LASER

Coherency

- Temporal Coherency

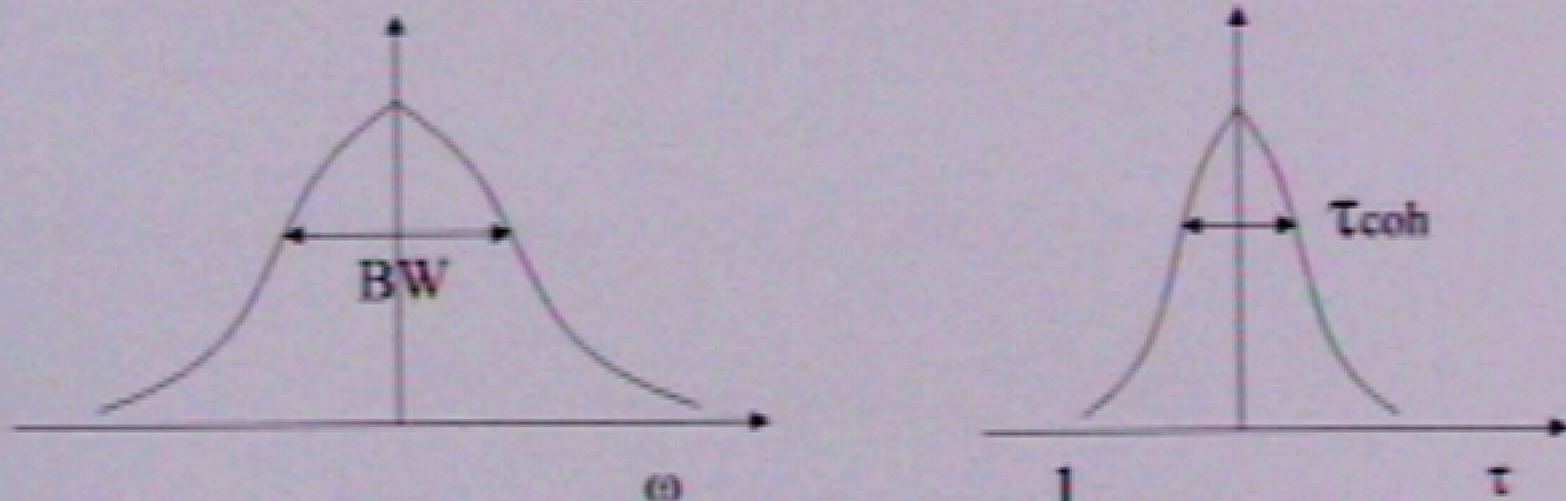
- Spatial Coherency

Temporal Coherence

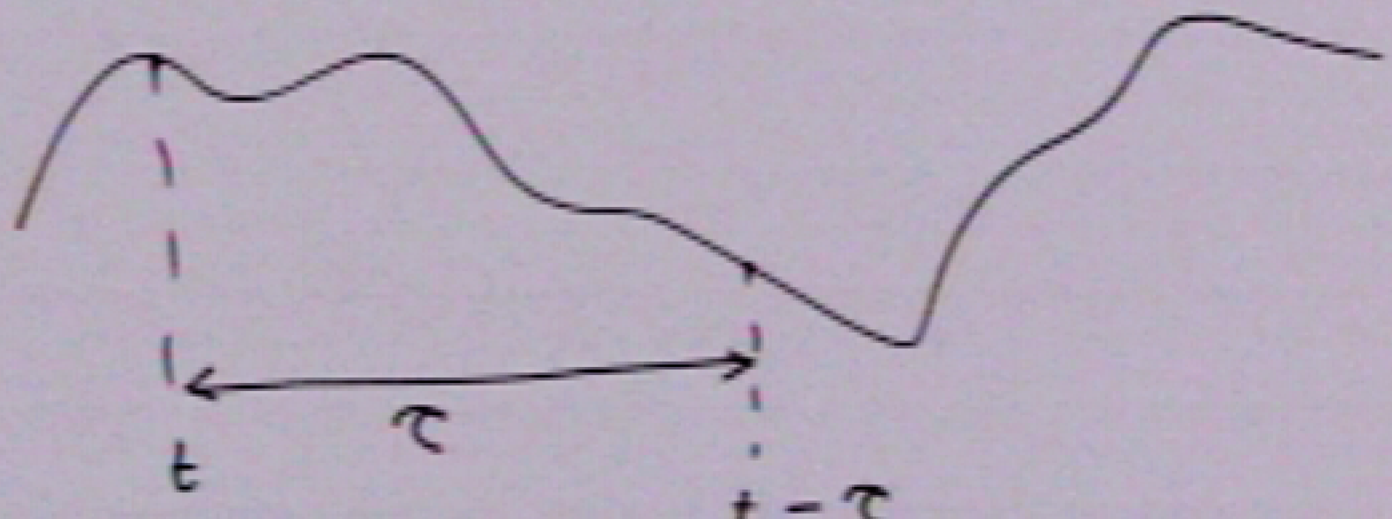
Temporal Coherence function $R(\tau) = \int_{-\infty}^{\infty} A(t)\, A^*(t-\tau)\, dt$

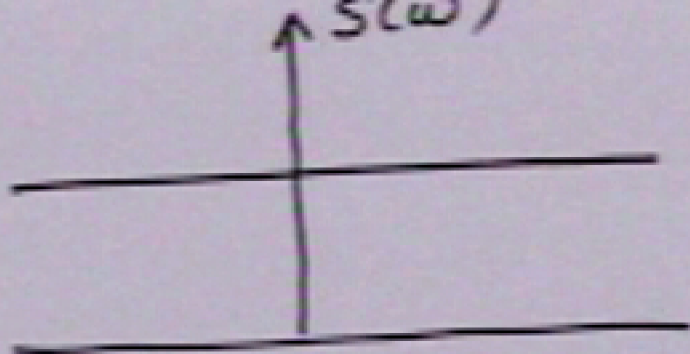
Power spectral density

$$S(\omega) \xleftrightarrow{FT} R(\tau)$$

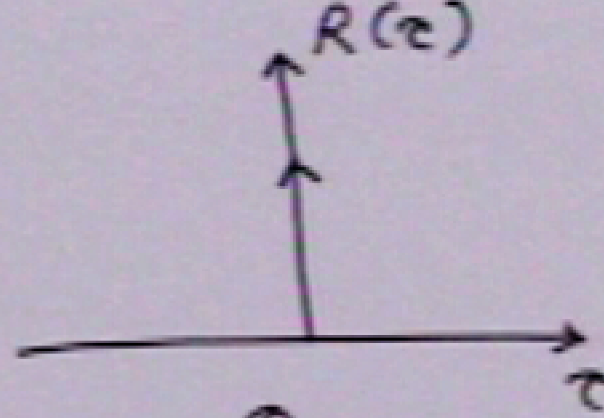


$$\tau_{coh} \approx \frac{1}{BW}$$

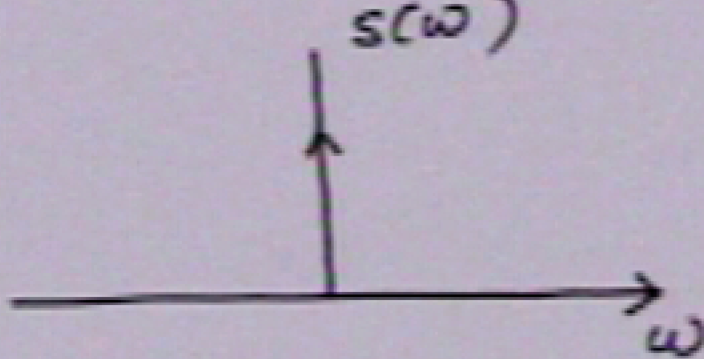

τ
t
t − τ



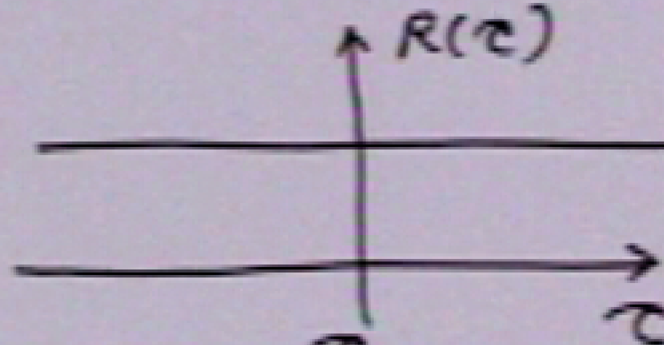
$BW = \infty$



$\tau_{coh} = 0$

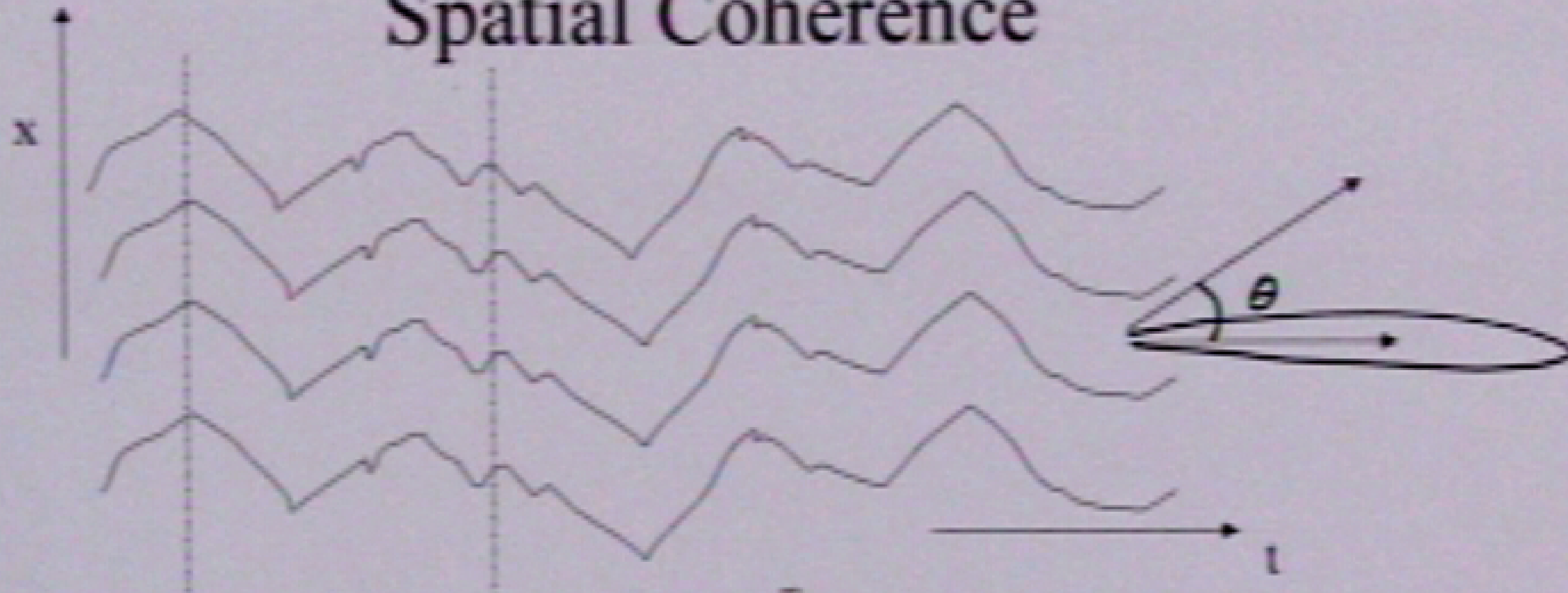


$BW = 0$



$\tau_{coh} = \infty$

Spatial Coherence



Spatial Coherence function $R(\lambda) = \int_{-\infty}^{\infty} A(x)\, A^{*}(x-\lambda)\, dx$

Power Radiation Pattern $\overset{FT}{\longleftrightarrow}$ R(λ)

Two Photons are Coherent iff they have

- Same Energy (i.e. frequency)
- Same phase
- Same Momentum vector
- Same Polarization

(E, **K**, p)

$T = 300\,K \quad , \quad \lambda = 0.7\,\mu m$

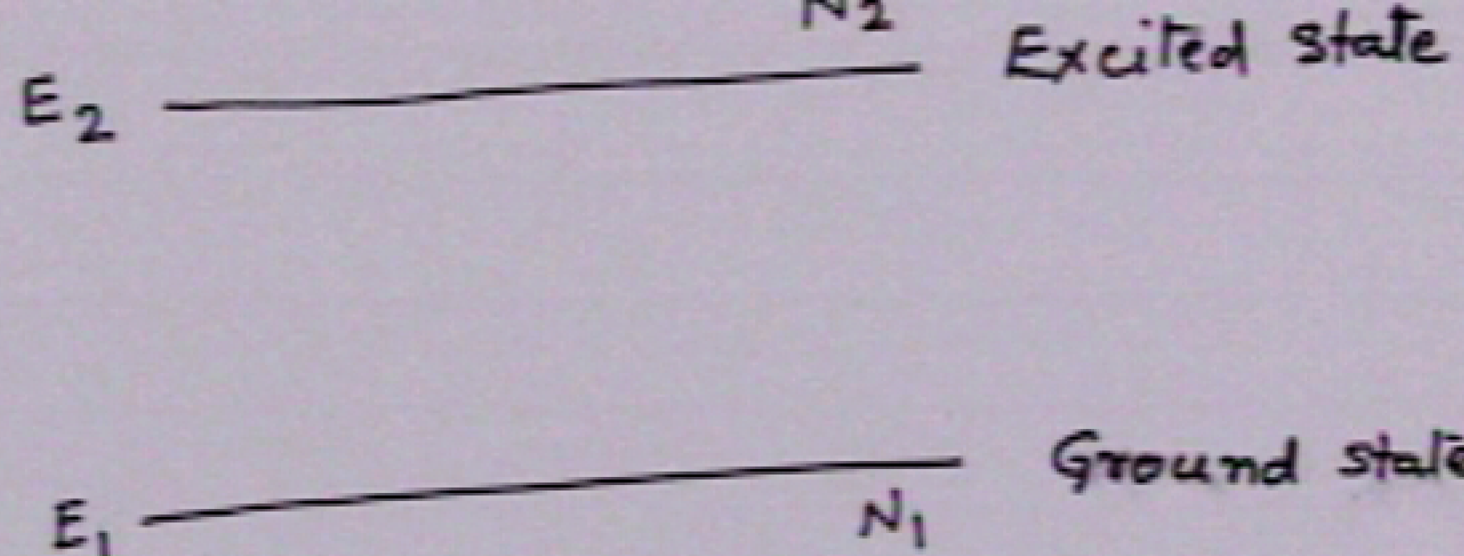
$$E_{ph} = E_2 - E_1 = hf = \frac{hc}{\lambda}$$

$$= \frac{6.6 \times 10^{-34} \times 3 \times 10^{8}}{0.7 \times 10^{-6}} \simeq 3 \times 10^{-19}\ ws$$

$$KT = 1.38 \times 10^{-23} \times 300 = 4 \times 10^{-21}\ ws$$

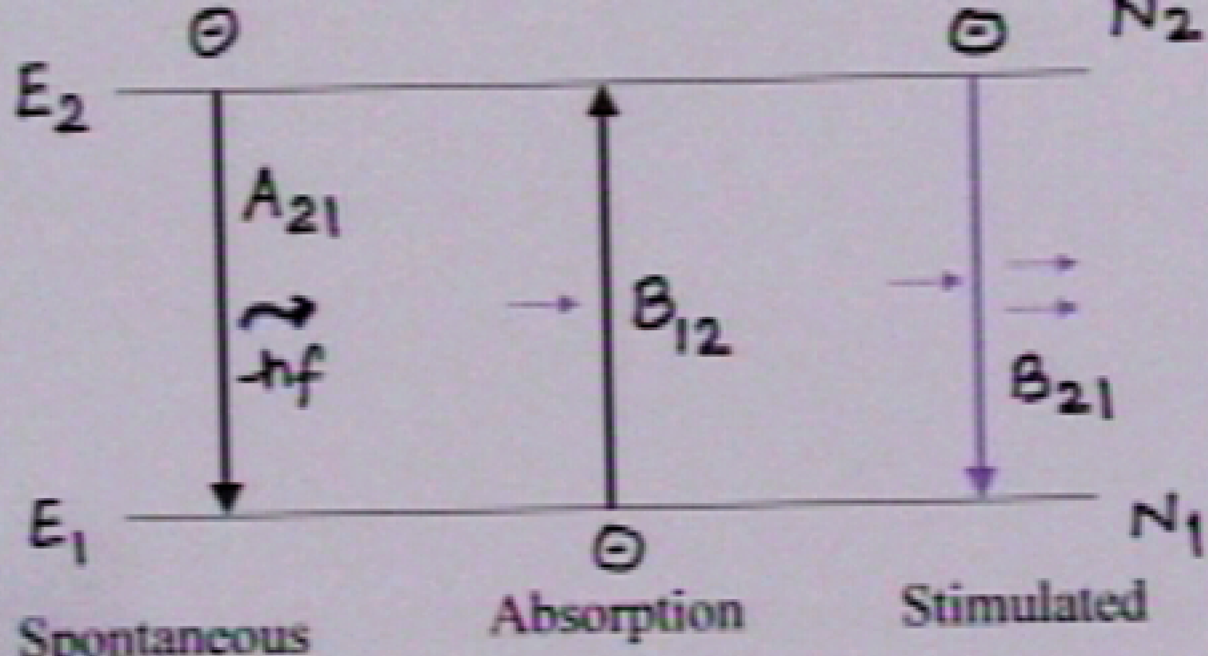
$$E_{ph}/KT \sim 100$$

$$\frac{N_2}{N_1} = e^{-E_{ph}/KT} \sim e^{-100}$$



$$E_2 - E_1 = E_{ph} = h\nu$$

Boltzmann Distibution $\frac{N_1}{N_2} = e^{h\nu/KT}$



E2
E1
N2
N1
A21
hf
B12
B21
Spontaneous
Absorption
Stimulated

Absorption

$$-\frac{dN_1}{dt} = B_{12}\,\rho(f)\,N_1$$

Stimulated process

$$-\frac{dN_2}{dt} = B_{21}\,\rho(f)\,N_2$$

$$A_{21}N_2 + B_{21}\,\rho(f)\,N_2 = B_{12}\,\rho(f)\,N_1$$

$$\rho(f) = \frac{A_{21} N_2}{B_{12} N_1 - B_{21} N_2}$$

$$= \frac{A_{21} / B_{21}}{\frac{B_{12}}{B_{21}} \frac{N_1}{N_2} - 1}$$