Photonics

LASERs

Light **A**mplification through **S**timullated **E**mission of **R**adiation

1954   C.H Towens

gravitation
electromagnetic
strong
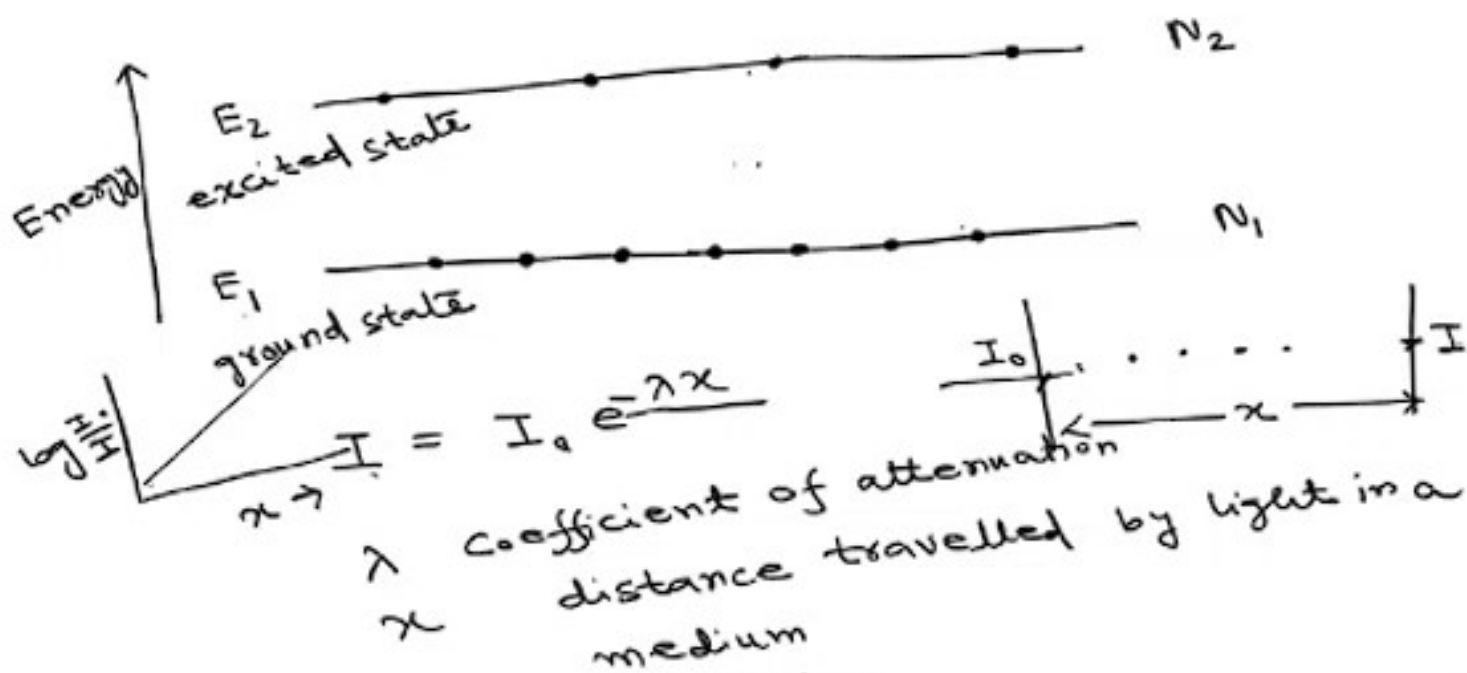weak

graviton
photon
gluons
$W, Z^{\pm}$ boson

$$I = I_0 e^{-\lambda x}$$

λ coefficient of attenuation
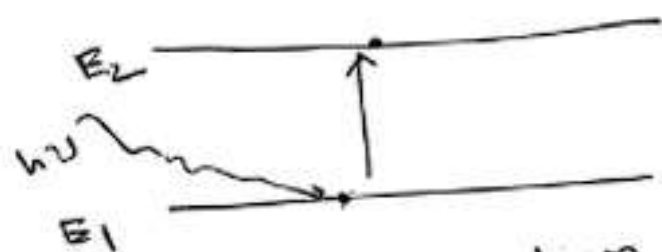
x distance travelled by light in a medium

$$N_1 = e^{-E_1/KT}$$

$$N_2 = e^{-E_2/KT}$$

$$\frac{N_2}{N_1} = e^{-(E_2-E_1)/KT} \simeq e^{-\Delta E/KT}$$

$$K = \frac{R}{N_A} = 1.38 \times 10^{-23}$$

$$h\nu = E_2 - E_1$$

E_2 ─────────────────────

$h\nu$

E_1 ─────────────────────
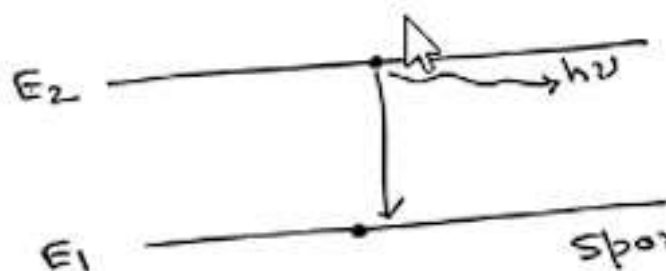
absorption transition

$$P_{12} \propto P(\nu)$$

$$P_{12} = B_{12} \, P(\nu)$$

$B_{12} \rightarrow$ Constant of proportionality
Einstein's coefficient of induced
absorption.

$$R_{abs} = - \frac{dN_1}{dt}$$

$$R_{abs} = \frac{dN_2}{dt}$$
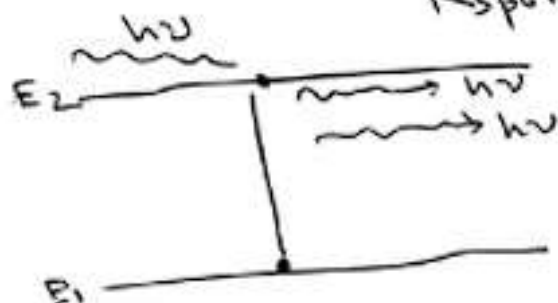
$$= B_{12} \, P(\nu) \, N_1$$

$$h\nu = E_2 - E_1$$

E_2 ─────────────── $\rightarrow h\nu$

E_1 ─────────────── Spontaneous emission

$$(P_{21})_{spon} = A_{21}$$

Einstein's coefficient of spontaneous
emission.

$$R_{spon} = A_{21} \, N_2$$

$$h\nu = E_2 - E_1$$

E_2 ─────── $\rightarrow h\nu$
$\rightarrow h\nu$

$$(P_{21})_{stimulated} = B_{21} \, P(\nu)$$

E_1 ───────

$$R_{stimulated} = B_{21} \, P(\nu) \, N_2$$