What is color for?
Color

- **Physics**
  - Light is E-M radiation of different frequencies.
  - Superposition principle
- **Perception**
  - 3 cones -> 3D color space. (Metamers).
  - Convex subset of 3D linear space.
  - Color matching: can't represent w/ 3 primaries.
- **Color Spaces**
  - CIE – a standard
  - RGB – a bit more intuitive, Monitors, OpenGL
  - CMYK – subtractive, what we learn in art class.
  - HSV – More intuitive
- **More Perception**
  - Perceptual distance
  - Context
- **Refs:** H&B Chapter 12; “The Foundations of Color Measurement and Color Perception”, by Brian Wandell:
Newton's drawing:

(Wandell)

(Varshney)
Achromatic light is light without color

Colored light is electromagnetic energy between 400 and 740 nanometers (nm)

Color is a function
Superposition

• Light is linear.
• Light from source A + light from source B = Light from sources A & B.
  – Any color is a combination of pure colors.
• Doubling intensity of source doubles amount of light reaching us.

Human Color Perception

• Cones allow color perception.
• 3 types of cones sensitive to different frequencies
• Perceptual color depends on how these are stimulated.

tristimulus theory
Metamers

Perceptual color space

• 3D
• Convex subspace
  – Cones don’t have negative response
• In general, any three colors projected onto this space span it.
  – But not with non-negative coefficients.
Some colors can’t be matched

• There isn’t a unique color for each cone.
  – “Green” light also excites “red” cones.
  – So to produce some greenish lights we need negative red light.
• But we can match that color + a primary color, using the other two primaries.
• Adding red to our color is like matching it with negative red.
• All colors can be matched like this
  – Shows perceptually color is 3D
  – But we can’t have negative light in a display.
  – Display space is convex too, but can’t match perceptual convex space.
Grassman’s Additivity Law

- Color matching follows superposition
- If we know how to produce all pure colors, we can produce any color.