

# **EE6310: Image and Video Processing**

## **Spring 2023**

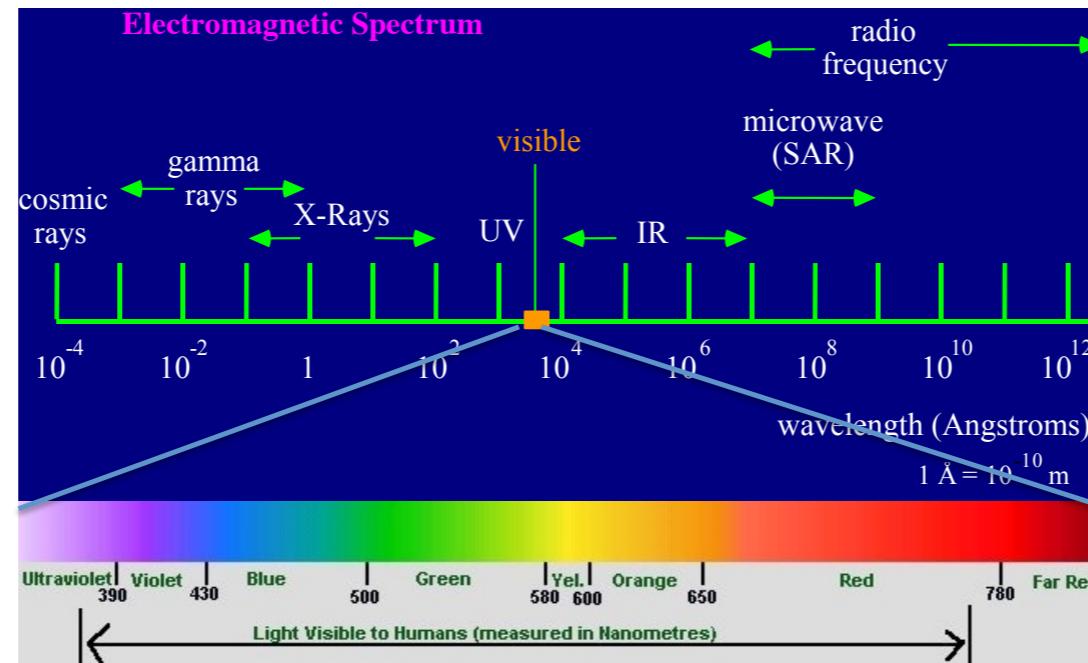
**Image Formation**



भारतीय प्रौद्योगिकी संस्थान हैदराबाद  
Indian Institute of Technology Hyderabad

# The Electromagnetic Spectrum

## Fundamental Source of Image Formation



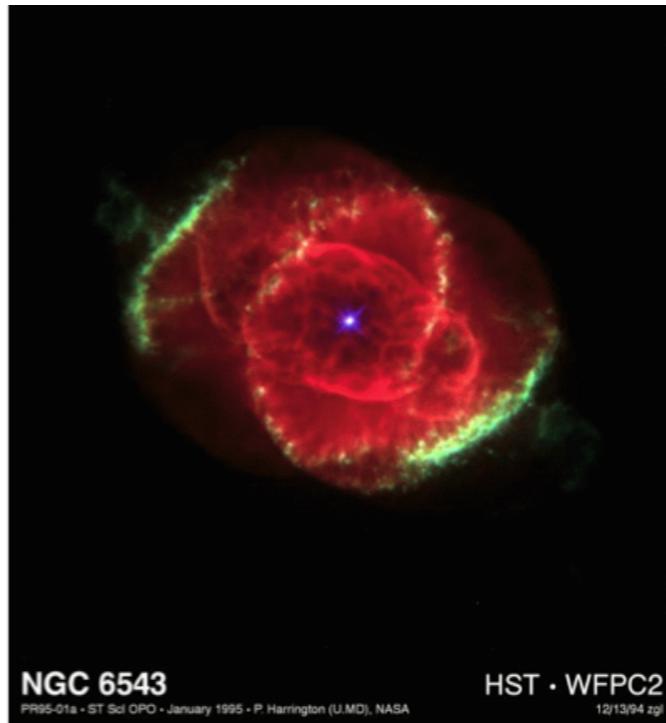
Imaging done across the spectrum - from gamma rays to radio waves

- Gamma rays: nuclear medicine, astronomy
- X-rays: medical imaging
- UV rays: industrial inspection, fluorescence microscopy
- Visible spectrum: too many to list
- Radio waves: astronomy, medicine (magnetic resonance imaging)
- Recall  $E = h\nu, c = \lambda\nu$ ; implies short waves have high energy

# Image Types



Reflection



NGC 6543

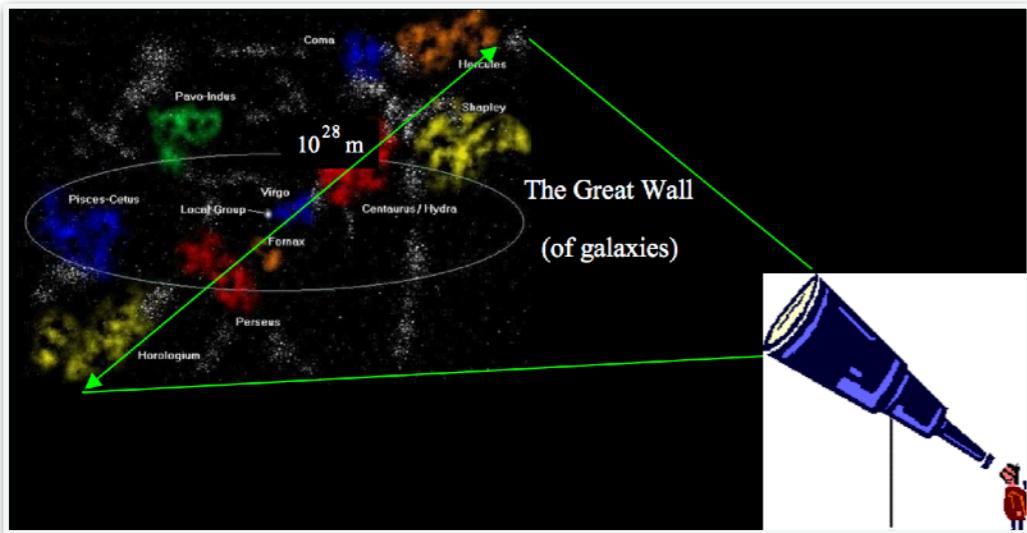
PR95-01a - ST Scl OPO - January 1995 - P. Harrington (U.MD), NASA

Emission

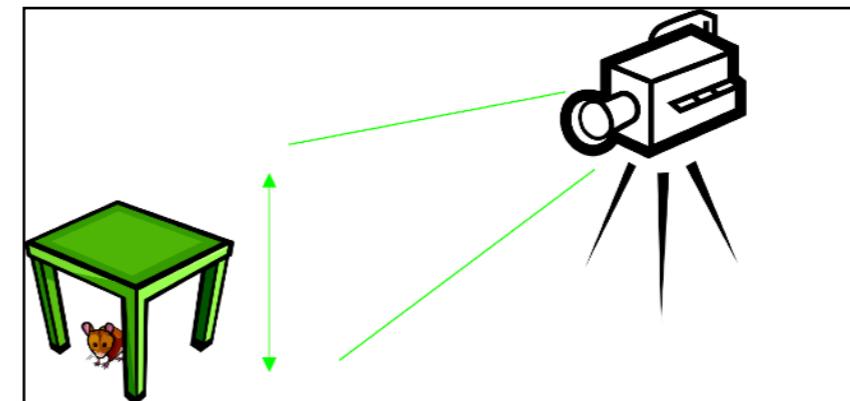


Absorption

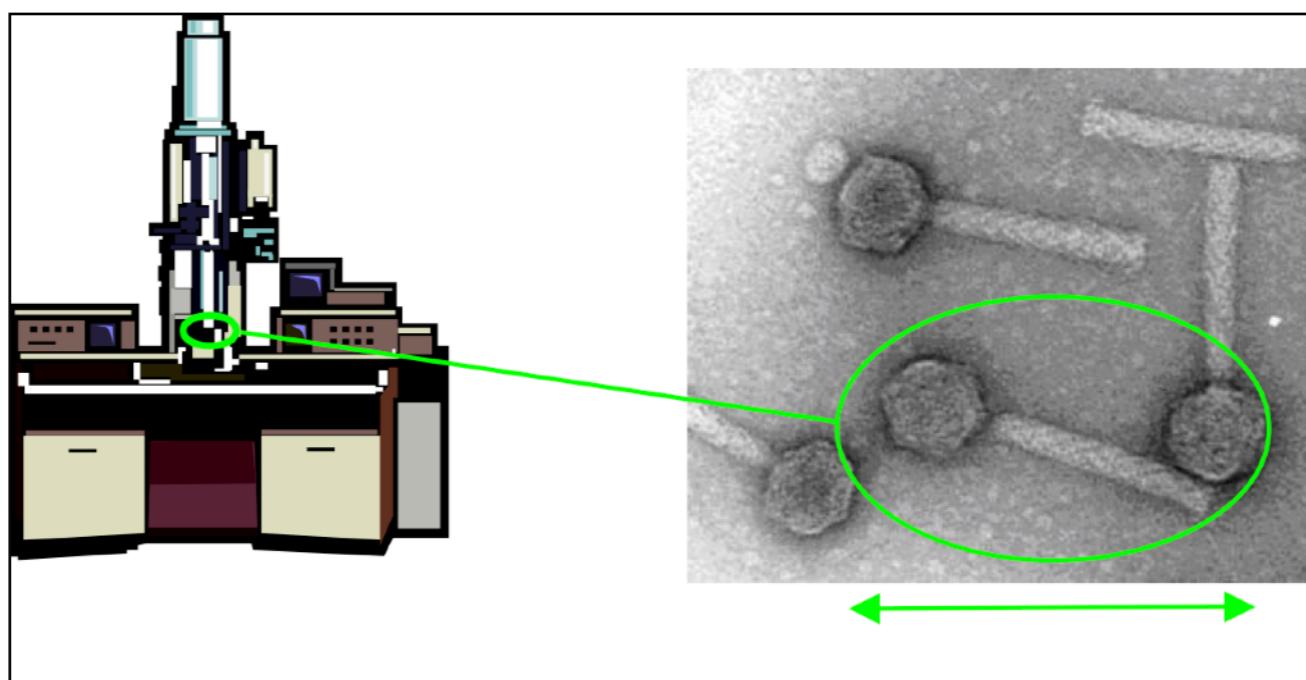
# Image Scales



Gigantic



Everyday



# Image Sensing and Acquisition



# Image Sensing and Acquisition

- Sensors: Charge Coupled Device (CCD), Complementary Metal Oxide Semiconductor (CMOS)
- CCD
  - Three potential wells, charge applied to middle well
  - Photon strike creates electron
  - Number of electrons proportional to number of photons
  - Output voltage proportional to number of electrons
  - High quality, high power, low noise
- CMOS
  - Multiple transistors amplify signal at sensor
  - Image acquired piece-wise
  - Cheaper, low power, noisier

# Image Sampling and Quantization

- Sampling
  - Output of sensor first sampled – sampling theorem must be obeyed
  - Sampled image is an array of numbers of dimension  $M \times N$
- Quantization
  - Sampled signal then quantized - converting the signal into a finite digital representation
  - For gray scale, typically  $K = 2^B$  levels, or  $B$  bit representation
  - $K$  chosen to avoid excessive information loss

# Image Sampling and Quantization

- Elements of a picture called a **pixel**
- Representation
  - $\mathbf{I} = [I(i, j); 0 \leq i \leq N - 1, 0 \leq j \leq M - 1]$
  - $(i, j)$ : (row, column)
  - $I(i, j)$ : pixel value at  $(i, j)$

# Image Sensing and Acquisition

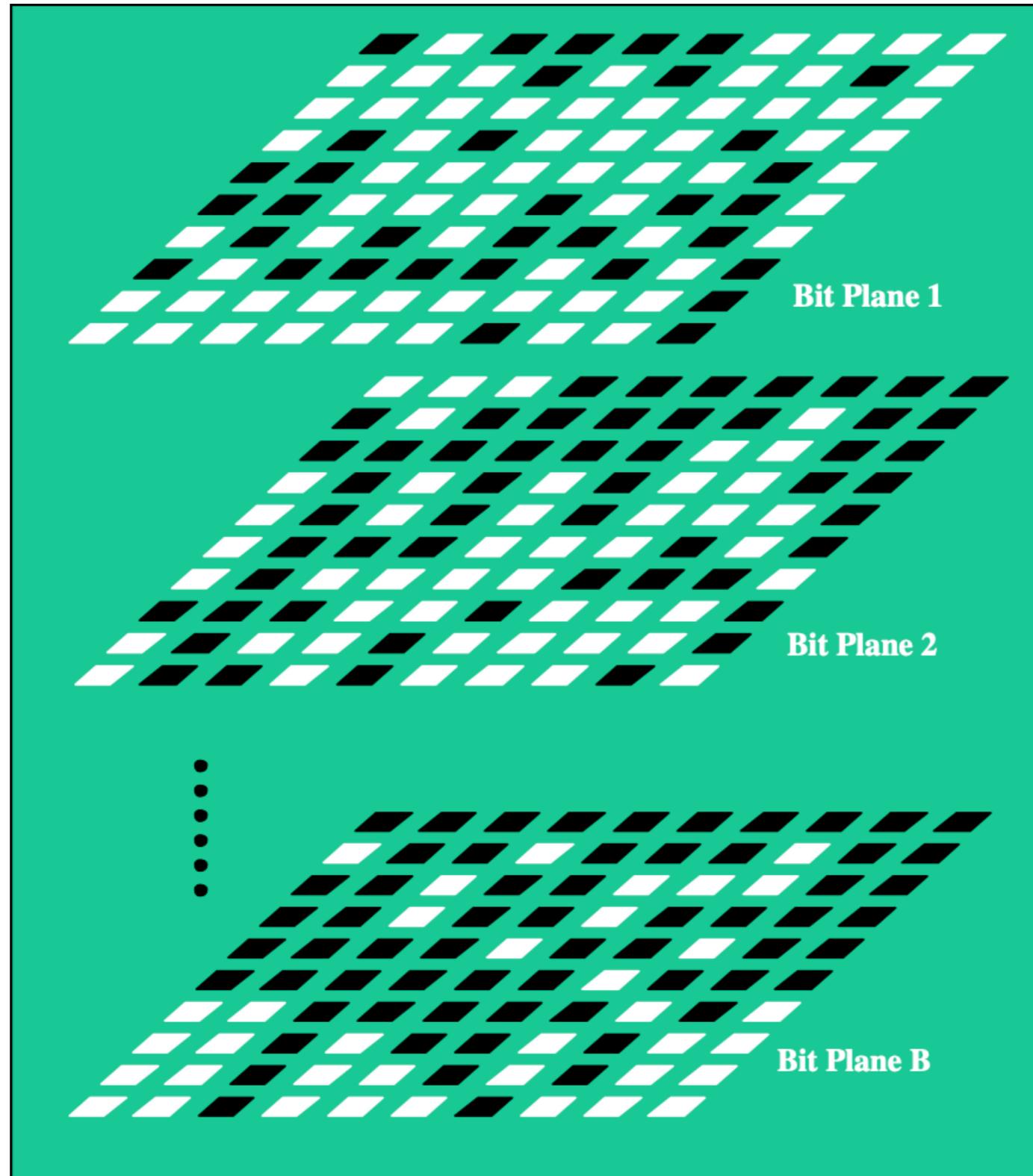


a pixel

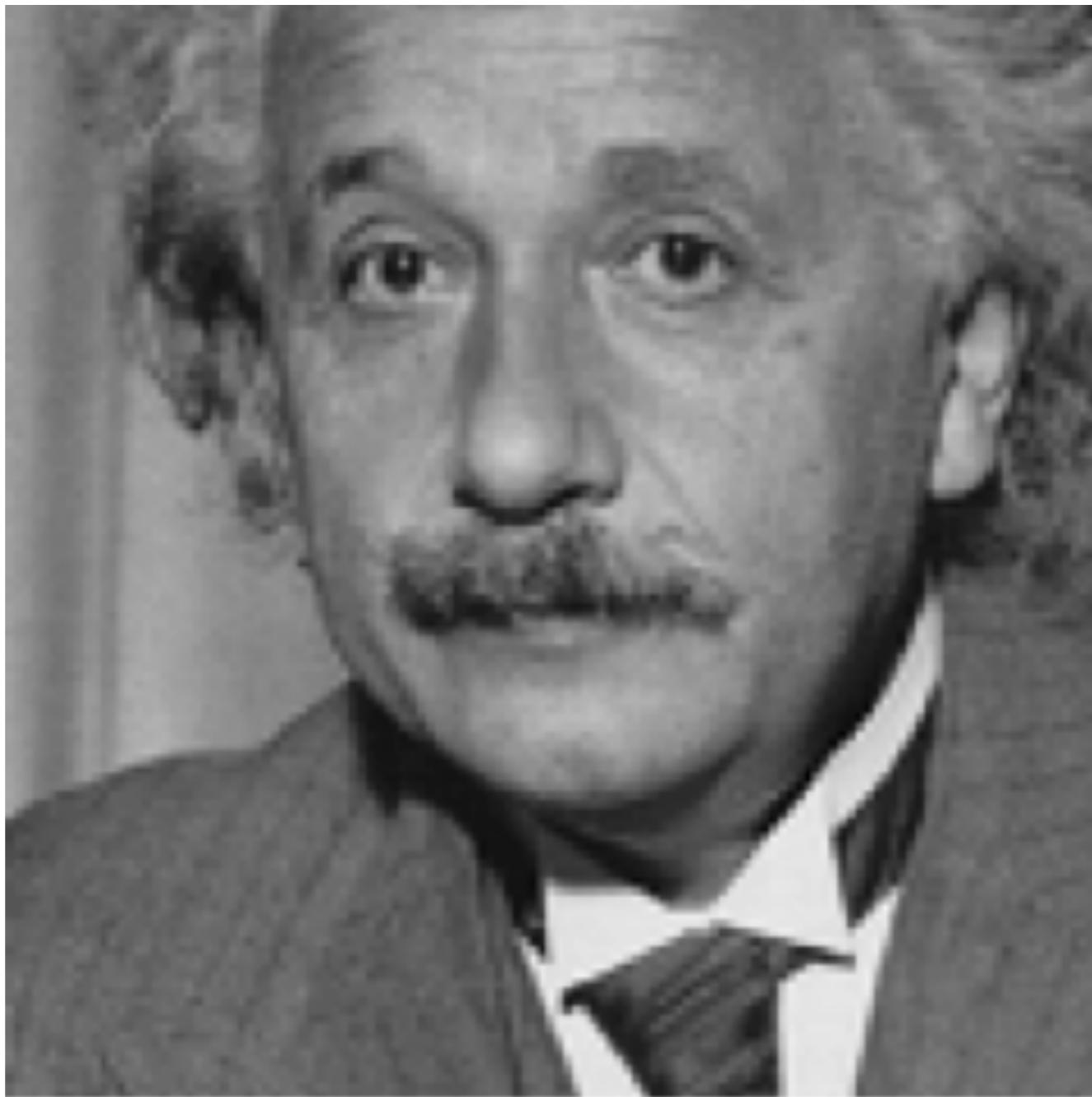


8-bit representation

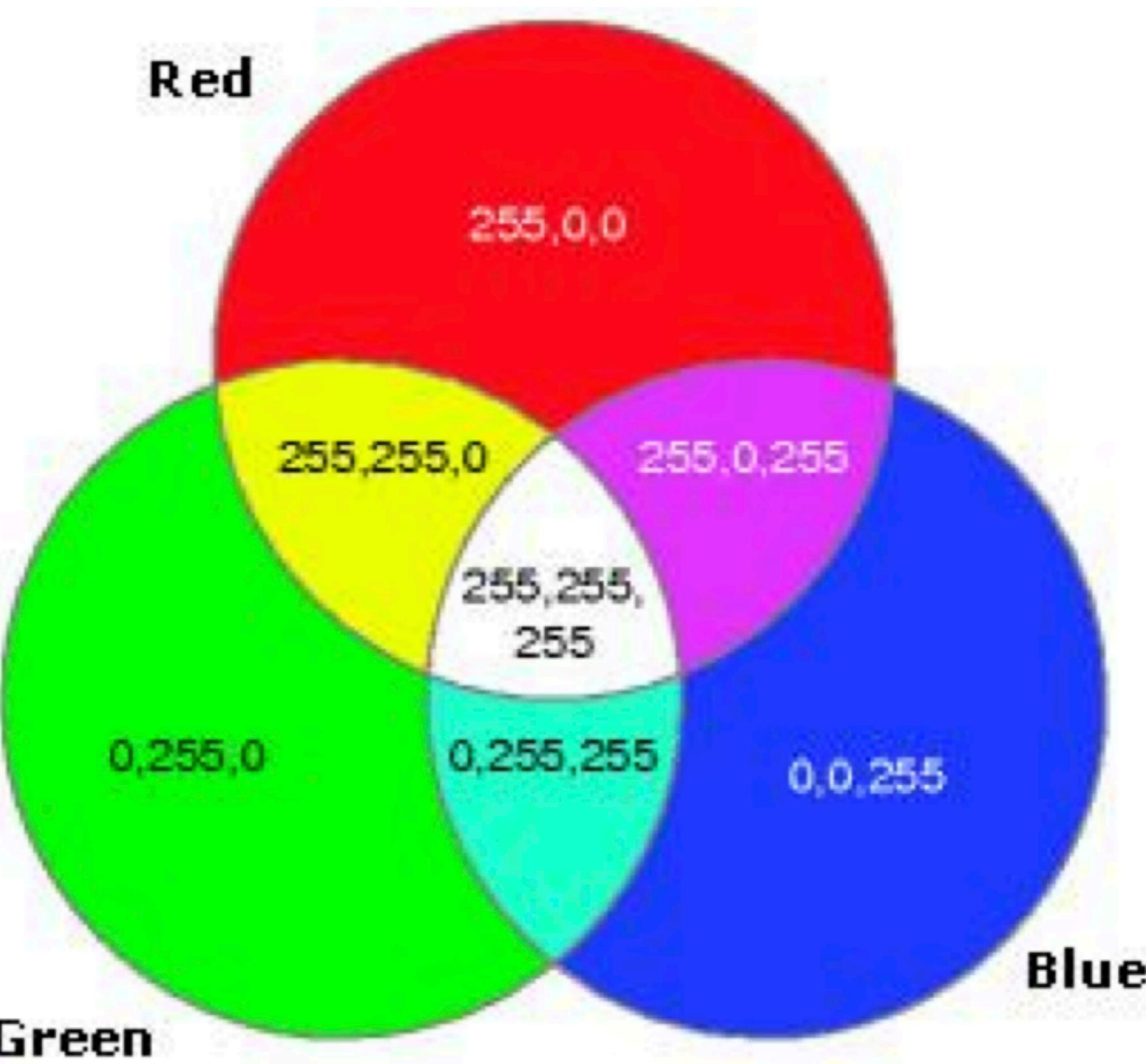
# Image Sensing and Acquisition



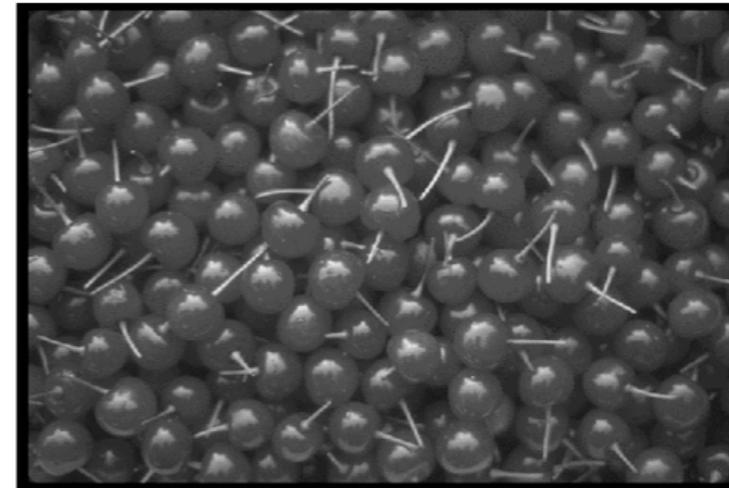
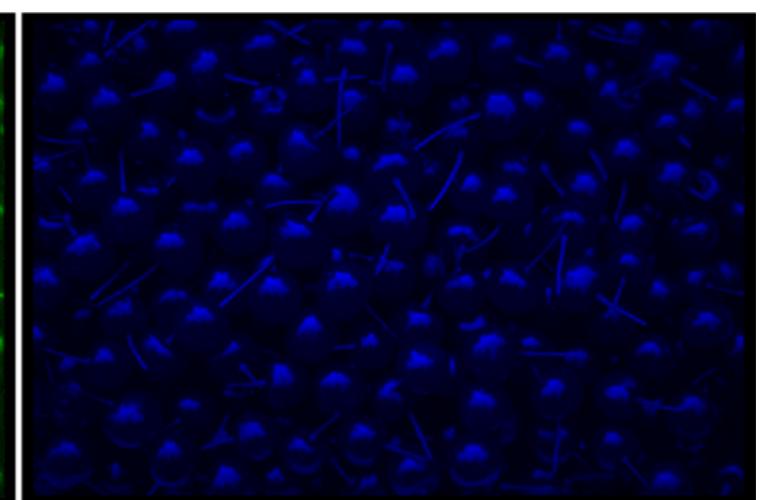
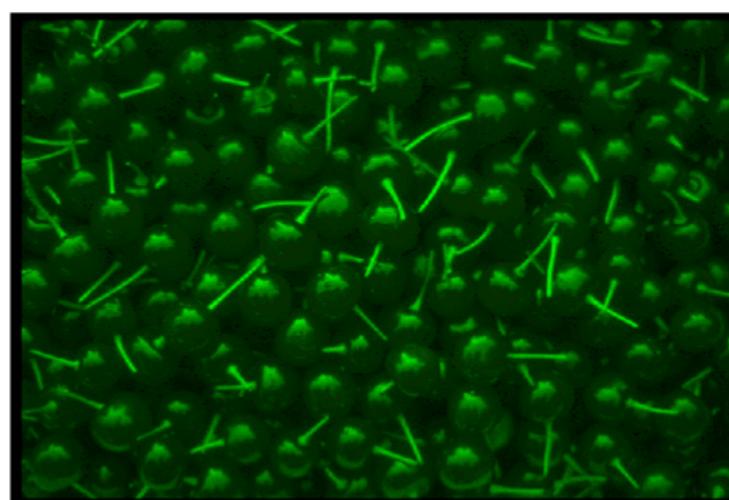
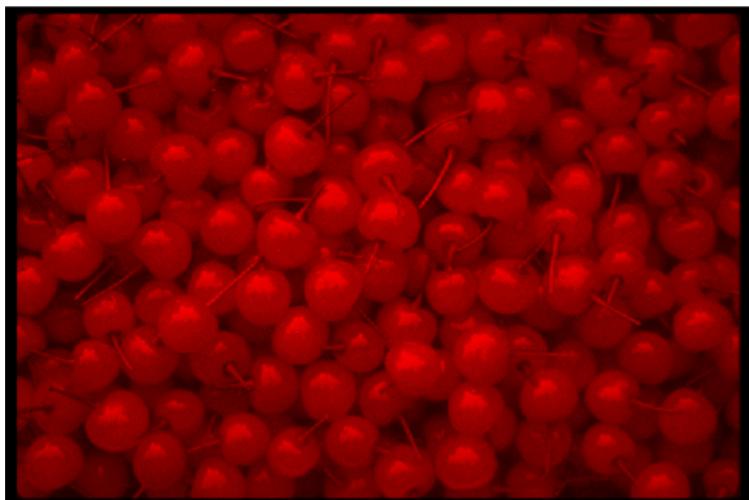
# A Gray Scale Image



# Color



# Color



# Color

- Important aspect of images
- Red, green and blue - basic components
- Colour image is a vector valued signal - R, G, B
- Typically, colour image processing happens either on the three components separately or on the intensity
- Can function without colour (?)
- Colour constancy: perceived colour of objects remain constant under varying illumination conditions

# Color: Can we function without it?

