Non-chromaticity of L$^{\text{th}}$

Temporal Coherence

When there is no phase change at a point on the wave over a time. $\langle \Delta\phi \rangle = 0$ (mean $\Delta\phi$ of E-field)

Coherence Time

Time over which a propagating wave remains coherent. τ_c (major time interval over which the wave has definite phase relation).
For He-Ne:

$$\tau_c = 2 \times 10^{-3} \approx 2\text{ms}$$

Na-lamp:

$$\approx 10^{-15}$$

Brightness/Intensity

Laser produce highly intense beams, because more light energy is concentrated in a small region. Also laser light is coherent, so at a time many photons are in phase, they superimpose to produce a wave of larger amplitude. Hence resultant intensity (αAmp^2) is very high.

Spontaneous & Stimulated Emission

Spontaneous Emission

Atom initially at excited state makes transition voluntarily on its own, without aid of any external agency, to ground state and emits photon of energy $h\nu_2 = E_2 - E_1$.

Different atoms of medium emits light at different times and different directions. Hence emitted photons are incoherent.

Stimulated Emission

Here, photon having energy $h\nu_2 = (E_2 - E_1)$ impinges (passes in the vicinity) on an atom present in its excited state and atom is stimulated to make transition to ground state and gives off a photon of energy $h\nu_2$.

Emitted photon is in phase with the incident photon. These two travel in same direction and possess same frequency. They're coherent.

Einstein's Coefficients

For a system containing atoms and radiation, ratio of atoms in ground state to atoms in excited state is:

$$\frac{N_2}{N_1} = e^{\frac{E_1 - E_2}{kT}} = e^{\frac{-\Delta E}{kT}}$$

If atom in ground state gets excited to higher state, absorption rate of radiation

$$B_{12} n(\nu) \rho_\nu \quad (\rho_\nu = \text{energy density of incident radiation})$$

- Rate of spontaneous emission: $R_{21} = N_2 A_{21}$
- Rate of absorption: $R_{12} = N_1 B_{12} \rho_\nu$
- Rate of stimulated emission: $R'_{21} = N_2 B_{21} \rho_\nu$