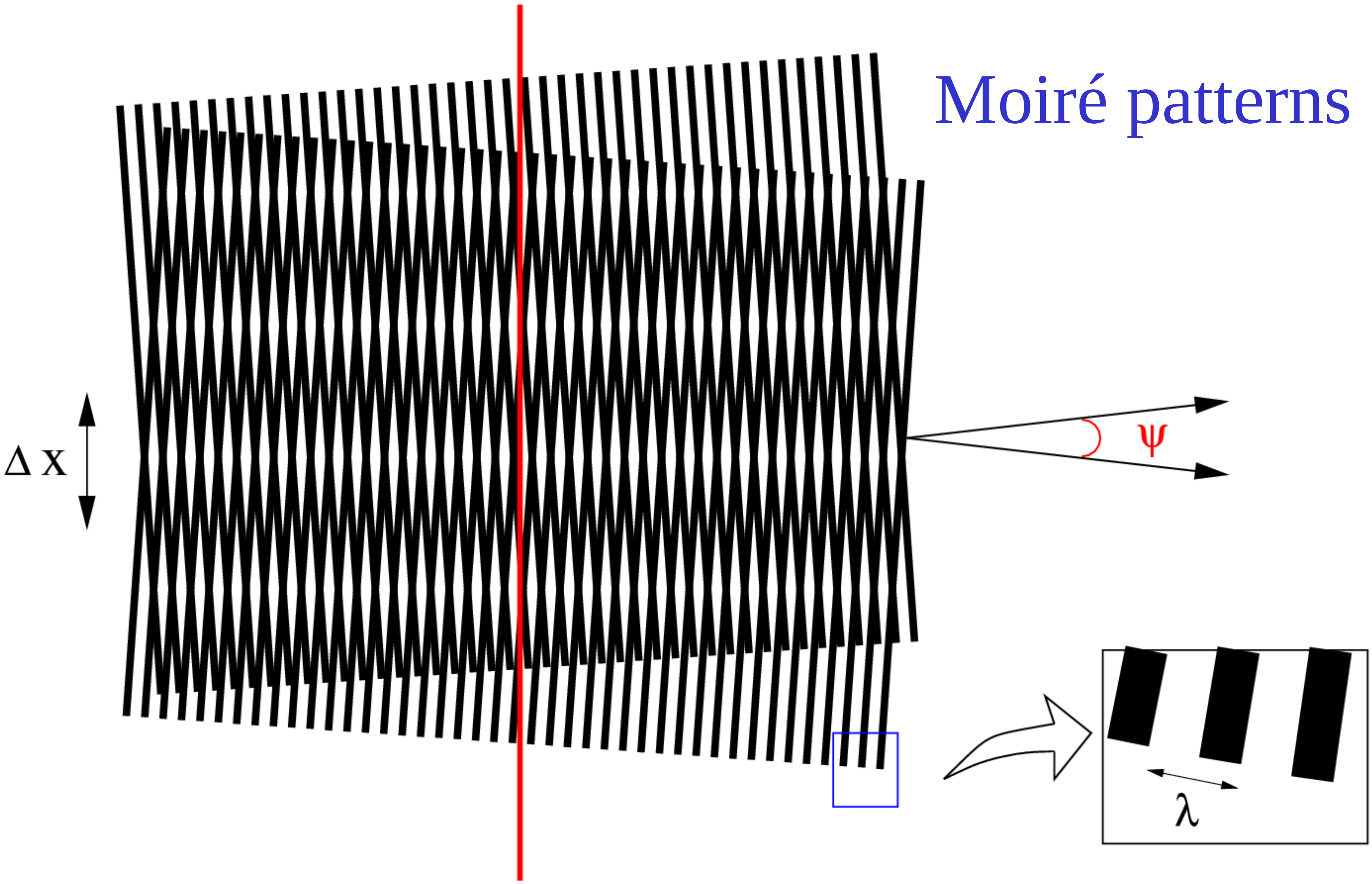
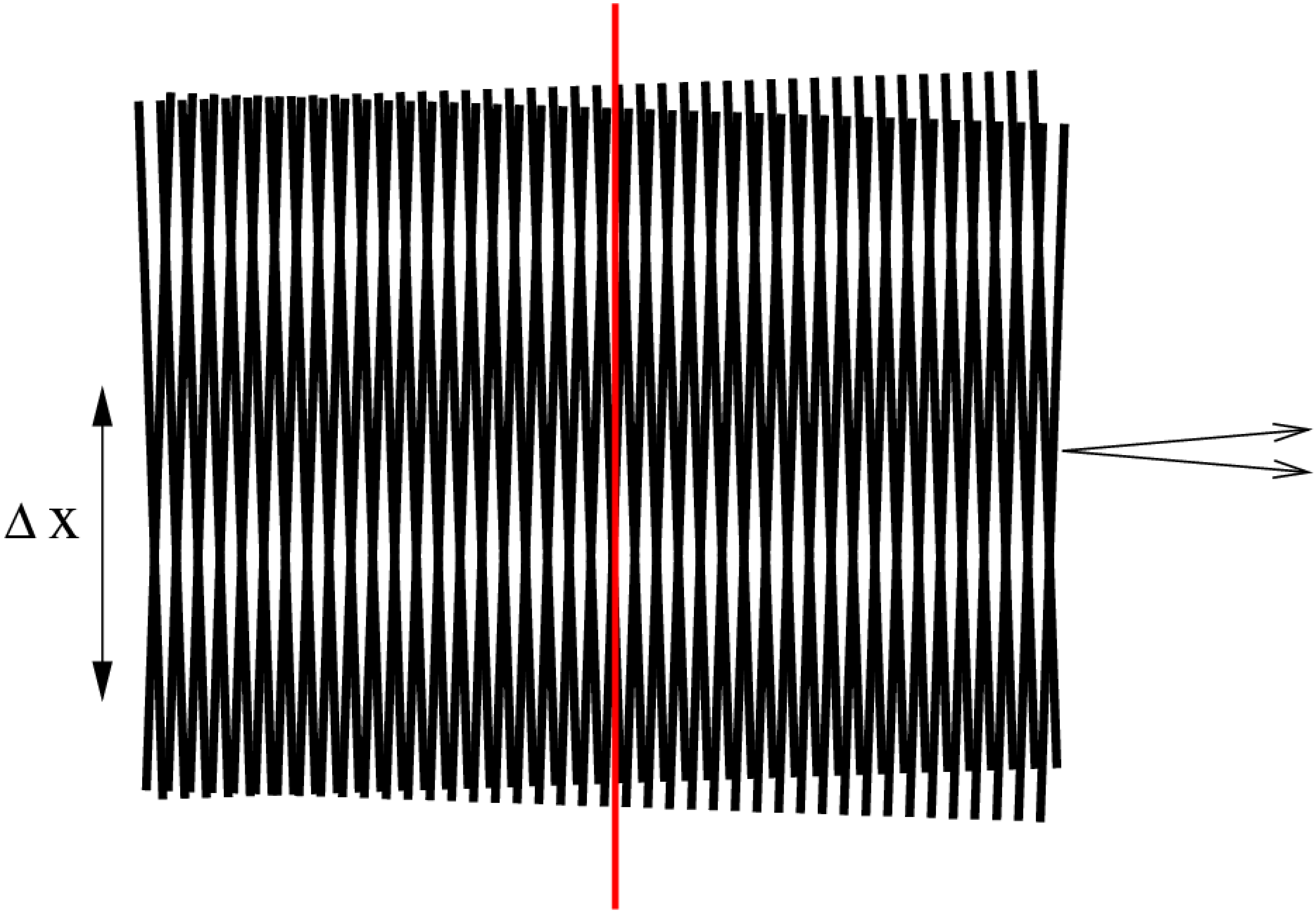
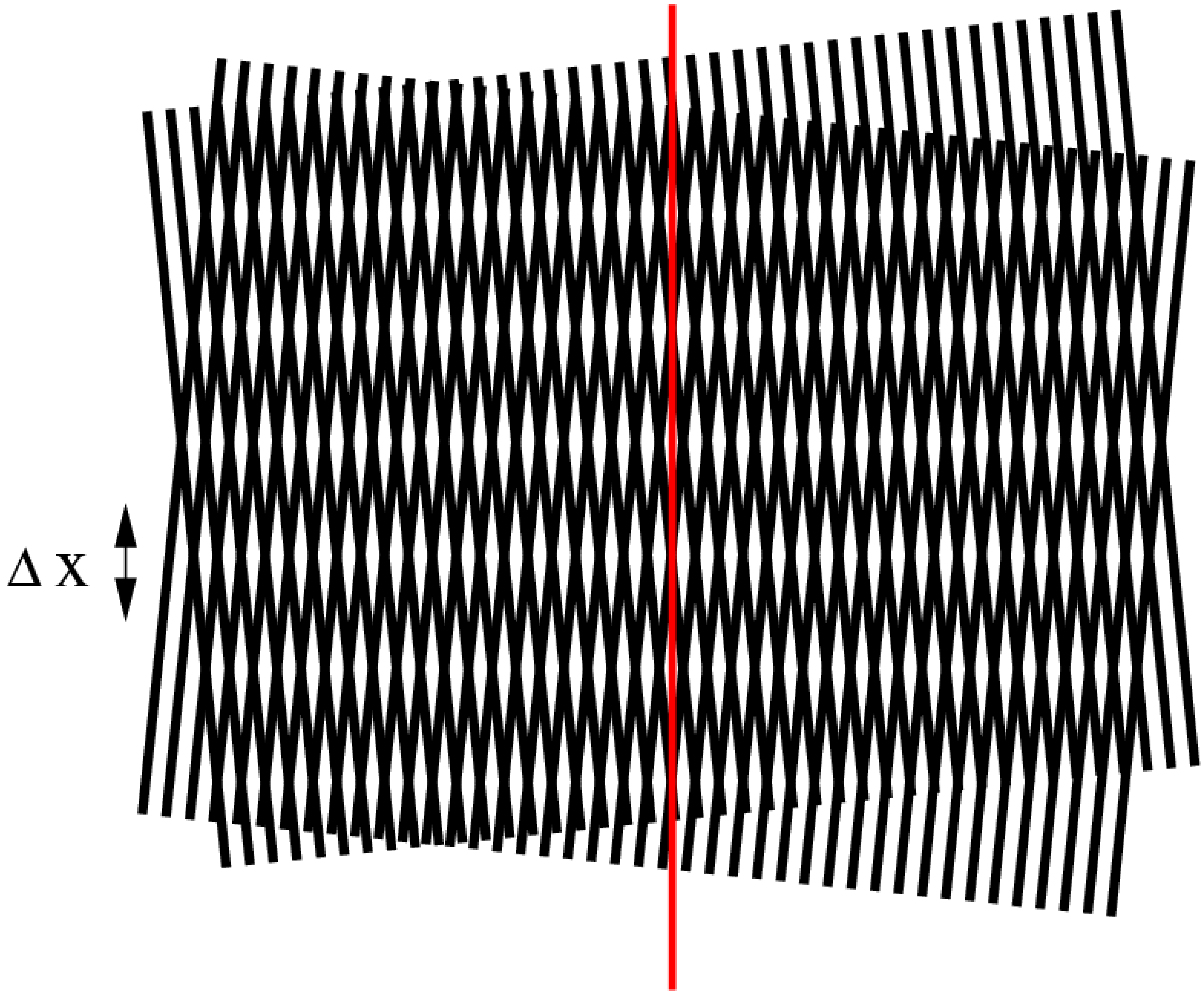
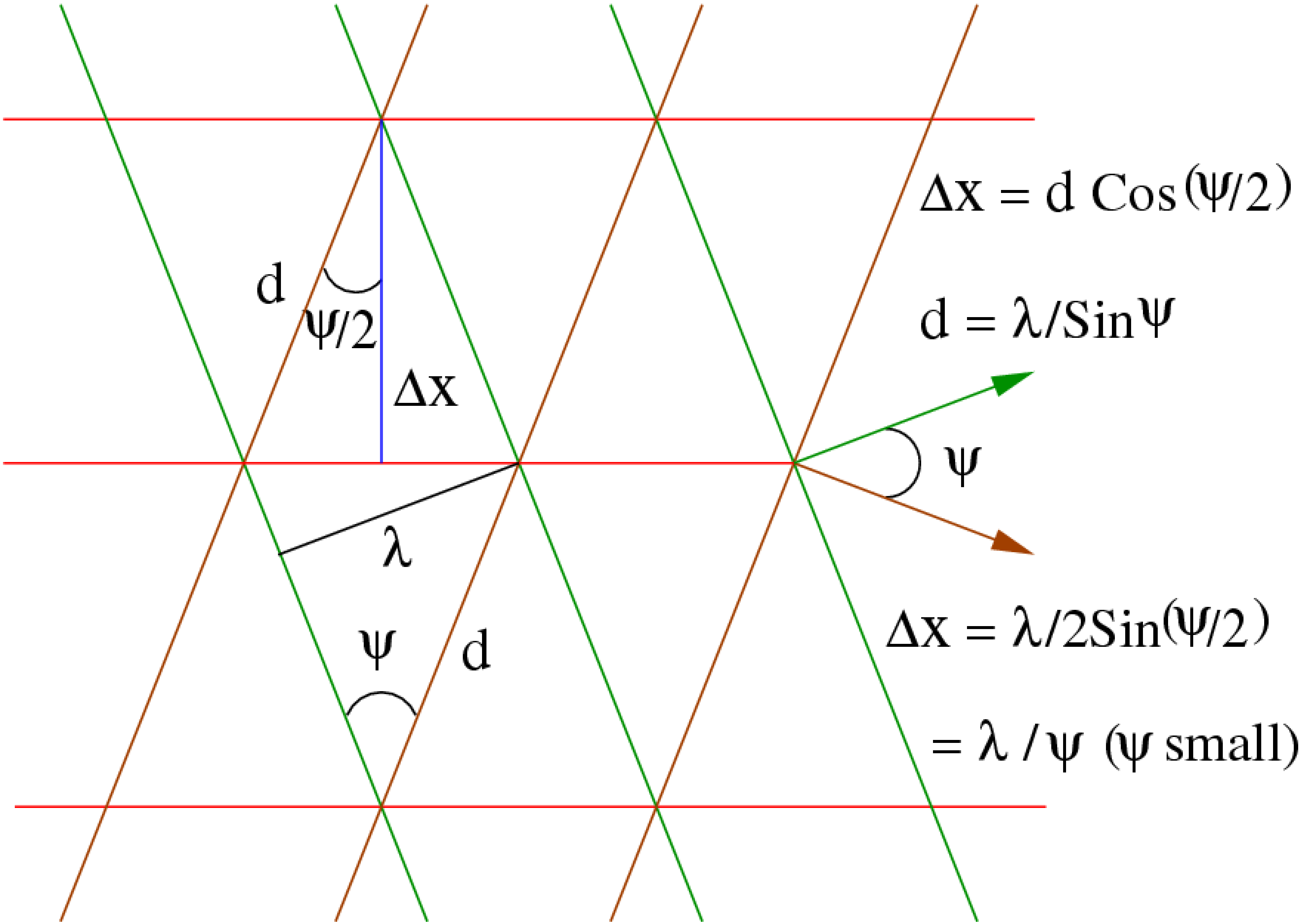
Interference with Plane waves and fringe-width

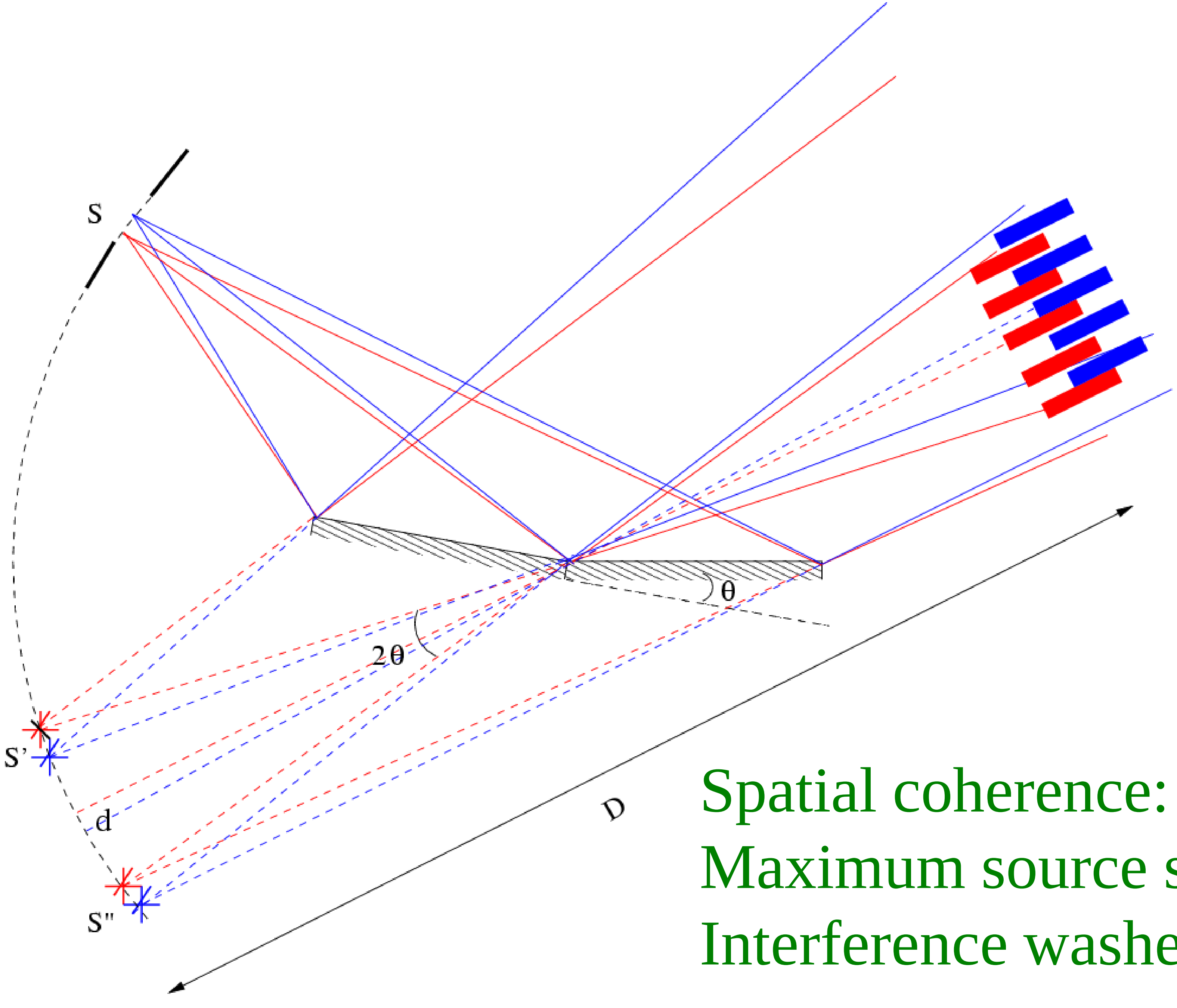



Δ x


Δ x



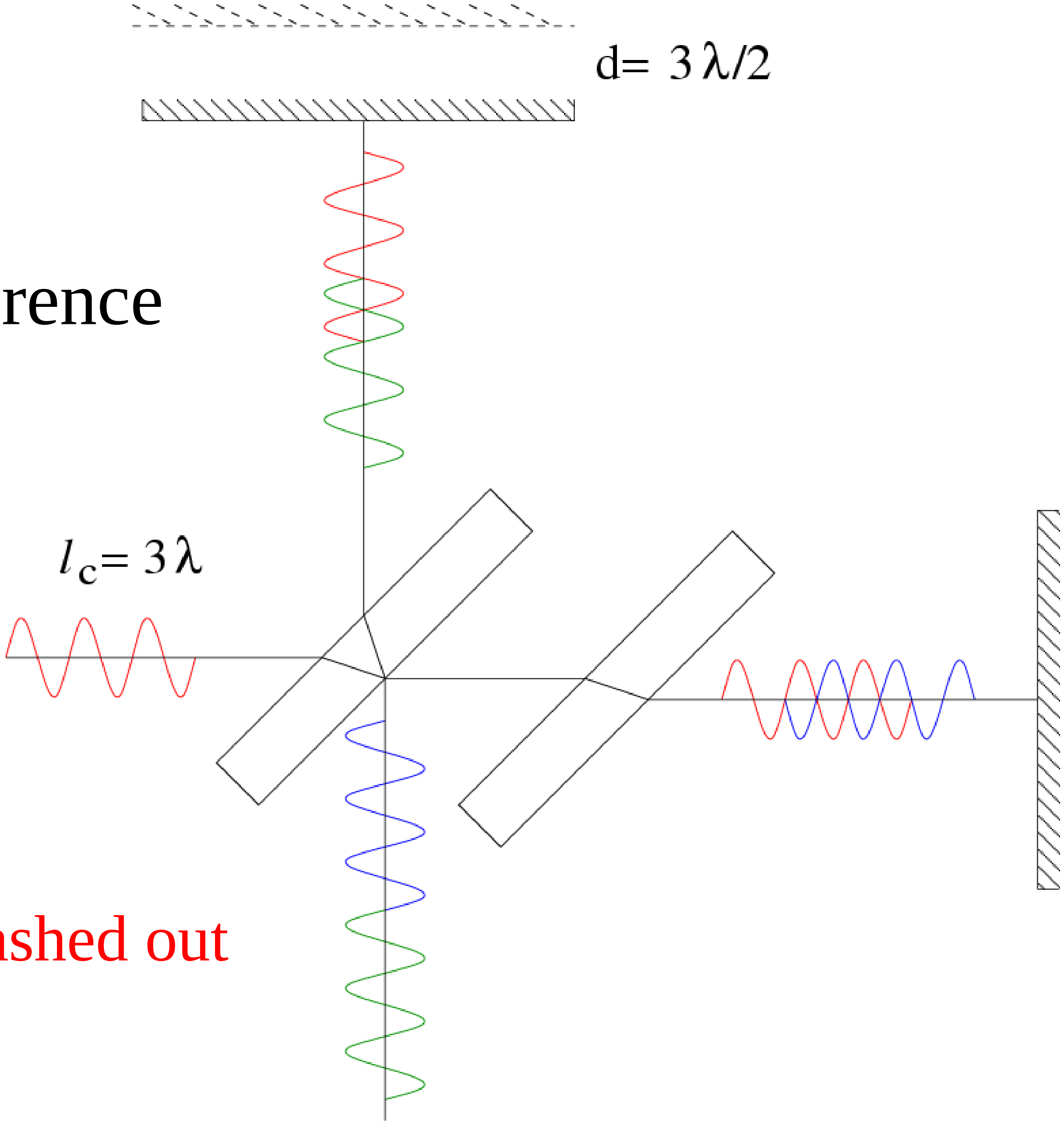
Δx = d Cos(ψ/2)
d = λ/Sinψ
Δx = λ/2Sin(ψ/2)
= λ / ψ (ψ small)
d
ψ/2
Δx
λ
ψ
d
ψ



Spatial coherence:
Maximum source size
Interference washed out

Temporal coherence

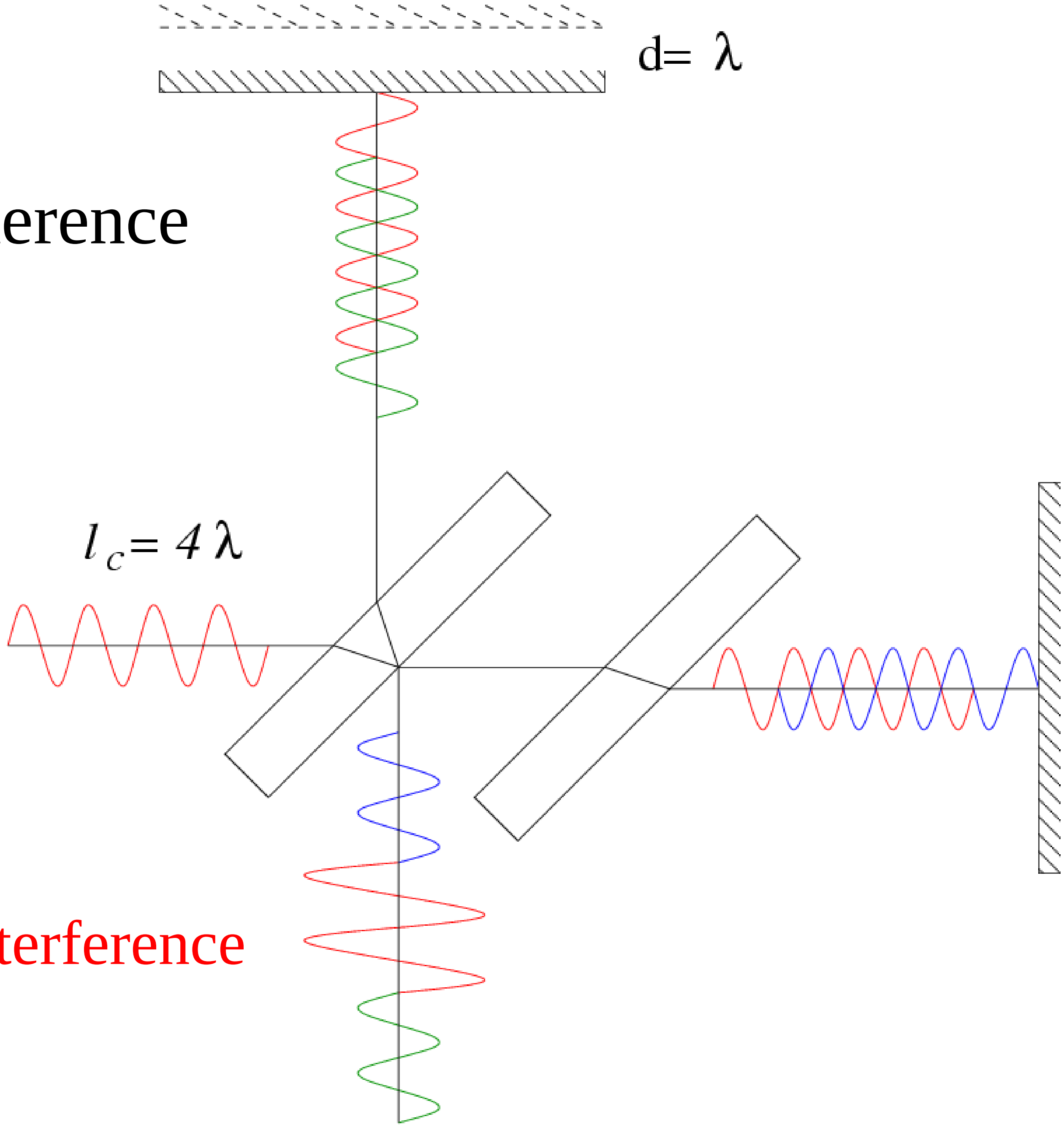
$2d = l_c$



Interference washed out

Temporal coherence

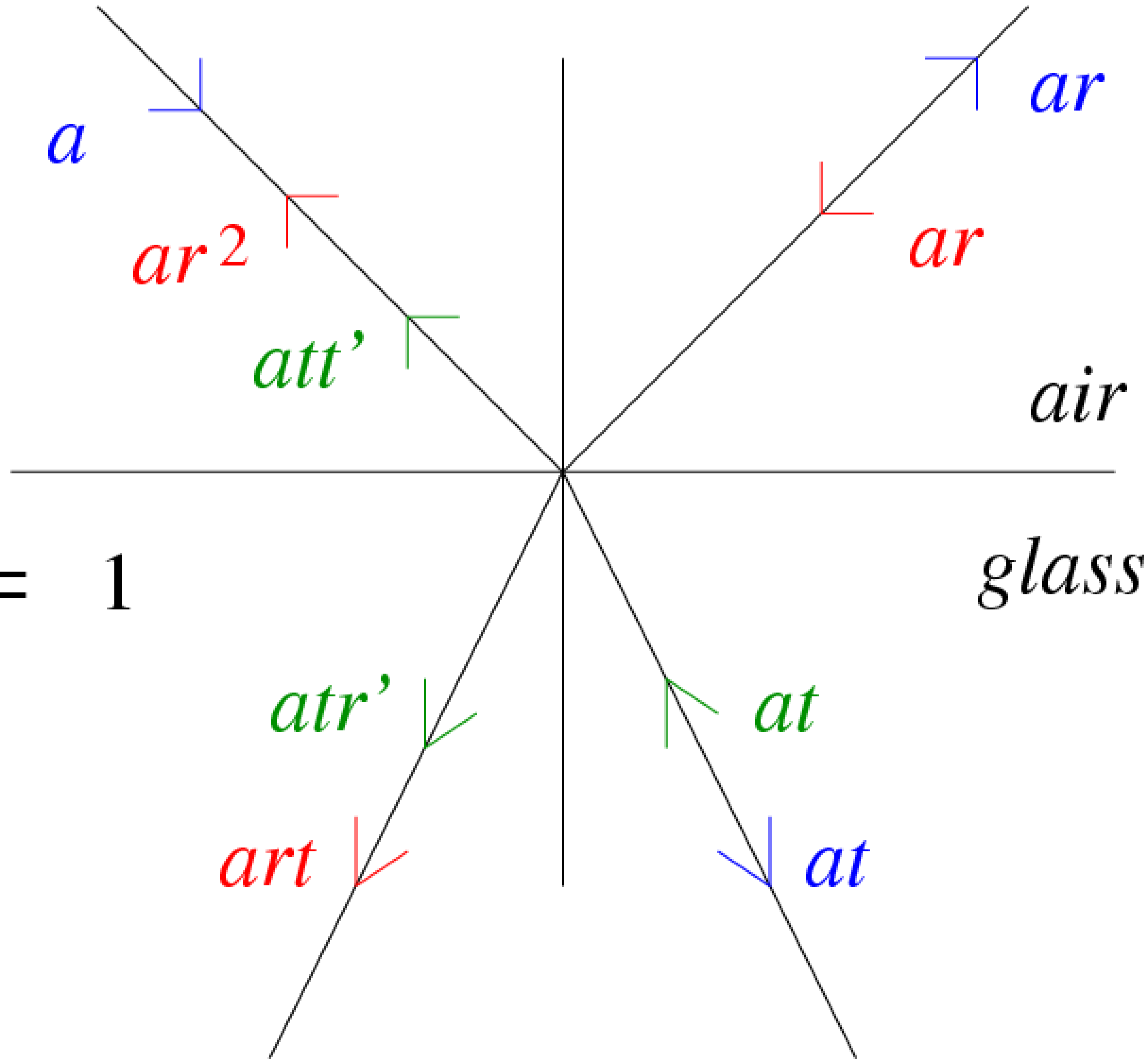
$2d < \boldsymbol{l_c}$



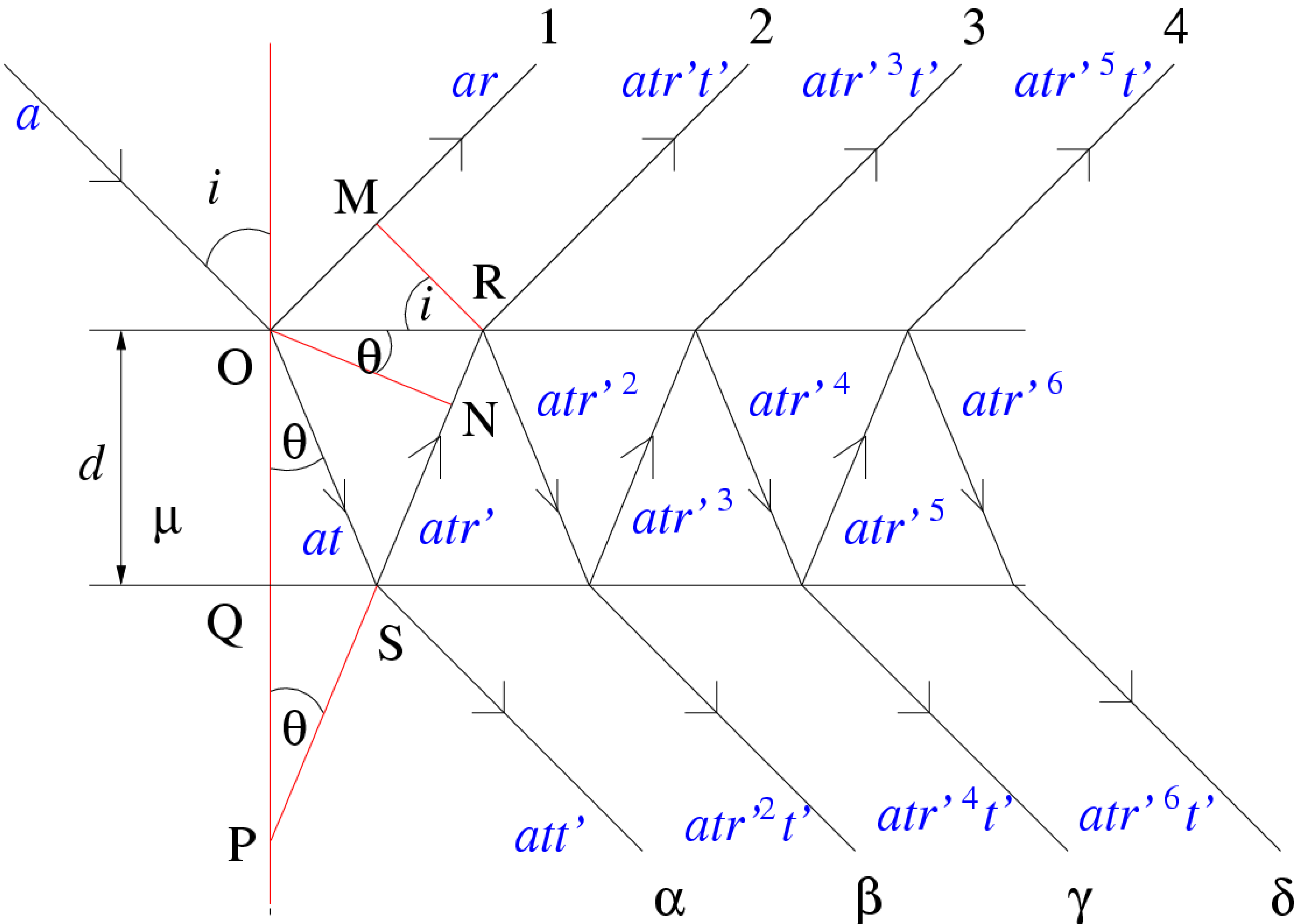
Stokes' relations

$$r = -r'$$

$$r^2 + tt' = 1$$



Thin films: multiple beam interference



Path difference between rays 2 and 1

[(OS + SR)(*in film*)] – [OM(*in air*)]

= [(PS + SR)(*in film*)] – [OM(*in air*)]

= [(PR)(*in film*)] – [OM(*in air*)]

$= \mu\ (PN + NR) - OM$

$= \mu\ (PN) = \mu\ (OP \cos\theta)$

$$\Delta = 2\mu\, d \cos\theta$$

If $2\mu\, d \cos\theta_m = m\,\lambda$

then rays 2,3,4, 5, …. are in phase and 1 out of phase.

Amplitude of 2+3+4+5 ….

$$= atr't'(1 + r'^2 + r'^4 + r'^6 + \ldots)$$

$$= atr't'(1/(1 - r'^2))$$

$$= atr't'(1/tt') \quad = ar'$$

Amplitude of transmitted beams α, β, γ, δ …

$$= att'(1 + r'^2 + r'^4 + r'^6 + \ldots)$$

$$= a$$

If $2\mu\, d\, \mathrm{Cos}\, \theta_m = (m+1/2)\, \lambda$

then rays 1,2,4, 6, … are in phase and 3,5,… are out of phase.

Rays α, γ, … in phase and rays β , δ, … are out of phase

Intensity of fringes

Transmitted beams: Amplitude

$$A = att'(1 + r^2 \exp(i\phi) + r^4 \exp(i2\phi) \cdots)$$

$$A = \frac{att'}{1 - r^2 \exp i\phi}$$

$$I = AA^* = \frac{a^2(tt')^2}{(1 - r^2 \exp(i\phi))(1 - r^2 \exp(-i\phi))}$$

$$I = \frac{I_0(1-r^2)^2}{1+r^4-2r^2\cos\phi}$$

$$I = \frac{I_0(1-r^2)^2}{(1-r^2)^2+2r^2(1-\cos\phi)}$$

$$I = \frac{I_0}{1+f^2\sin^2(\phi/2)}$$

$$f = \frac{2r}{1-r^2}$$ = Finesse

Bright fringes Transmitted rays

Dark fringes Reflected rays

$$\phi_m = 2m\pi = 2\pi\Delta_m/\lambda \Rightarrow \Delta_m = m\lambda$$

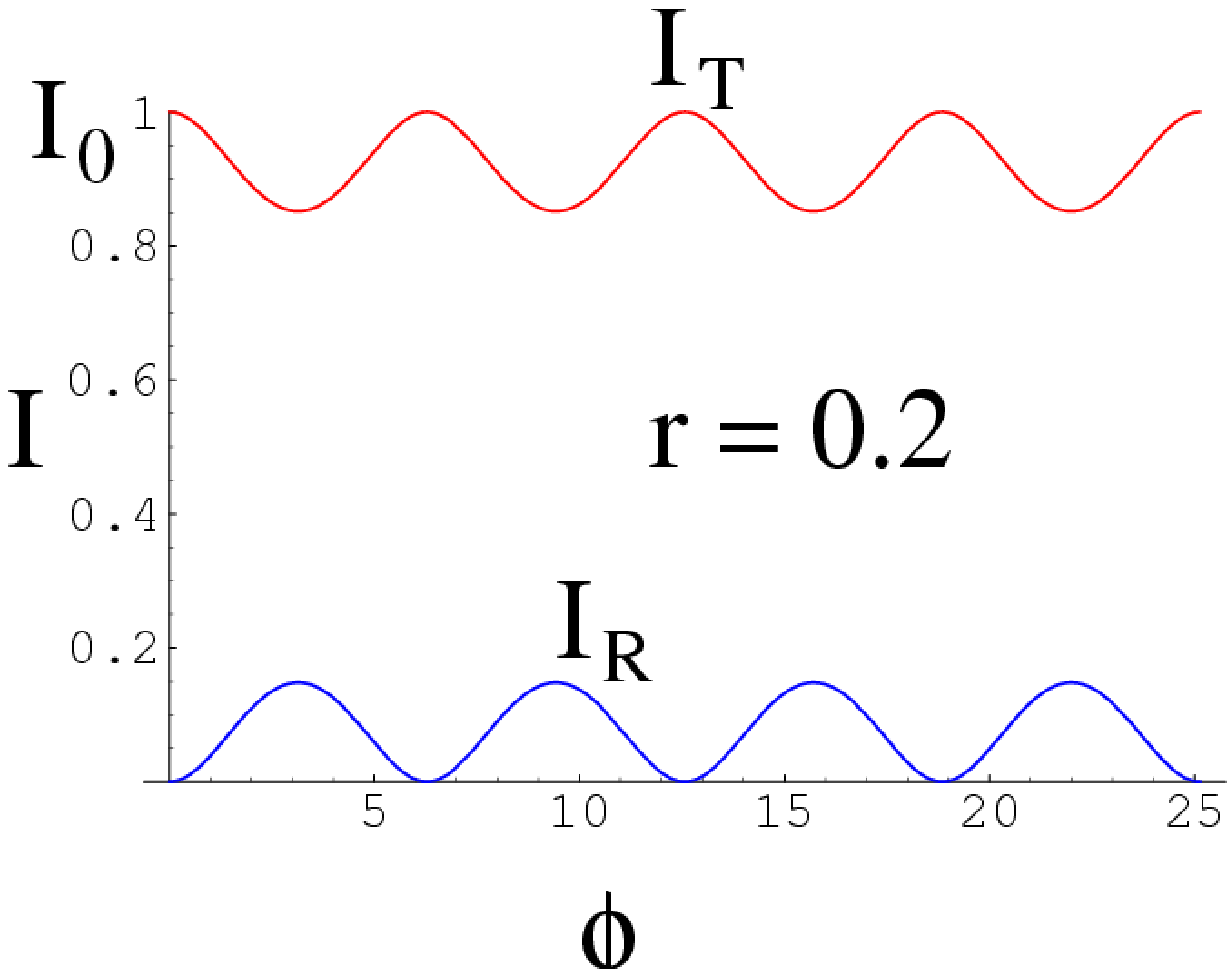
Dark fringes Transmitted rays

Bright fringes Reflected rays

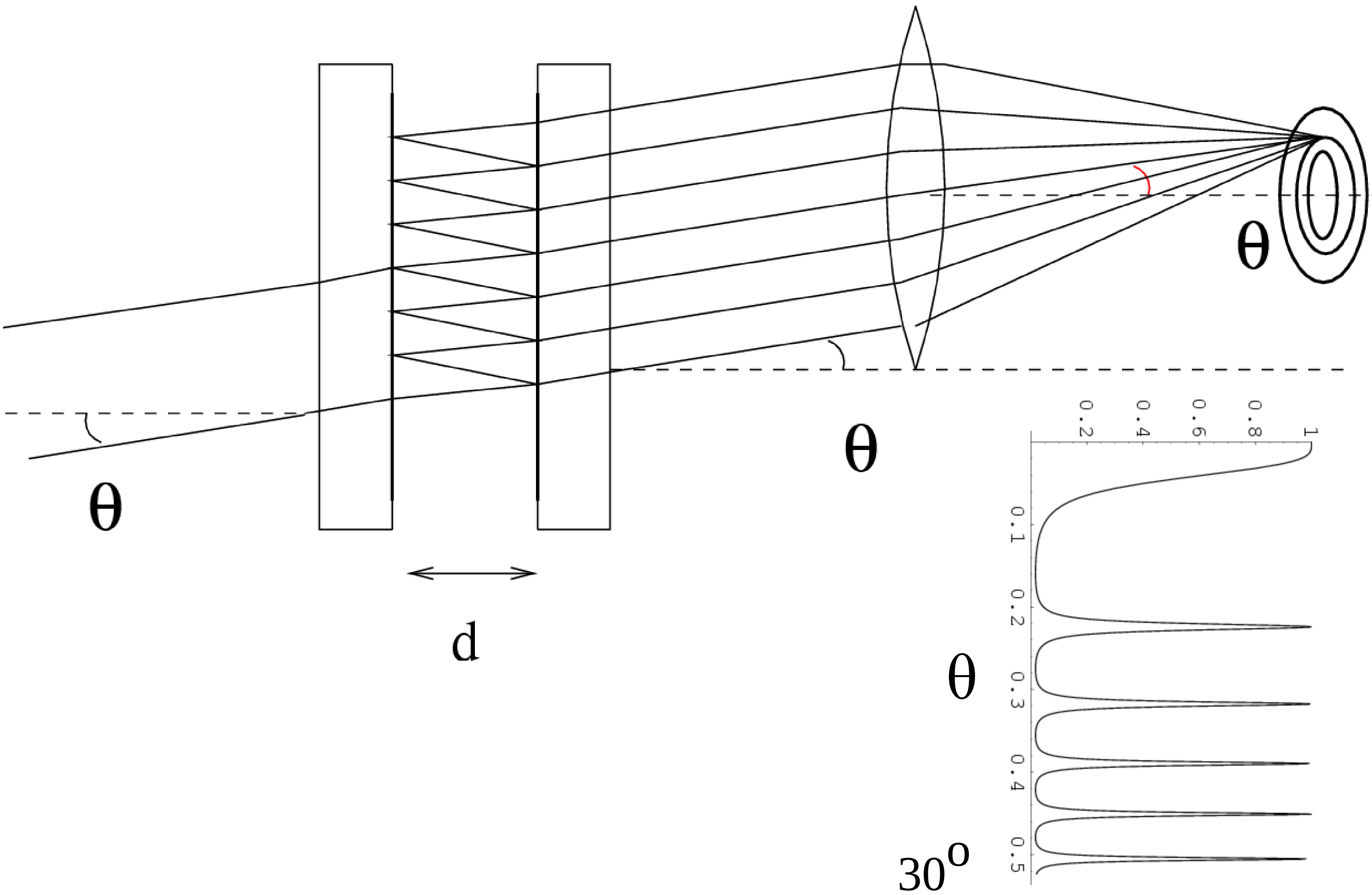
$$\phi_n = (2n+1)\pi = 2\pi\Delta_n/\lambda$$

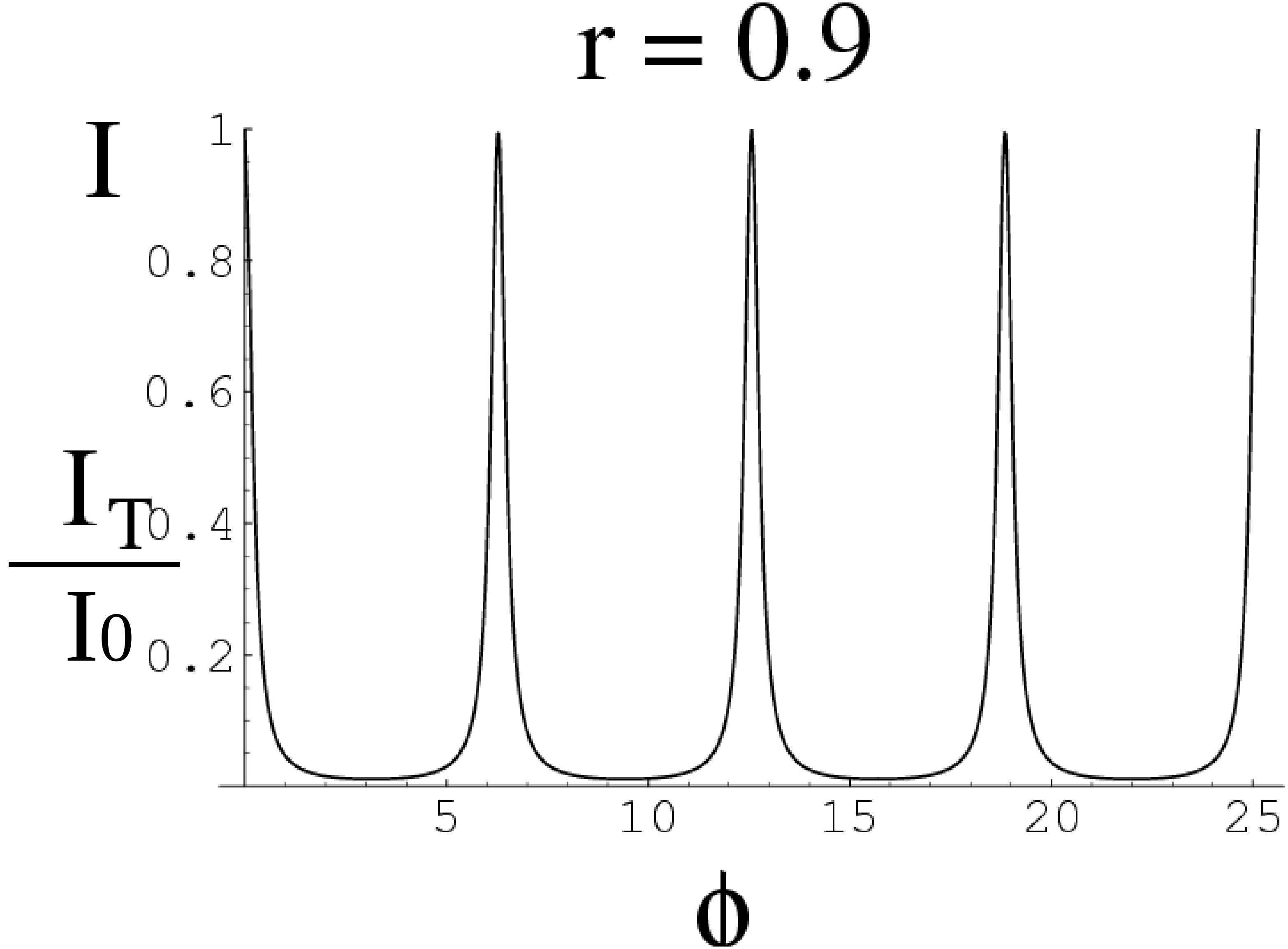
$$\Rightarrow \Delta_n = (n+1/2)\lambda$$

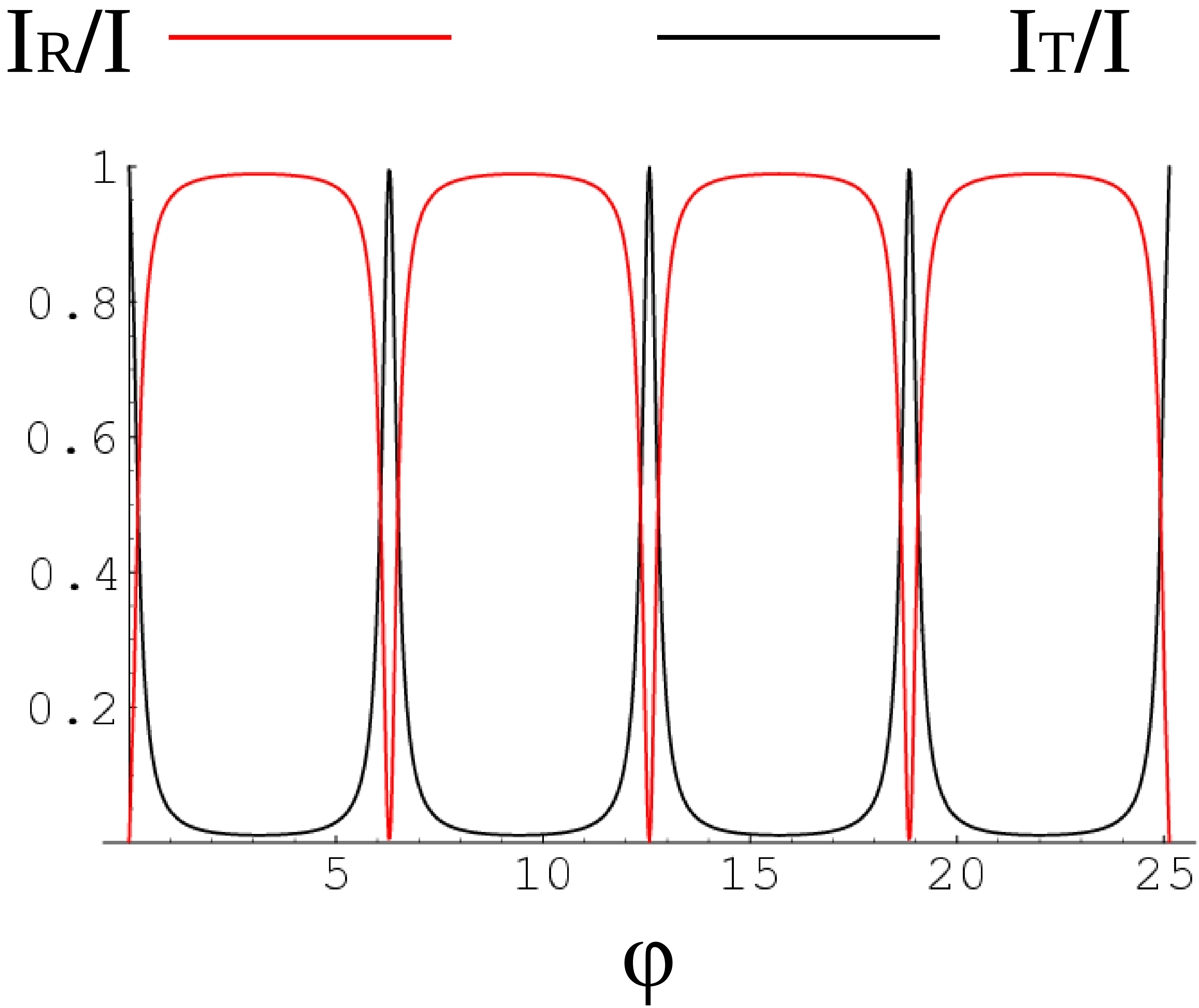
Variation of intensities with phase



Fabry-Perot Interferometer



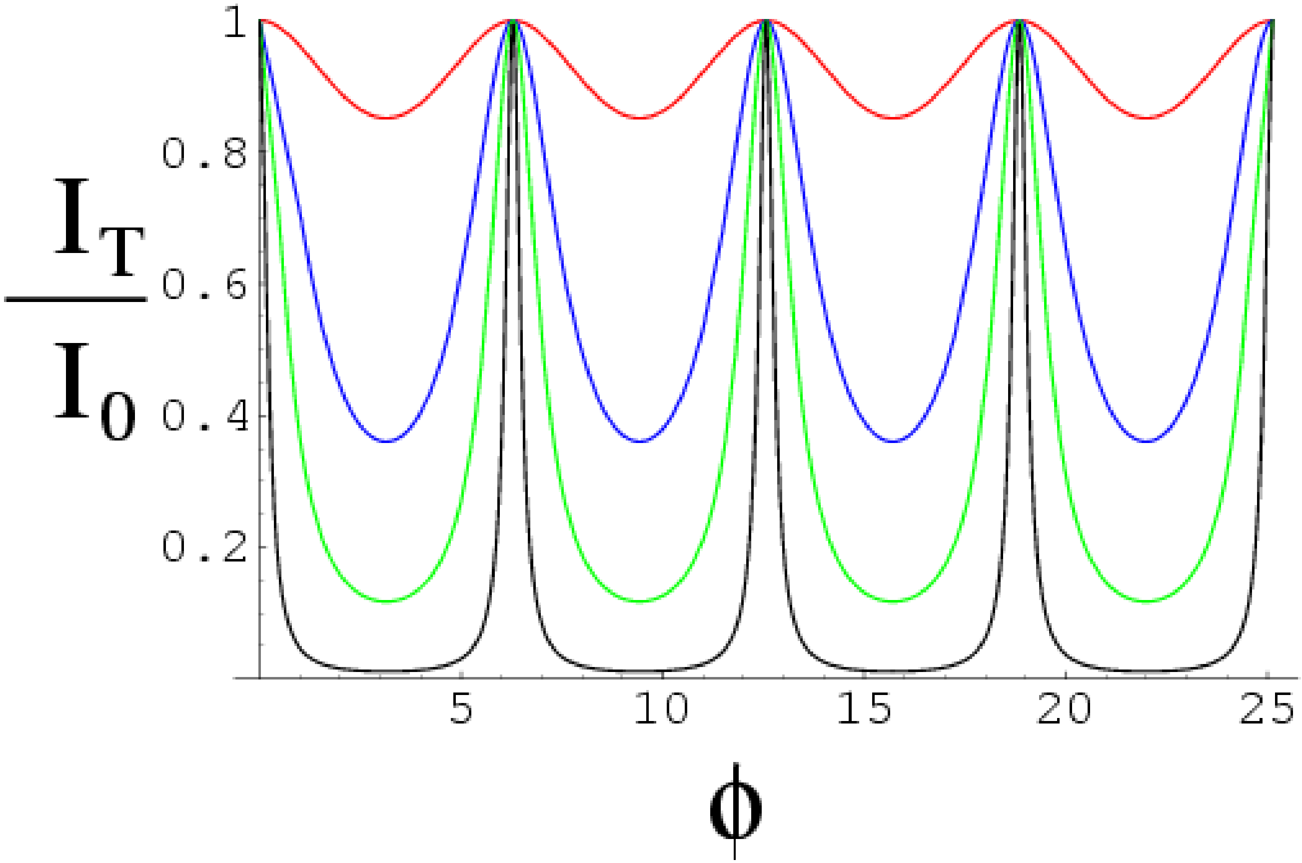

r = 0.9
I_T / I_0
1
0.8
0.6
0.4
0.2
5
10
15
20
25
ϕ

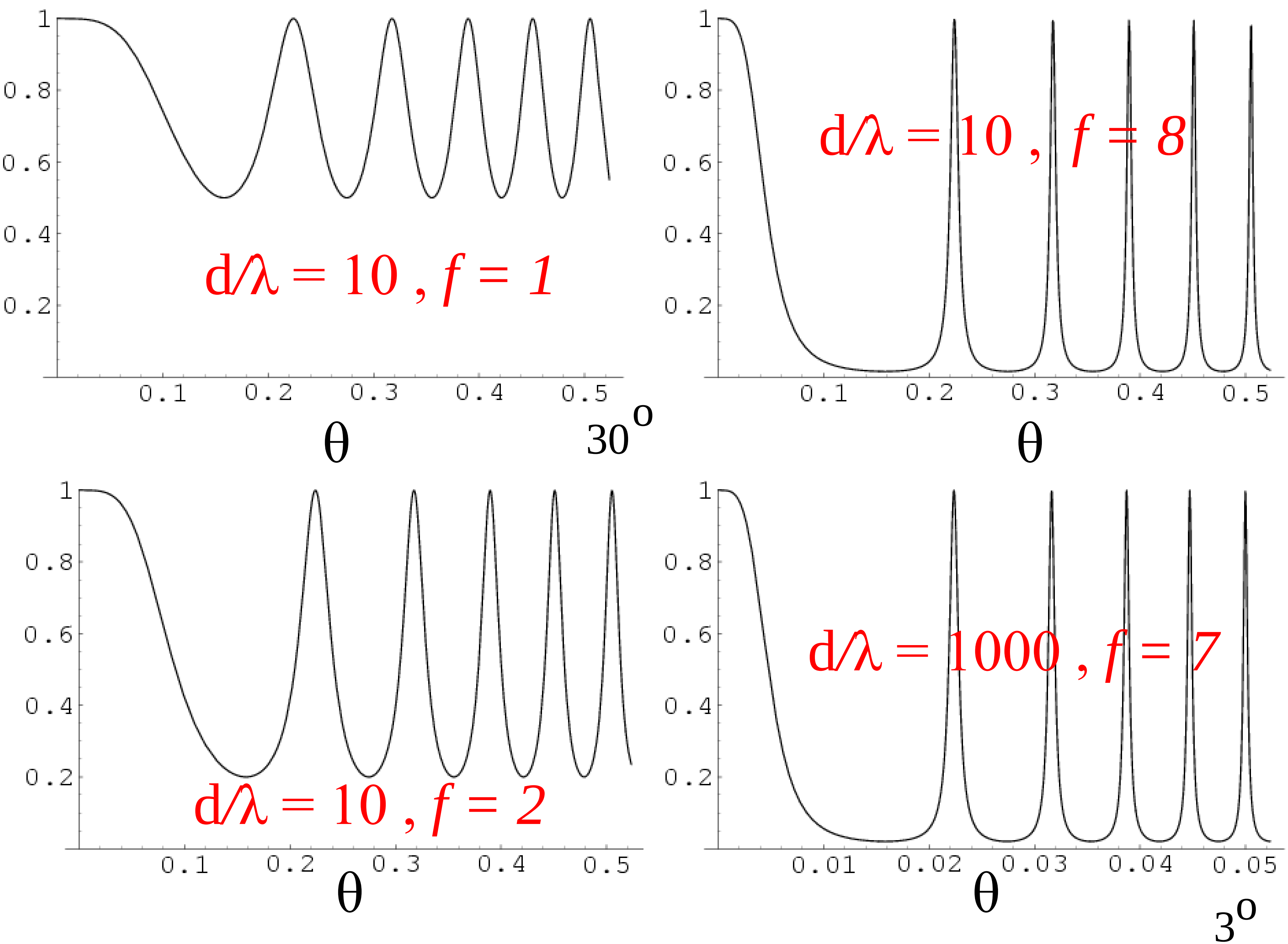


IR/I
IT/I
1
0.8
0.6
0.4
0.2
5
10
15
20
25
φ

Transmitted intensity

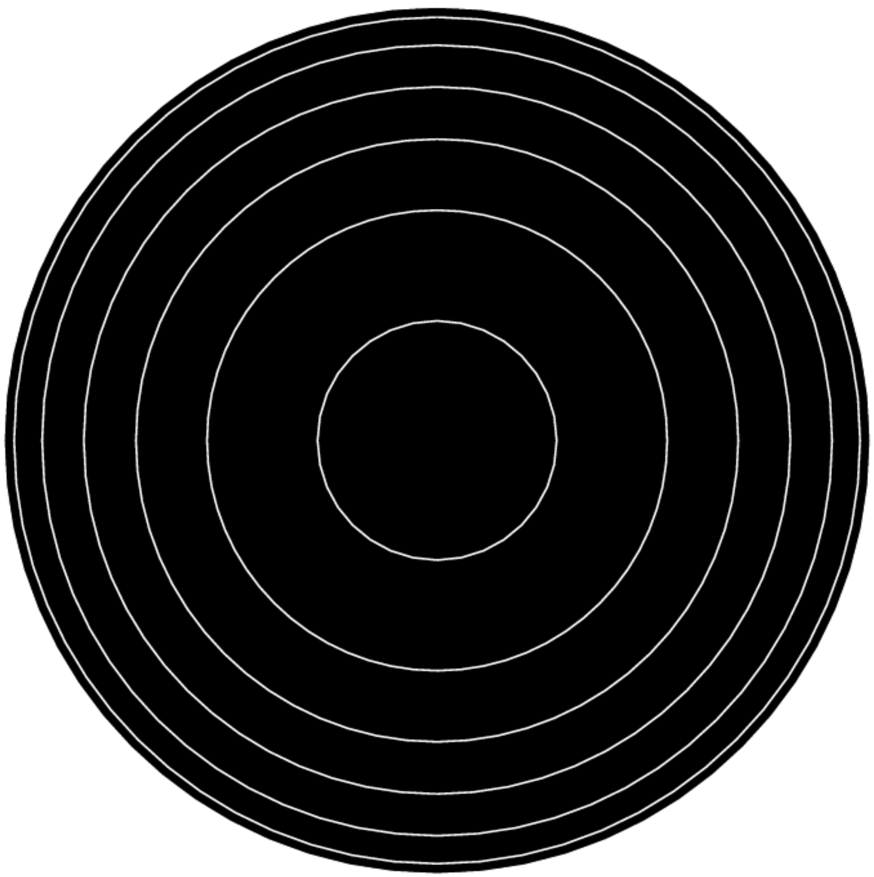
r = 0.2 r = 0.5
r = 0.7 r = 0.9





d/λ = 10 , f = 1
d/λ = 10 , f = 8
d/λ = 10 , f = 2
d/λ = 1000 , f = 7
θ
θ
θ
θ
30°
3°

Fabry-Perot fringes



Michelson fringes