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

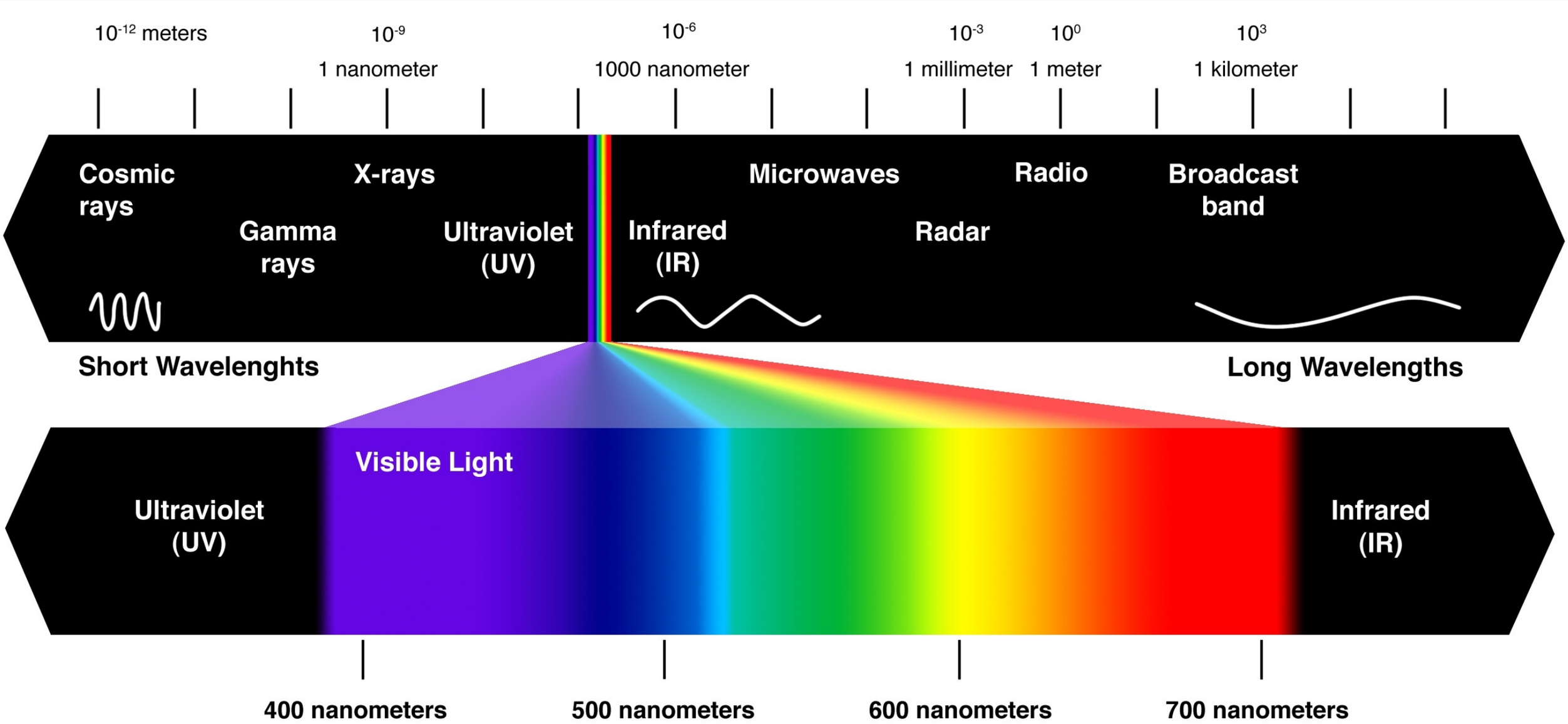
When light goes through a prism, it is separated into its component colors.

Each color you see is actually a different wavelength.

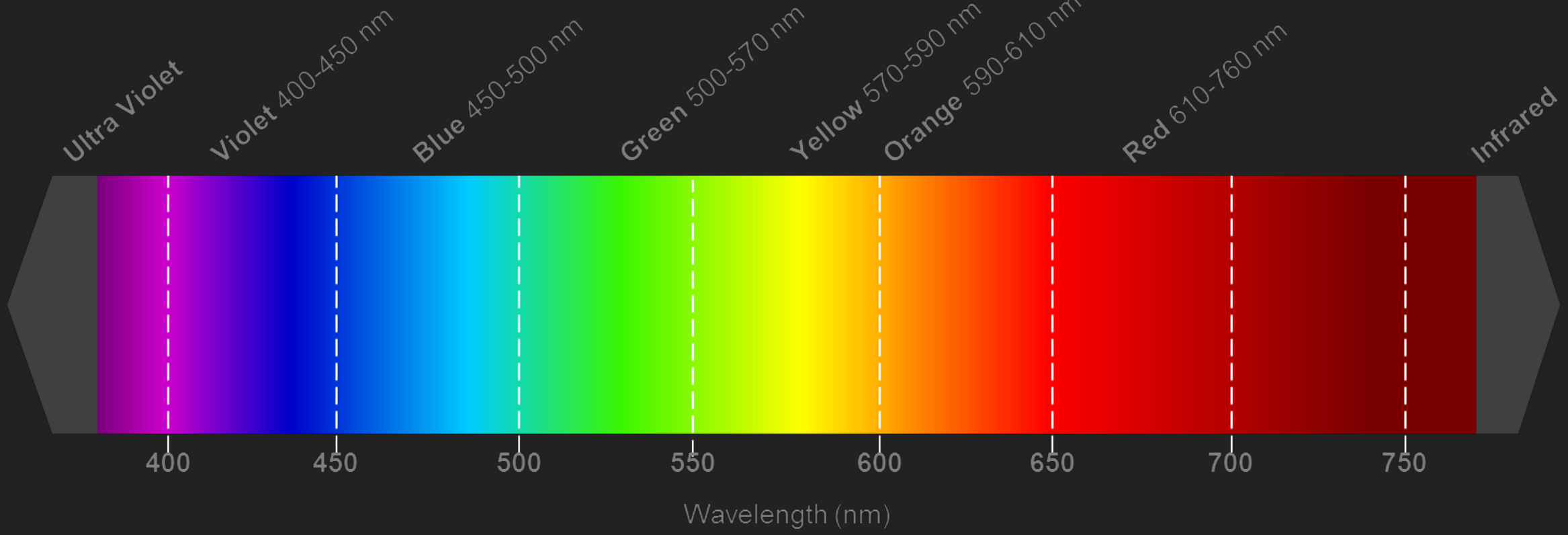
THE ELECTROMAGNETIC SPECTRUM

- 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



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.

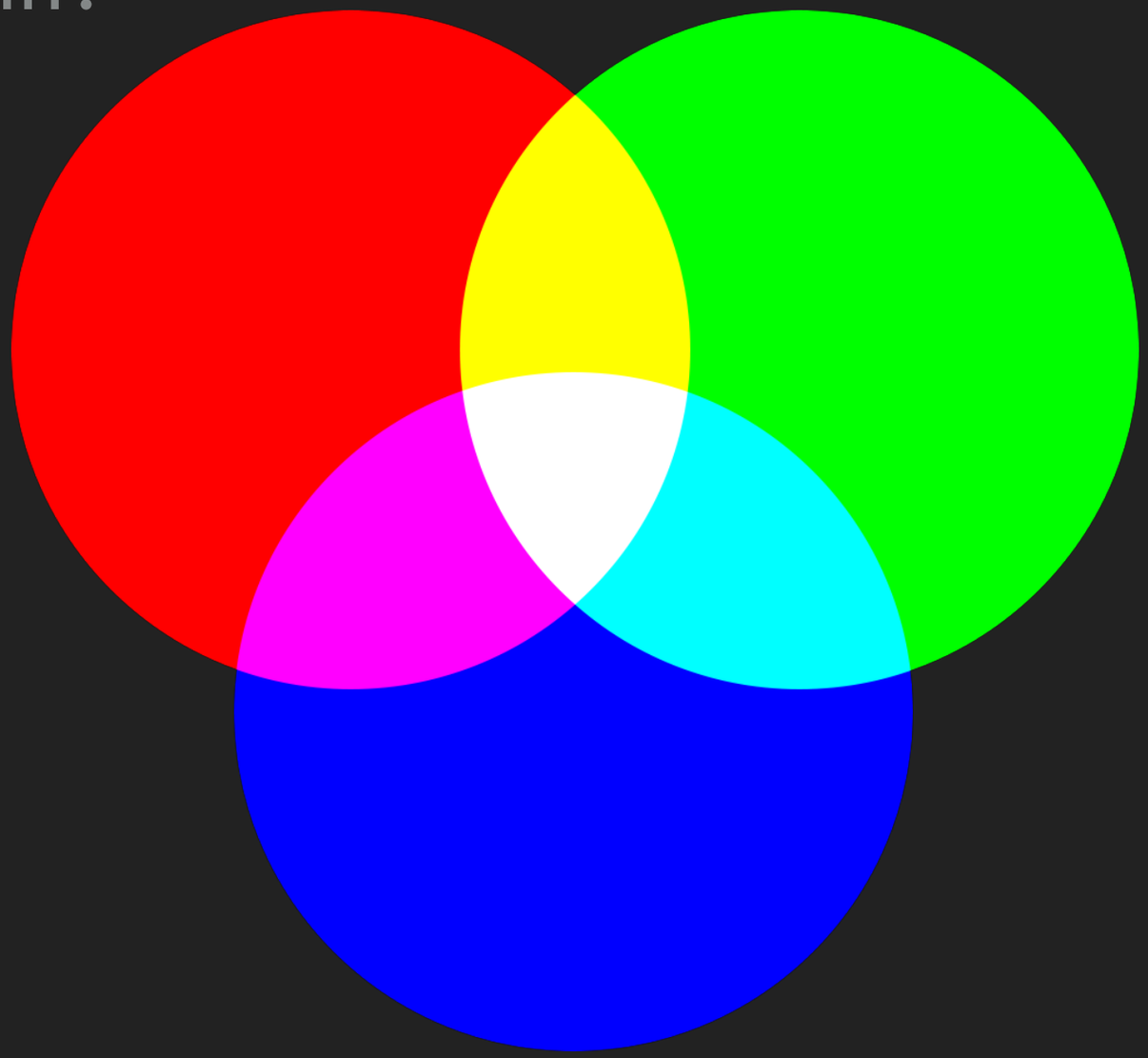
METHODS TO PRODUCE COLOR

- 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

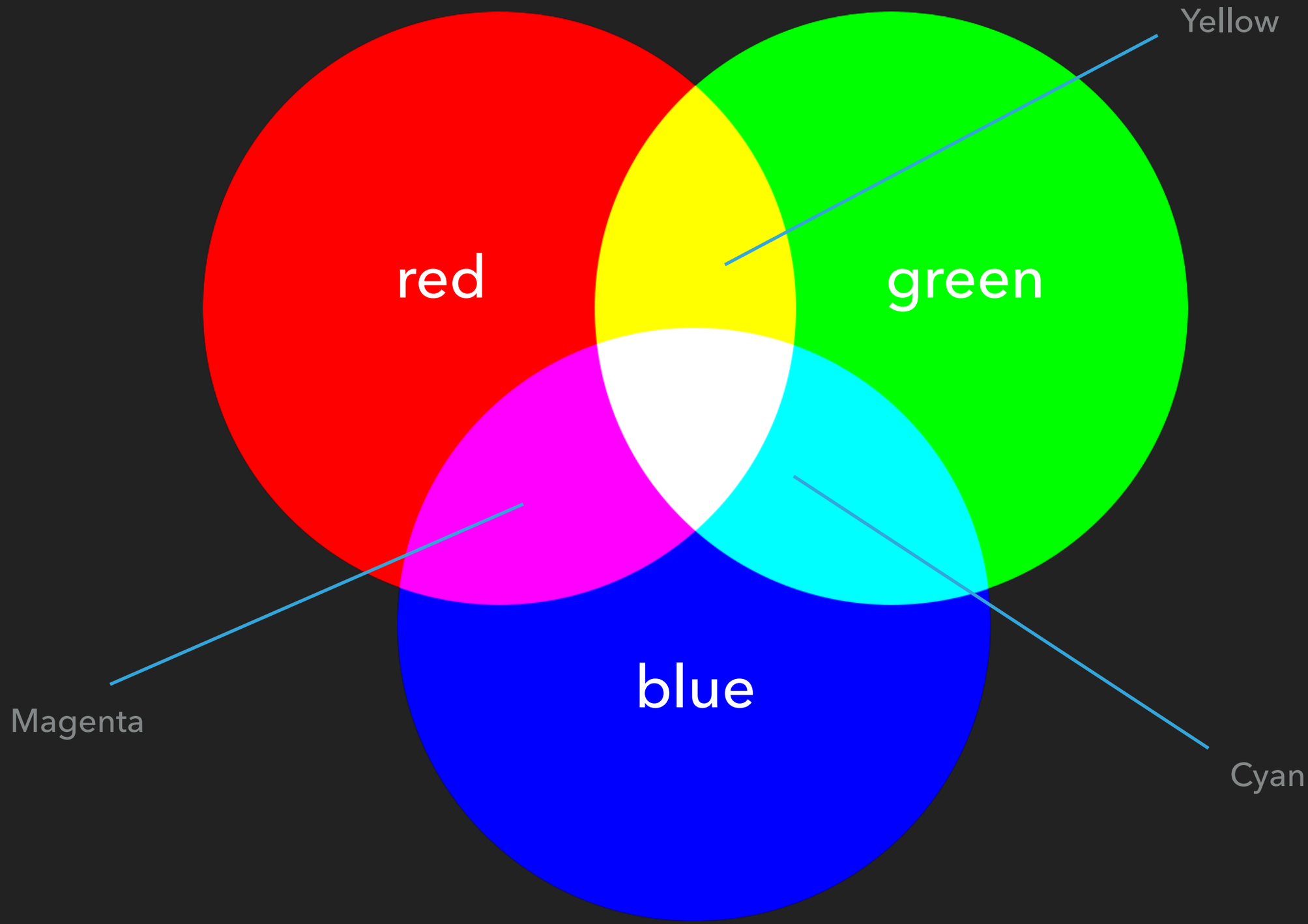
COLOR MODES

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

RGB



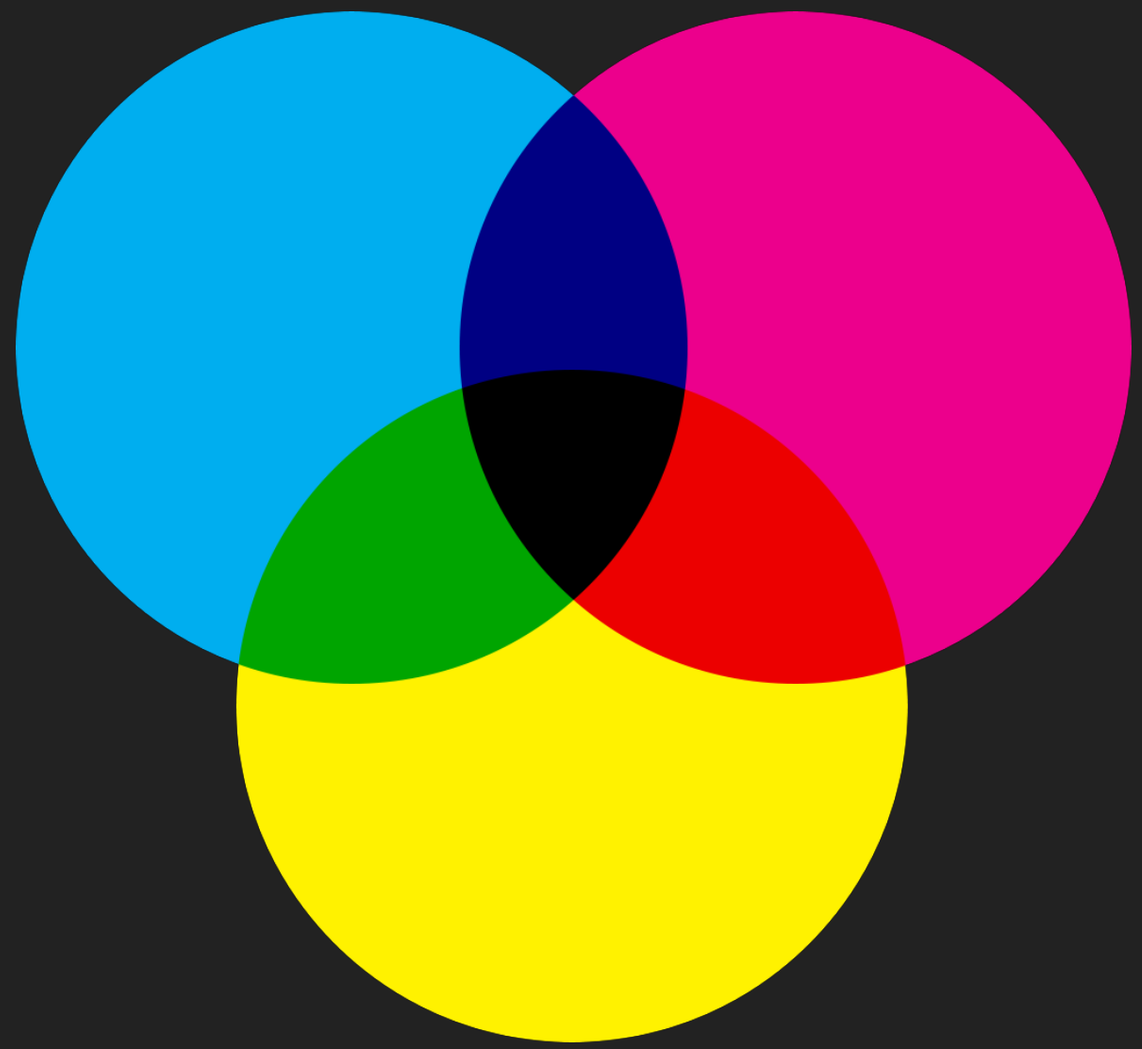
RGB COLOR MODE



COLOR MODES

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

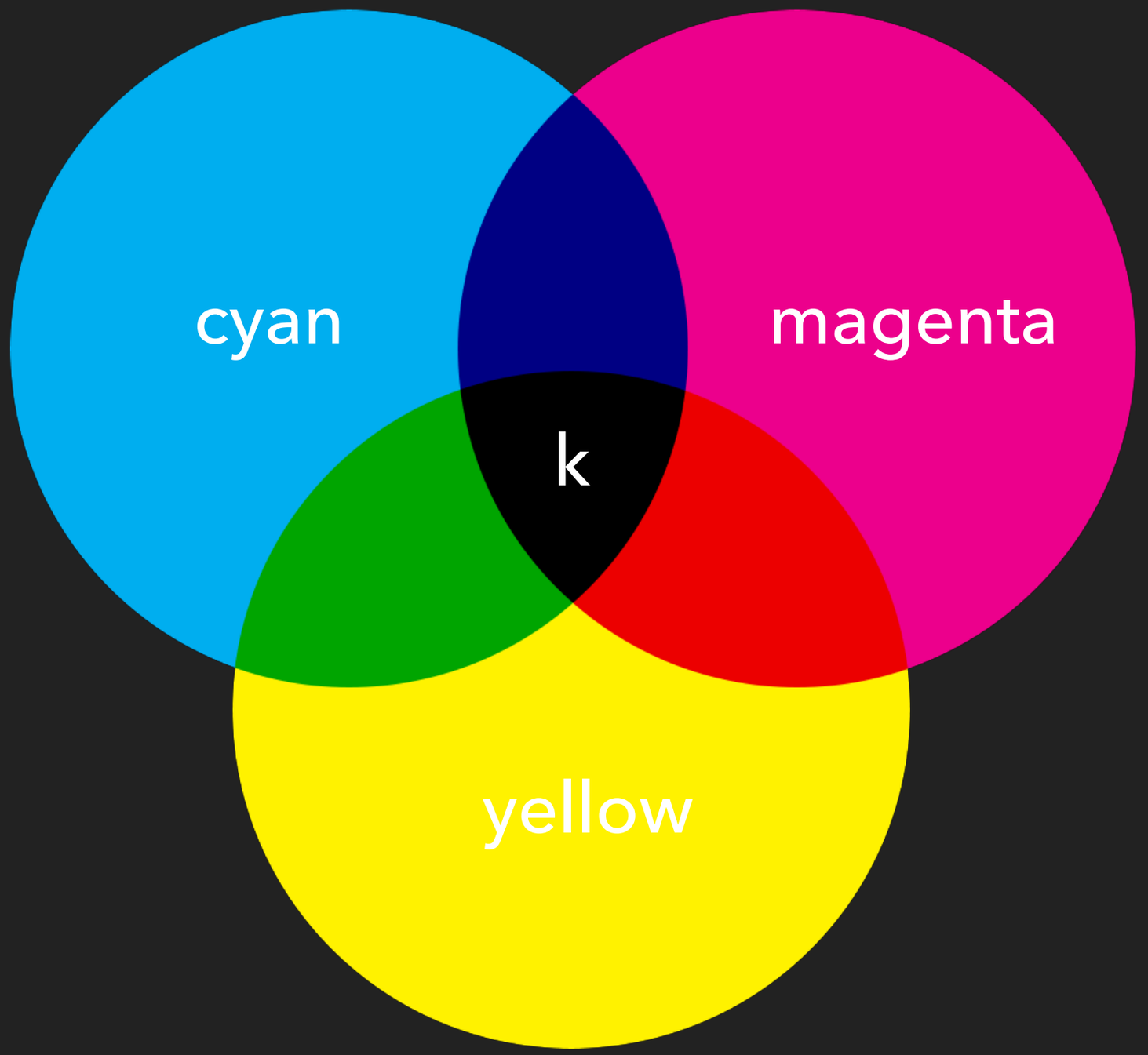
CMYK



CMYK COLOR MODE

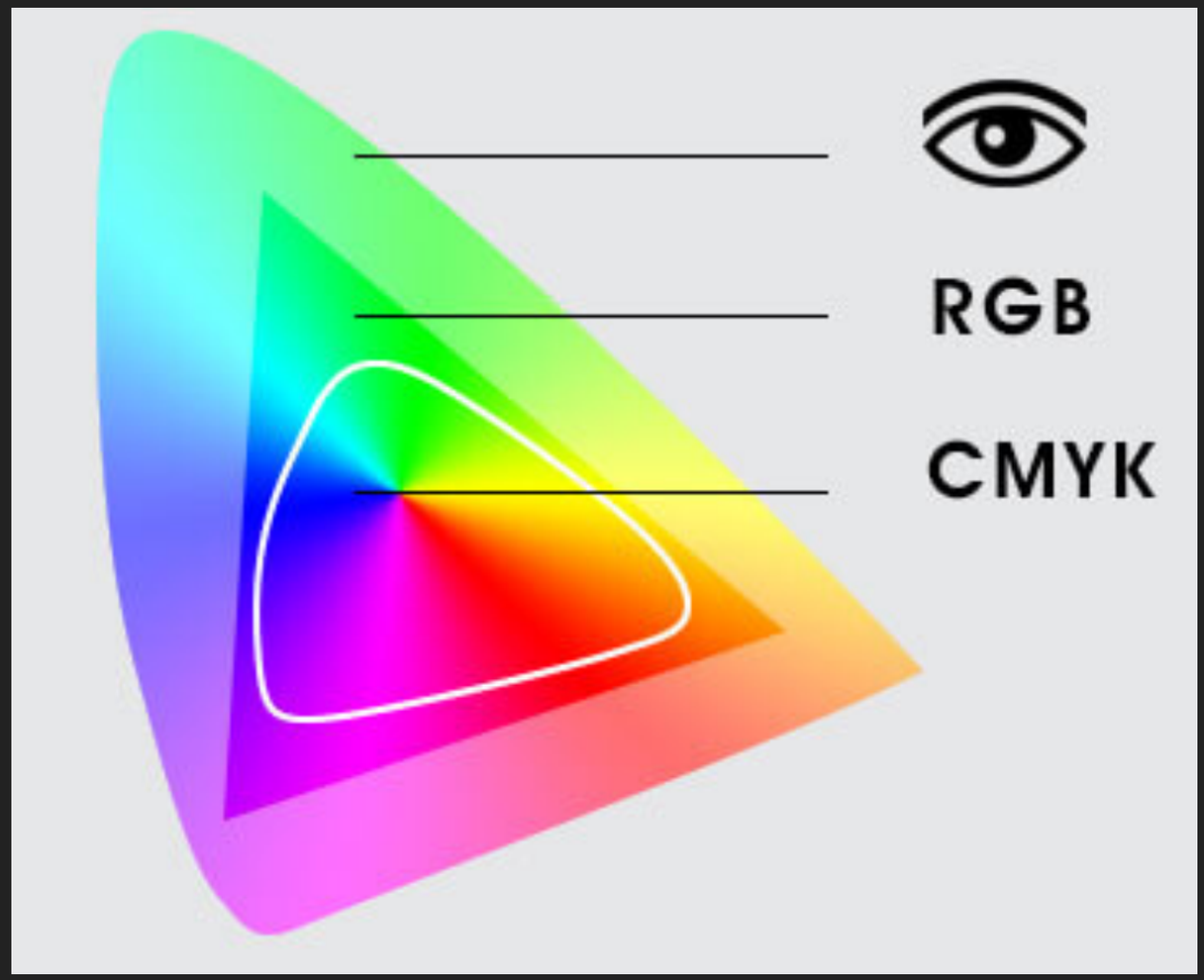
- The CMYK model represents a lesser percentage of the visible spectrum of colors
- The CMYK model is based on the light-absorbing quality of ink printed on paper.
- As white light strikes translucent inks, certain visible wavelengths are absorbed (subtracted), while others are reflected back to your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

CMYK COLOR MODEL



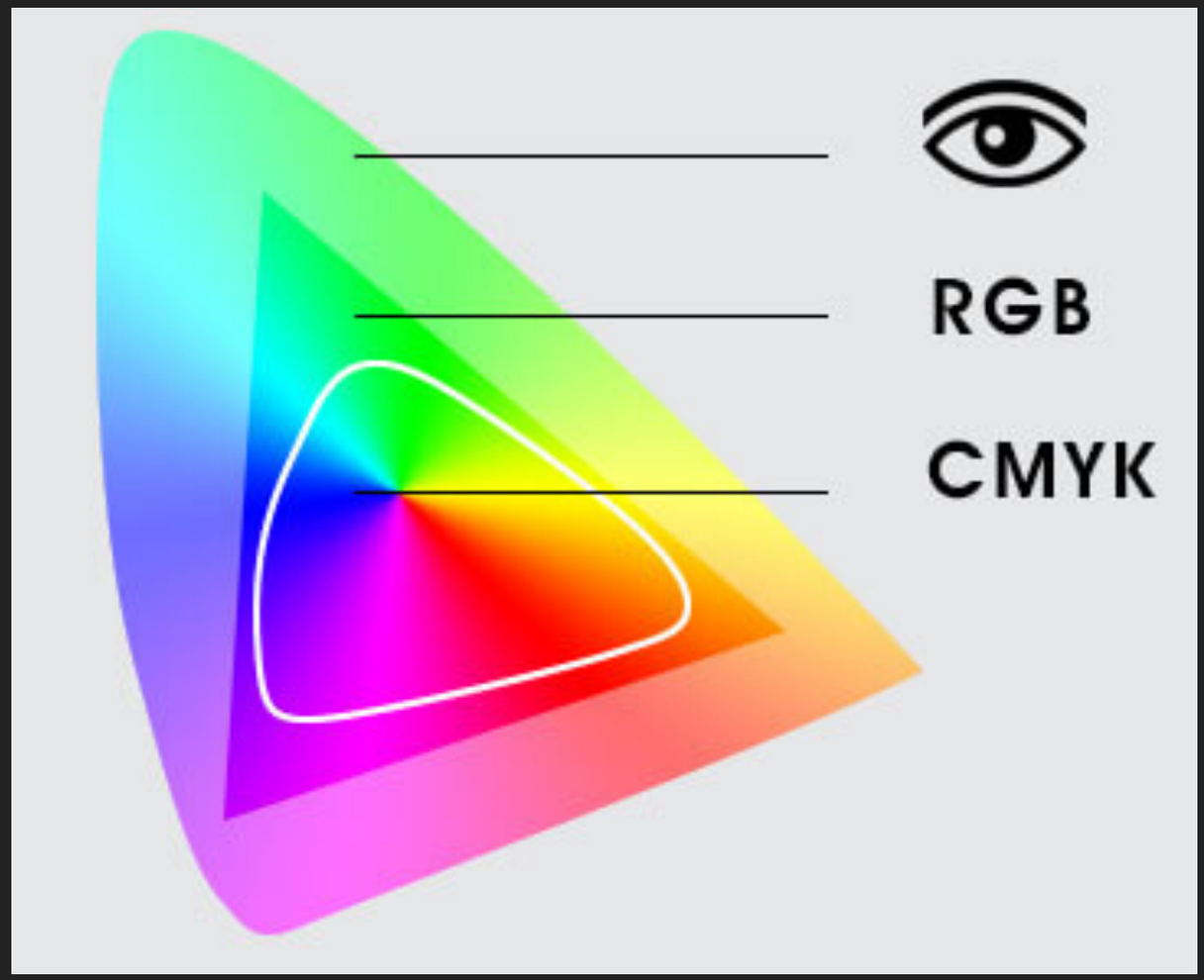
COLOR MODELS WITHIN THE VISIBLE SPECTRUM

- This diagram illustrates all visible colors, and the color models within them
  - The visible spectrum
  - RGB
  - CMYK



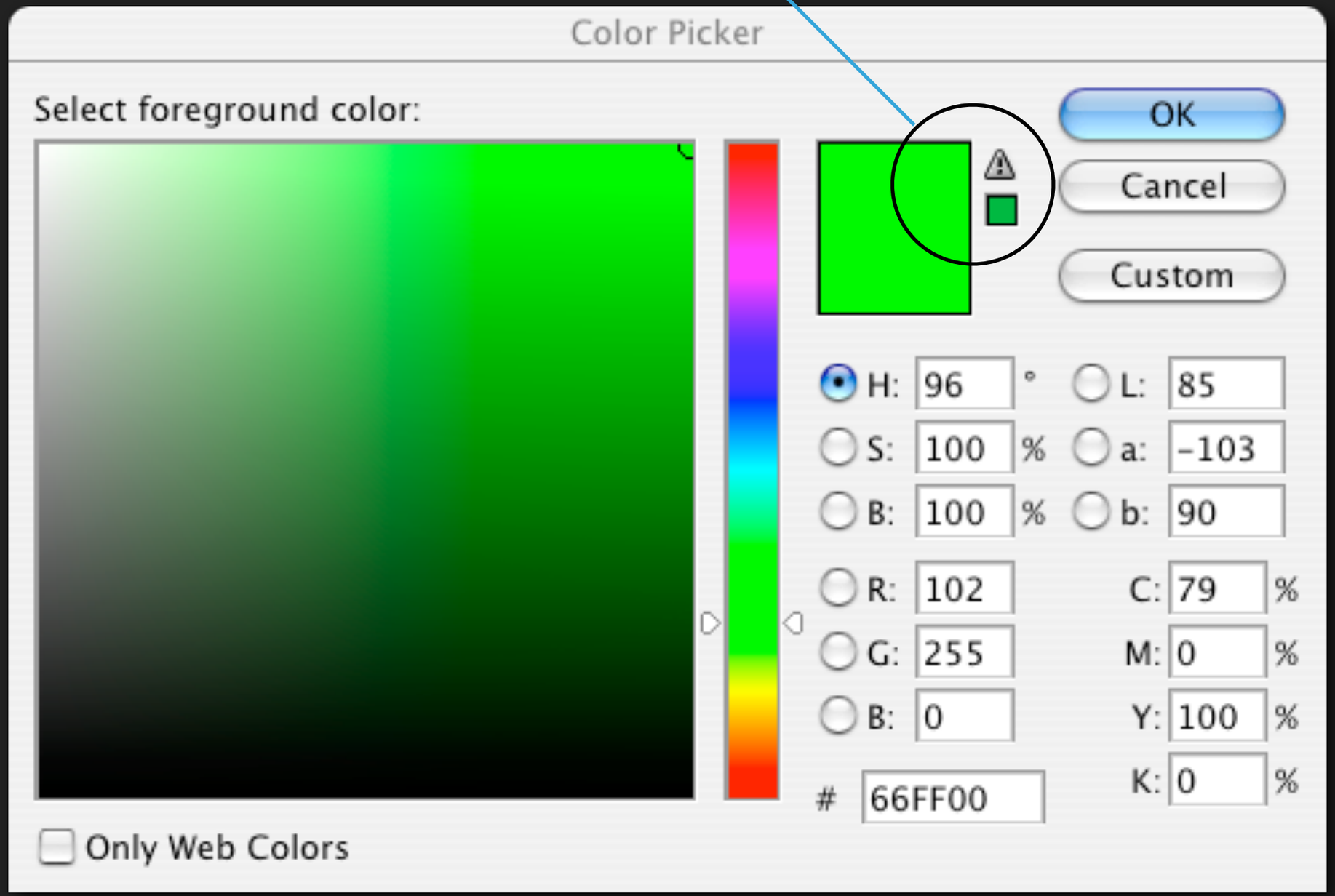
COLOR MODES

- 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

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

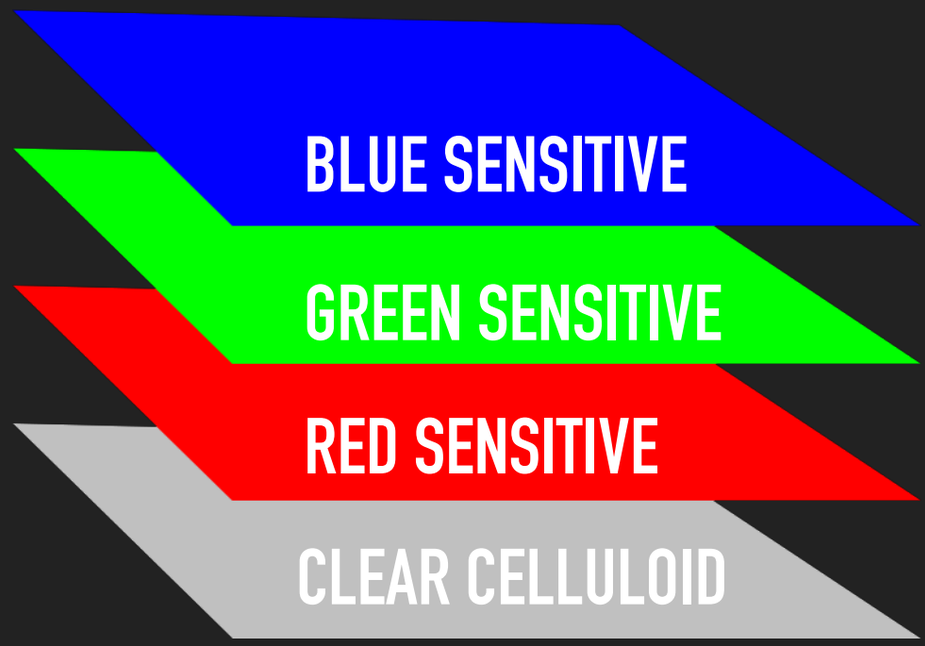
- Photography has been around since 1816.
- Film-based photography Photography as we know it has been around about 100 years.
- This photography is based off a chemical reaction to light

NICÉPHORE NIÉPCE INVENTED “HELIOGRAPHS”

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



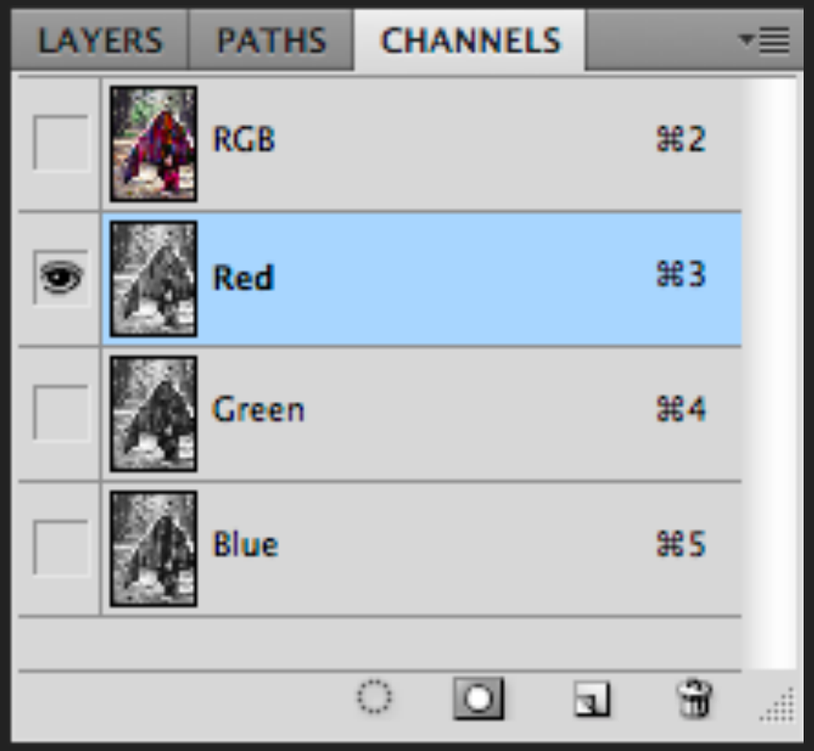
COLOR FILM EXPOSURE

SPECTRAL-SENSITIVE EMULSION LAYERS CAPTURE GRAYSCALE IMAGES THAT FORM A COLOR IMAGE

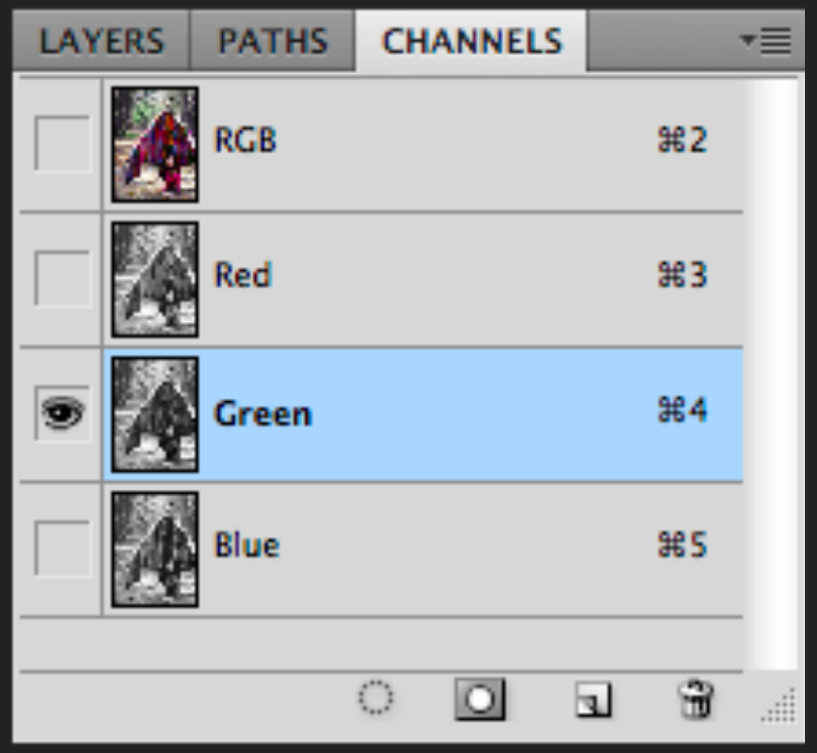
Red

Green

Blue



CHANNELS

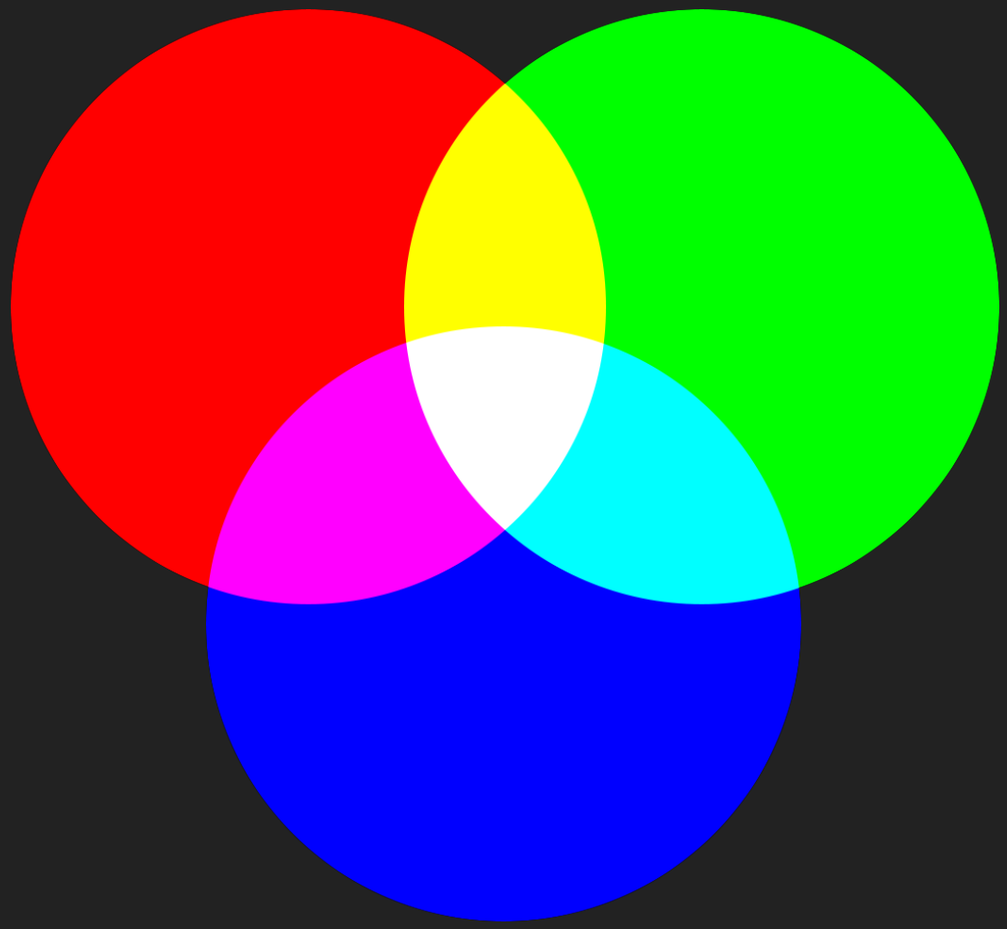


CHANNELS

CHANNELS

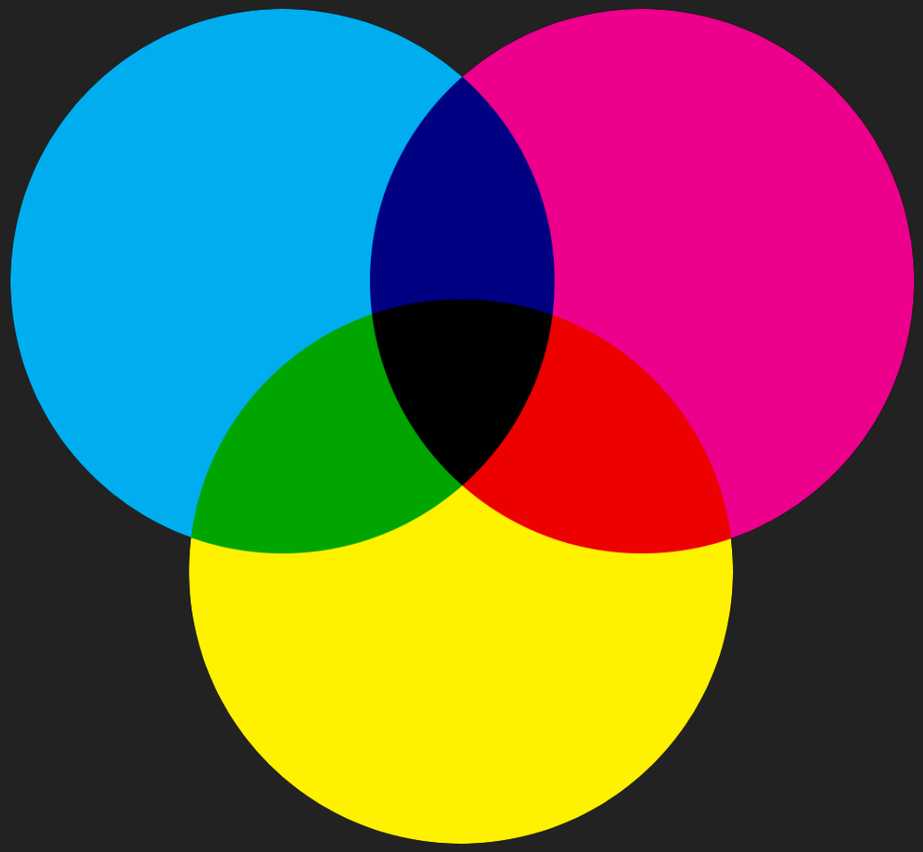
RGB TO CMY

RGB



RGB TO CMY

CMYK



RAW DIGITAL CAPTURE

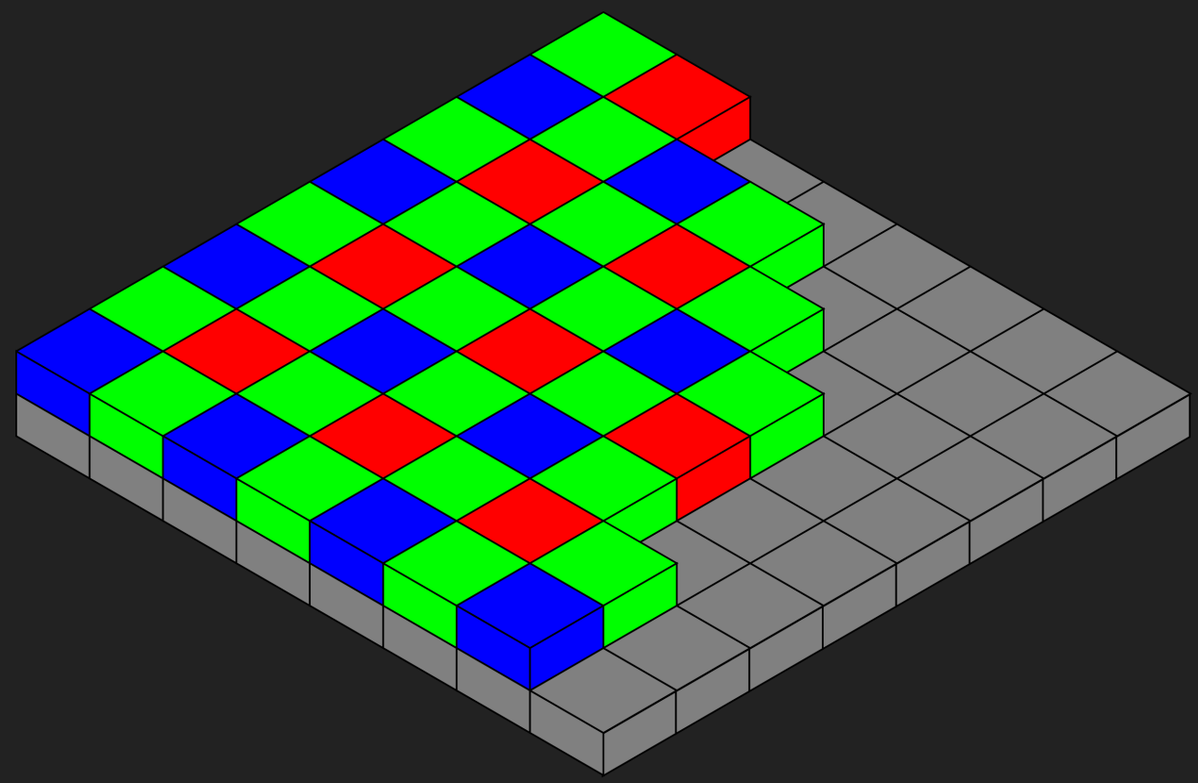
- A raw file format is a general term for a variety of proprietary formats including:
  - Canon's .crw / .cr3
  - Fuji's .rar
  - Hasselblads' .3fr
  - Nikon's various .nef / .nrw
  - Adobe's .dng
  - All forms have similar features

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

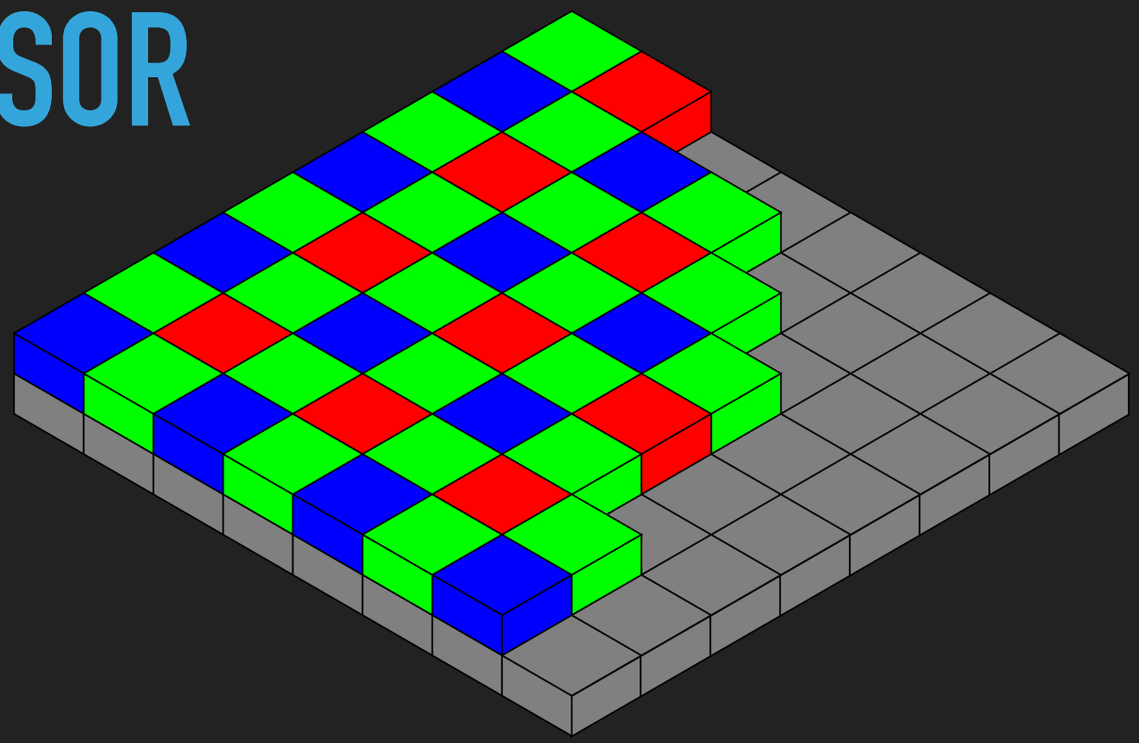
- A color filter array creates color images from the grayscale capture
- Each element in the array is covered by a color filter so that it is only sensitive to Red, Green & Blue light
- A Bayer pattern is most commonly used
- Twice as many Green is used since our eyes are more sensitive to it

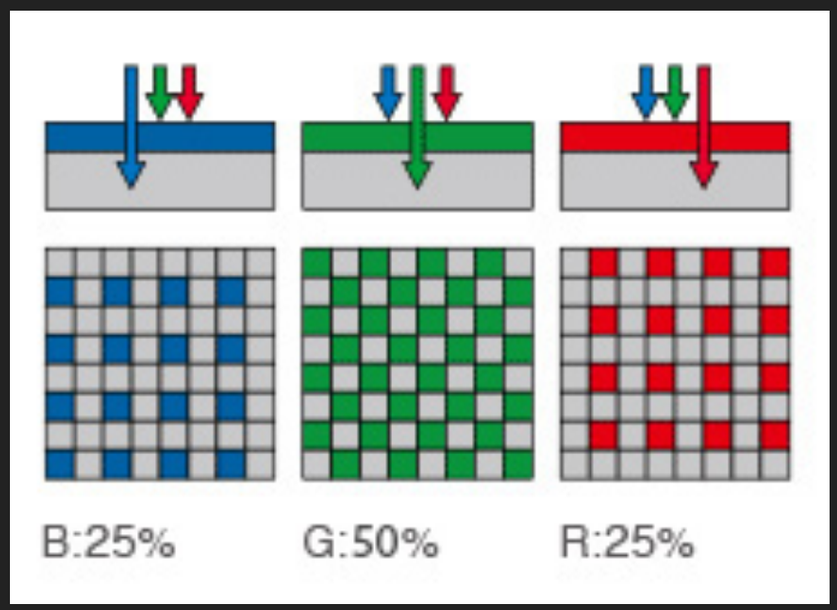


Bayer Pattern CFA

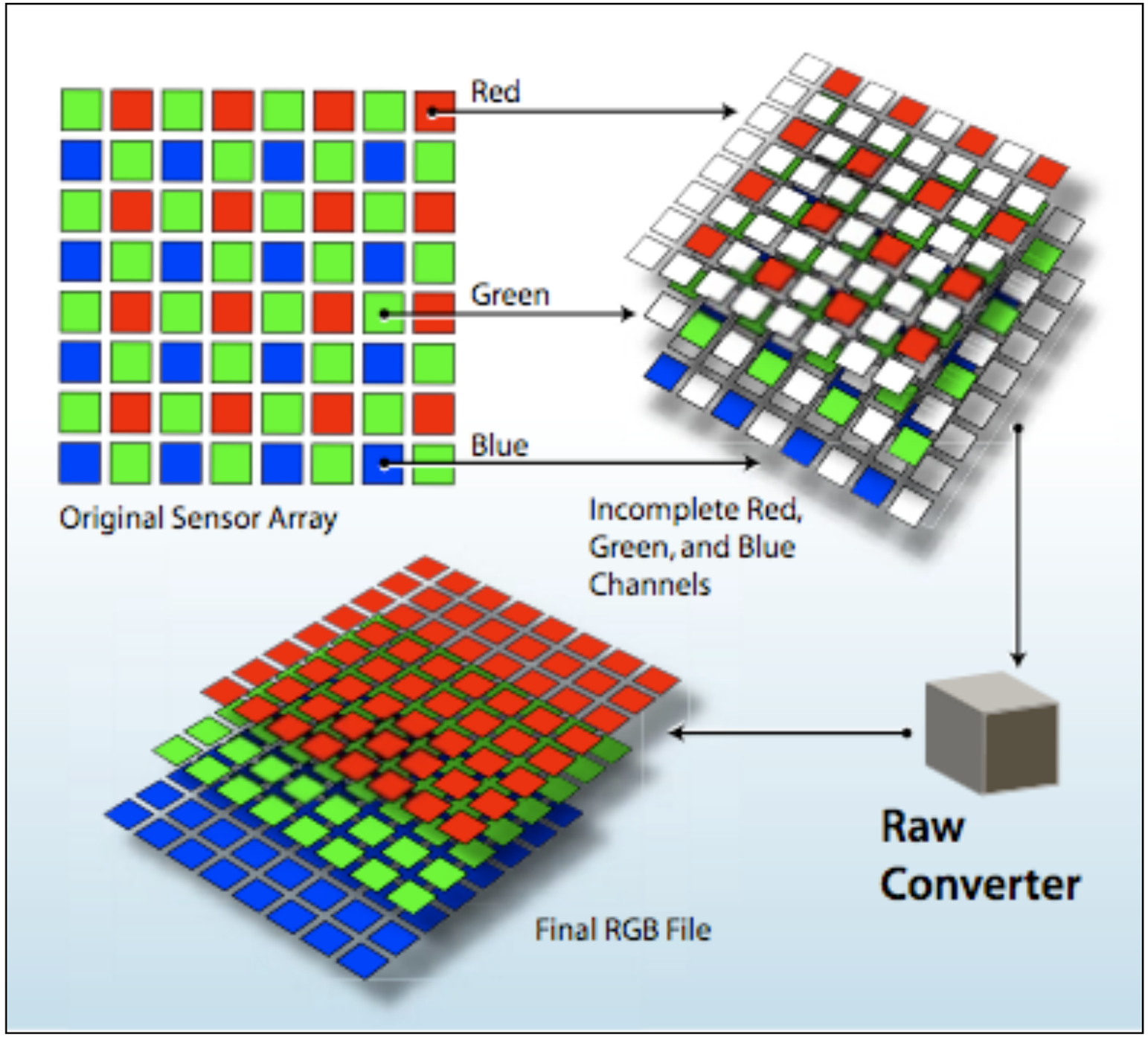
COLOR FILTER ARRAY SENSOR

- 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





RAW CONVERSION



SPECTRAL-SENSITIVE SENSORS CAPTURE GRAYSCALE IMAGES THAT FORM A COLOR IMAGE

Red

Green

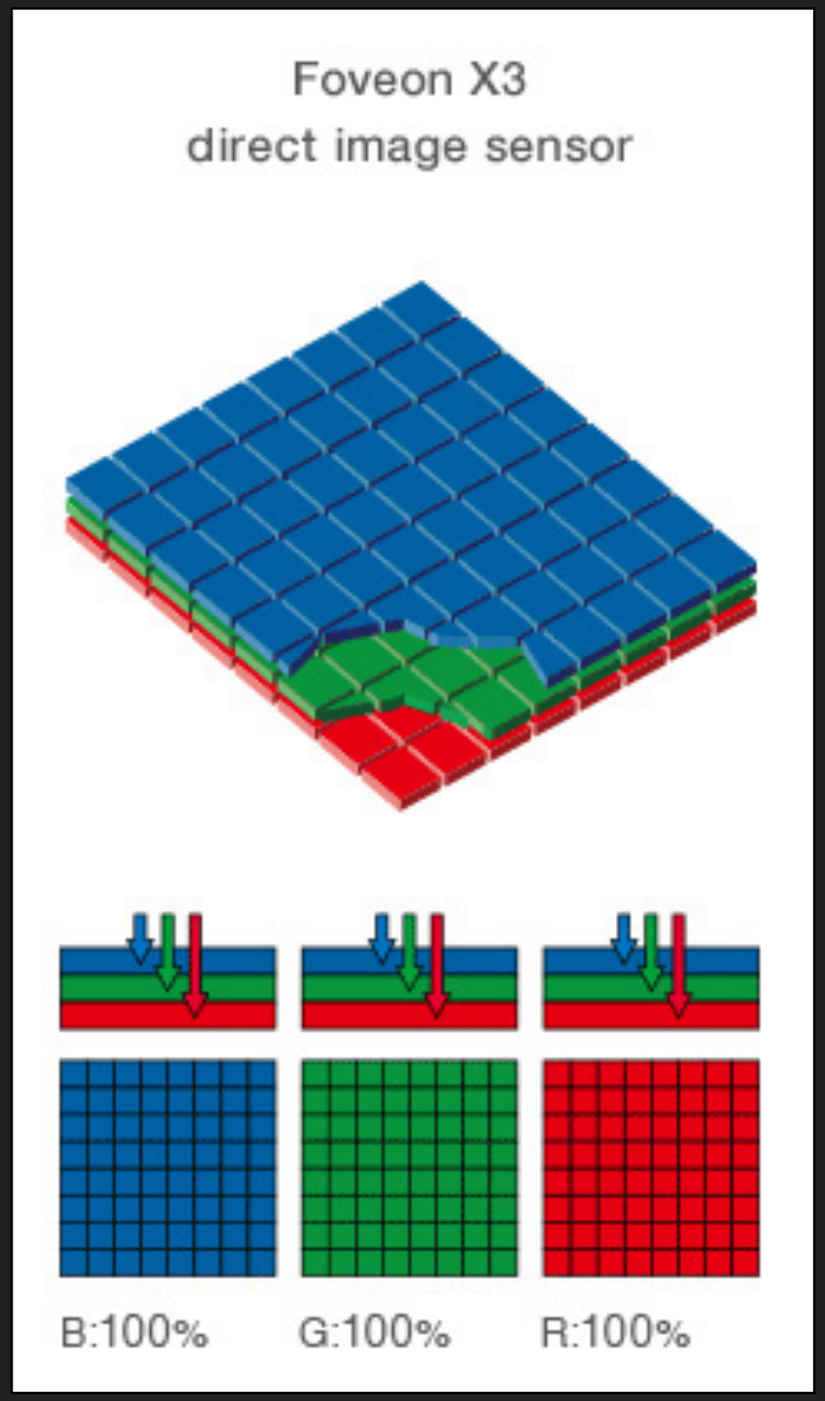
Blue

3 GRAYSCALE CHANNELS REPRESENTING RGB MAKE UP A COLOR IMAGE

OTHER CFA TYPES

SIGMA'S FOVEON X3 SENSOR

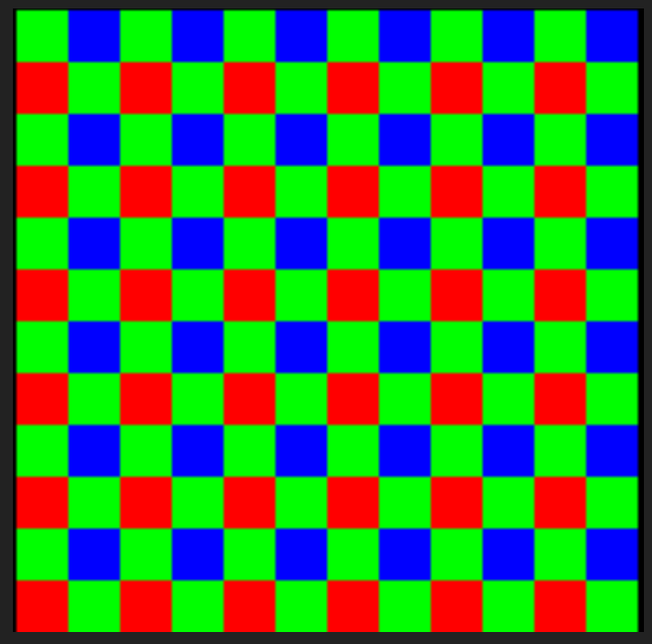
- Uses an array of layered pixel sensors, separating light via the inherent wavelength-dependent absorption property of silicon
- Every pixel sensor detects all three color channels
- This method is similar to how color film for photography works



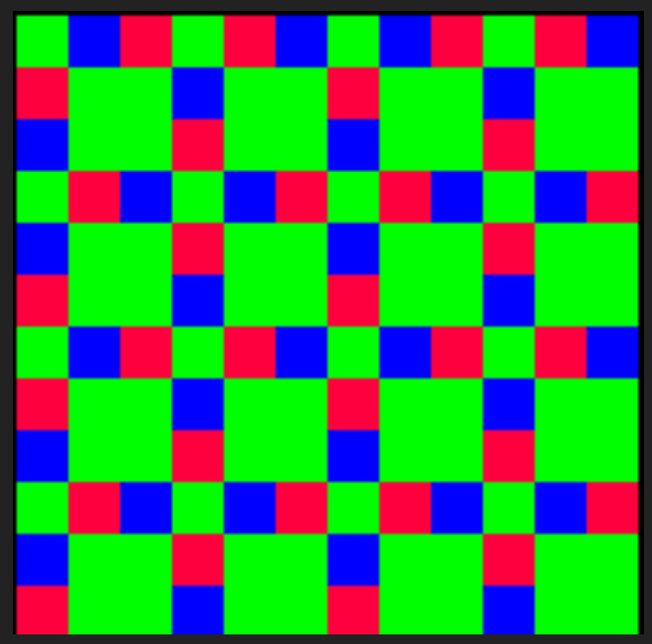
NEW CFA TYPES

FUJI'S X-TRANS PATTERN

- Uses a unique 6x6 pixel pattern which may minimize moiré effects
- Fuji claims it increases resolution by eliminating the need for a low-pass filter



Bayer Pattern filter array



X-Trans filter array

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

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