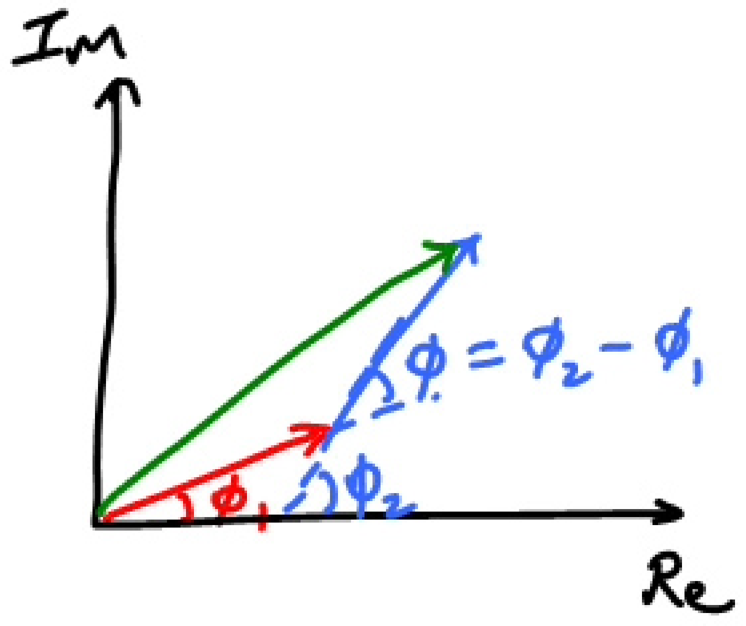
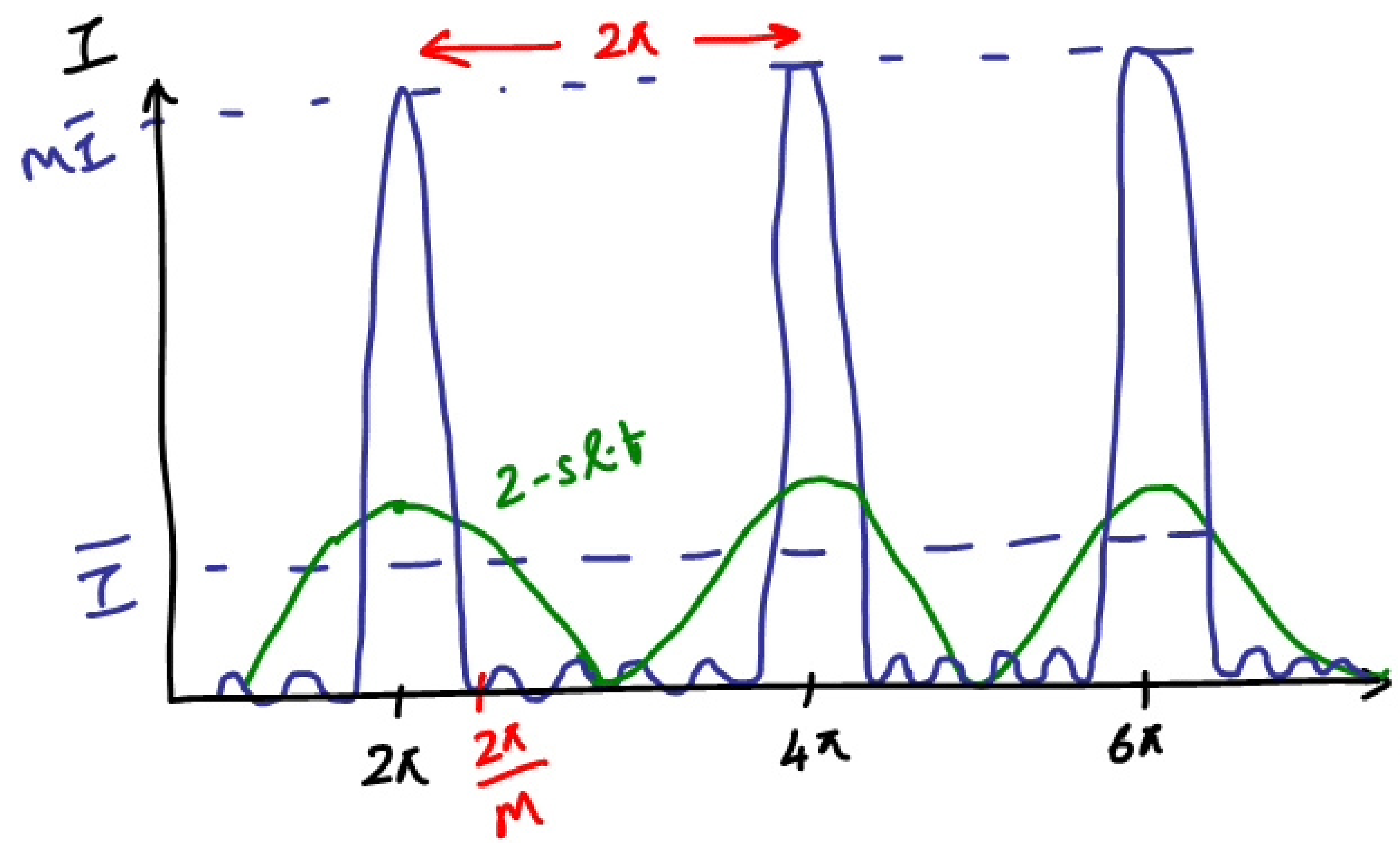
Total Wave amplitude $U = \sqrt{I_0}\,(1 + h + h^2 + \dots + h^{M-1})$ where $h = e^{j\phi}$

$$= \sqrt{I_0}\cdot\frac{1-h^M}{1-h} = \sqrt{I_0}\cdot\frac{1-e^{jM\phi}}{1-e^{j\phi}}$$

Total Intensity $I = |U|^2 = I_0 \cdot \left|\frac{1-e^{jM\phi}}{1-e^{j\phi}}\right|^2 = I_0\left|\frac{e^{-jM\phi/2} - e^{jM\phi/2}}{e^{-j\phi/2} - e^{j\phi/2}}\right|^2$



$$\boxed{I = I_0 \cdot \frac{\sin^2(M\phi/2)}{\sin^2(\phi/2)}}$$



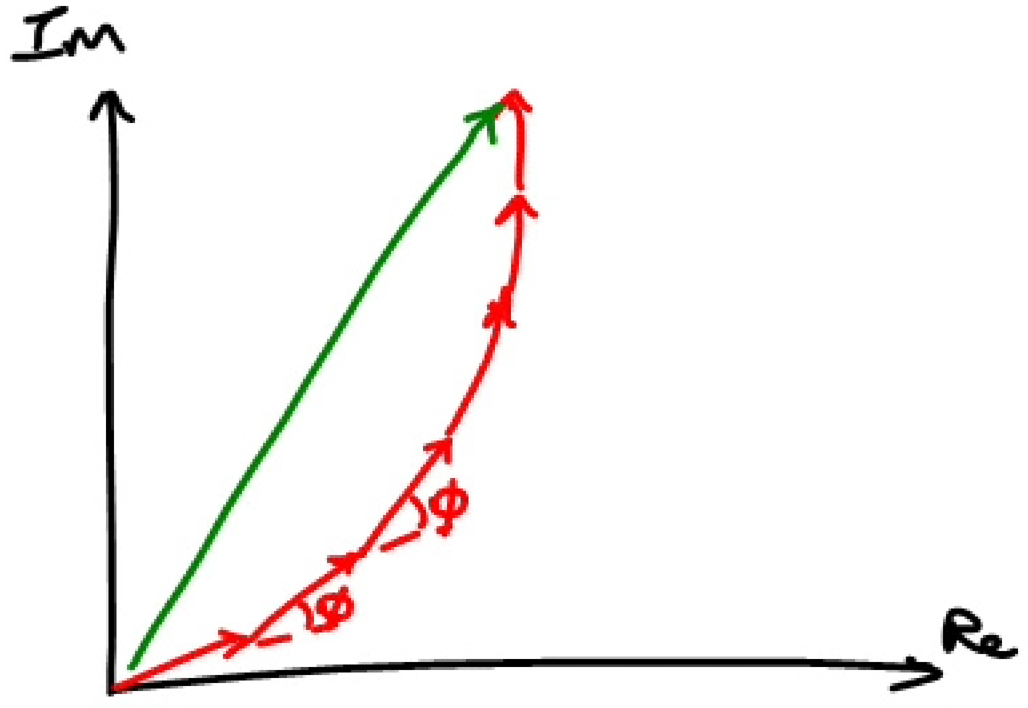
$\phi = \frac{2\pi}{\lambda} d \sin\theta_m$

$\frac{M\phi_{min}}{2} = \pi$

$\phi_{min} = \frac{2\pi}{M}$

More # of interfering sources

$\Rightarrow$ Narrower spectral selectivity



Interferometers

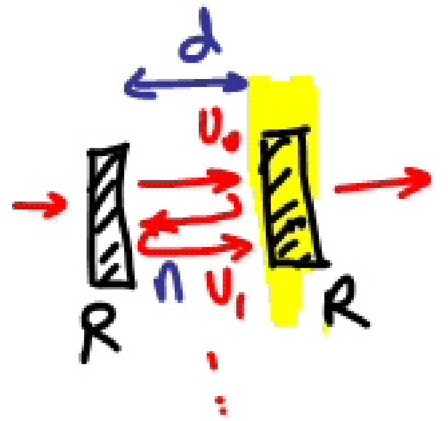
Common Path

Sagnac

Gyroscope

$\phi_{cw} - \phi_{ccw}$

Fabry-Perot



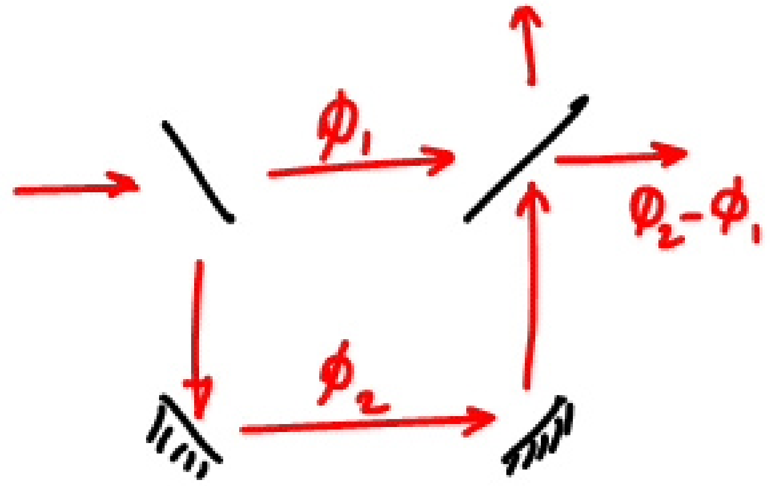
$$\Delta\phi = \frac{2\pi}{\lambda} n . 2d$$

$$= 2\pi m$$

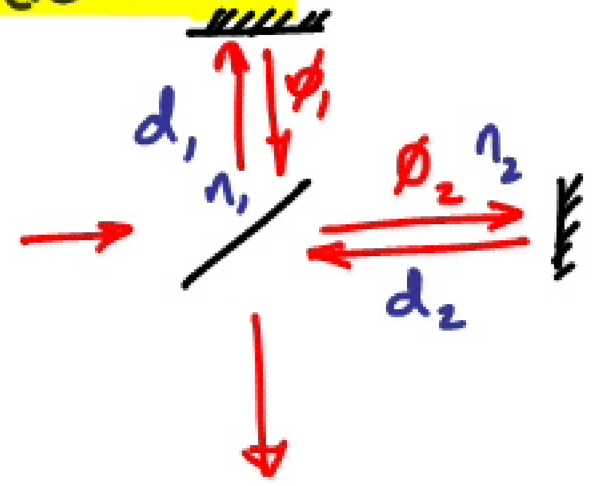
$n=1$, $\boxed{d = m.\frac{\lambda}{2}}$

Differential Path

Mach-Zehnder



Michelson



$$\phi_2 - \phi_1 = \frac{2\pi}{\lambda} 2 n_2 d_2 - \frac{2\pi}{\lambda} 2 n_1 d_1$$

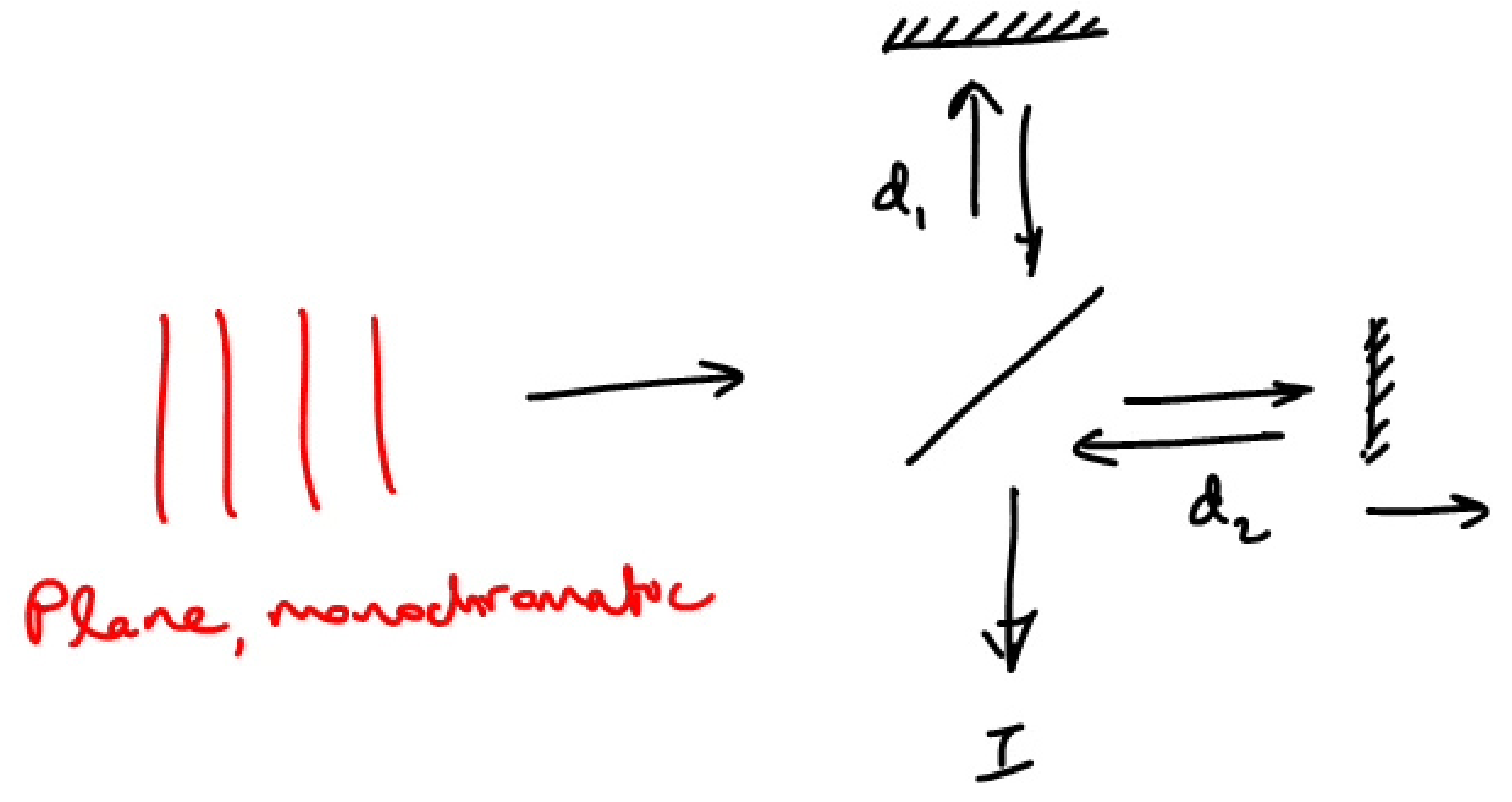
$$= \frac{2\pi}{\lambda} 2 (n_2 d_2 - n_1 d_1)$$

Optical path length difference

Constructive Interference, $\phi_2 - \phi_1 = 2\pi m$

If $n_1 = n_2 = 1$, $\boxed{d_1 - d_2 = \frac{m\lambda}{2}}$

Coherence of light:



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

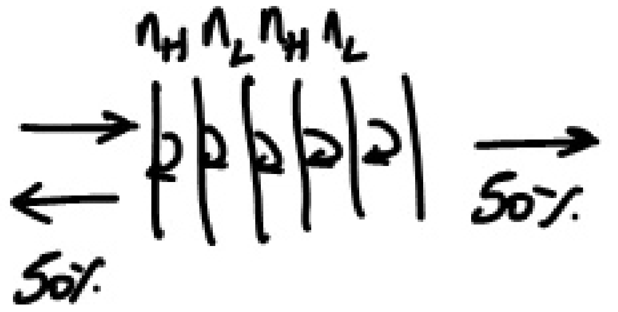
Auto correlation $G(\tau)$ $\langle U_1^*(t)\ U_1(t+\tau)\rangle$

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

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

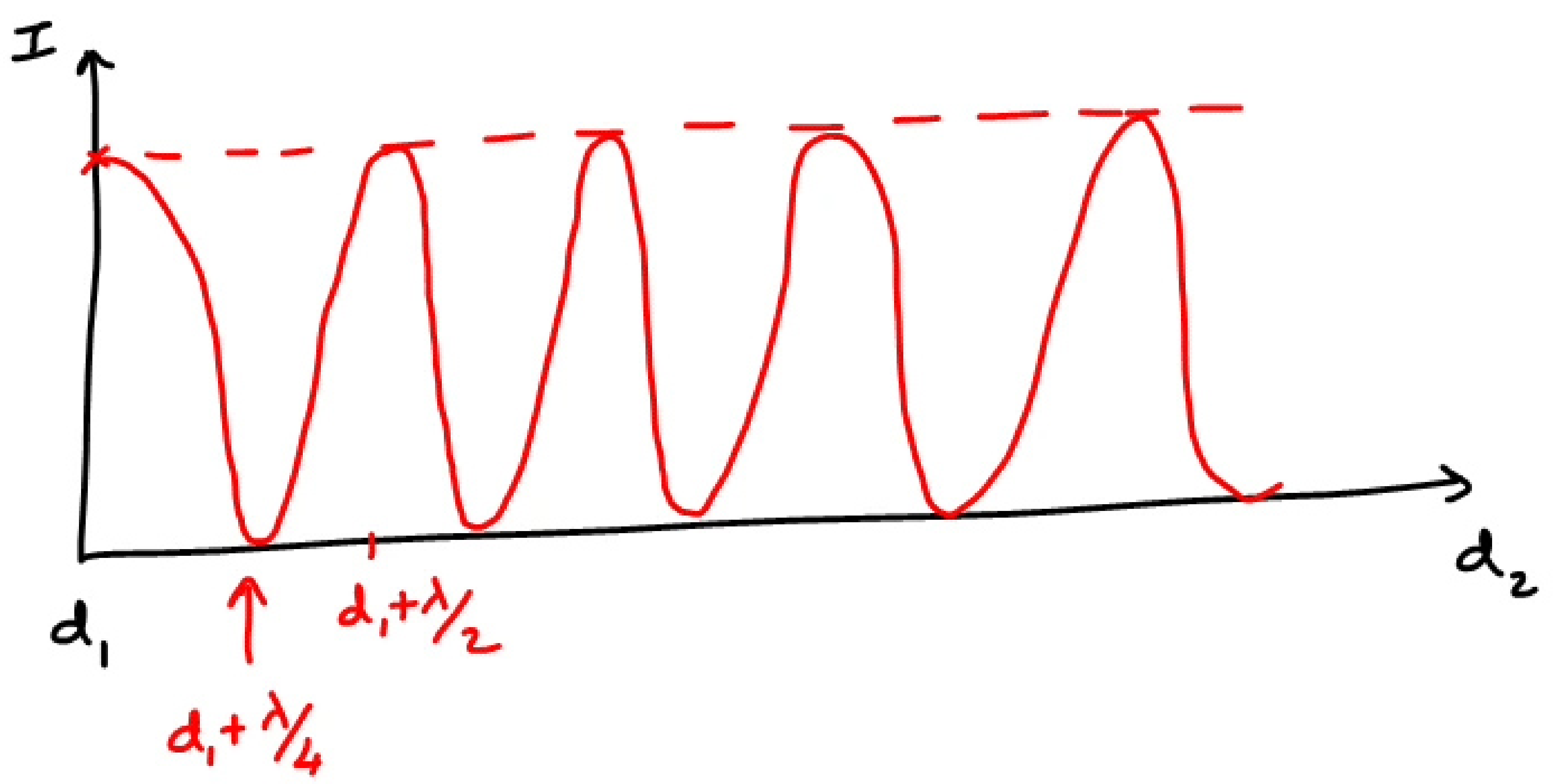
Degree of coherence $g(\tau) = \dfrac{G(\tau)}{\langle U^*(t) U(t)\rangle}$

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

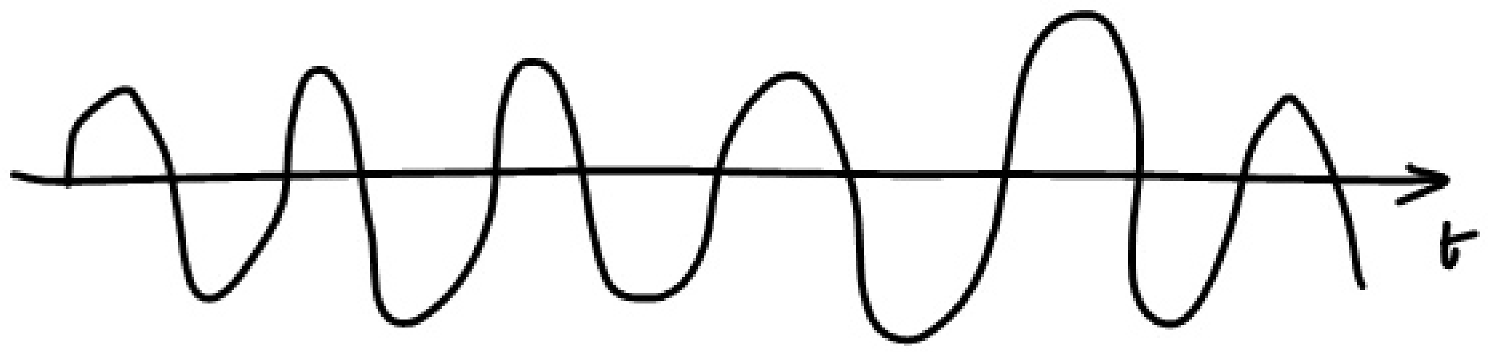


$$\Delta\phi = \frac{\cancel{2\pi}}{\lambda} 2(d_2 - d_1) = \cancel{2\pi} m$$

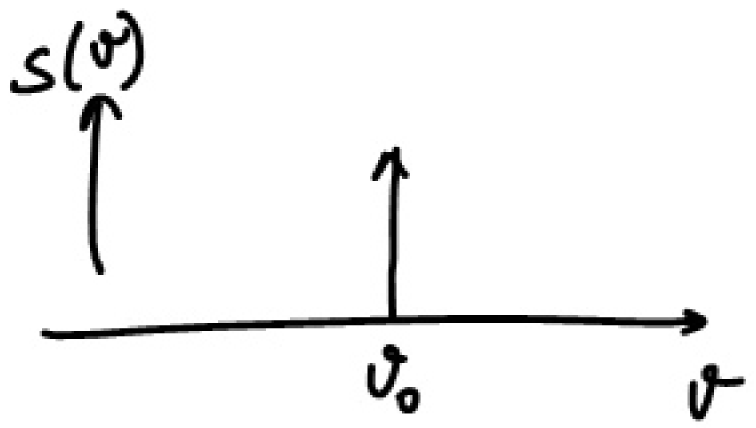
$$d_2 - d_1 = \frac{m\lambda}{2}$$



Monochromatic



⇒

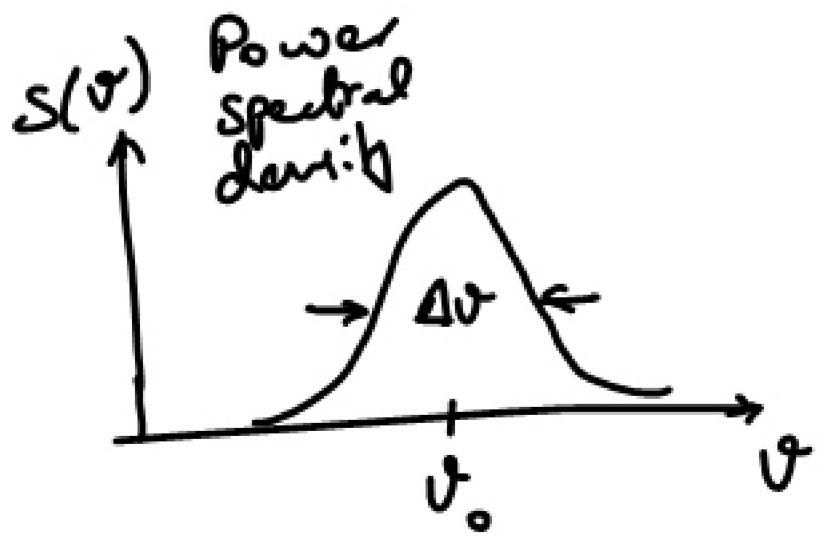


Weiner – Khinchin Theorem

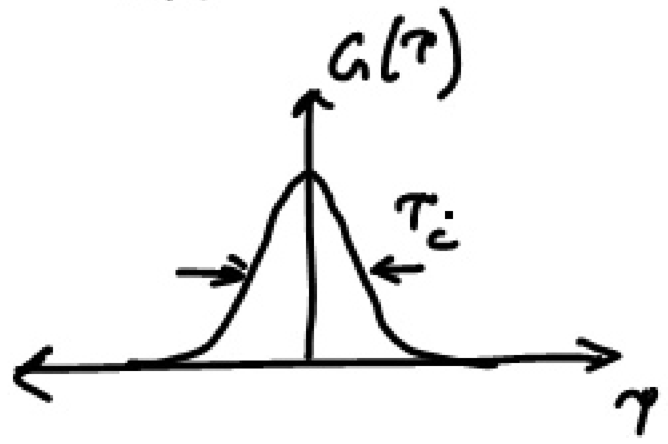
$$S(\nu) = \int_{-\infty}^{\infty} G(\tau)\,\exp(-j2\pi\nu\tau)\,d\tau$$

Non-ideal (practical)

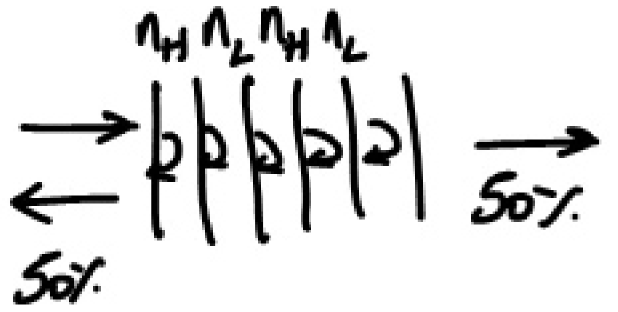
⇒

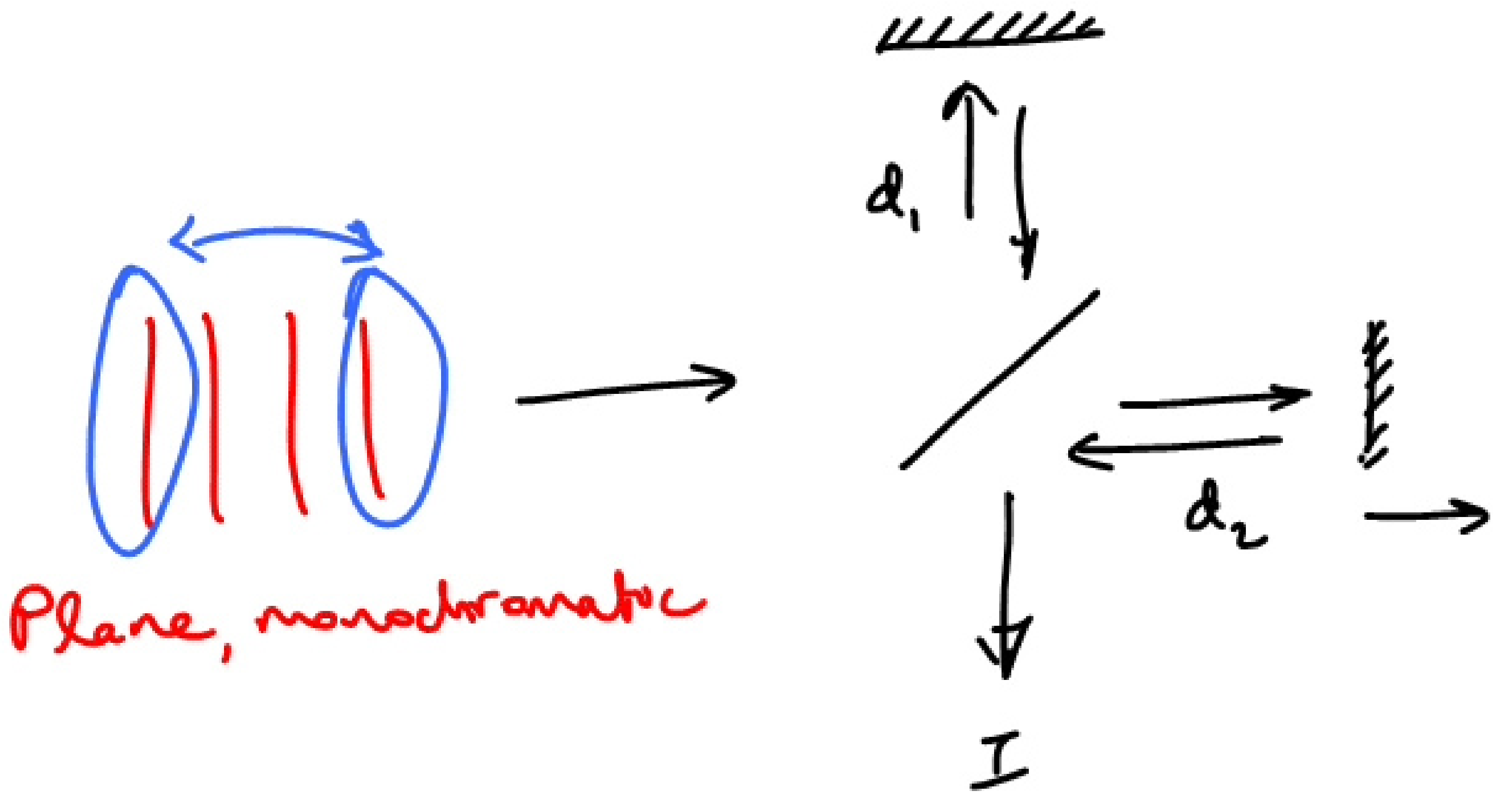


⇒



Coherence of light:





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

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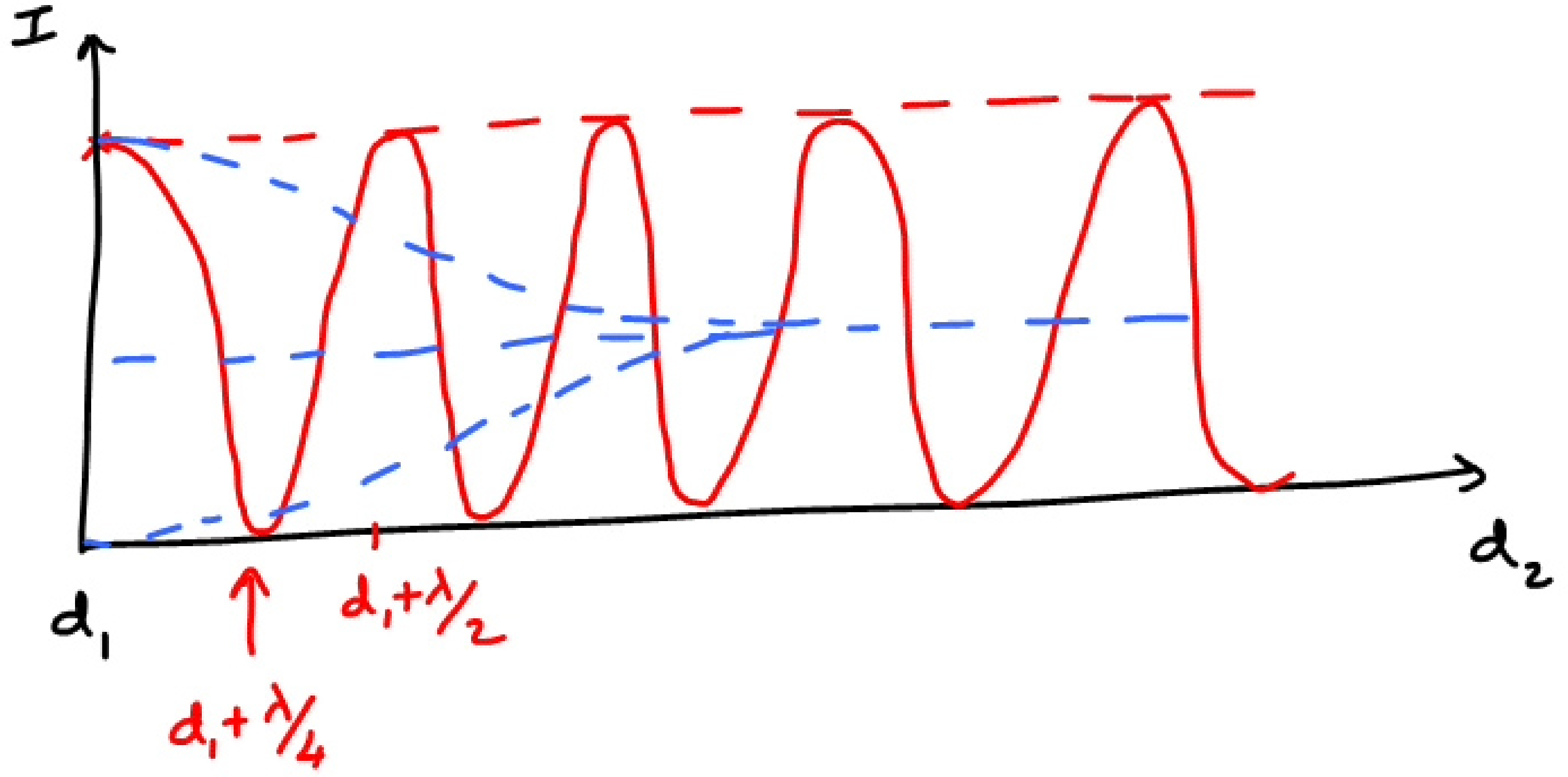
$$= U_0^2\, e^{j\omega\tau}$$



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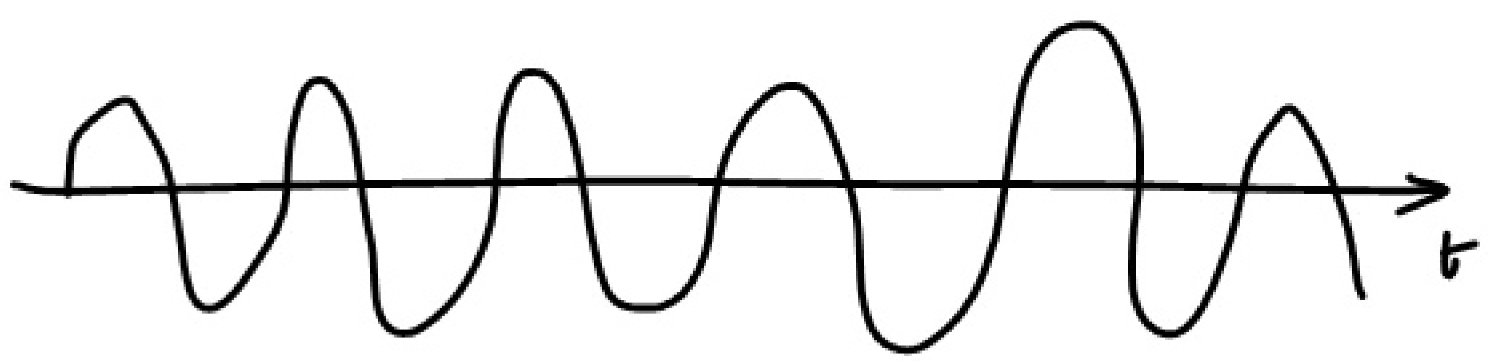
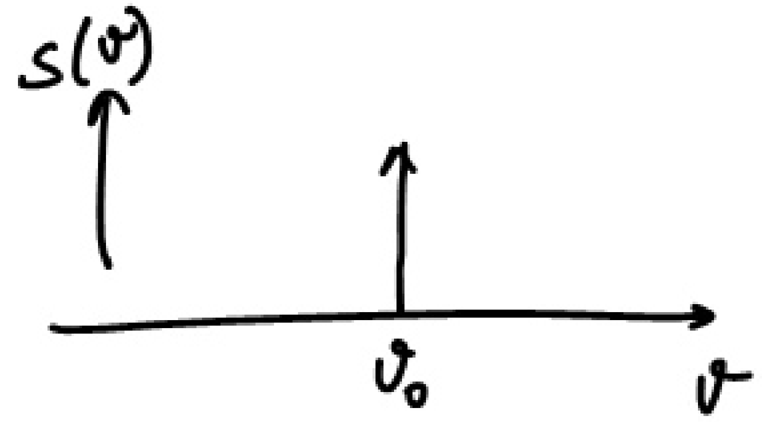
Monochromatic



$\Rightarrow$



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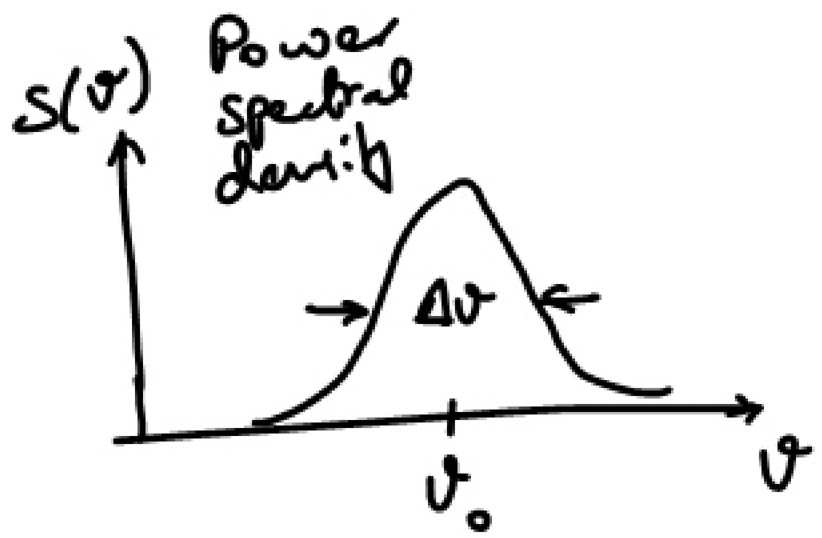
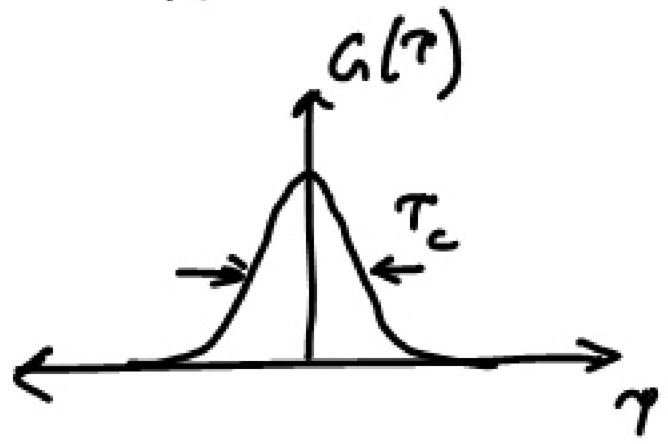
Non-ideal (practical)

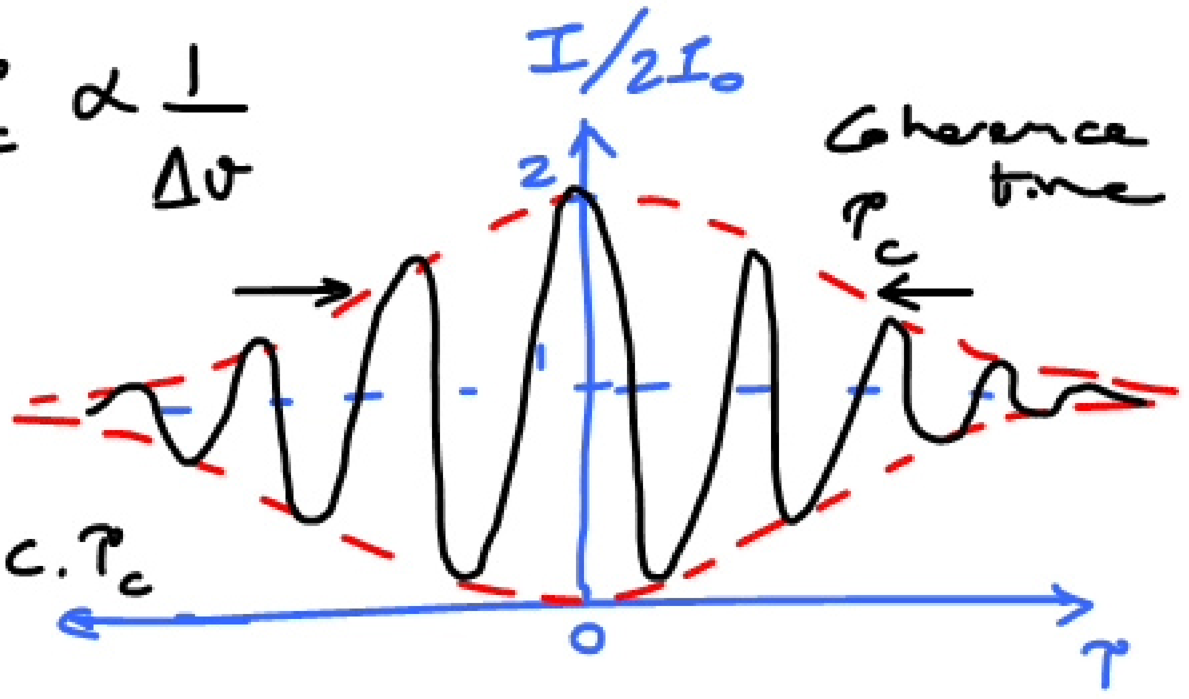
$\Rightarrow$



$\Rightarrow$



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



Longitudinal coherence length $l_c = c.\tau_c$