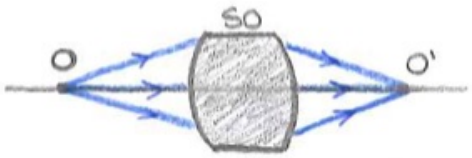
TEMA 4.

ABERRACIONES

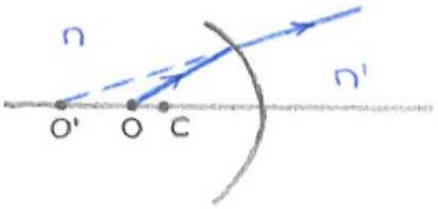
1. Introducción

~ Concepto de estigmatismo



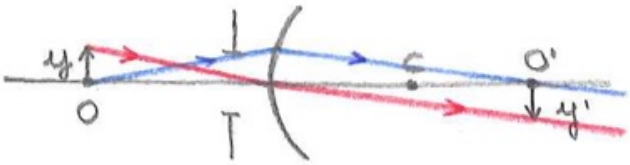
~ Relación entre rayos y frentes de onda. Teorema de Malus-Dupin

~ Refracción en un dioptrio esférico. Puntos de Young

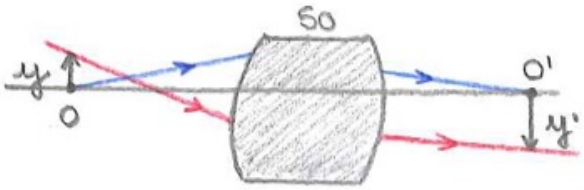


n > n'

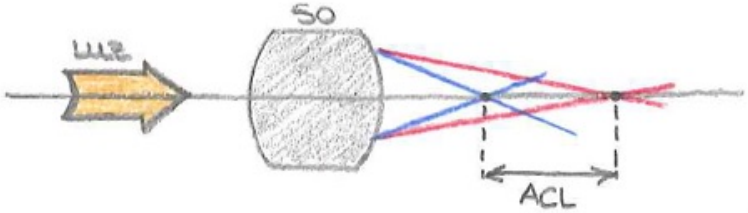
~ Región paraxial



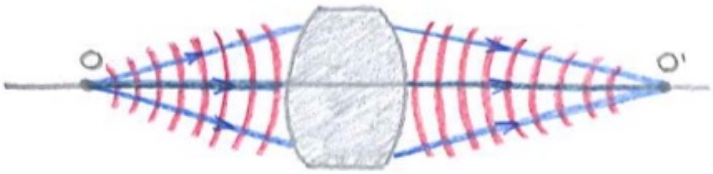
~ Tratado analítico de rayos paraxiales



~ Aberraciones cromáticas

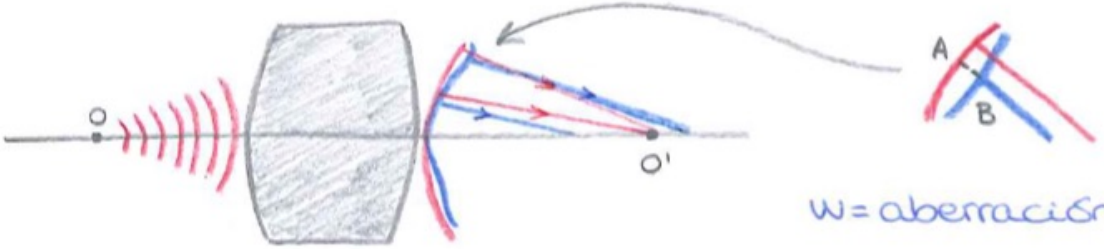


En un sistema perfecto tendríamos:



En un sistema real ... :

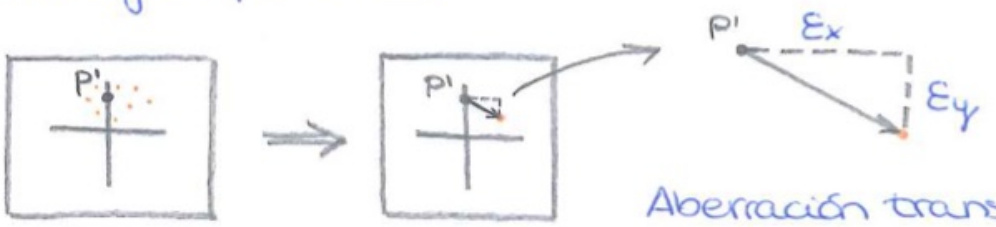
2. Aberración de onda y de rayo



W = aberración de onda

$W = n' AB$

Plano imagen paraxial



Aberración transversal de rayo : $(\varepsilon_x, \varepsilon_y)$

$$\rightarrow \varepsilon_x \propto \frac{\partial W}{\partial x_p} \quad \wedge \quad \varepsilon_y \propto \frac{\partial W}{\partial y_p}$$

en un medio: $v < c$

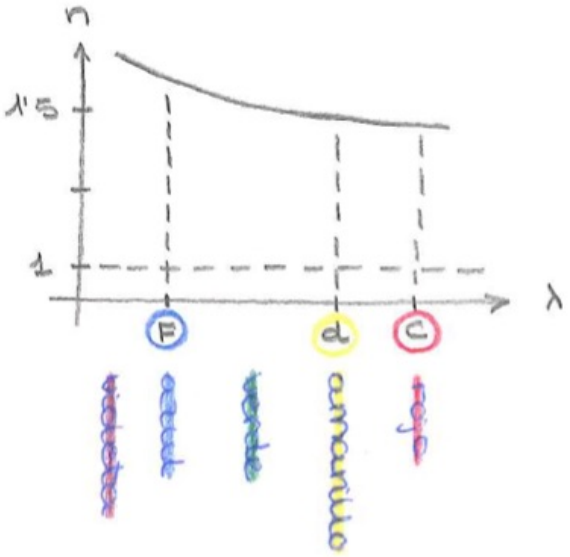
$n = \frac{c}{v}$ → Adimensional
→ Superior a 1.

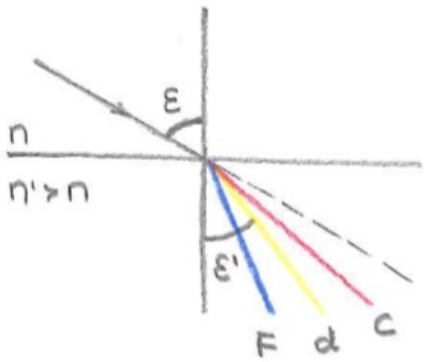
Frecuencia f (Hz) $\Rightarrow$ $\lambda = \frac{v}{f} = \frac{c \cdot v}{c \cdot f} = \frac{c}{nf} = \frac{\lambda_0}{n}$

Medio homogéneo e isótropo $\Rightarrow$ n = cte

Medio anisótropo $\Rightarrow$ n cambia con la dirección

Medio heterogéneo $\Rightarrow$ n varía de un punto a otro.





Número de Abbe

$$\nu = \frac{n_d - 1}{n_F - n_C} \Rightarrow$$

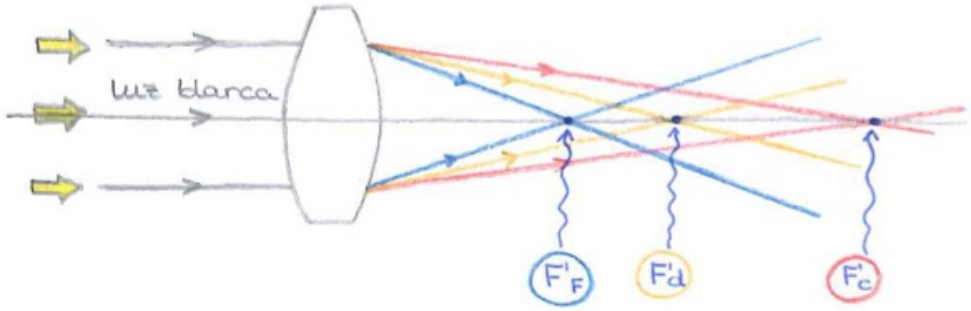
Para vidrios ópticos: $30 < \nu < 70$

Si $\nu \geq 50$ vidrio crown

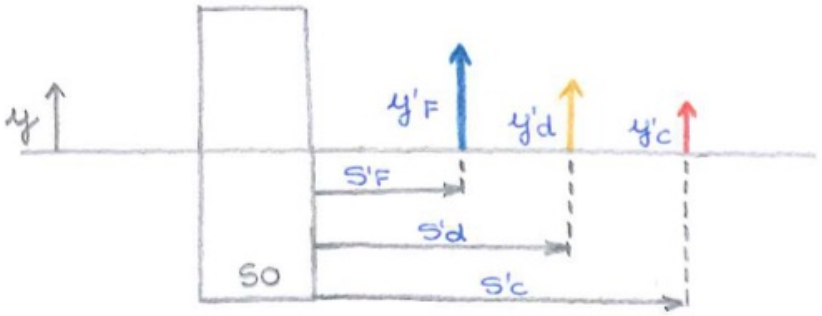
Si $\nu < 50$ vidrio flint

↳ + dispersivo

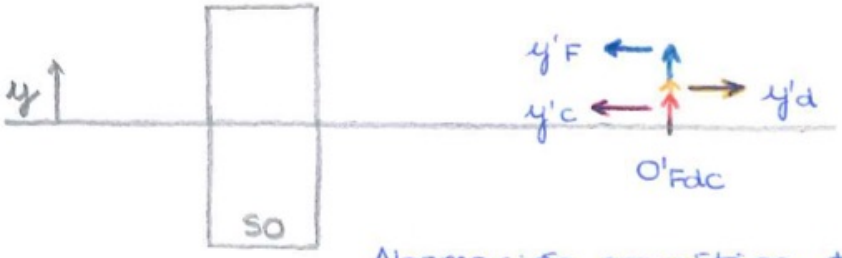
~ Aberración cromática



~ Aberración cromática longitudinal y transversal

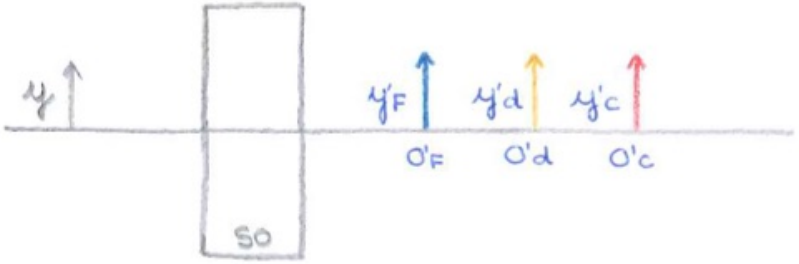


$ACL = S'_F - S'_c$



$ACT = y'_F - y'_c$

Aberración cromática transversal o de aumento.

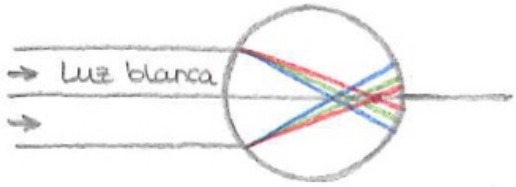


Aberración cromática longitudinal o de posición.

~ Aberración cromática longitudinal en el ojo

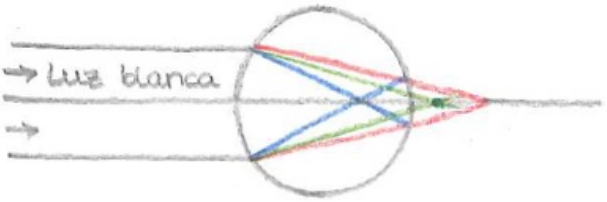
En el test bicromático:

Miope:



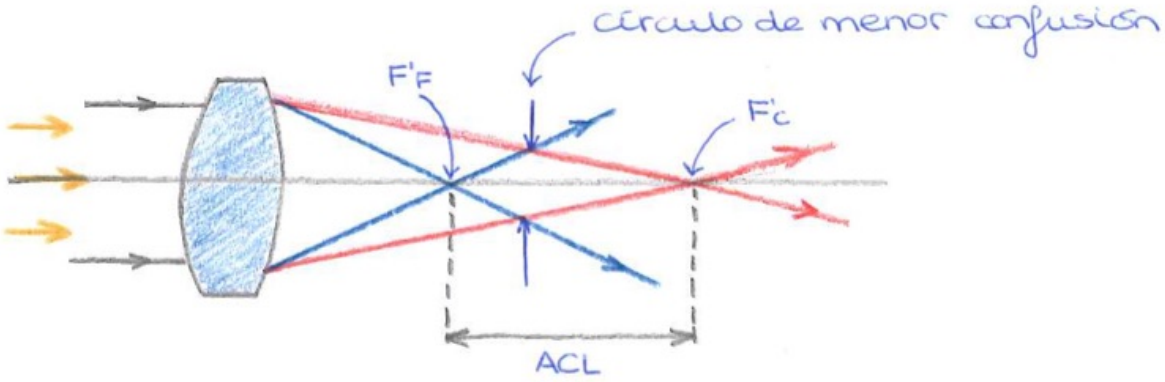
⟹ Ve mejor el rojo

Hipermétrope:



⟹ Ve mejor el verde

~ Aberración cromática de una lente delgada



$$\Delta P = \frac{P}{v} \quad ; \quad ACL = -\frac{P}{v} S'_d{}^2 \quad ; \quad ACT = \frac{y}{S} ACL$$

$$\Delta P = P_F - P_C$$

$$P_F = (n_F - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = (n_F - 1)\cdot X \quad \wedge \quad P_C = (n_C - 1)\cdot X$$

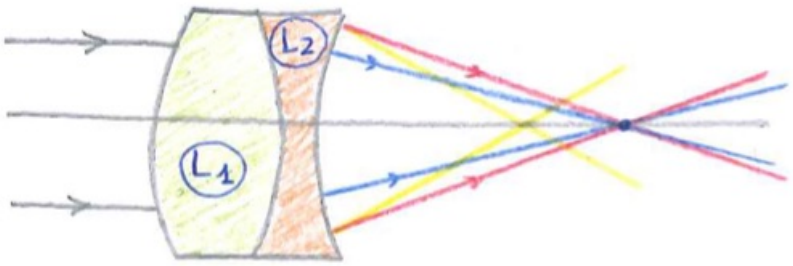
$$\Delta P = [(n_F - 1) - (n_C - 1)]\cdot X = (n_F - n_C)\cdot X$$

$$v = \frac{(n_d - 1)}{(n_F - n_C)} \Rightarrow (n_F - n_C) = \frac{(n_d - 1)}{v} \Rightarrow \Delta P = \frac{(n_d - 1)}{v}\cdot X = P_d$$

~ Doblete acromático pegado

→ Conseguir que $\Delta P = 0$, es decir, $P_F = P_c$.

↳ Variación de potencia del DOBLETE!!



$$P = P_1 + P_2$$

$$\frac{P_1}{\nu_1} + \frac{P_2}{\nu_2} = 0$$

$$\rightsquigarrow \quad P_1 = \frac{P\,\nu_1}{\nu_1 - \nu_2} \quad \wedge \quad P_2 = -\frac{P\,\nu_2}{\nu_1 - \nu_2}$$

¡NOTA!

Crown $\nu \geq 50$

Flint $\nu < 50$

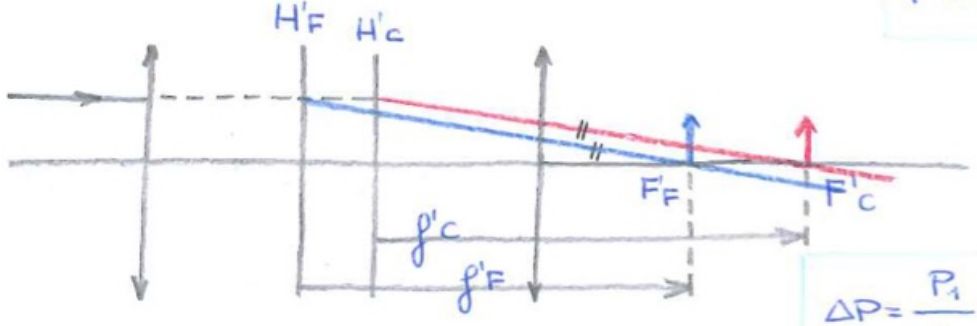
⊛ Se corrige la AC de aumento para objetos lejanos.

Si $\nu_1 > \nu_2 \Rightarrow P_1 > 0 \wedge P_2 < 0$ (Crown)

Si $\nu_1 < \nu_2 \Rightarrow P_1 < 0 \wedge P_2 > 0$ (Flint)

~ Doblete acromático separado

$$P = P_1 + P_2 - e P_1 P_2$$



$$\beta' = 1 - \frac{a'}{f'} \quad ⊛$$

$$\Delta P = \frac{P_1}{\nu_1} + \frac{P_2}{\nu_2} - e P_1 P_2 \left(\frac{1}{\nu_1} + \frac{1}{\nu_2}\right) = 0$$