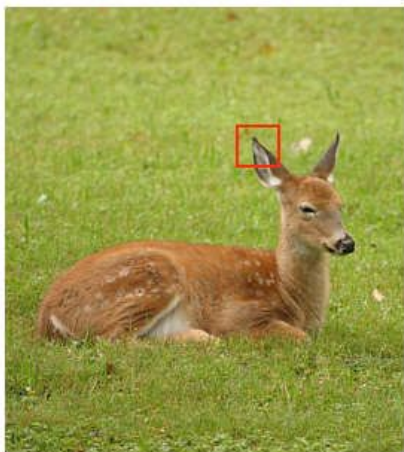


# FITS files and DS9

ASTR 2910 ★ Week 11

# Images as scientific data



Images are rectangular (2D) grids, with a value at each grid point (**pixel**).

0,0	0,1	0,2
1,0	1,1	1,2
2,0	2,1	2,2

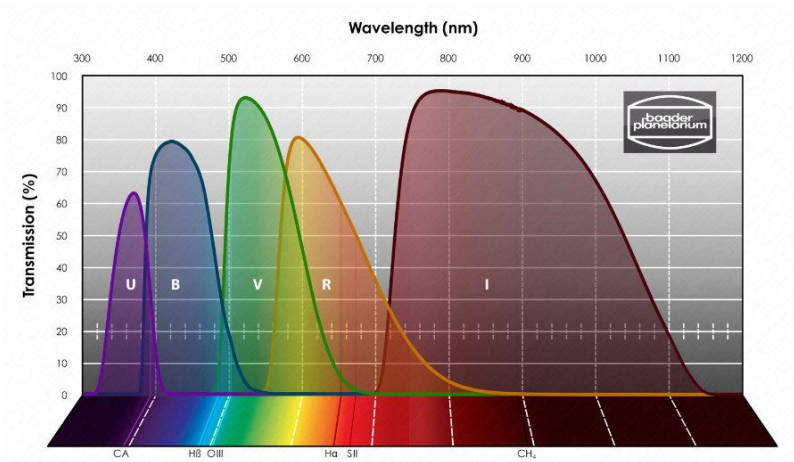
By convention, the top left pixel is (0,0).

To represent colors, we use **RGB format**: three integers describing the amount of red, green, and blue in each pixel.

# Images as scientific data

In astronomical images, pixel values represent **the number of photons that hit that pixel during the exposure time of the image.**

These measurements need to be calibrated/converted to magnitudes.



Most astronomical images are taken with photometric filters, which select portions of the EM spectrum.

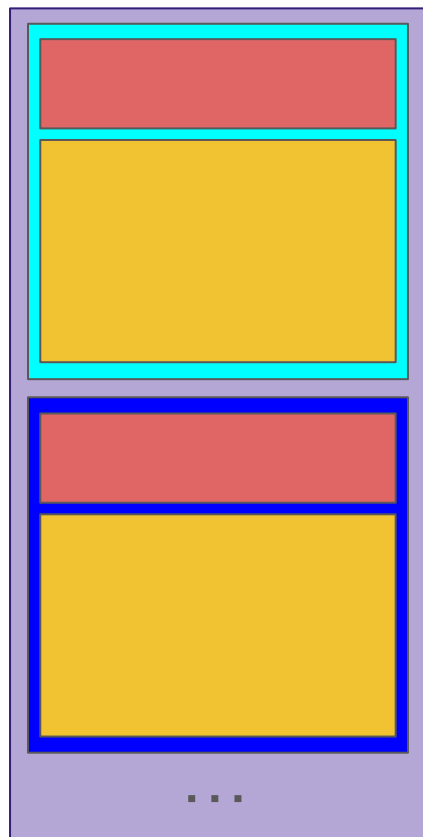
3 different filters  $\rightarrow$  “RGB” image!

# Introduction to FITS

FITS = **F**lexible **I**mage **T**ransport **S**ystem ([docs](#))

- Developed in the 1980s to make sharing astronomical data easier; now the **most ubiquitous** file type in astronomy
- Designed specifically for storing scientific data alongside relevant metadata like coordinate systems, observing conditions, other notes
- Not just an image format! Can store tables, multiple extensions, etc

# FITS file structure



FITS file = **list** of “Header Data Units” (HDUs)

Each HDU consists of:

1. **Header**: Keyword-value pairs
2. **Data unit**: Image data (2D array of ints or floats) or some other approved data format

The **primary HDU** (listed first) must contain a 2D array.  
**Subsequent HDUs** (“extensions”) can contain tables, etc.

To figure out the structure: read documentation, examine the header, and/or ask around!

# Demo: Reading FITS files with Python

# SAOImageDS9

## DS9 = Image viewer for FITS files

- Developed in the 1990s, now a ubiquitous tool in astronomy
- Great for quick visual checks, preparing for observations, making color images, and more
- Capabilities:
  - Loading images
  - Changing color scales
  - Zooming and panning
  - Viewing header info
  - Region definitions and measurements
  - Much more! (see [docs](#))

# Activity: Measuring stars in DS9



# Activity description

1. Download images of M103 from Courseworks. Each group member should download a different filter (g, r, i).
2. Using DS9, measure the brightnesses of at least 5 stars in each filter. Coordinate with your group to make sure you're measuring the same stars and using the same Circle radius! To measure stars:
  - a. Make sure Edit > Region is enabled
  - b. Region > Shape > Circle
  - c. Draw circles around the stars and double-click
  - d. Analysis > Statistics > sum gives you the brightness
3. Enter your measurements in the DS9 section of the `fits_ds9` notebook and run the cells to make plots.
4. Be prepared to share your results with the class!