Digital colors

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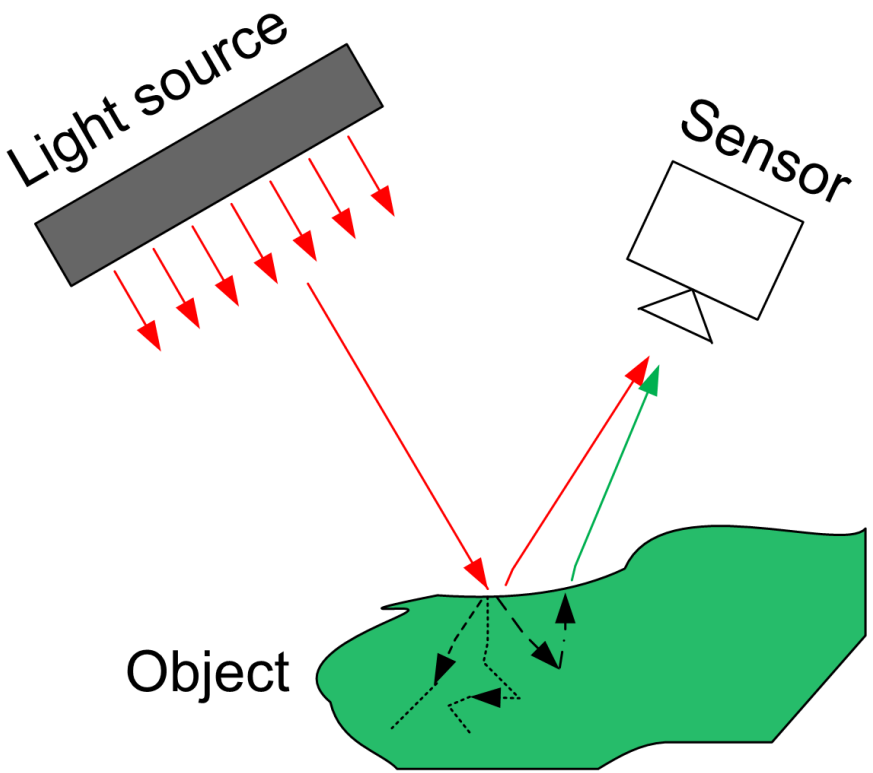
What are colors?

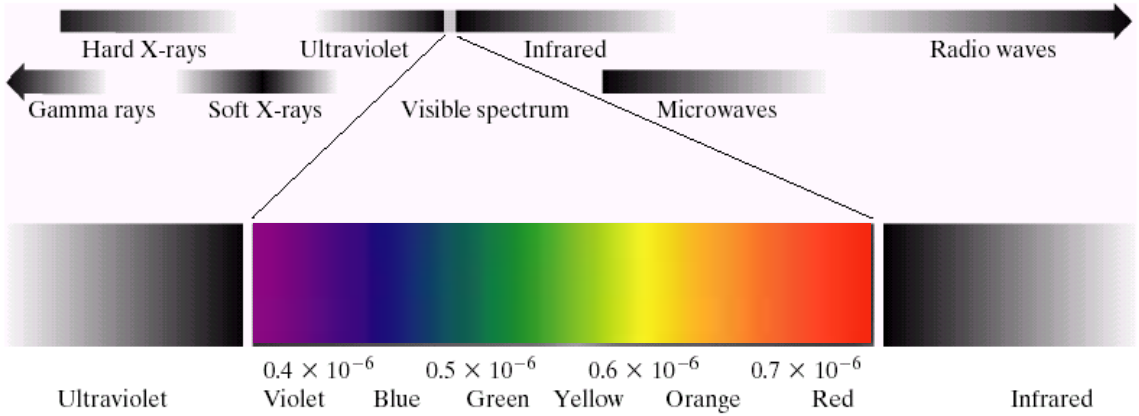


- The colors that humans and cameras perceive are determined by the nature of the light reflected from an object!
- Green objects reflect “green” light!

What are colors?

- Achromatic: Only intensities (amount of light)
  - Gray levels as seen on black/white TV-monitor
  - Ranges from black to white

- Chromatic: Light waves; Visual range: 400nm-700nm



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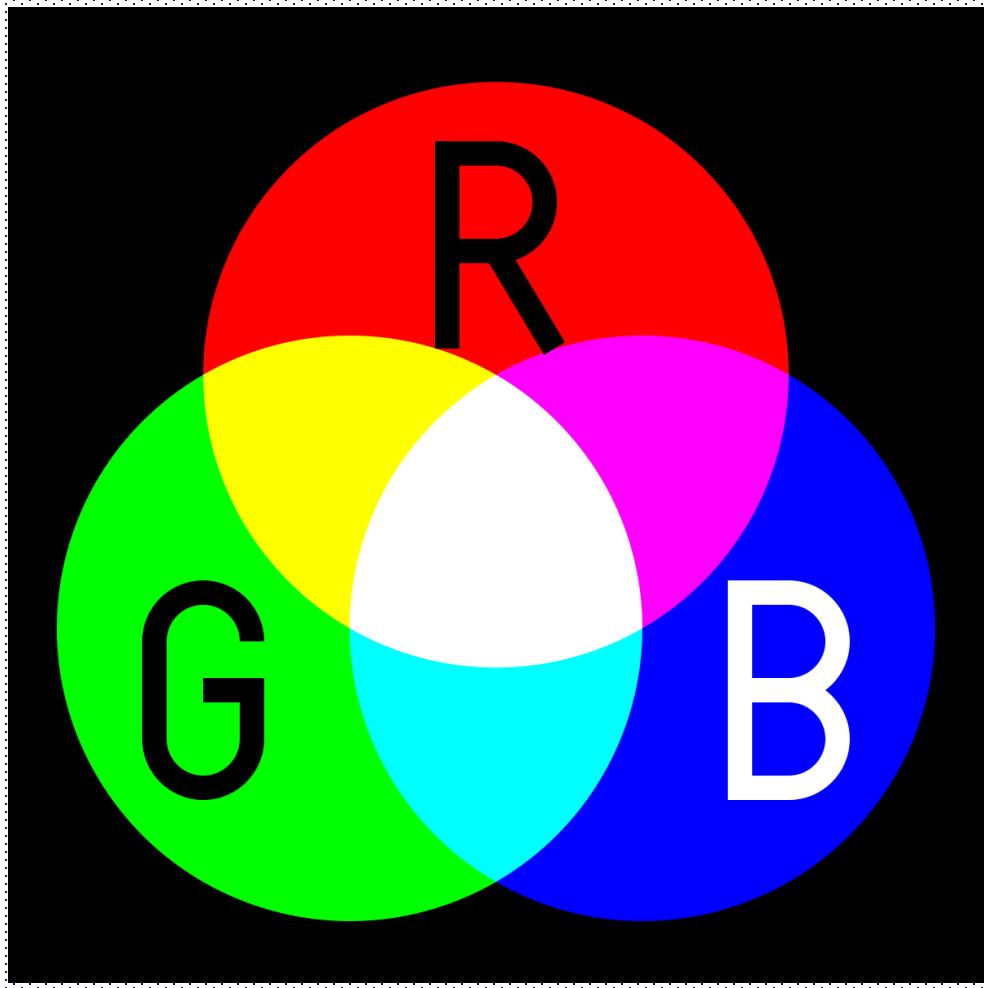
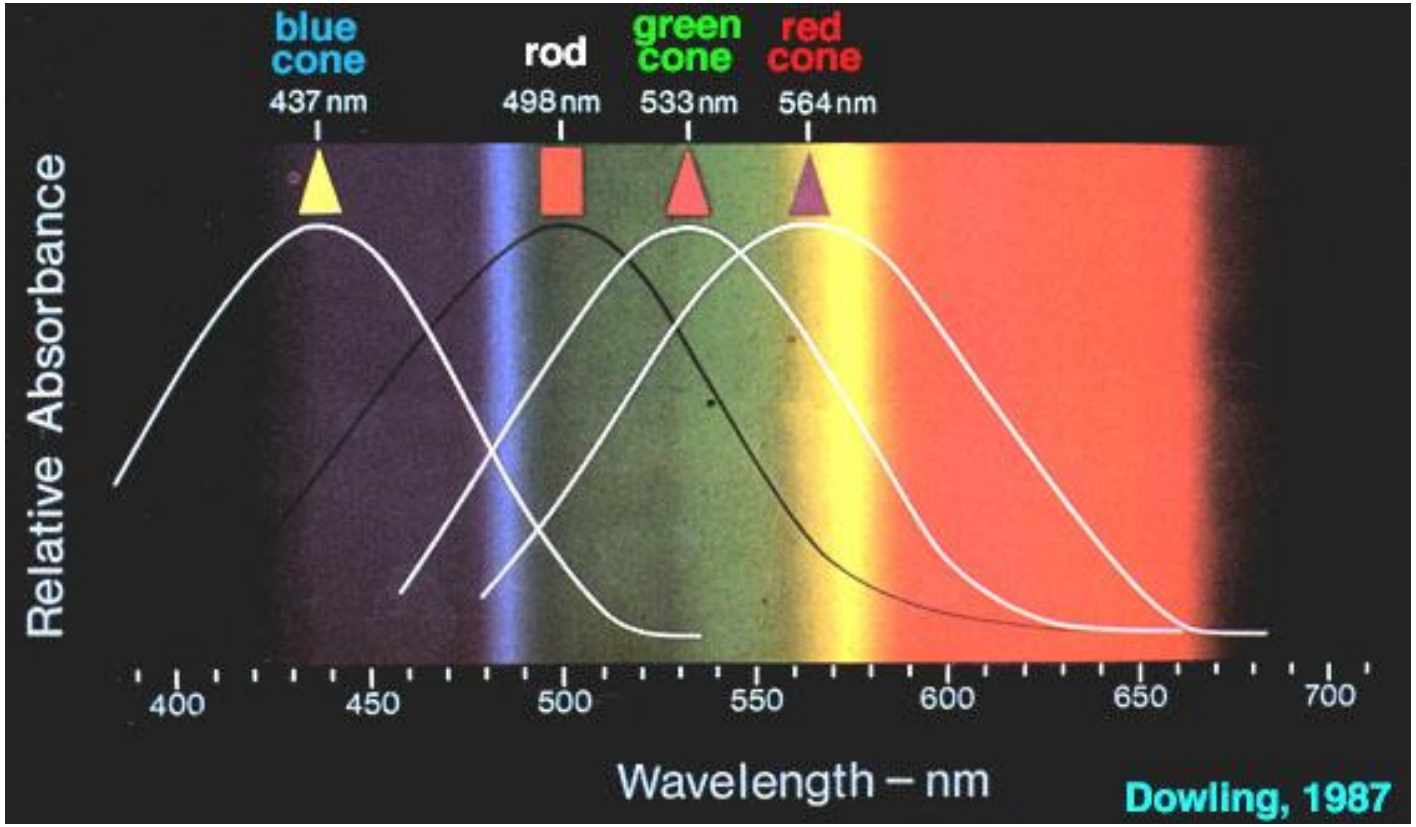


Colors on displays

- Red, green, blue are called **Primary Colors**
- R,G,B were chosen due to the structure of the human eye
- R,G,B are used in cameras

Receptivity of the eye cells

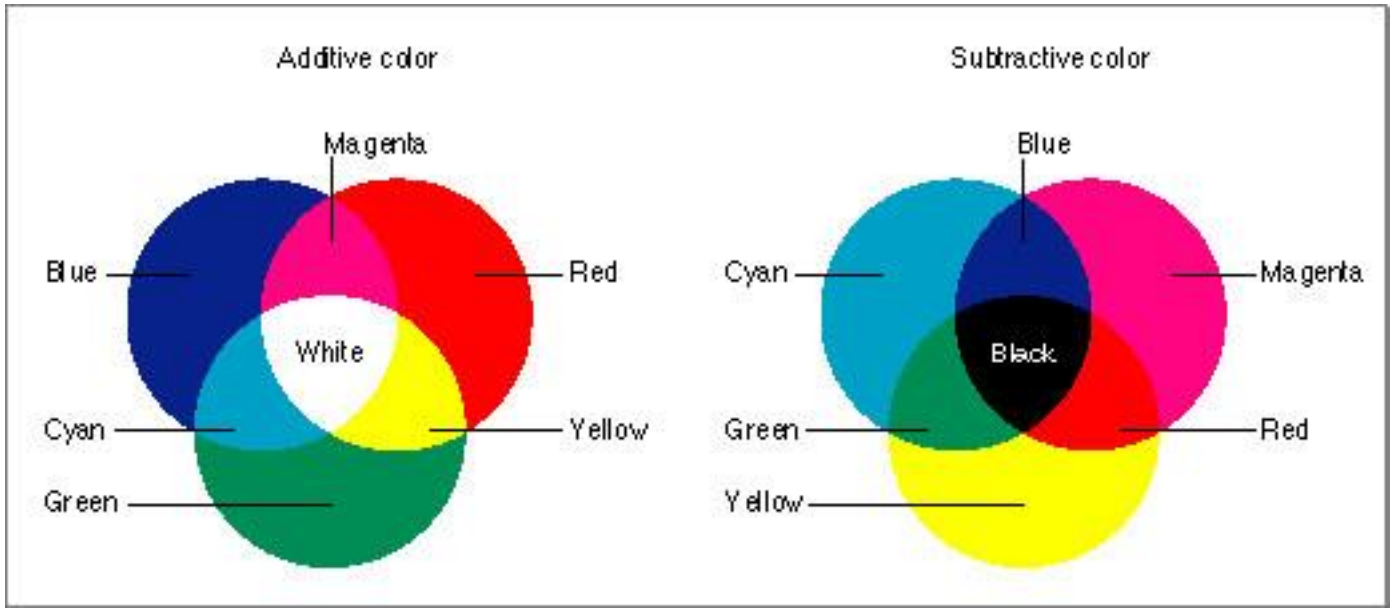
- Rods (DK = Stave): Light sensitive (intensity)
- Cones (DK = Tappe): Color sensitive



R+G+B = White?!

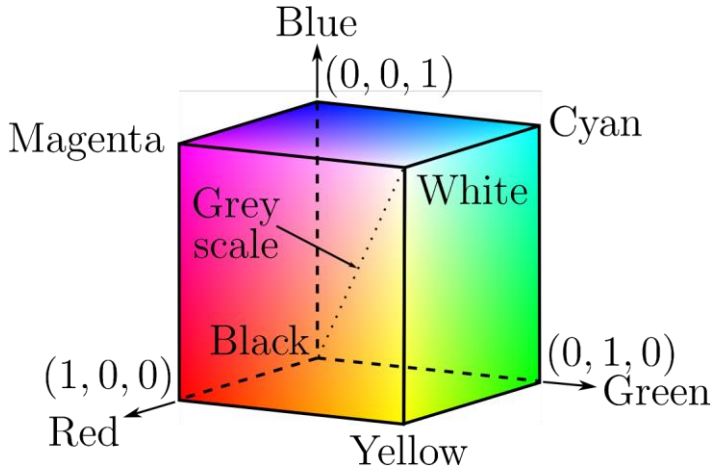
- So why don’t we get white, when we use paint? *Subtractive Color.*
- But why does it work for the TV? *Additive Color.*

- Additive Color: Sum of light of different wave lengths. That light reaches our eye directly.
  - Examples: TVs, projectors
- Subtractive Color: White Color is emitted by the sun and is only partly reflected from an object
  - Red paint filters all light, except red
  - Yellow paint absorbs blue, but reflects red and green
  - Examples: Paint, prints

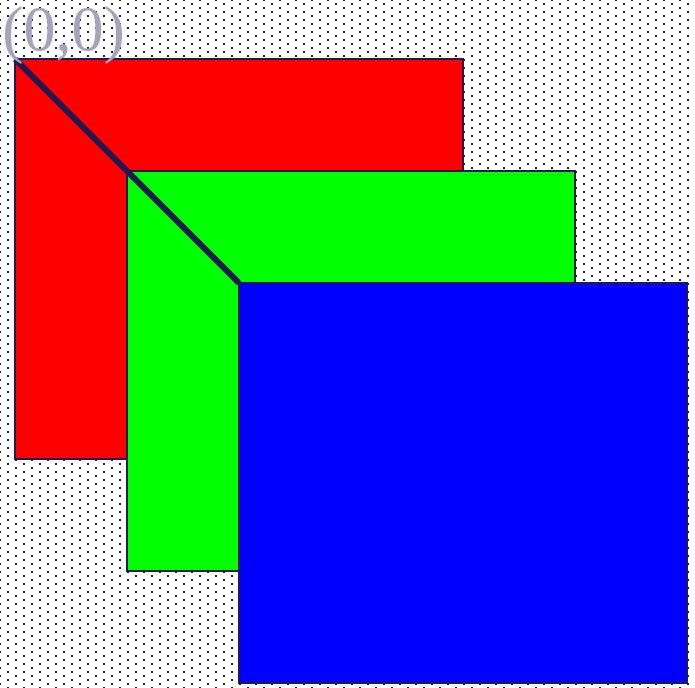


RGB color space

- The “classical” Computer Color space
- 3 different colors: Red, Green, Blue
- Similar to the human visual system!
- If R,G,B have the same energy, we perceive a shade of grey



RGB pixels



A single pixel consists of three components: [0,255].
Each pixel is a **Vector**.

180	219	93

=

Pixel-Vector in the computer memory

Final pixel in the image

RGB example

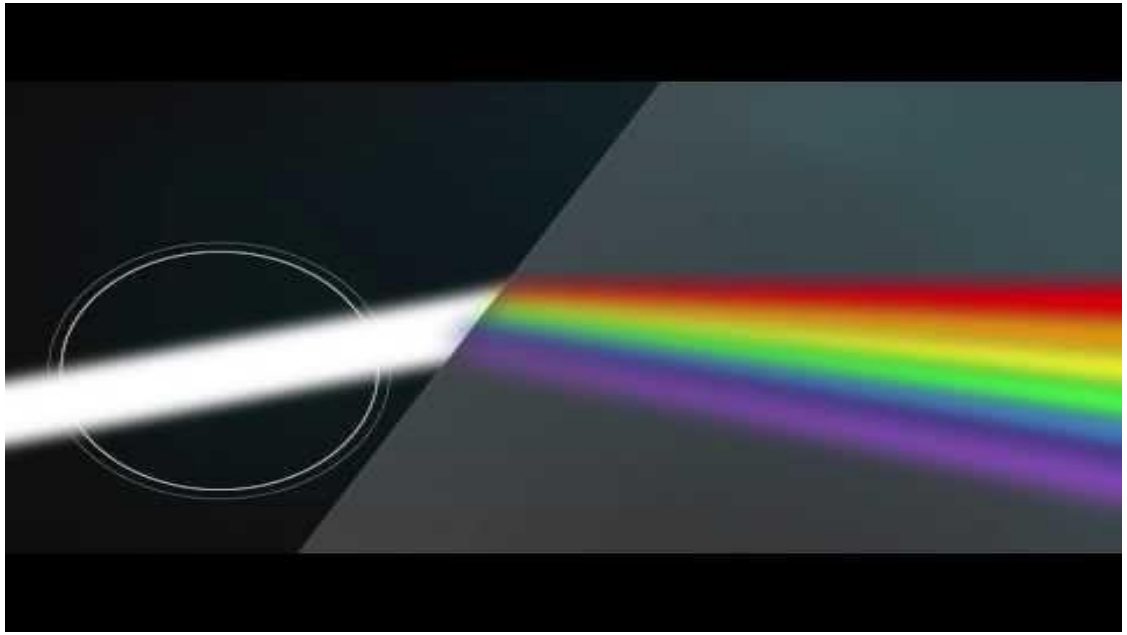
Original Image

R-Component

G-Component

B-Component

Capturing colors digitally – 3CCD camera



https://youtu.be/Aggi0g67uXM

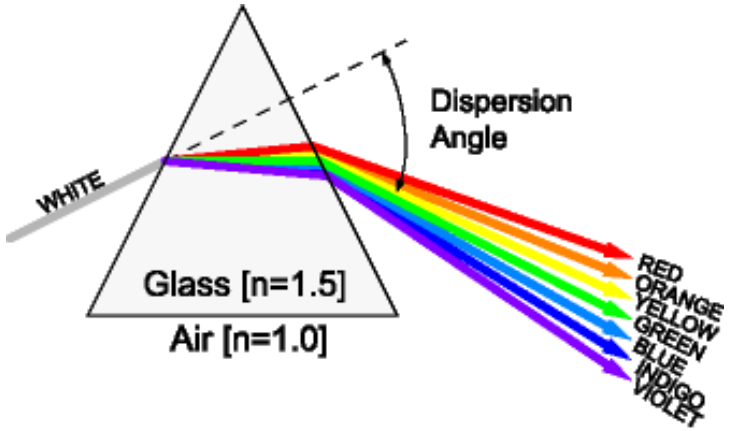
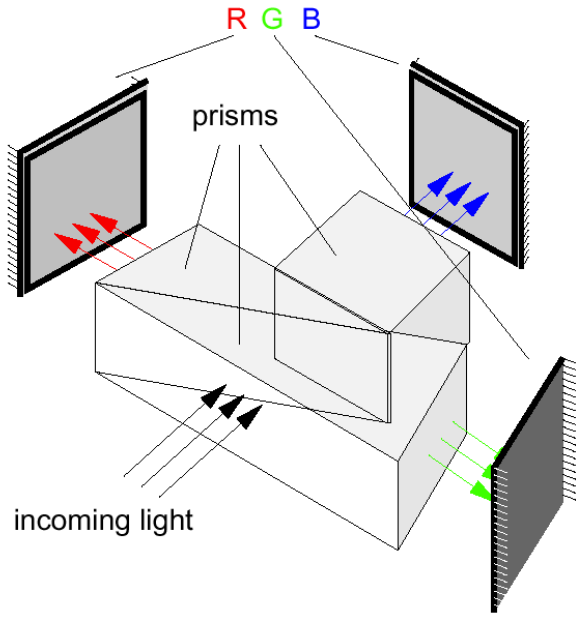
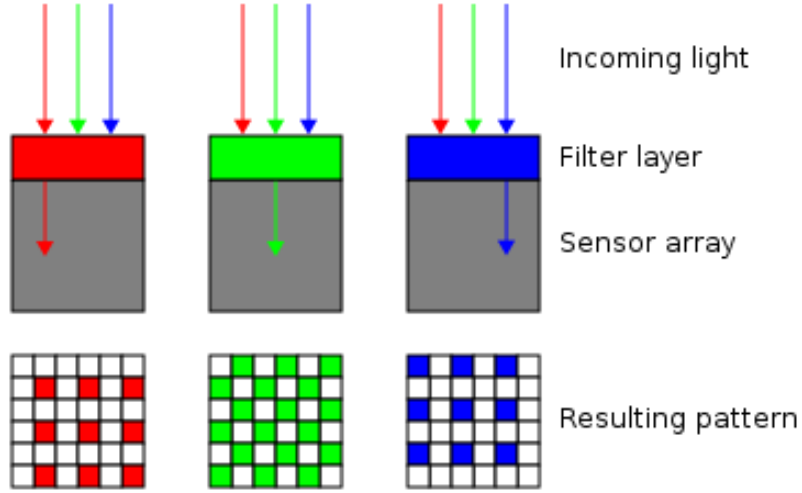


Fig. 4.8 Refraction through a prism.



Single sensor color (most cameras)

- Use achromatic sensors but filter the light in a certain pattern: The Bayer pattern.
- Demosaicing: Finding the RGB-value for a particular pixel.
  - Set the color component for the filter color directly.
  - Set the two other values by averaging the neighbors with that filter.
  - Examples: For a G pixel, set G = value, R = mean($R_{neighbors}$) and B = mean($B_{neighbors}$)



B	G	B	G	B	G	B
G	R	G	R	G	R	G
B	G	B	G	B	G	B
G	R	G	R	G	R	G
B	G	B	G	B	G	B
G	R	G	R	G	R	G
B	G	B	G	B	G	B

Bayer pattern

Converting color to grayscale

?

- $I = (R+G+B) / 3$

$($  $+$  $+$  $)$ $/ 3 =$

- $I = W_R \times R + W_G \times G + W_B \times B,$ $\quad W_R+W_G+W_B=1$