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Human Color Vision and Colorimetry

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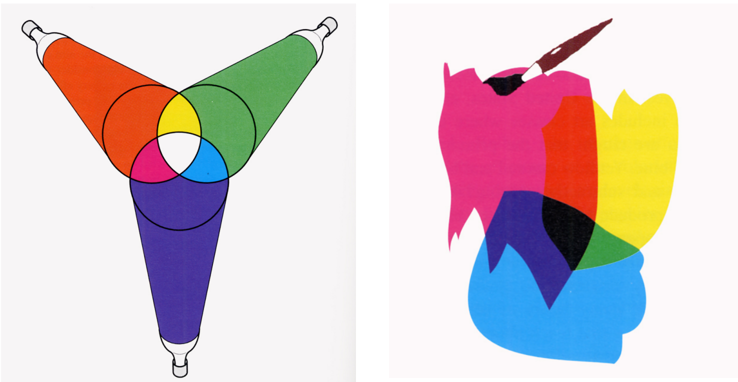
Contents

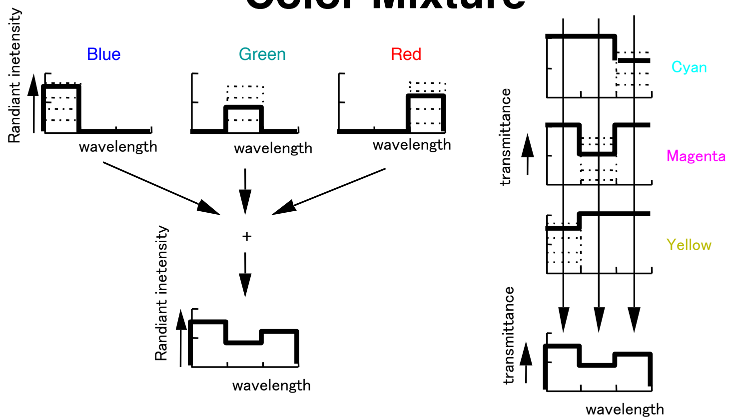
- Human color vision model
- CIE colorimetry
- Advanced colorimetry

Additive and Subtractive Color mixture



Billmeyer and Saltzman's principles of color technology, Roy S. Berns.

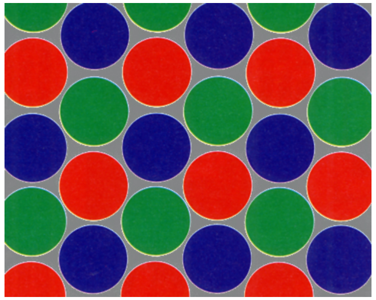
Additive and Subtractive Color Mixture

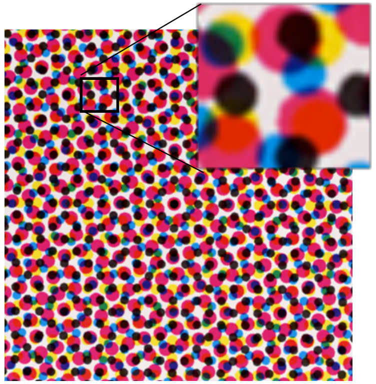


(a) additive

(b) subtractive

Color Reproduction

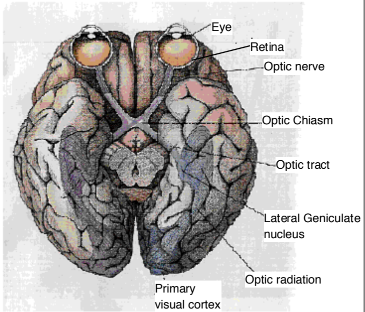




TV(CRT, LCD, etc.)
(additive color mixture)

Printing
(subtractive color mixture)

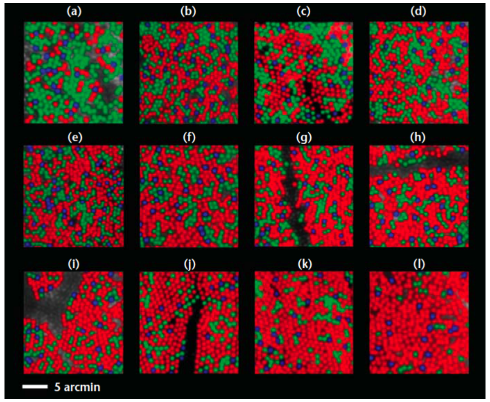
Human visual information processing



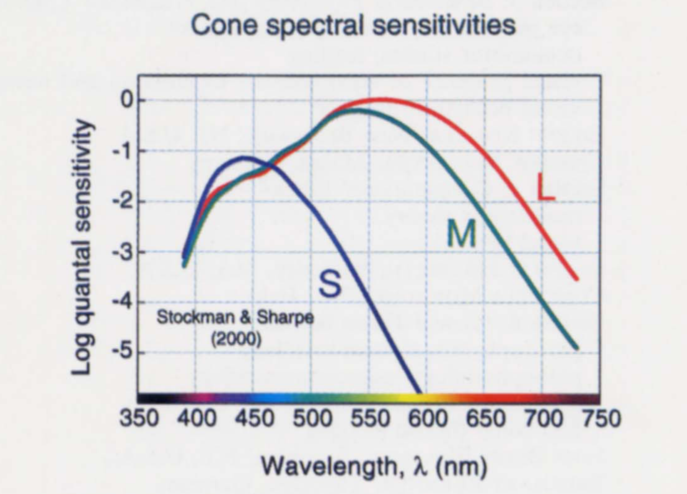
- Eye balls: Camera
- Retina：High intelligent input device
  - **Photo-sensitive sensor (rods and cones)**
  - **Luminance channel and chromatic channel (horizontal cells)**
  - **Contrast (ganglion cells)**
- LGN：M-path; where?
  P-path; what?
  - Place, motion, depth, shape, color, texture, detail
- Visual cortex
  - Parietal stream
  - Inferotemporal steam

Cone mosaic

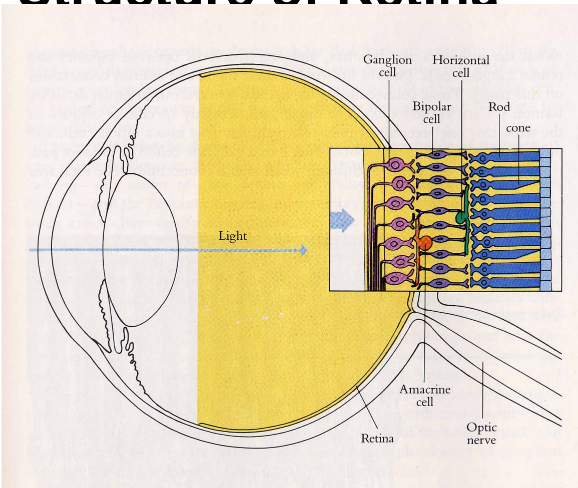
Joseph Carroll, Daniel C. Gray, Austin Roorda and David R. Williams, Optics & Photonics News, vol. 16, 36-41 (2005)



Spectral sensitivity of cone



Structure of Retina



Electrophysiological Recordings from Single Cone of the Carp Retina

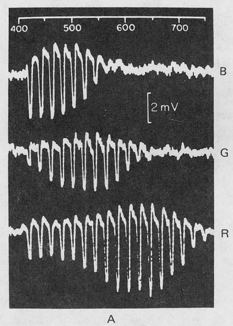


FIGURE 7.6 A: Sample recordings from single cones of the carp retina, for the three types of cones that were found. (Continued on page 222.)

Electrophysiological Recordings from Horizontal Cells of Carp Retina

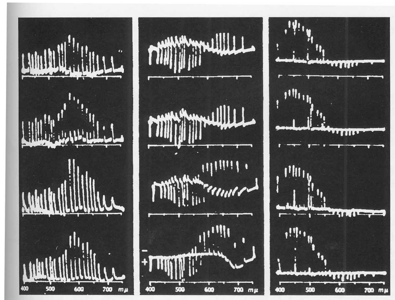
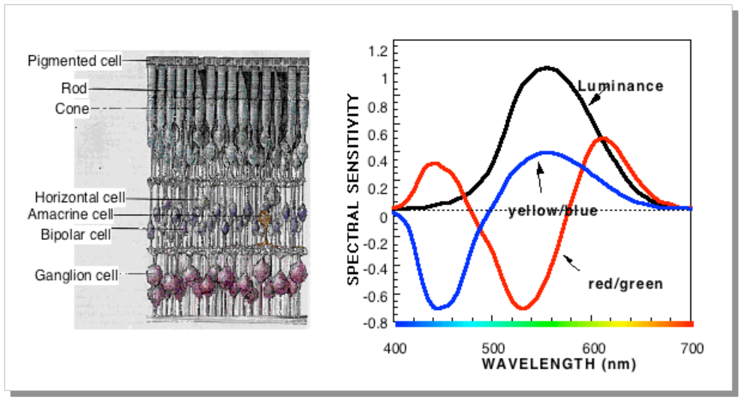
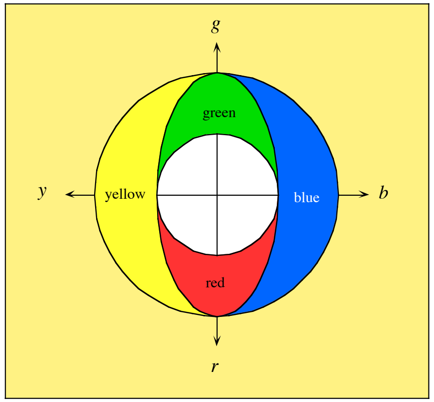


Figure 7.5 Sample recordings from horizontal cells of carp retina. The left column shows data analogous to an spectrally nonopponent, achromatic signal. The middle column represents a spectrally opponent red-green signal and the right column represents a blue-yellow signal. (From Svaetichin, 1956).

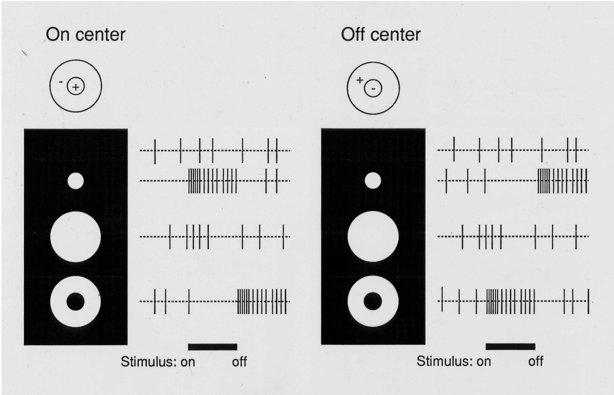
Opponent-color Stage (Luminance and Color)



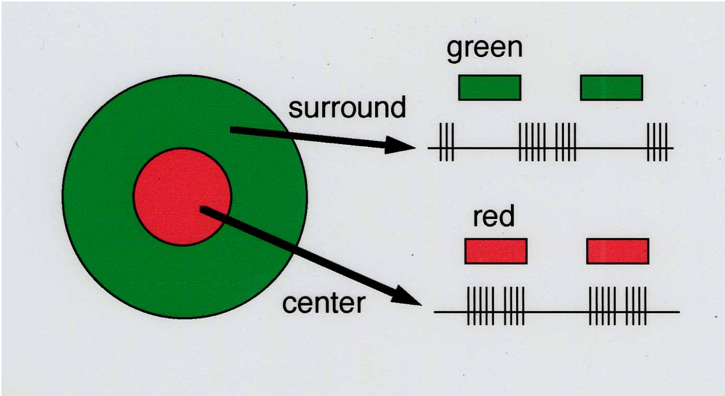
Hering's Color Circle



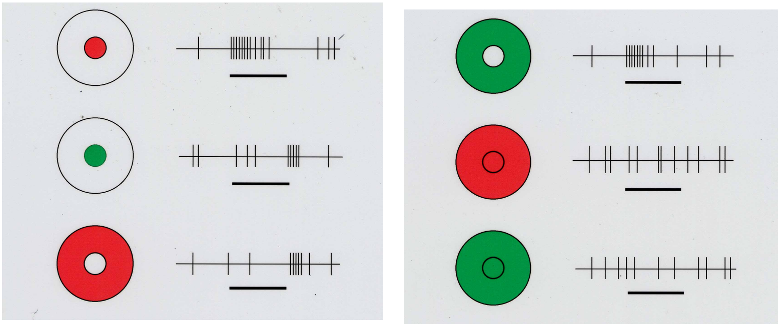
Receptive field of retinal ganglion cells



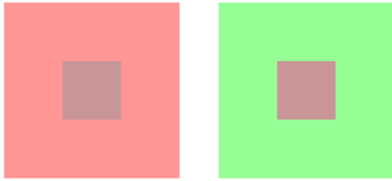
Color opponent cell of the retinal ganglion cell



Double Opponent Color

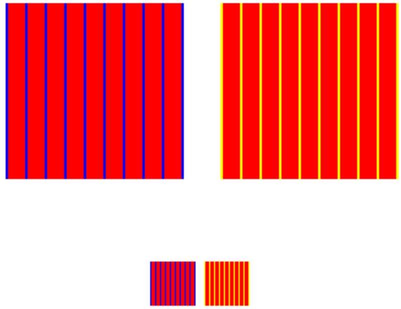


Color Contrast



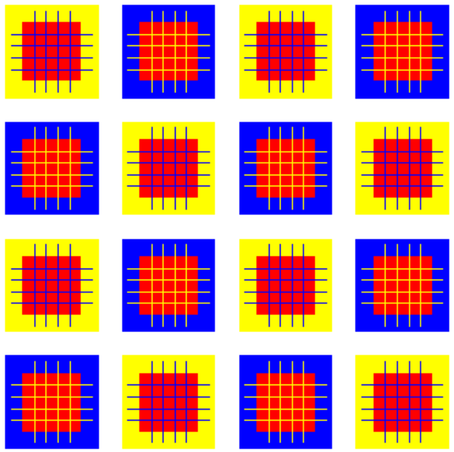
http://www.psy.ritsumei.ac.jp/~akitaoka/LorealWS2005.html

Color Assimilation



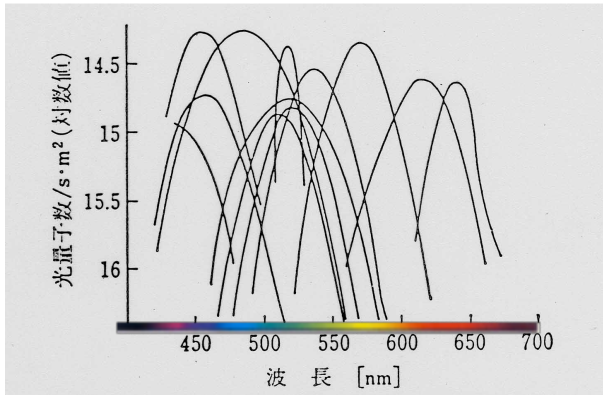
http://www.psy.ritsumei.ac.jp/~akitaoka/LorealWS2005.html

Color contrast and color assimilation

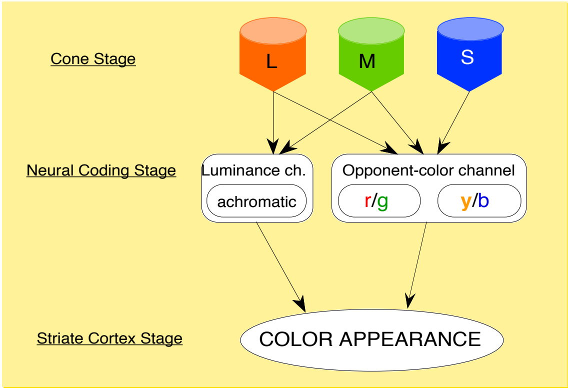


http://www.psy.ritsumei.ac.jp/~akitaoka/LorealWS2005.html

Spectral Selectivity of the V4 Cells in the Visual Cortex



Color Vision Model



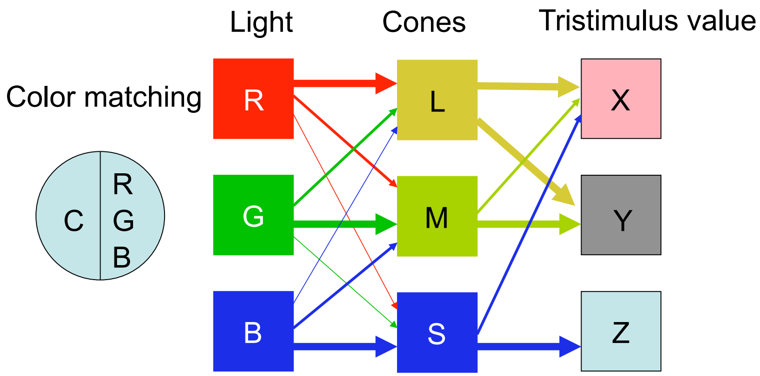
Basic Colorimetry
Wyszecki (1973)

- ***Colorimetry is a tool used to making a prediction on whether two lights of different spectral power distributions will match in color for certain given conditions of observation. The prediction is made by determining the tristimulus values of the two visual stimuli. If the tristimulus values of a stimulus are identical to those of the other stimulus, a color match will be observed by an average observer with normal color vision.***

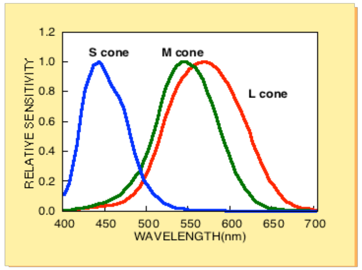
Basic colorimetric system

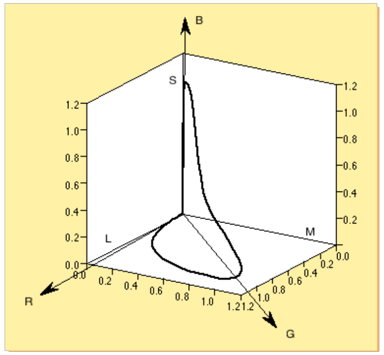
- **LMS (Physiological system)**
- **RGB (Physical system)**
- **XYZ (Mathematical system)**

Color Matching and Tristimulus Value

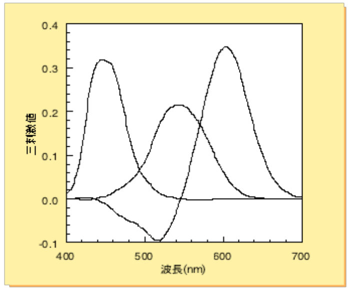


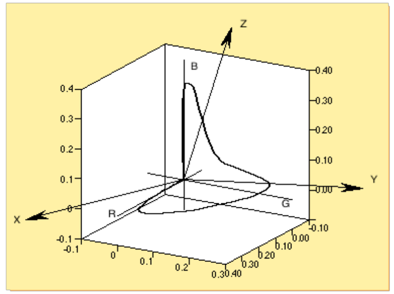
LMS
(Physiological colorimetry)



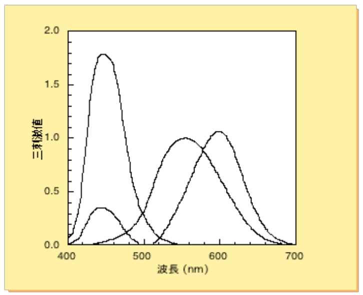


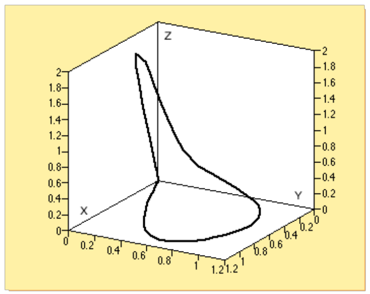
RGB
(Physical colorimetry)



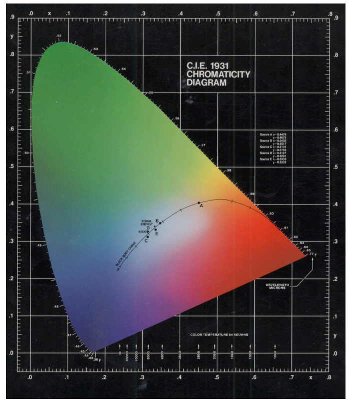


XYZ
(Mathematical colorimetry)

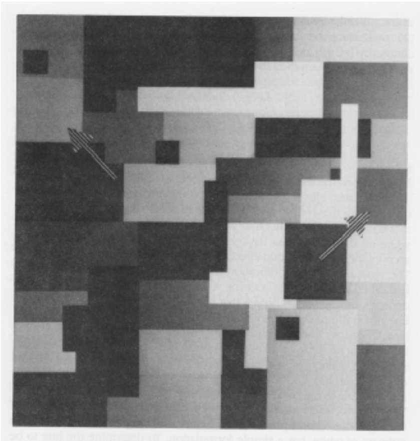


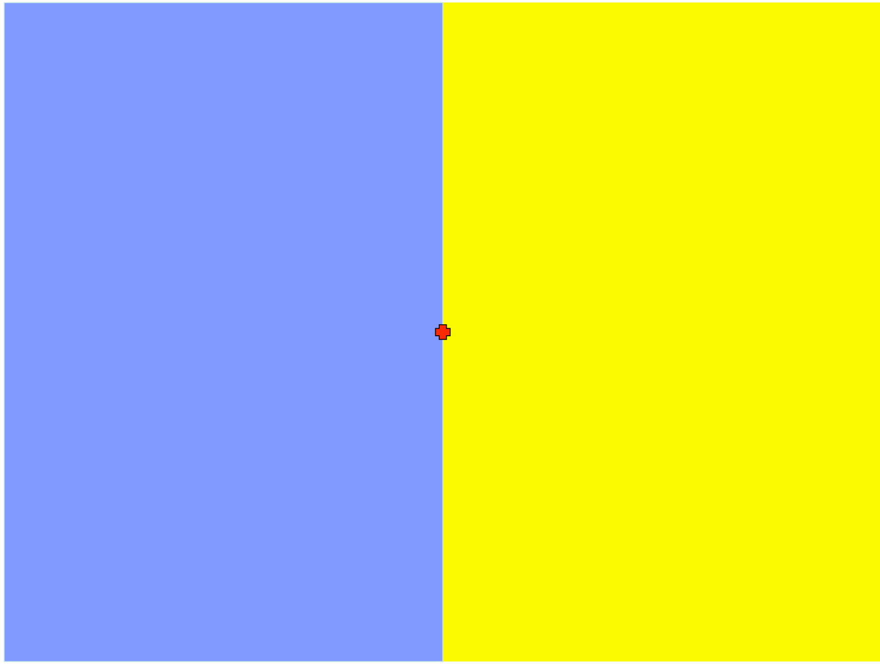


CIE1931 (*x*, *y*) chromaticity diagram



We do not see the light but the object





Advanced Colorimetry
Wyszecki (1973)

- ***Colorimetry is its broader sense includes methods of assessing the appearance of color stimuli presented to the observer in complicated surroundings as they may in occur in everyday life. This is considered the ultimate goal of colorimetry, but because of its enormous complexity, this goal is far from being reached.***

Advanced colorimetric system

- **Uniform color space, CIE1976L*a*b***
- **Color appearance model, CIECAM02**

CIELAB(CIE1976L*a*b*)

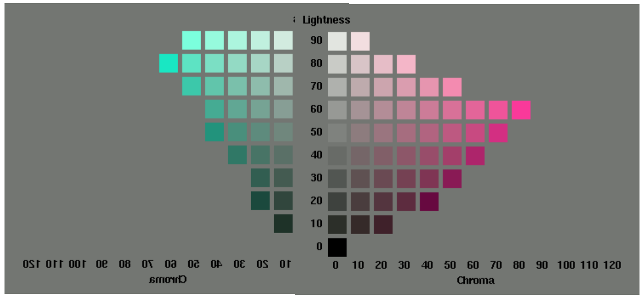
$$L^* = 116\left(\frac{Y}{Y_n}\right)^{\frac{1}{3}} - 16$$

$$a^* = 500\left\{\left(\frac{X}{X_n}\right)^{\frac{1}{3}} - \left(\frac{Y}{Y_n}\right)^{\frac{1}{3}}\right\}$$

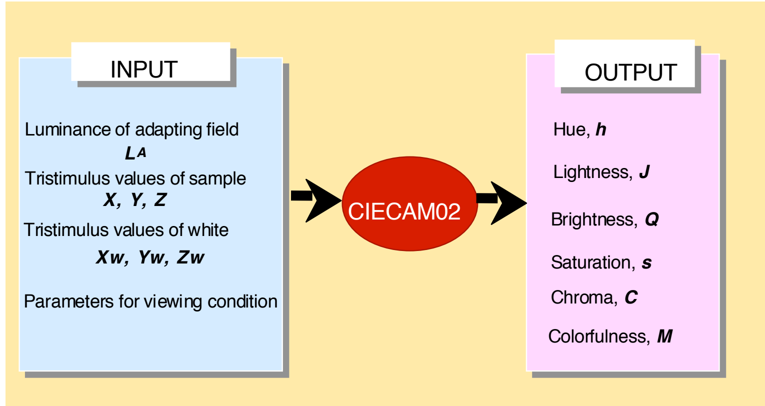
$$b^* = 200\left\{\left(\frac{Y}{Y_n}\right)^{\frac{1}{3}} - \left(\frac{Z}{Z_n}\right)^{\frac{1}{3}}\right\}$$

- Color adaptation
  - White is always white
- Non-linearity
  - Physical unit to psychological l unit
- Color opponency
  - Luminance and chromaticness

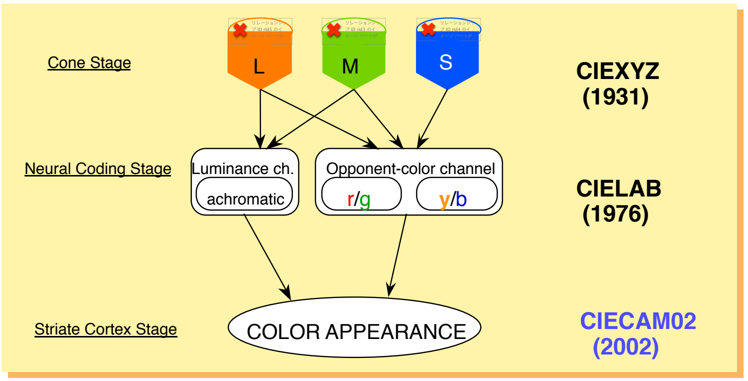
CIELAB Color Space



CIE Color Appearance Model (CIECAM02)



Human color vision and advance of colorimetry



Labo Tour for JPAC

July 29 (Mon), 2013 12:50-14:25
at Yaguchi-Mizokami Labo
SHIZEN-2, 3F, tel:3473