Color Principles for Computer Graphics

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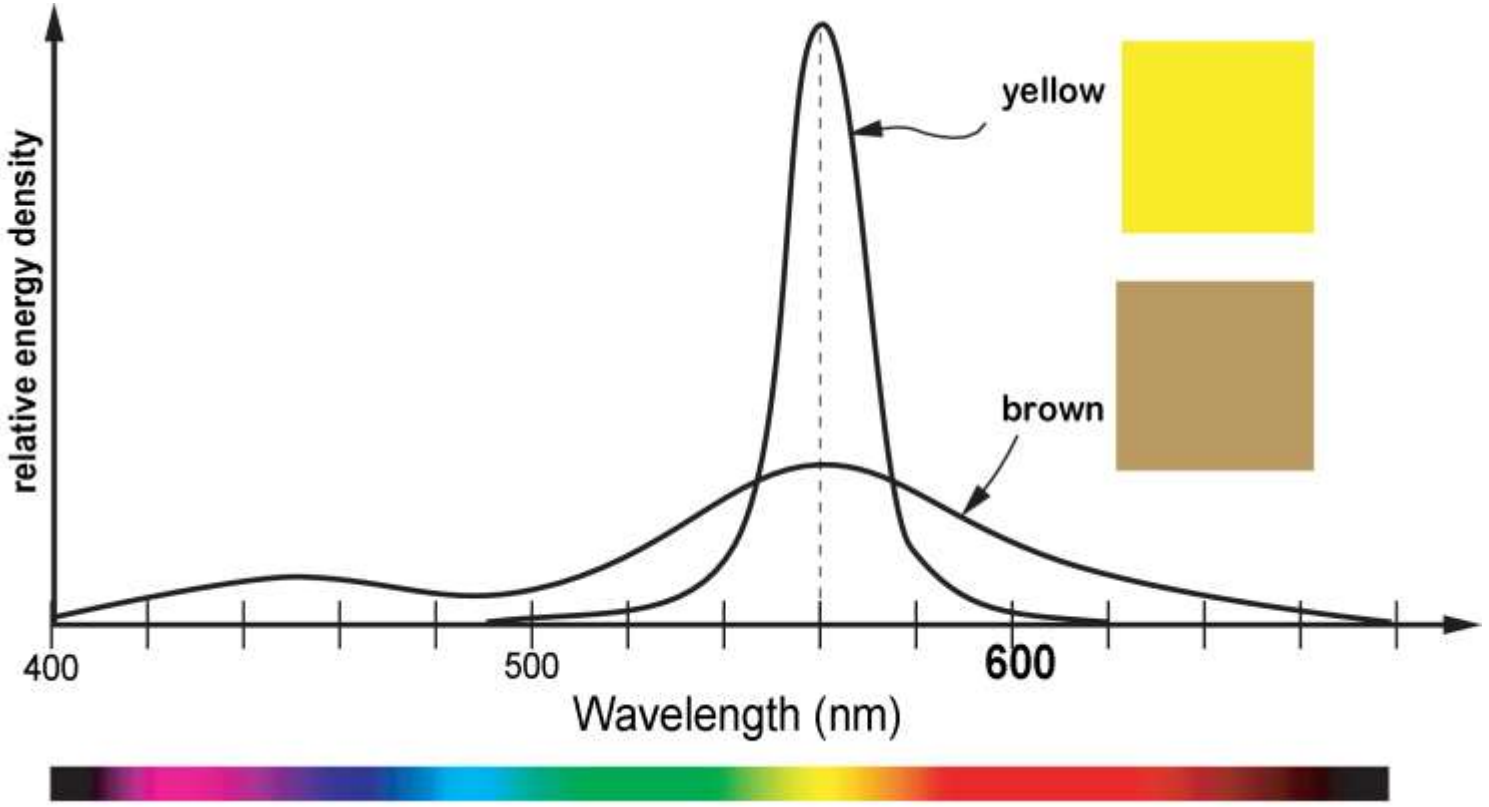
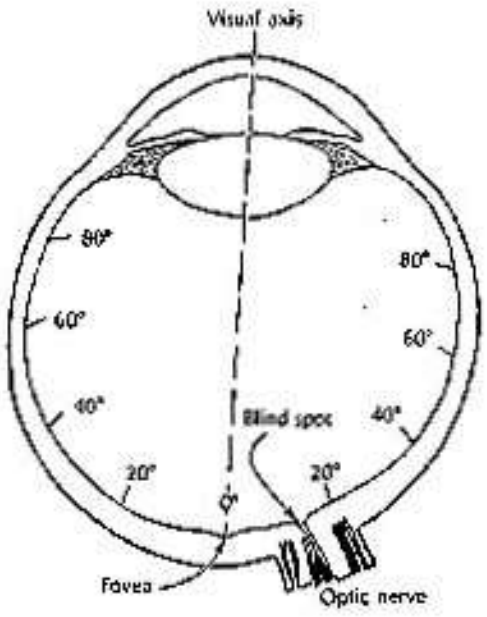
9/17/09

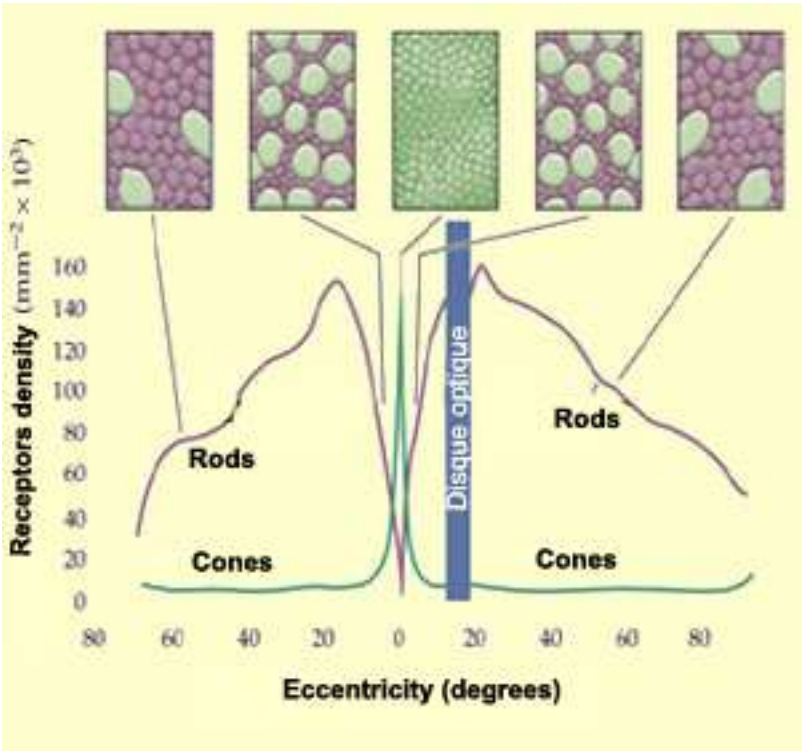
Artist’s slides by Lynette House

Physics of Color

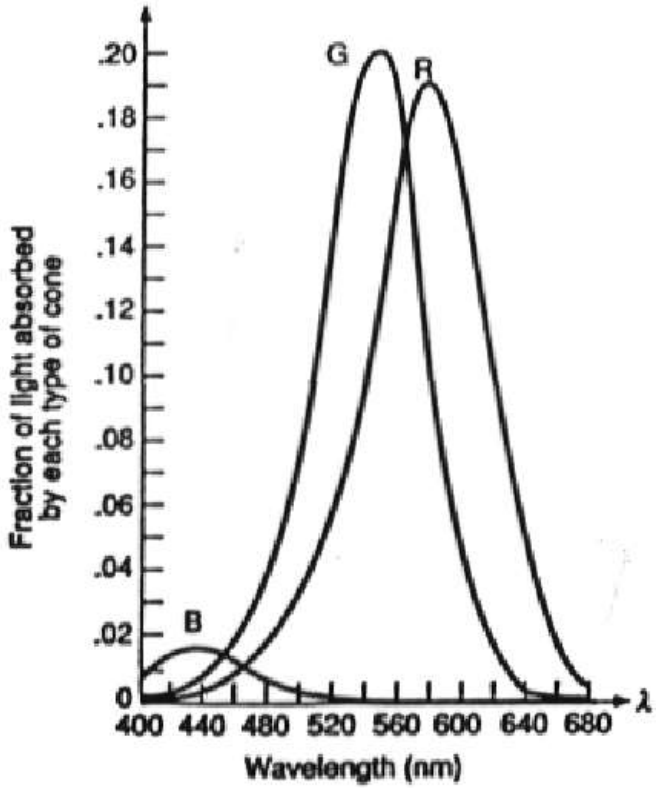


Physiology of Color

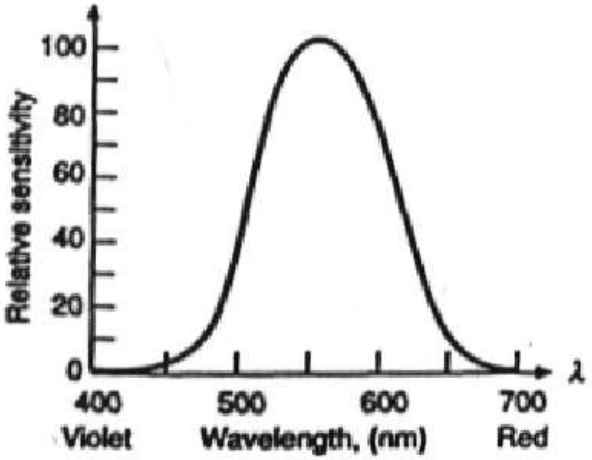




Physiology of Color

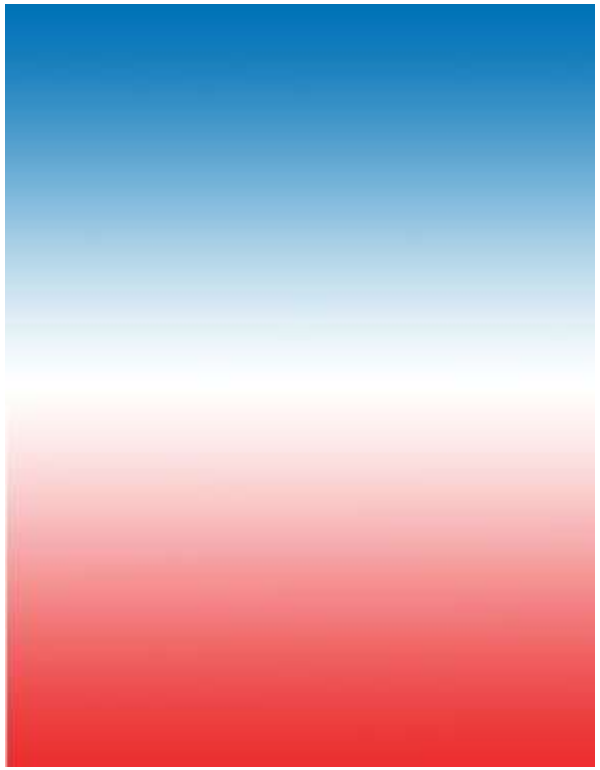


3 cone response curves



Luminance efficiency

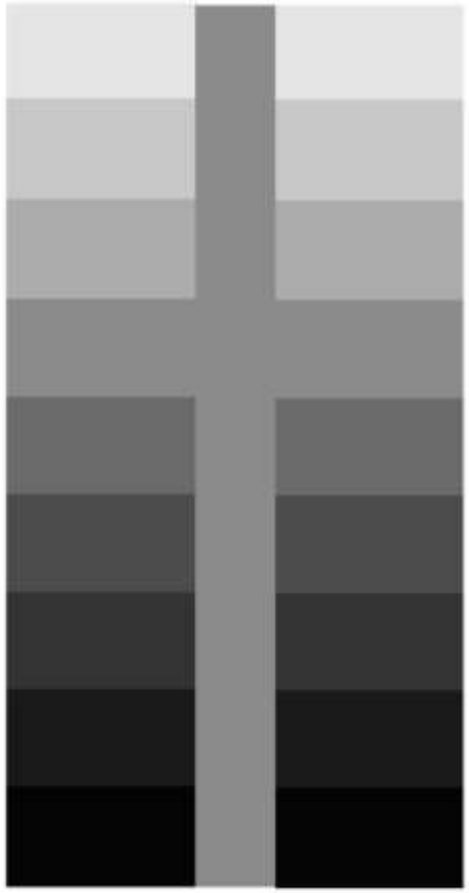
Artist’s Color



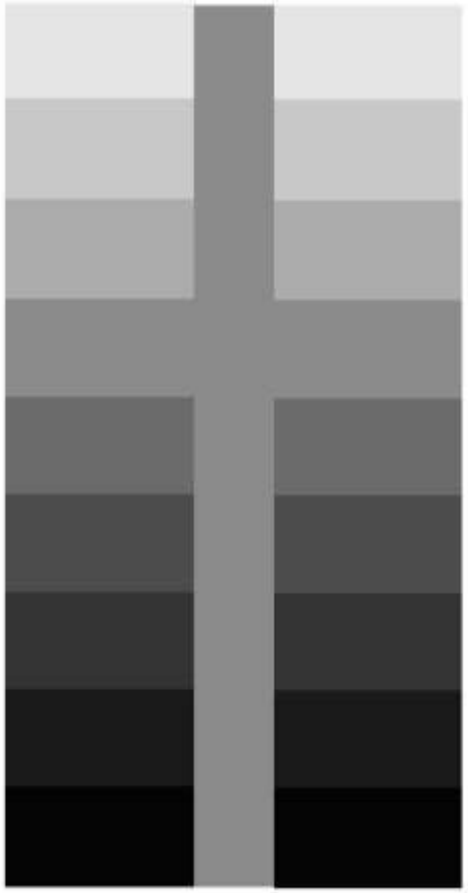
Hue

Saturation

Value

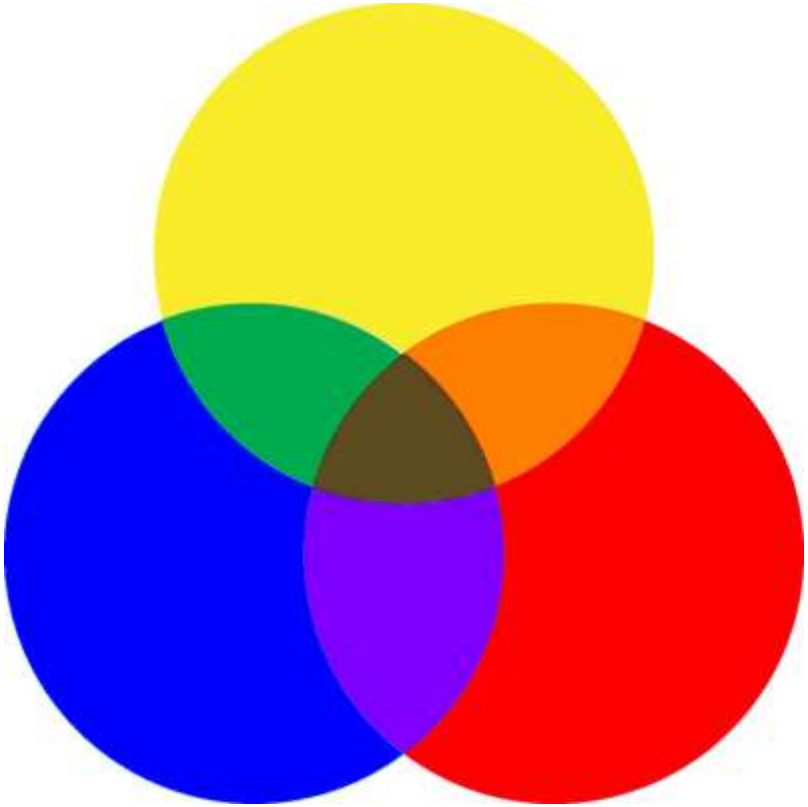


Value



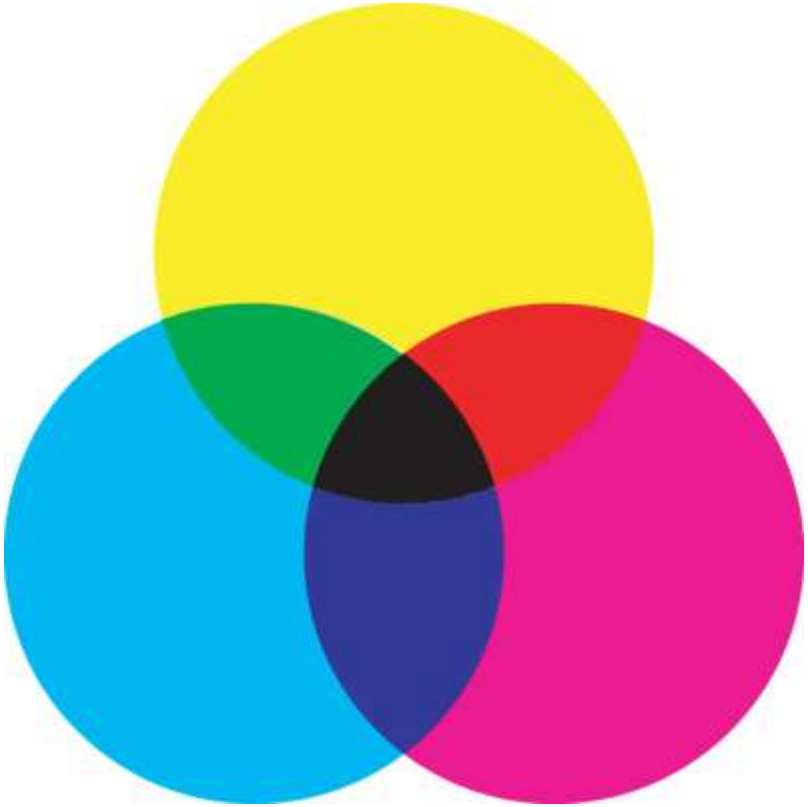
- Luminance
- Dark to Light
- Value range
  - High key
  - Middle key
  - Low key

Hue - Paint Mixing



- Physical mix of opaque paints
- Primary: RYB
- Secondary: OGV
- Neutral: R + Y + B

Hue - Ink Mixing



- Subtractive mix of transparent inks
- Primary: CMY
- Secondary: RGB
- ~Black: C + M + Y
- Actually use CMYK to get true black

Hue - Ink Mixing

Assumption: ink printed on pure white paper

CMY = White – RGB:

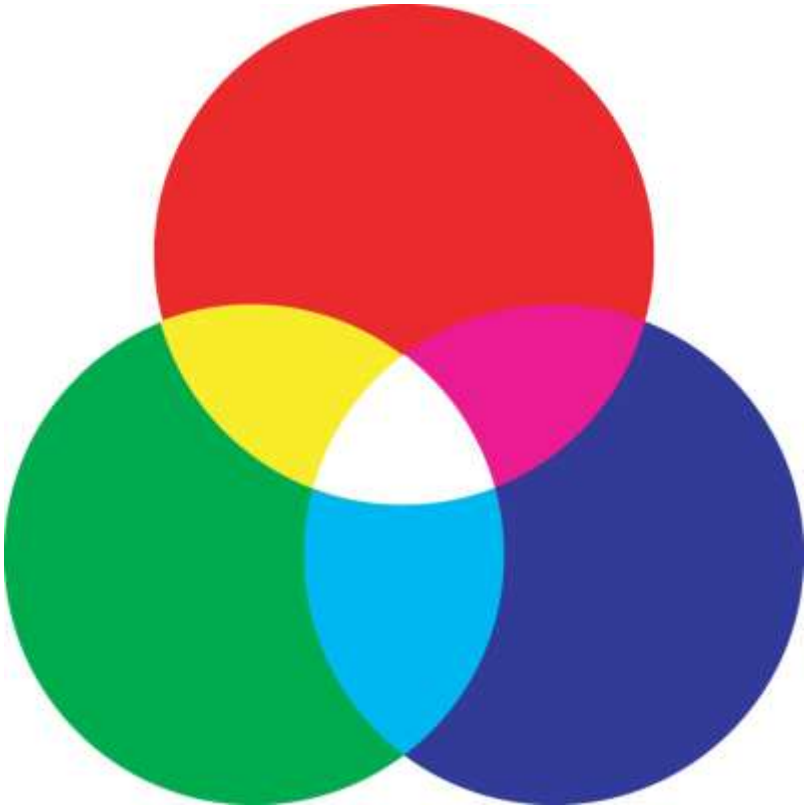
$C = 1 – R, M = 1 – G, Y = 1 – B$

CMYK from CMY (K is black ink):

$K = \min(C, M, Y)$

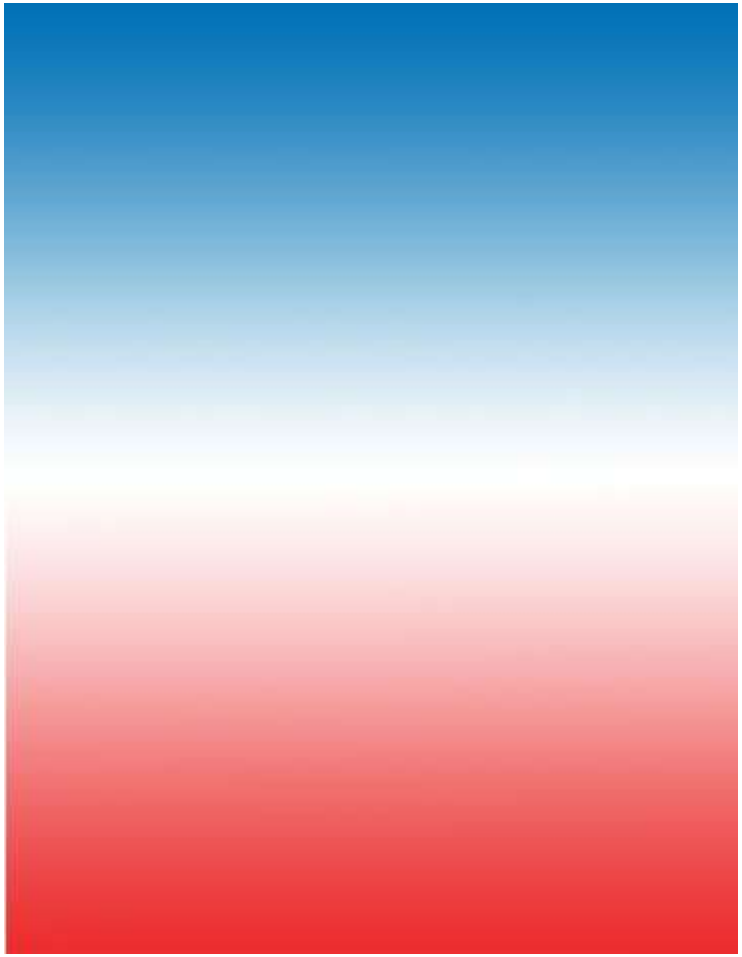
$C = C – K, M = M – K, Y = Y - K$

Hue - Light Mixing



- Additive mix of colored lights
- Primary: RGB
- Secondary: CMY
- White = R + G + B
- Show demonstration of optical mixing

Saturation

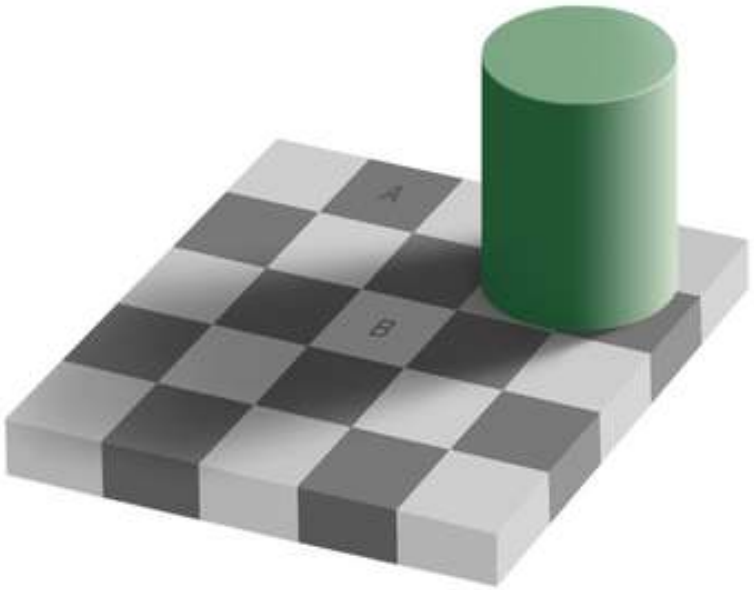


- Purity of color

Perception of Color

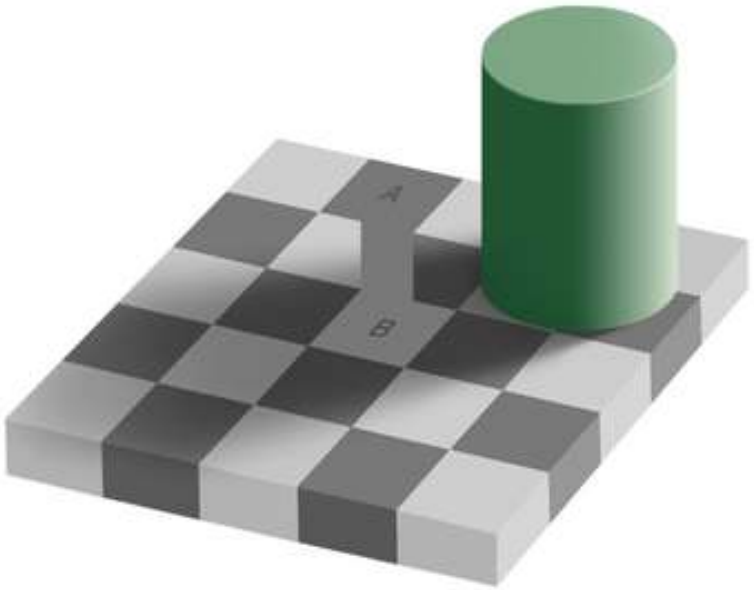
In the end, color is a perceptual phenomenon

Color Constancy



- Perceived color is highly context dependent
- Allowing color recognition with variable lighting conditions

Color Constancy

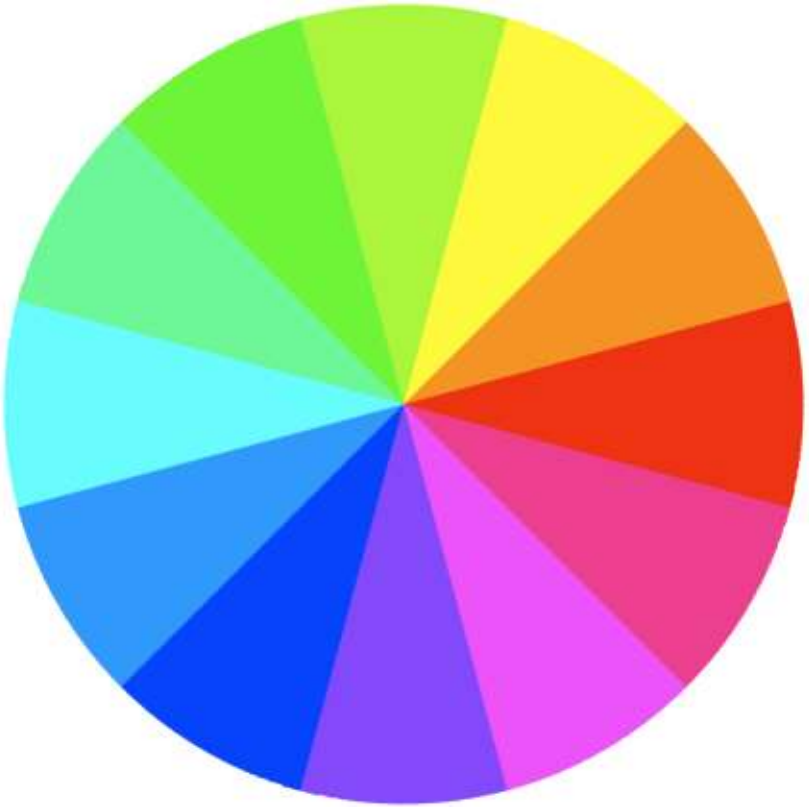


- Perceived color is highly context dependent
- Allowing color recognition with variable lighting conditions

Simultaneous Contrast

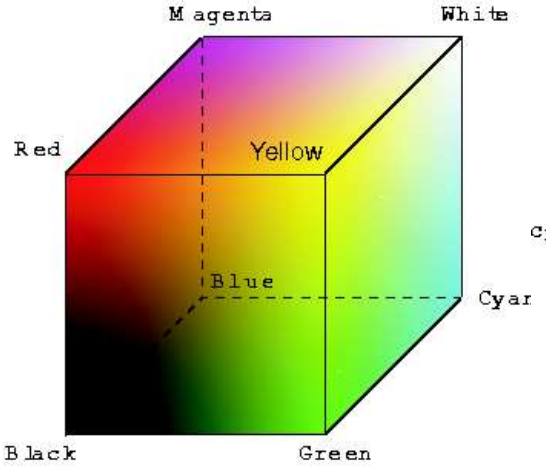
Simultaneous Contrast

RGB Color Wheel

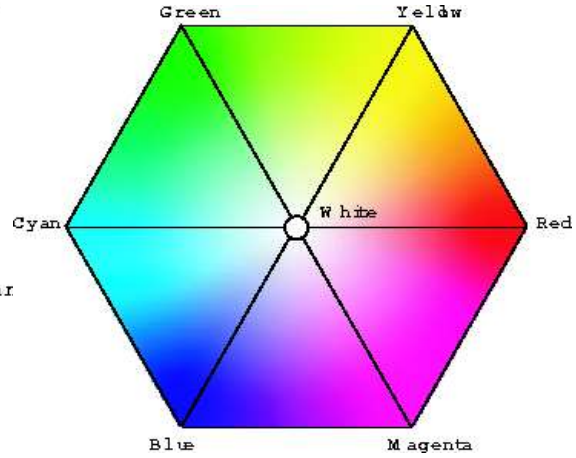


- Warm/Cool
- Complements
- Split Complement
- Analogous
- Show RGB Cube

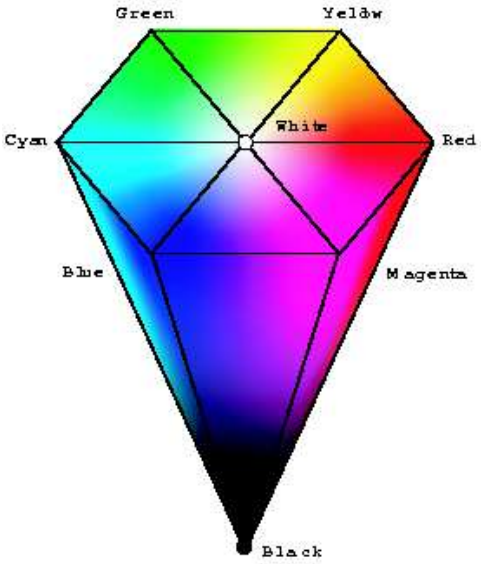
HSV Color Model



RGB cube



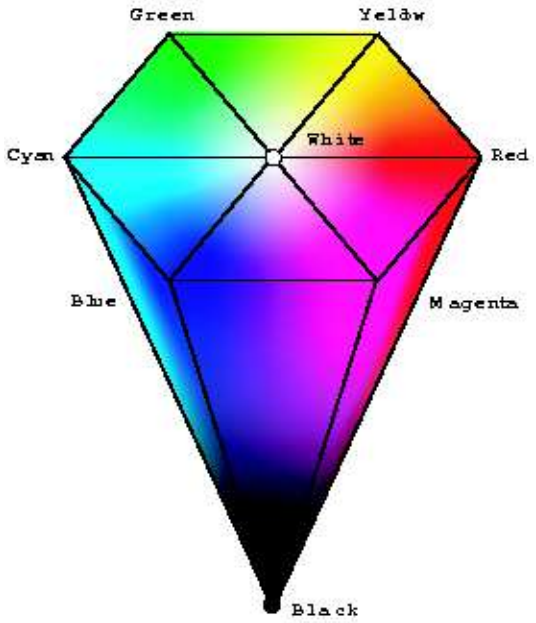
HSV top view

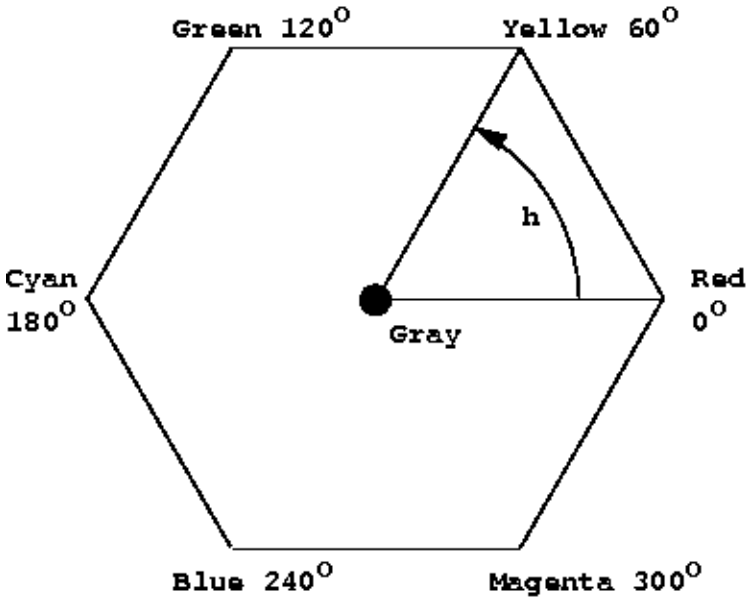


HSV cone

HSV is a projection of the RGB space

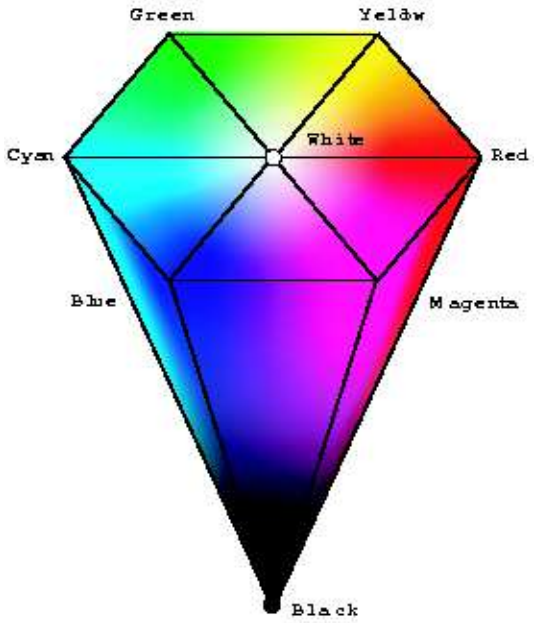
HSV Color Model

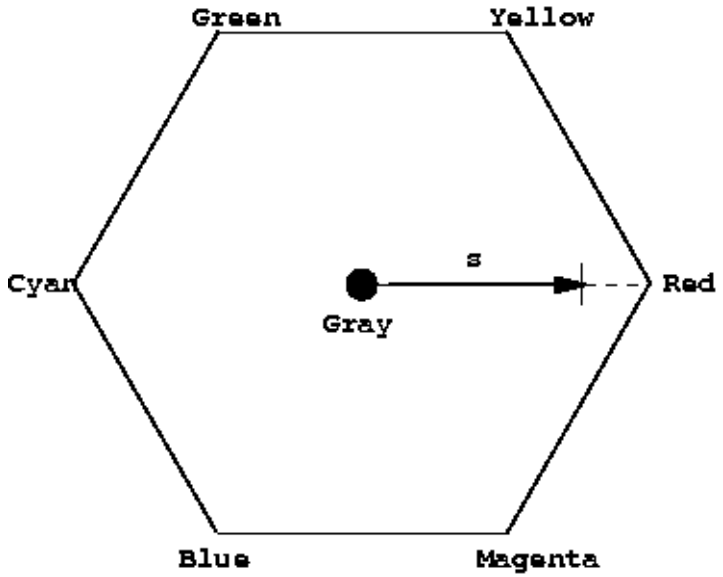




Hue, an angular measure (0 … 360)

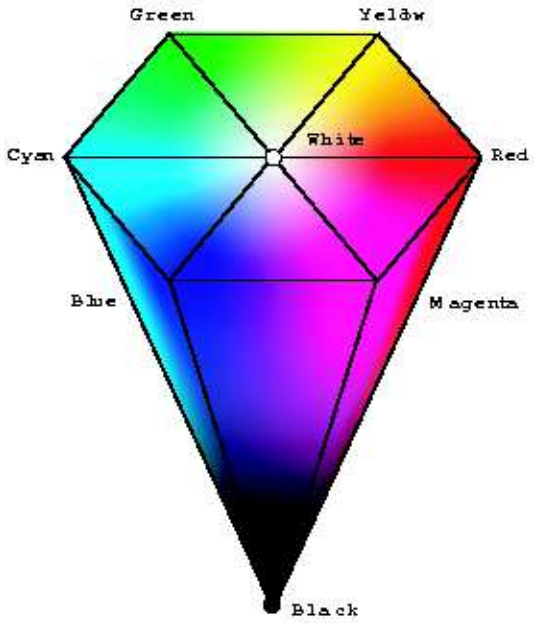
HSV Color Model

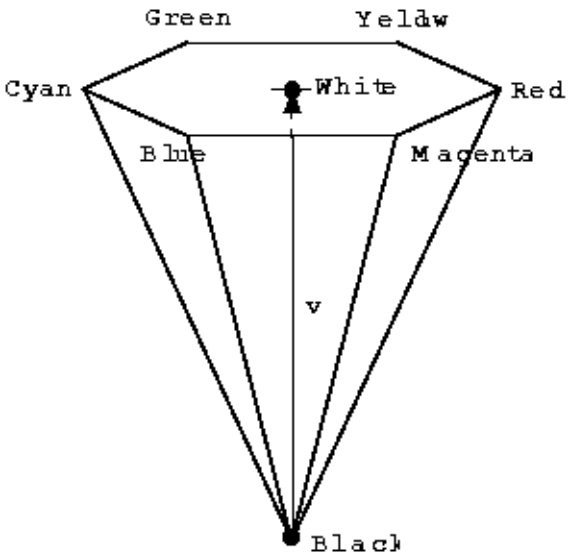




Saturation, a fractional measure (0.0 … 1.0)

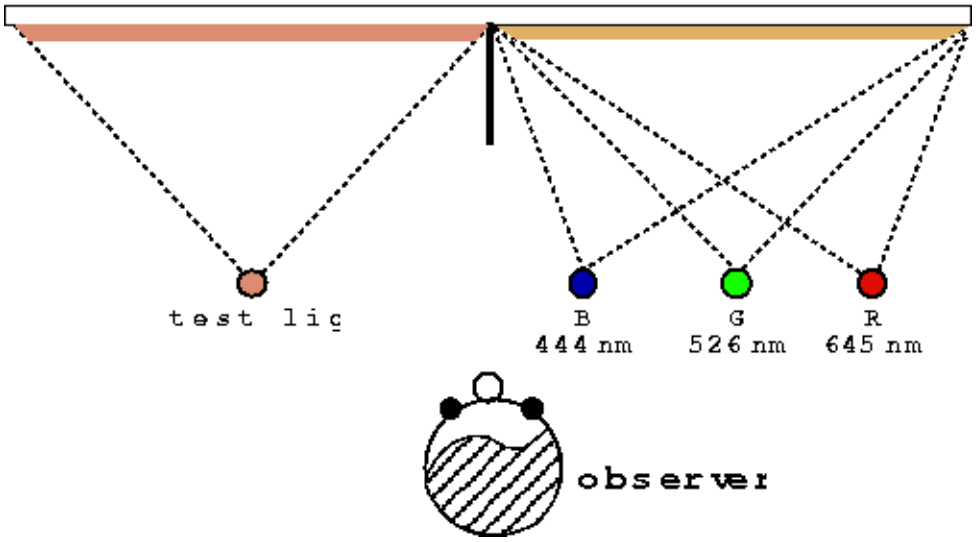
HSV Color Model





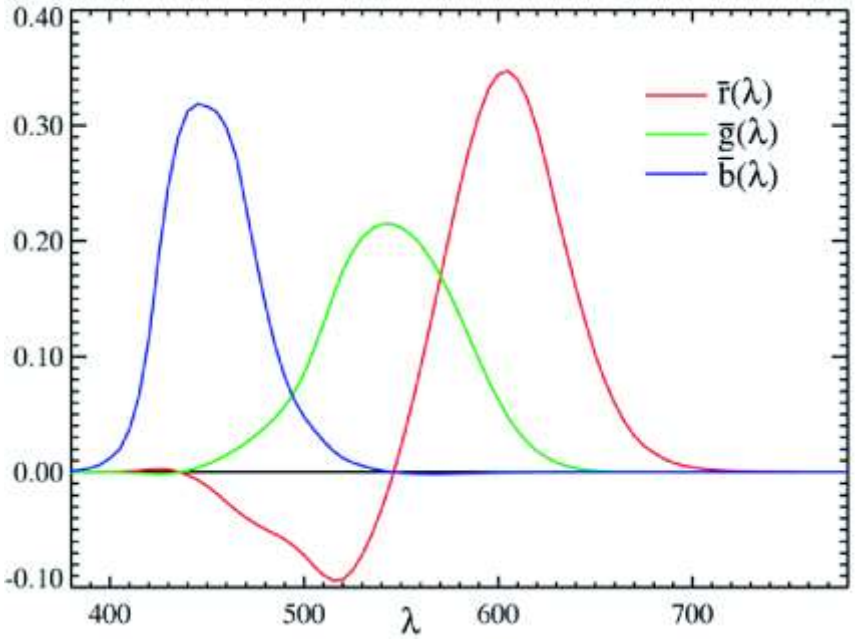
Value, a fractional measure (0.0 … 1.0)

CIE 1931 Study

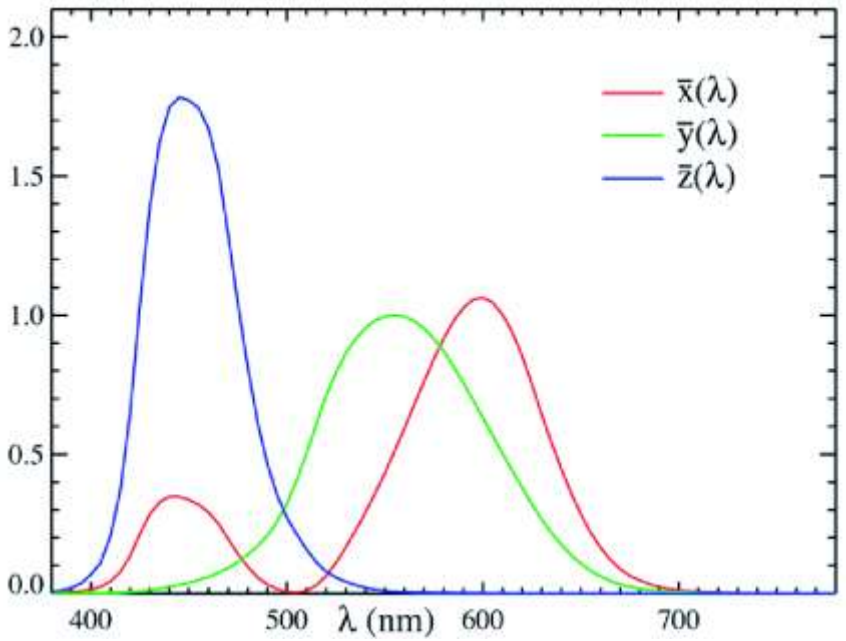


Color Matching Experiment

CIE Color Matching Functions

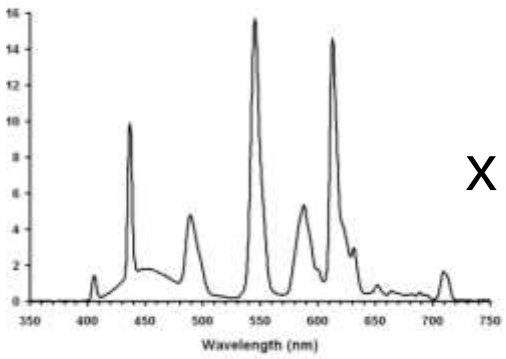
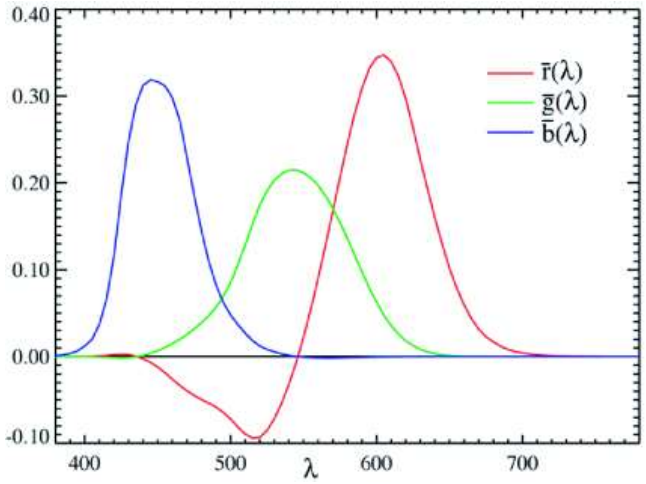


CIE *RGB* Matching Functions

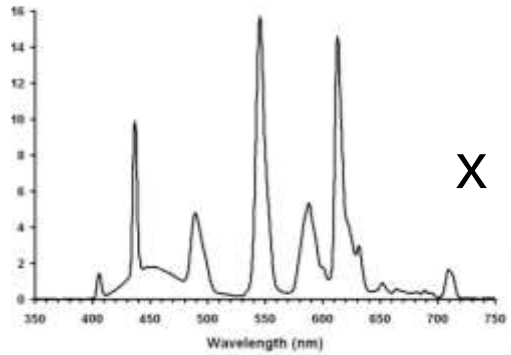
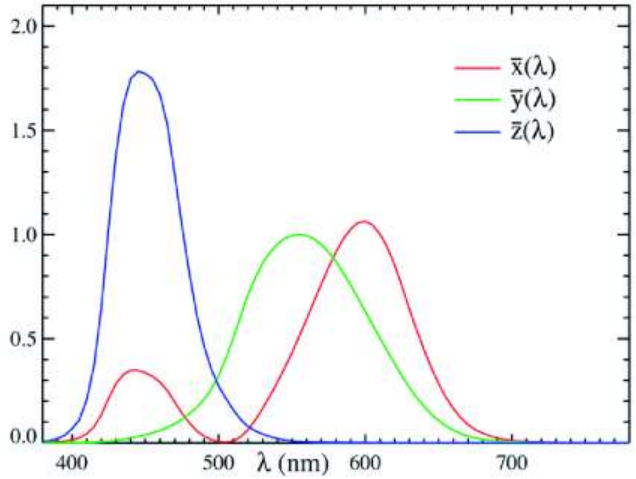


CIE *XYZ* Matching Functions

RGB from Spectrum

RGB = $\int$  x  $d\lambda$

XYZ from Spectrum

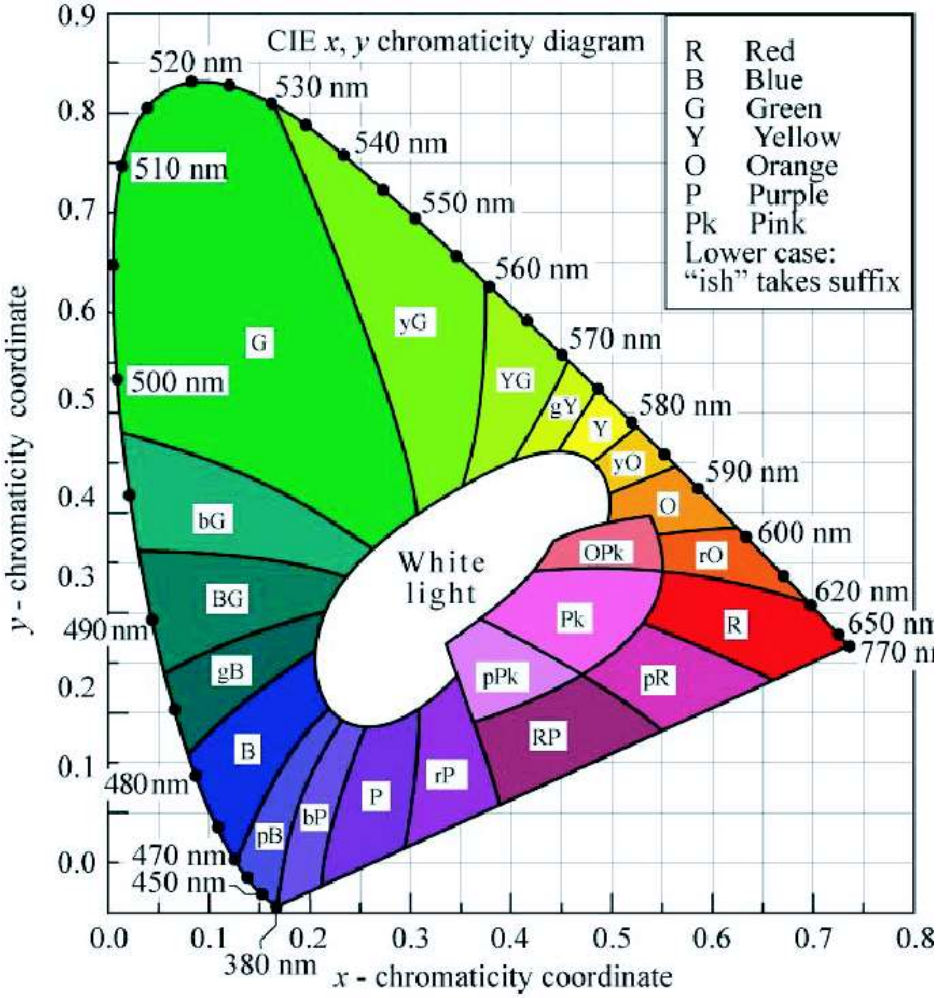
$$XYZ = \int \text{  } \times \text{  } d\lambda$$

CIE *xyY* from CIE *XYZ*

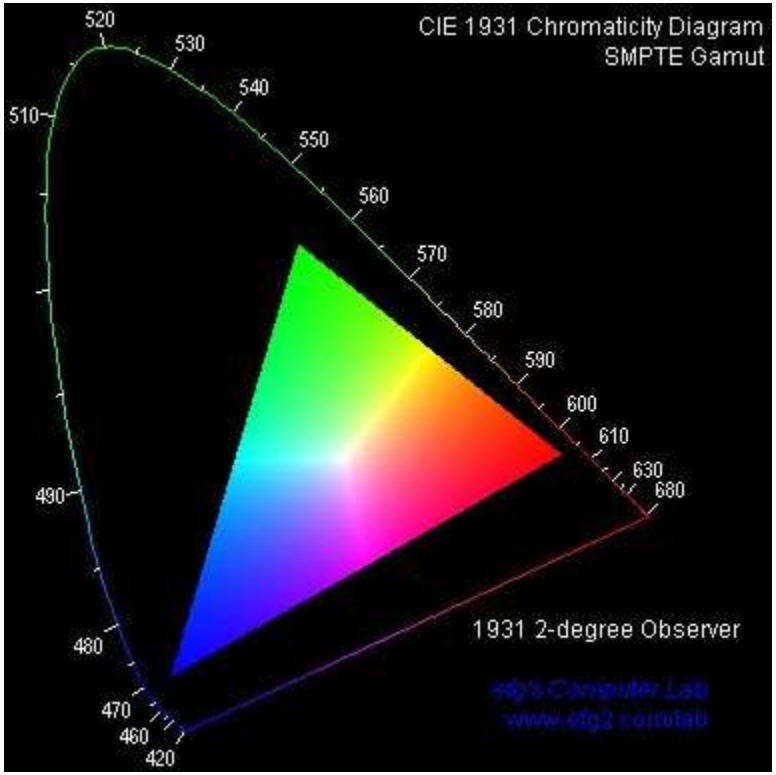
CIE xyY color model is used to catalog colors:

$$x = X / (X + Y + Z)$$
$$y = Y / (X + Y + Z)$$
$$Y = \text{luminance}$$

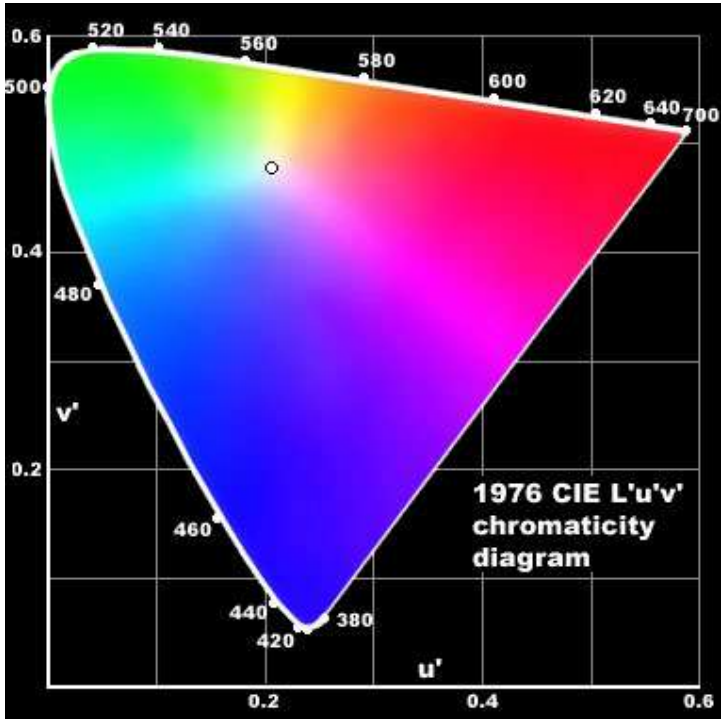
CIE *xyY* Color Cone

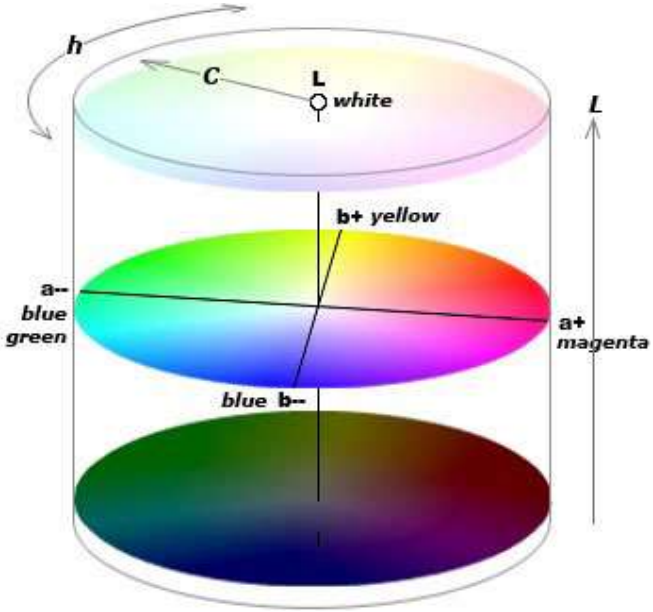


CIE *xyY* Typical Display Gamut



CIE *Lu*v** and *Lab* Perceptually Uniform Spaces

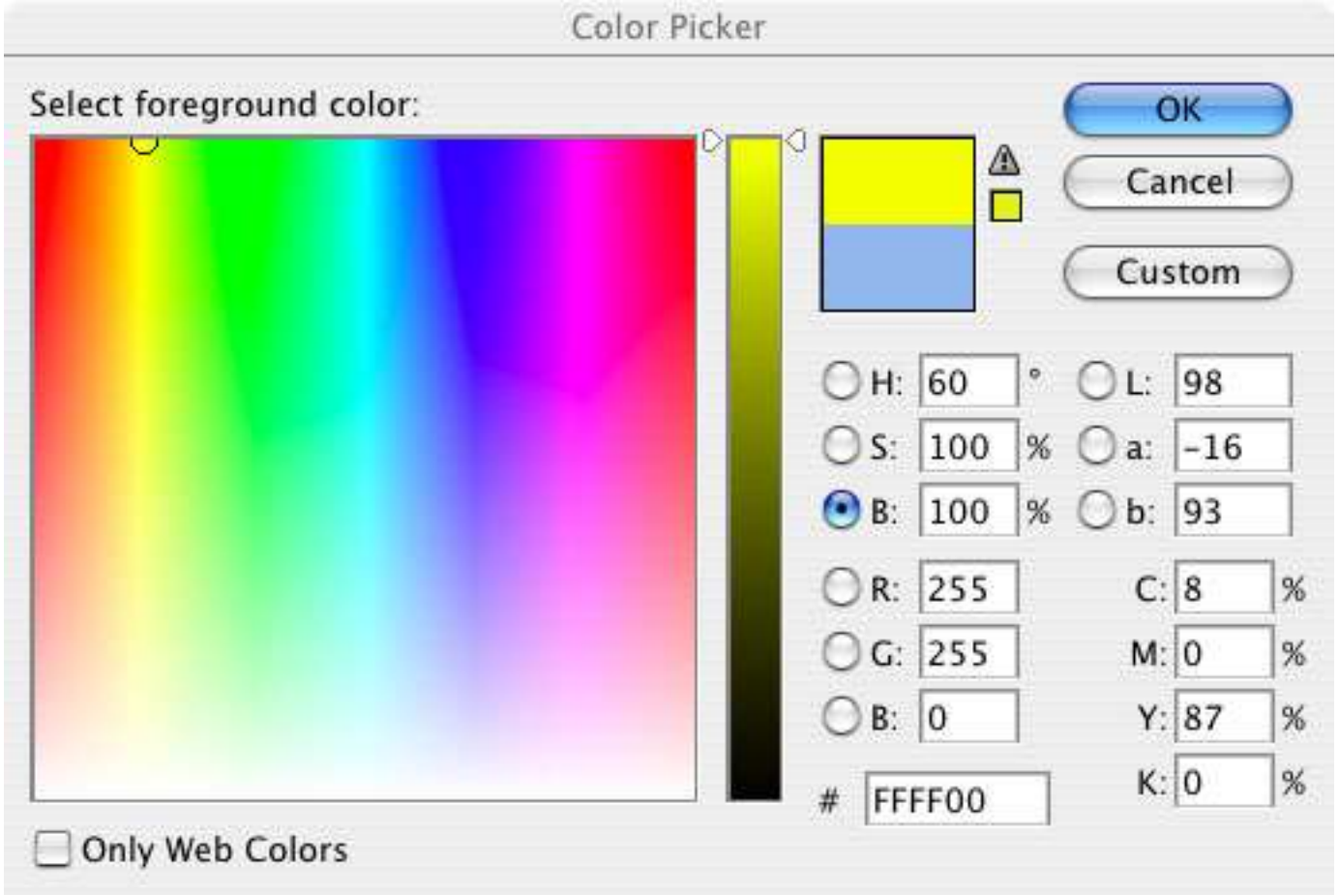




*Lu*v** rescales *xyY*

Lab color opponents

Color Picker



End