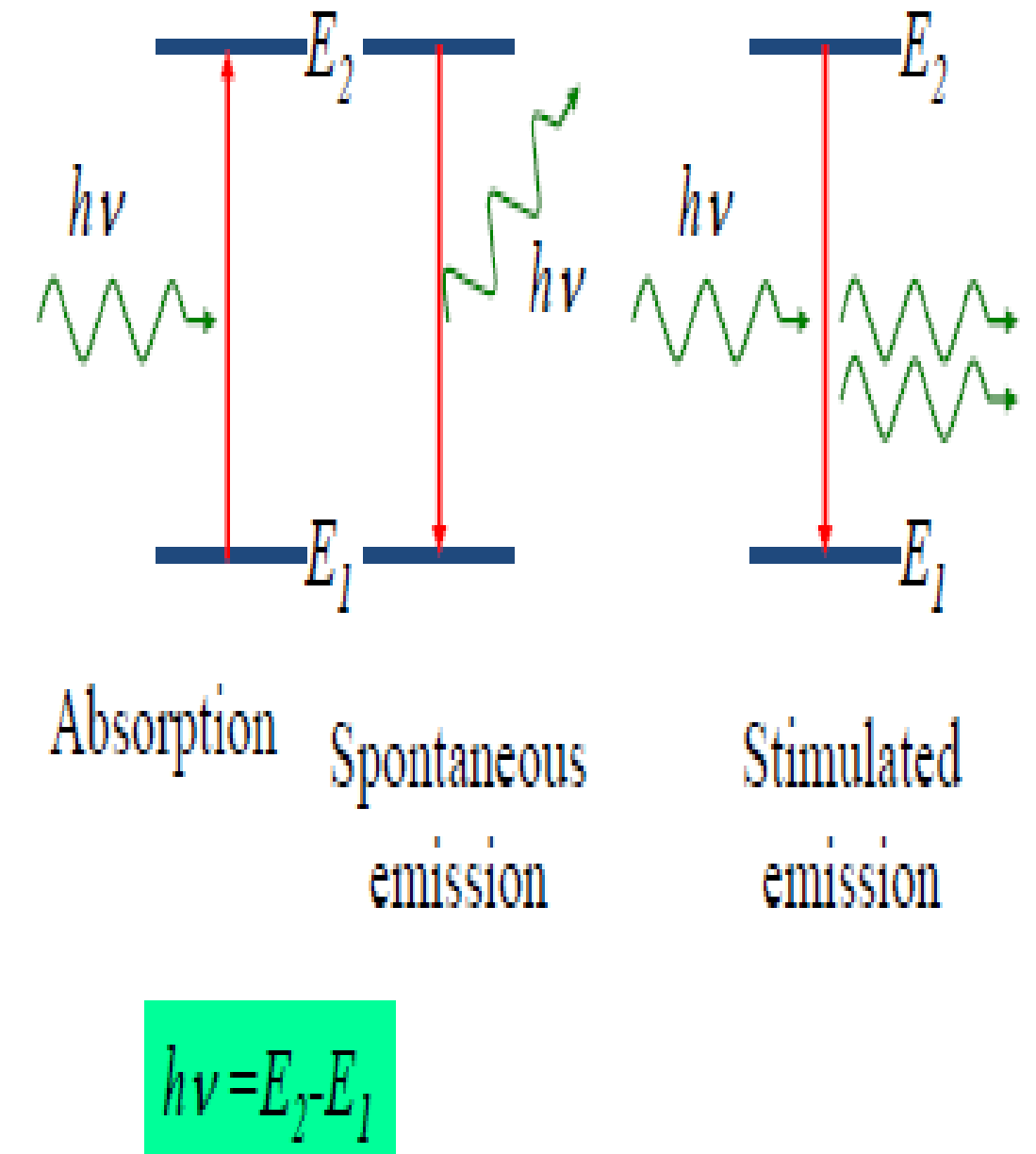


The **principle** of a **laser** is based on three separate features:

- Stimulated emission within an amplifying medium,
- Population inversion of electronics,
- An optical resonator.

### 1. Stimulated absorption

The atom in lower level  $E_1$  may absorb the incident photon and jump to excited state  $E_2$ . This process is called **induced or stimulated absorption** or simply absorption





## 2. Spontaneous emission

The atom in the excited state returns to the ground state by emitting a photon of energy  $E = (E_2 - E_1) = h\nu$ , without any external energy. This process is known as **spontaneous emission**.

## 3. Stimulated emission

The atom in the excited state returns to the ground state by external triggering (or) inducement of photon thereby emitting a photon of energy equal to the energy of the incident photon, known as stimulated emission.



# ASSESSMENT - 1

Find the answers

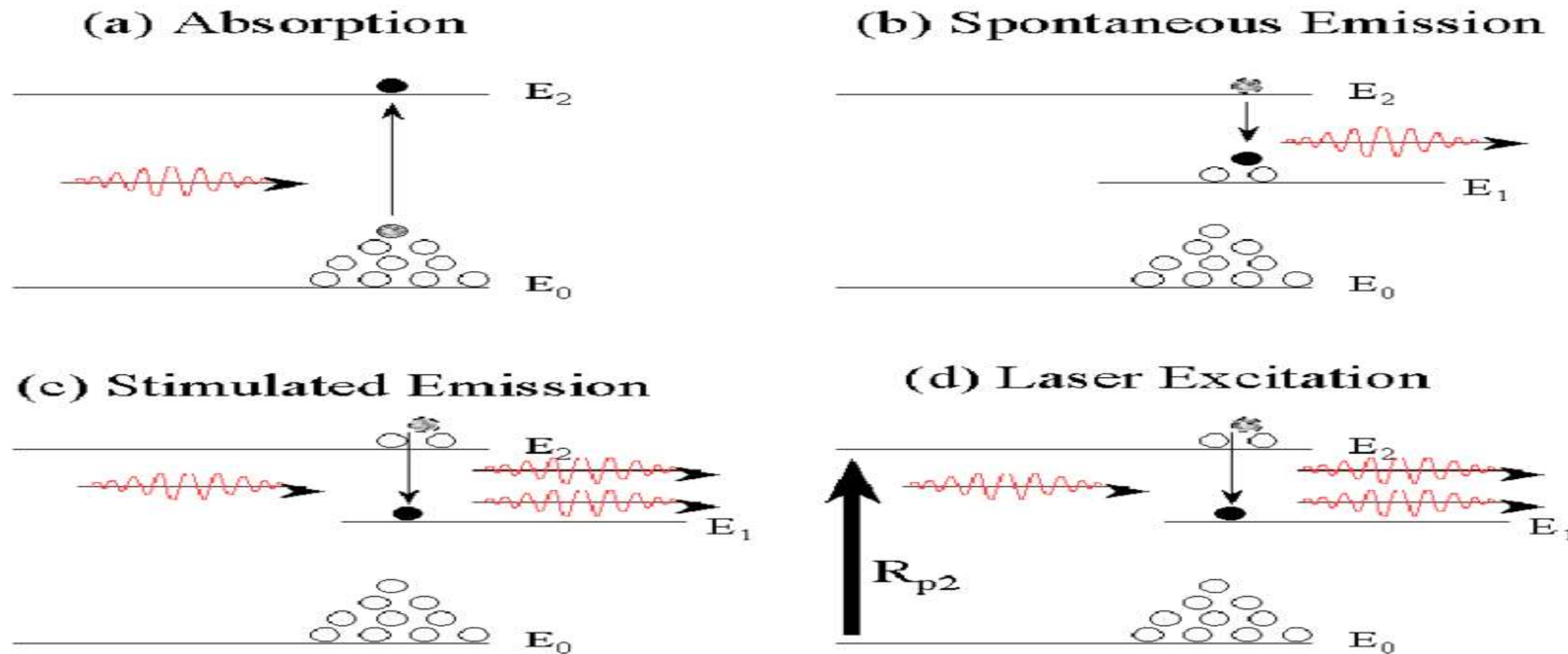


1. What is meant by stimulated emission?
2. How is population inversion achieved?
3. What is population inversion and pumping?



# Metastable state

These are the energy states in which atoms can remain more than  $10^{-8}$  seconds are called metastable states.





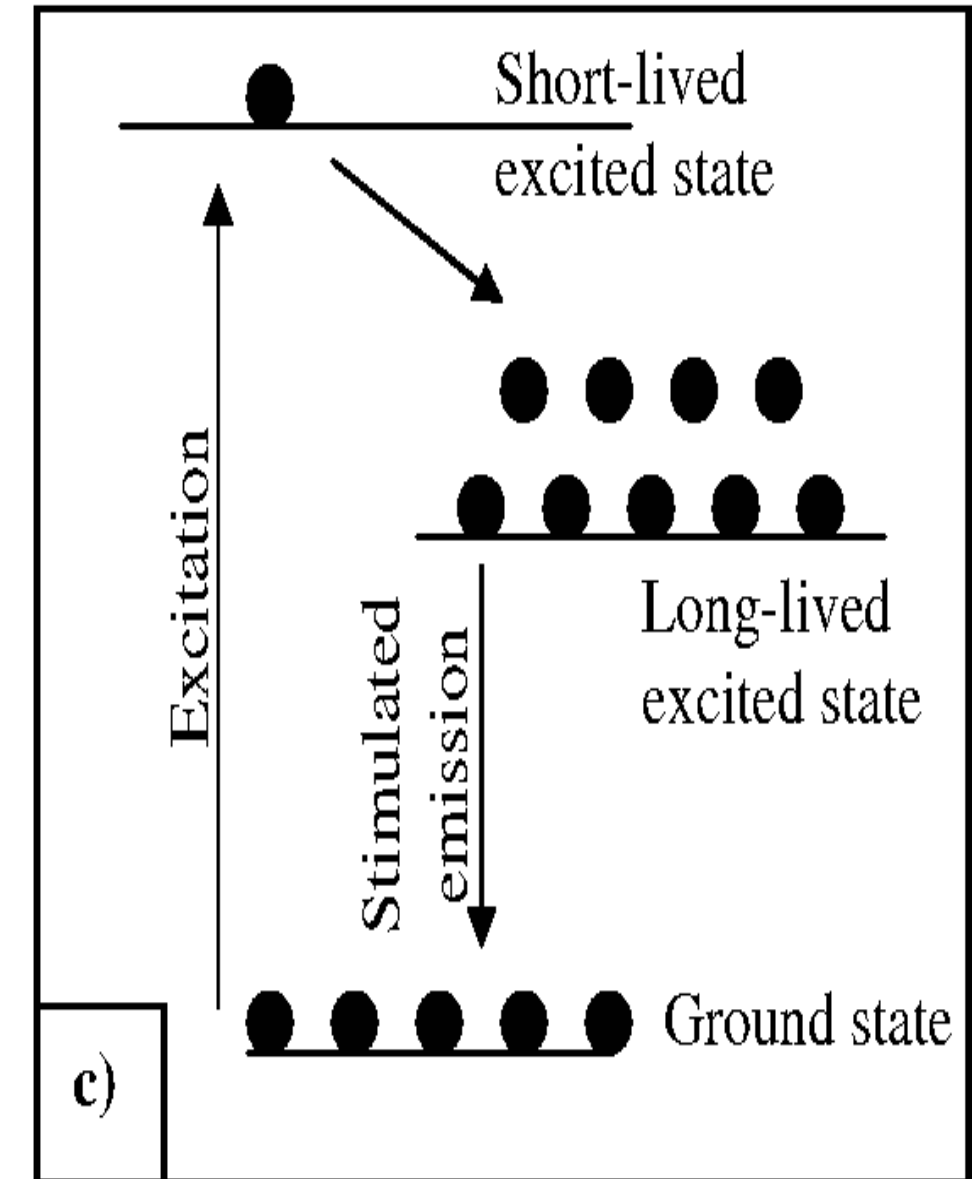
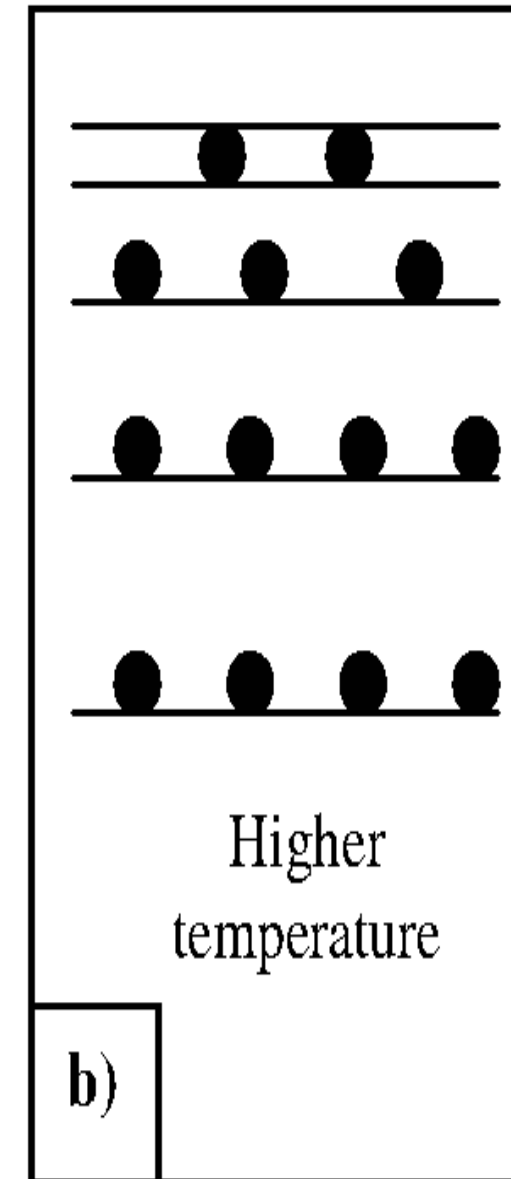
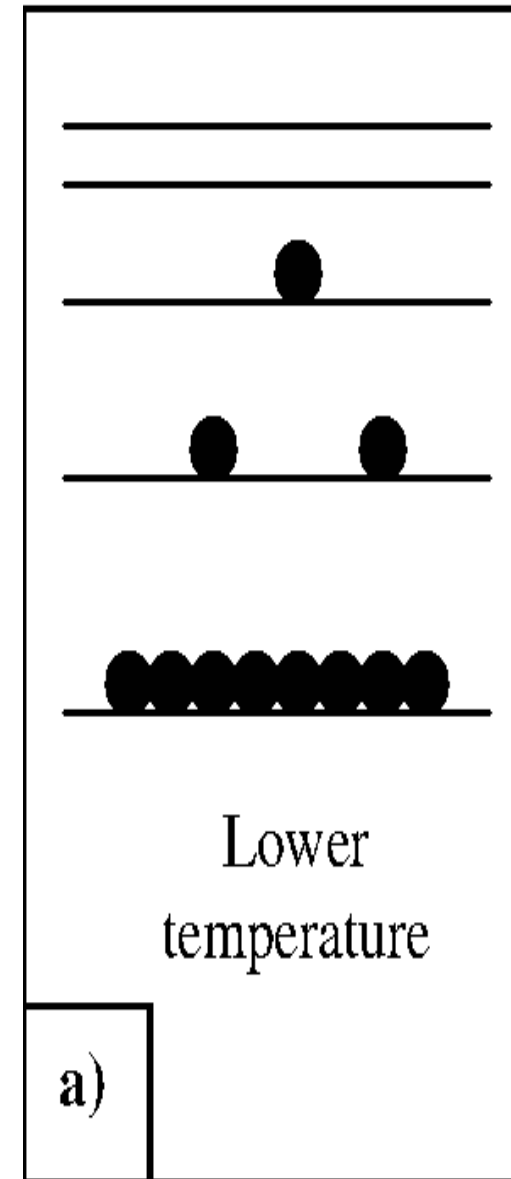
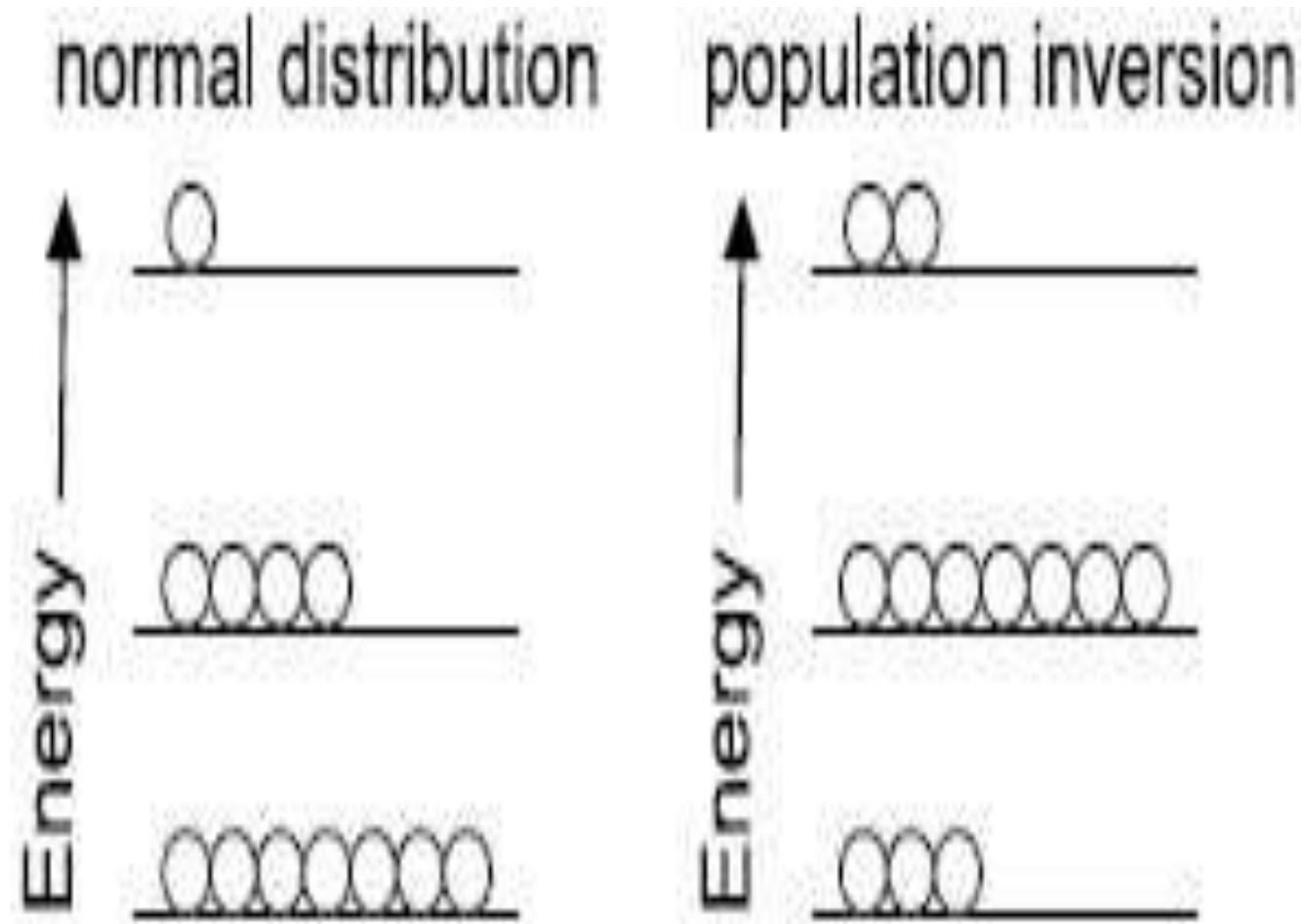
# Distinguish between spontaneous emission and stimulated emission.



S.no	Stimulated Emission	Spontaneous emission
1.	An atom in the excited state is induced to return to the ground state , thereby resulting in two photons of same frequency and energy is called Stimulated emission	The atom in the excited state returns to the ground state thereby emitting a photon, without any external inducement is called Spontaneous emission.
2.	The emitted photons move in the same direction and is highly directional	The emitted photons move in all directions and are random
3.	The radiation is highly intense , monochromatic and coherent	The radiation is less intense and is incoherent.
4.	The photons are in phase, there is a constant phase difference.	The photons are not in phase (i.e.) there is no phase relationship between them.
5.	The rate of transition is given by $R_{21}(St) = B_{21}\rho_v N_2$	The rate of transition is given by $R_{21}(SP) = A_{21}N_2$



An upper-state system will eventually give off a photon of the proper wavelength and drop to the ground state.







# References



- <https://images.app.goo.gl/n8oLZ79b8psfbX7Z8>
- <https://images.app.goo.gl/ZsGZU31vsnv2mMo29>
- <https://images.app.goo.gl/Yo8XhQWdgt1AUkgx5>
- <https://images.app.goo.gl/T3kR1GX5KXbKzhhY7>
- <https://images.app.goo.gl/RDzxWKdxmUr62YtJ8>
- <https://images.app.goo.gl/6EMVr5h5ERdFfHp47>

*Thank You*