

Couleur

Motivation

Calibration (moniteurs, projecteurs, imprimantes, scanners)

Codage (RGB, HSV, xyY, Lab...)

Comment définir les couleurs?

Comment l'humain les perçoit?

Comment les coder?

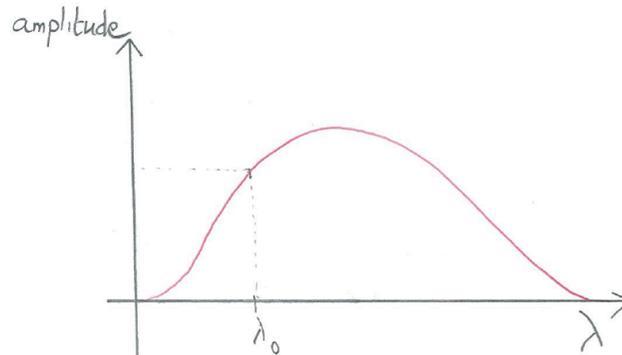


...ent due to the lack of global representation e
Popping artifacts are present when the surface
parameterizations are in general not fully con
sistent frames. This limitation also restricts
section to investigate non-local features in the
surface the visualization of a synthetic spiral
the surface of a cylinder using dense texture com
vention. Only with the global view of the flow can
directly circumnavigate the surface to convey the
tence to extend existing planar texture-based m
defined on curved surfaces in a general way, a glob
of the surface flow in the 2D texture domain is needed

One way to attain such a representation is surface
which provides the mapping between the texture
physical space. This technique has been success
many problems involving curved surfaces, such as
texture synthesis, or mesh processing. Although
parameterization methods exist, their use in dense
calibration has been limited so far. The specific reg
Many dense texture flow visualization methods
by flow visualization methods partially explain
Lagrangian principle of particle advection, which
is they are related to surface parameteriza
of are typically necessary to accommodate a wide ran
causing many numerical schemes used for part
irregularly introduces discontinuity particles, not
the texture spike is necessary to preserve acou
Moreover, the ability to redirect particles, not
the texture spike is necessary to preserve acou
Finally, interactivity is an essential dimension
face data exploration. Therefore the development
sive task exploration. Therefore the development
structure of modern Graphics Processing Unit

Lumière

- Signal lumineux
 - Somme de signaux à une longueur d'onde donnée
- Spectre lumineux
 - Amplitude pour chaque longueur d'onde



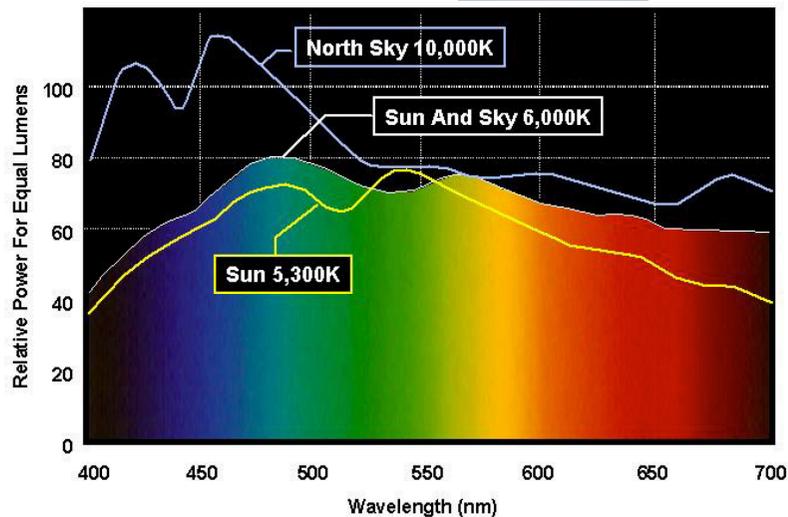
Spectre lumineux



- Lumière visible
 - De 400 nm à 700 nm
 - Au dessus: infrarouge, micro-onde, radio
 - En dessous: ultra-violet, rayon X, nucléaire

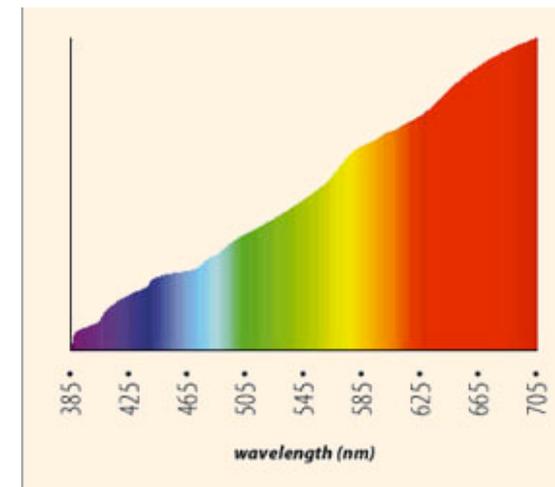
Exemples de spectre dans lumière visible

Lumière naturelle



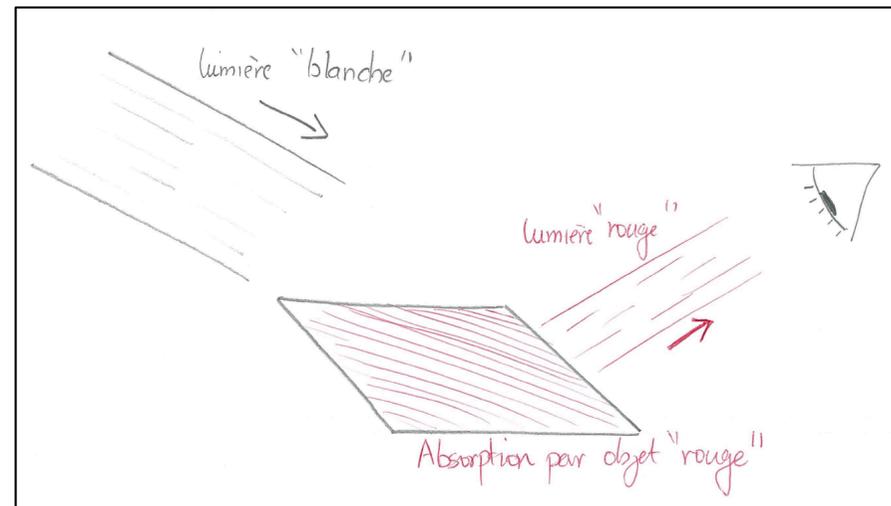
[Démonstration](#)

Lampe à incandescence



Lumière - Interactions

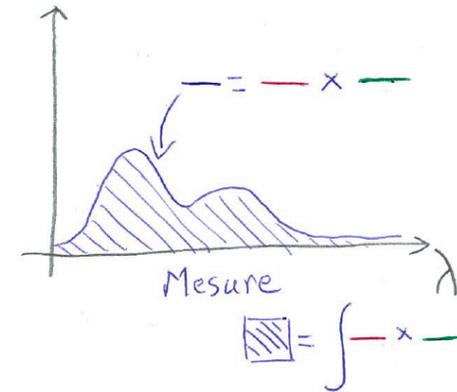
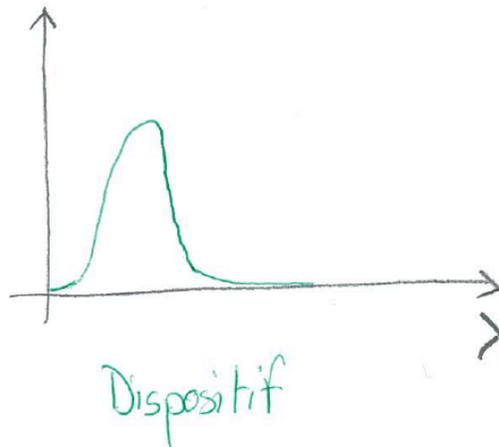
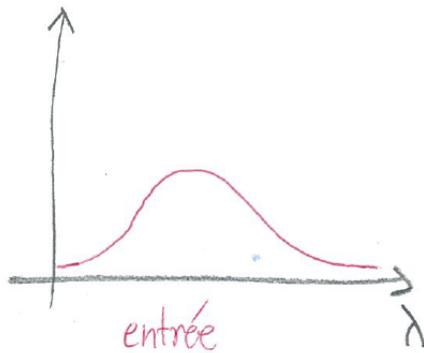
- Emission
- Réflexion
- Transmission (réfraction)
- Absorption



Lumière - Mesure

Abstraction:

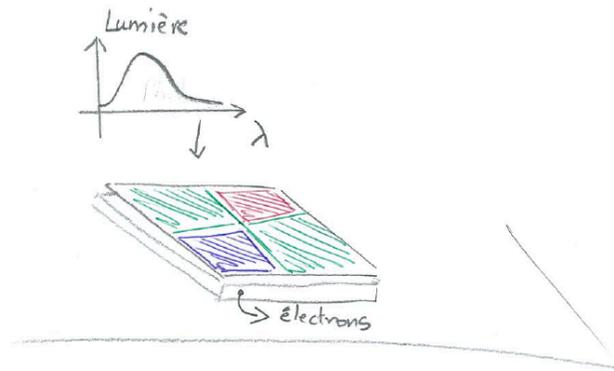
Spectre lumineux (fonction) -> Dispositif (fonction) -> Un nombre (Intégrale)



Mesure = Calcul d'Intégrale!!!

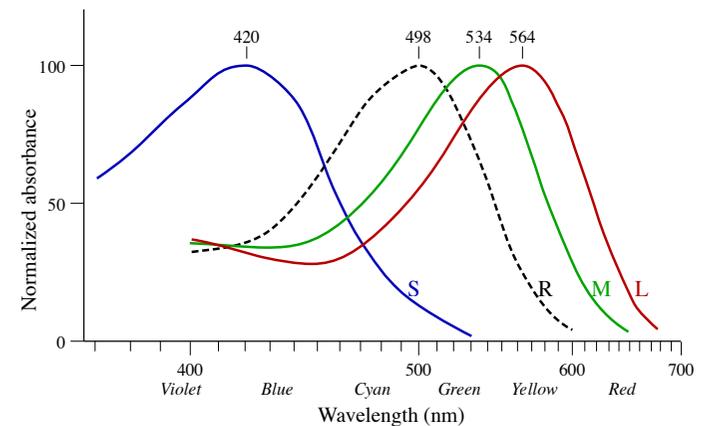
Deux dispositifs de mesure

- Capteur CCD
 - Photoélectrique
 - Filtre de Bayer



- Signal électrique numérisé

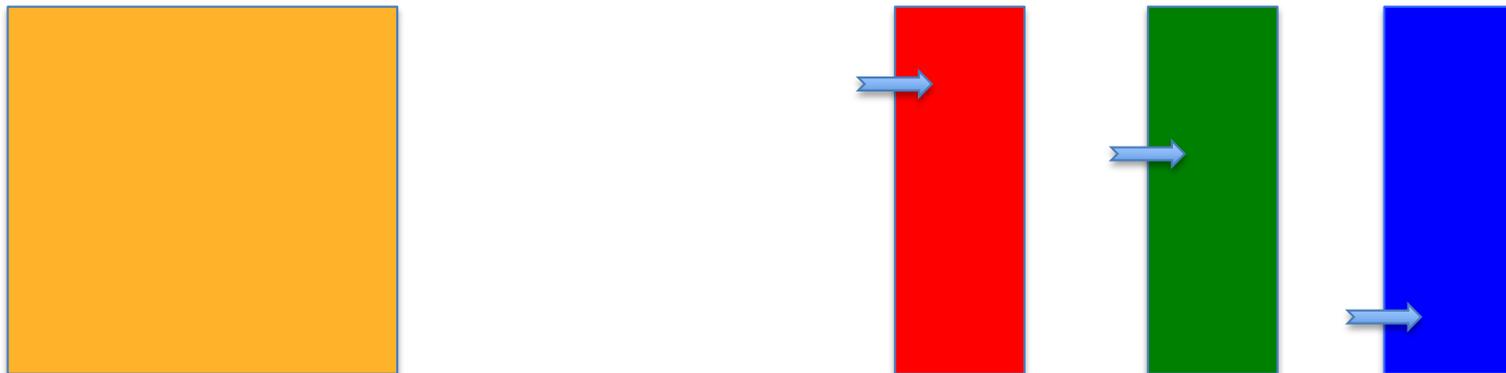
- Œil
 - Biochimique (Phototransduction)
 - Cônes S, M, L (+ bâtonnets R)



- Signal électrique transmis au système nerveux

Espace de couleur par expérimentation (1929-1931)

- Trois couleurs monochromatiques « Primaires »
 - Lasers R = 700 nm, G = 546 nm, B = 435 nm
- Ajustement de la luminosité des primaires jusqu'à identification



Lois de Grassmann

- Expérimentations

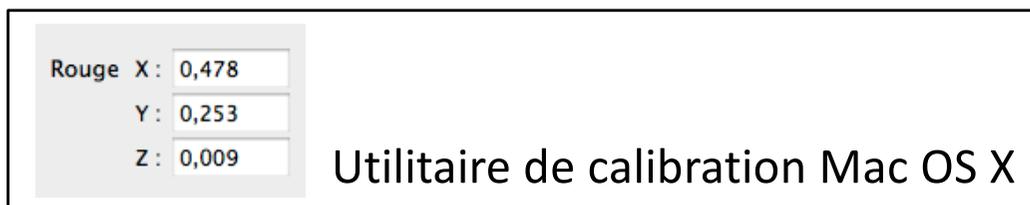
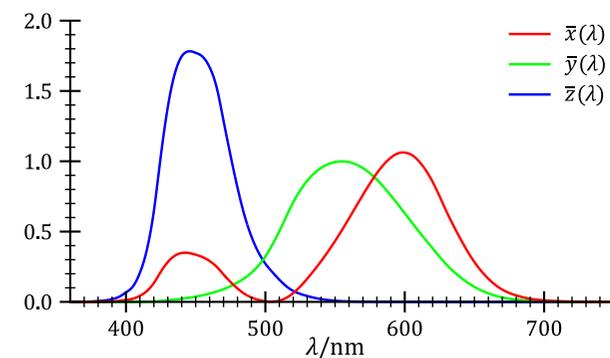
$$\begin{aligned} C_1 &= (R_1, G_1, B_1) \\ C_2 &= (R_2, G_2, B_2) \end{aligned} \implies C_1 + C_2 = (R_1 + R_2, G_1 + G_2, B_1 + B_2)$$

$$C = (R, G, B) \implies \alpha C = (\alpha R, \alpha G, \alpha B)$$

Nécessité d'une mesure standard: espace X, Y, Z

- S, M, L: dépend de l'observateur!!!
- Commission Internationale de l'Eclairage
 - Définition d'un « Observateur Standard »
 - 3 mesures X, Y, Z : données par 3 spectres

$$\bar{x}(\lambda), \bar{y}(\lambda), \bar{z}(\lambda)$$



Espace x, y, Y

Chrominance, Luminance

On conserve Y, la luminance

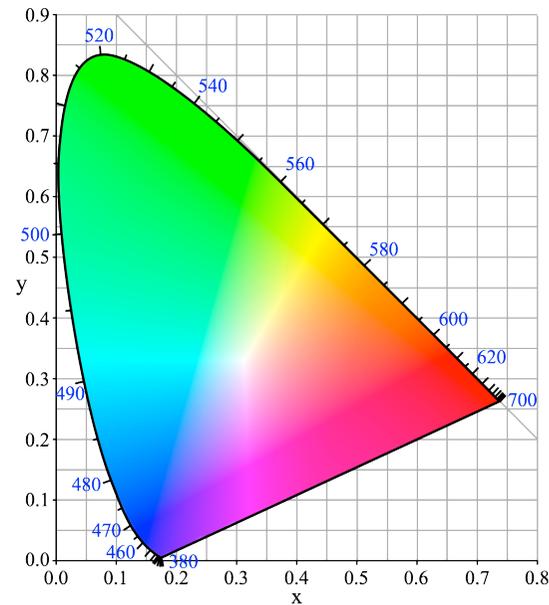
On normalise X, Y, Z en x, y, z

$$x = \frac{X}{X+Y+Z}$$
$$y = \frac{Y}{X+Y+Z}$$
$$z = \frac{Z}{X+Y+Z}$$

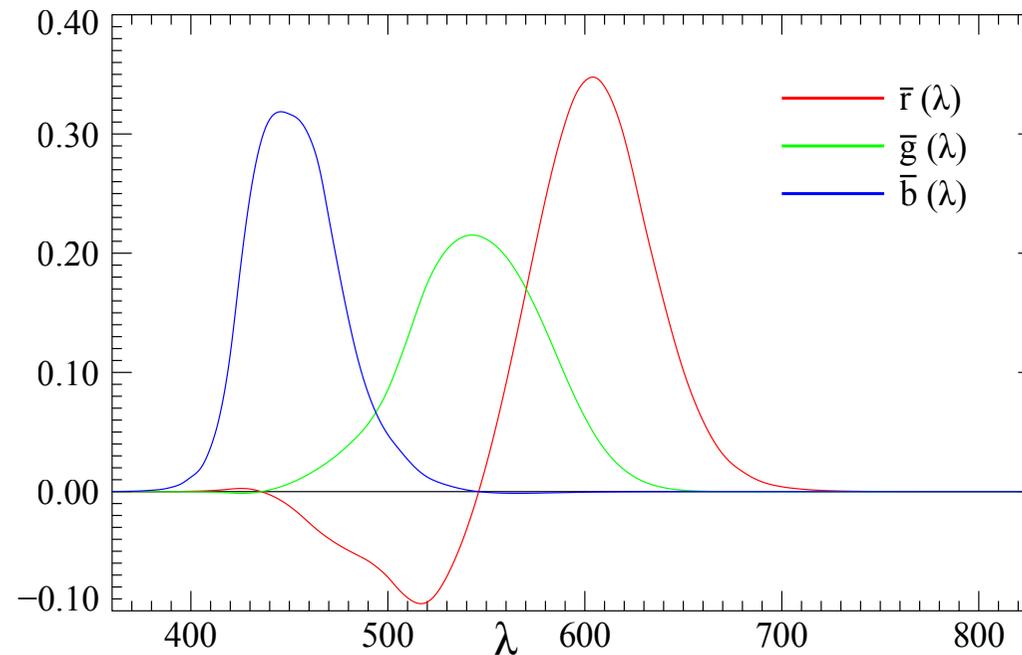
x, y: Chrominance
Y: Luminance

Diagramme de Chrominance

Blanc : (1/3, 1/3)



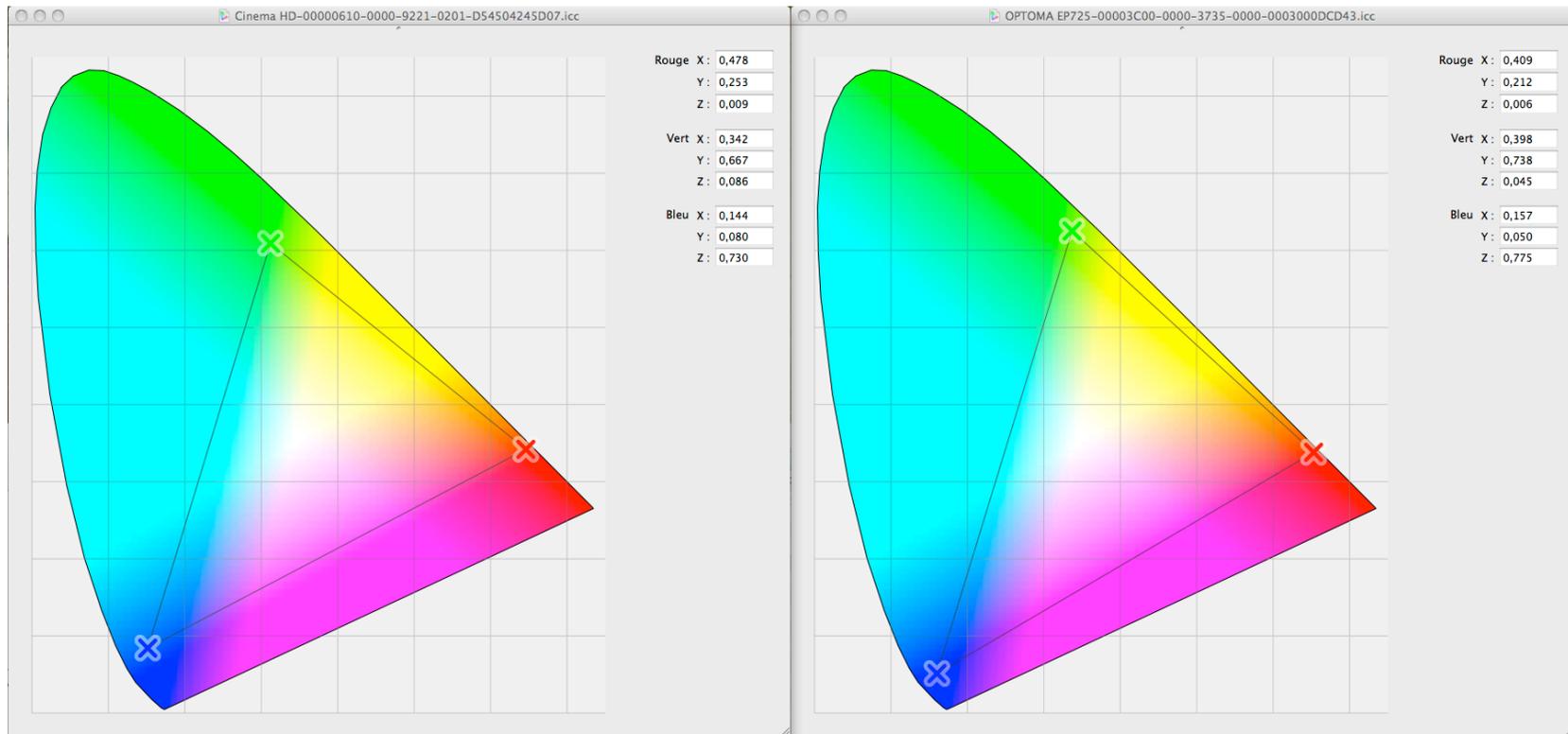
Espace de couleur par Expérimentation



- 3 couleurs « primaires » non monochromatiques
- Une couleur monochromatique
- On règle l'intensité des primaires pour retrouver la couleur monochromatique
 - Quantité négatives!!!

Espace RGB

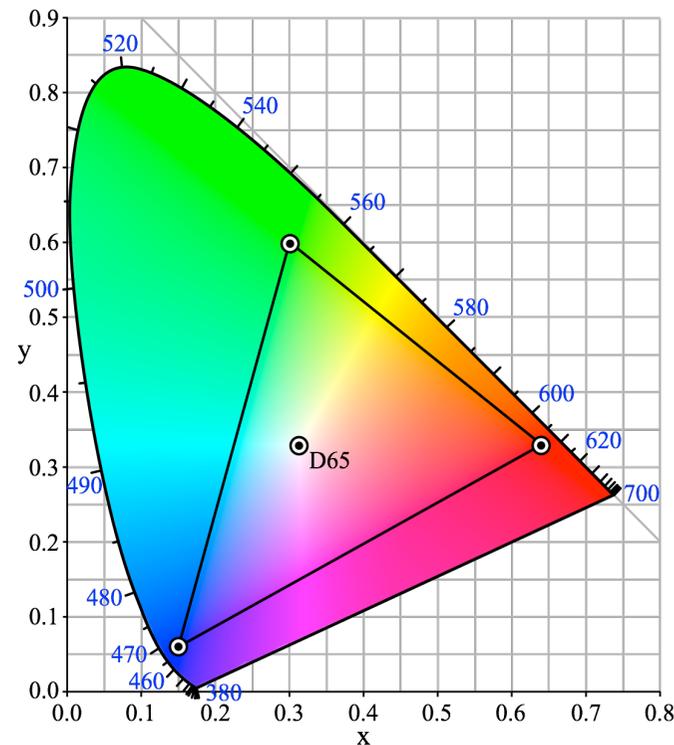
- (X, Y, Z) pour les pixels rouge, vert, bleu du moniteur => coordonnées R, G, B



Outil de calibration Mac OS X

Gamut

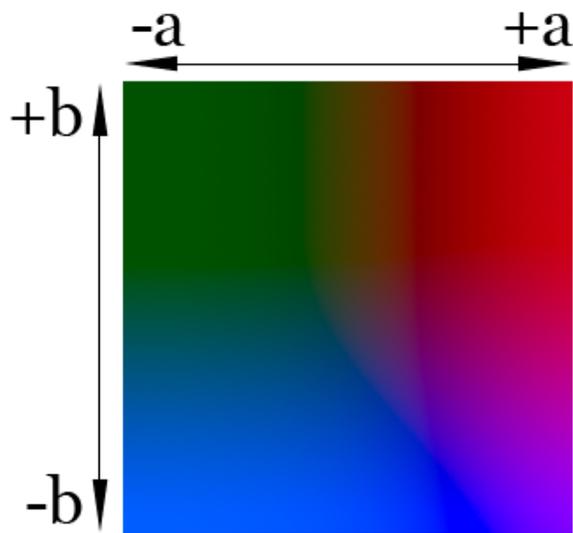
- Ensemble des couleurs pouvant être rendus par un dispositif



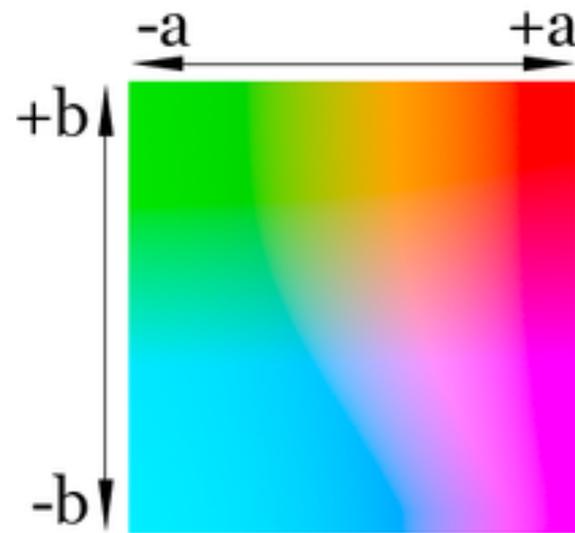
Rec. 709
sRGB, standard pour la HDTV

Espace lié à la perception

- CIE L,a,b
 - différence *perçue* \simeq distance dans le diagramme
 - 2 composantes chromatiques a et b
- Non linéaire



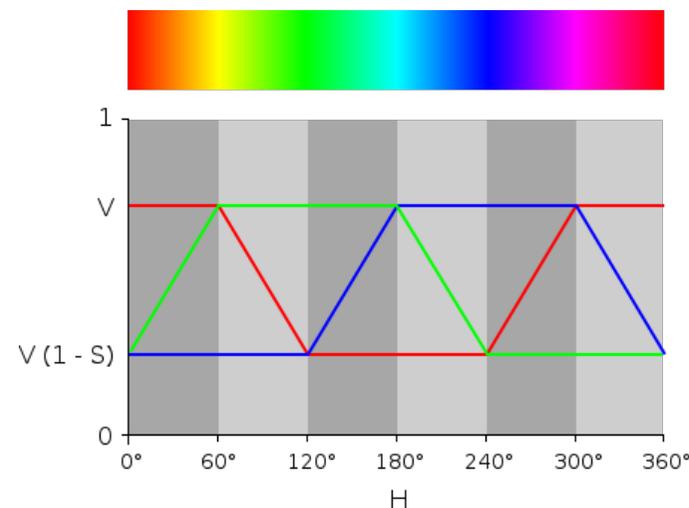
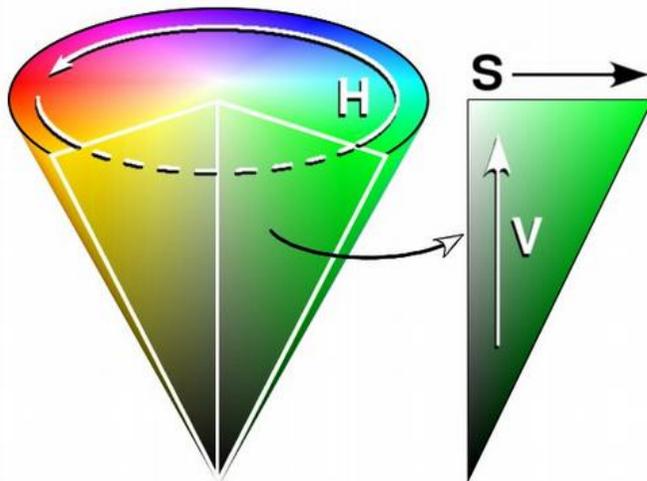
Luminosité à 25%



Luminosité à 75%

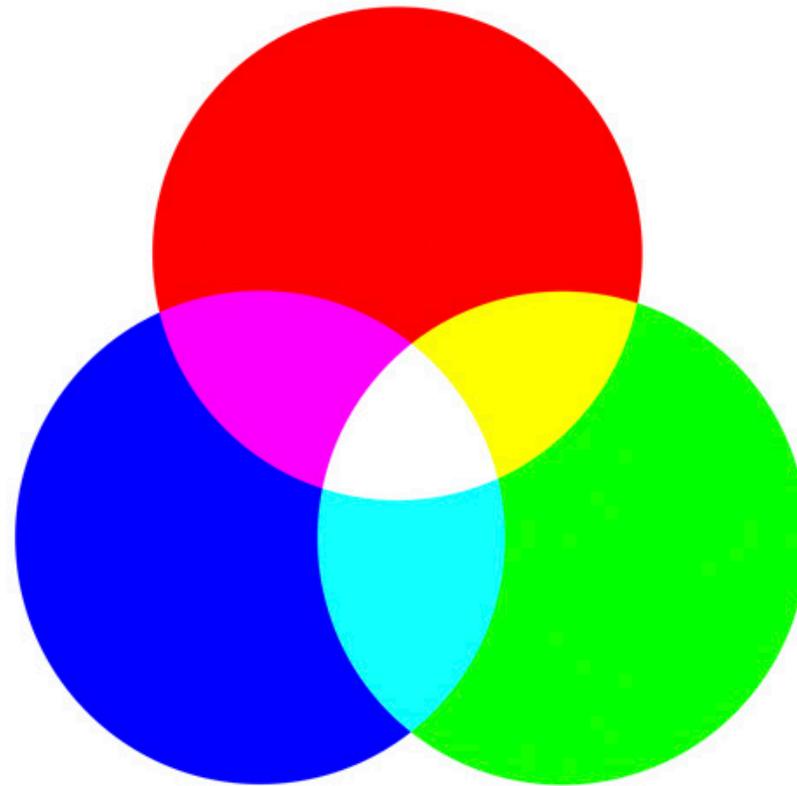
Espace lié à la perception

- HSV
 - Séparation de la Chrominance, Saturation et Luminosité
 - Modèle périodique pour la teinte



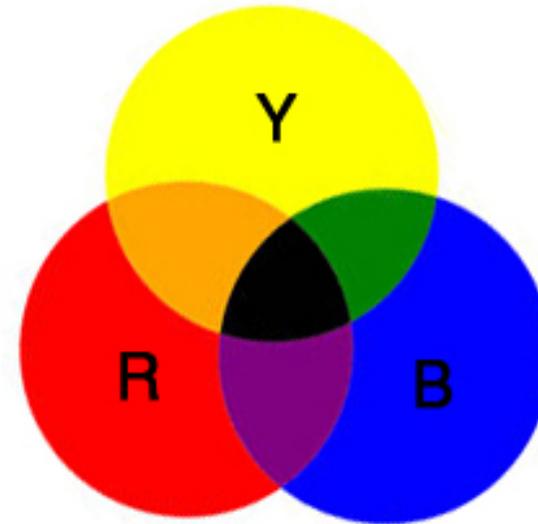
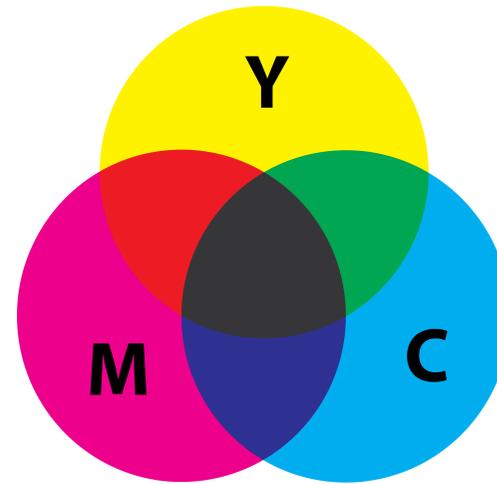
Synthèse Additive

- Moniteurs

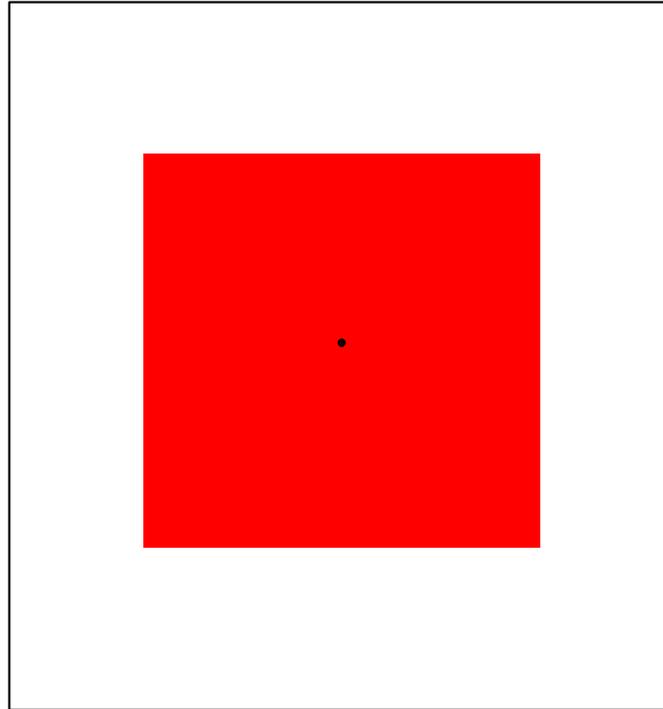


Synthèse Soustractive

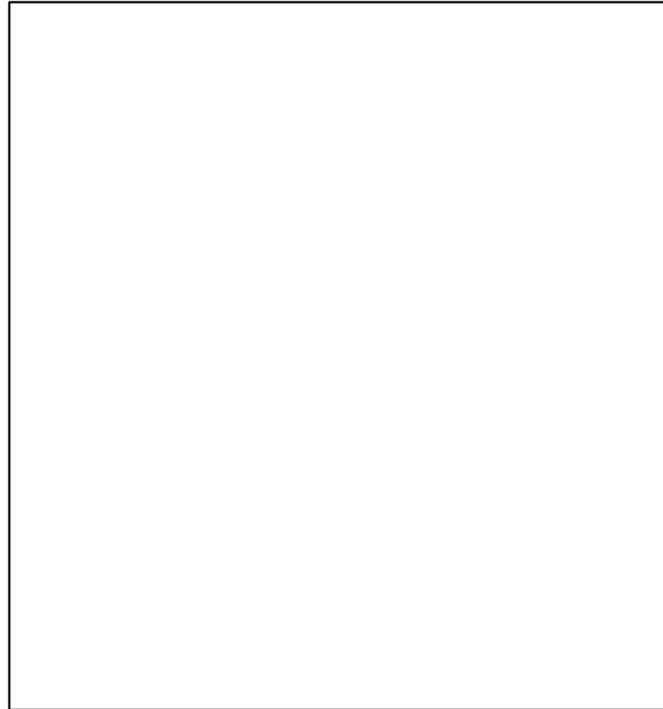
- Imprimante: CMYK
- Peinture: RYB



Couleurs Opposées



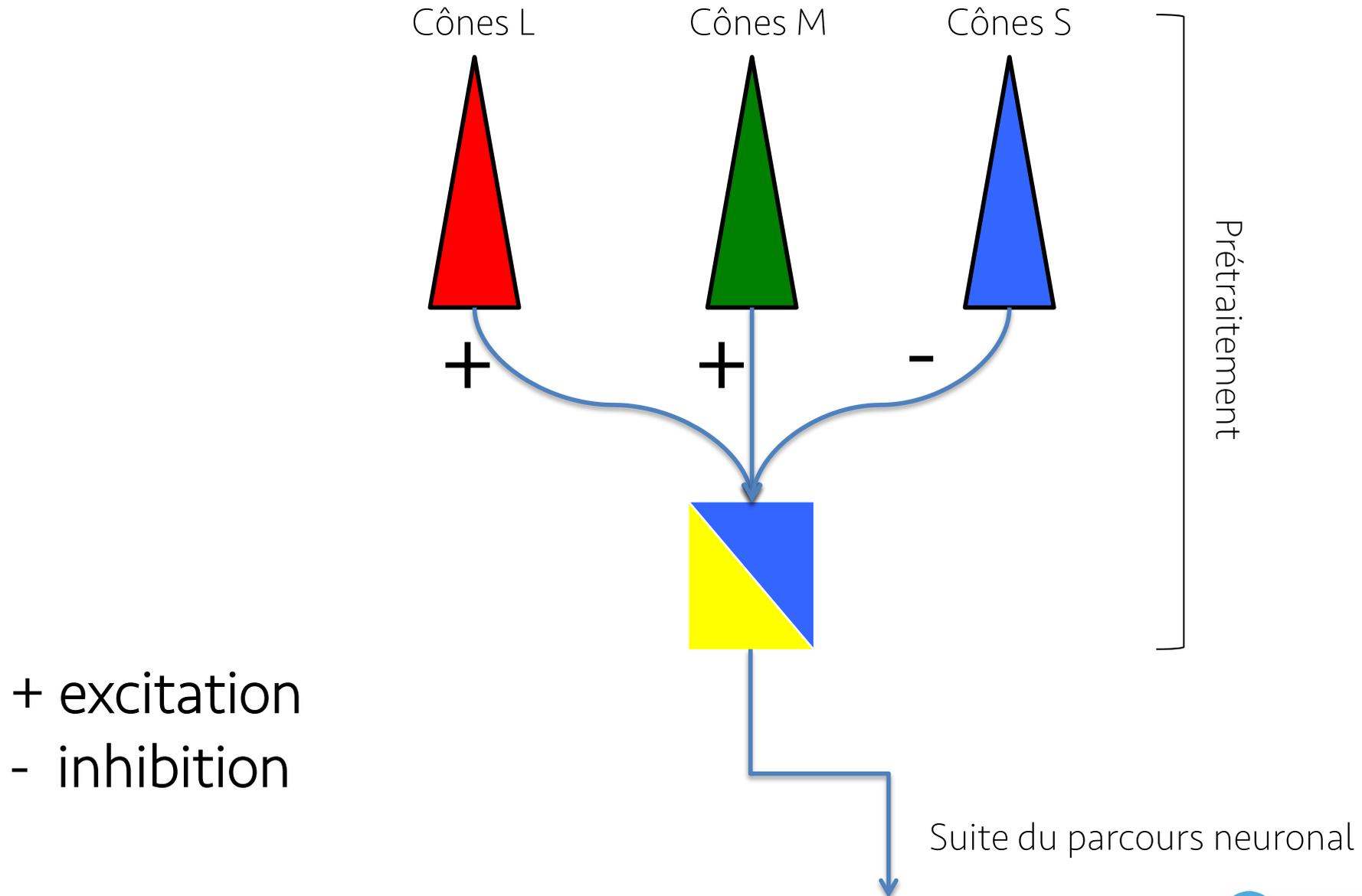
Couleurs Opposées



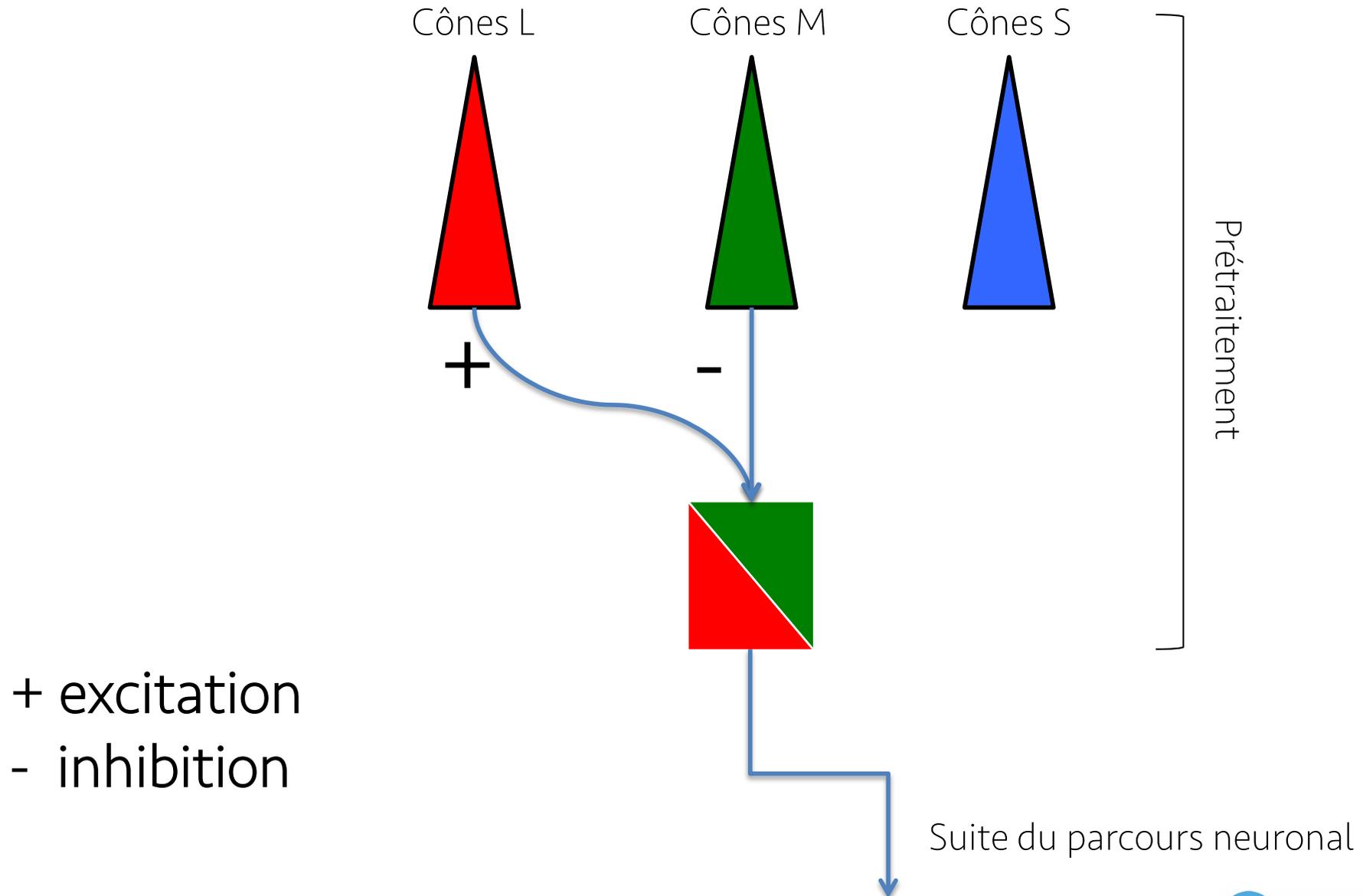
***note:
black & white***



Couleurs Opposées: Bleu/Jaune



Couleurs Opposées: Rouge/Vert



Color Wheel

