Colour Reproduction (Monitors & Projectors)

$$\begin{vmatrix} X \\ Y \\ Z \end{vmatrix}_{apple}$$

Find (R,G,B)

$$\begin{vmatrix} X \\ Y \\ Z \end{vmatrix}_{apple} = M \begin{vmatrix} R \\ G \\ B \end{vmatrix}_{apple}$$

$$\begin{vmatrix} R \\ G \\ B \end{vmatrix}_{apple} = M^{-1} \begin{vmatrix} X \\ Y \\ Z \end{vmatrix}_{apple}$$

$$\begin{vmatrix} R \\ G \\ B \end{vmatrix}_{apple} = M^{-1} \begin{vmatrix} X \\ Y \\ Z \end{vmatrix}_{apple}$$

Possible problems?

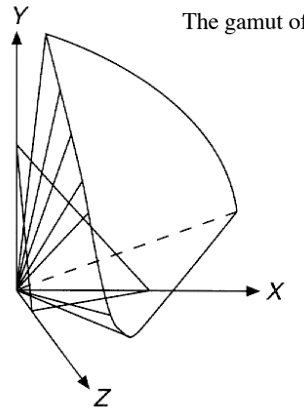
XYZ color space

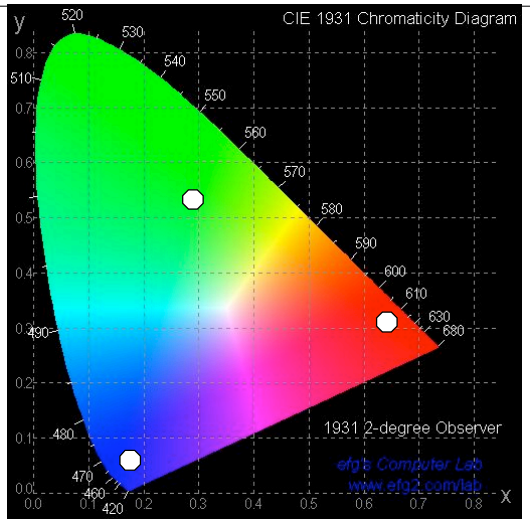
XYZ color space is a linear transformation of the matches to standard lights.

The transformation is used to ensure that all color co-ordinates are positive

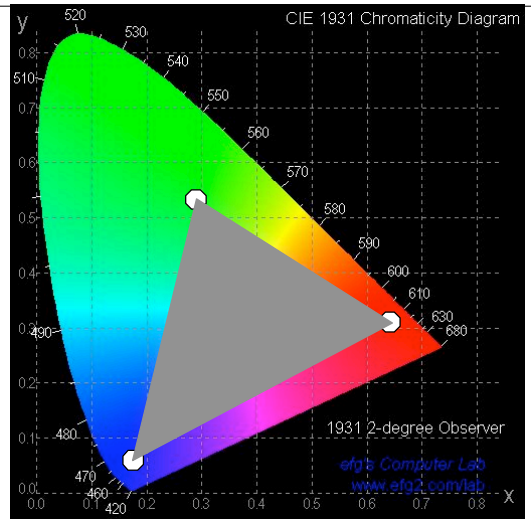
This means that XYZ corresponds to matches of fictitious (physically impossible) lights.

The gamut of all colors





Available from efg2.com



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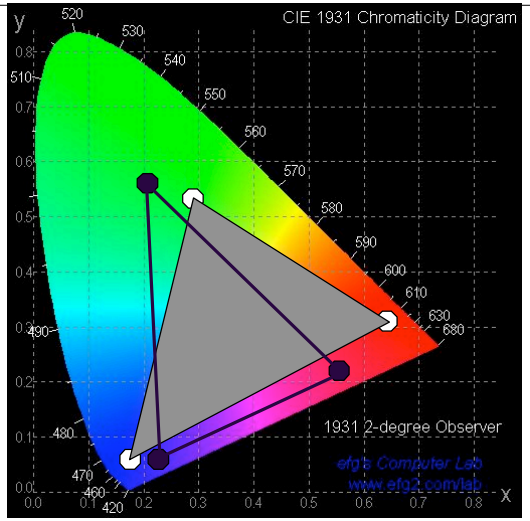

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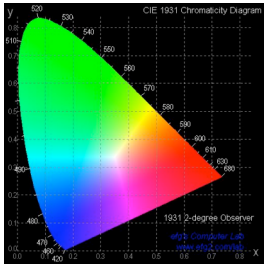
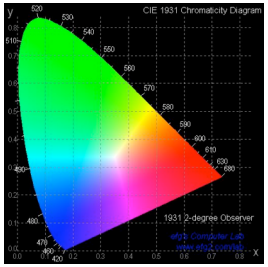
Qualitative features of CIE x, y

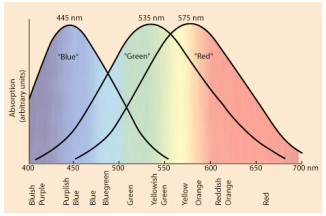
- Linearity implies that colors obtainable by mixing lights with colors A, B lie on line segment with endpoints at A and B
- Monochromatic colours (spectral colors) run along the "Spectral Locus"



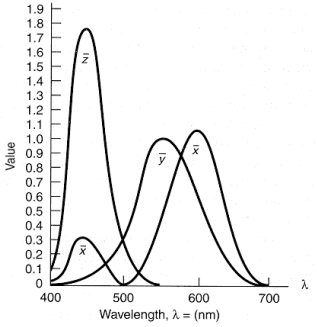
Qualitative features of CIE x, y

- Why the funny shape?





One measurement of human cone absorption



XYZ response curves

Matching is only for “aperture” color

- When color is viewed in the context of other colors numerous effects occur which complicate the characterization of color (simultaneous contrast, color constancy, etc)
- Other complications include chromatic aberration in the eye and different spatial resolution for different colors (these are linked)

Colour Reproduction

Key point--color reproduction is based on “metamerism”

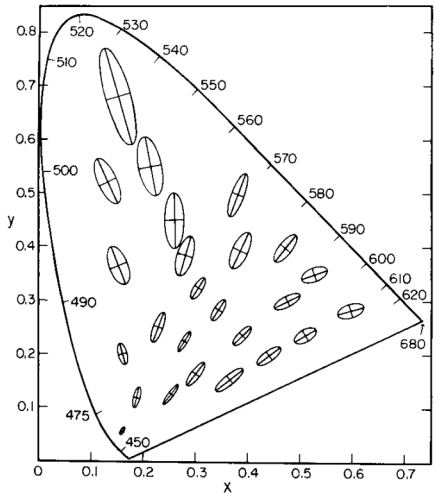
Metameric match--colors which match, despite different spectra.

Duplicating spectra would work, but for practical reasons, we duplicate the match.

For reflective surfaces, e.g prints, this means that the match can change if the illumination changes.

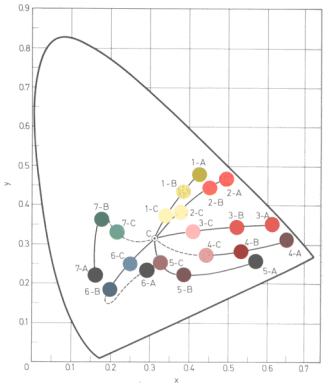
The quest for uniform colour spaces

- Definition of uniform: equal (small!) steps give the same perceived color changes.
- XYZ is not uniform!
- Uniformity only applies to small differences. There is no theory for numerically deciding if yellow is perceptually closer to green or red.



MacAdam Ellipses (scaled by a factor of 10) on CIE x, y

Mixing pigments in CIE



Color matching is linear, but combining pigments is not necessarily linear like mixing light .