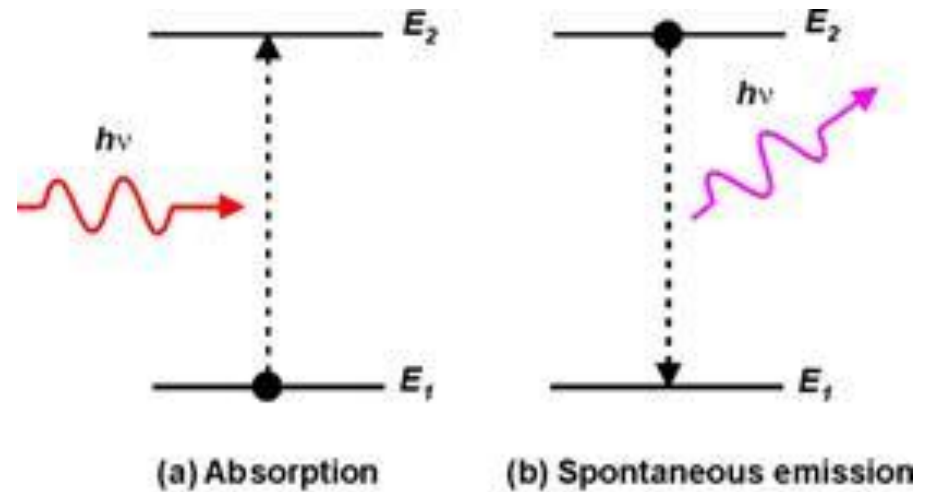


LASER - I

Stimulated Emission

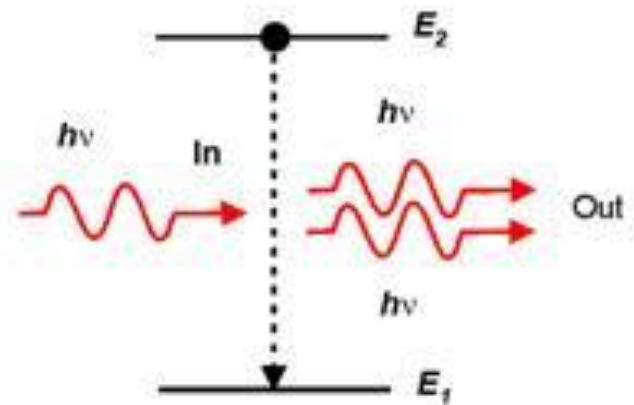
1905 - Absorption & Emission

Photo electric effect
(Nobel Prize 1921)



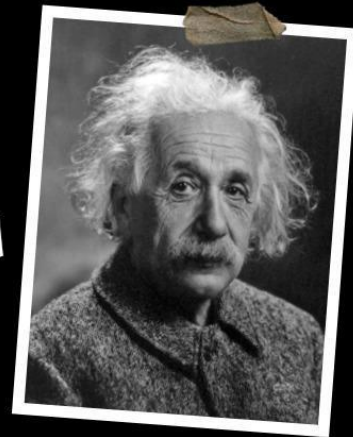
(a) Absorption

(b) Spontaneous emission



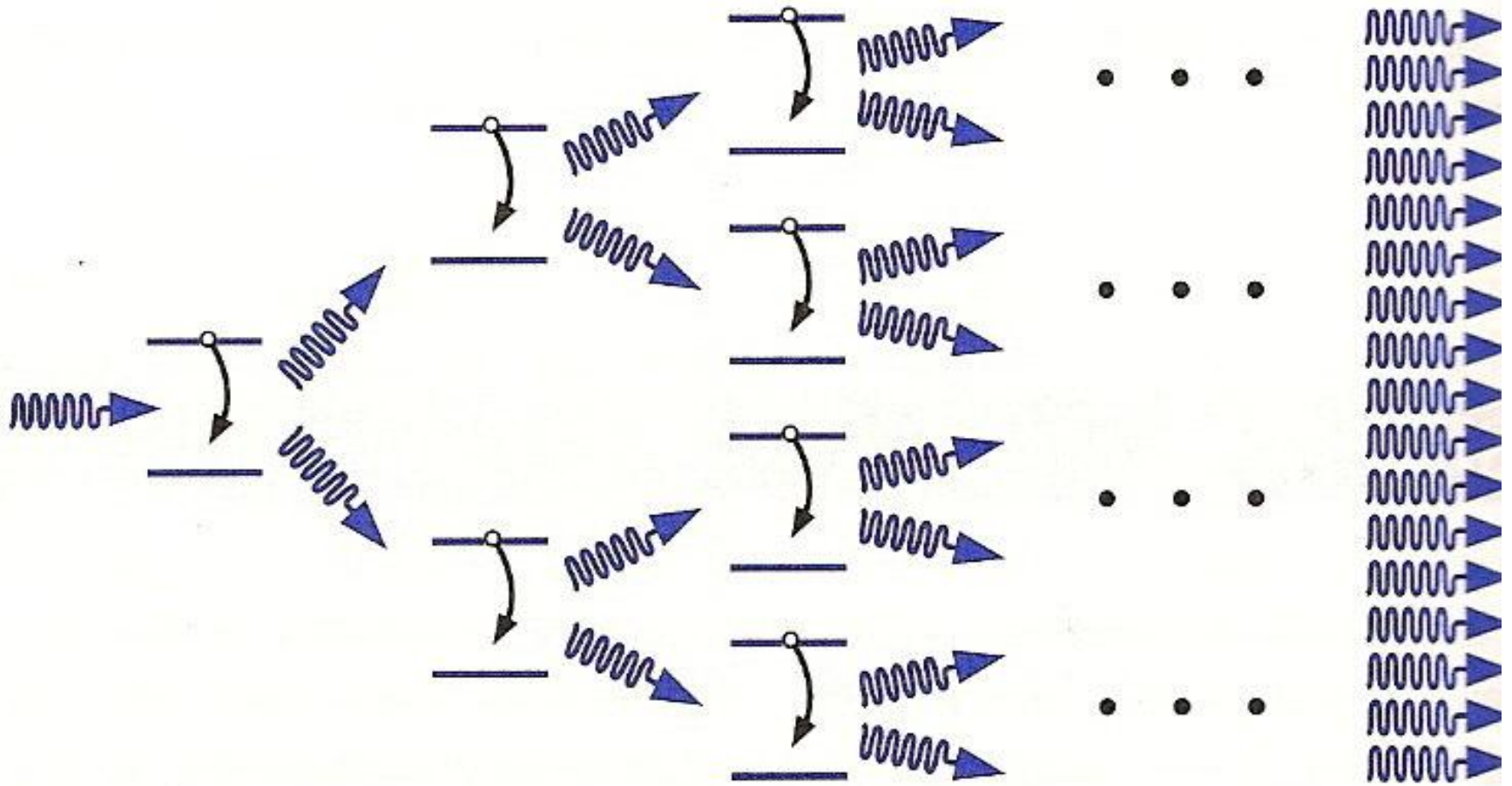
(c) Stimulated emission

"Education is not
the learning of
facts, but the
training of the mind
to think."
-Albert Einstein



1917 – **stimulated emission is possible !**

Light Amplification by Stimulated Emission of Radiation (LASER)

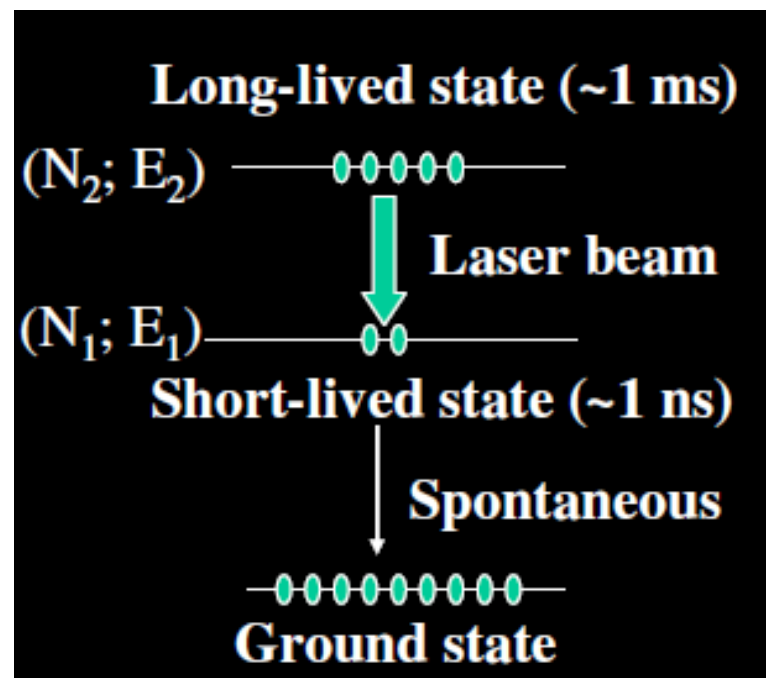
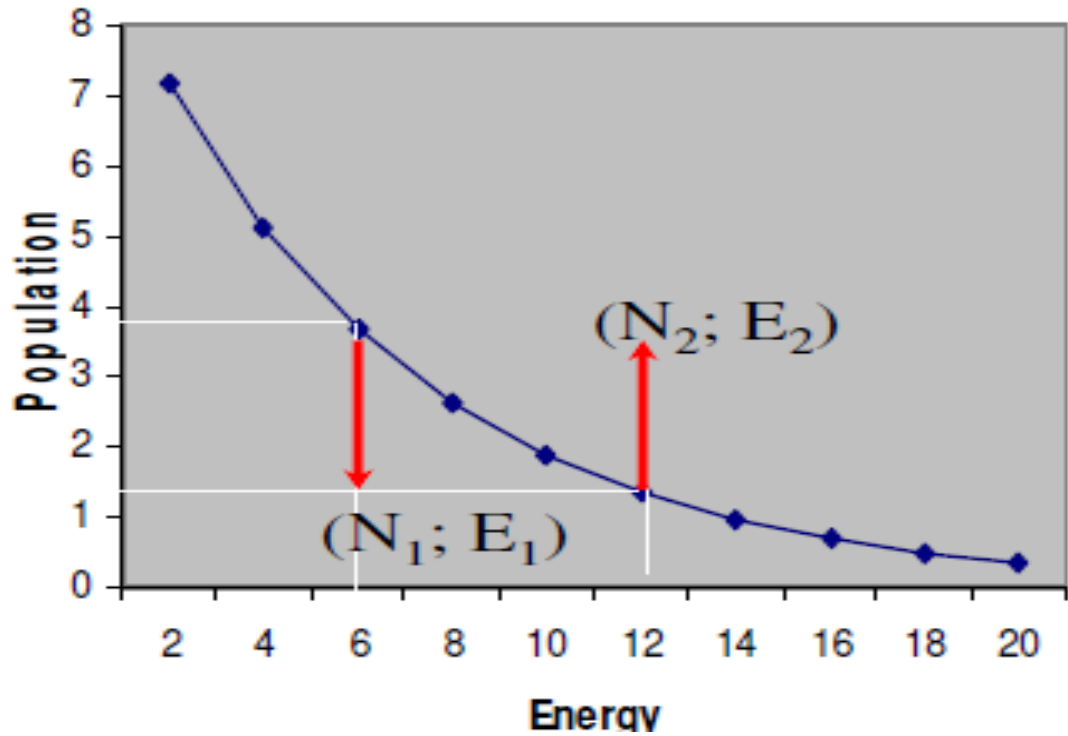


Necessary condition for LASER source

(i) Population Inversion ←

$$N_2 \gg N_1$$

(ii) Metastable states (long-lived)



Elements of a LASER

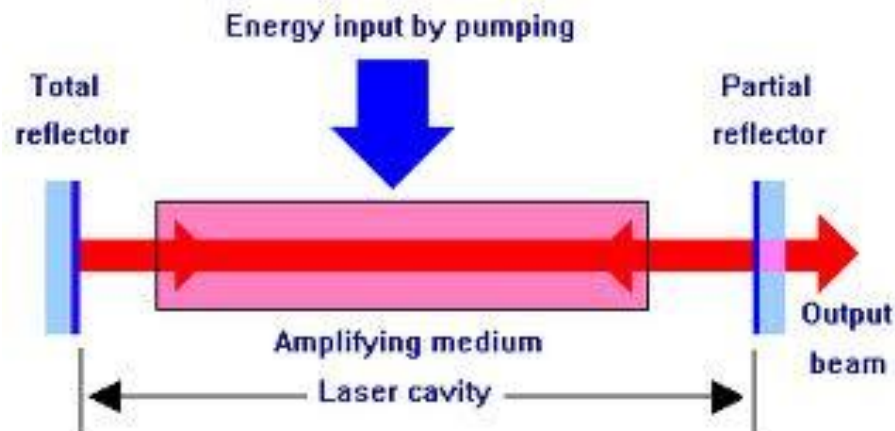
Active medium: contain atoms whose electrons may be excited to a metastable states by an energy source.

Solid crystals – Ruby or Nd:YAG, Gases – CO₂ or Helium/Neon

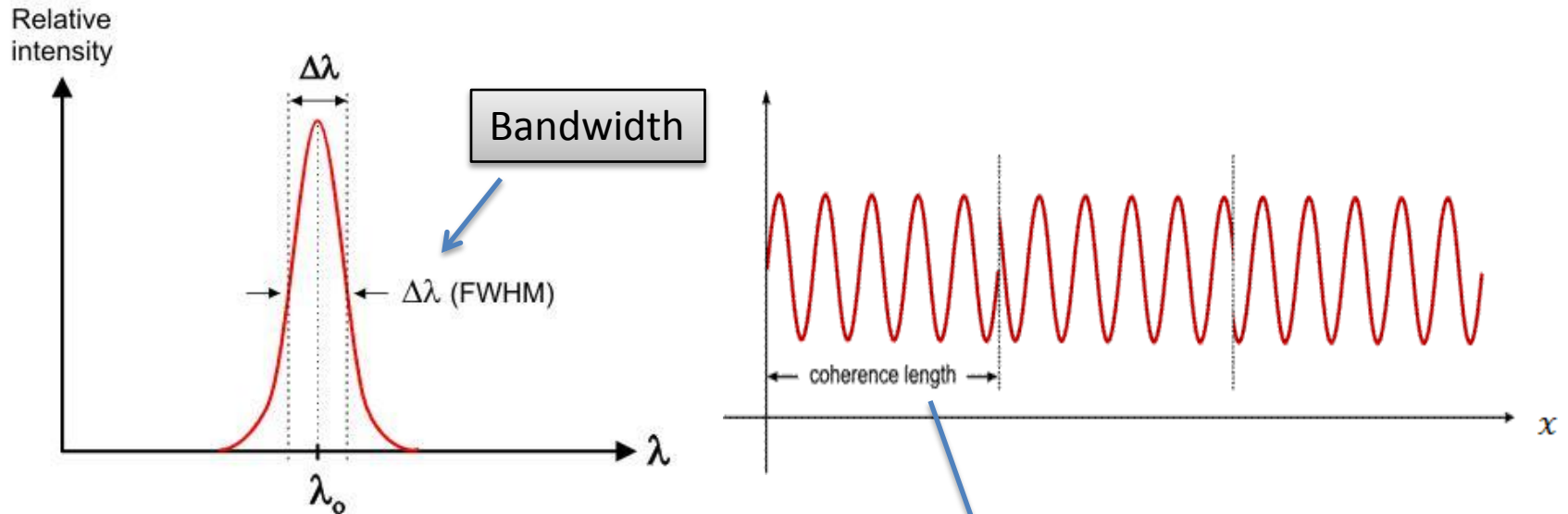
Semiconductors – GaAs, Liquid dyes

Excitation mechanism: pump energy into the active medium by one or more of three basic methods:
optical, electrical, chemical.

Optical Cavity: Two mirrors (100% & 99% reflectance)



Coherence



Since $c = \nu\lambda$, $\Delta\nu = \Delta\lambda \left| \frac{-c}{\lambda^2} \right|$.

Coherence time, $\Delta t \approx 1/\Delta\nu$

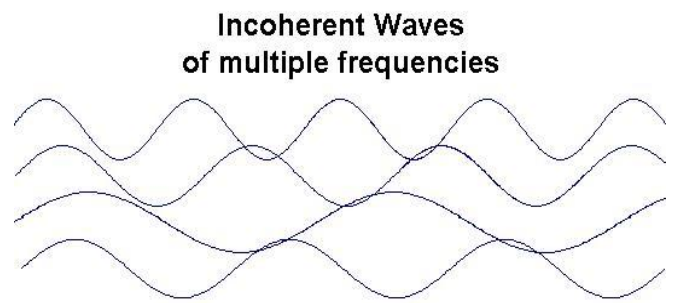
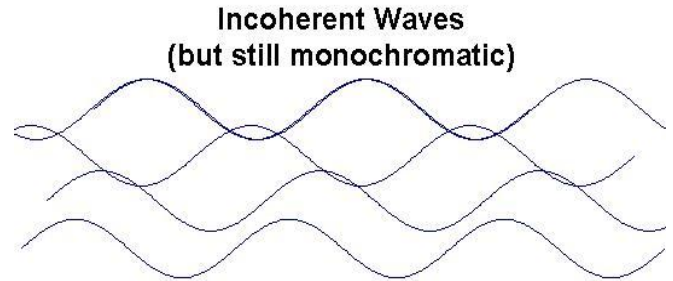
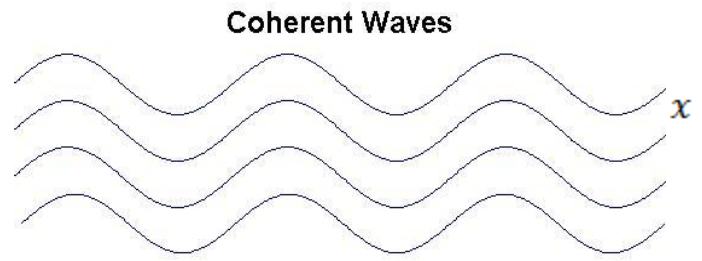
Coherence length,

$$L = c\Delta t \approx \frac{\lambda^2}{\Delta\lambda}$$

(distance up to which light is a continuous sinusoidal EM-wave)

Properties of a LASER

	Sodium	He-Ne Laser
λ (A°)	5890	6328
$\Delta\lambda$ (A°)	0.1	0.01
L (cm)	3	40



Laser Light

- Mono-chromatic
- Directional
- Coherent

Ordinary Light

Milestones

- 1917 – Theory of stimulated emission (Albert Einstein)
- 1954 – Principle of MASER (**Charles Townes**)
- 1958 – Principle of LASER (Schawlow & C. Townes)
- 1960 – First laser device using ruby crystal (T.H. Maiman)
- 1961 – First gas (He-Ne) laser (Ali Javan, W.R. Bennett, D.R. Herriott)
- 1962 – Semiconductor laser (four groups)
- 1963 – CO₂ laser (C.K.N Patel)
- 1964 – Ar-ion laser, Nd:YAG laser

The Nobel Prize in Physics (1964)



Charles H Townes



Nicolay G Basov



A M Prokhorov

“For the fundamental work in the field of quantum electronics which has lead to the construction of oscillators and amplifiers based on the maser-laser principle.”