

# Théorie(s) de la Couleur

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# Motivation

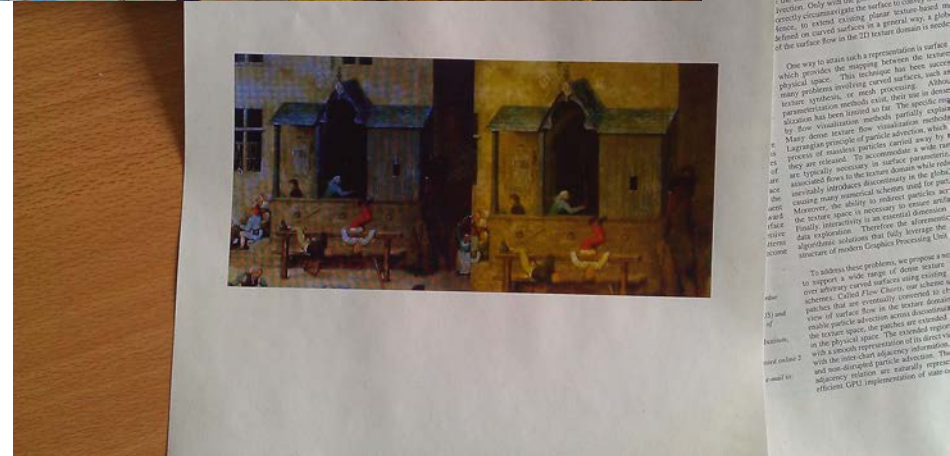
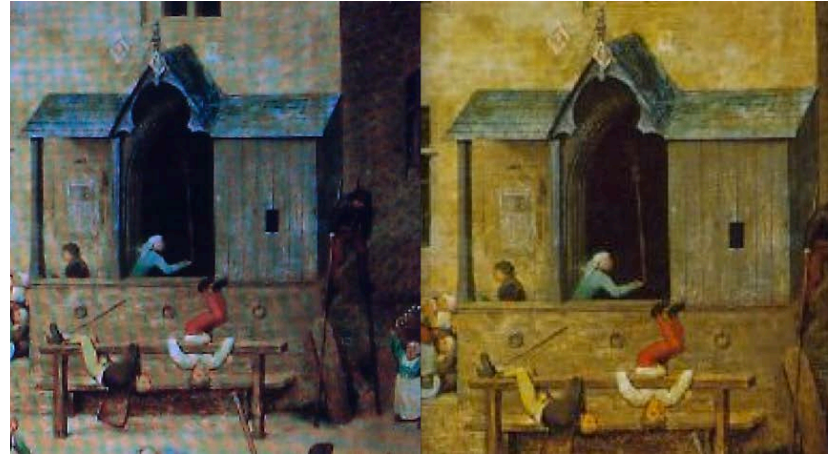
Calibration (moniteurs, projecteurs, imprimantes, scanners)

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

Comment définir les couleurs?

Comment l'humain les perçoit?

Comment les coder?



...sistent due to the lack of global representation. Popping artifacts are present when the surface is parameterized in a general and fully topographic frame. This limitation also restricts the ability to investigate non-local features in the field of view. The visualization of a 3D volume is held on the surface of a cylinder along some texture coordinate. Only with the global view of the flow can the precisely circumscribed the surface be held in place. In a more complex manner, texture is defined on curved surfaces in a general way, a global view of the surface flow in the 2D texture domain is needed.

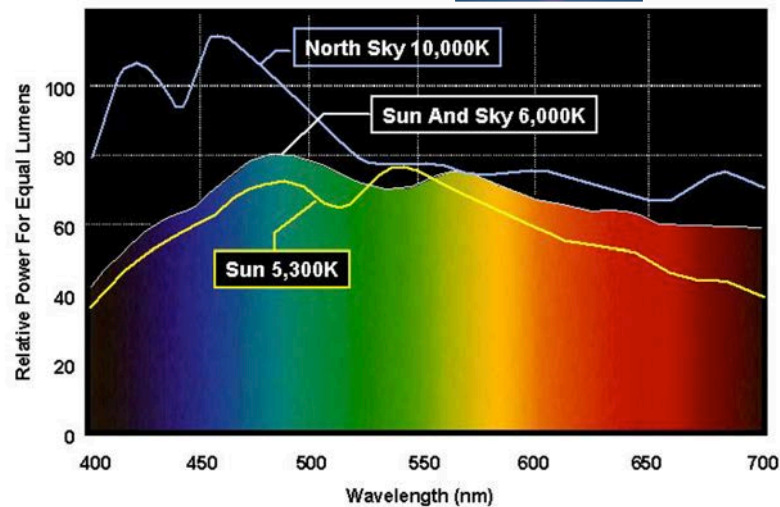
One way to attain such a representation is surface which provides the mapping between the texture and physical space. This technique has been used in many problems involving curved surfaces, such as texture synthesis, or mesh processing. Although parameterization methods exist, their use in dense visualization has been limited so far. The specific visualization of flow visualization methods by many dense texture flow visualization methods by Lagrangian principle of particle advection, which process of massive particles carried away by flow are released. To accommodate a wide range of flow visualization in the texture domain while not necessarily introducing discontinuity in the global space, causing many numerical schemes used for particle advection. Moreover, the ability to reduce particle advection. Finally, interactivity is an essential dimension of data exploration. Therefore, the algorithmic solutions that fully leverage the structure of modern Graphics Processing Units.

To address these problems, we propose a new support to a wide range of dense texture over arbitrary curved surfaces using existing schemes. Color Flow Charts, our scheme, is a technique that can eventually cover the view of surface flow in the texture domain. In the texture space, the particles are represented by a smooth representation of the direction in the physical space. The extended region with a smooth representation of the direction and non-distorted particle advection. The adjacency relations are naturally represented efficient GPU implementation of volume

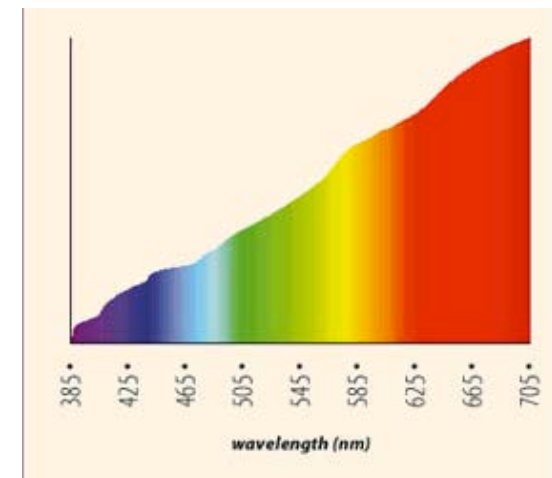
- Lumière visible
  - De 400 nm à 700 nm
  - Au dessus: infrarouge, micro-onde, radio
  - En dessous: ultra-violet, rayon X, nucléaire

### Exemples de spectre dans lumière visible

Lumière naturelle

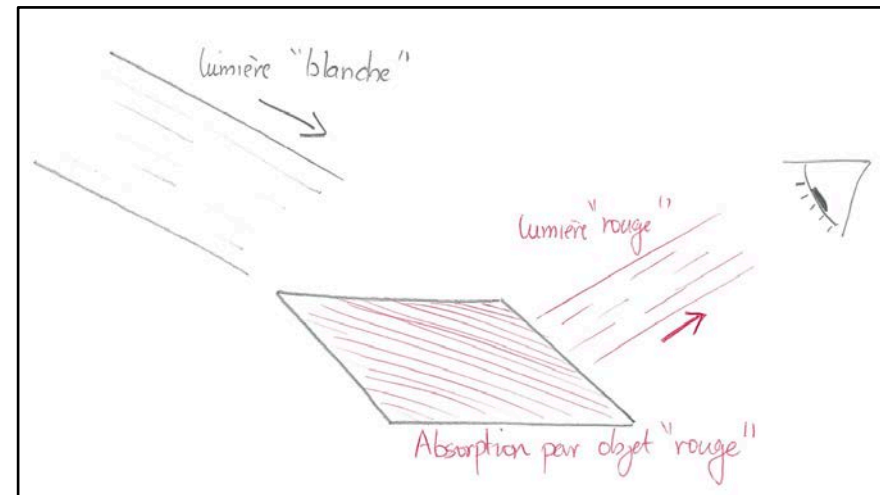


Lampe à incandescence



# Lumière - Interactions

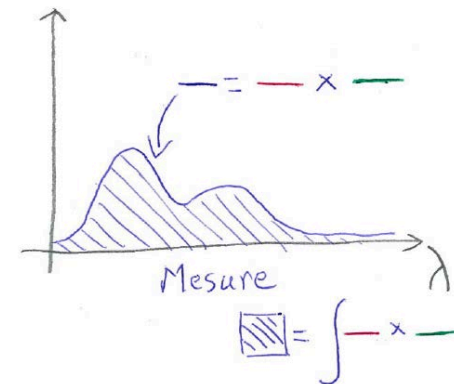
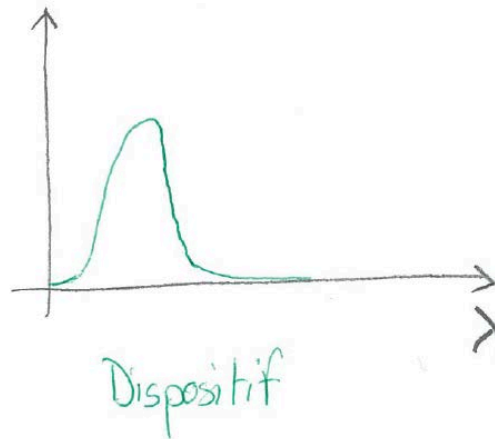
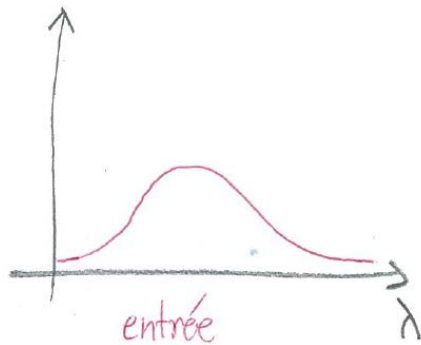
- Emission
- Transmission (réfraction)
- Absorption
- Réflexion



# Lumière - Mesure

Abstraction:

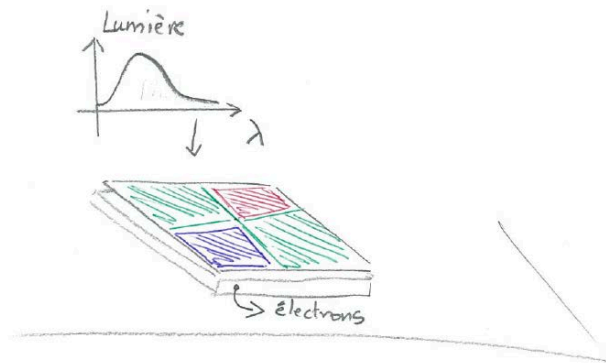
Spectre lumineux (fonction) -> Dispositif (fonction) -> Un nombre (Intégrale)



Mesure = Calcul d'Intégrale!!!

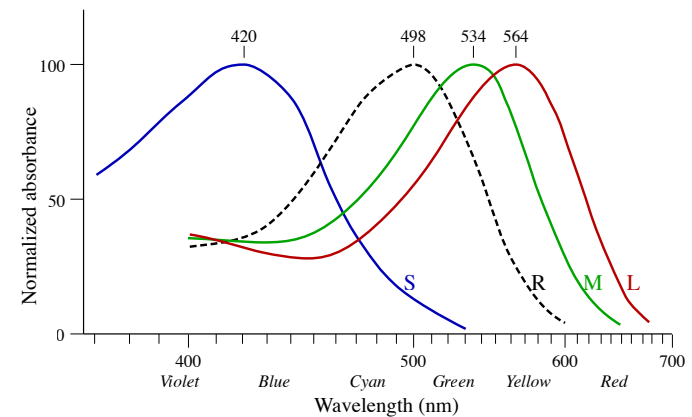
# L'oeil comme instrument de mesure

- Capteur CCD
  - Photoélectrique
  - Filtre de Bayer



- Signal électrique numérisé

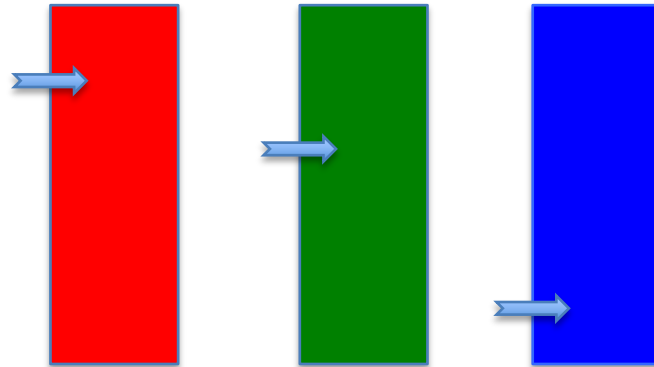
- Œil
  - Biochimique (Phototransduction)
  - Cônes S, M, L (+ bâtonnets R)



- Signal électrique transmis au système nerveux

# Couleur: expérimentation

- Trois « couleurs »
  - Lasers R = 700 nm, G = 546 nm, B = 435 nm
- Ajustement de l'intensité des lasers jusqu'à identification



# Lois de Grassmann

- Expérimentations

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

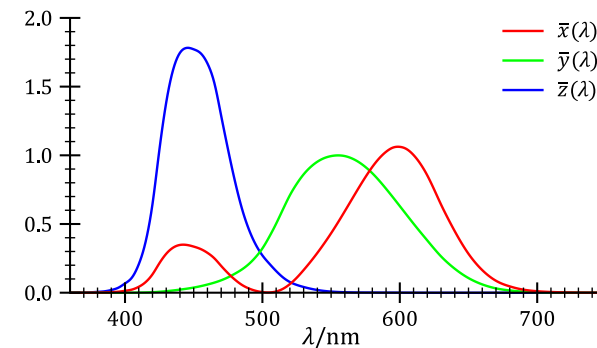
$$C = (R, G, B) \implies \alpha C = (\alpha R, \alpha G, \alpha B)$$



# 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

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



Rouge X: 0,478

Y: 0,253

Z: 0,009

Utilitaire de calibration Mac OS X

# Espace x, y, Y

## Chrominance, Luminance

On conserve Y, la luminance

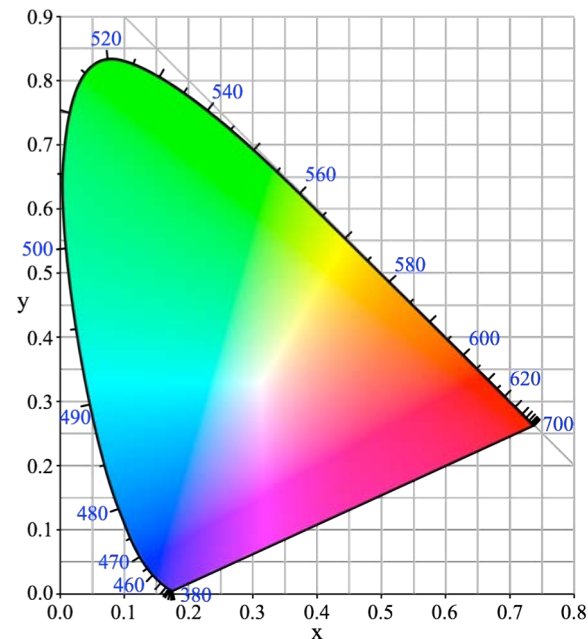
On normalise X, Y, Z en x, y, z

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

x, y: Chrominance  
Y: Luminance

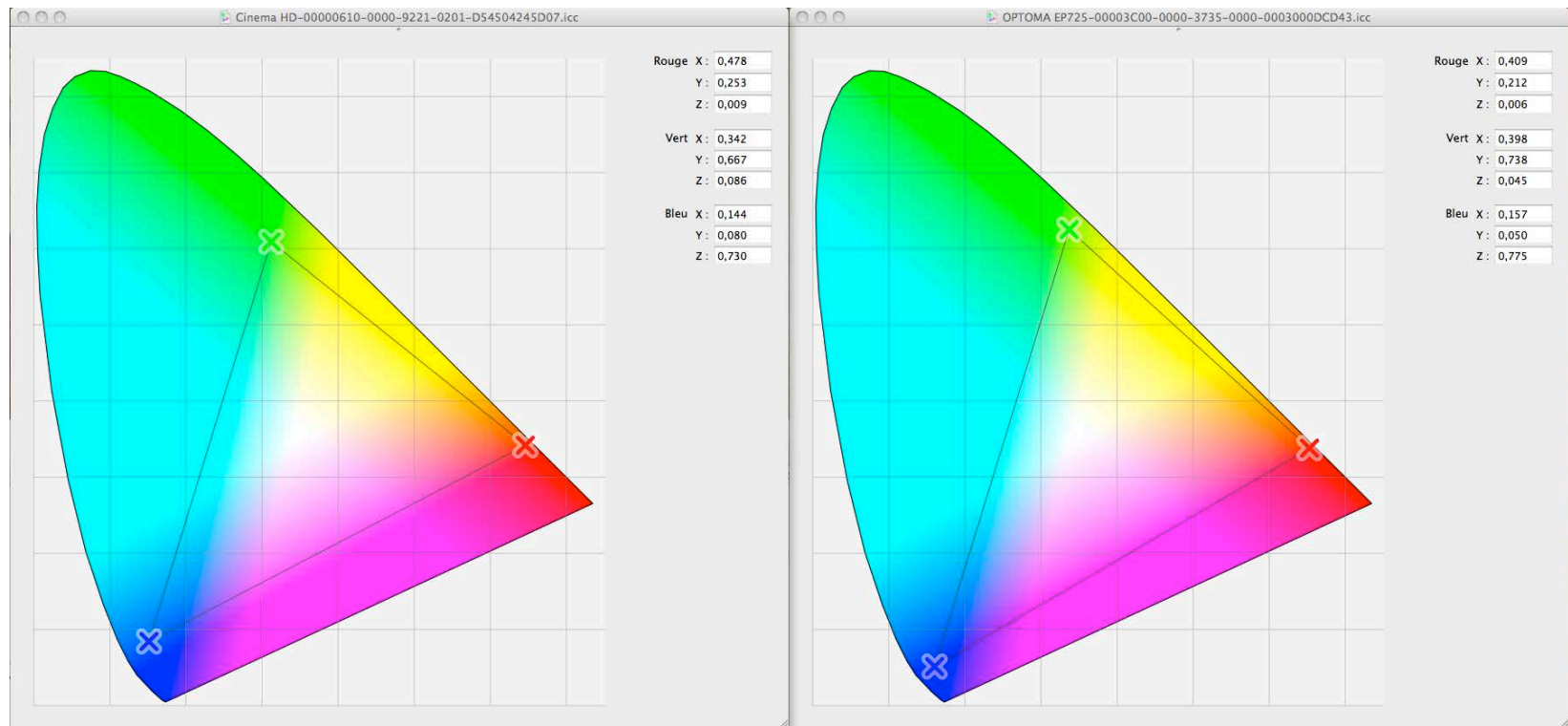
Diagramme de Chrominance

Blanc : (1/3, 1/3)



# Espaces liés à un dispositif: R,G,B

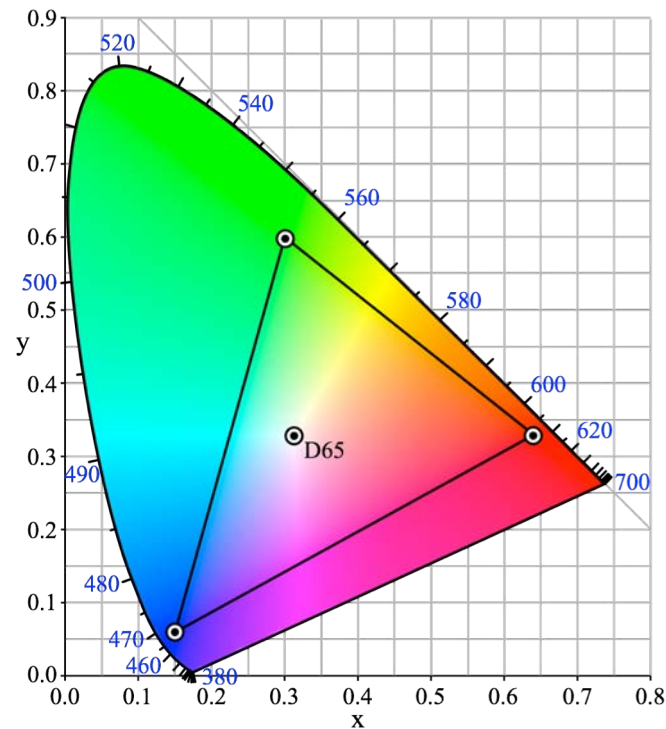
- $(X, Y, Z)$  pour les pixels rouge, vert, bleu du moniteur => coordonnées R, G, B



Outil de calibration Mac OS X

# Gamut

- Ensemble des couleurs pouvant être rendus par un dispositif

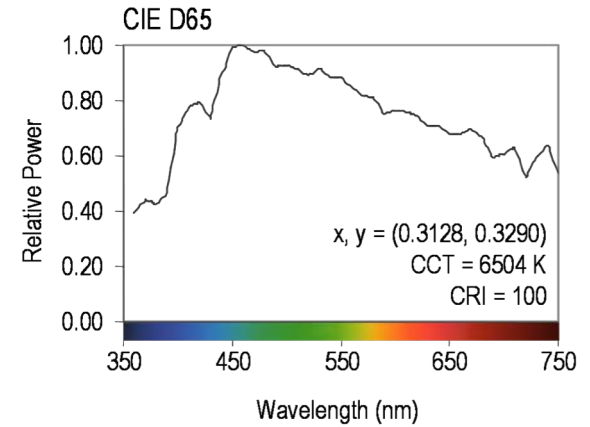
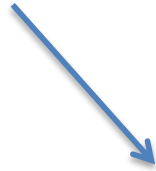


sRGB, standard pour la HDTV

Adobe RGB

Prophoto RGB

# Illuminant



- D65: « plus chaud », D50: « plus froid »

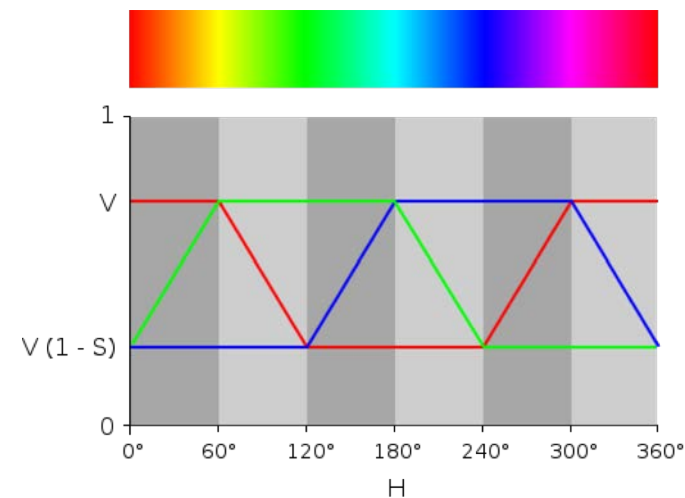
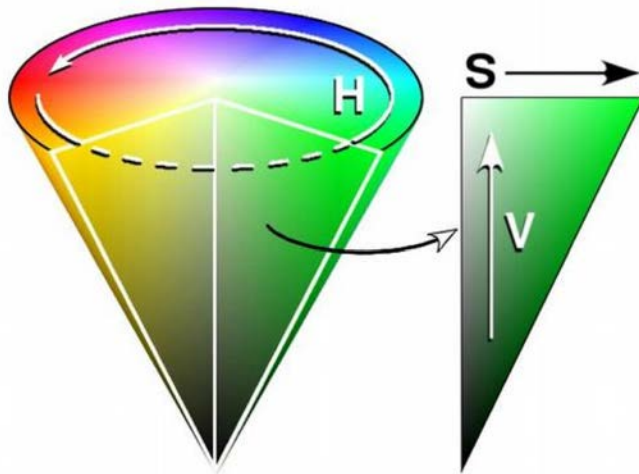
# Illuminant

- Changement des couleurs tenant compte de l'illuminant



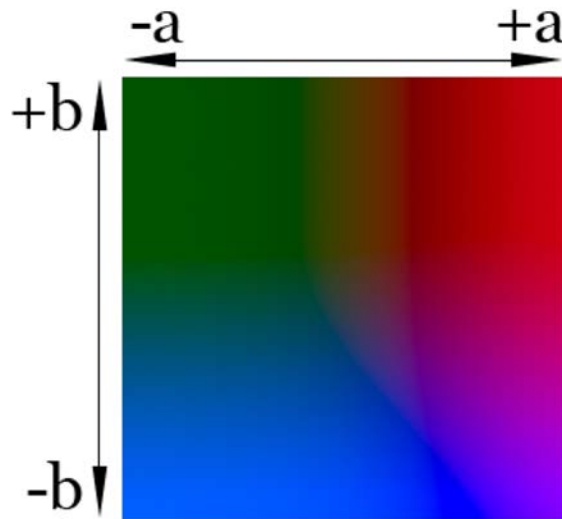
# Espace lié à la teinte

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

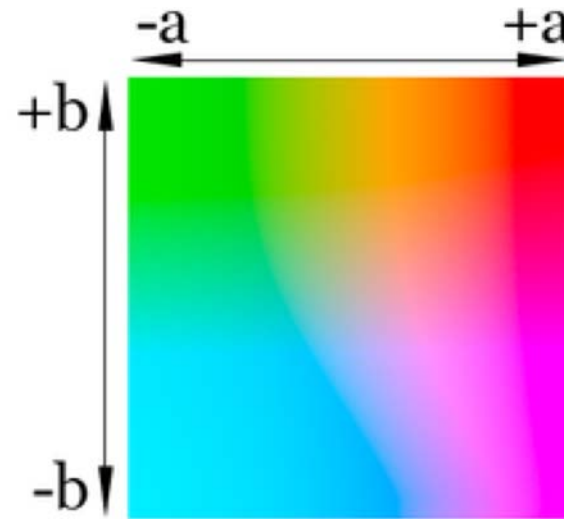


# Espace lié à la perception

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



Luminosité à 25%

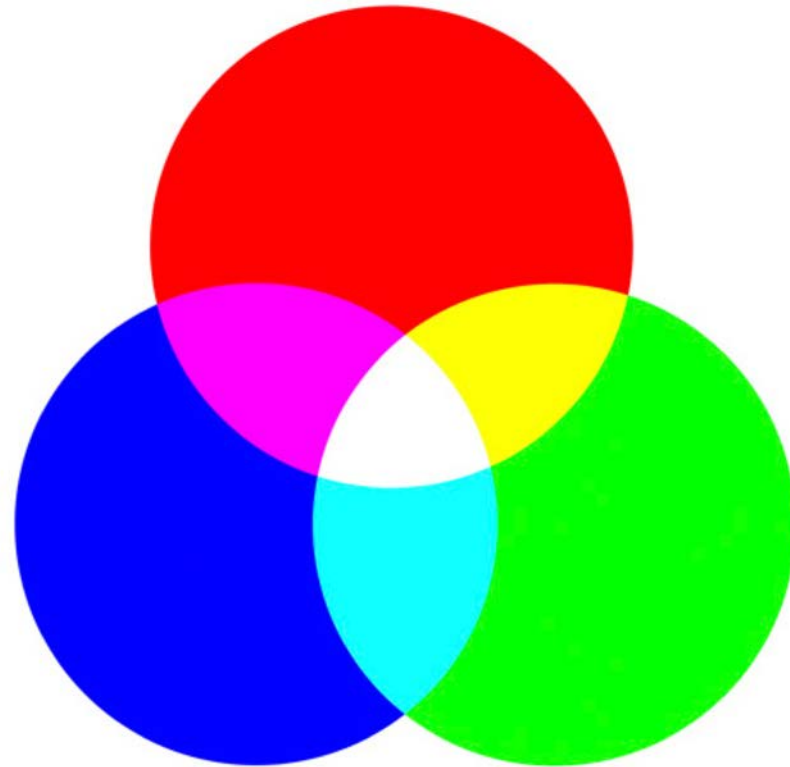


Luminosité à 75%



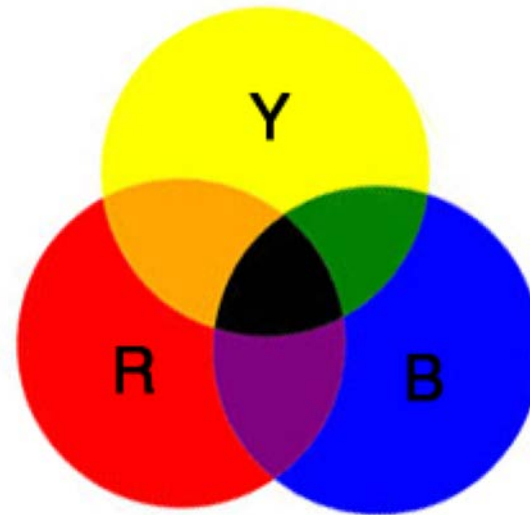
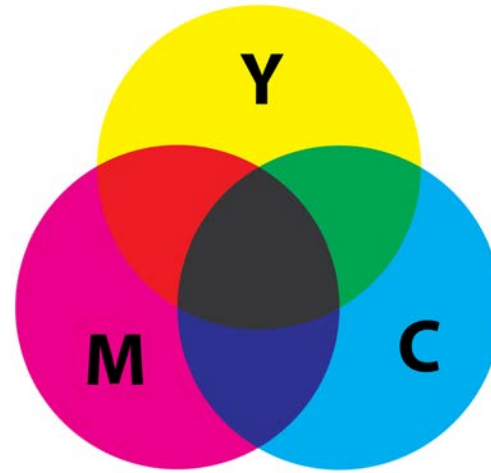
# Synthèse Additive

- Moniteurs

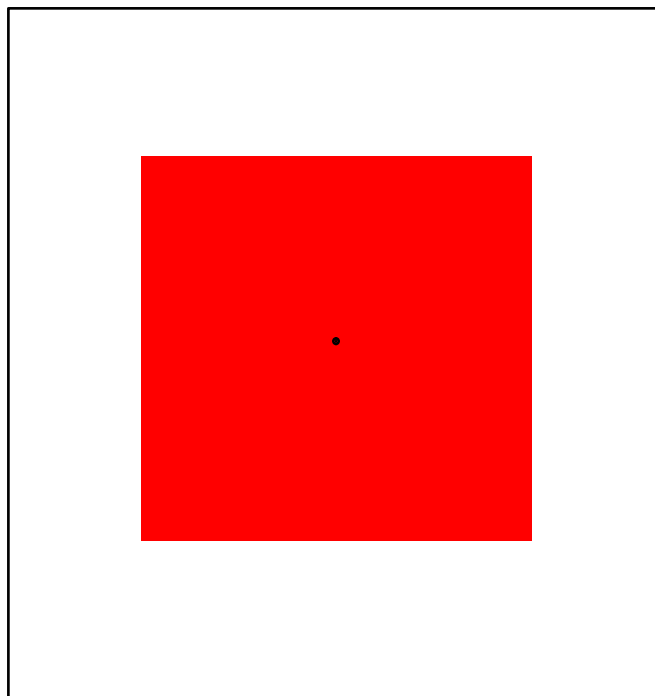


# Synthèse Soustractive

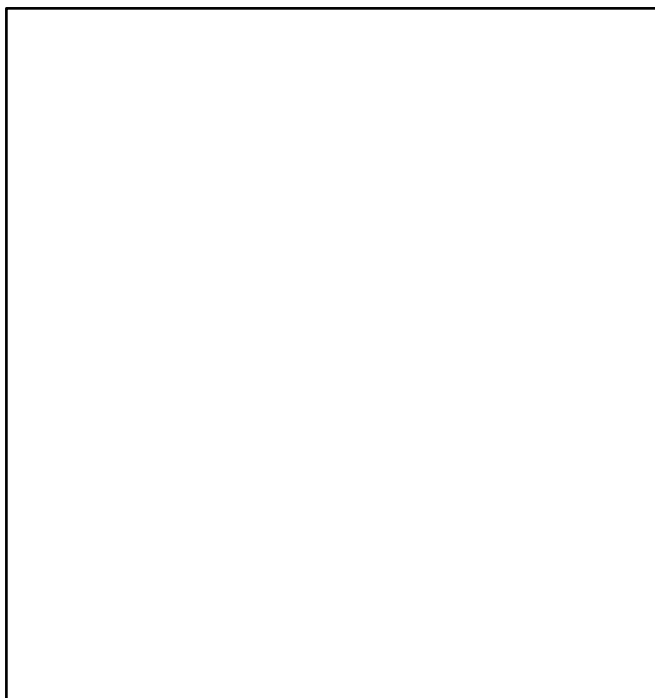
- Imprimante: CMYK
- Peinture: RYB



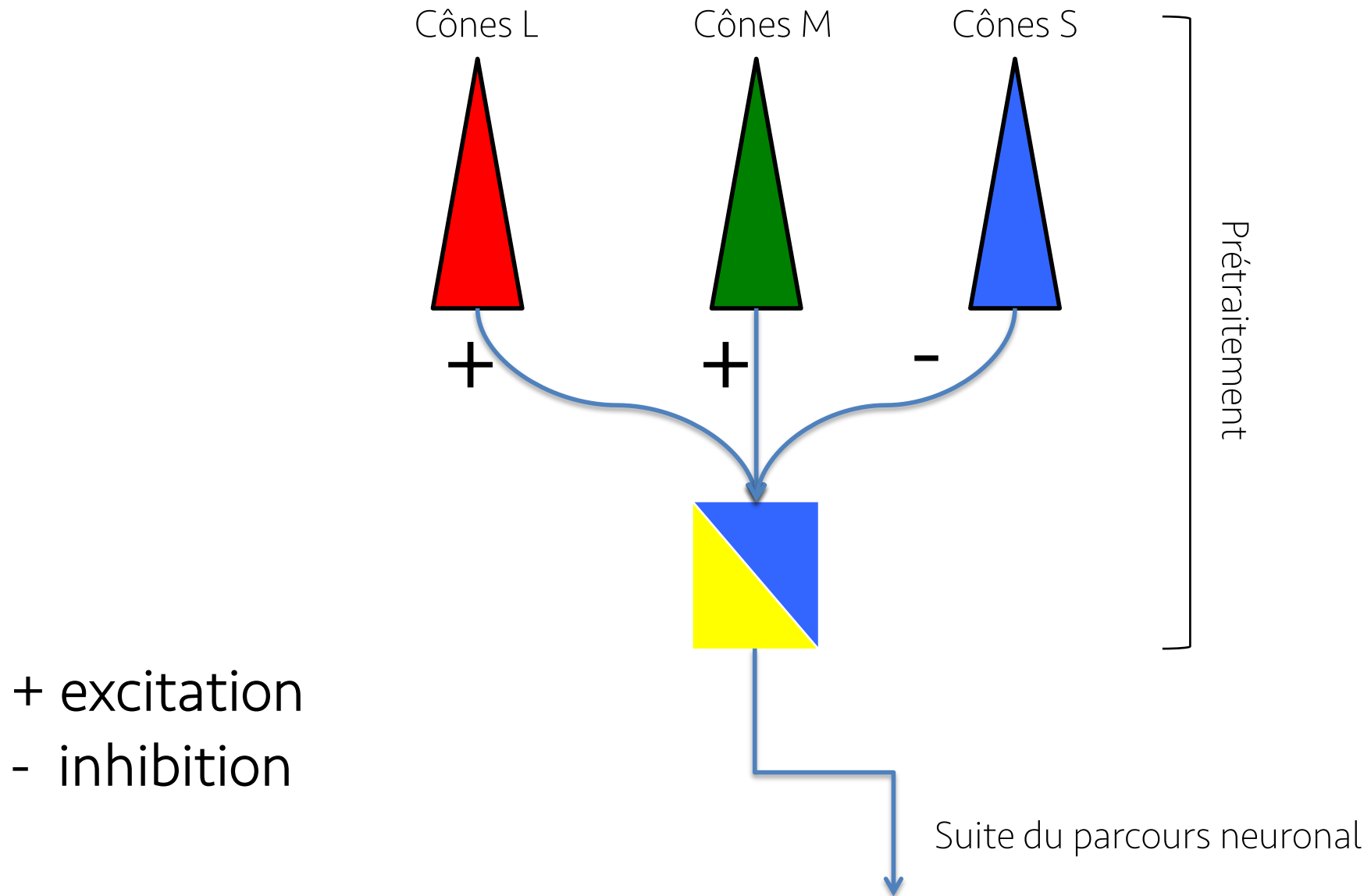
# Couleurs Opposées



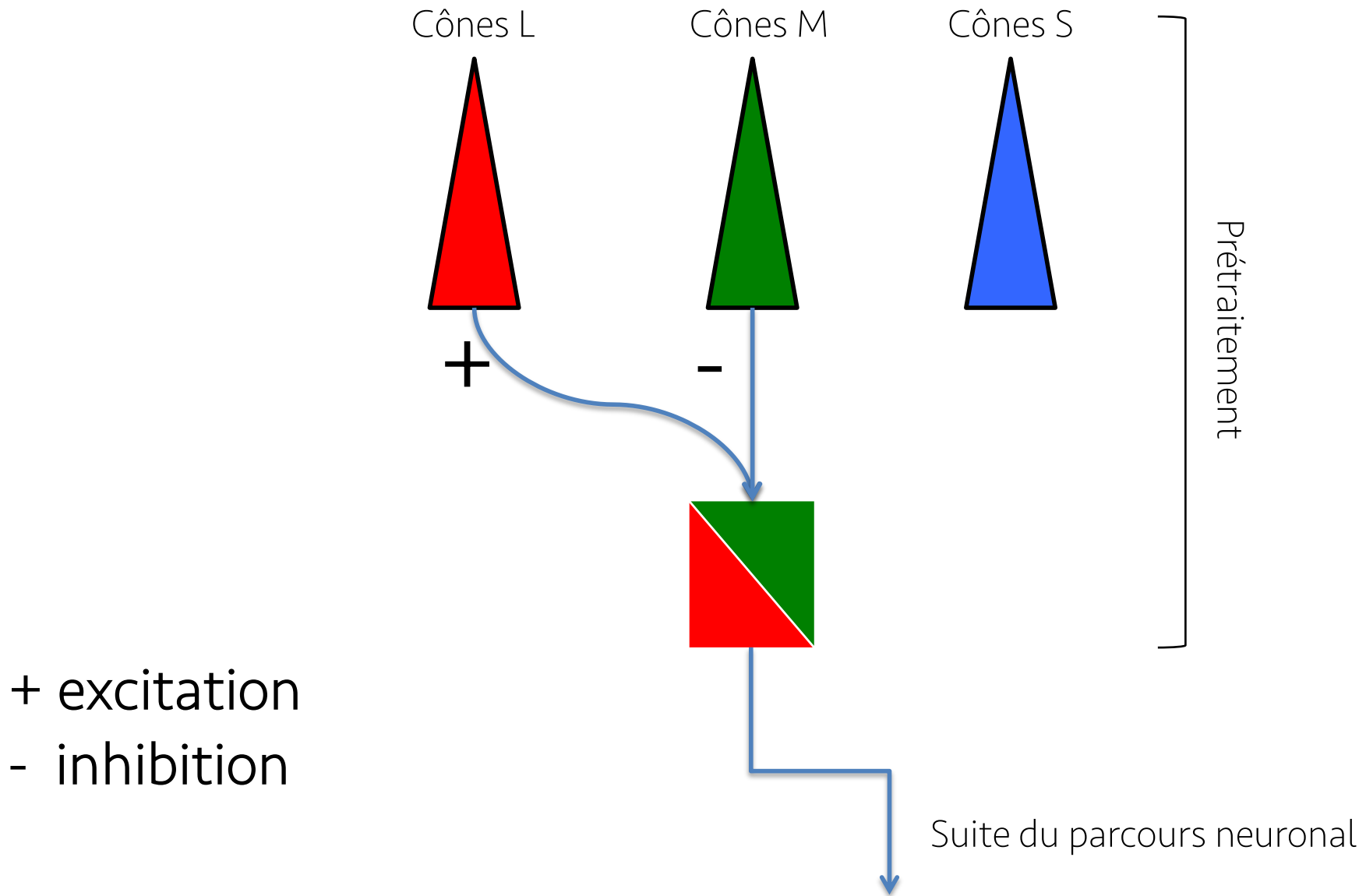
# Couleurs Opposées



# Couleurs Opposées: Bleu/Jaune



# Couleurs Opposées: Rouge/Vert



# Color Wheel

