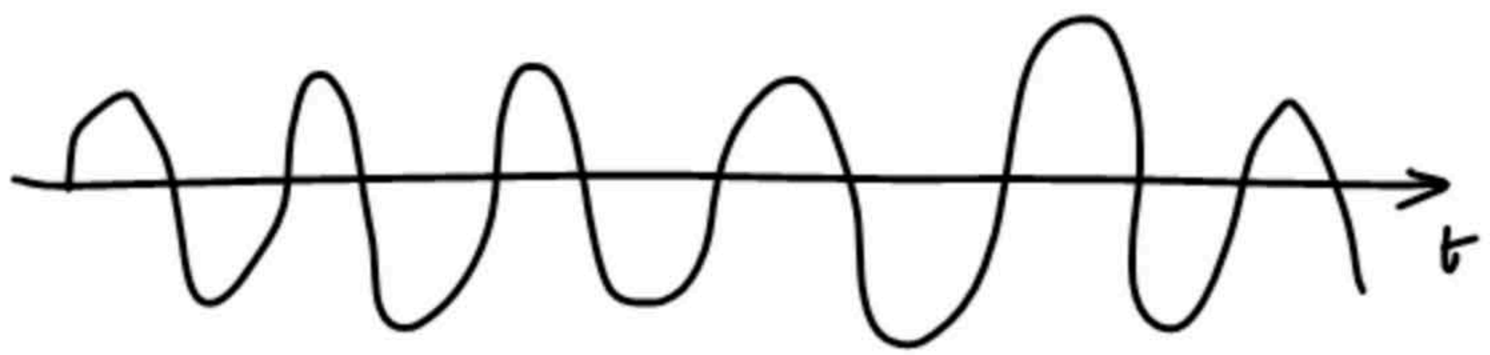
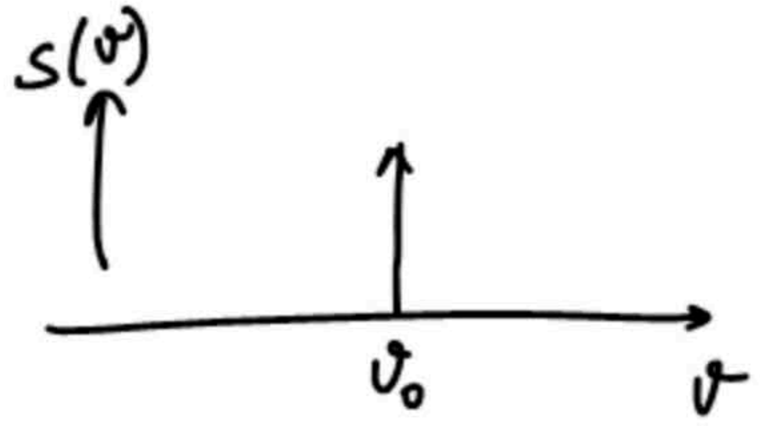
Monochromatic



$\Rightarrow$

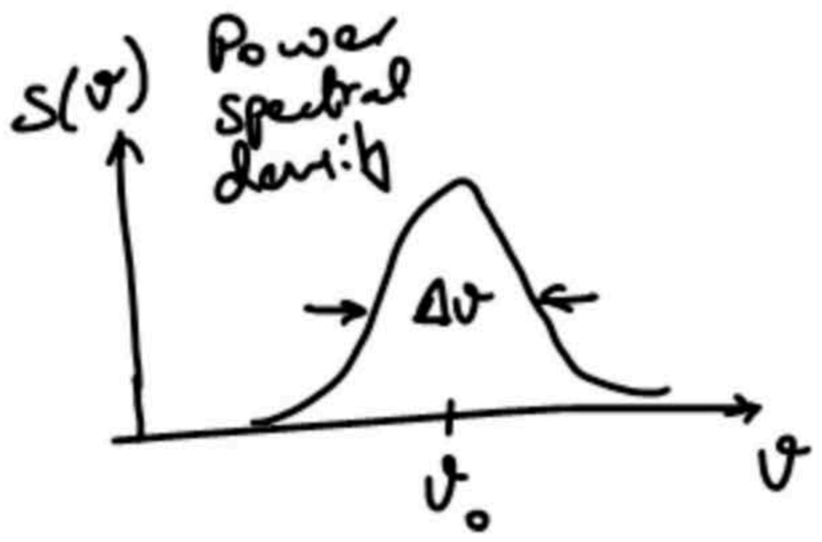


Weiner - Khinchin Theorem

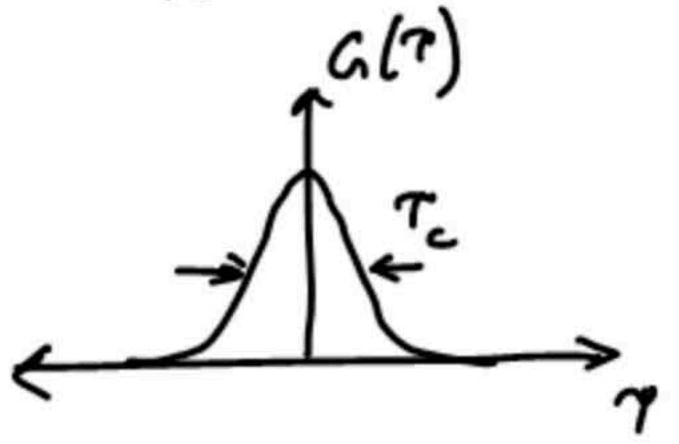
$$S(\nu) = \int_{-\infty}^{\infty} G(\tau) \exp(-j 2\pi \nu \tau)\, d\tau$$

Non-ideal (practical)

$\Rightarrow$



$\Rightarrow$

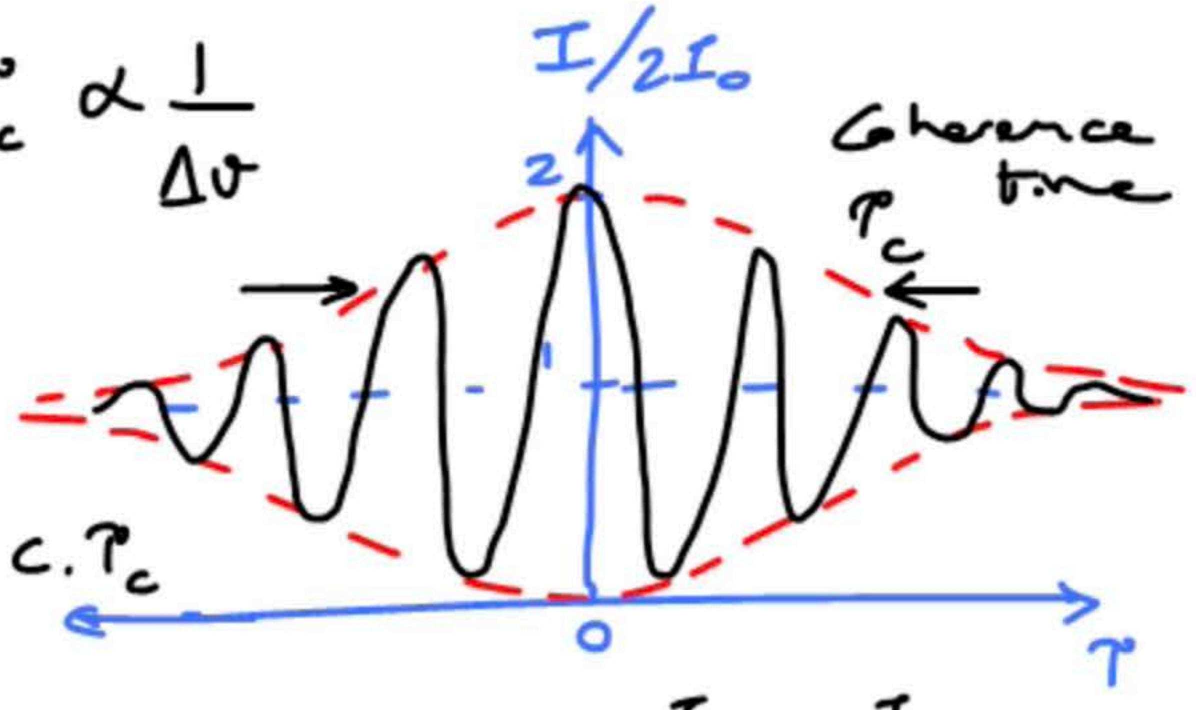


	$\Delta\nu$ (Hz)	τ_c	l_c
Sunlight (0.4 - 0.7 μm)	3.75×10^{14}	2.67 fs	800 nm
Semiconductor LED (λ_0 = 1μm, $\Delta\lambda$ = 50 nm)	1.5×10^{13}	67 fs	20 μm
Laser Diode (λ_0 = 1μm, $\Delta\lambda$ = 1 nm)	3×10^{11}	3.3 ps	1 mm
He - Ne laser (λ_0 = 0.633 μm)	1×10^{6}	1 μs	300 m

20 μm $\rightarrow$ OCT

300 m: LIGO 6 km long

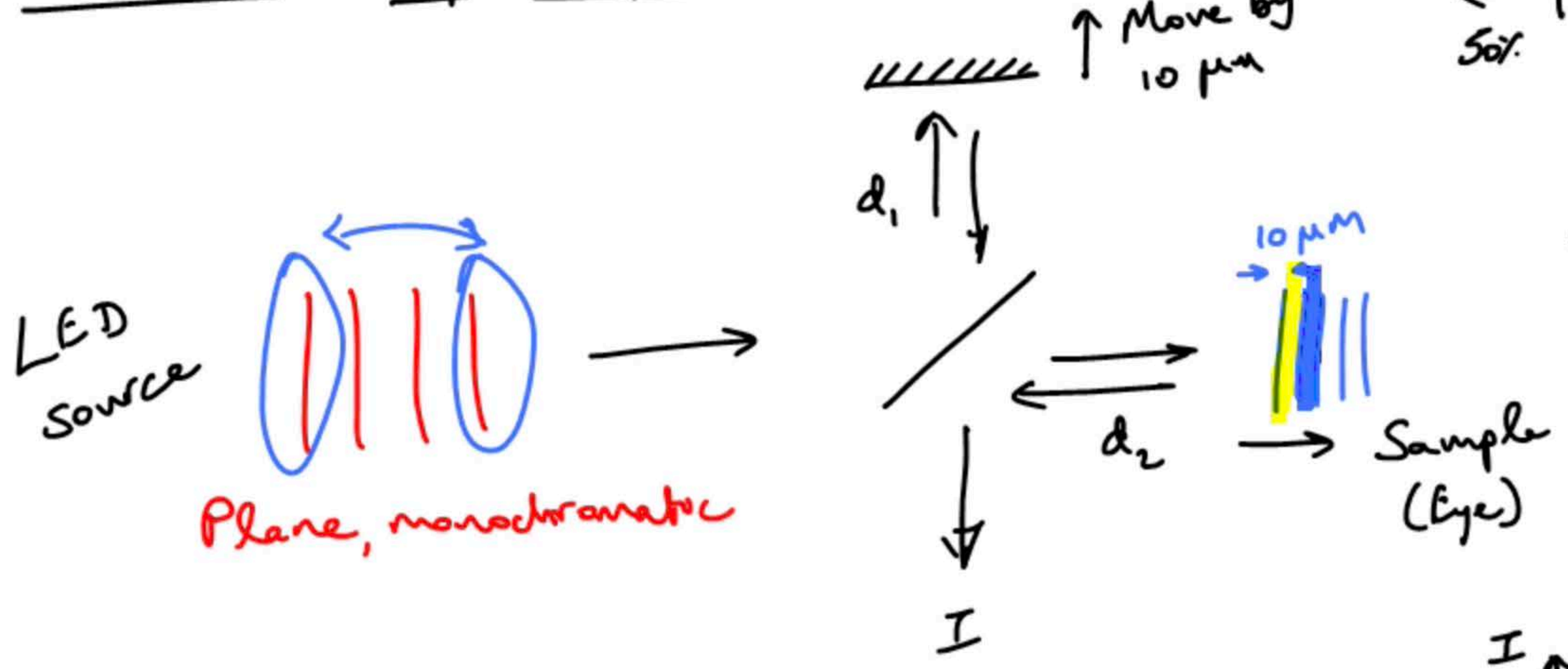
Coherence time $\tau_c \propto \dfrac{1}{\Delta\nu}$

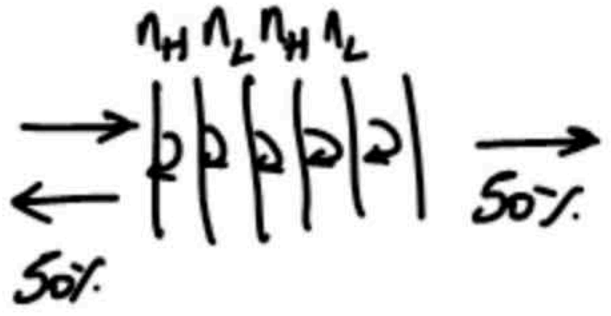


Longitudinal coherence length $l_c = c . \tau_c$

$$\text{Visibility} = \frac{I_{max} - I_{min}}{I_{max} + I_{min}}$$

Coherence of light:





$$\Delta\phi = \frac{\cancel{2\pi}}{\lambda} 2(d_2 - d_1) = \cancel{2\pi} m$$

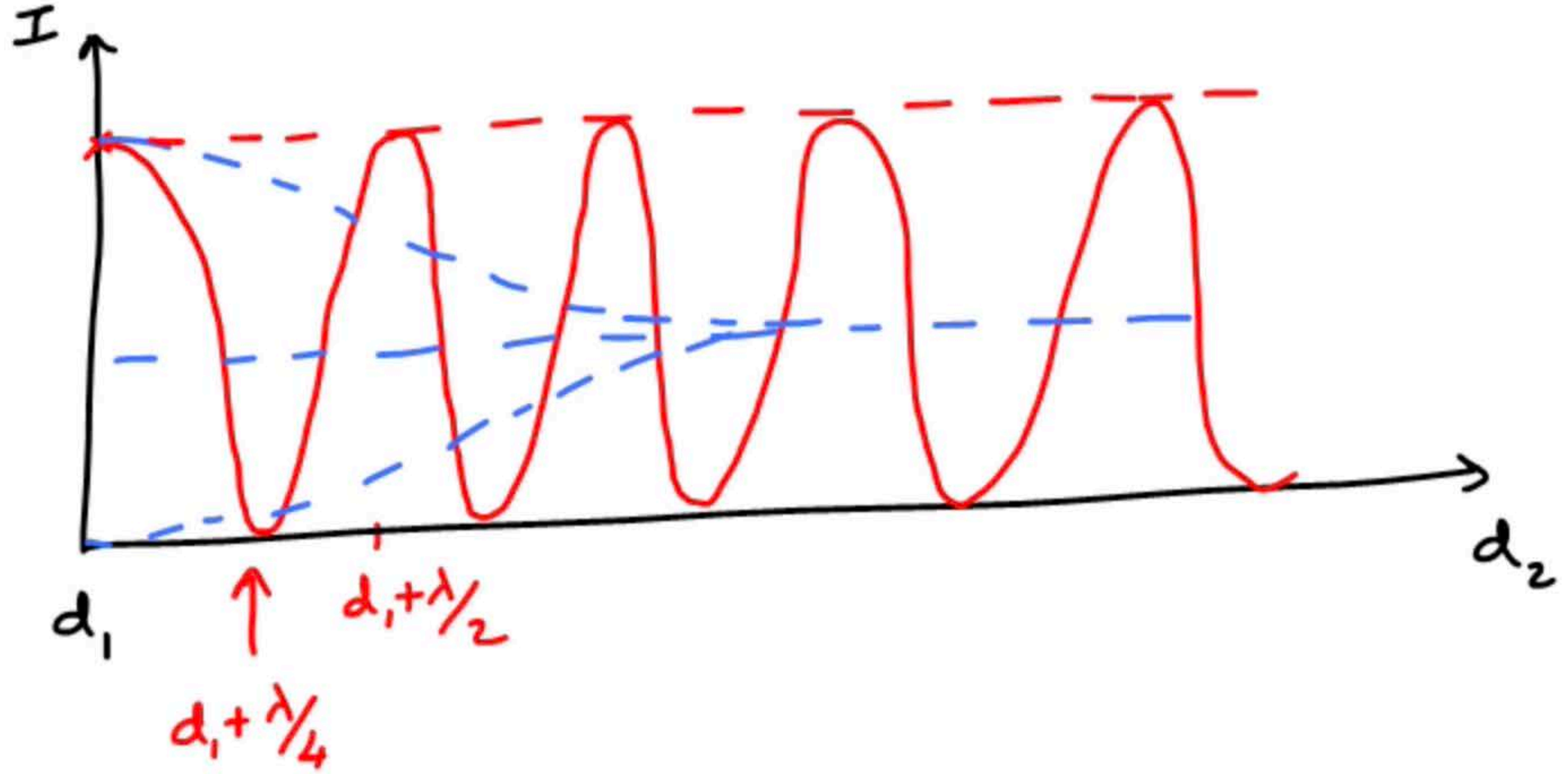
$$d_2 - d_1 = \frac{m\lambda}{2}$$

$$\langle U_1^*(t) \; U_2(t) \rangle$$

Auto correlation $G(\tau)$ $\langle U_1^*(t) \; U_1(t+\tau) \rangle$

$$U_0 e^{-j\omega_0 t} \; U_0 e^{j\omega_0 (t+\tau)}$$

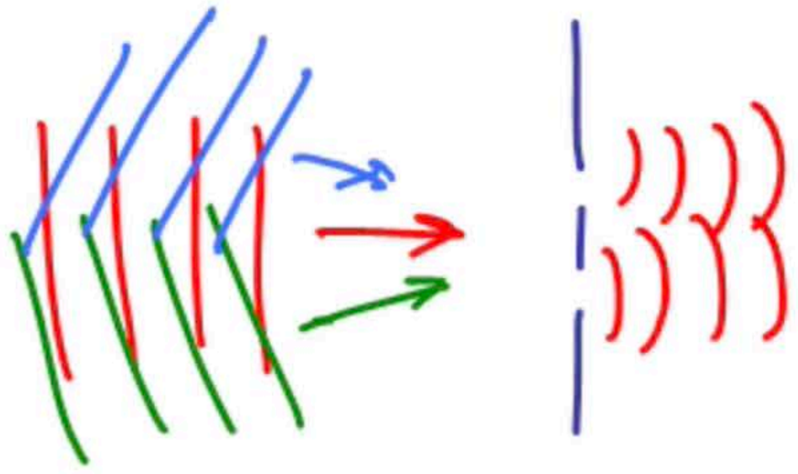
$$= U_0^2 e^{j\omega\tau}$$

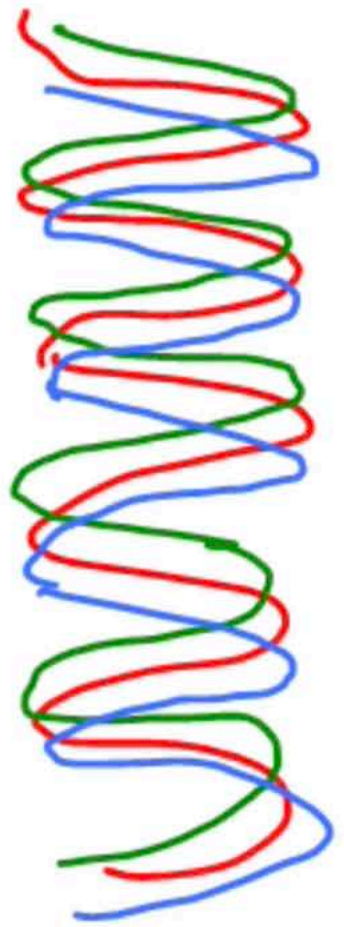


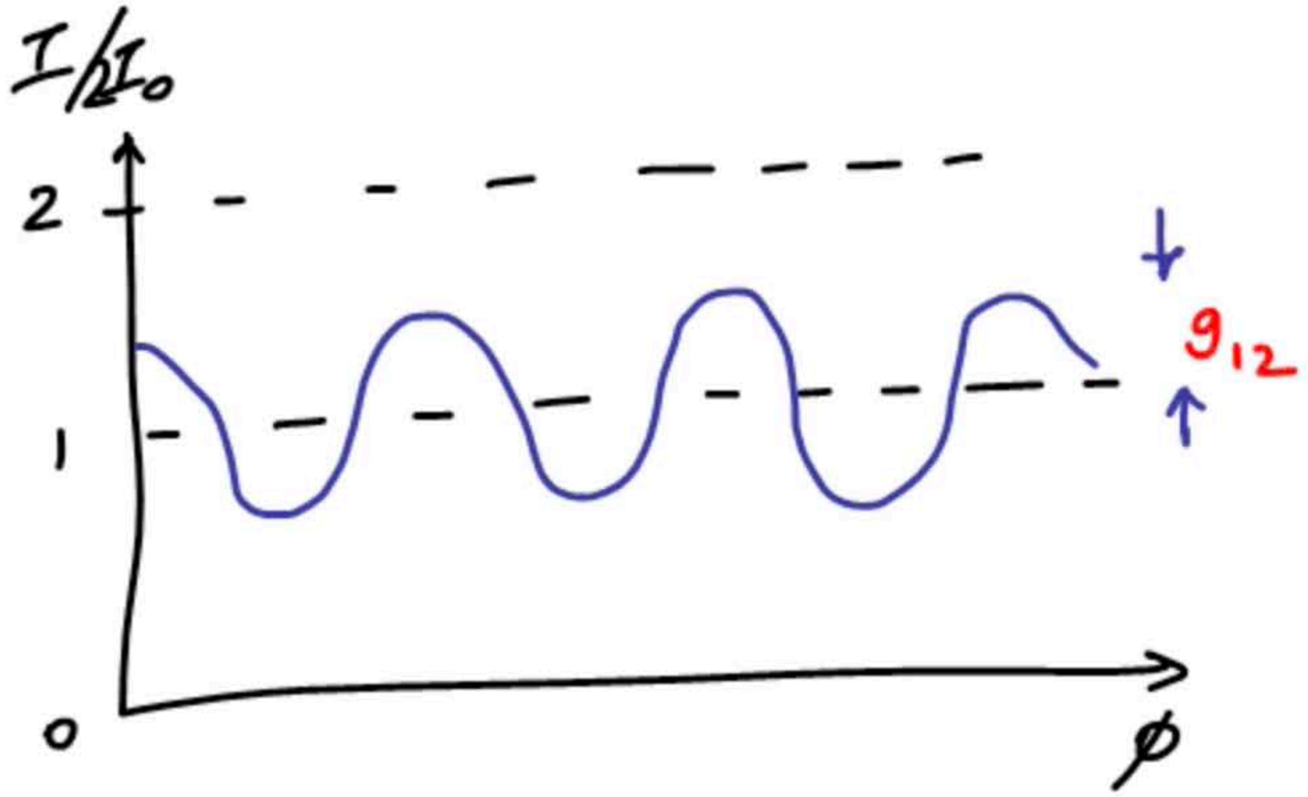
Degree of coherence $g(\tau) = \dfrac{G(\tau)}{\langle U^*(t) U(t) \rangle}$

$$0 \le |g(\tau)| \le 1$$

Spatial Coherence

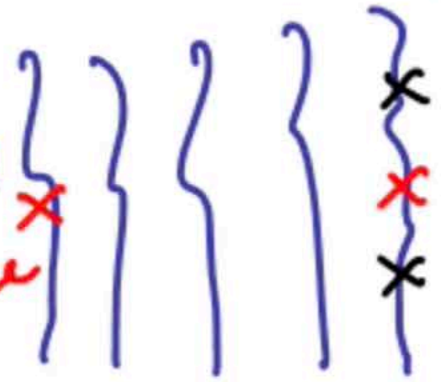






Spatial coherence function $= \langle U^*(r_1)\, U(r_2) \rangle$

$$\boxed{\rho_c = \frac{\lambda}{\theta_s}} \rightarrow \text{Angles subtended by source}$$



Temporal coherence

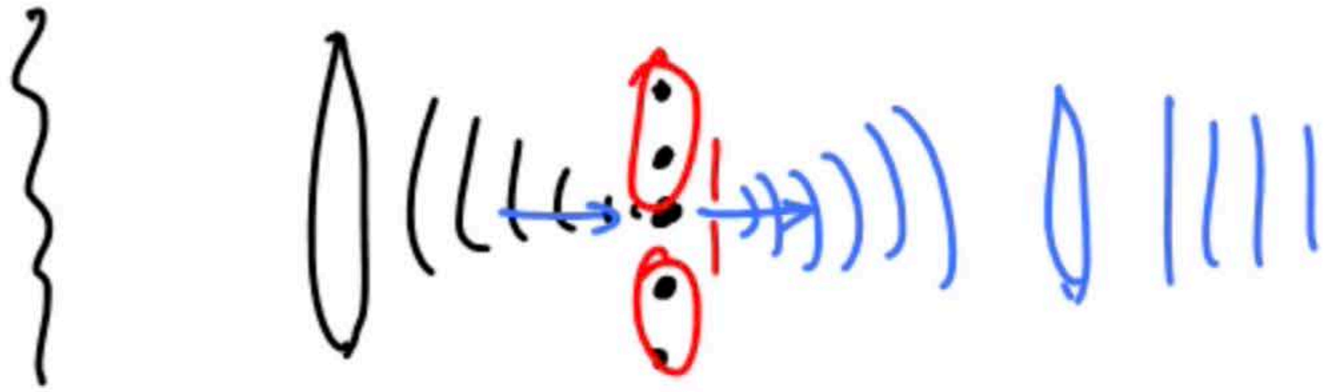
$\tau_c \propto \frac{1}{\Delta\nu}$

$$I = \langle |U_1 + U_2|^2 \rangle = \langle |U_1|^2 \rangle + \langle |U_2|^2 \rangle + \langle U_1^* U_2 \rangle + \langle U_1 U_2^* \rangle$$

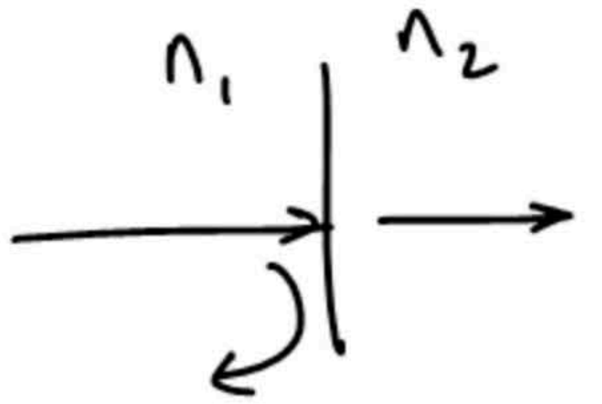
$$= I_1 + I_2 + G_{12} + G_{12}^*$$

$$= I_1 + I_2 + 2\,\mathrm{Re}\{G_{12}\} = I_1 + I_2 + 2\sqrt{I_1 I_2}\,\mathrm{Re}\{g_{12}\}$$

$$= I_1 + I_2 + 2\sqrt{I_1 I_2}\,|g_{12}| \cos \Delta\phi$$



Example 1: Interference in thin films (multiple layers)



$$n = \sqrt{\frac{\mu}{\epsilon}}$$

$$\sqrt{\epsilon_r} = n$$

$$r = \frac{n_1 - n_2}{n_1 + n_2}$$

If $n_2 > n_1$, r is negative

π phase shift