Colors

Color Systems

- In computer graphics, we use RGB colors. But…
  - Can it represent all colors?
  - Is it linear? For example,
    - (1.0, 1.0, 1.0) is white
    - (1.0, 0.0, 0.0) is red
    - Is (1.0, 0.5, 0.5) half white and half red?
    - Does the color (r, g, b)*0.5 look like the color (r, g, b) in half intensity?

What is a Color, After All?

- We may define a color by its wavelength.
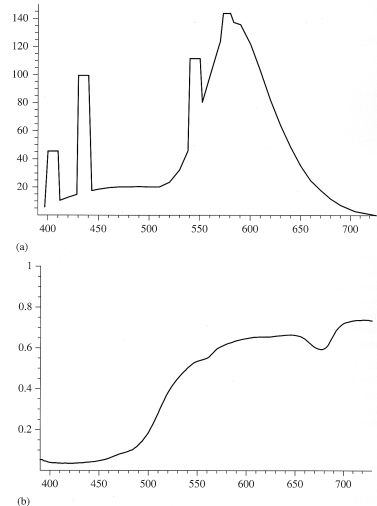- However, most colors have energy spread in every wavelength.

Figure 5.1 in Pharr's book:
(a) Fluorescent light
(b) Lemon skin

What is a Color (II)

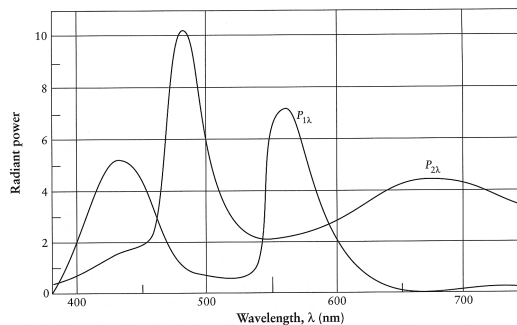- What is more interesting is that different energy distributions may be perceived as the same color!
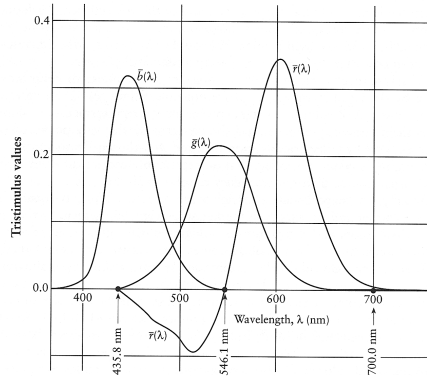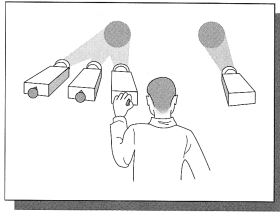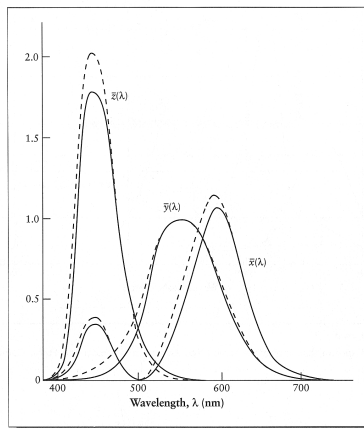
FIGURE 1.40

Two different spectra that appear the same. Redrawn from Wyszecki and Stiles, *Color Science*, fig. 6, p. 126.

The CIE Color Matching

CIE XYZ Space

- To get rid of the negative values, CIE defined 3 new hypothetical light sources .

Color and Spectrum in PBRT

- XYZ color:

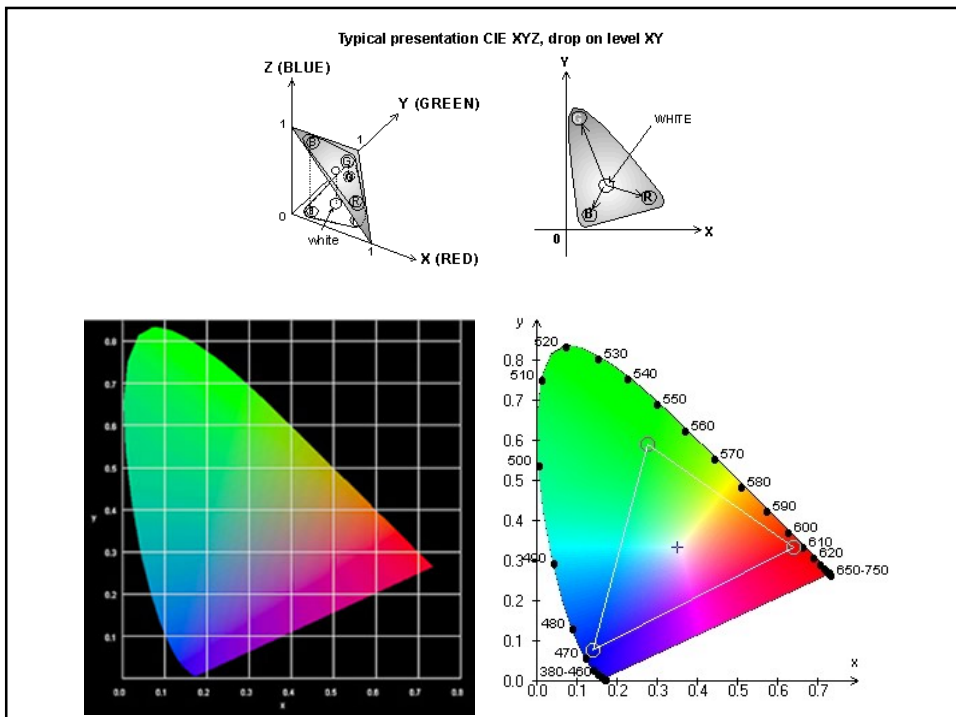$$x_\lambda = \int_\lambda S(\lambda)X(\lambda)d\lambda$$

$$y_\lambda = \int_\lambda S(\lambda)Y(\lambda)d\lambda$$

$$z_\lambda = \int_\lambda S(\lambda)Z(\lambda)d\lambda$$
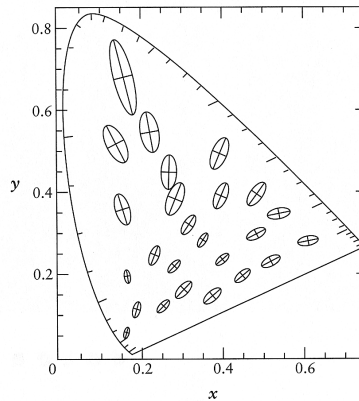
- Spectrum class in PBRT:

```
Class COREDLL spectrum {
public:
private:
    float c[COLOR_SAMPLES];
}
```
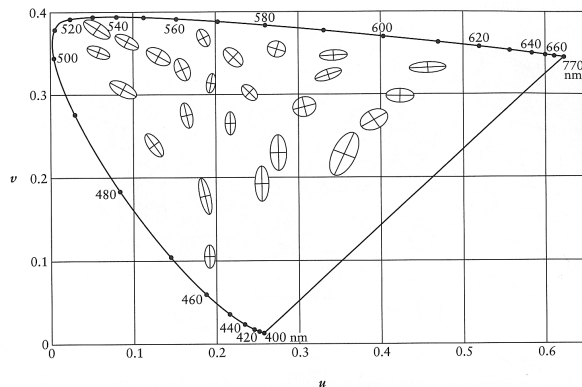

Typical presentation CIE XYZ, drop on level XY

Linearity

- Unfortunately equal steps in the XYZ space does not produce perceptually equal steps in the color.

CIE L*u*v Space

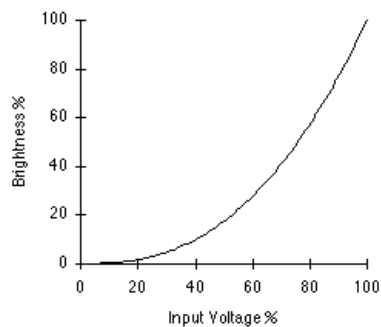- Designed to be perceptually uniform.

Other Color Space

- HSV: hue, saturation, value.
- HSL: hue, saturation, lightness.
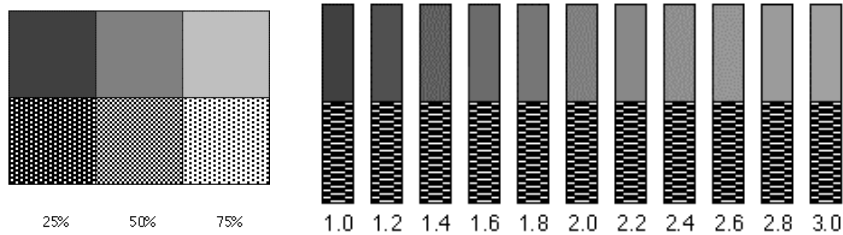- For more information, See Watt's Sections 15.2 and 15.3.

Gamma Correction

- For a monitor, the light intensity follows an exponential curve such as:

How to Determine the Gamma?

- How to detect the gamma of your monitor? Compare it with dithering: (Hint: how do you produce a square with 50% gray on the screen?)

25%   50%   75%   1.0 1.2 1.4 1.6 1.8 2.0 2.2 2.4 2.6 2.8 3.0

Reading Assignment

- Pharr's book, section 5.1, which defines the `Spectrum` class in PBRT.