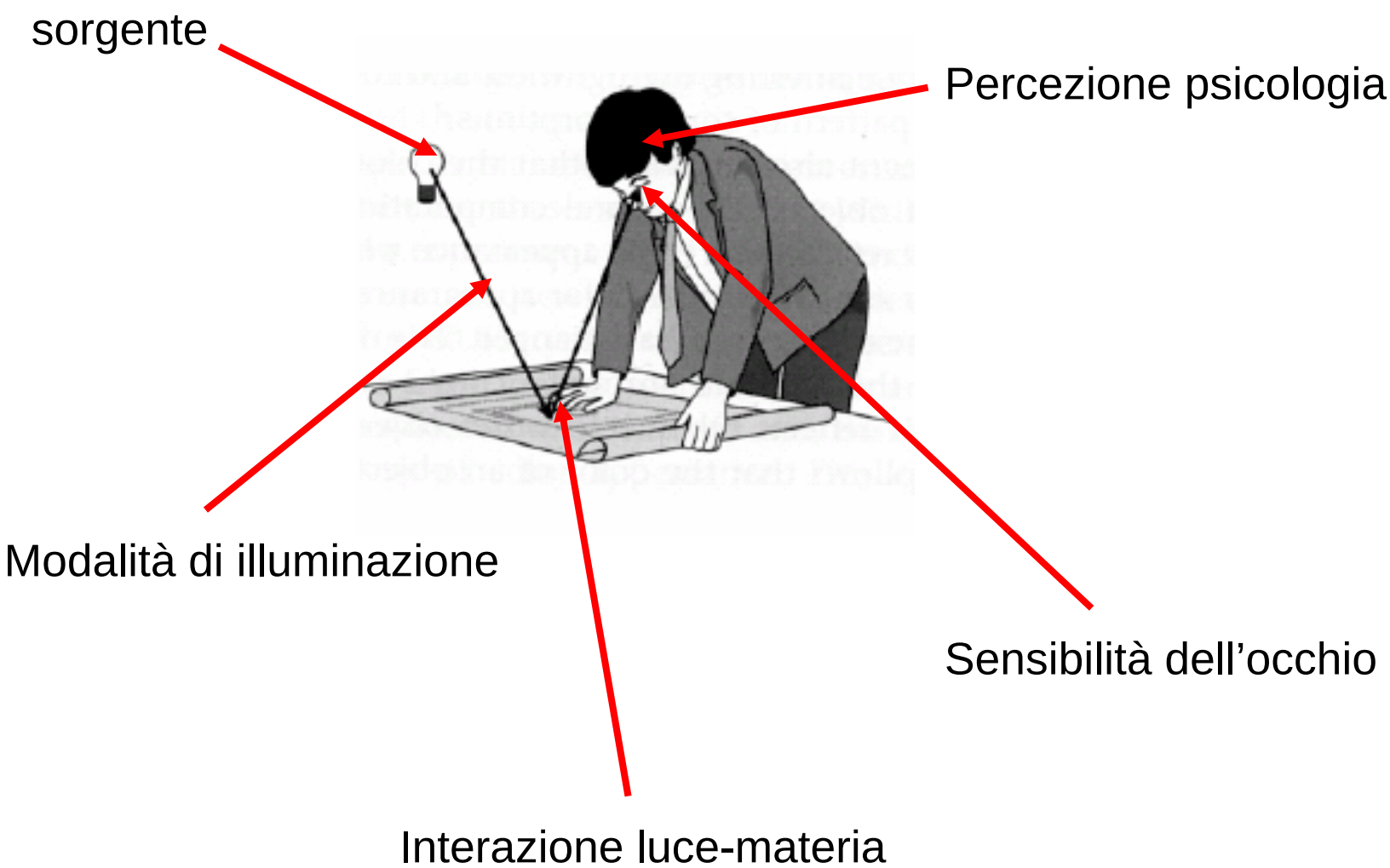
Università degli Studi di Firenze

Facoltà d' Ingegneria
Dipartimento di Elettronica e Telecomunicazioni

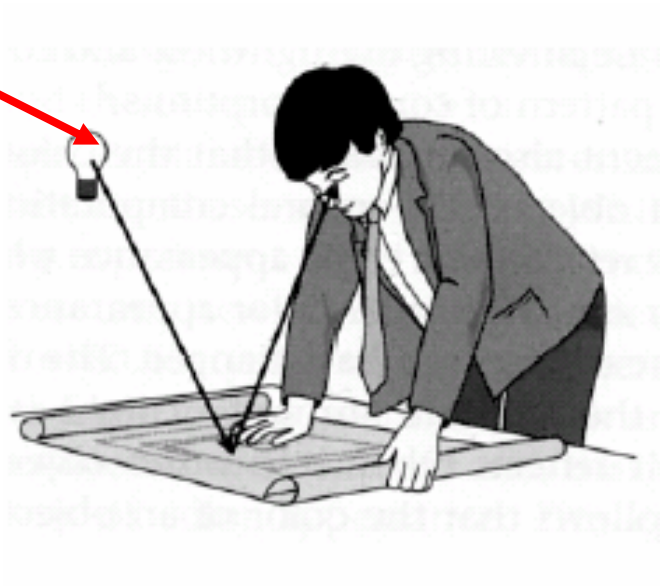
Colorimetria

Massimiliano Pieraccini

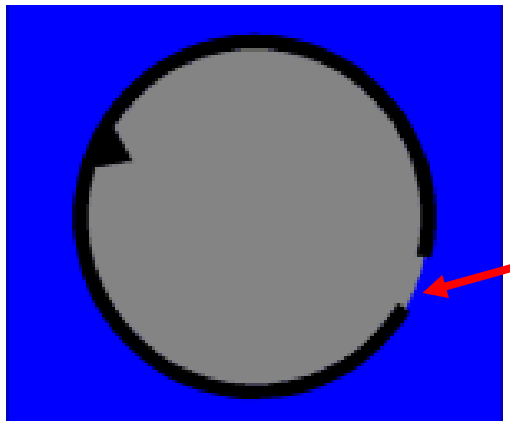

sorgente
Percezione psicologia
Modalità di illuminazione
Sensibilità dell’occhio
Interazione luce-materia

Sorgente

sorgente



Corpo Nero



Corpo nero

ϕ **= flusso (W)**

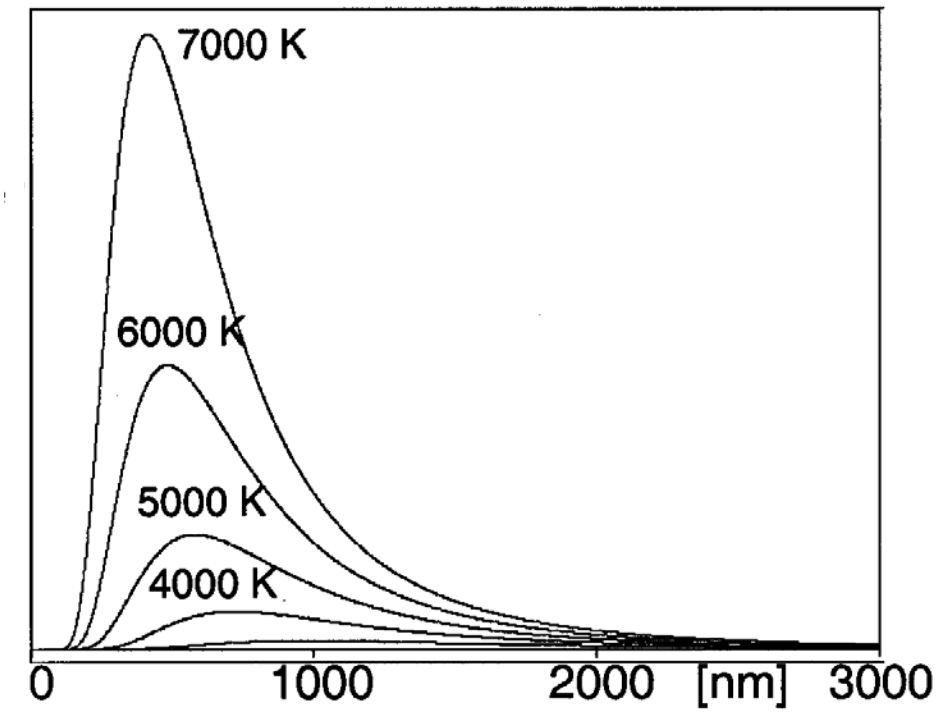
Legge di Plank

$$\frac{d\phi}{dA\,d\lambda} = \frac{2\pi hc^2}{\lambda^5}\,\frac{1}{e^{\frac{hc}{kT\lambda}} - 1}$$

dA = superficie irradiante
λ = lunghezza d'onda
h = costante di Plank
c = velocità della luce

Spettro del corpo nero

$$\frac{d\phi}{dA\,d\lambda}\left[\frac{W}{m^3}\right]$$



Legge di Wien

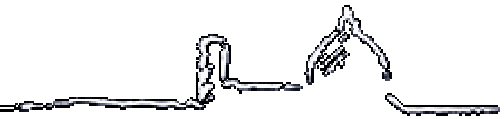
$$\lambda_{max} T = 2880\,\mu m\,K$$

Legge di Stefan-Boltzman

$$\frac{d\phi}{dA} = \sigma T^4$$

σ =5.67×10^{-8} W/(m^2 K^4)

Temperatura del colore



Candela	1500 K
Lampada a incandescenza da 40W	2680 K
Lampada a incandescenza da 200W	3000 K
Alba/Tramonto	3200 K
Lampada al tungsteno	3400 K
Sole a mezzogiorno con il cielo terso	5000 K
Flash fotografico	5500 K
Cielo nuvoloso	7000 K
Cielo azzurro	11000 K

SORGENTI E ILLUMINANTI

Sorgente A
corpo nero a T=2856°K (lampada a incandescenza)

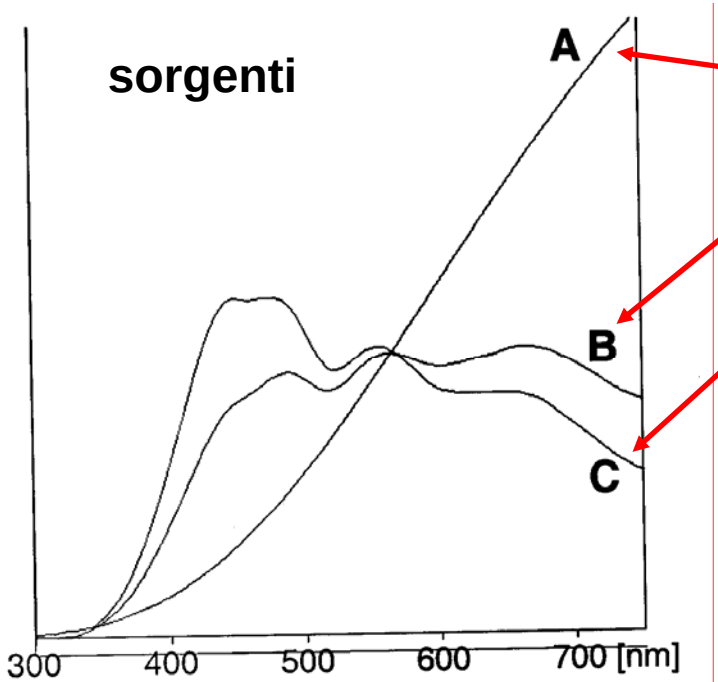
Sorgente B
luce del sole diretta (sorgente A + filtri) T=4874°K

Sorgente C
Luce del sole diretta + luminosità del cielo (sorgente A + filtri) T=6774°K

Illuminanti D_{65},D_{55},D_{75}
luce del sole diretta + luminosità del cielo, T=6504, 5503, 7504°K

Illuminante E
distribuzione spettrale costante tra 400nm e 700nm

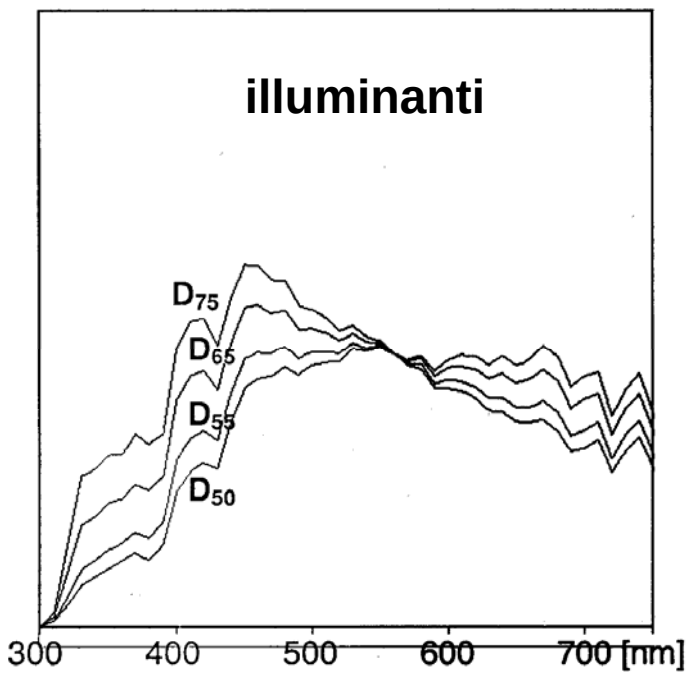
Sorgenti e illuminanti



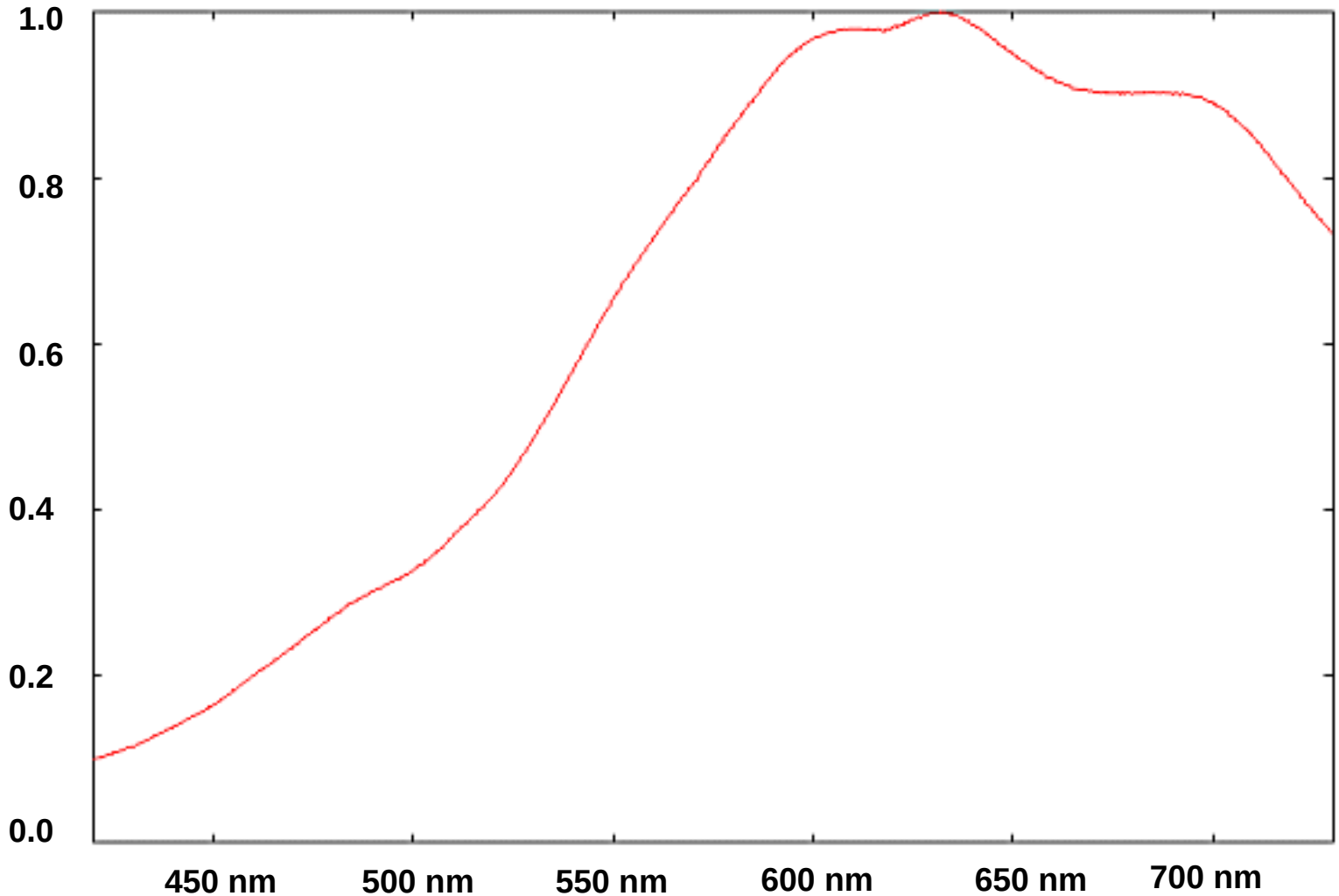
(lampada a incandescenza)

luce del sole diretta

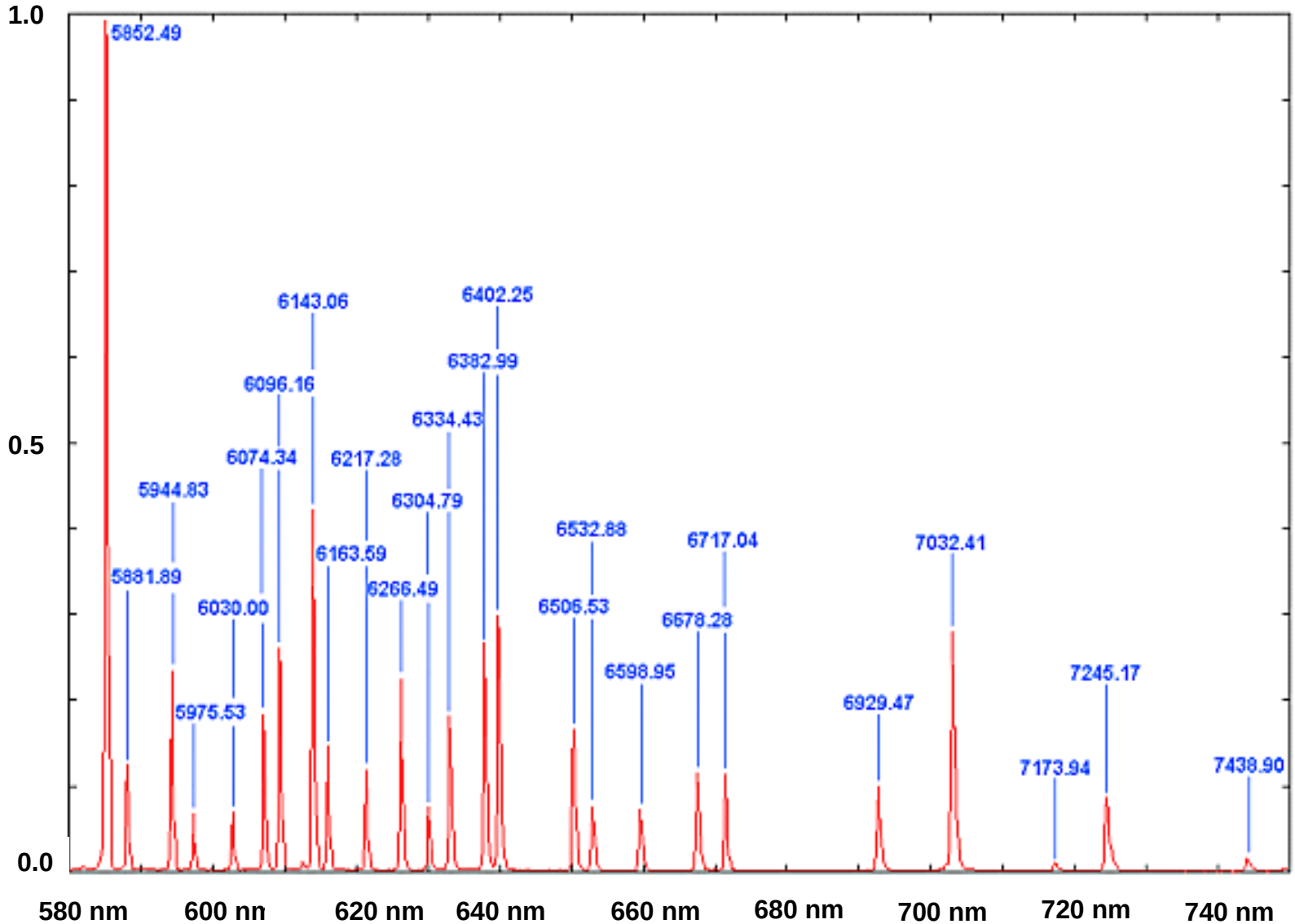
Luce del sole diretta + luminosità del cielo



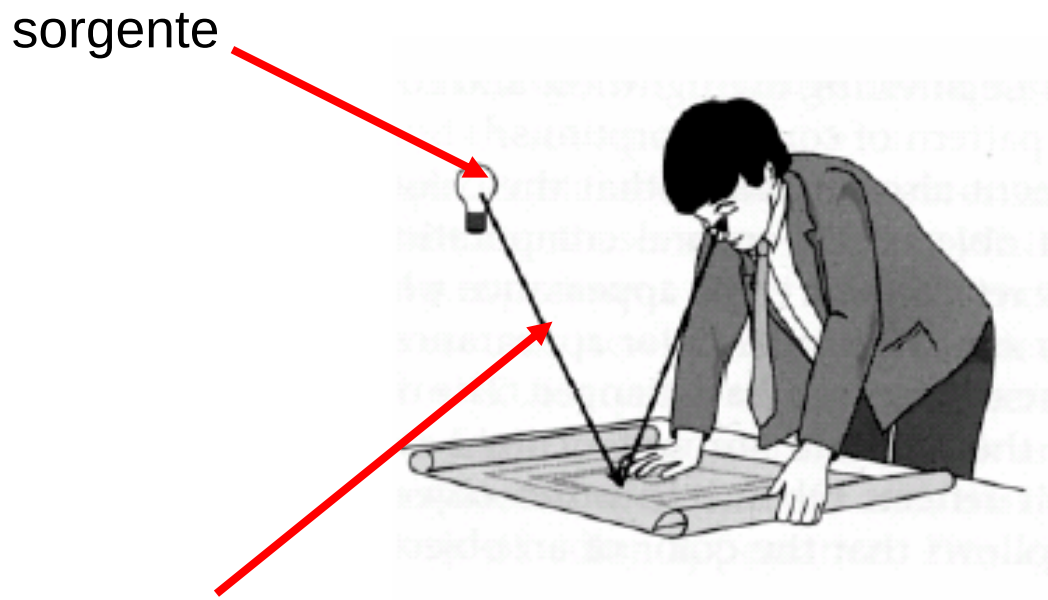
Domestic incandescent lamp



Domestic Neon Lamp

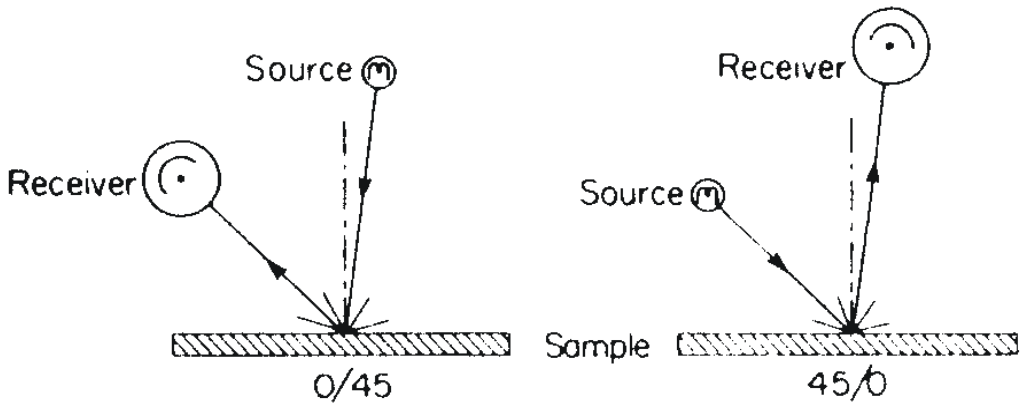


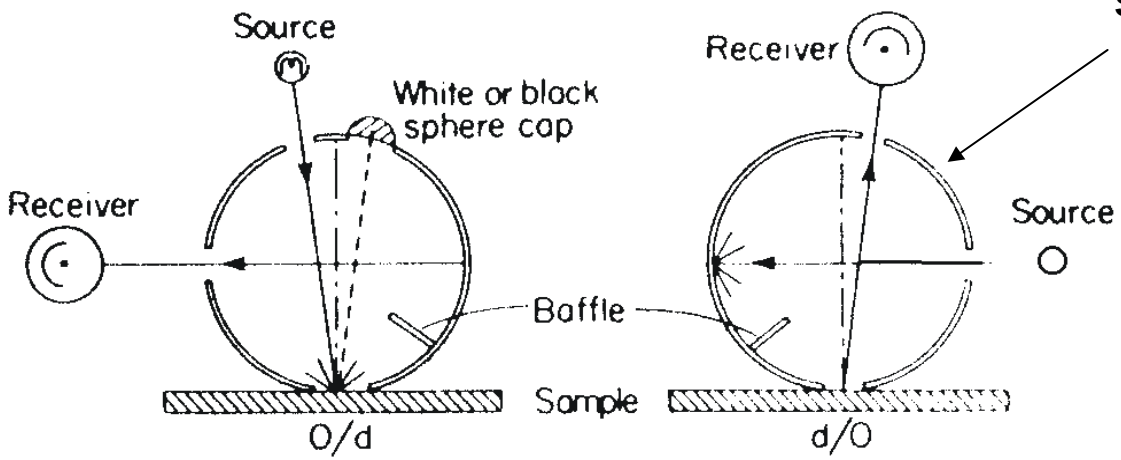
Modalità di illuminazione



Modalità di illuminazione

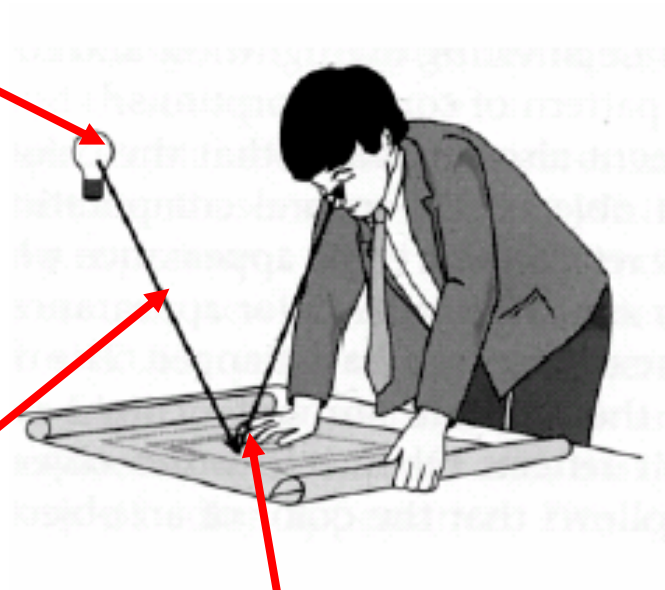
Modalità di illuminazione



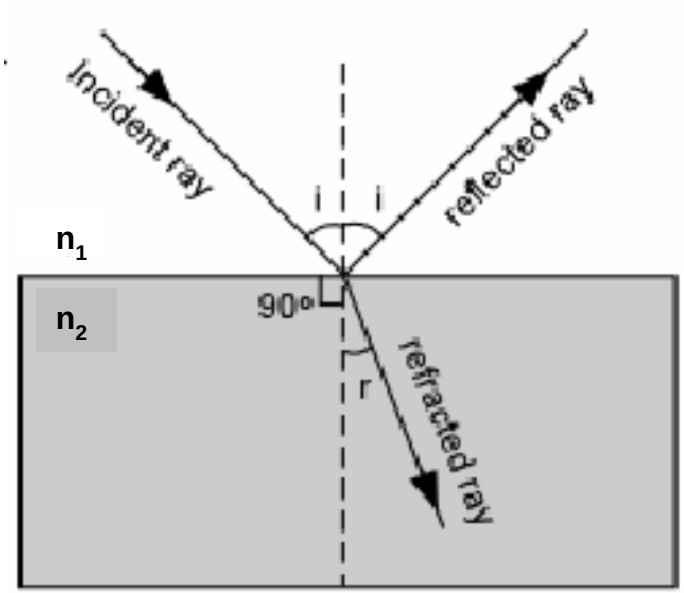


Superficie interna lambertiana

Interazione luce-materia



Riflessione e rifrazione

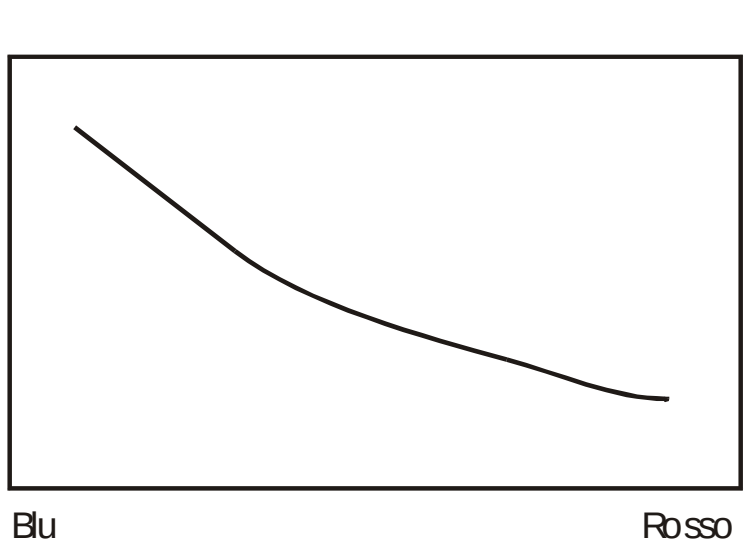


Legge di Snell $$\frac{\sin(i)}{\sin(r)} = \frac{n_2}{n_1}$$

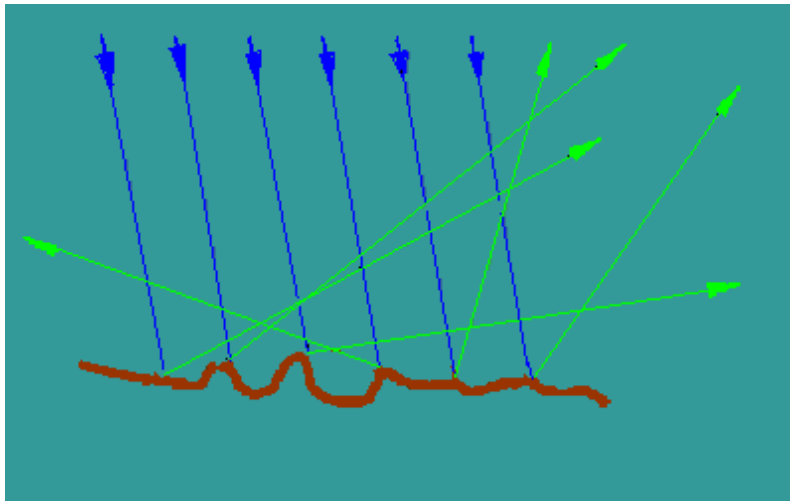
Legge di Fresnel $$R = \frac{|n_1 - n_2|}{n_1 + n_2}$$

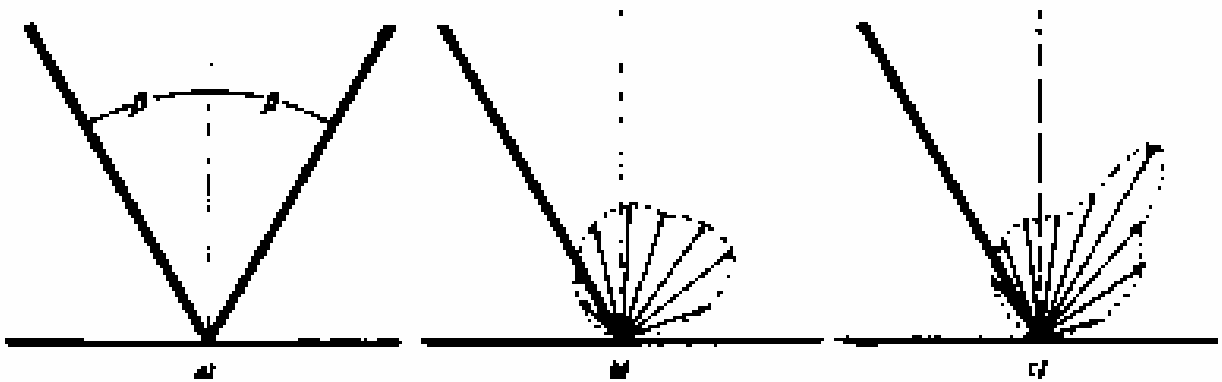
(incidenza perpendicolare)

n dipende dalla lunghezza d'onda

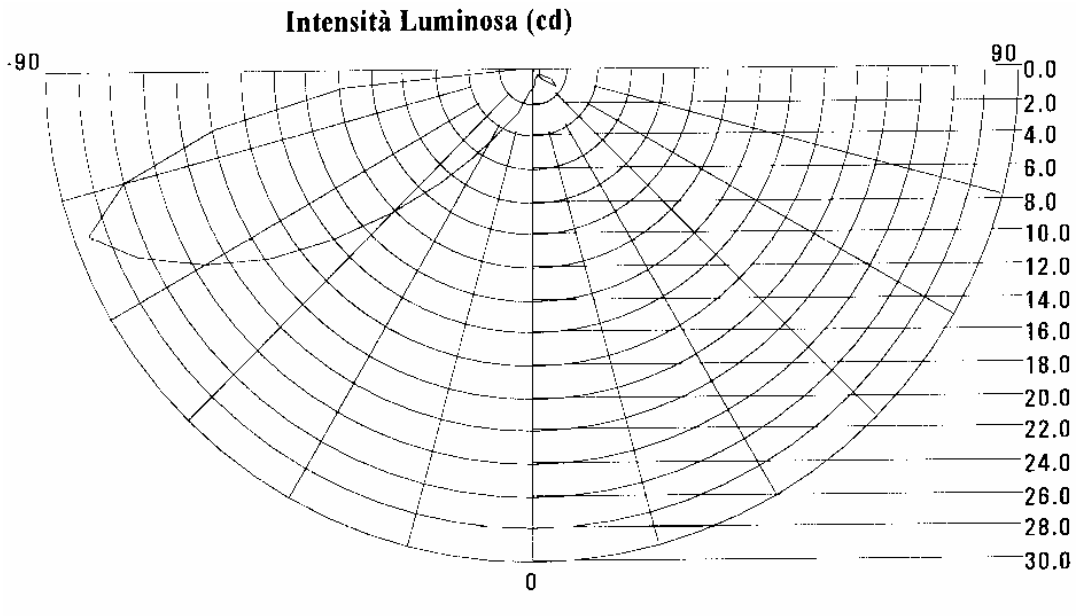


Diffusione

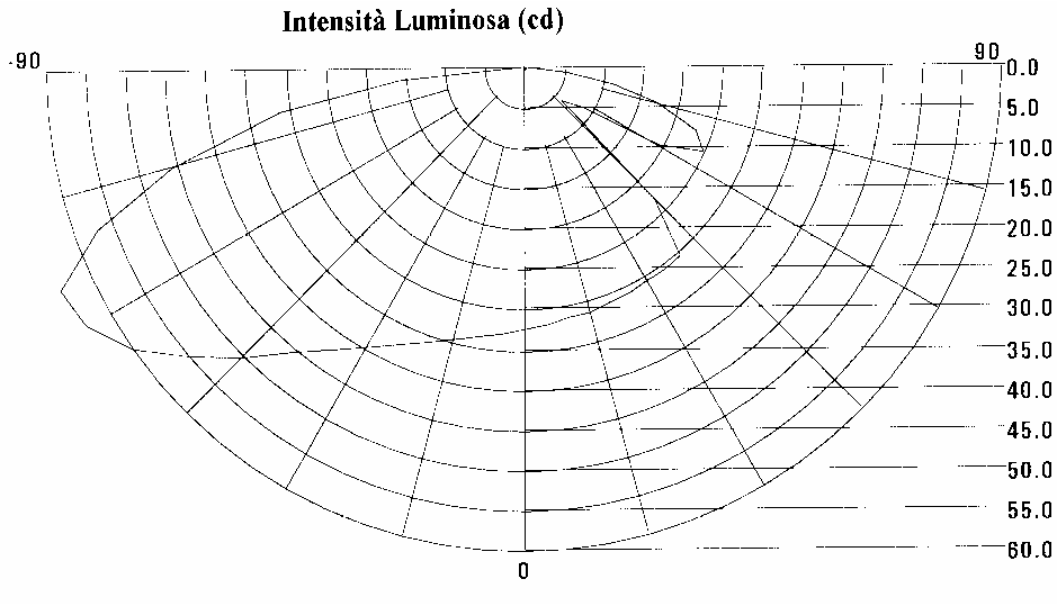




Diffusione

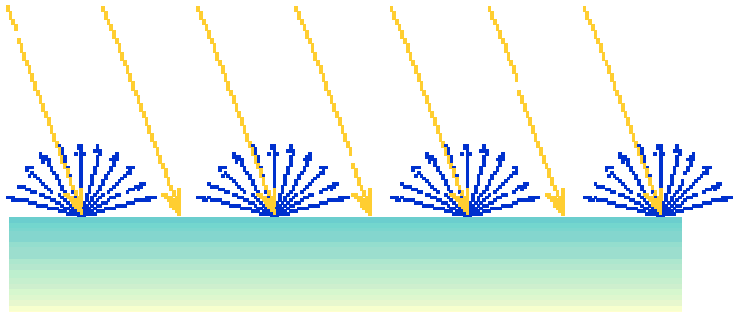


Lobo di riflessione di una pelle lucida

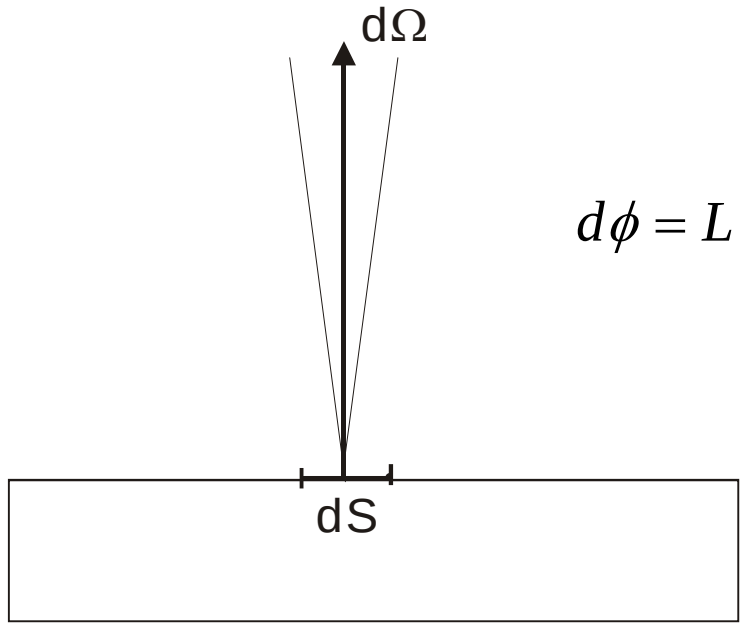


Lobo di riflessione di un foglio di carta da stampante

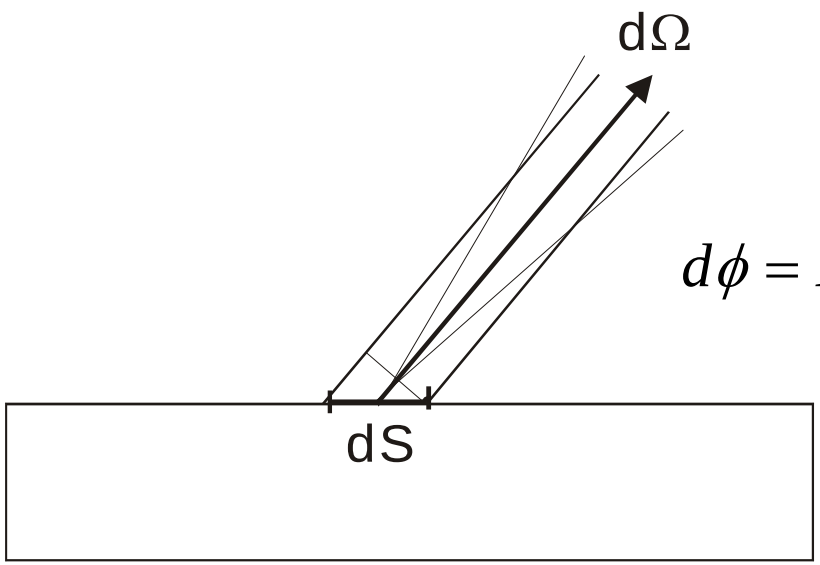
Diffusione



Legge di Lambert



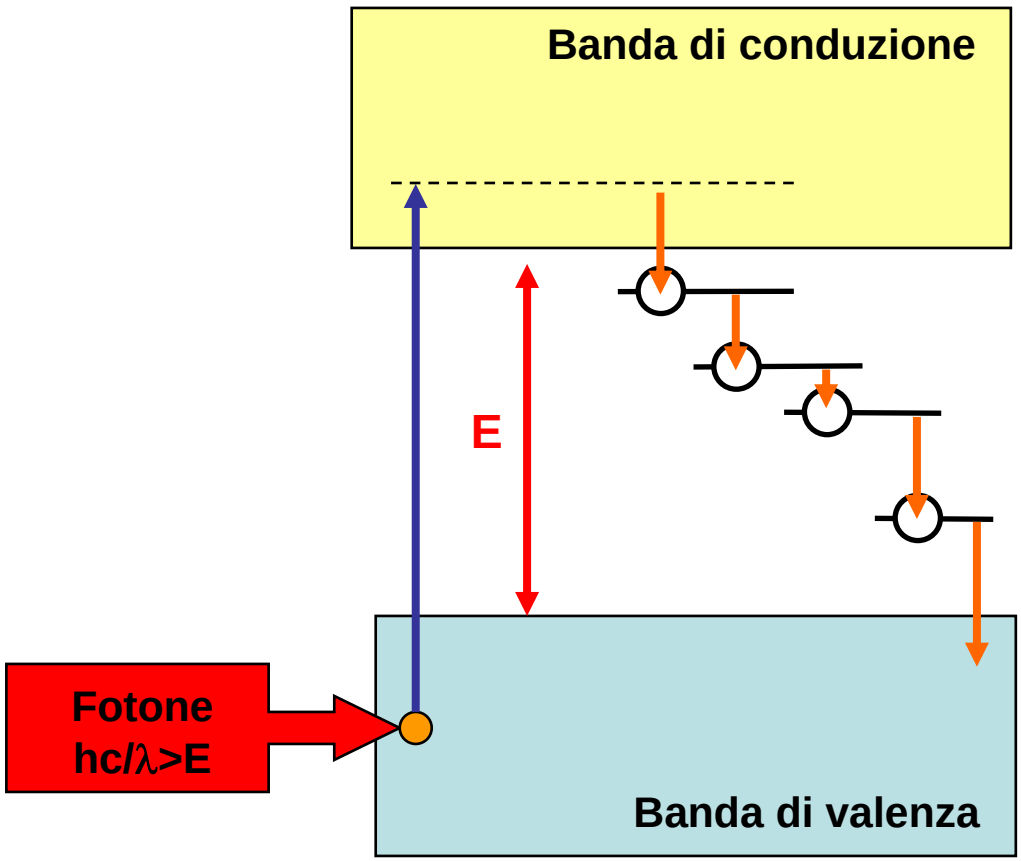
$$d\phi = L\, dS\, d\Omega$$

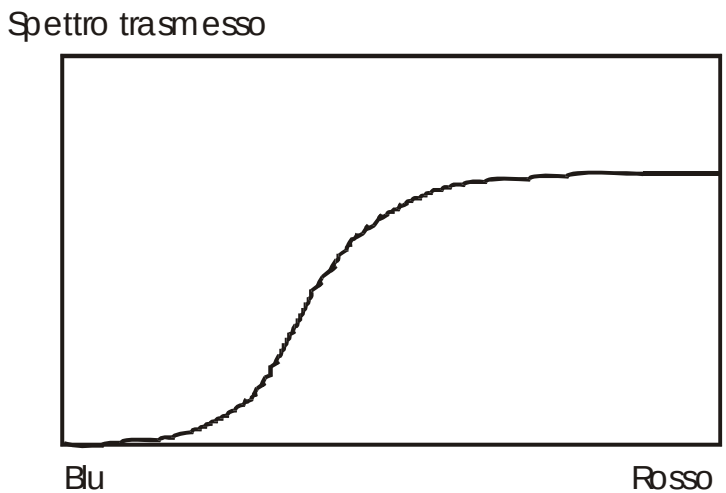


$$d\phi = L\, dS \cos(\vartheta) d\Omega$$

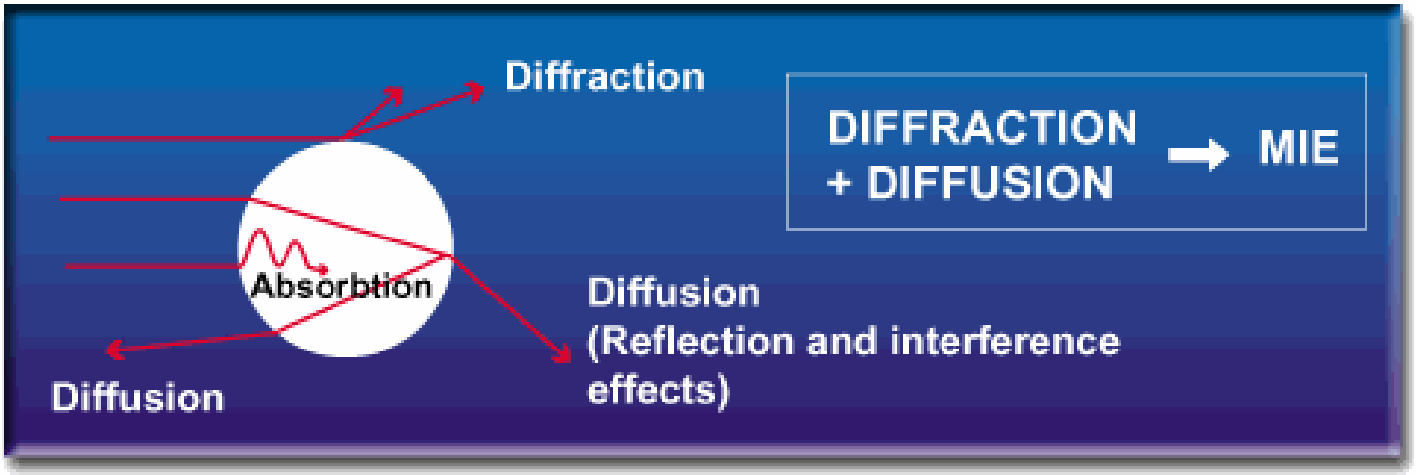
In generale $L(\vartheta)$

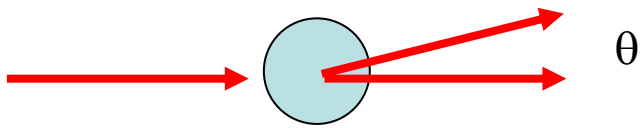
Assorbimento



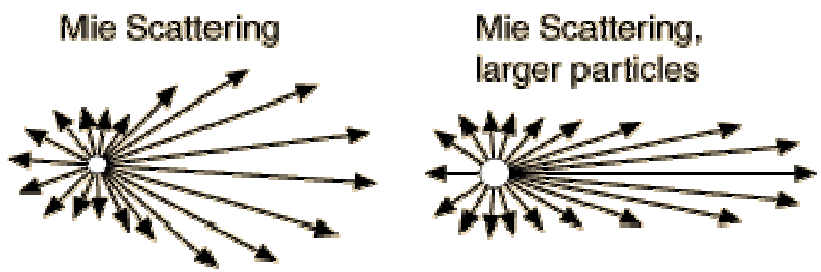


Scattering





Teoria di Mie ⟶ Pattern angolare $P(\theta,\lambda)$



Scattering

Potenza integrata sull'angolo solido

$$\propto \frac{D^6}{\lambda^4} \qquad D << \lambda$$

$$\propto \frac{D^4}{\lambda^2} \qquad D \cong \lambda$$

$$\propto D^2 \qquad D >> \lambda$$

Riflessione/Diffusione

Rifrazione

Assorbimento/Scattering

Scattering

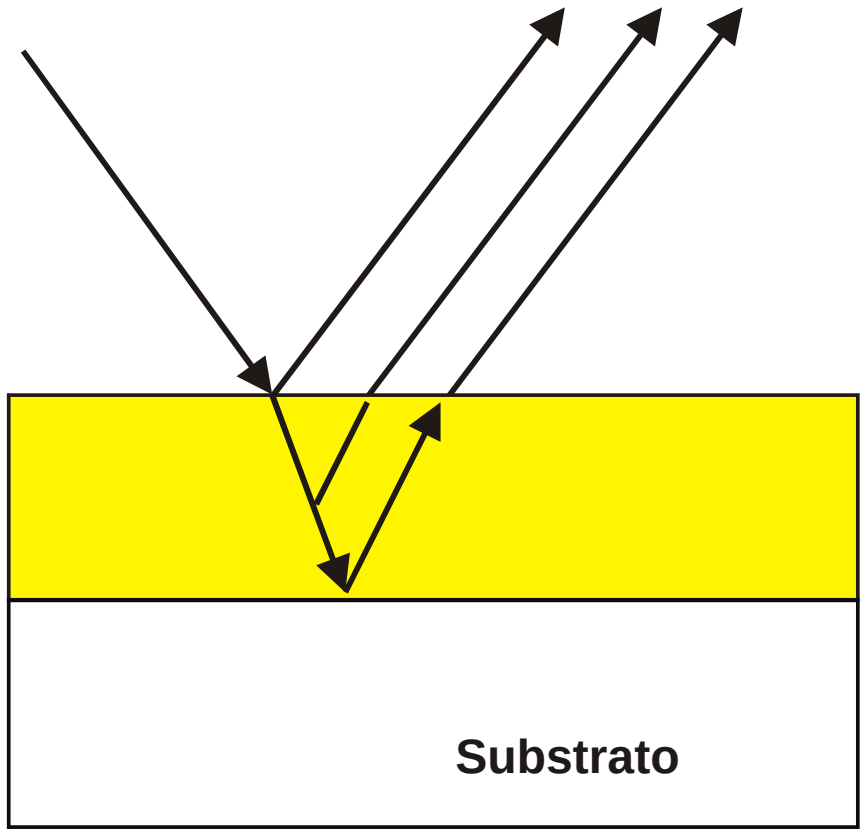
Assorbimento/Scattering

Rifrazione

Riflessione

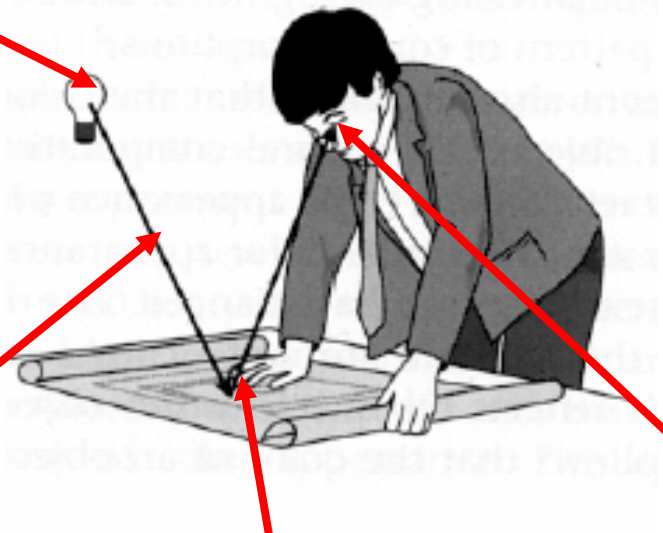
Assorbimento/Scattering

Rifrazione



“EFFETTO BAGNATO”

Colorimetria



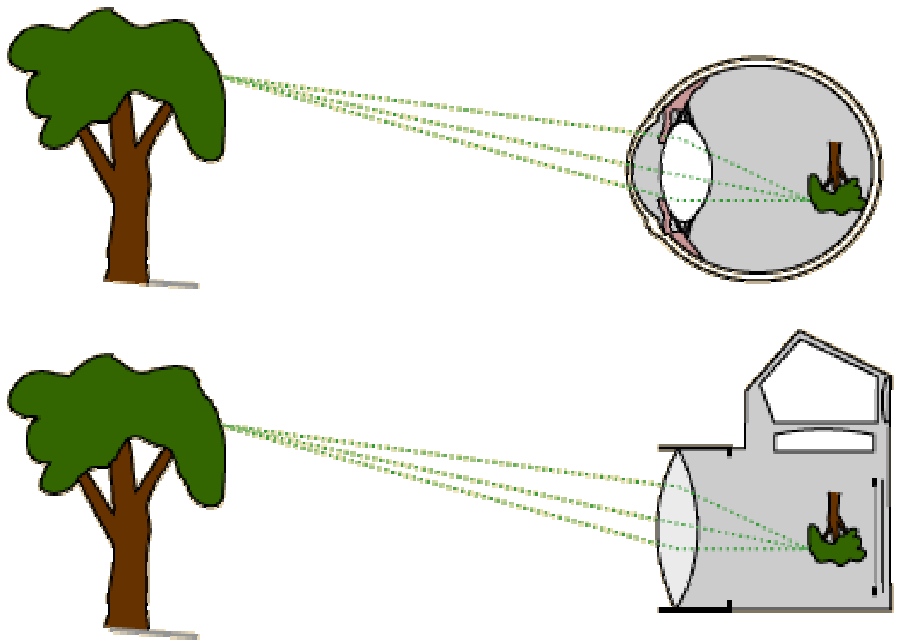
sorgente

Modalità di illuminazione

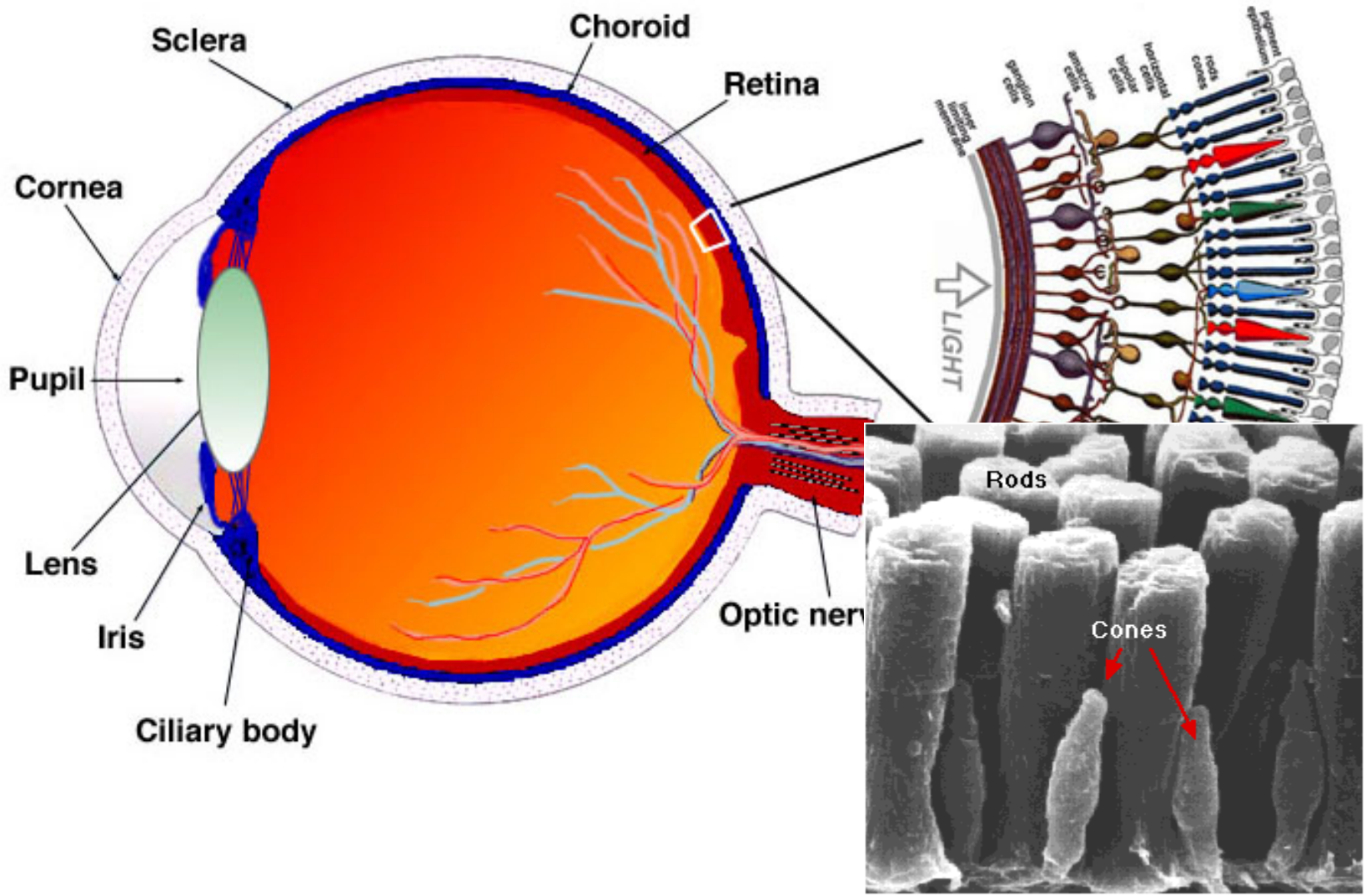
Interazione luce-materia

Sensibilità dell’occhio

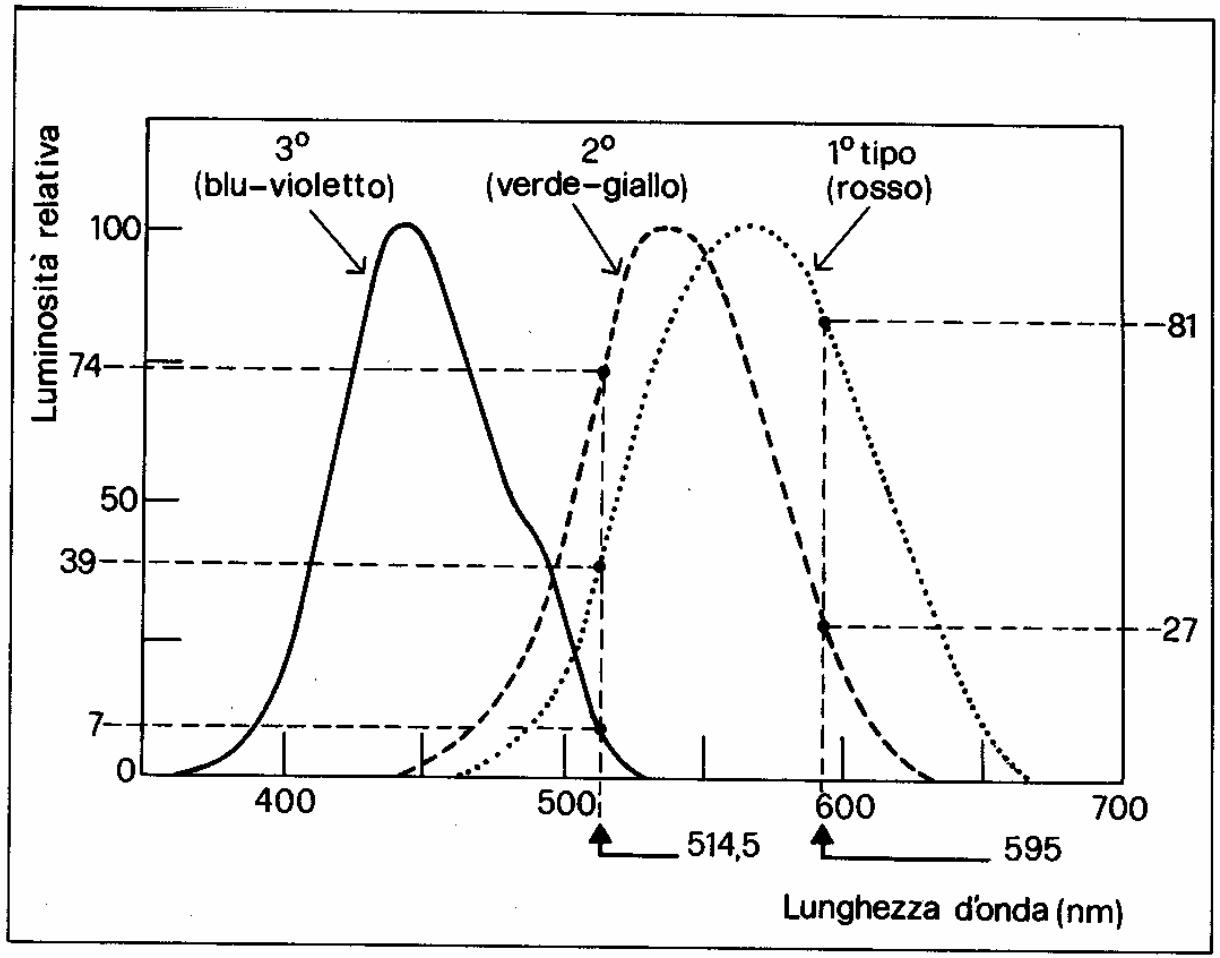
L’ occhio umano



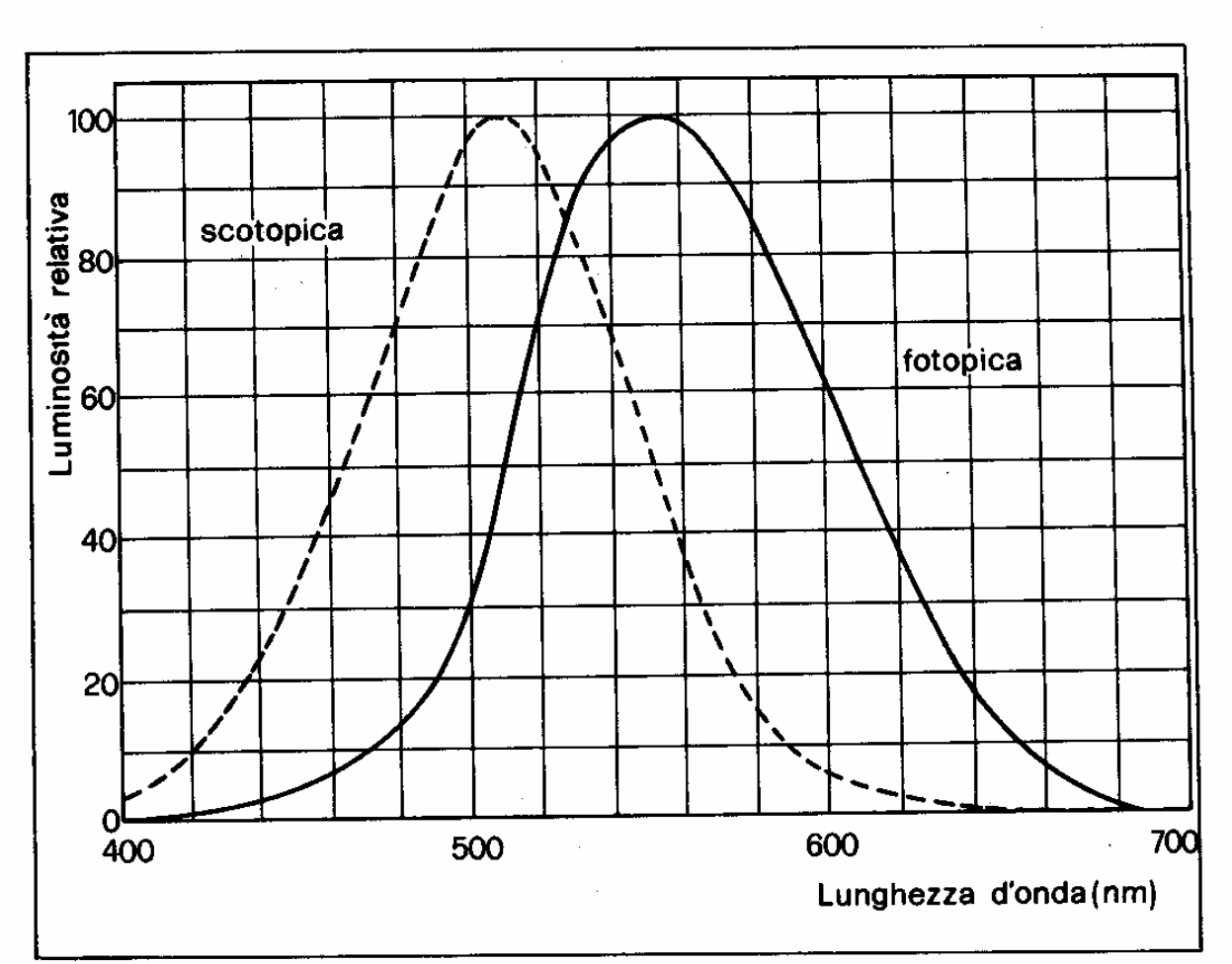
L’ occhio umano



Risposta dei coni

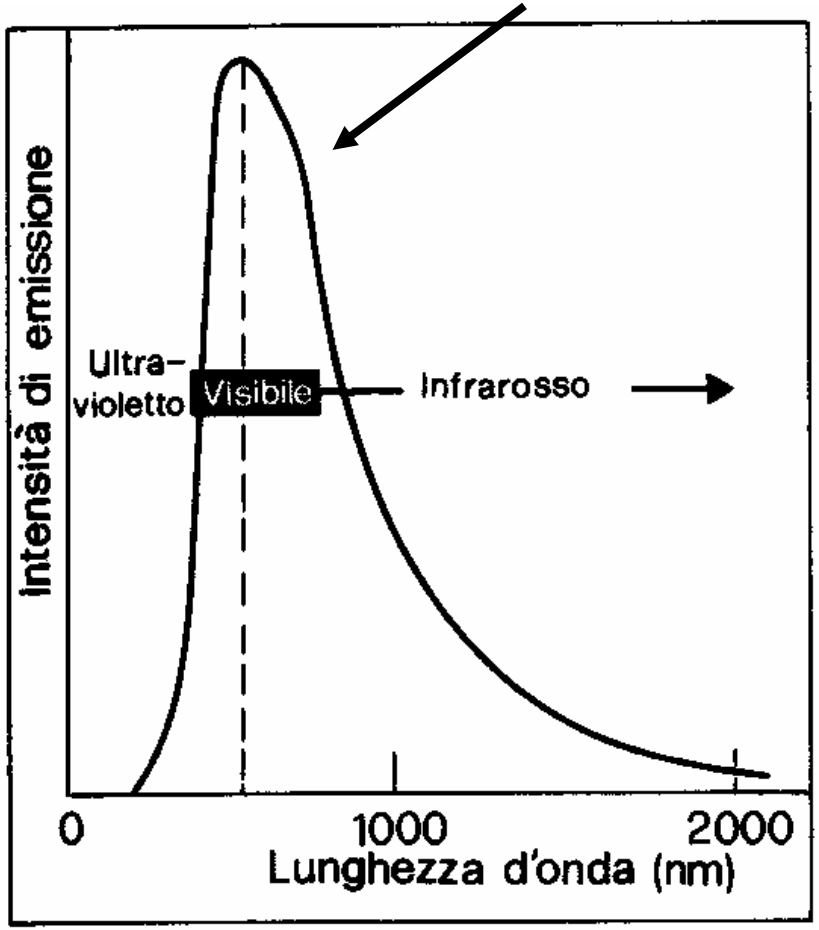


Risposta diurna e notturna (coni – bastoncelli)

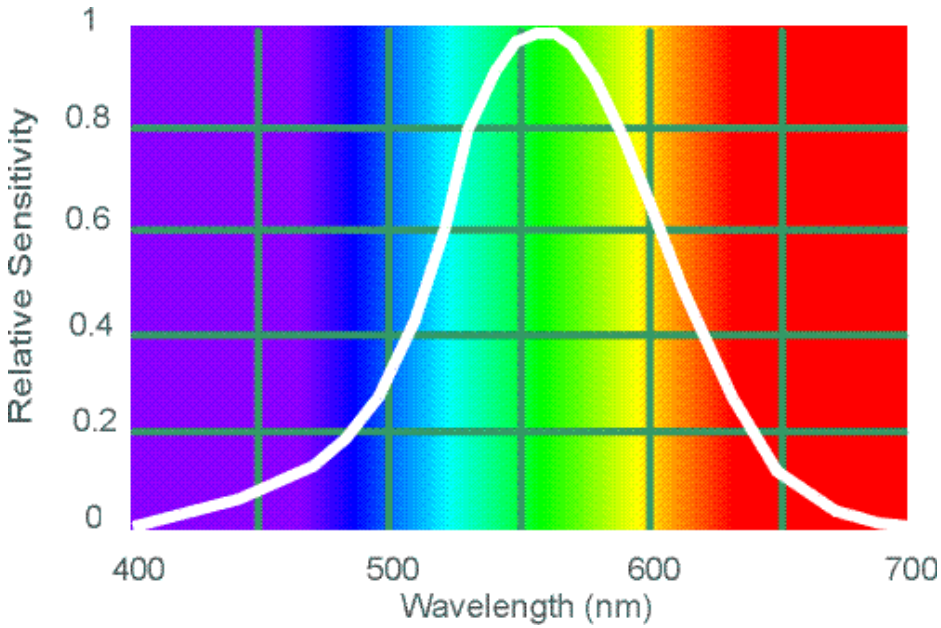


Spettro visibile

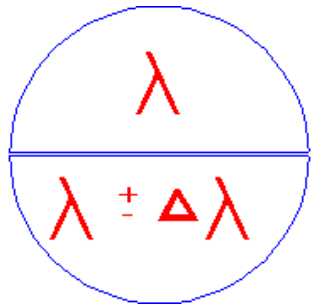
Corpo nero alla temperatura del sole

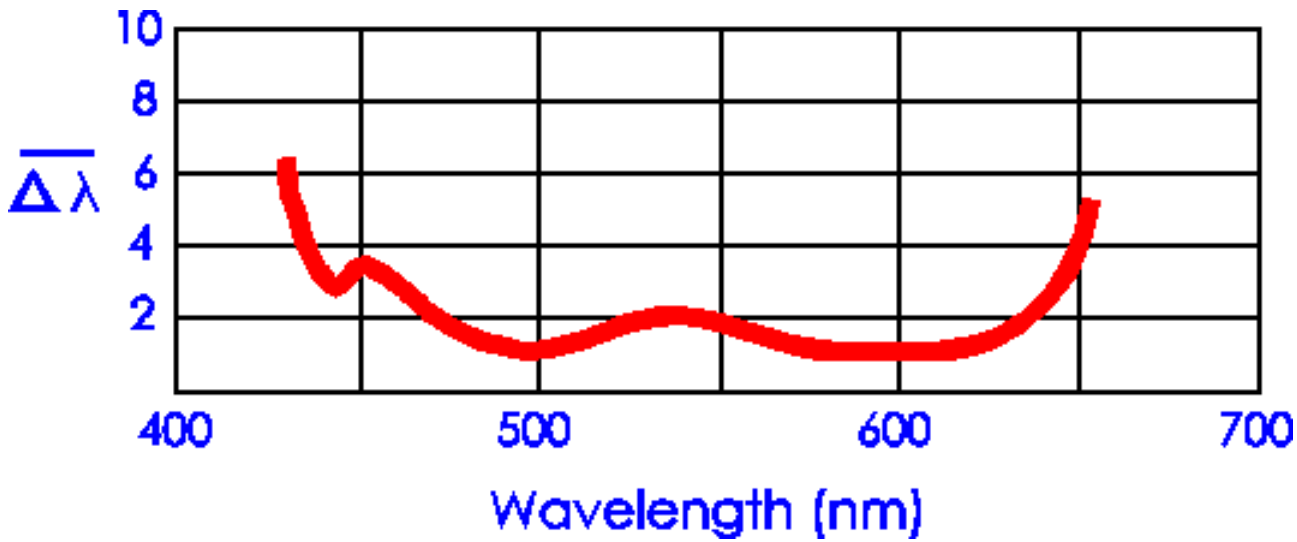


Lo spettro visibile

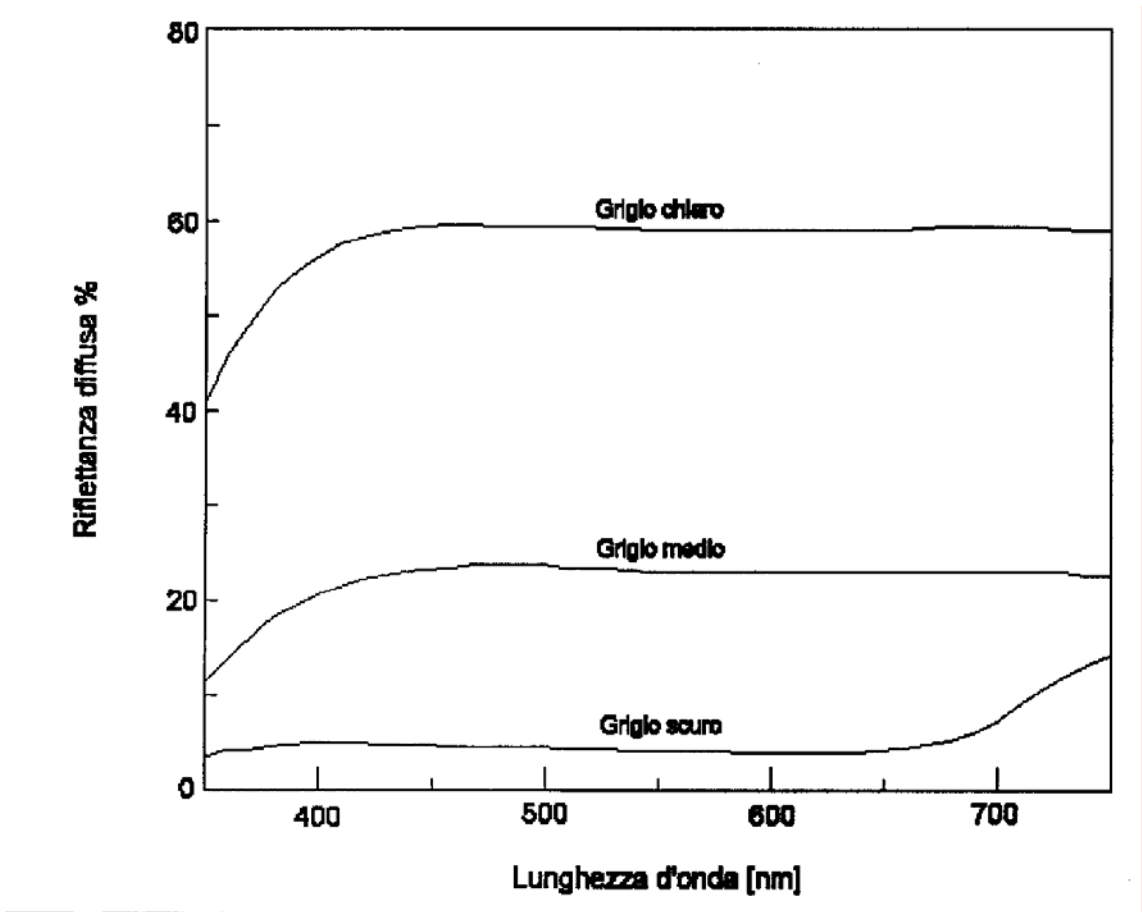


Photopic (CIE 1924)

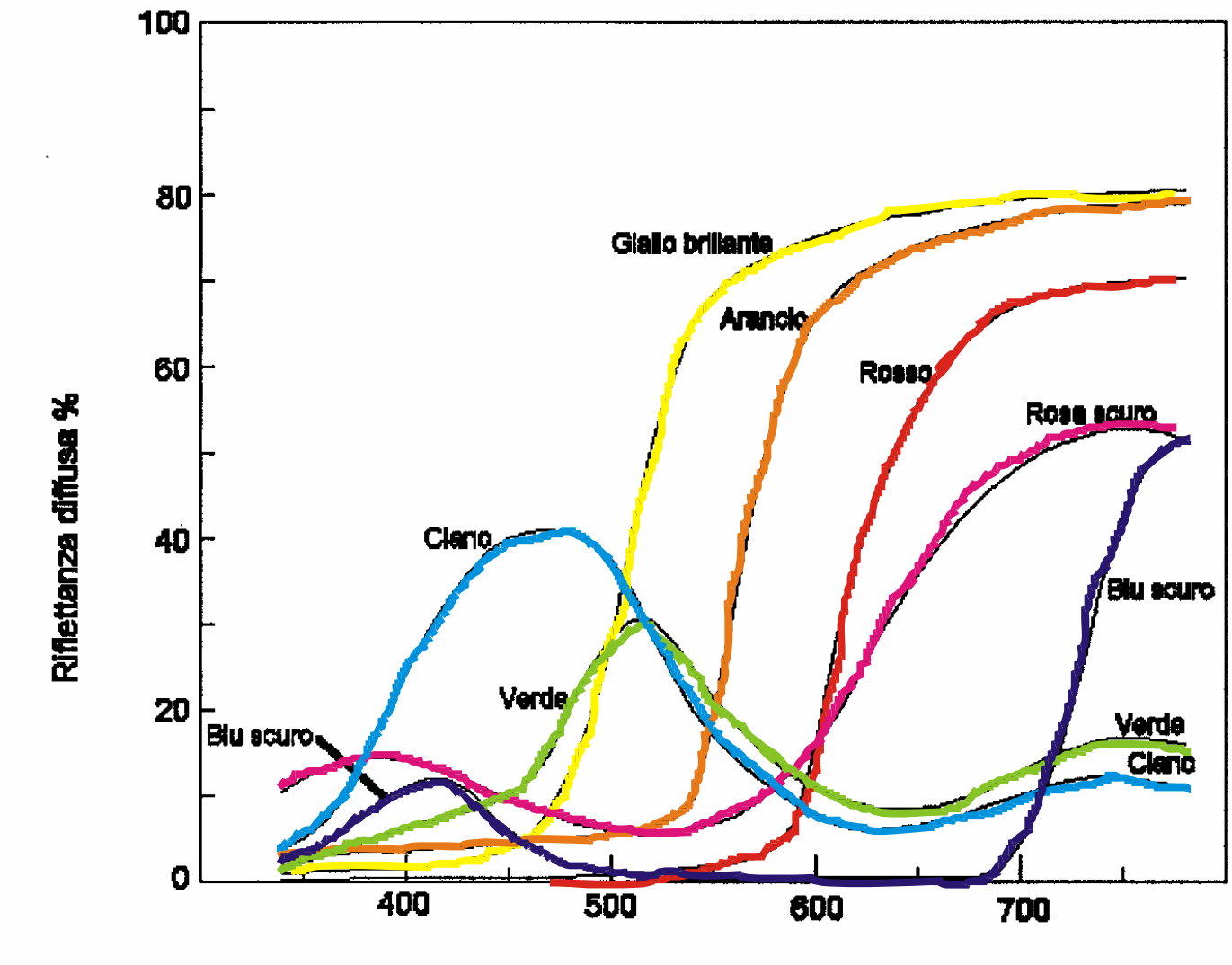




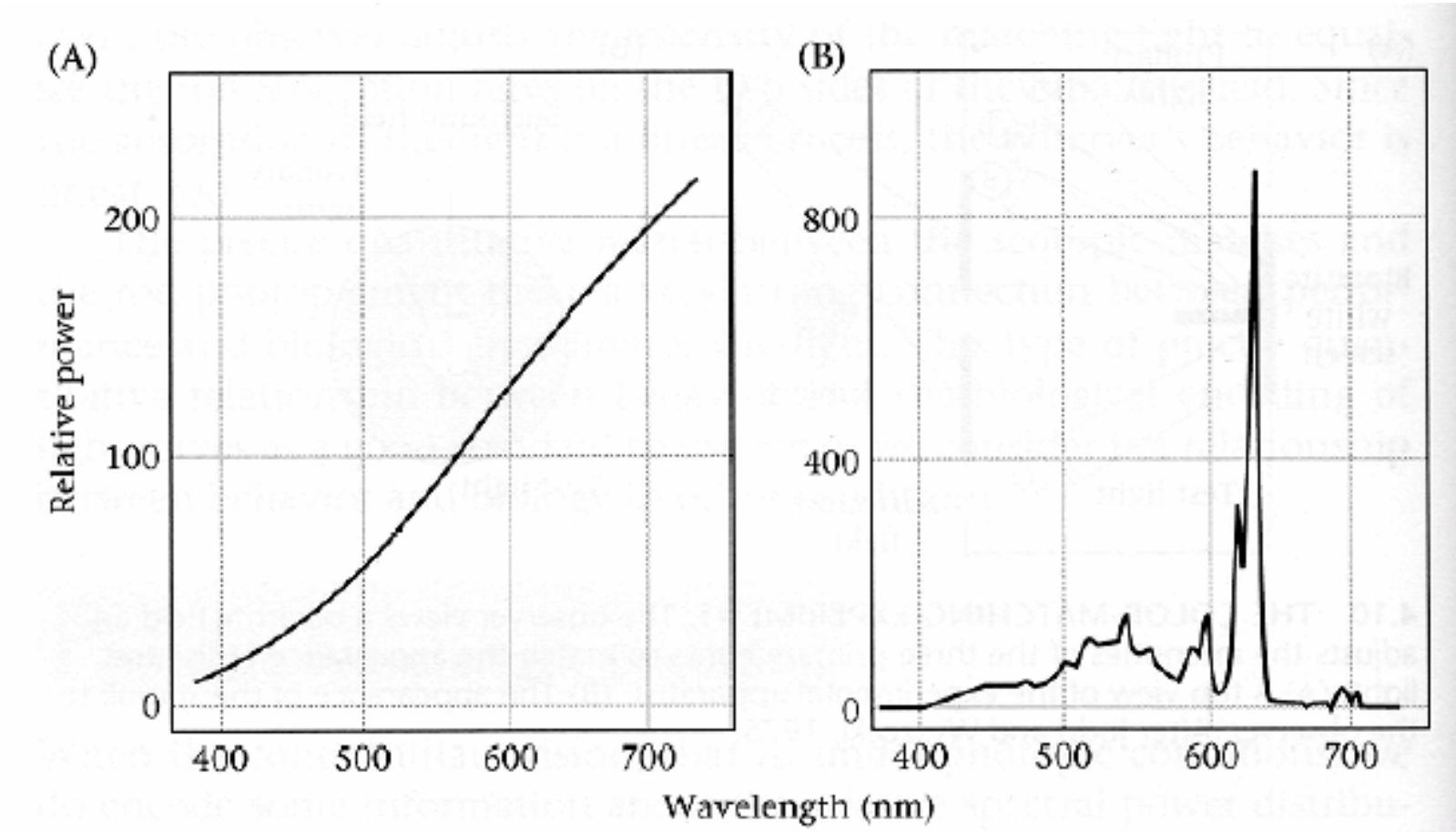
Spettro del grigio (Bianco-Nero)



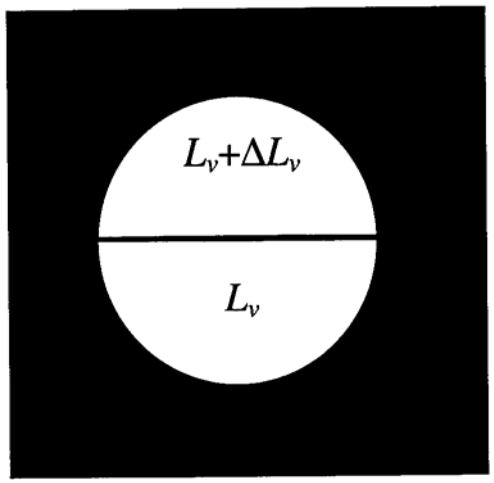
Spettro dei colori

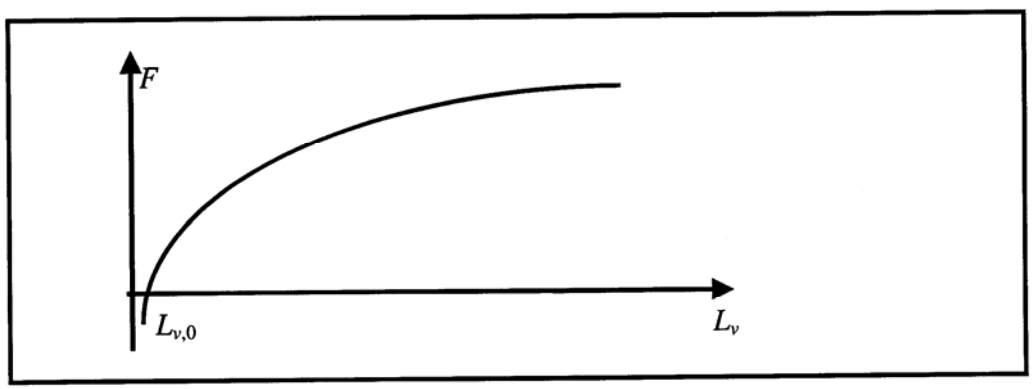


Metamerismo

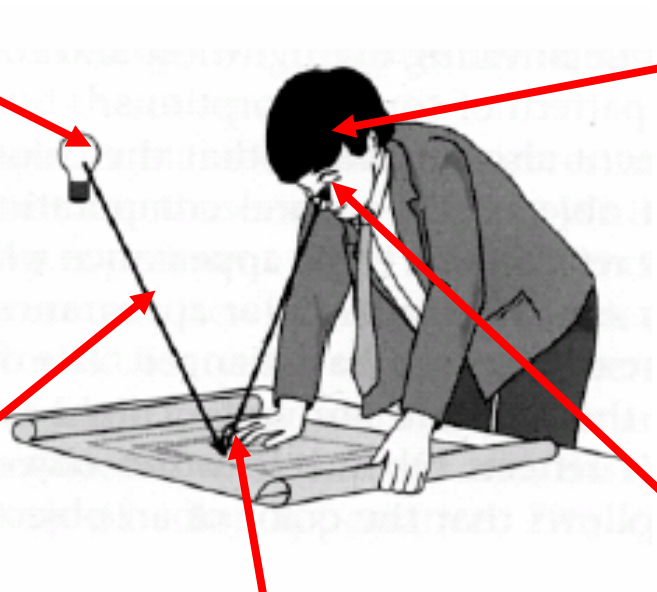


Weber-Fechner law



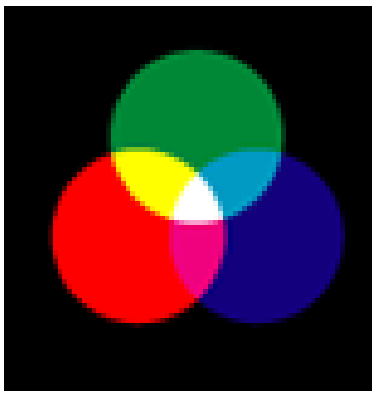


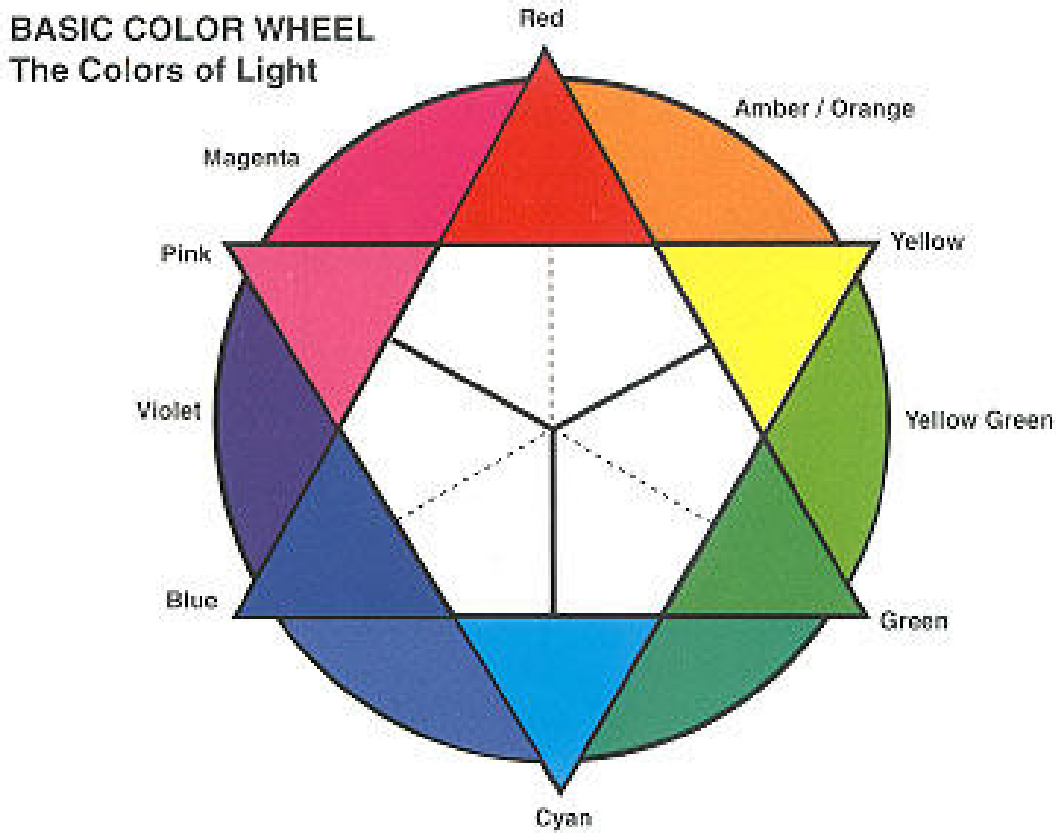
Colorimetria



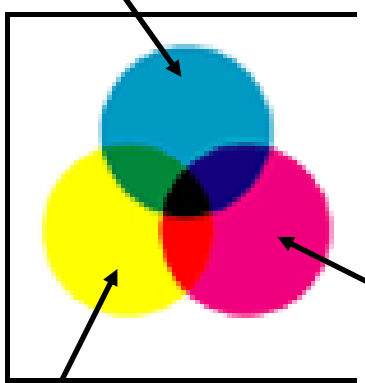
Colori Primari

Somma





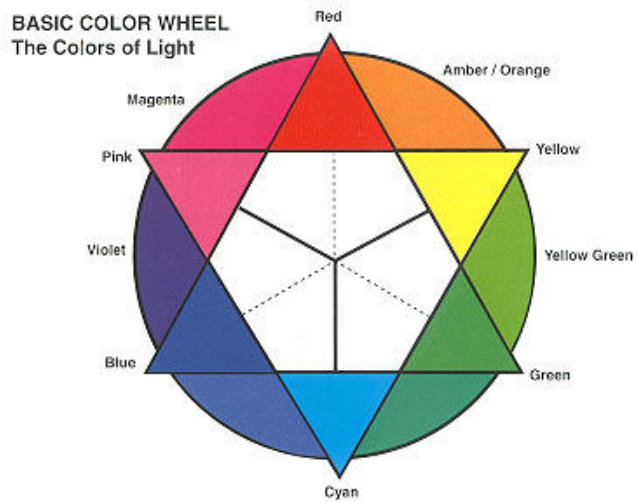
Sottraggo il rosso



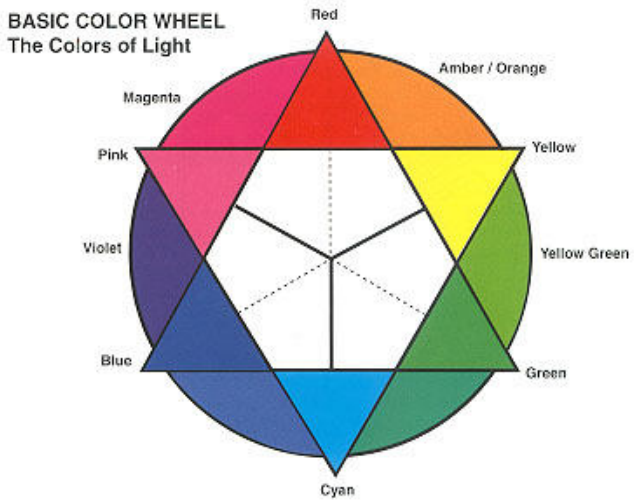
Sottraggo il verde

Sottraggo il blu

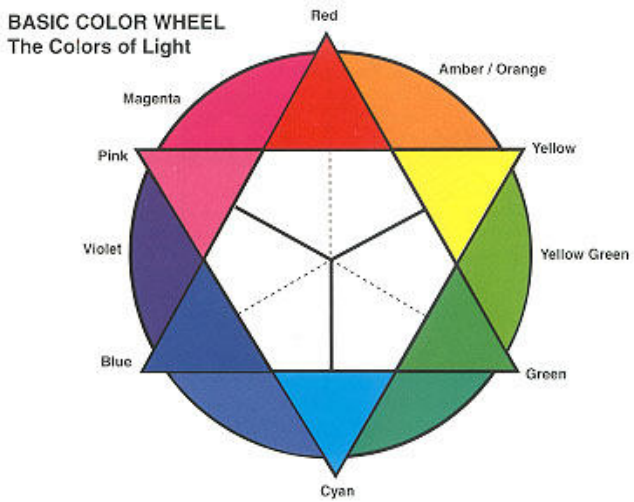
Colori monocromatici



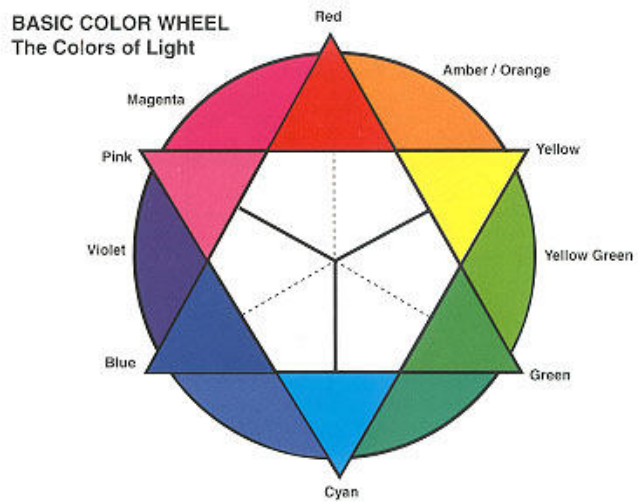
Colori complementari



Colori analoghi



Colori caldi



Colori freddi