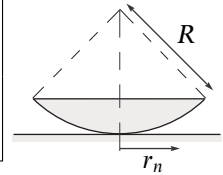


8.2 Interference

Newton's rings^a

n th dark ring	$r_n^2 = nR\lambda_0$	(8.1)	r_n radius of n th ring n integer (≥ 0) R lens radius of curvature λ_0 wavelength in external medium
n th bright ring	$r_n^2 = \left(n + \frac{1}{2}\right) R\lambda_0$	(8.2)	



^aViewed in reflection.

Dielectric layers^a

Quarter-wave condition	$a = \frac{m}{\eta_2} \frac{\lambda_0}{4}$	(8.3)	a film thickness m thickness integer ($m \geq 0$) η_2 film refractive index λ_0 free-space wavelength R power reflectance coefficient
Single-layer reflectance ^b	$R = \begin{cases} \left(\frac{\eta_1 \eta_3 - \eta_2^2}{\eta_1 \eta_3 + \eta_2^2} \right)^2 & (m \text{ odd}) \\ \left(\frac{\eta_1 - \eta_3}{\eta_1 + \eta_3} \right)^2 & (m \text{ even}) \end{cases}$	(8.4)	η_1 entry-side refractive index η_3 exit-side refractive index
Dependence of R on layer thickness, m	$\max \text{ if } (-1)^m (\eta_1 - \eta_2)(\eta_2 - \eta_3) > 0$ $\min \text{ if } (-1)^m (\eta_1 - \eta_2)(\eta_2 - \eta_3) < 0$ $R = 0 \text{ if } \eta_2 = (\eta_1 \eta_3)^{1/2} \text{ and } m \text{ odd}$	(8.5) (8.6) (8.7)	
Multilayer reflectance ^c	$R_N = \left[\frac{\eta_1 - \eta_3 (\eta_a / \eta_b)^{2N}}{\eta_1 + \eta_3 (\eta_a / \eta_b)^{2N}} \right]^2$	(8.8)	R_N multilayer reflectance N number of layer pairs η_a refractive index of top layer η_b refractive index of bottom layer

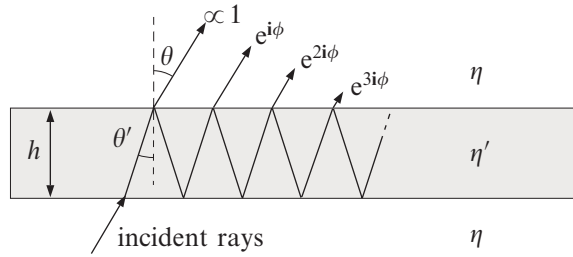
^aFor normal incidence, assuming the quarter-wave condition. The media are also assumed lossless, with $\mu_r = 1$.

^bSee page 154 for the definition of R .

^cFor a stack of N layer pairs, giving an overall refractive index sequence $\eta_1 \eta_a \eta_b \eta_a \dots \eta_a \eta_b \eta_3$ (see right-hand diagram). Each layer in the stack meets the quarter-wave condition with $m = 1$.



Fabry-Perot etalon^a



Incremental phase difference ^b	$\phi = 2k_0 h \eta' \cos \theta' \quad (8.9)$ $= 2k_0 h \eta' \left[1 - \left(\frac{\eta \sin \theta}{\eta'} \right)^2 \right]^{1/2} \quad (8.10)$ $= 2\pi n \quad \text{for a maximum} \quad (8.11)$	ϕ incremental phase difference k_0 free-space wavenumber ($= 2\pi/\lambda_0$) h cavity width θ fringe inclination (usually $\ll 1$) θ' internal angle of refraction η' cavity refractive index η external refractive index n fringe order (integer)
Coefficient of finesse	$F = \frac{4R}{(1-R)^2} \quad (8.12)$	F coefficient of finesse R interface power reflectance
Finesse	$\mathcal{F} = \frac{\pi}{2} F^{1/2} \quad (8.13)$ $= \frac{\lambda_0}{\eta' h} Q \quad (8.14)$	$\mathcal{F}$ finesse λ_0 free-space wavelength Q cavity quality factor
Transmitted intensity	$I(\theta) = \frac{I_0(1-R)^2}{1 + R^2 - 2R \cos \phi} \quad (8.15)$ $= \frac{I_0}{1 + F \sin^2(\phi/2)} \quad (8.16)$ $= I_0 A(\theta) \quad (8.17)$	I transmitted intensity I_0 incident intensity A Airy function
Fringe intensity profile	$\Delta\phi = 2 \arcsin(F^{-1/2}) \quad (8.18)$ $\simeq 2F^{-1/2} \quad (8.19)$	$\Delta\phi$ phase difference at half intensity point
Chromatic resolving power	$\frac{\lambda_0}{\delta\lambda} \simeq \frac{R^{1/2} \pi n}{1-R} = n\mathcal{F} \quad (8.20)$ $\simeq \frac{2\mathcal{F} h \eta'}{\lambda_0} \quad (\theta \ll 1) \quad (8.21)$	$\delta\lambda$ minimum resolvable wavelength difference
Free spectral range ^c	$\delta\lambda_f = \mathcal{F} \delta\lambda \quad (8.22)$ $\delta\nu_f = \frac{c}{2\eta' h} \quad (8.23)$	$\delta\lambda_f$ wavelength free spectral range $\delta\nu_f$ frequency free spectral range

^aNeglecting any effects due to surface coatings on the etalon. See also *Lasers* on page 174.

^bBetween adjacent rays. Highest order fringes are near the centre of the pattern.

^cAt near-normal incidence ($\theta \simeq 0$), the orders of two spectral components separated by $< \delta\lambda_f$ will not overlap.

