

Color & Photographic Technology

What is Color?

- To understand this question you must first understand *Light*
- Light is a form of radiation and travels in waves which can be grouped into what is called a *spectrum*
- The wavelengths of light are not colored, but produce the sensation of color



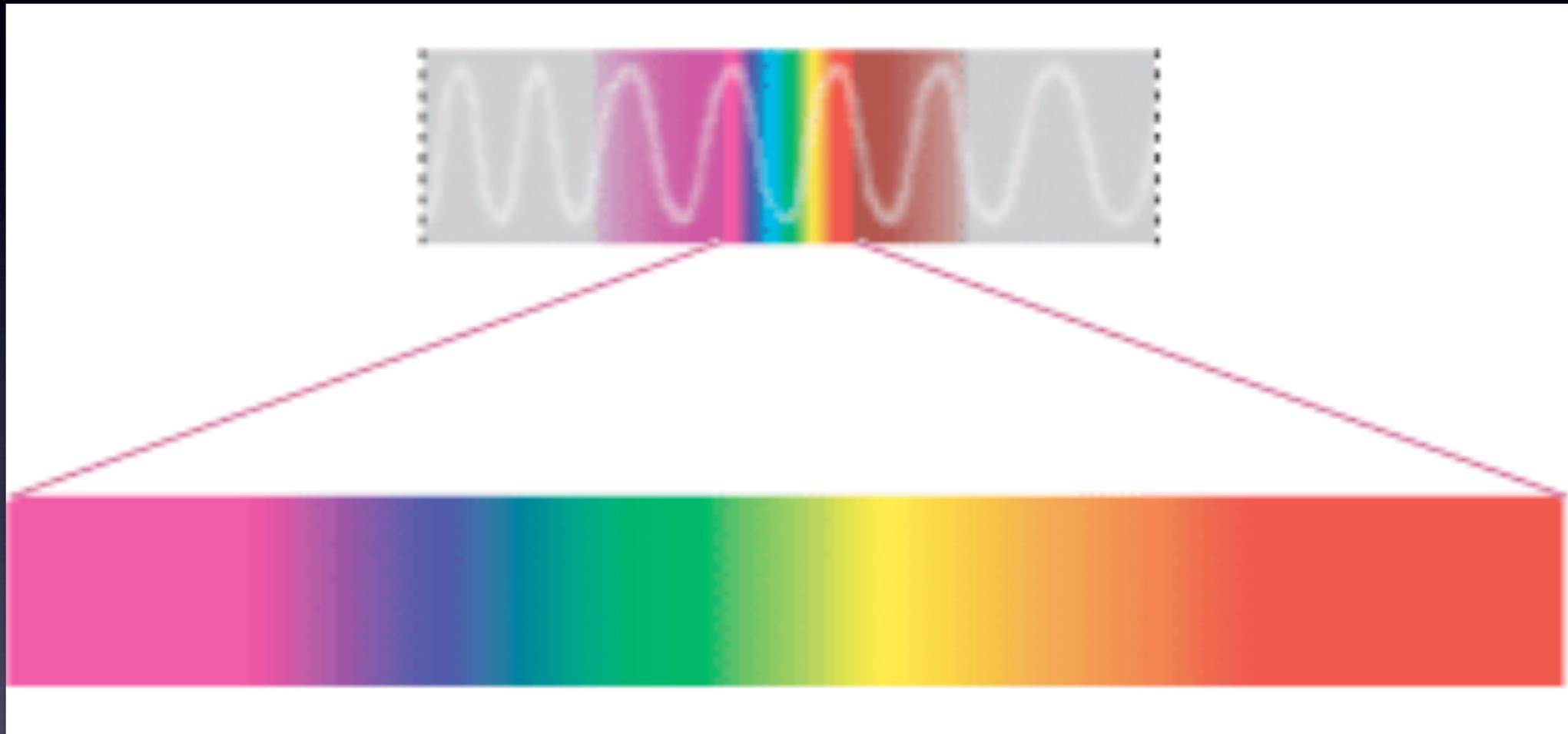
When light goes through a prism, it is separated into its component colors.

Each color you see is actually a different wavelength.

The Electromagnetic Spectrum

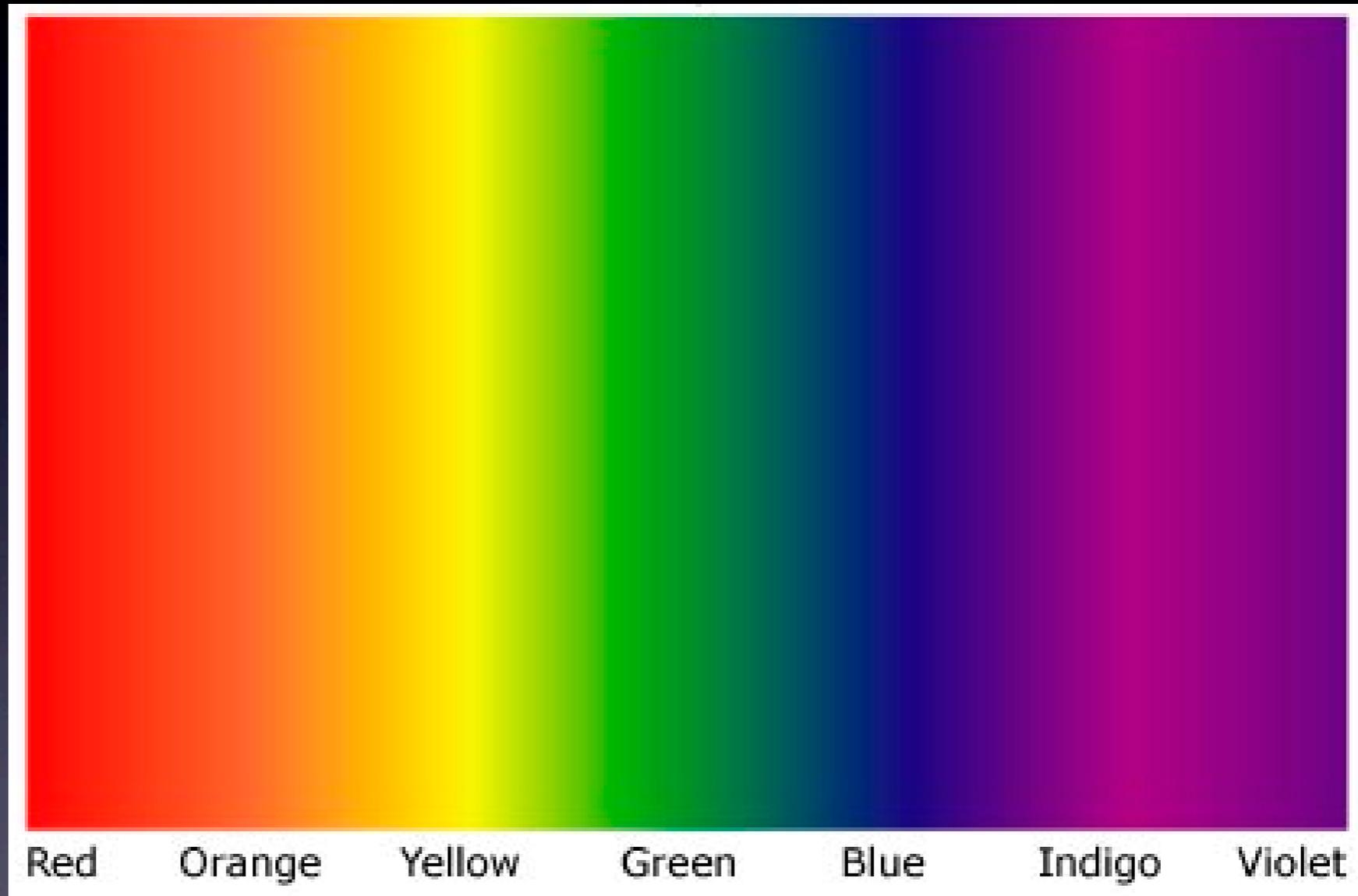
- The entire electromagnetic spectrum consists of many different wavelengths including, radio, microwave, infrared, ultraviolet, x-rays and gamma rays
- The wavelengths our eyes can detect is only a small portion of the electromagnetic energy spectrum
- We call the wavelengths between 400-700 nm the "visible" spectrum.

The Visible Spectrum



The visible spectrum as part of the entire electromagnetic spectrum

The Visible Spectrum



The range of colors within the visible spectrum.

Color Models

- Color models attempt to describe the colors within the visible spectrum.
- Each color model represents a different method for describing and classifying color.
- All color models use numeric values to represent the visible spectrum of color.

Color Modes

- Photoshop uses color modes (similar to a color model) that let you work with an image in a specific color space.
- Photoshop keeps track of an image's color space and will indicate in the title bar if the working space and the document's color space don't match.

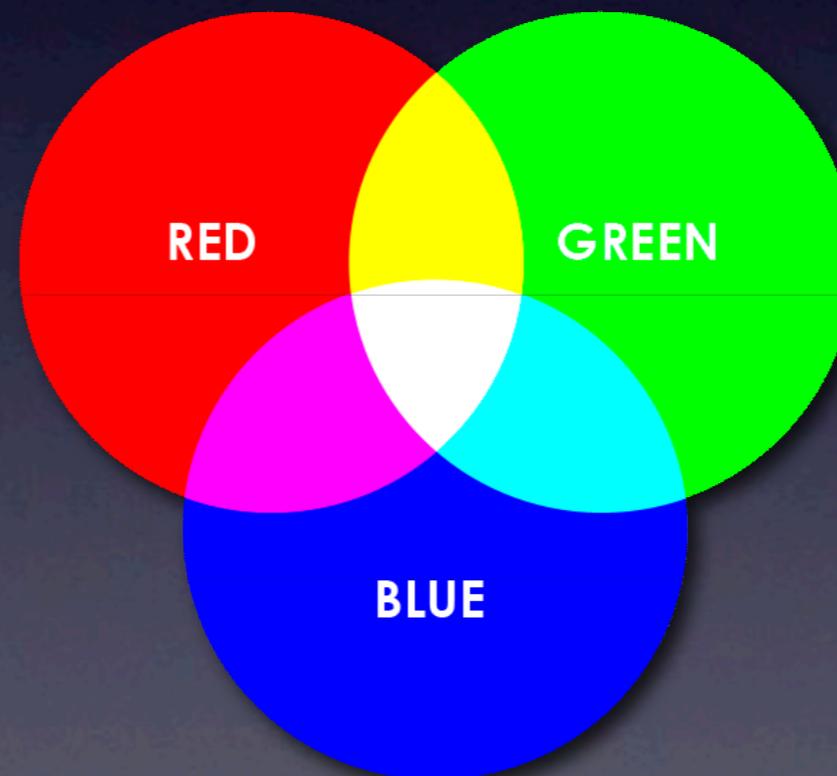
Methods to Produce Color

- Why bother with having different color models?
- Different devices use different methods to produce color
 - Additive method—the mixing of light to produce color
 - Subtractive method—the mixing of pigment to produce color

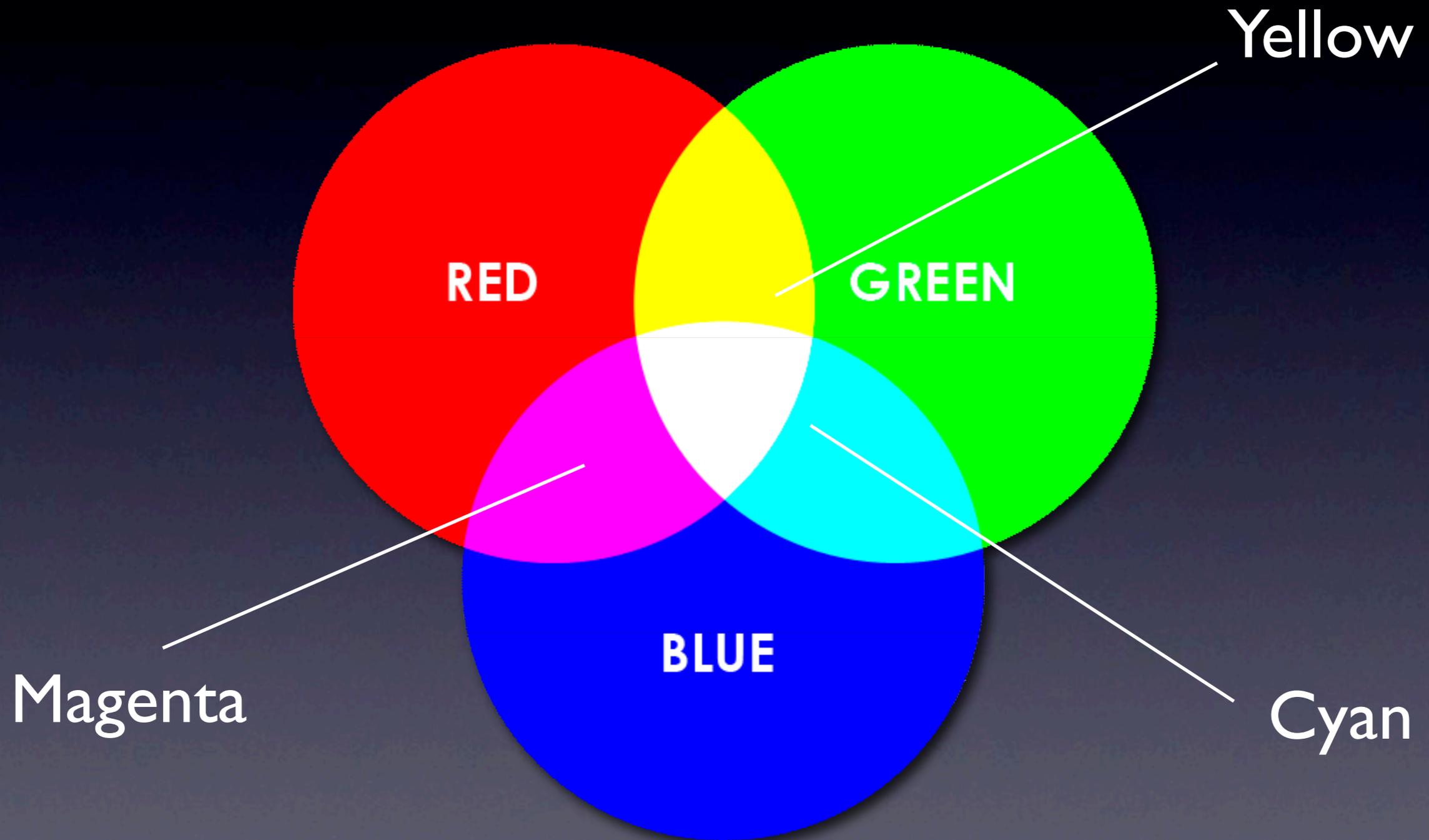
Color Modes

- What color mode does your computer screen, camera and scanner operate in?

RGB



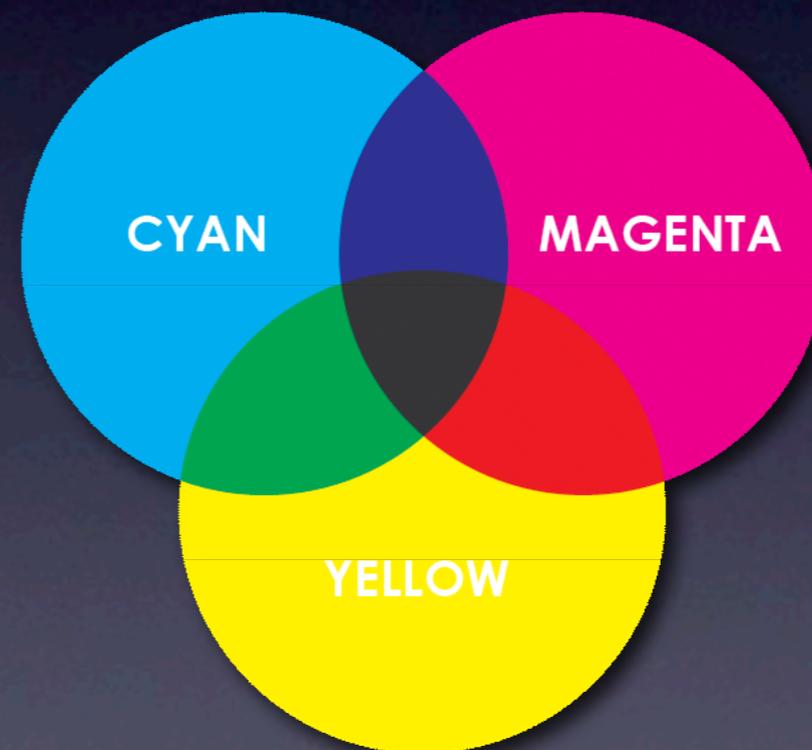
RGB Color Mode



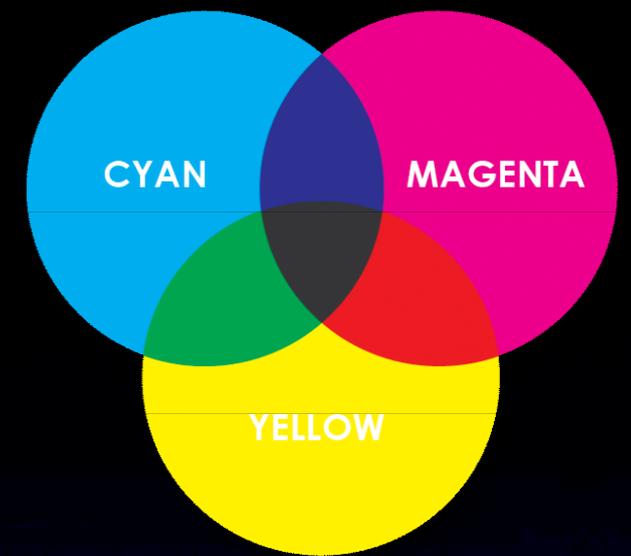
Color Modes

- What color mode is used for images destined for the printing world?

CMYK

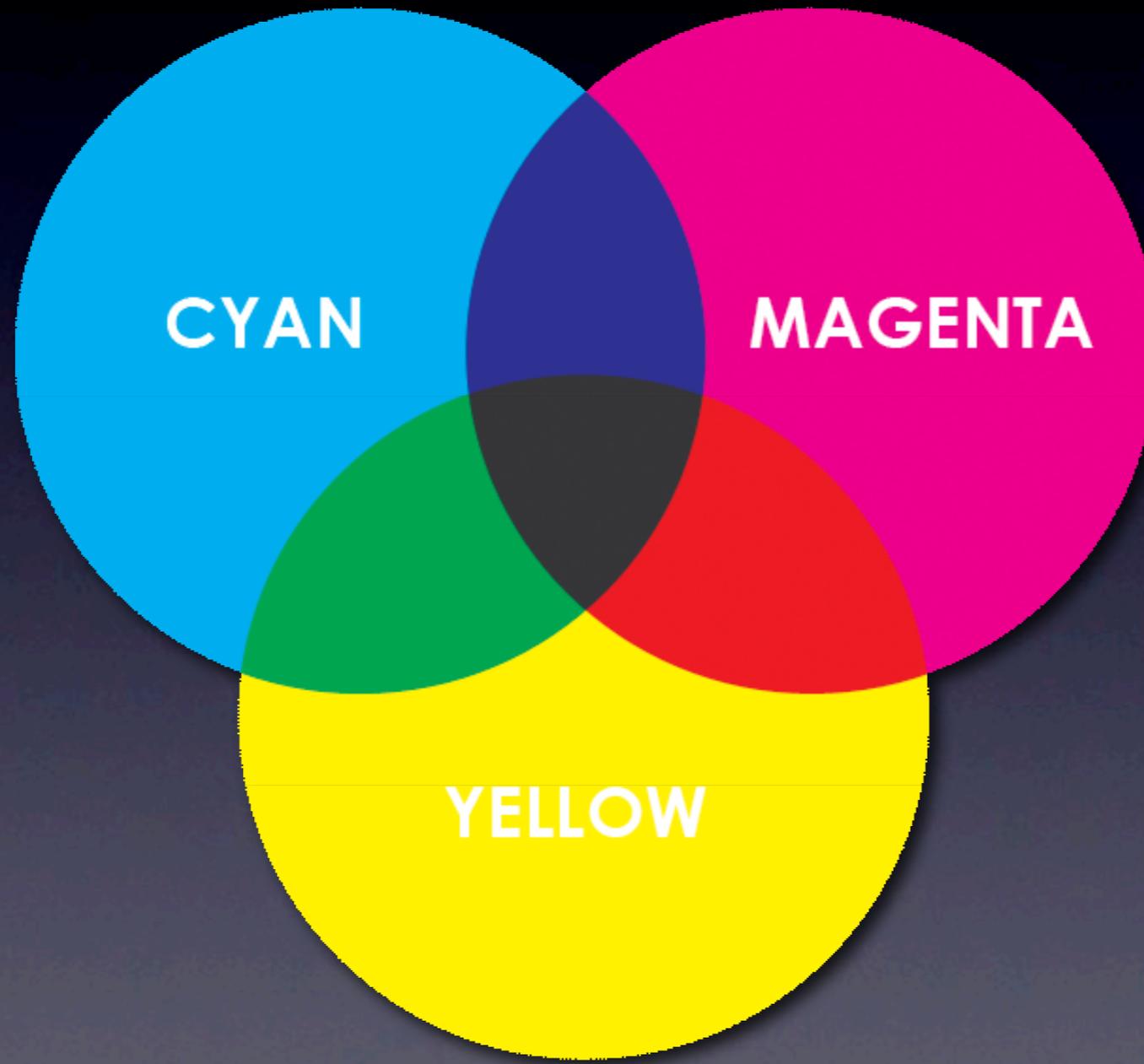


CMYK Color Mode

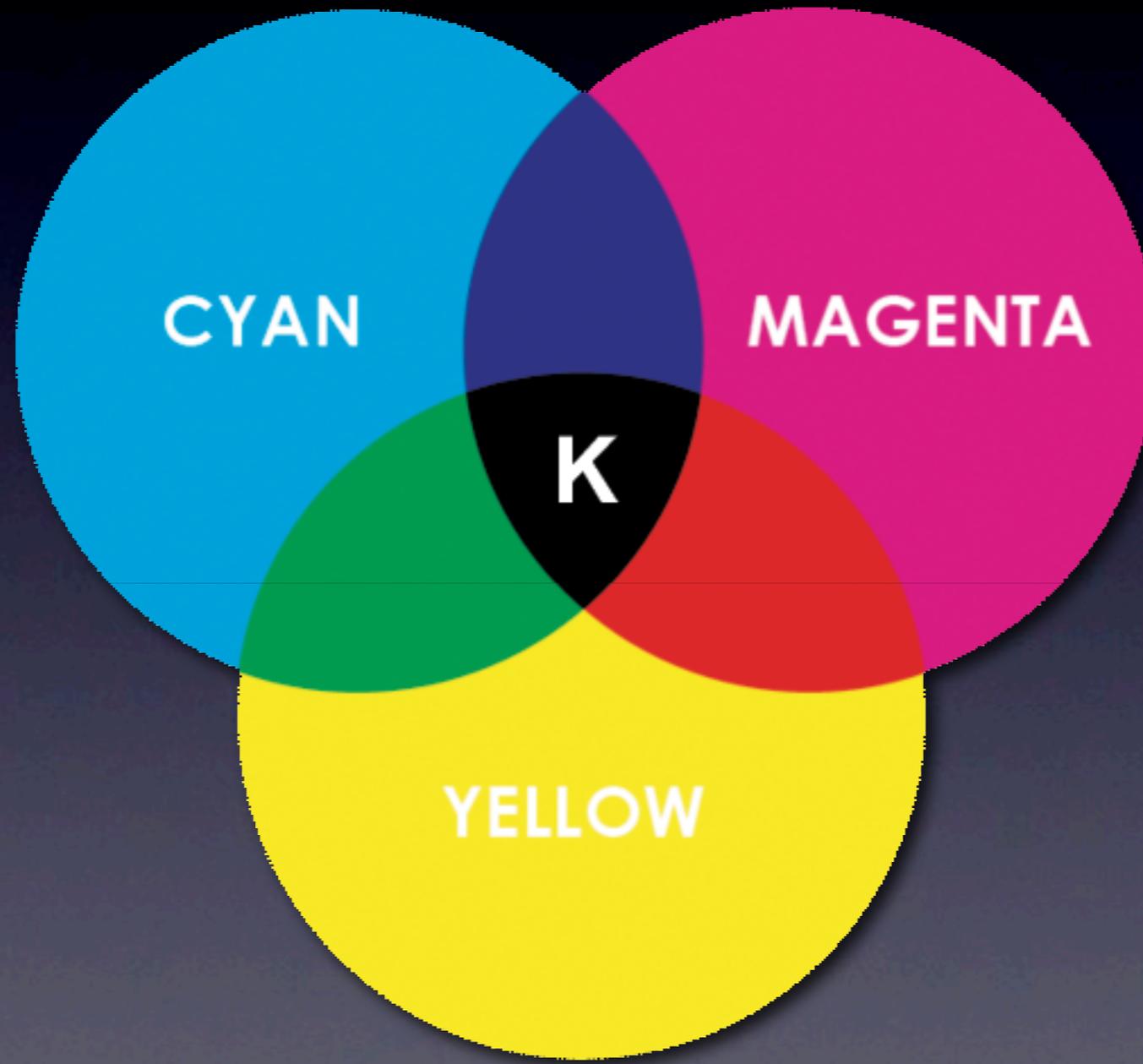


- The CMYK model represents a lesser percentage of the visible spectrum of colors
- The CMYK model is based on the light-absorbing quality of ink printed on paper.
- As white light strikes translucent inks, certain visible wavelengths are absorbed (subtracted), while others are reflected back to your eyes.
- For this reason, this color mode is considered *subtractive*.

CMYK Color Model



CMYK Color Model



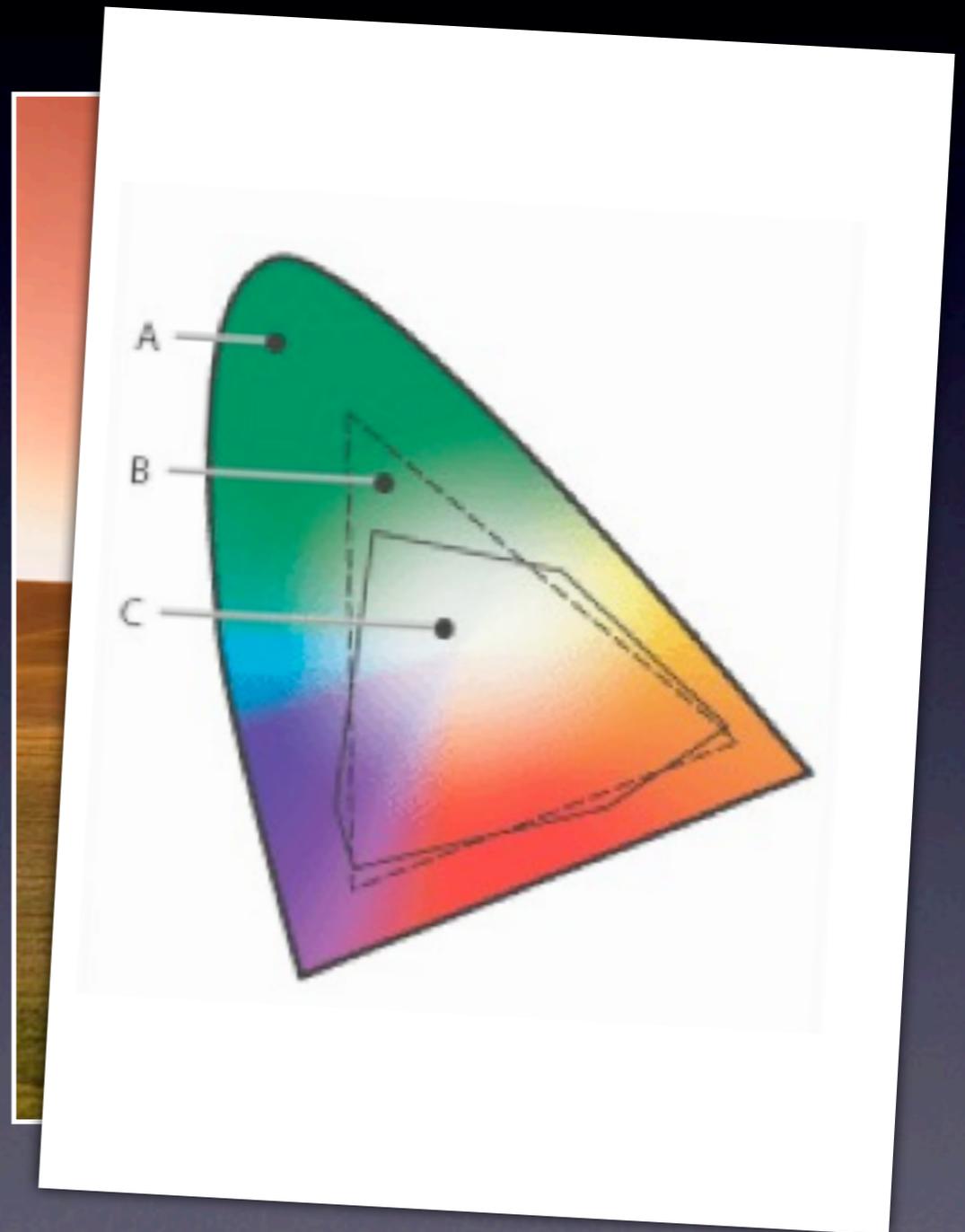
Color Models within the Visible Spectrum

- This diagram illustrates all visible colors, and the color models within them
- A represents LAB as well as the visible spectrum
- B represents RGB
- C represents CMYK



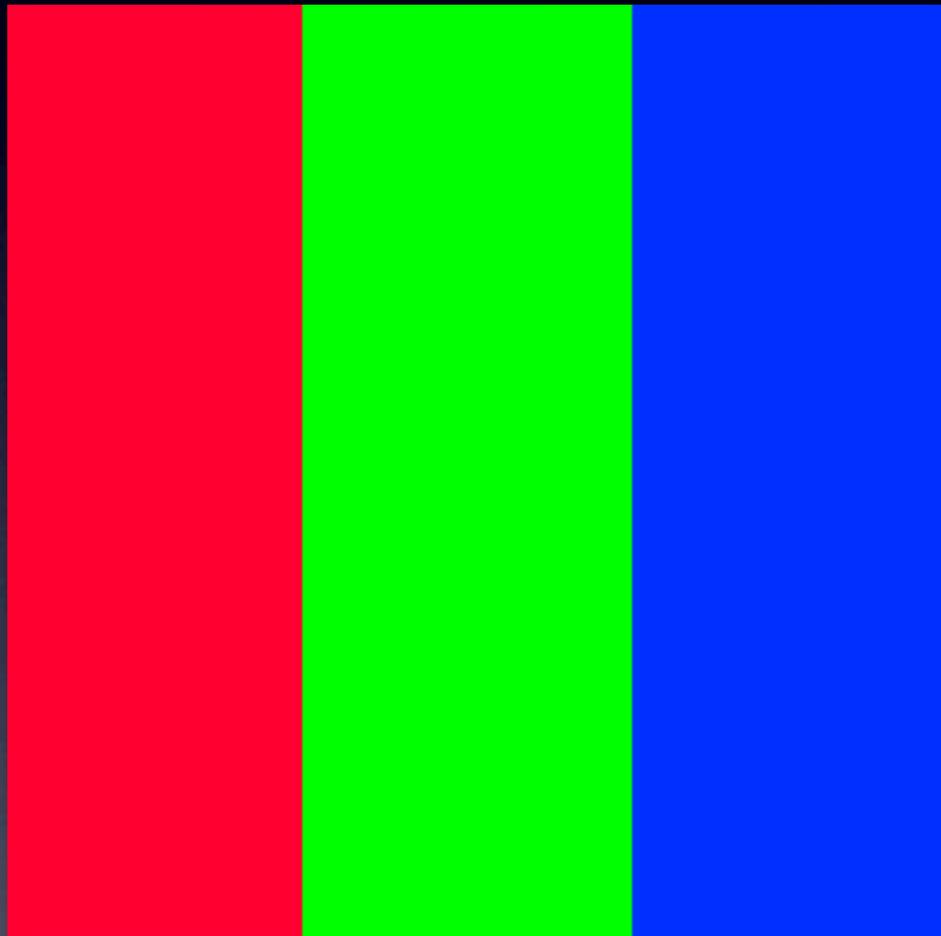
Color Modes

- In Photoshop the RGB and CMYK color spaces represent two different Color Modes
- Neither color mode comprises of all the visible spectrum
- CMYK has a smaller color space than RGB
- The range of color encompassed by a color space is called a **gamut**



Differences in color rendering

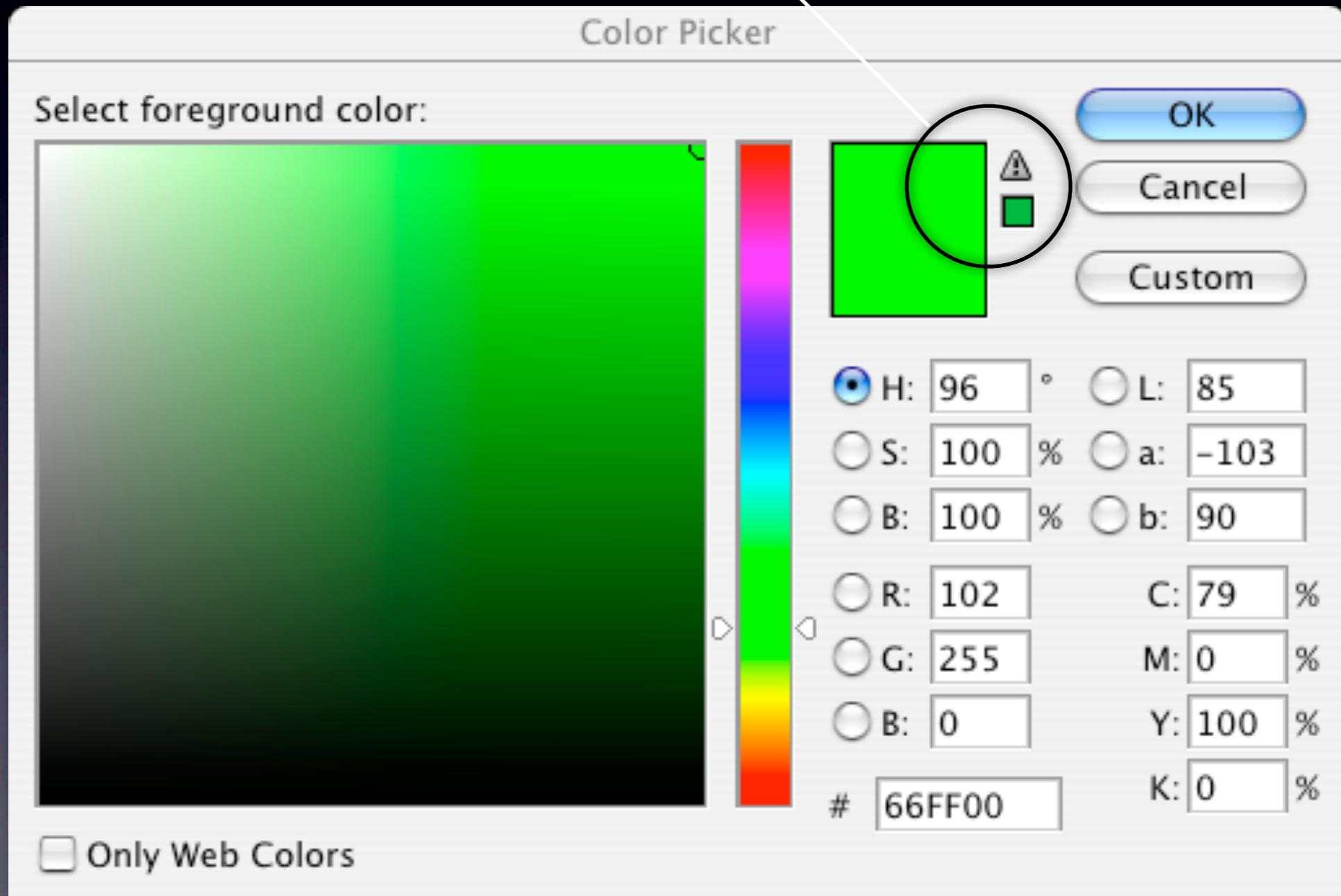
Colors as displayed in RGB mode



The same colors in CMYK mode



Out-of-gamut color



What is Photography?

- The art or process of producing images by the action of light on a light sensitive medium



Traditional Photography

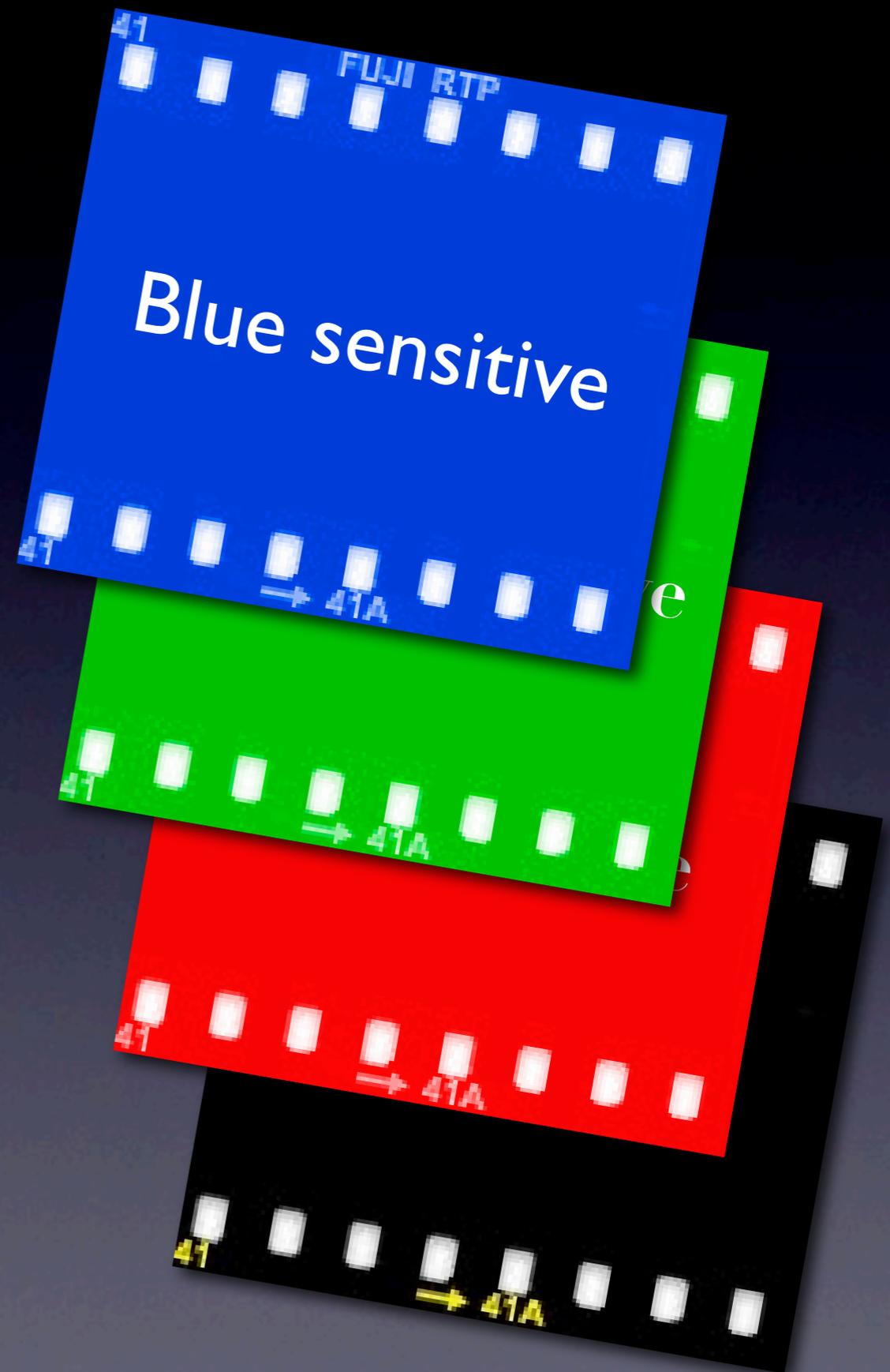
- Photography has been around since 1816.
- Film-based photography
Photography as we know it has been around about 100 years.
- This photography is based off a chemical reaction to light



Niepce

Color Film Exposure

- The basis of film exposure is the emulsion which is coated with light-sensitive silver-halide crystals
- The stronger the light the larger the clumps
- Color film has additional spectral sensitive layers



Spectral-sensitive emulsion layers

capture grayscale images that form a color image



Red



Green

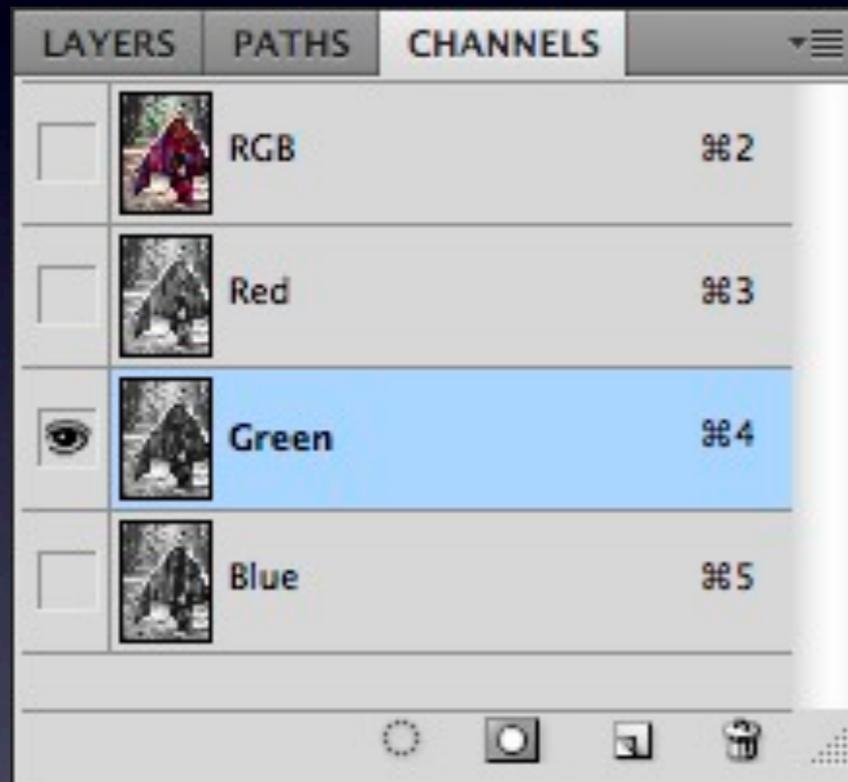


Blue

Channels



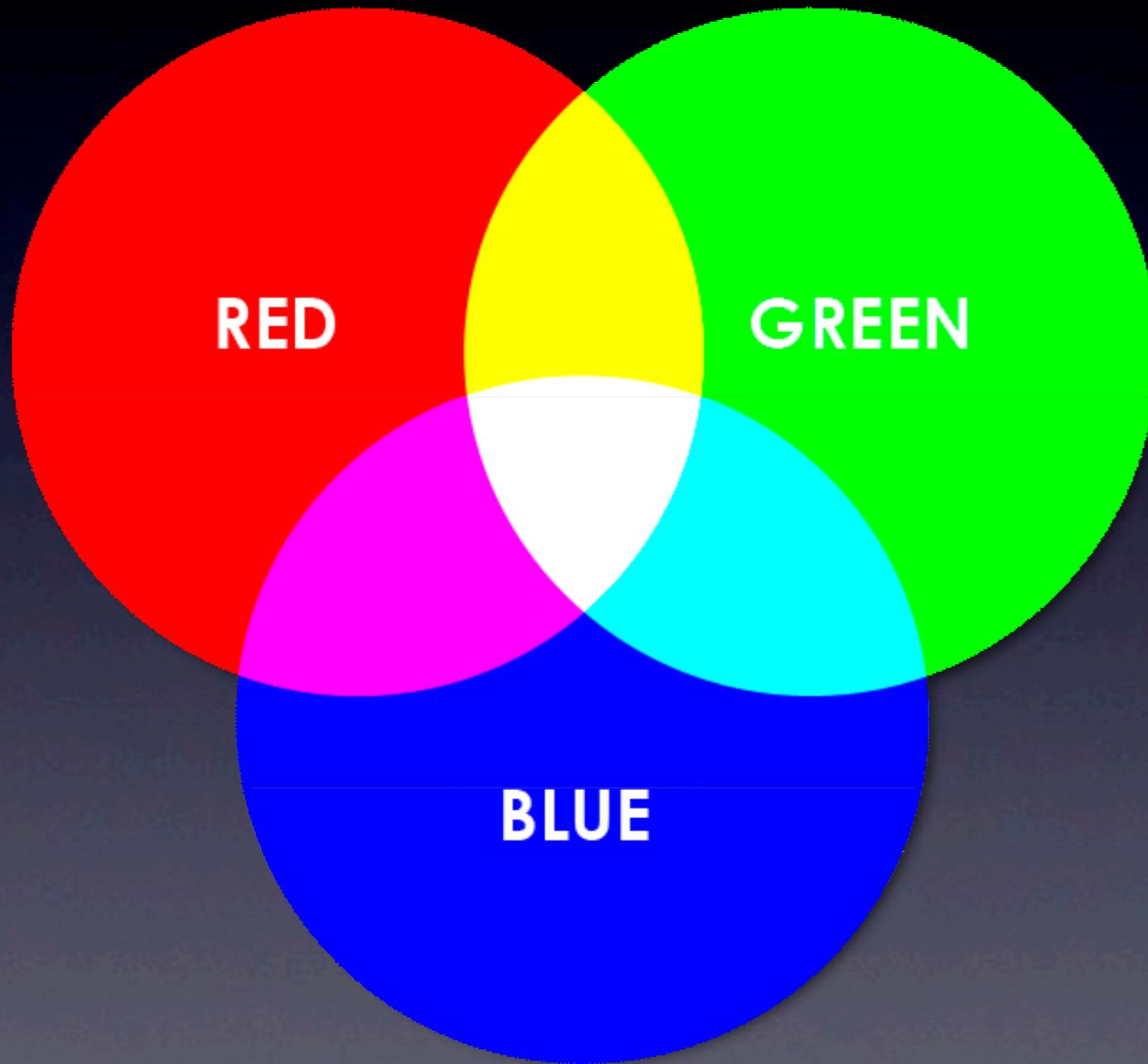
Channels



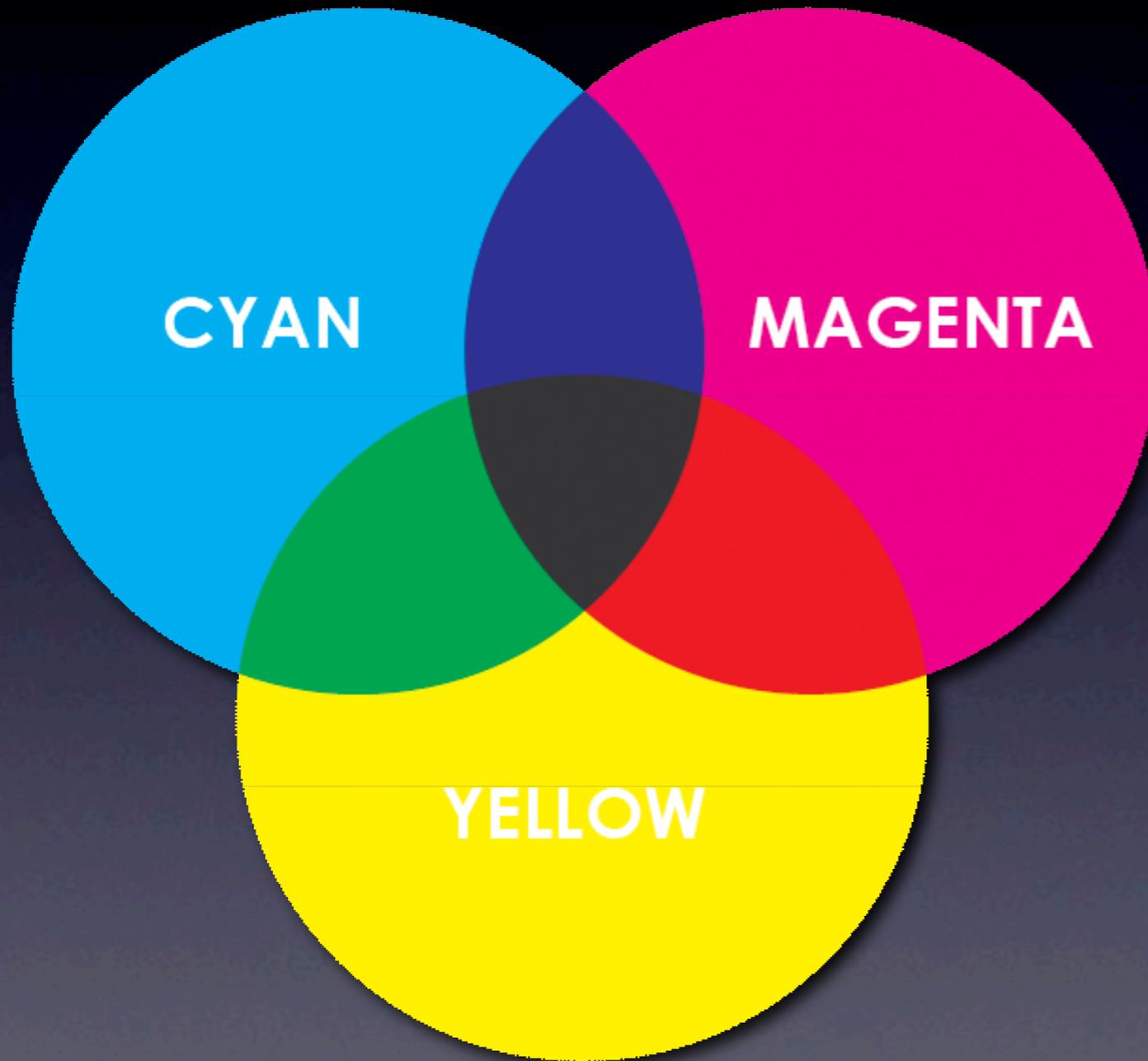
Channels



RGB to CMY



RGB to CMY



Raw Digital Capture

- A raw file format is a general term for a variety of proprietary formats including:
 - Canon's .CRW and .CR2
 - Minolta's .MRW
 - Olympus' .ORF
 - Nikon's various .NEF
 - Adobe's .DNG
 - All forms have similar features

Raw Digital Capture

- A Raw file is a record of the unprocessed data captured by the sensor
- Nearly all cameras that record Raw are captured with a Color Filter Array (CFA) sensor

Color Filter Array Sensor

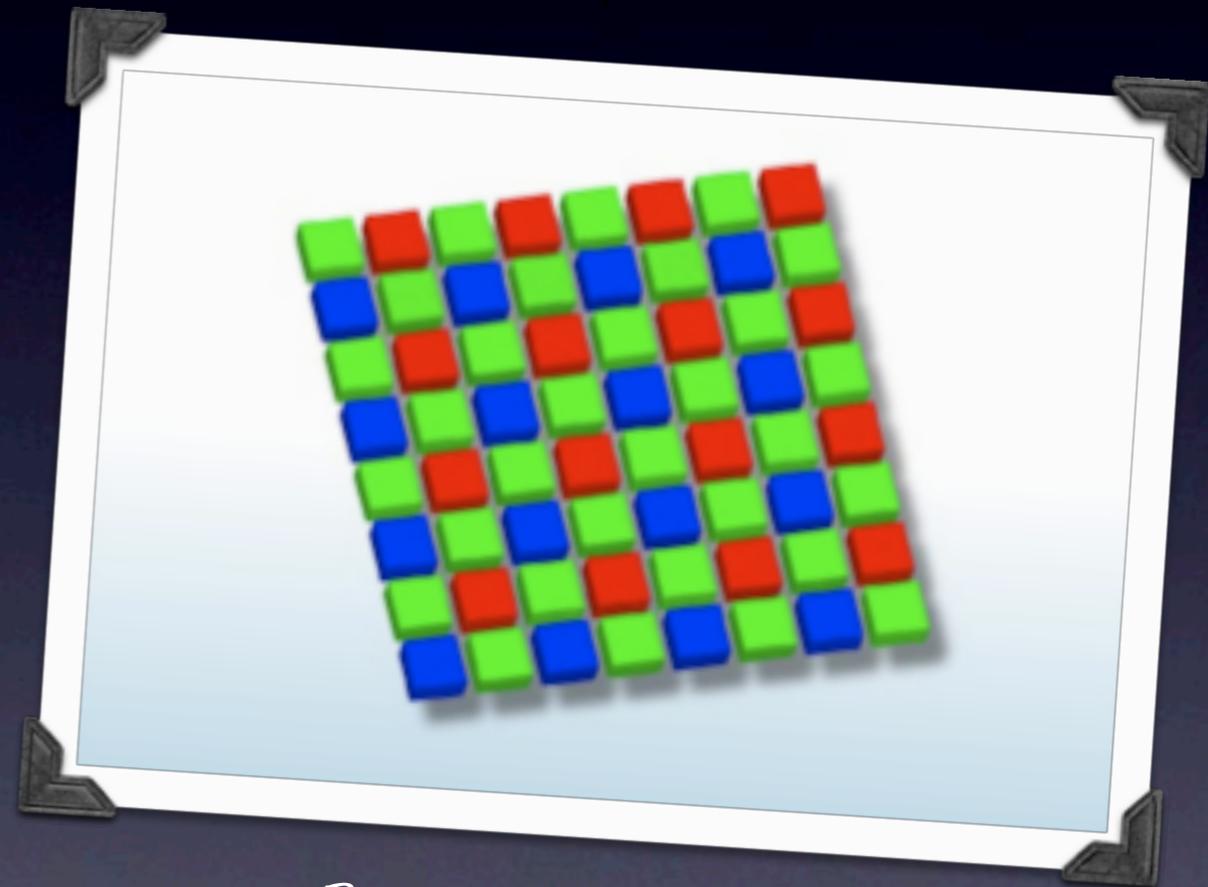
- Rows & columns of photo-sensitive detectors
 - CCD or CMOS Technology
- Each photosensor produces a charge equal to the amount of light that hits it
- Each photosensor contributes to a single pixel in the image
- This is in grayscale



An Area Array

Color Filter Array Sensor

- A color filter array creates color images from the grayscale capture
- Each element in the array is covered by a color filter so that it is only sensitive to Red, Green & Blue light
- Twice as many Green is used since our eyes are more sensitive to it



Bayer Pattern

Spectral-sensitive sensors

capture grayscale images that form a color image



Red



Green



Blue

Spectral-sensitive sensors

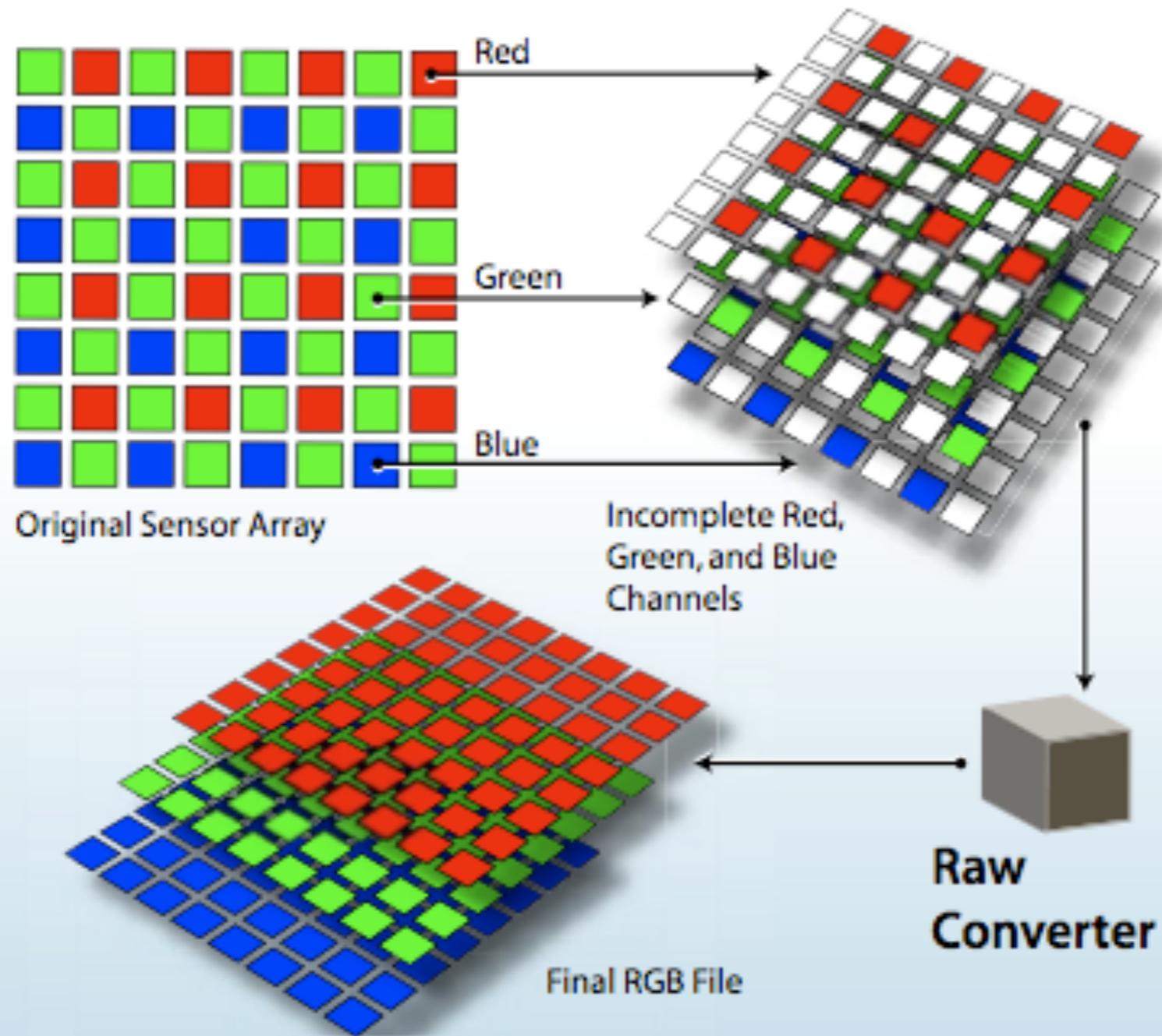
capture grayscale images that form a color image



Raw Files Contain Two Types of Information

- The image pixels themselves
- The image metadata
 - EXIF data
 - Other data for Raw converters
 - A 'Decoder Ring' to translate

Raw Conversion



Digital Capture

- When you are not shooting a Raw format, the data is converted according to the presets set in-camera, then compressed in your chosen format
- One large advantage of Raw format is the ability to custom interpret settings at a later time
- Raw also allows for a greater tonal range for these adjustments since no preset has been applied

Summary

- The nature of Light and Color
 - The Visible Spectrum
 - Color Models / Modes
 - Different ways to view an color image
 - RGB, light
 - CMYK, pigment
- Definition of Photography
- How color film captures/renders color
- How a digital imaging sensor captures / renders data