# Introduction à l'optique

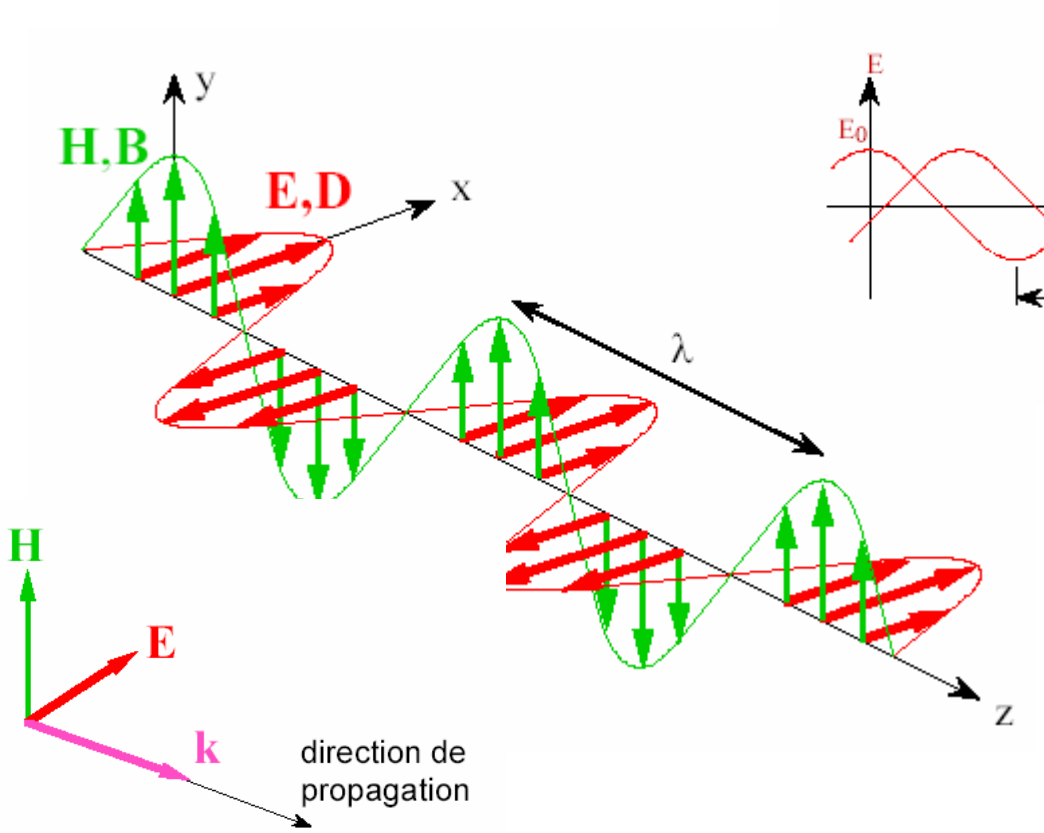
L. Falco – 19.08.2005

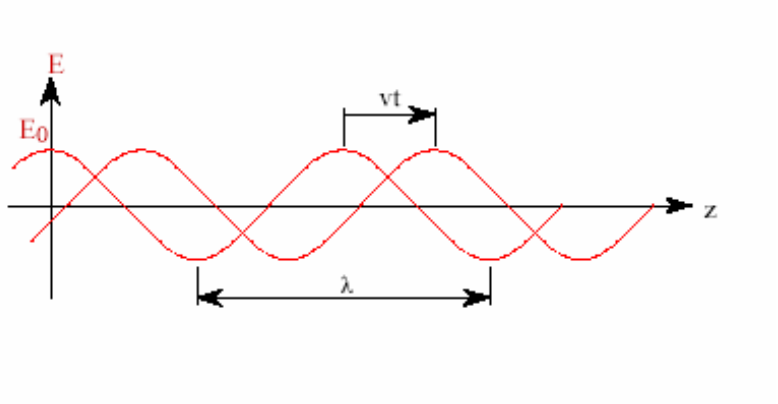
# Lumière:

## Onde ou particule ?

- **optique ondulatoire** -> diffraction, interférences
- **optique corpusculaire** -> effet photo-électrique (interaction avec la matière)
- **optique géométrique** -> notion de rayons lumineux

# Propagation d'une onde électromagnétique

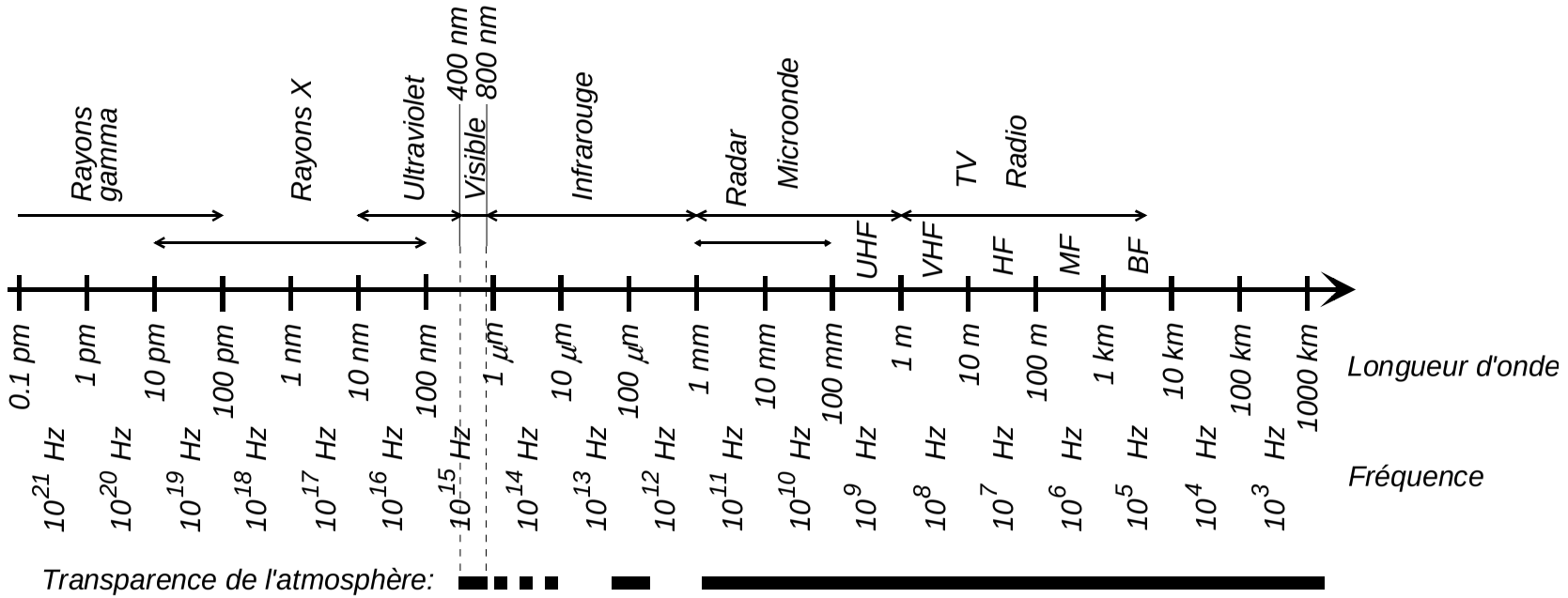


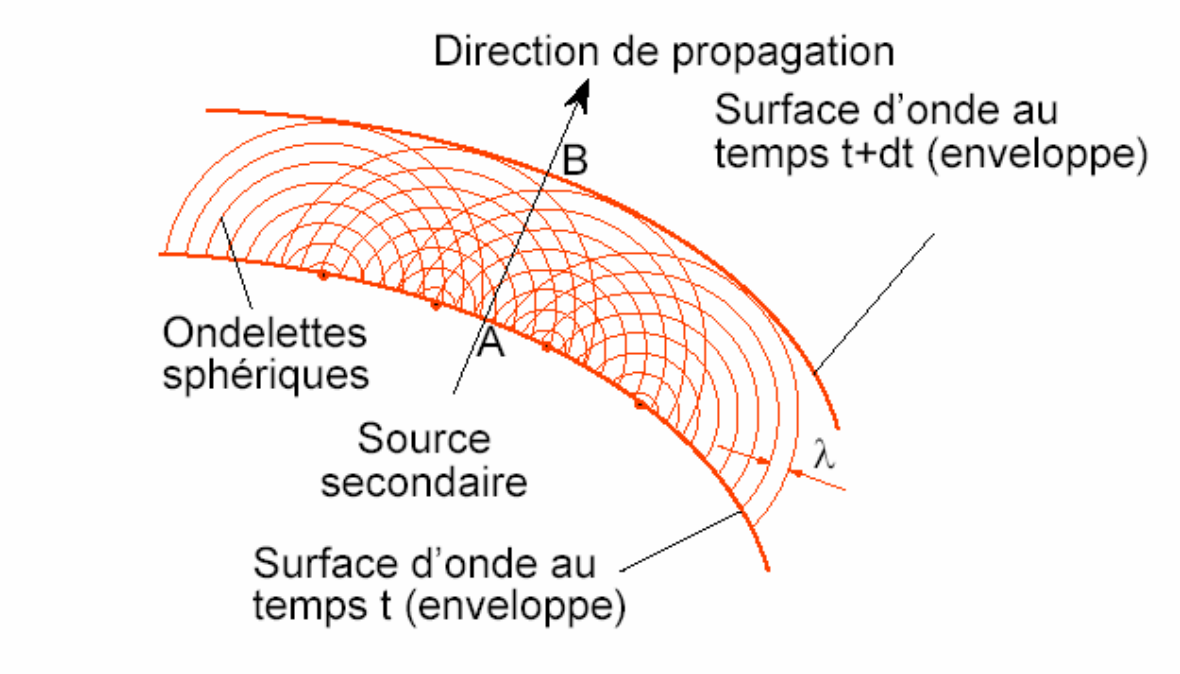

$$E(z,t) = E_0 \cdot \cos(kz - \omega t)$$

$c$ =299792.458 km/s.

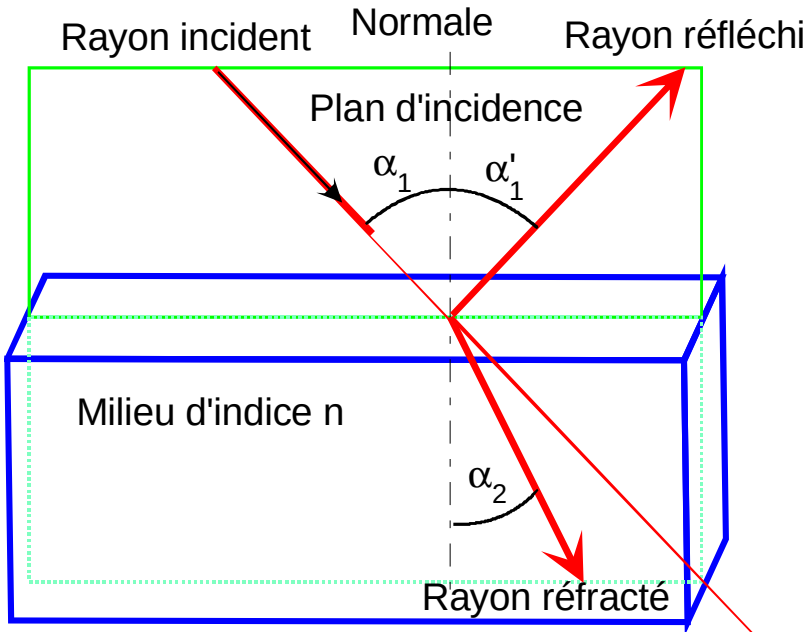
# Spectre des ondes électromagnétiques



# Principe des ondelettes d'Huygens



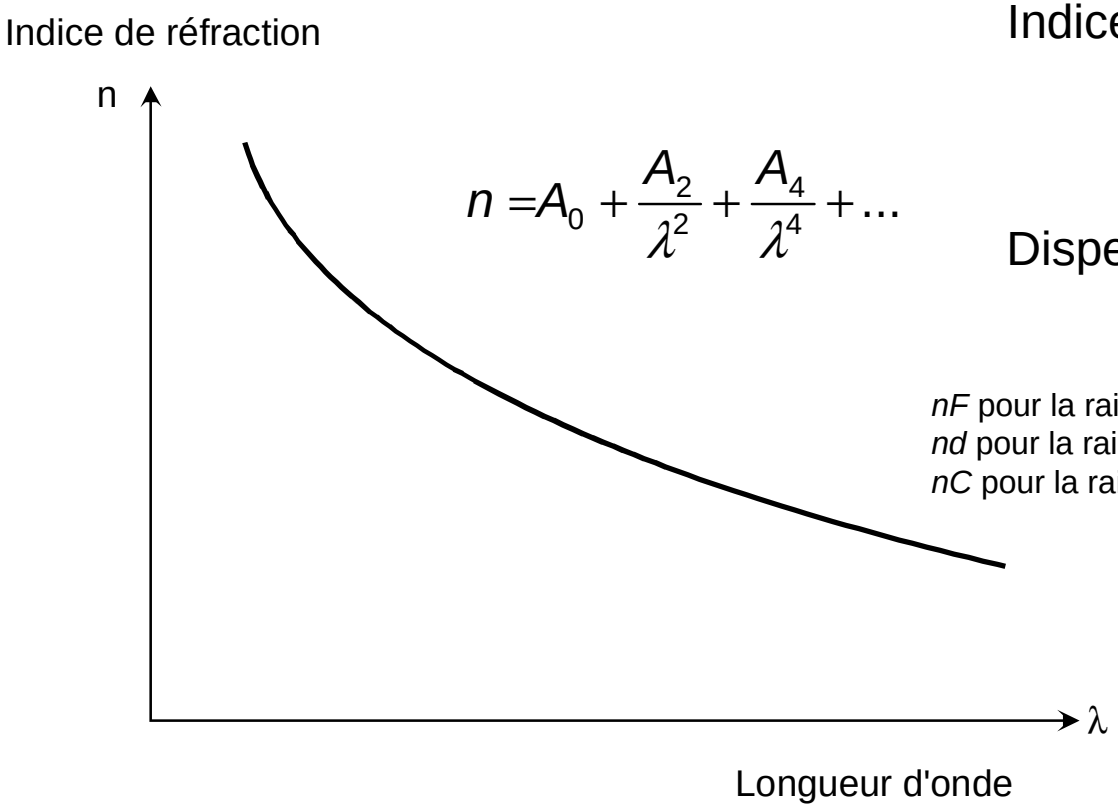
# Loi de réfraction et de réflexion




$$\sin\alpha_1 = n \cdot \sin\alpha_2$$

$$\alpha_1 = \alpha'_1$$

# Indice de réfraction - dispersion

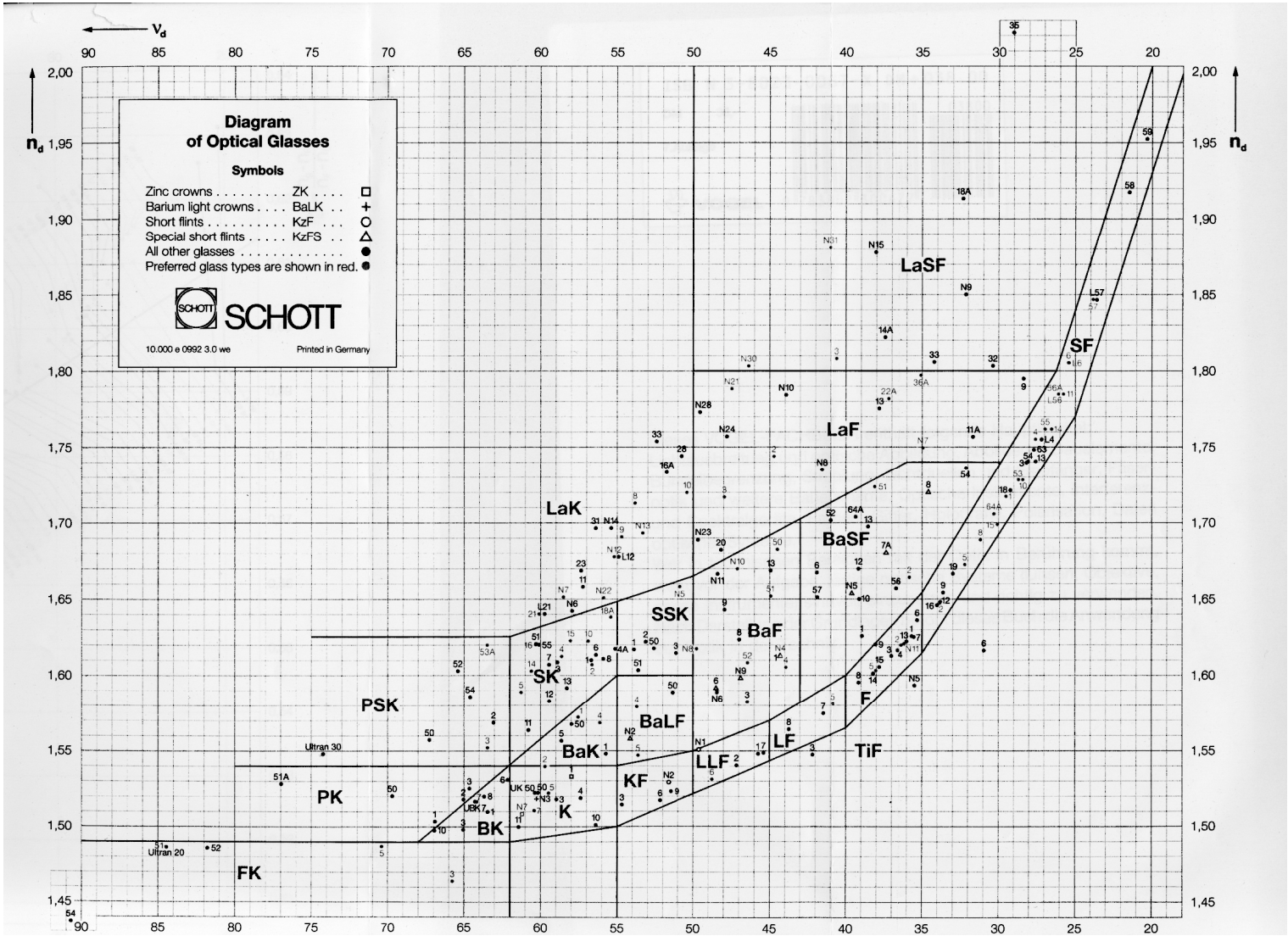



Indice de réfraction $n_d$

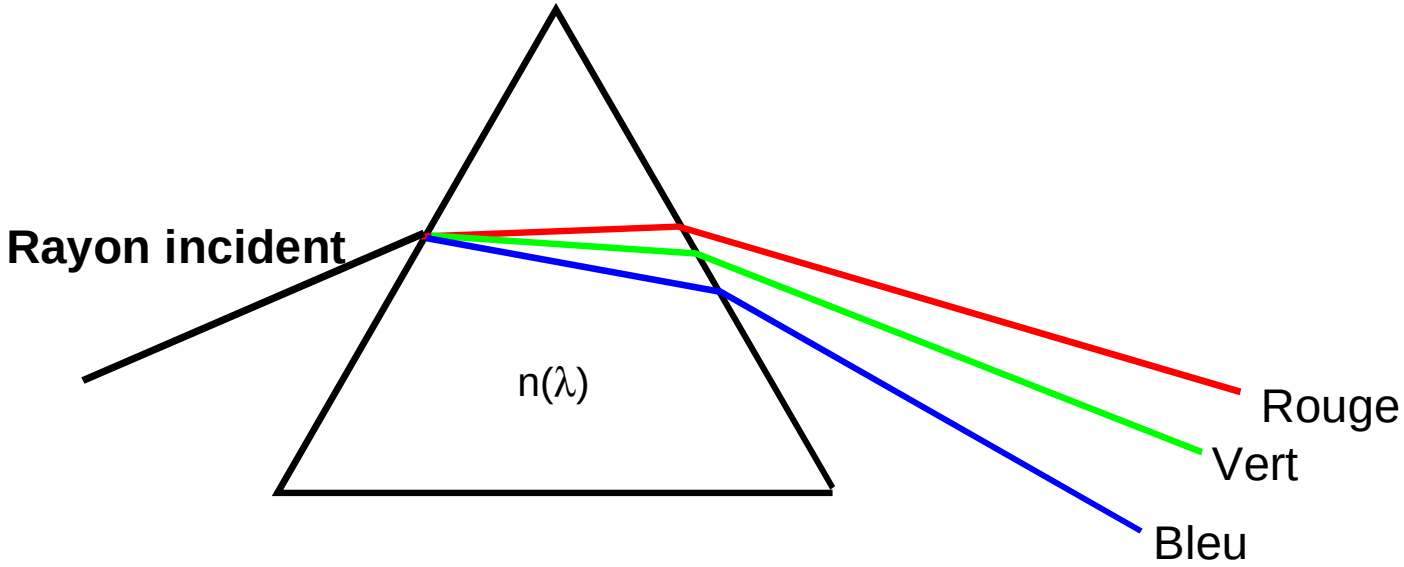
Dispersion $\upsilon_d = \frac{n_d - 1}{n_F - n_C}$

*nF* pour la raie bleue vert de l'hydrogène ($\lambda_F$=486 nm),
*nd* pour la raie jaune du sodium ($\lambda_d$=589 nm),
*nC* pour la raie rouge de l'hydrogène ($\lambda_F$=656 nm).

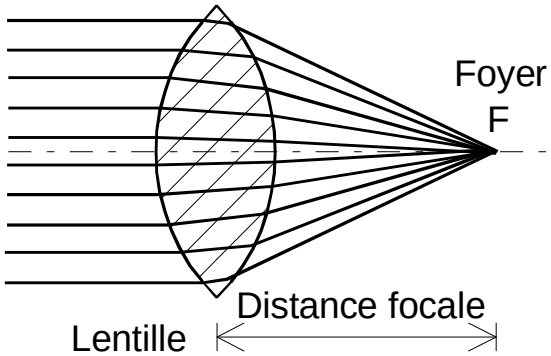
# Verres Schott



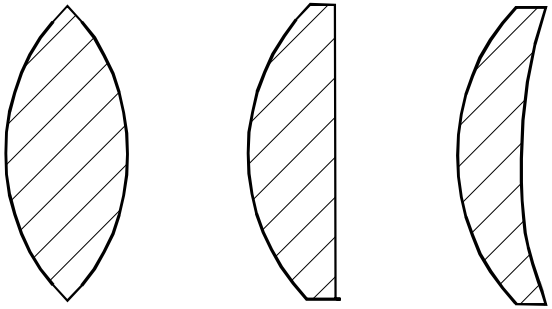
# Déviation du prisme



# Lentille

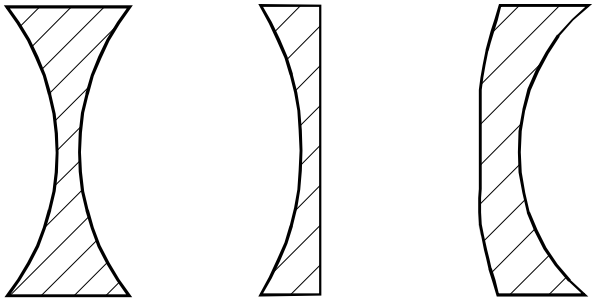



Lentilles convergentes



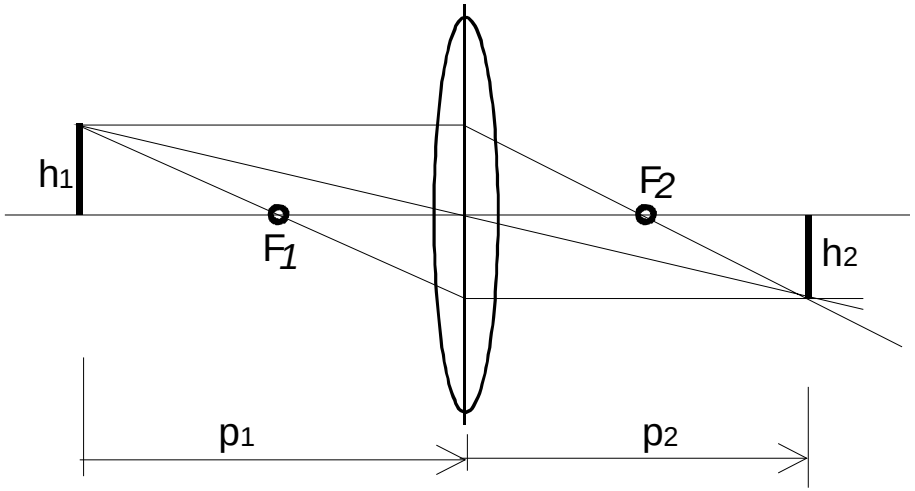
Biconvexe Plan-convexe Ménisque

Lentilles divergentes



Biconcave Plan-concave Ménisque

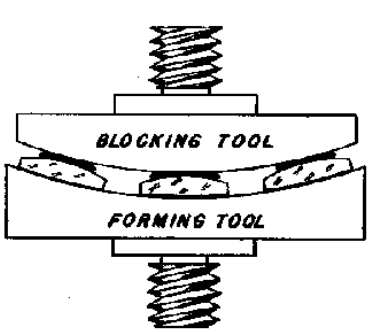
# Loi des lentilles

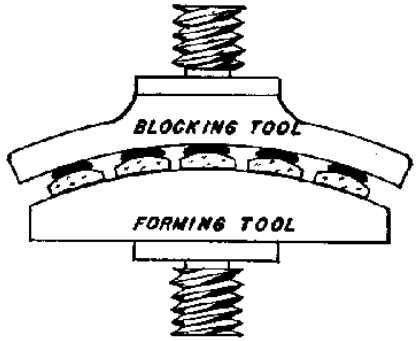


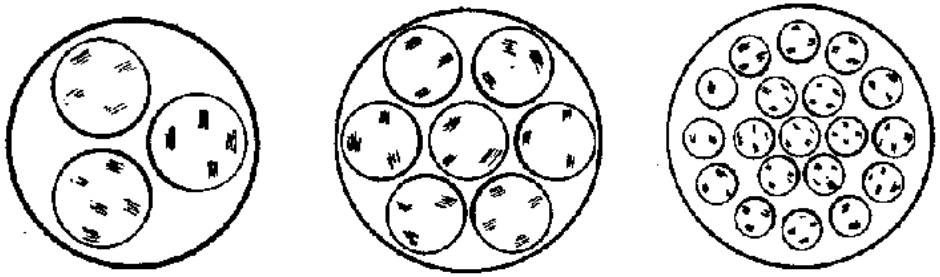

$$\frac{1}{f} = \frac{1}{p_1} + \frac{1}{p_2}$$

Grandissement: $$G = \frac{h_2}{h_1} = -\frac{p_2}{p_1}$$

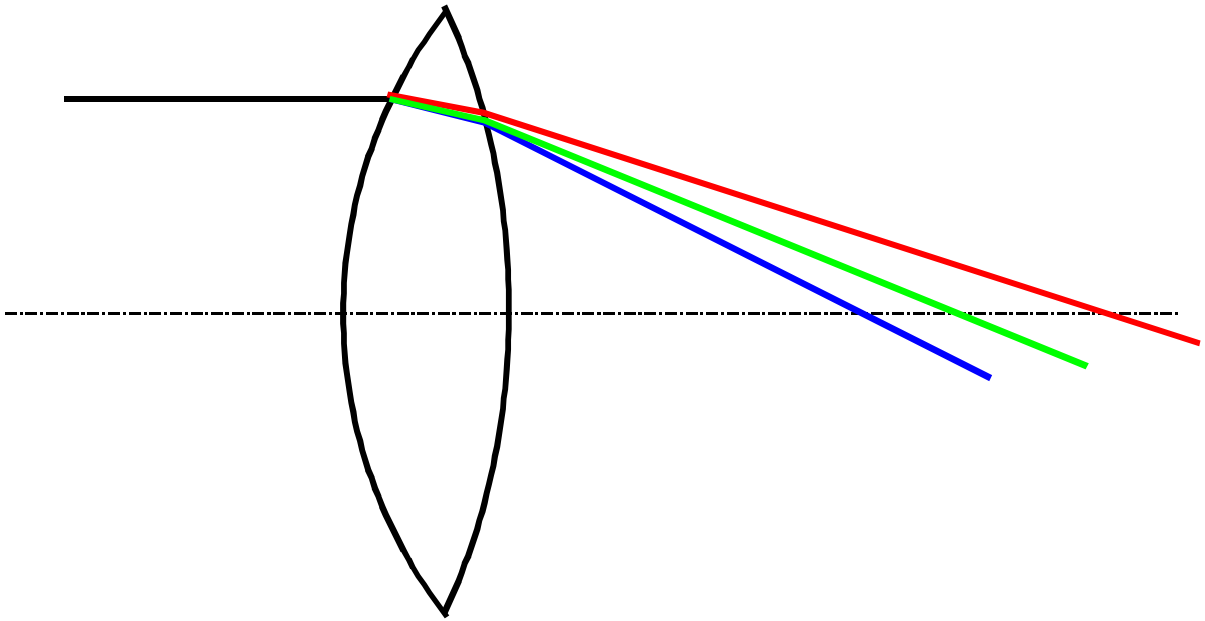
# Fabrication des lentilles



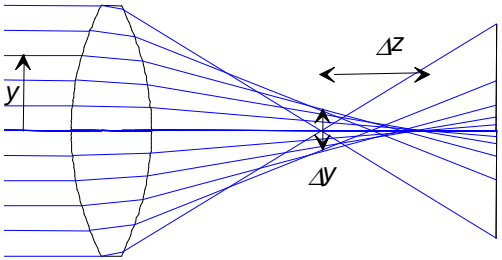



# Aberration chromatique

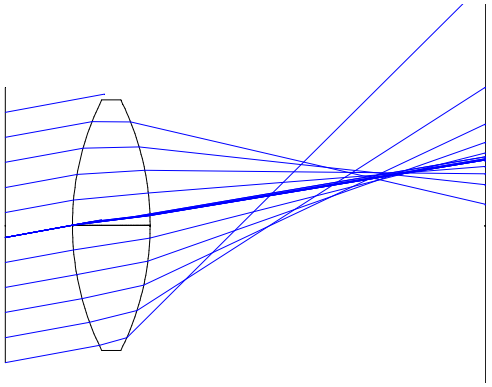


# Aberrations géométriques

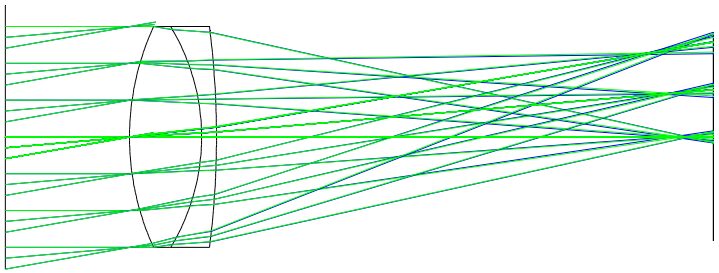
Aberration sphérique



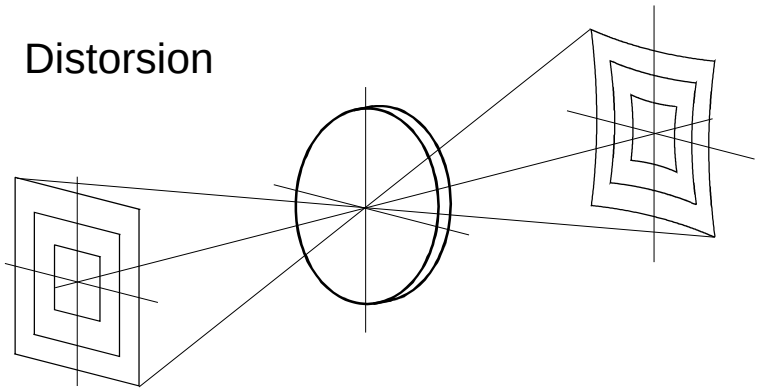

Coma



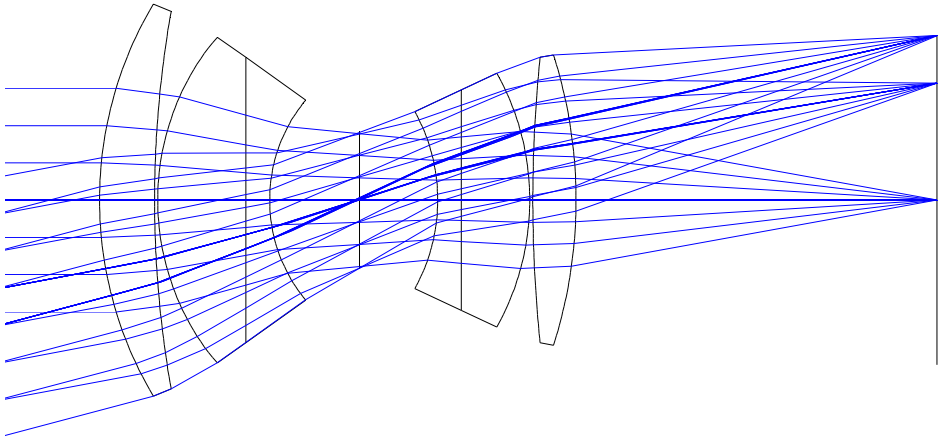
Courbure de champ

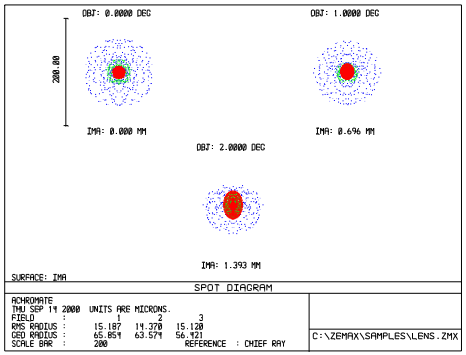


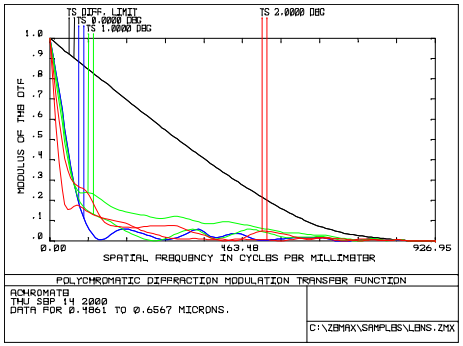
Distorsion

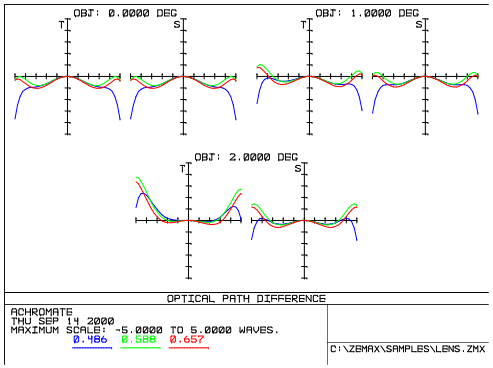


# Calcul de systèmes optiques

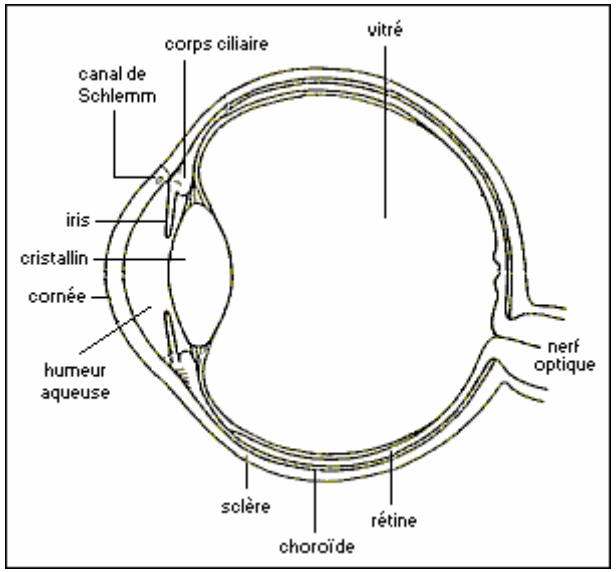




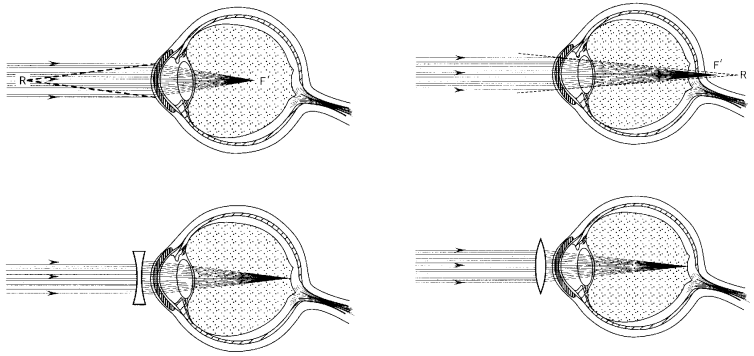
# L'oeil



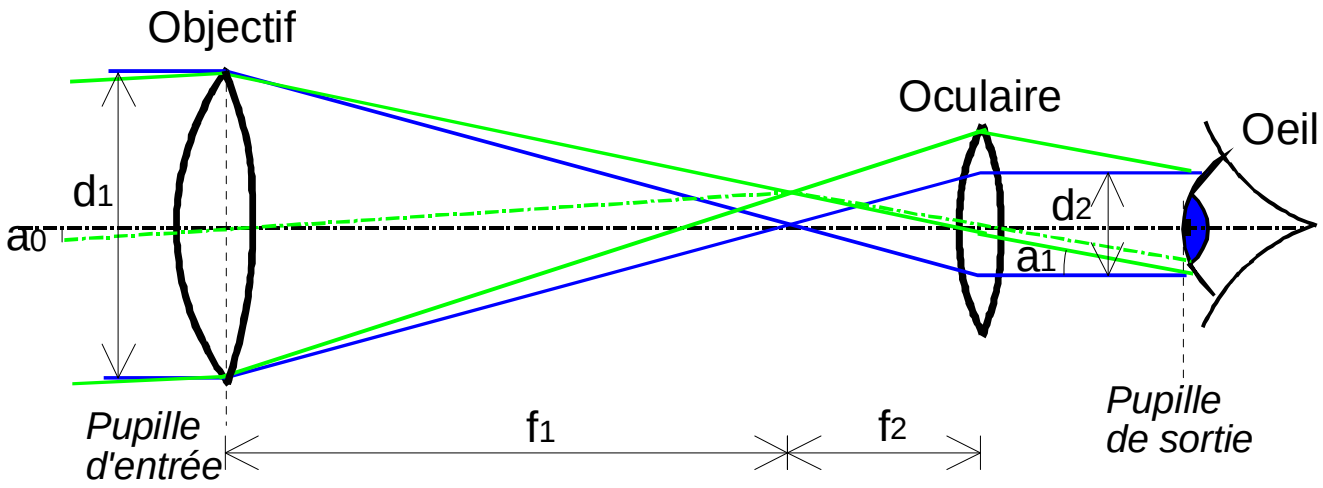

## Principales caractéristiques

- diamètre de la pupille: 3 mm
- diamètre angulaire du disque d'Airy: 1.5'
- distance moyenne entre cellule réceptrices:2 - 2.5 μm
- champ de vision à haute résolution: 1°
- dynamique: $10^{14}$.
- seuil de détection (entrée dans l'oeil): 100 photons/s

Défauts oculaires:

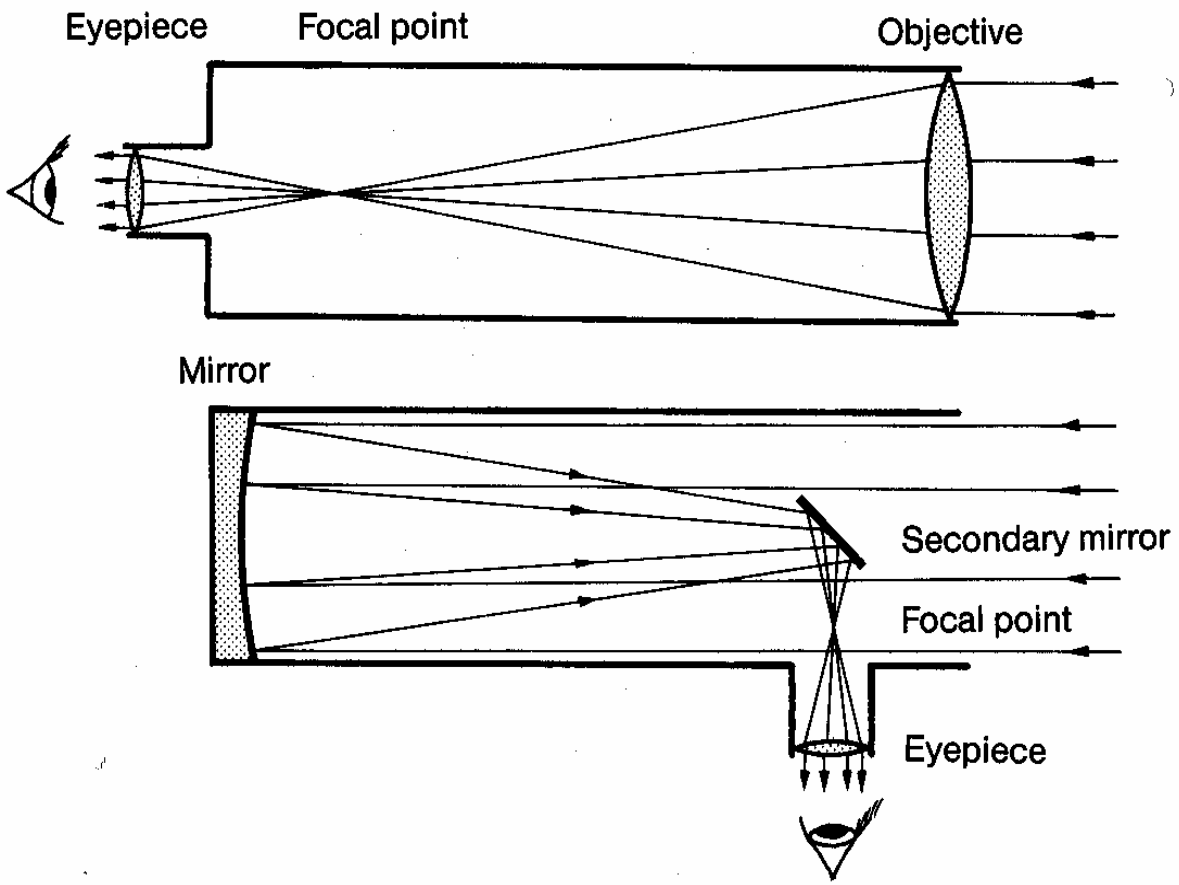


# Lunette: principe, pupilles et grossissement

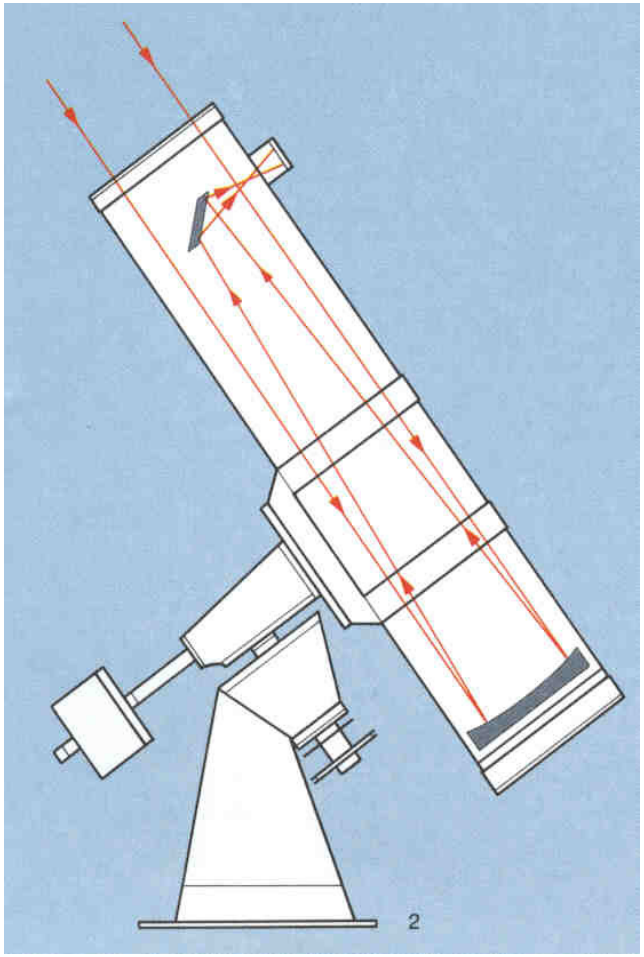



Grossissement: $G = \frac{\alpha_1}{\alpha_0} = \frac{f_1}{f_2} = \frac{d_1}{d_2}$

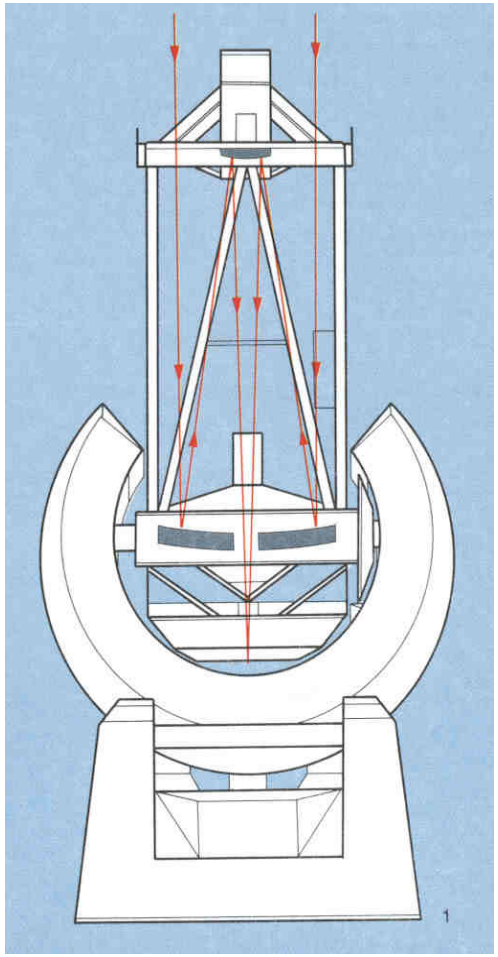
# Principe du télescope



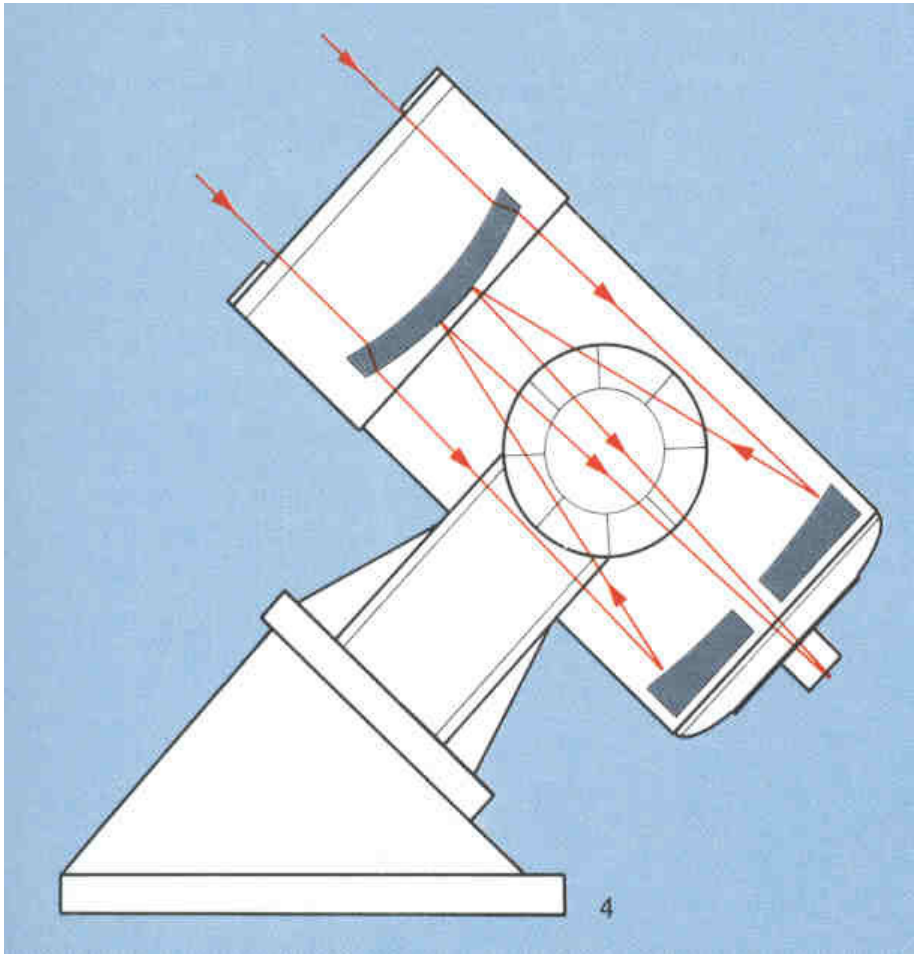
# Télescope de Newton



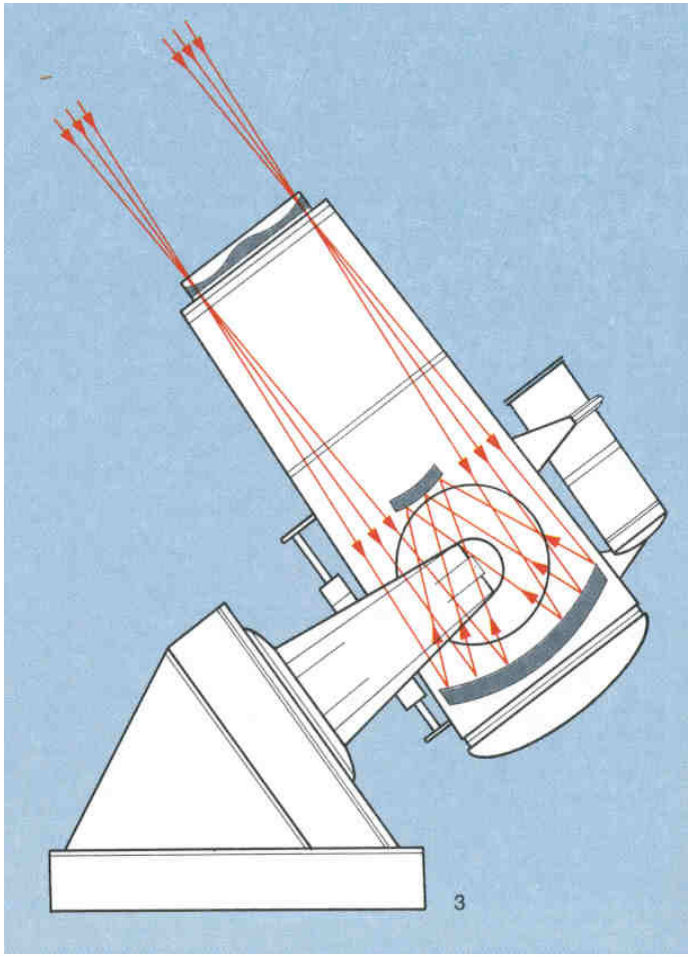
# Télescope de Cassegrain



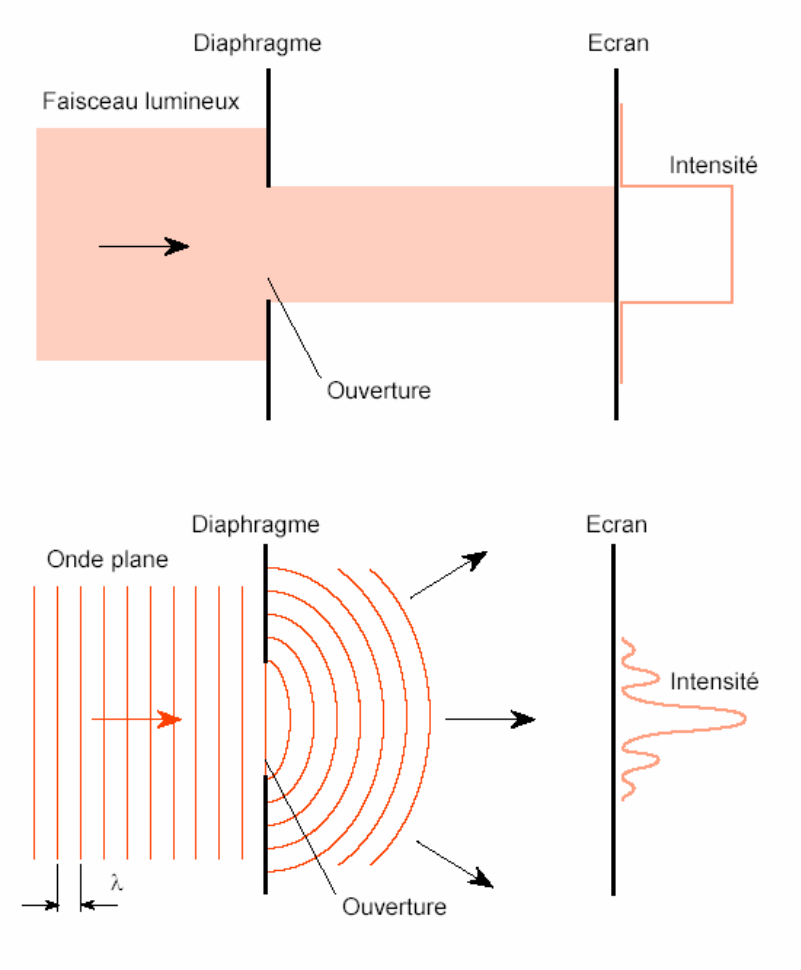
# Télescope de Matsukov



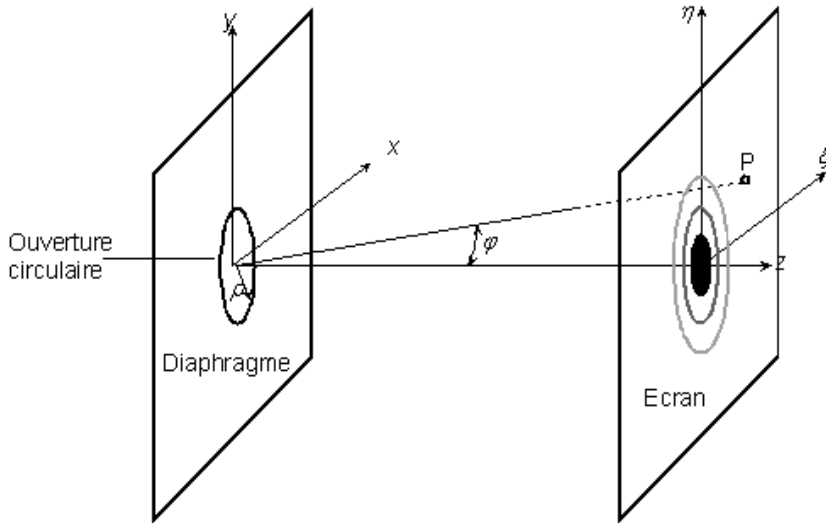
# Télescope de Schmidt

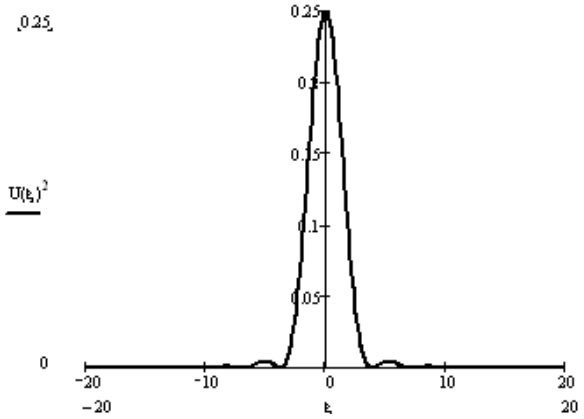


# Diffraction



# Diffraction par une ouverture circulaire

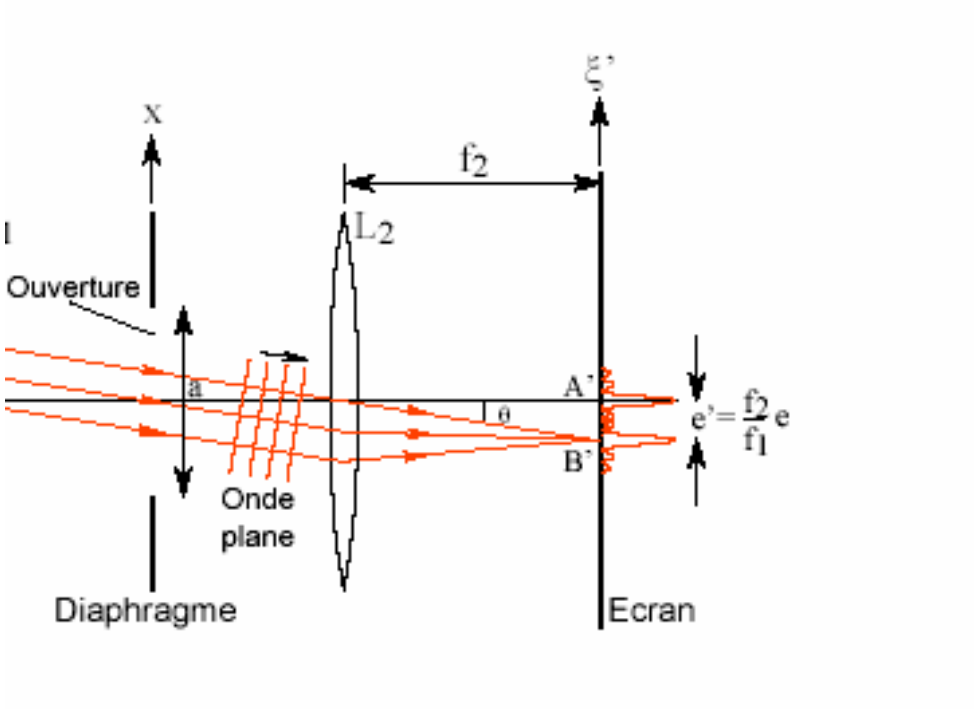


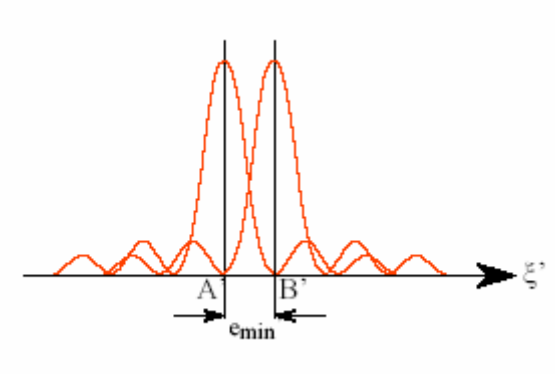

***Rayon angulaire du premier anneau noir:***

$$\varphi_0 = \frac{122\lambda}{2\rho}$$

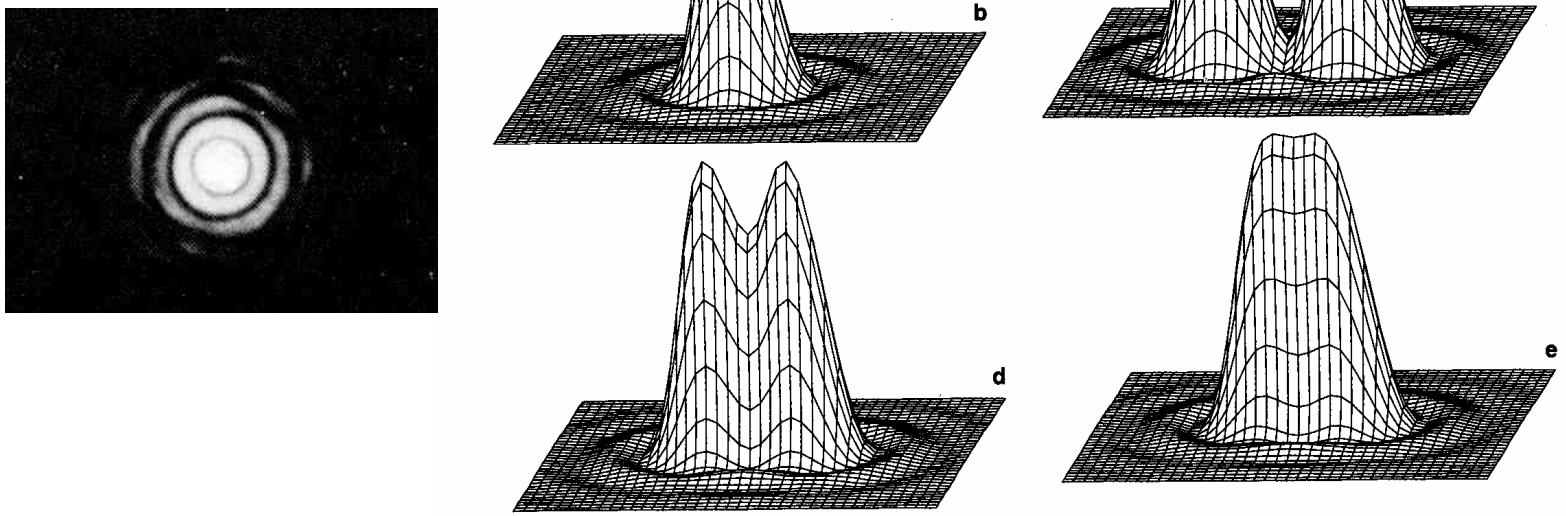
# Pouvoir séparateur d'un objectif




***Critère de Rayleigh***

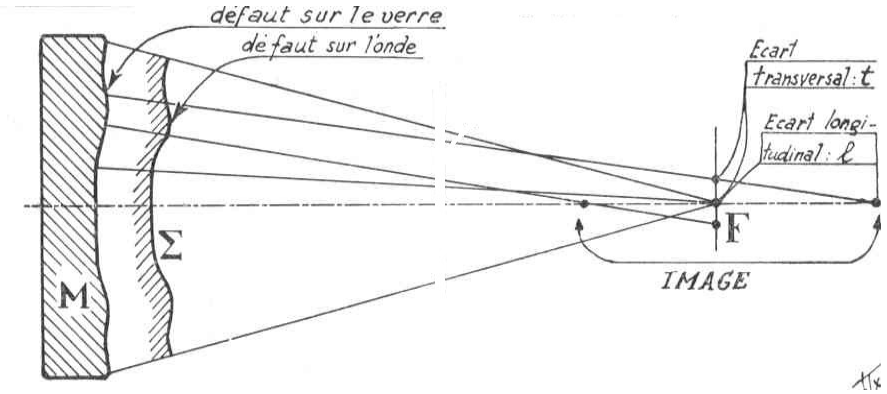


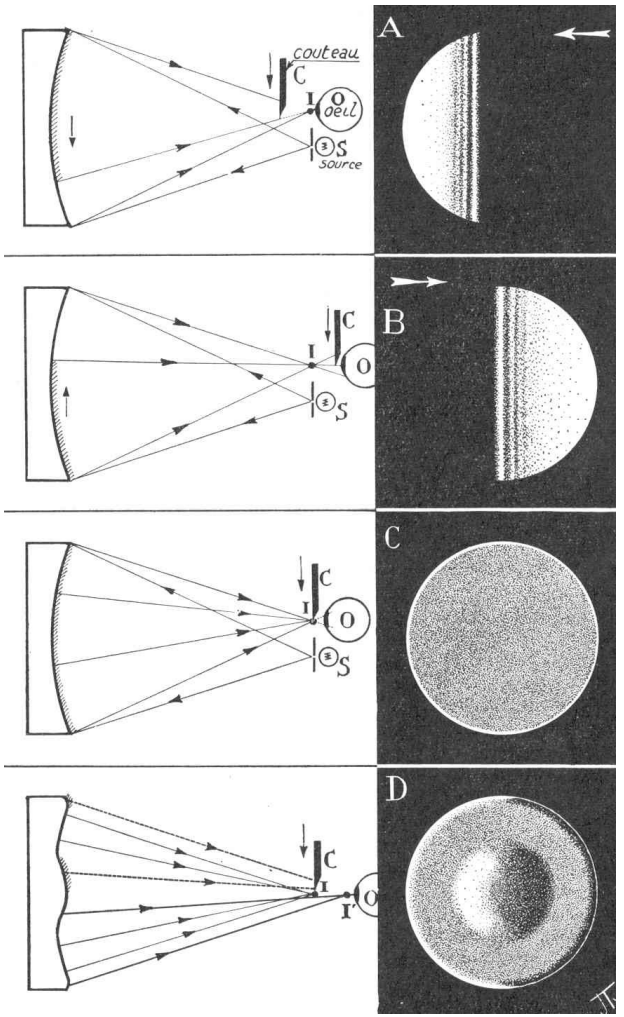
# Résolution d’un instrument



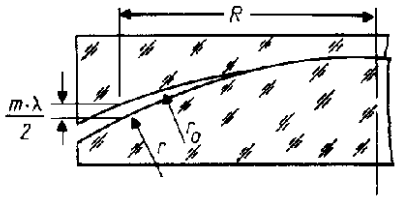
# Polissage du miroir principal

# Méthode de Foucault



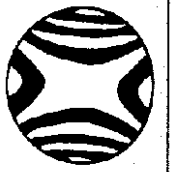



# Contrôle interférométrique des surfaces



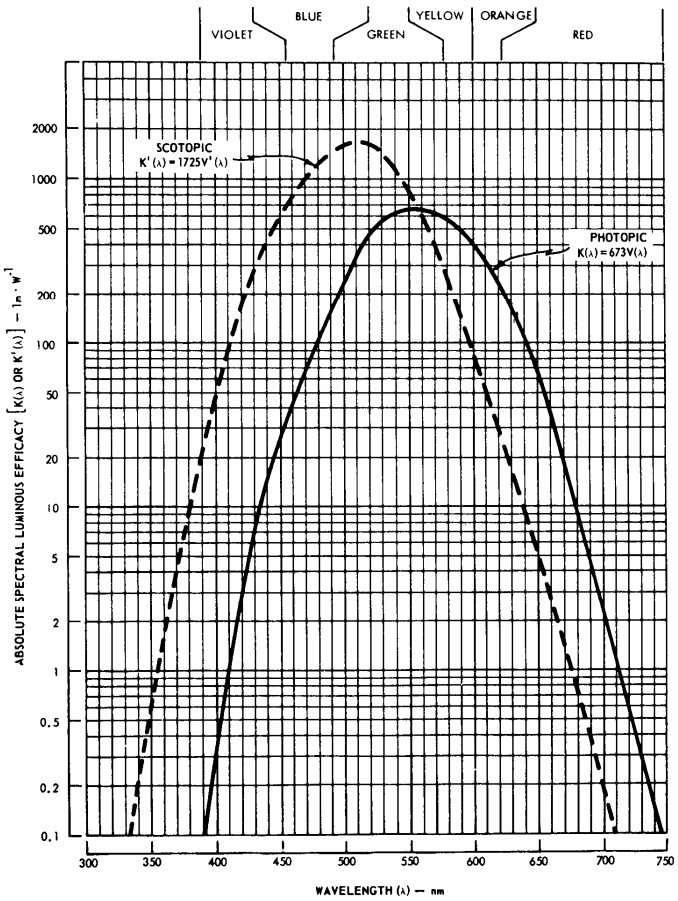

Grobpaßfehler

Feinpaßfehler

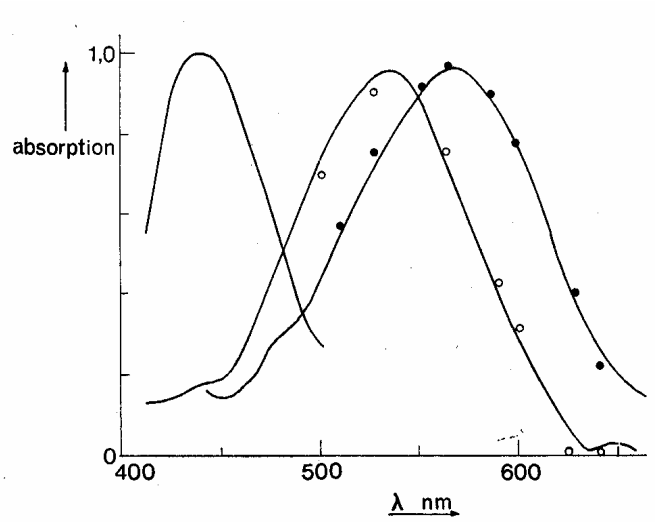
| | Regelmäßige Paßfehler | | | |
|---|---|---|---|---|
| Paßfehler-Typ | Kreispaß | Ovalpaß | Zylinderpaß | Sattelpaß |
| Bildbeispiel (DIN 3140 T5) |  |  |  |  |
| vertikal | $m_2 = 3$ | $m_2 = 4$ | $m_2 = 4$ | $m_2 = 3$ |
| horizontal | $m_1 = 3$ | $m_1 = 2$ | $m_1 = 0$ | $m_1 = -1$ |

# Photométrie - Colorimétrie

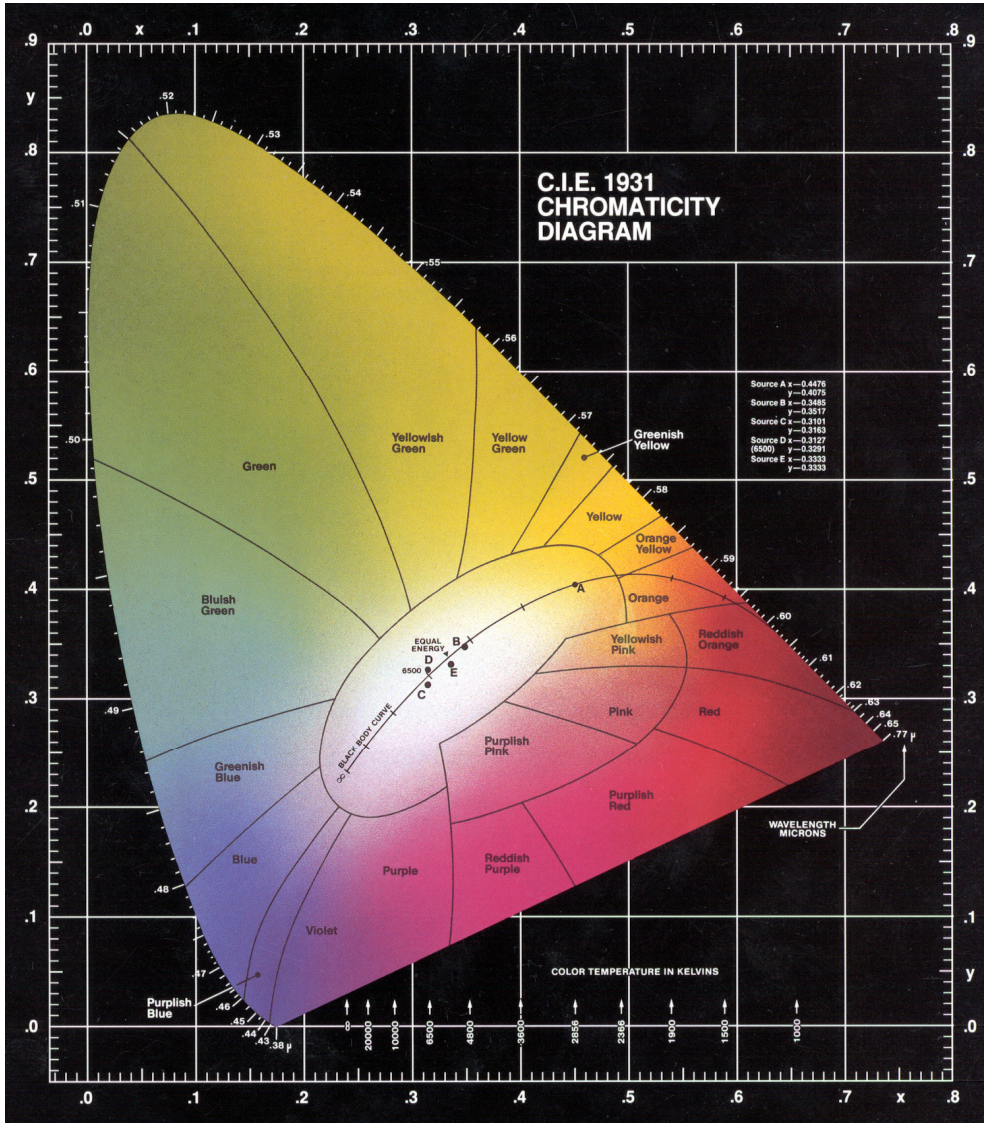
Sensibilité spectrale de l'oeil




Sensibilité spectrale des cônes



# Colorimétrie




$$x = \frac{R}{R+G+B}$$

$$y = \frac{V}{R+G+B}$$

**Questions?**

Merci de votre attention !