Chromaticity Diagrams

Measuring Color III

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PHY 3400
Light, Color and Holography

http://www.phys.ufl.edu/~avery/course/phy3400_f99/
**Chromaticity diagram**

- For every wavelength in the spectrum, calculate (XYZ) from the CIE color matching functions
- From XYZ, calculate (xy)
- Plot (x,y) for all wavelengths in spectrum
- Generates a horseshoe shaped diagram
  
  *All physical colors lie inside the horseshoe*
Artist’s rendition of chromaticity diagram

- Monochromatic wavelengths on outside curve
- White light in the middle. Why?
  Flat spectrum: \( X = Y = Z \implies (xyz) = (0.33, 0.33, 0.33) \)
- Other “white” sources lie close to this value
Two colors in diagram can produce any color lying between them

- Example of a *barocentric* system (center of gravity)
- Example: Different amounts of P,Q colors generate all points on red line. Similar to Newton color wheel.
Dominant wavelength and purity

- **Dominant wavelength**: draw line from white point through the \((xy)\) point of the color till it hits the curve \(\Rightarrow\lambda_D\)
- **Purity** is the percentage of distance to the edge. At the edge, the purity is 100\% and at the white point it is 0\% 
- Below: color can be reproduced by adding 45\% white light and 55\% monochromatic light at \(\lambda = 515\) nm
Complementary wavelength

- Two points on opposite side of line passing through white point are called complementary
- Meaning: combination of light at $P$ and $Q$ can give white

White = 50% $P$ + 50% $Q$
Color Gamuts

Any three colors form a triangle

- Combinations of colors must lie inside the triangle ⇒ gamut
- Best color reproduction ⇒ use biggest color gamut
- True for all media, print, monitor, film, slides
- No three primaries can reproduce human vision (see below)
CIE 1931 xy chromaticity diagram

Commission Internationale de l'Eclairage

Film
Monitor
Printing Press