These notes may contain copyrighted material!

They are for your own use only during this course.

Distributing them in anyway will be considered a breach of the Texas Tech academic integrity policy.

ASTR 2401

Filters

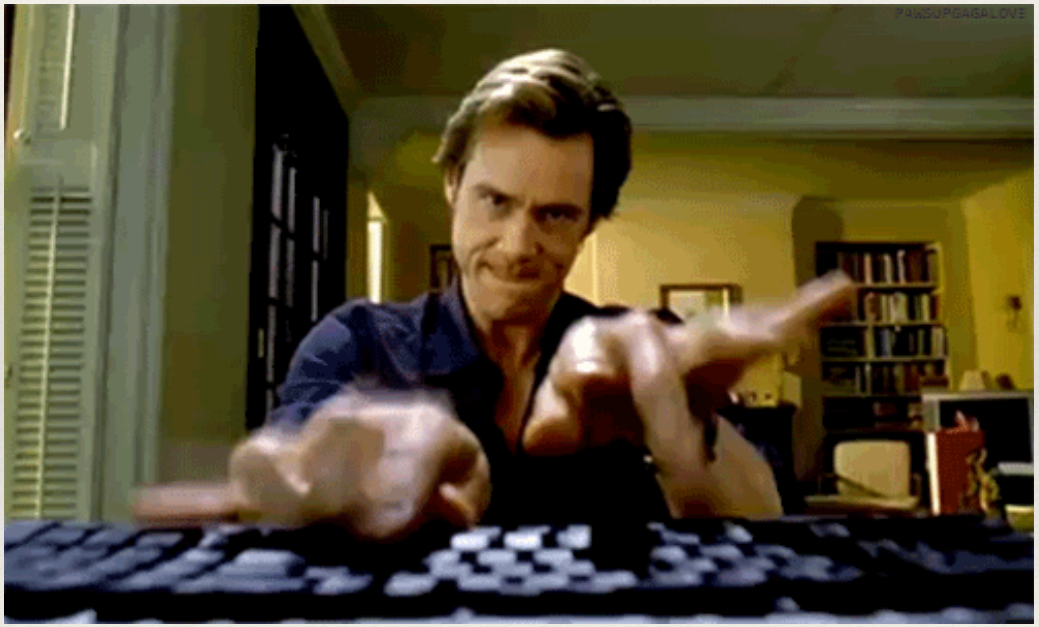
Observational Astronomy

Agenda

- Weather for Tonight
- Semester Project Proposal
- Lab/Observing Notebook Due Friday 09/30 by 4:25 PM
  - Cutoff TBD
- Lecture:
  - Problems with Images
  - Filters

Semester Project Proposal

- 2-page double spaced (12pt font 1-inch margins)
- Must contain:
  - Scientific background
  - Observational techniques to be used
  - Targets to be observed
  - Equipment (telescopes, CCDs, filters, etc.)
  - Plan for data reduction/analysis
  - At least two peer-review references cited
- Due in class October 4th



Problems with your Data

So what will the data look like when things go wrong?

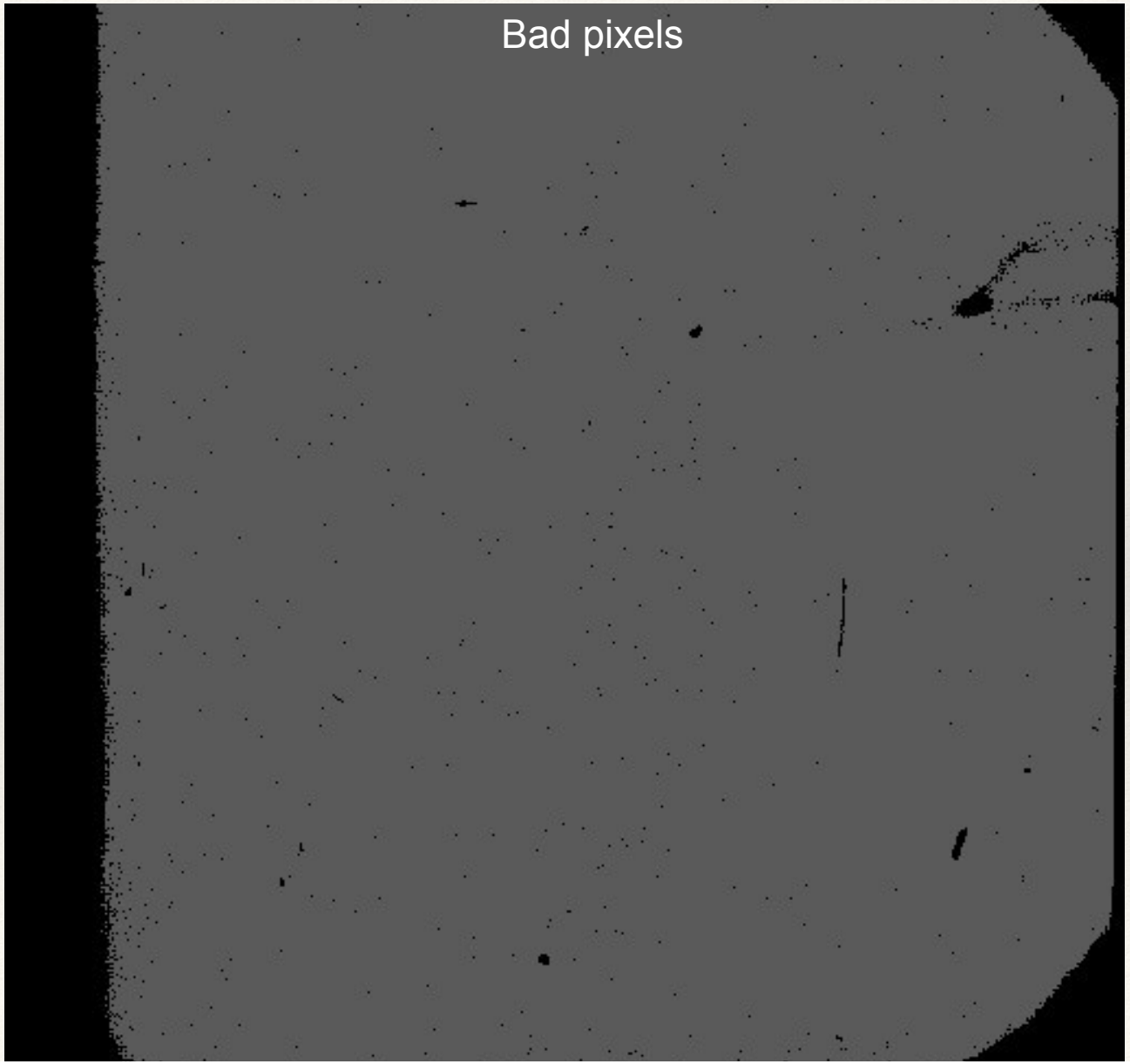
Defects that are always present:

- Bad Pixels
- Cosmic Rays
- Bleed Trails

More serious issues

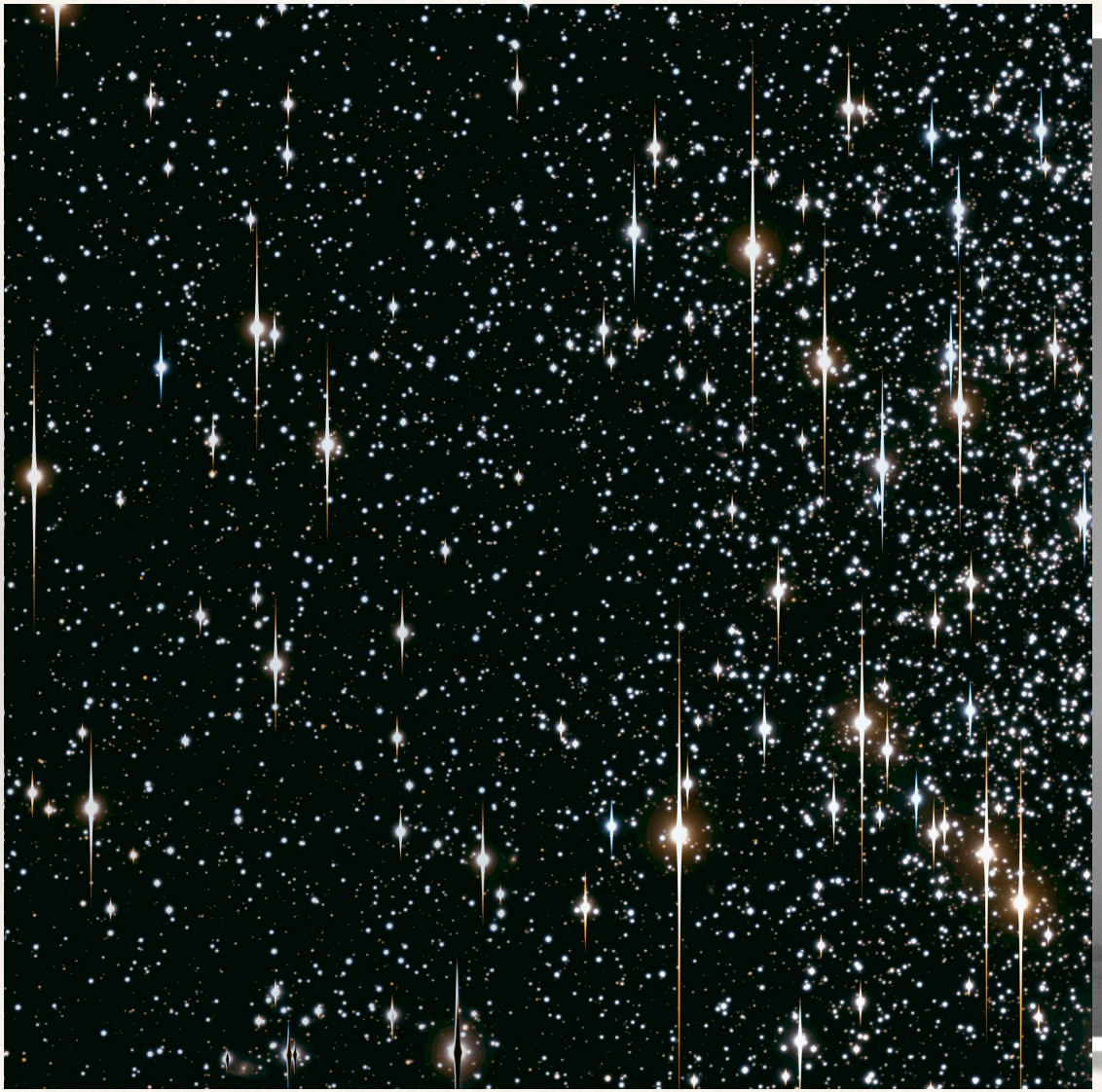
- Saturated Image
- Vignetting (sometimes unavoidable)
- Out of Focus
- Bad Tracking
- Scattered light

Problems with your Data



Problems with your Data

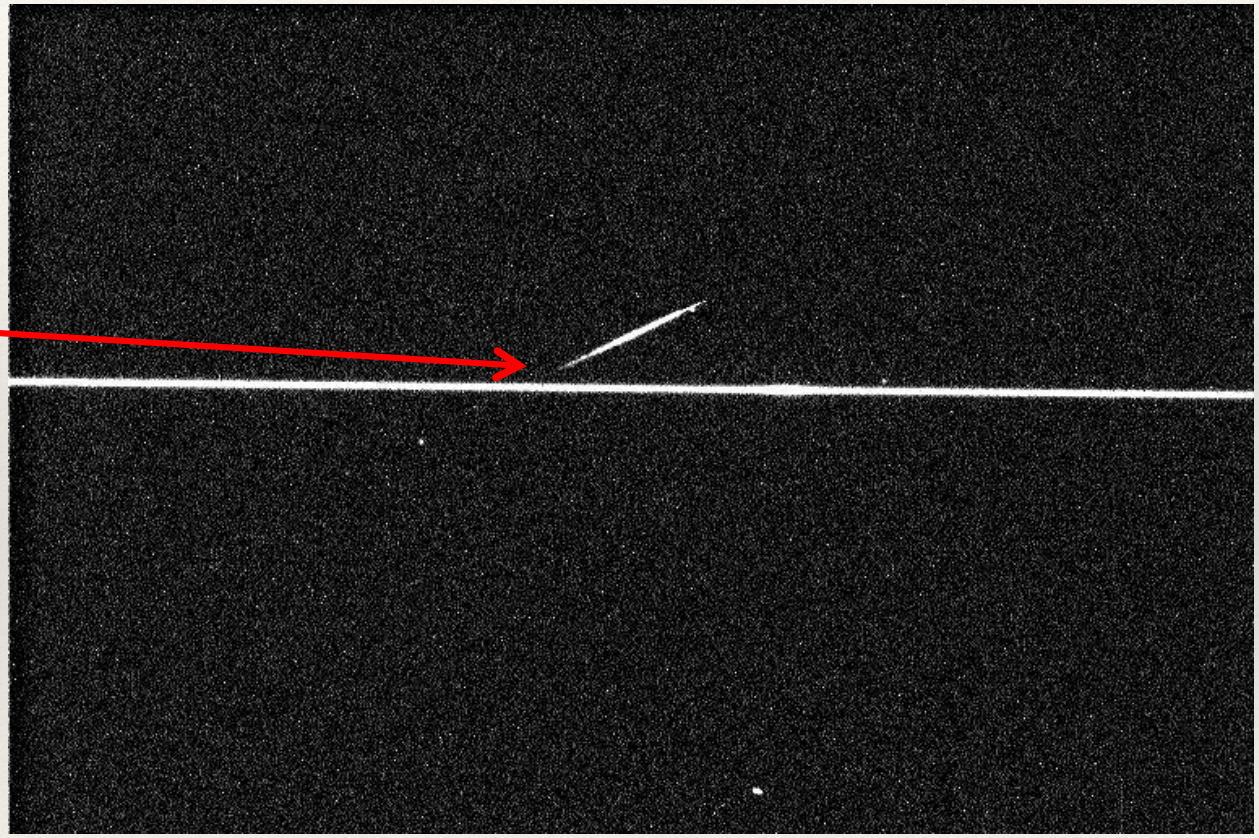
Bleed Trails



Credit: Kurtis Williams

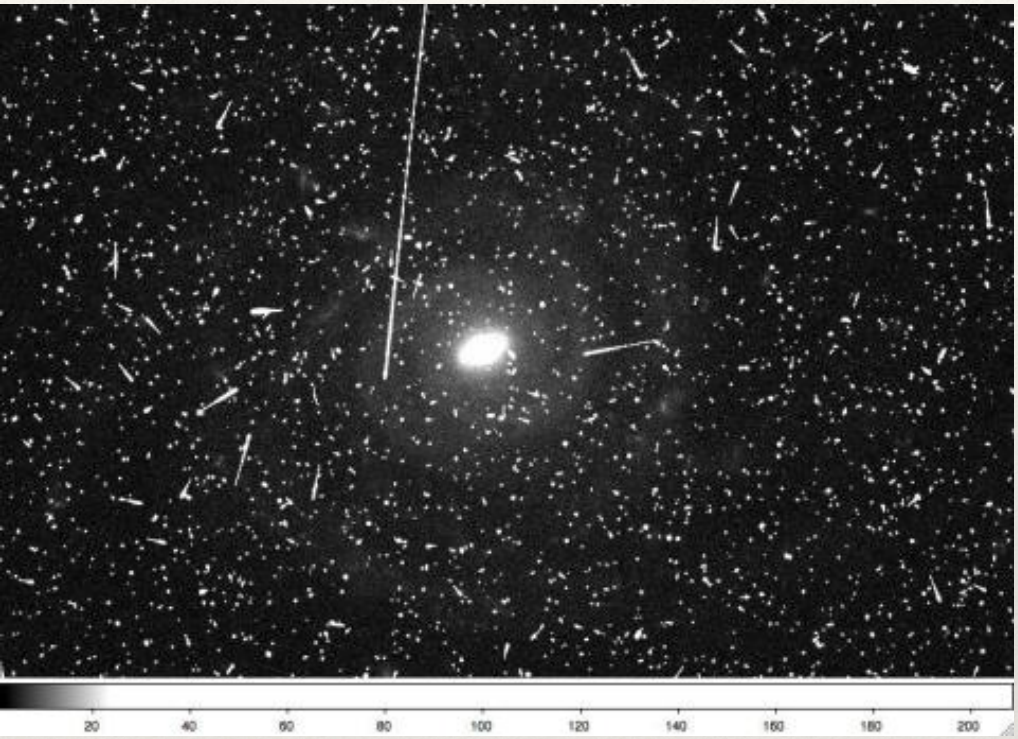
Problems with your Data

Cosmic Rays

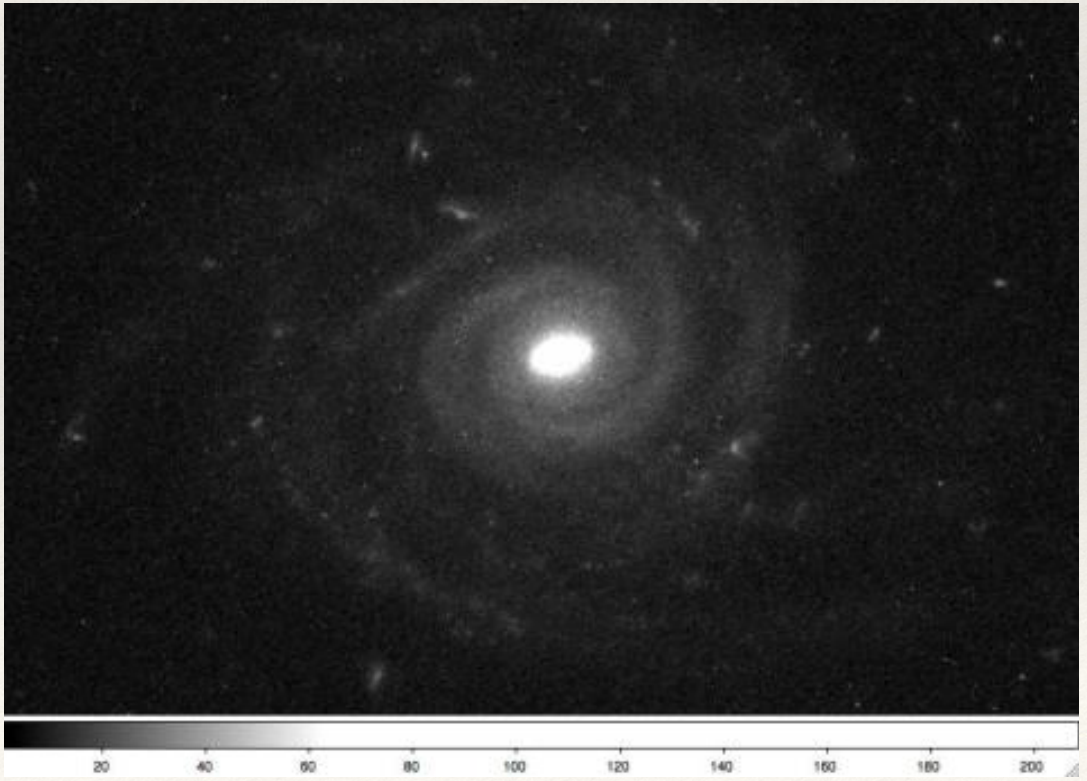


Problems with your Data

Cosmic Rays

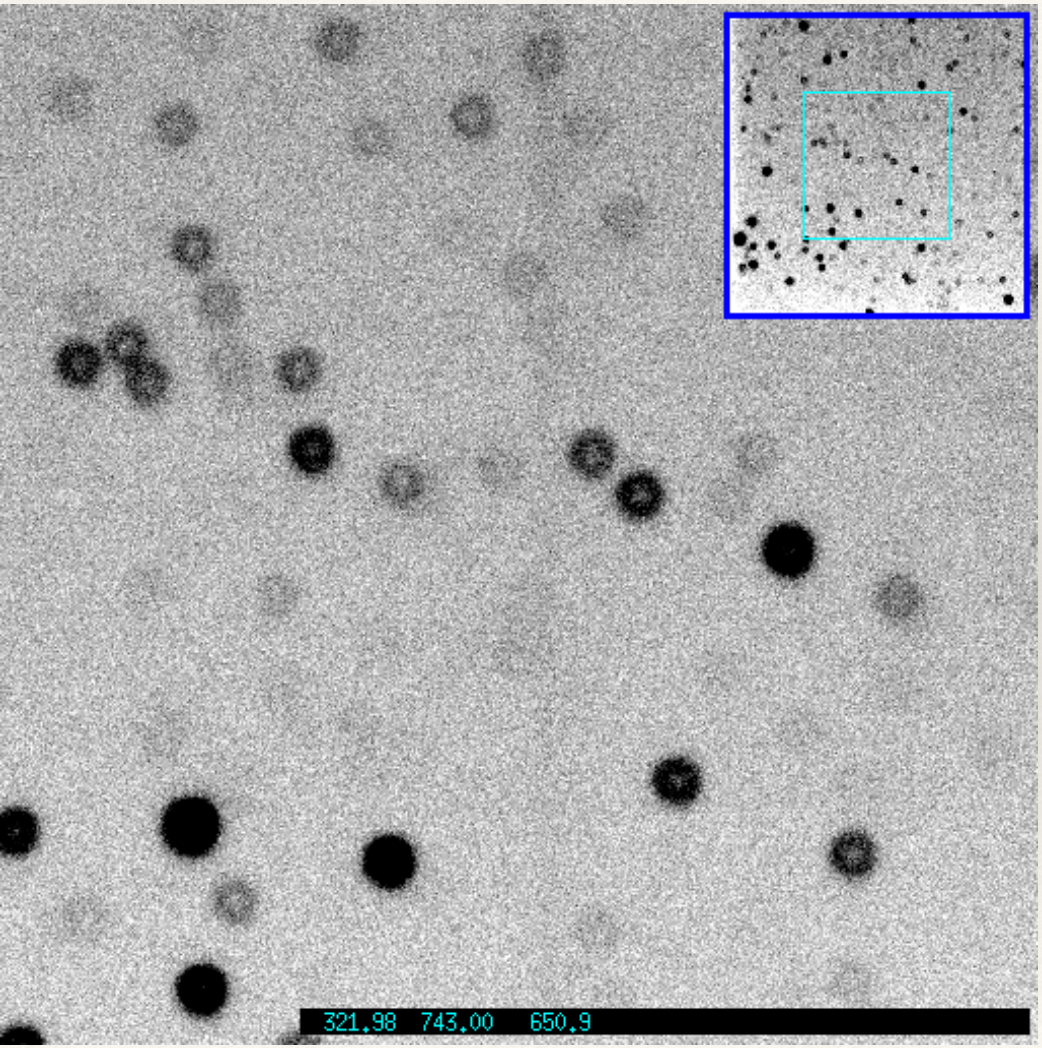


Courtesy: http://blog.galaxyzoo.org/2010/04/12/how-to-handle-hubble-images/

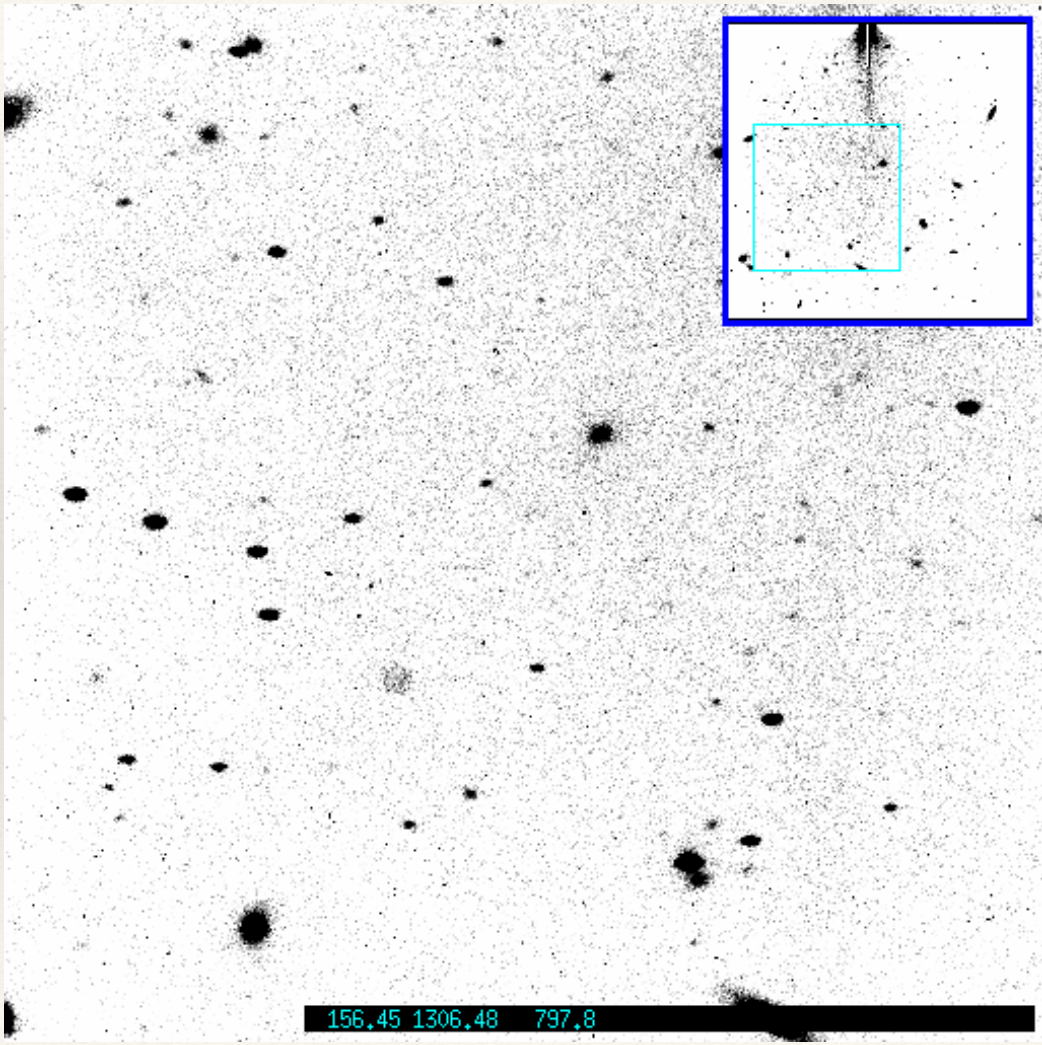


Problems with your Data

Out of focus



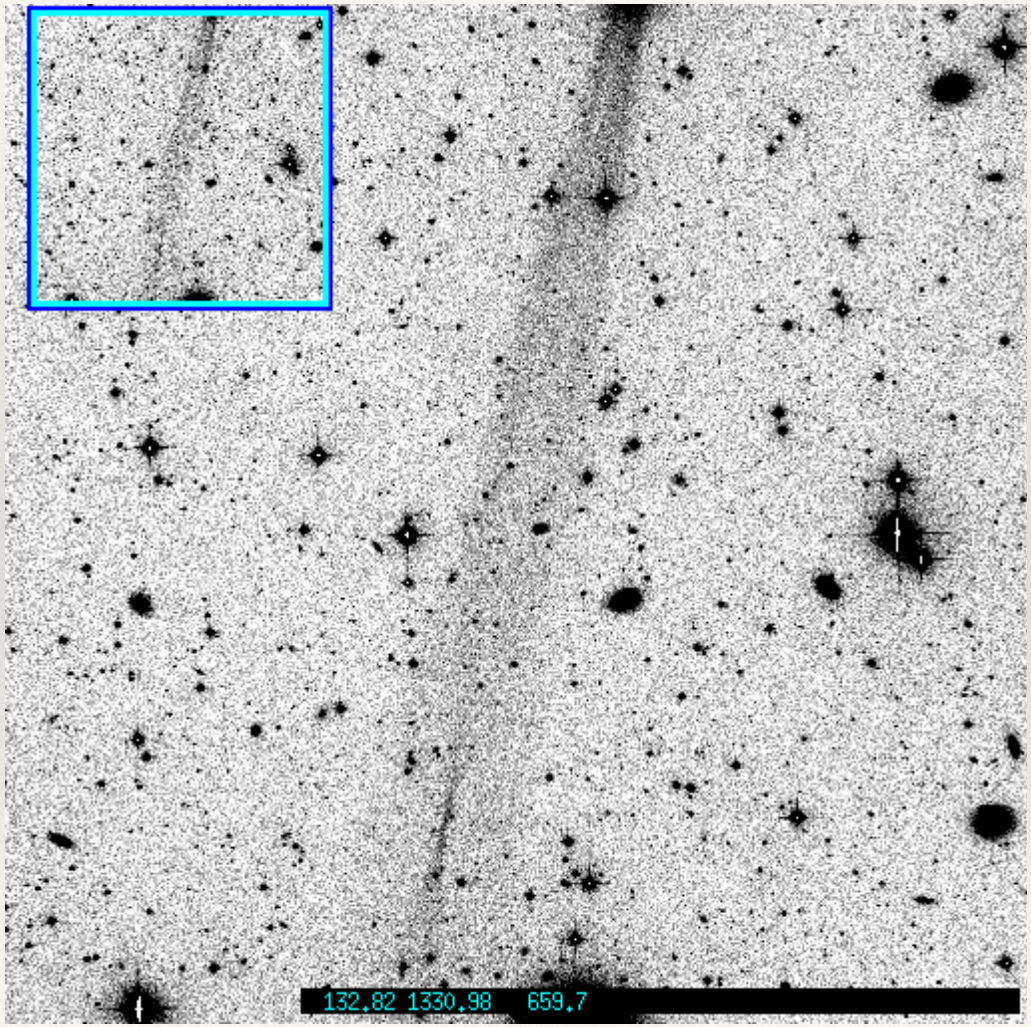
Bad tracking



Courtesy http://www.dtm.ciw.edu/vonbraun/obs_mishaps/mishaps.html

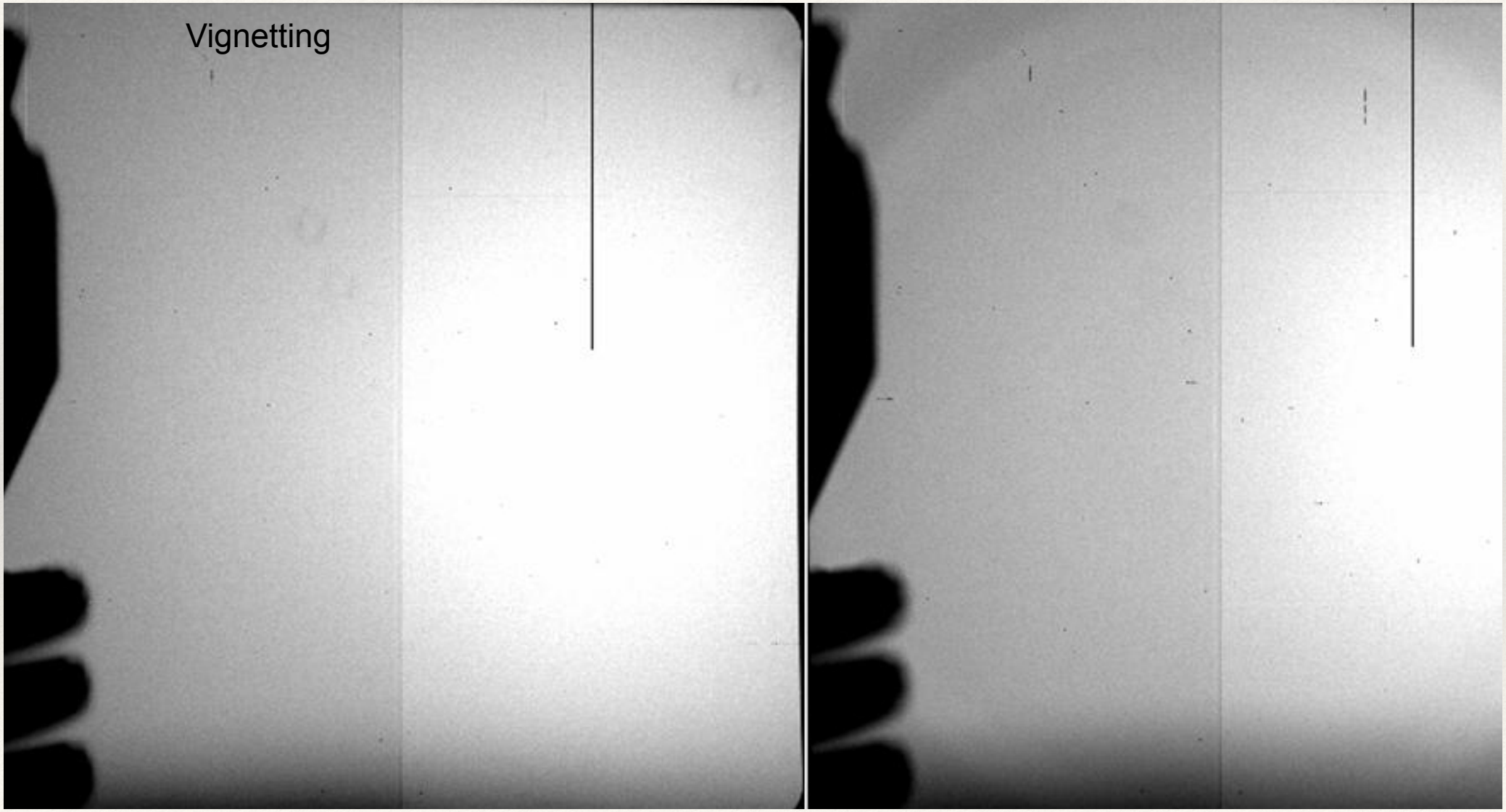
Problems with your Data

Scattered Light



Courtesy http://www.dtm.ciw.edu/vonbraun/obs_mishaps/mishaps.html

Problems with your Data



Filters

http://wfc3.gsfc.nasa.gov/art2/gallery_images/filter-images/ir-wheel.jpg

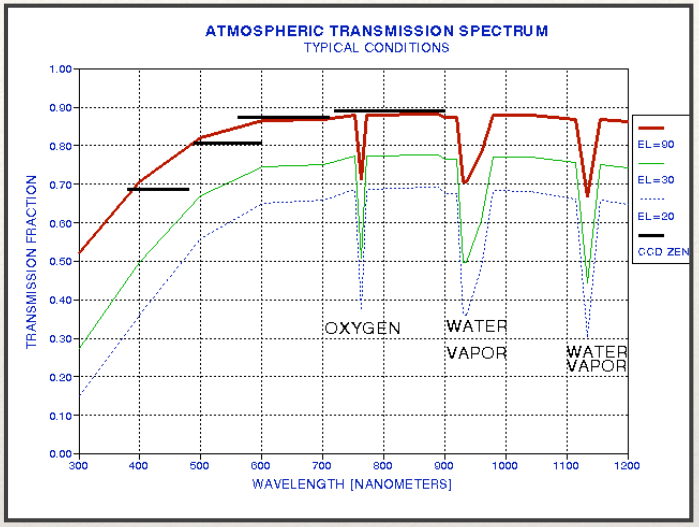
Filters

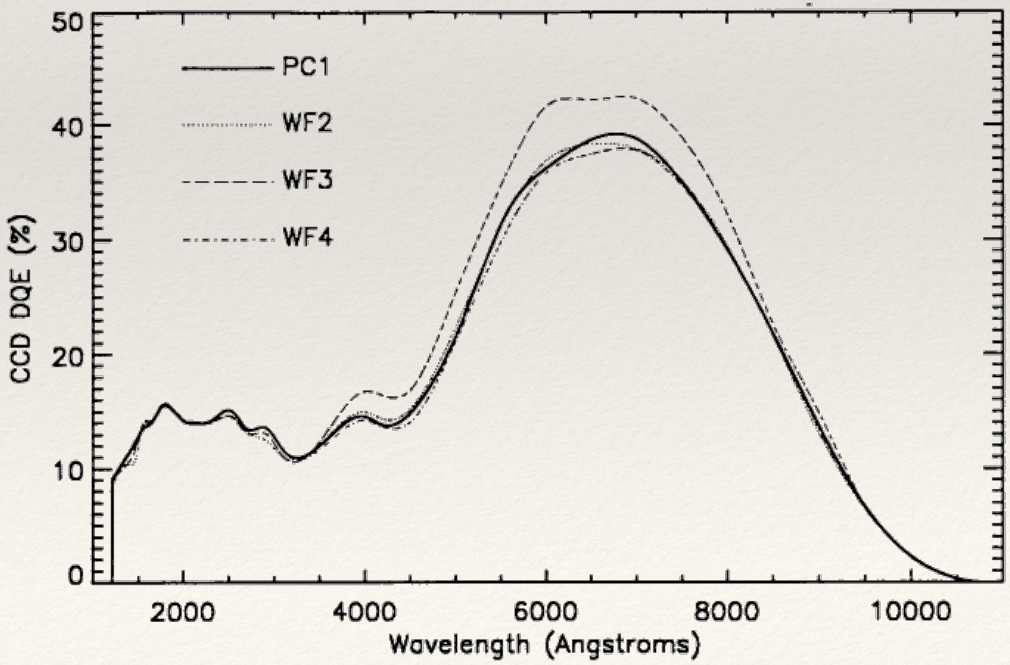
Filters are optical elements designed to transmit only certain wavelengths of light.

They are defined by their **central wavelength** and **bandwidth** (how wide a range of wavelengths the transmit).

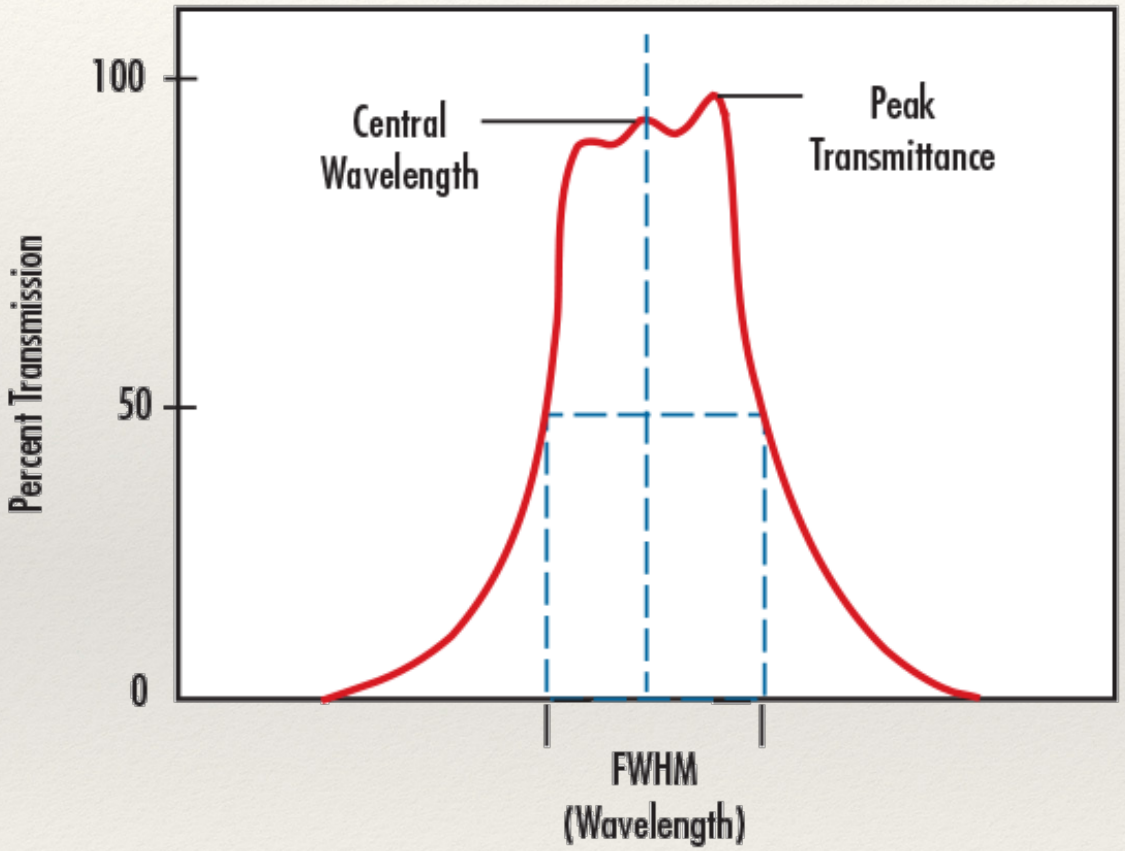
Without a filter, all light that passes through telescope hits detector.

Amount of light then determined by QE of detector, and transmission of optics and the atmosphere.





Filters



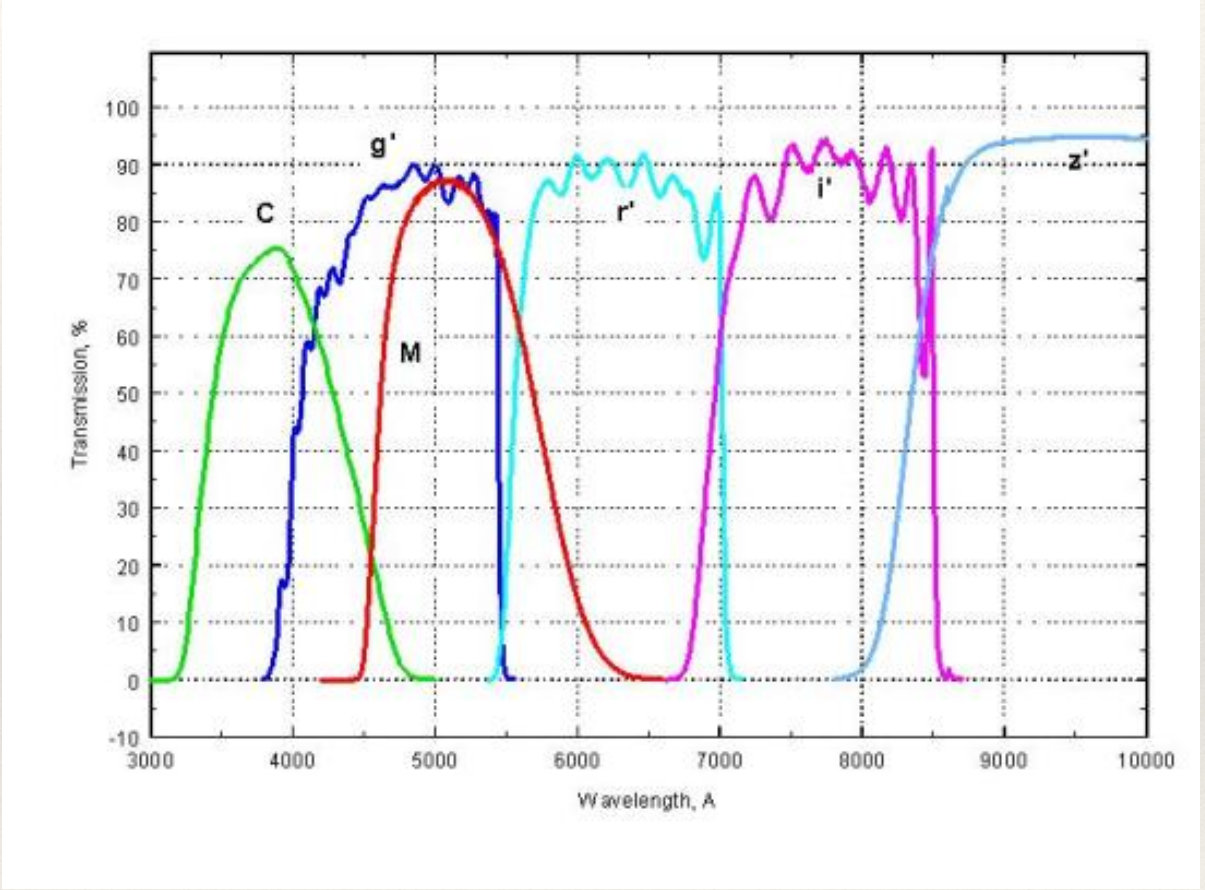
Bandwidth is usually defined as the full with at half maximum (FWHM)

Filters

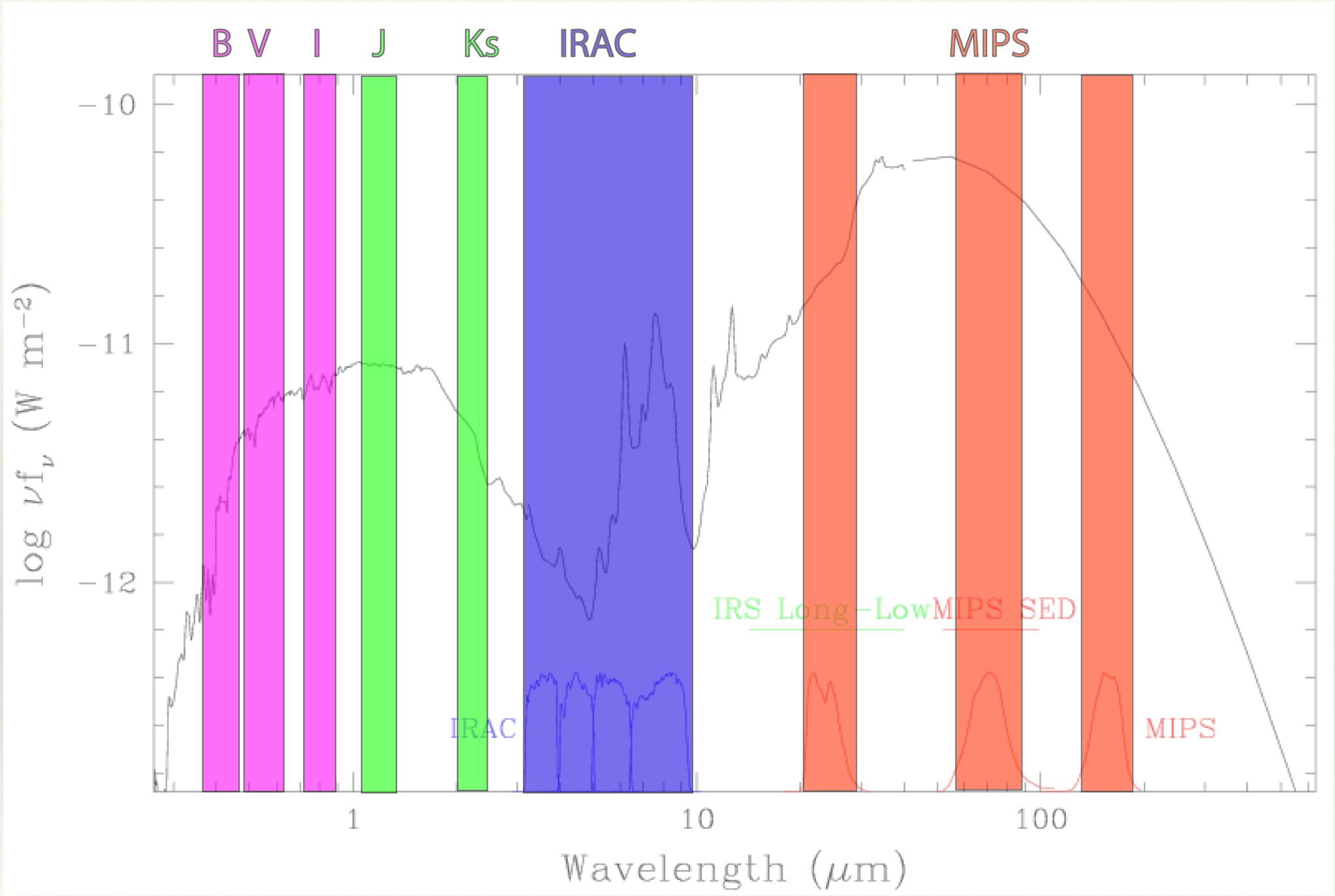
The point of filters is to allow you to observe only certain wavelengths of light at a time.

Provides color information

Enables analysis of physical properties of objects.

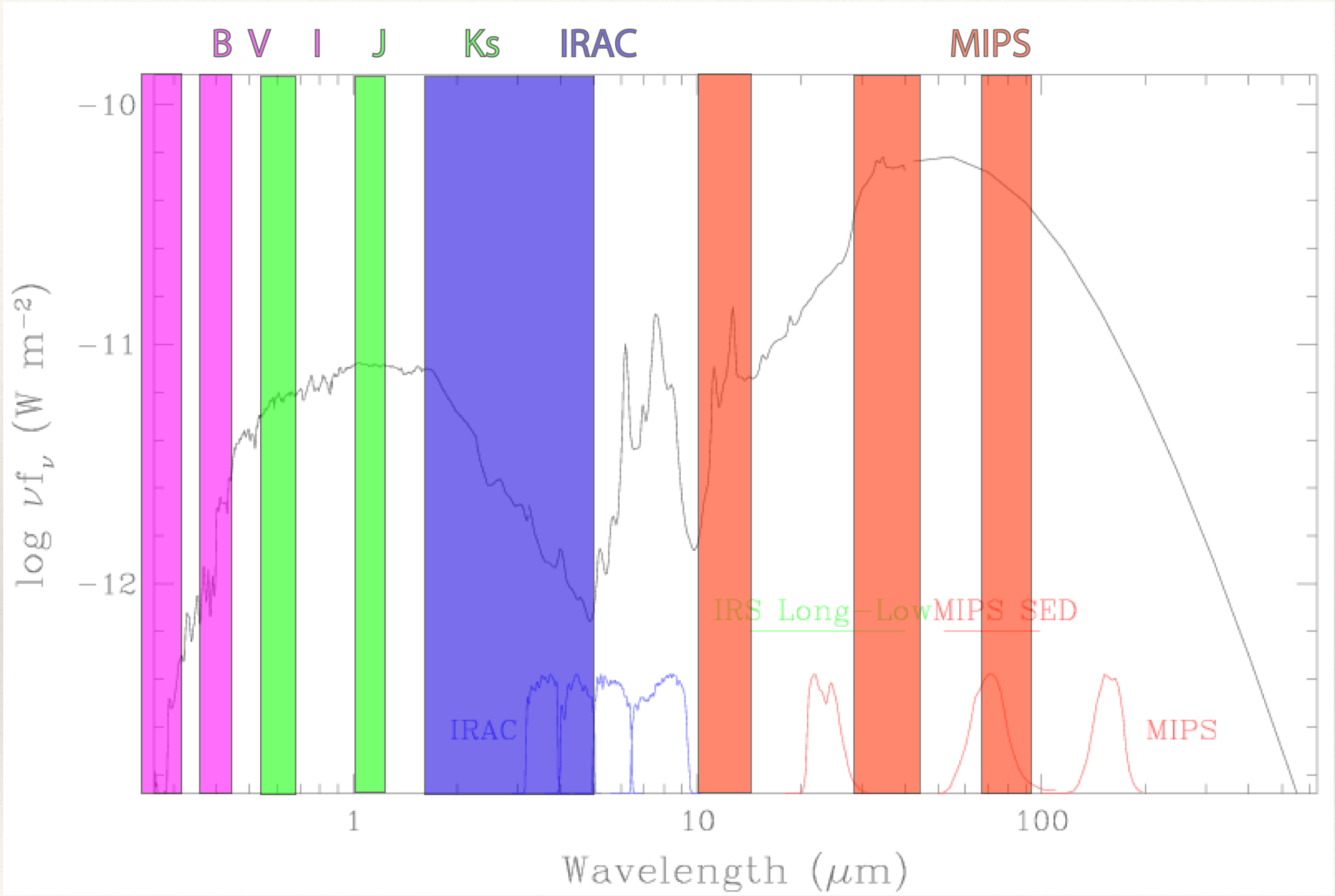


www.noao.edu/kpno/mosaic/filters



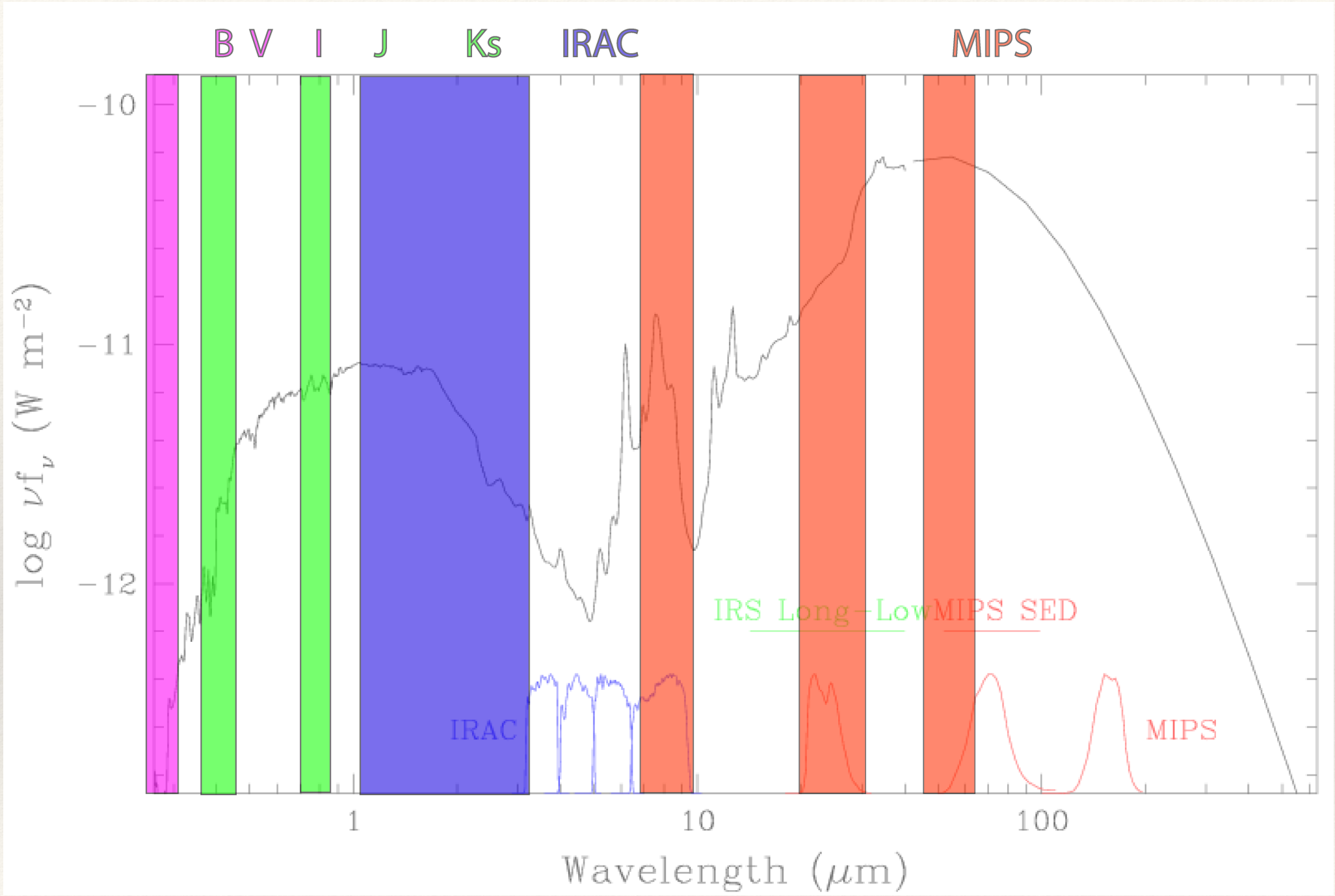
z=0

M82 (http://sings.stsci.edu)



z=1

M82 (http://sings.stsci.edu)



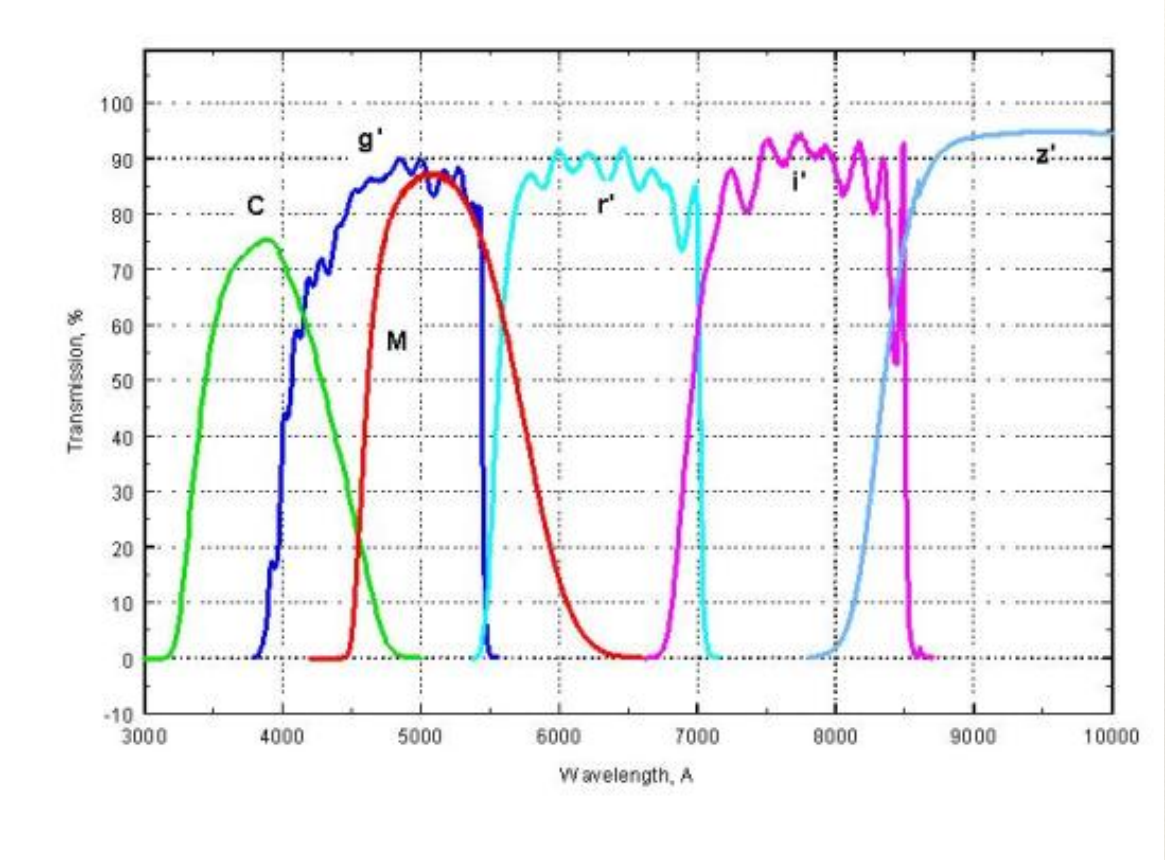
z=2

M82 (http://sings.stsci.edu)

Filters

There are a host of different filters used in astronomy, typically defined based upon some combination of the physics being studied and atmospheric transmission.

- For all filters one can define a *resolution,*
  - $R = \lambda/\Delta\lambda$
- Filters are generally considered "broad", "medium", or "narrowband" depending upon the resolution.
- Very Rough Guide
  - Broad: R<10
  - Medium: R~10-50
  - Narrow: R>50

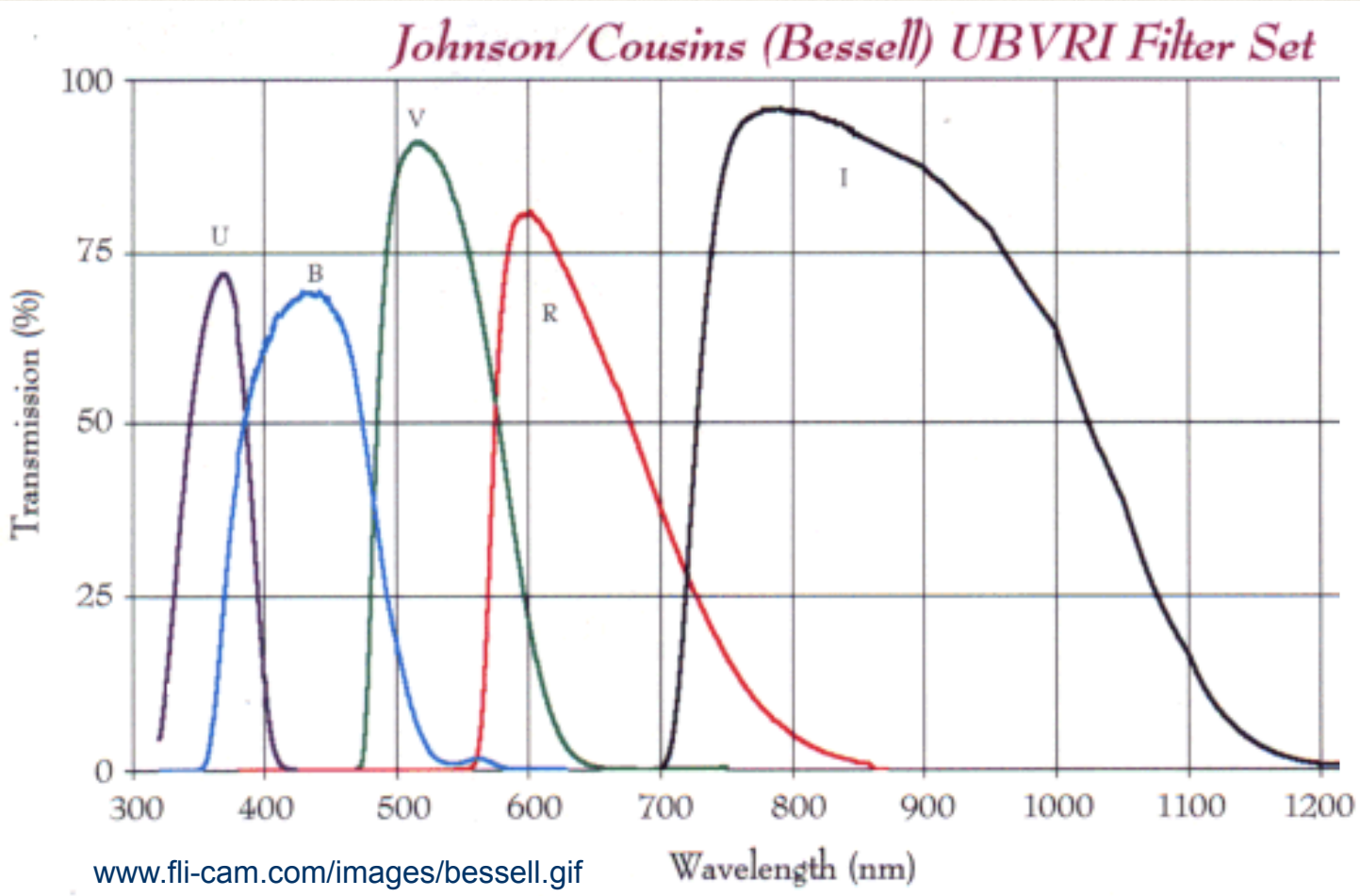


www.noao.edu/kpno/mosaic/filters

Broadband Filters

Johnson-Cousins Filter Set

- UBVRI
- Classical filter set
  - Ultraviolet (U)
  - Blue (B)
  - Visible (V)
  - Red (R)
  - "Infrared" (I)
- Optical and very near IR
- Wavelength cutoffs not very sharp

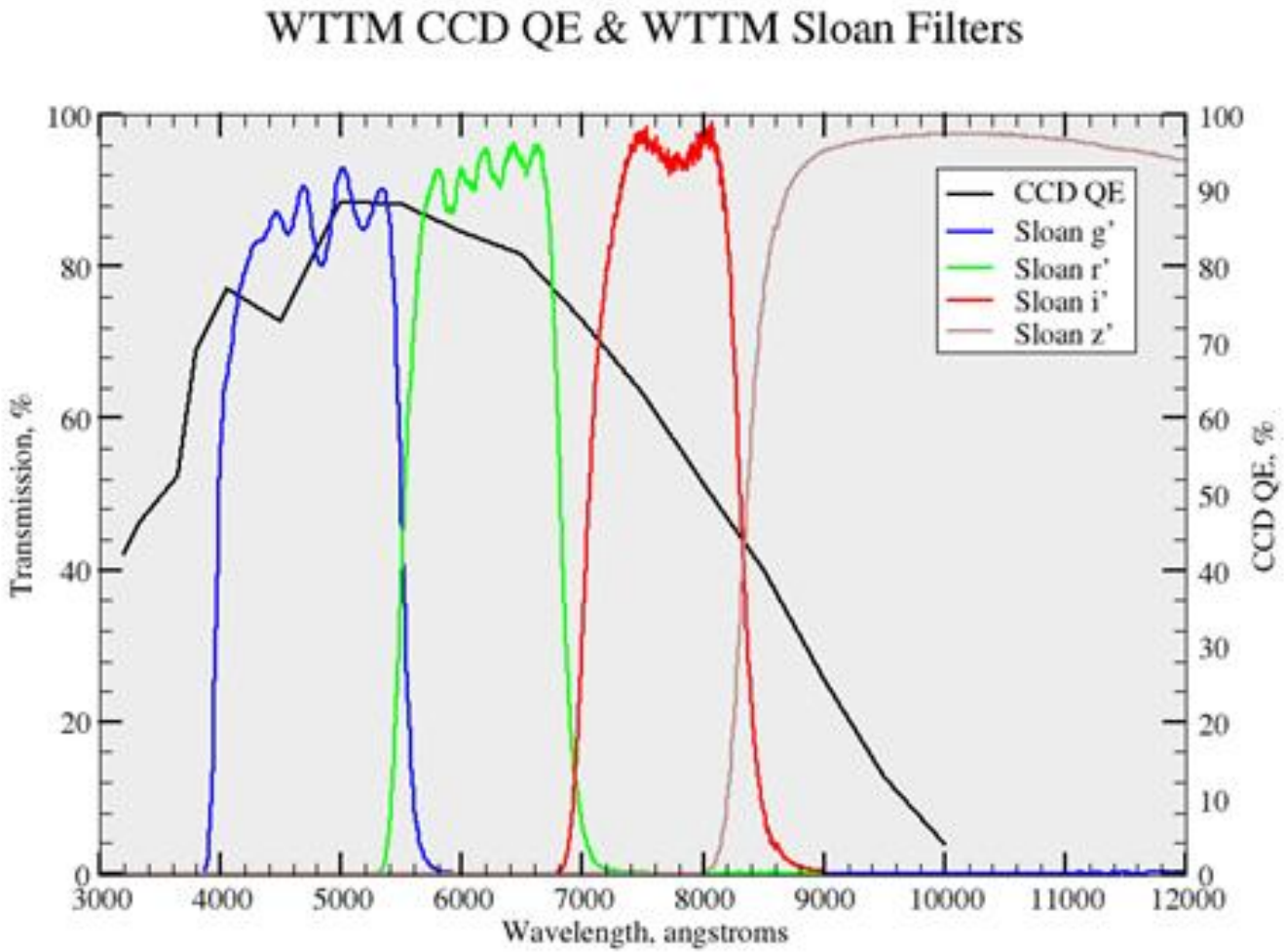


www.fli-cam.com/images/bessell.gif

Broadband Filters

Sloan Filter Set

- g′r′i′z′
- Relatively new
- Sharp cutoffs
- Used for Sloan Digital Sky Survey
- Optical and very near IR
- No red cutoff for z′



www.noao.edu/kpno/wiyn

http://wfc3.gsfc.nasa.gov/art2/gallery_images/filter-images/ir-wheel.jpg

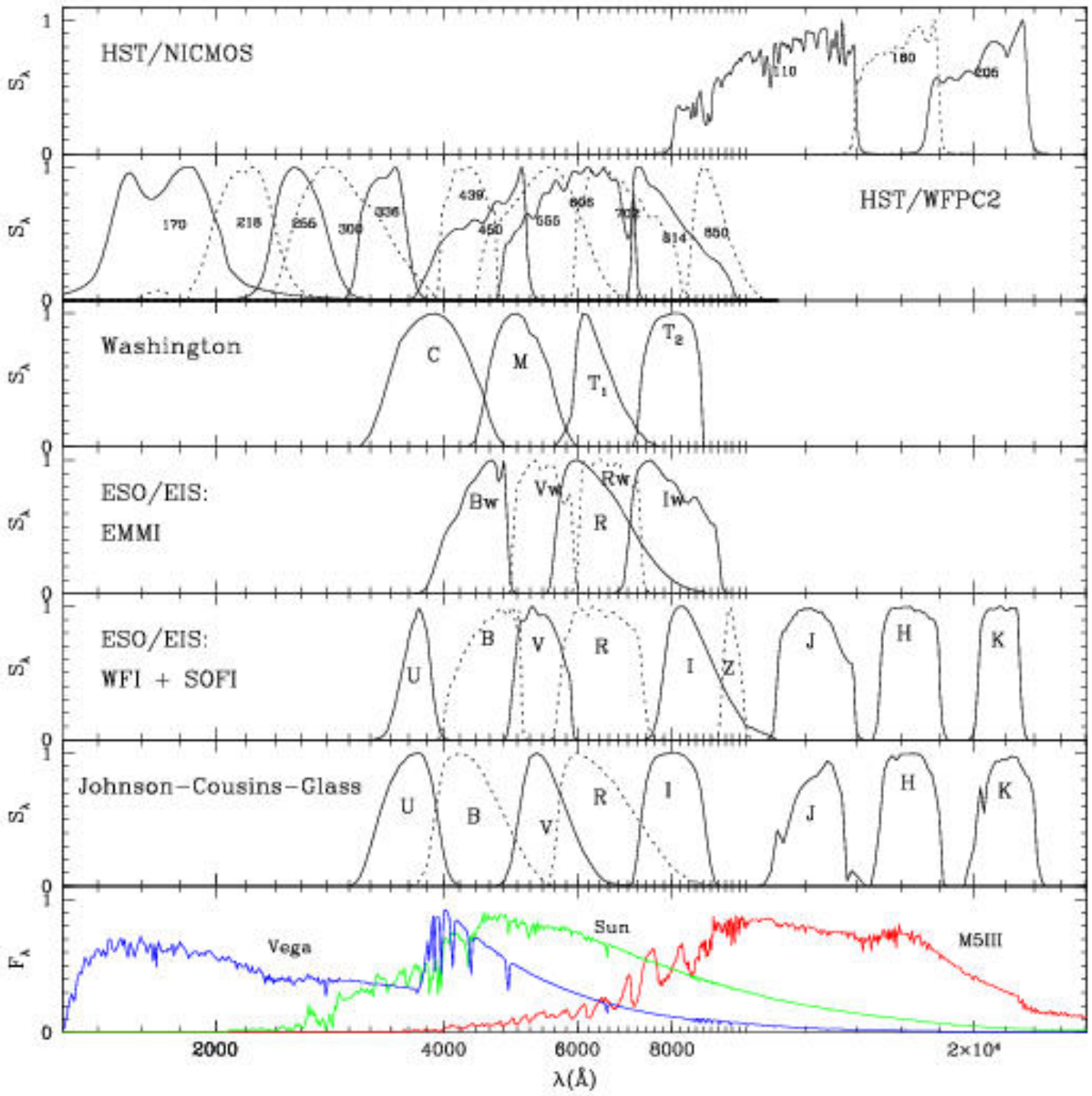
Many Different Systems

Kron

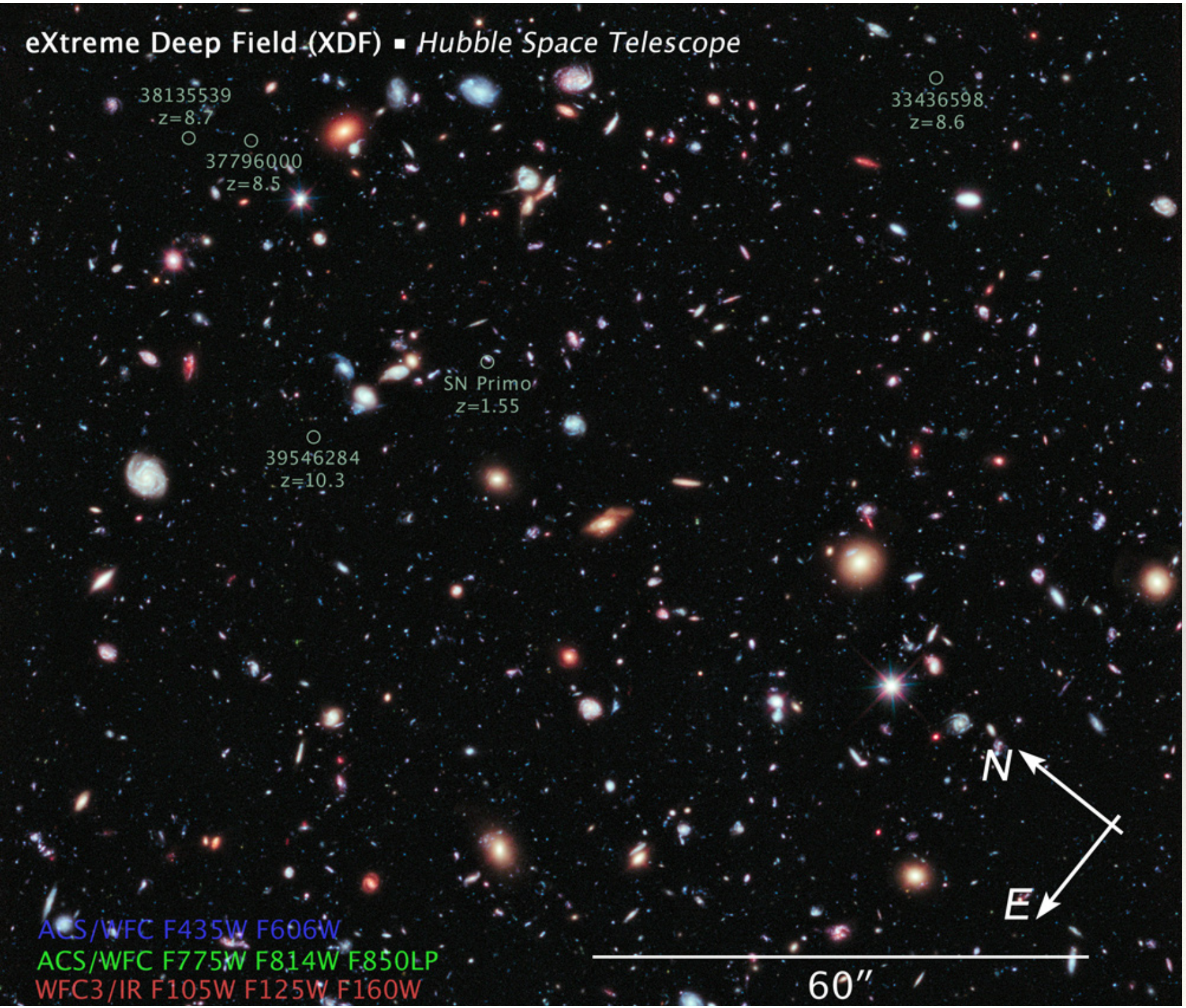
Washington

...

Even filters on the same system will have slightly different transmission



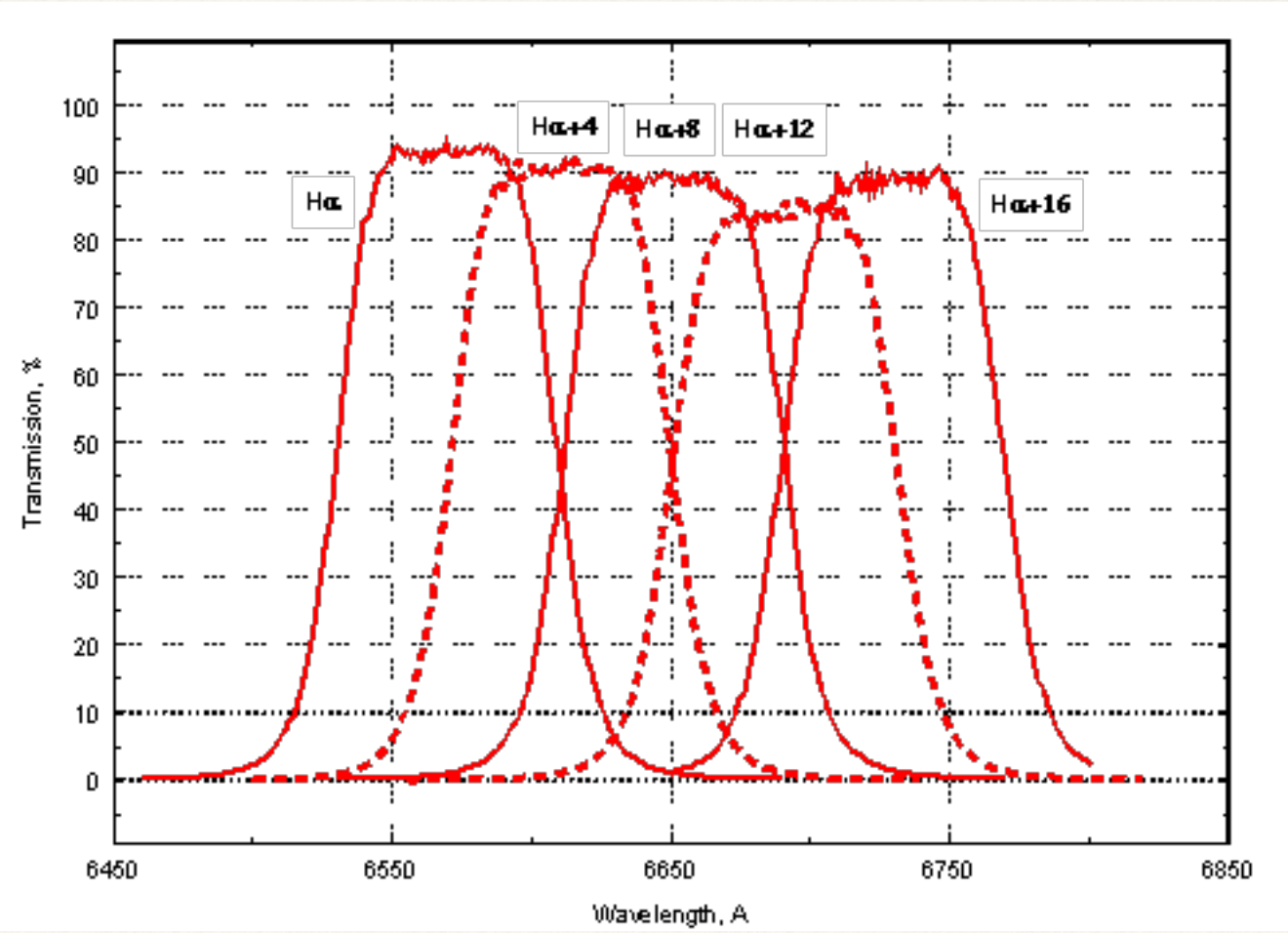
http://pleiadi.pd.astro.it/isoc_photsys.00/filters1.jpg


eXtreme Deep Field (XDF) ▪ *Hubble Space Telescope*
38135539
z=8.7
37796000
z=8.5
33436598
z=8.6
SN Primo
z=1.55
39546284
z=10.3
N
E
60″
ACS/WFC F435W F606W
ACS/WFC F775W F814W F850LP
WFC3/IR F105W F125W F160W

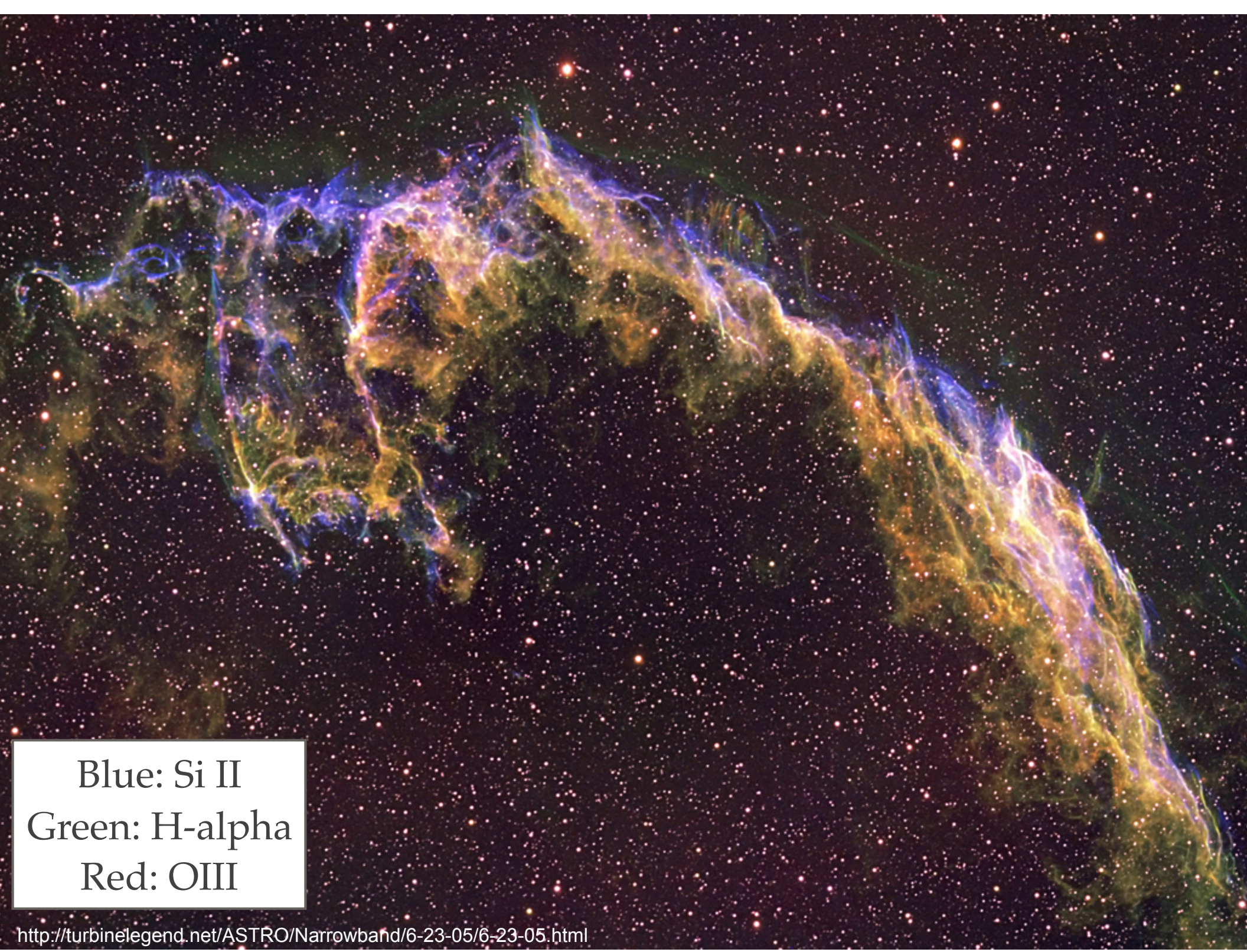
Narrowband Filters

Typically target specific emission lines

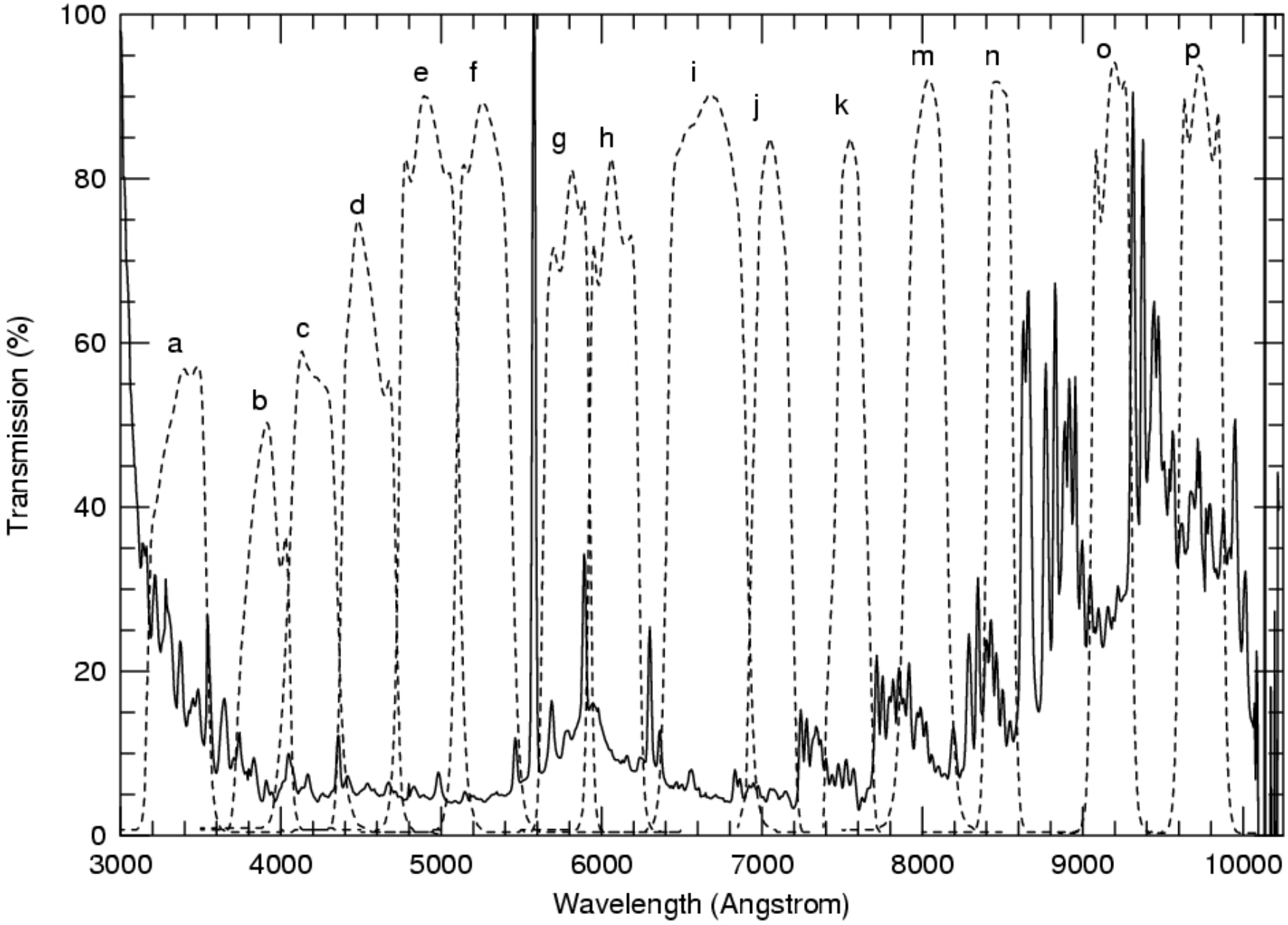
- H-alpha
- Lyman-alpha
- OII
- OIII
- etc...



www.noao.edu/kpno/mosaic/filters



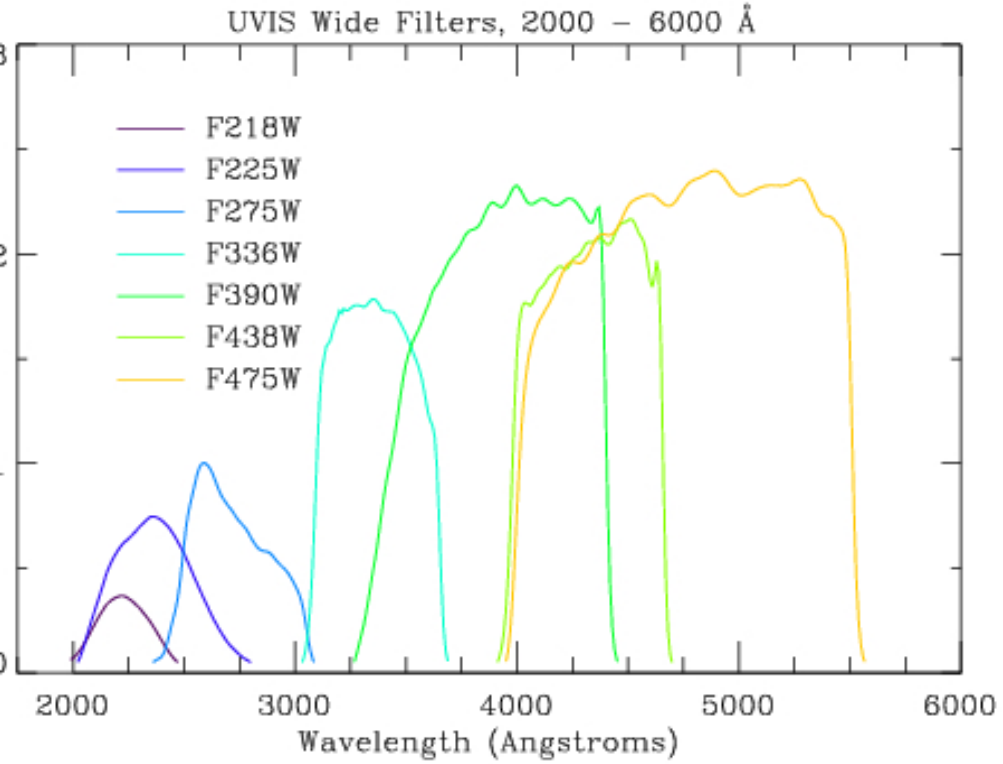
http://turbinelegend.net/ASTRO/Narrowband/6-23-05/6-23-05.html

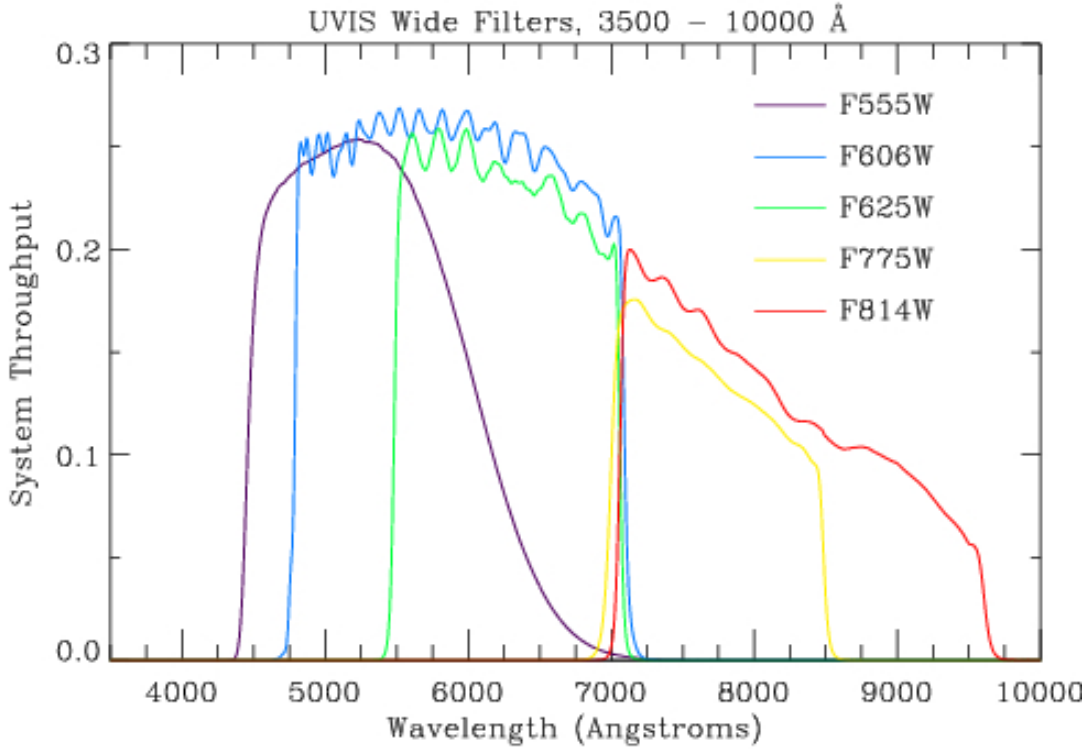


Need a different filter for each redshift...

Windhorst Filters: www.noao.edu/kpno/mosaic/filters

WFC3 for HST

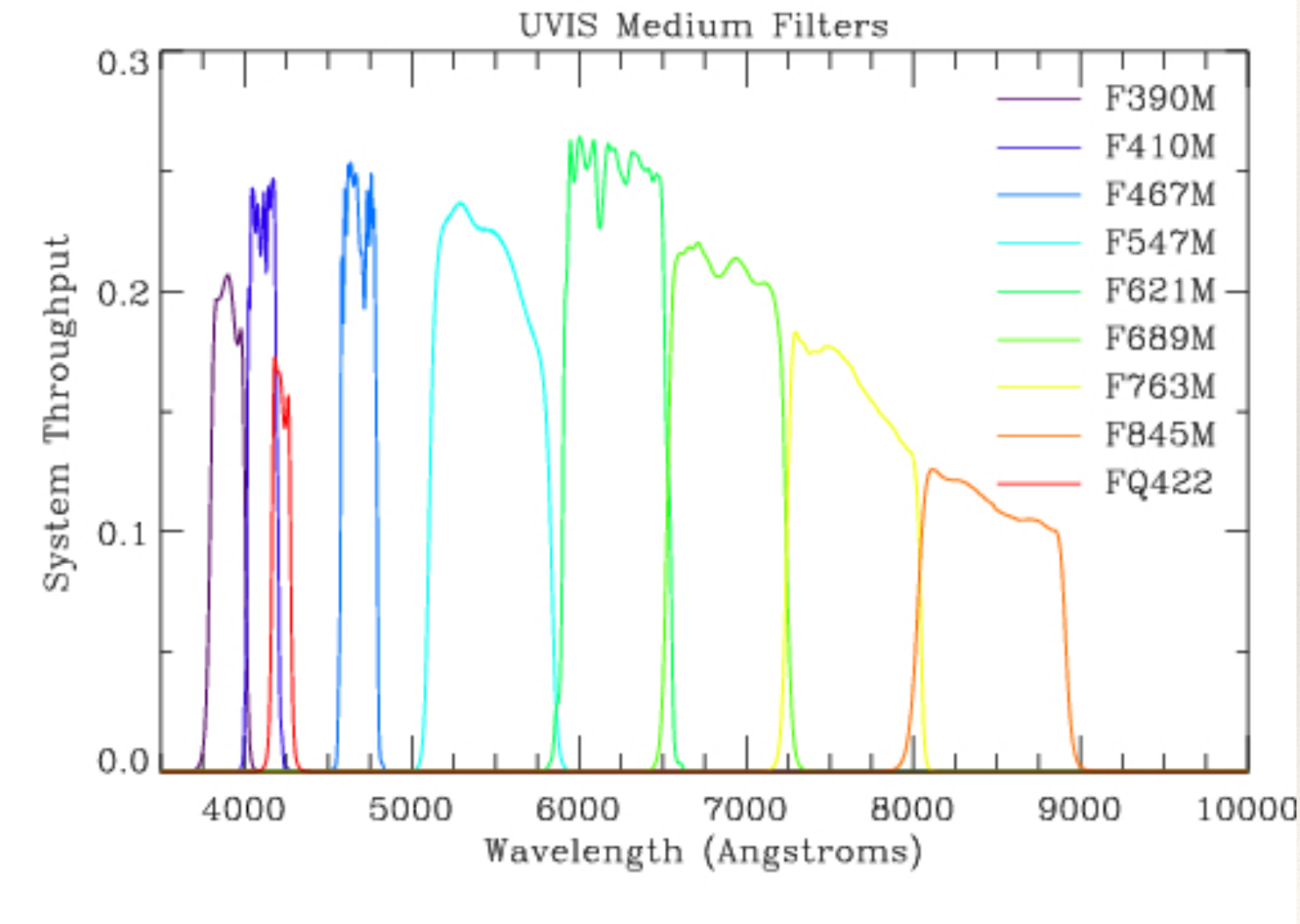


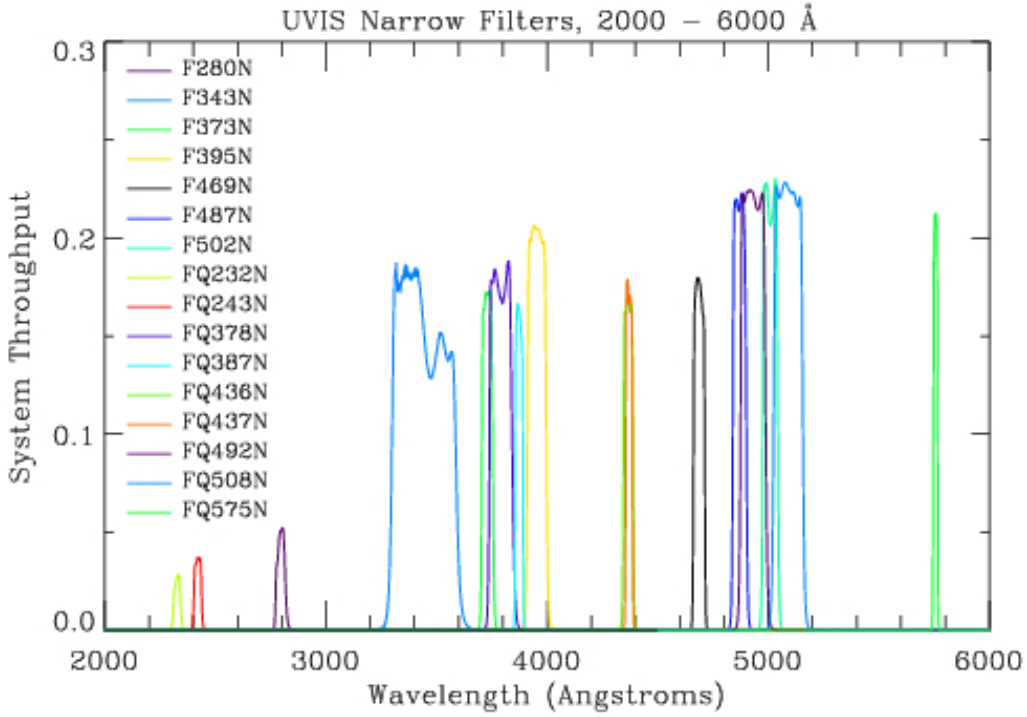


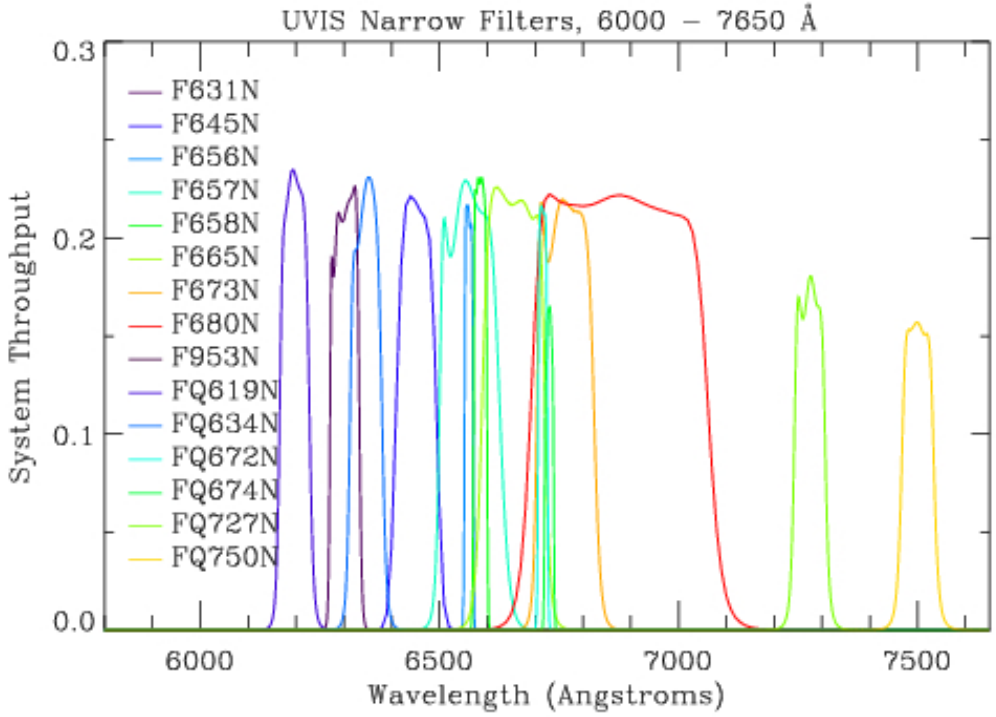
Broad band optical

WFC3 for HST

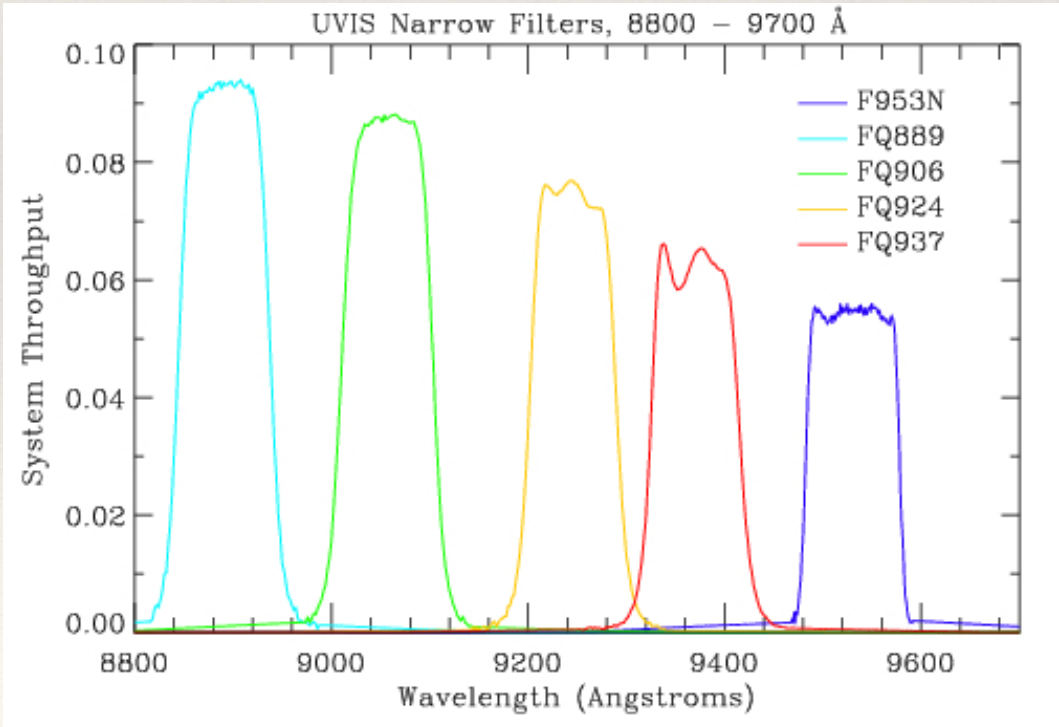
Medium band optical

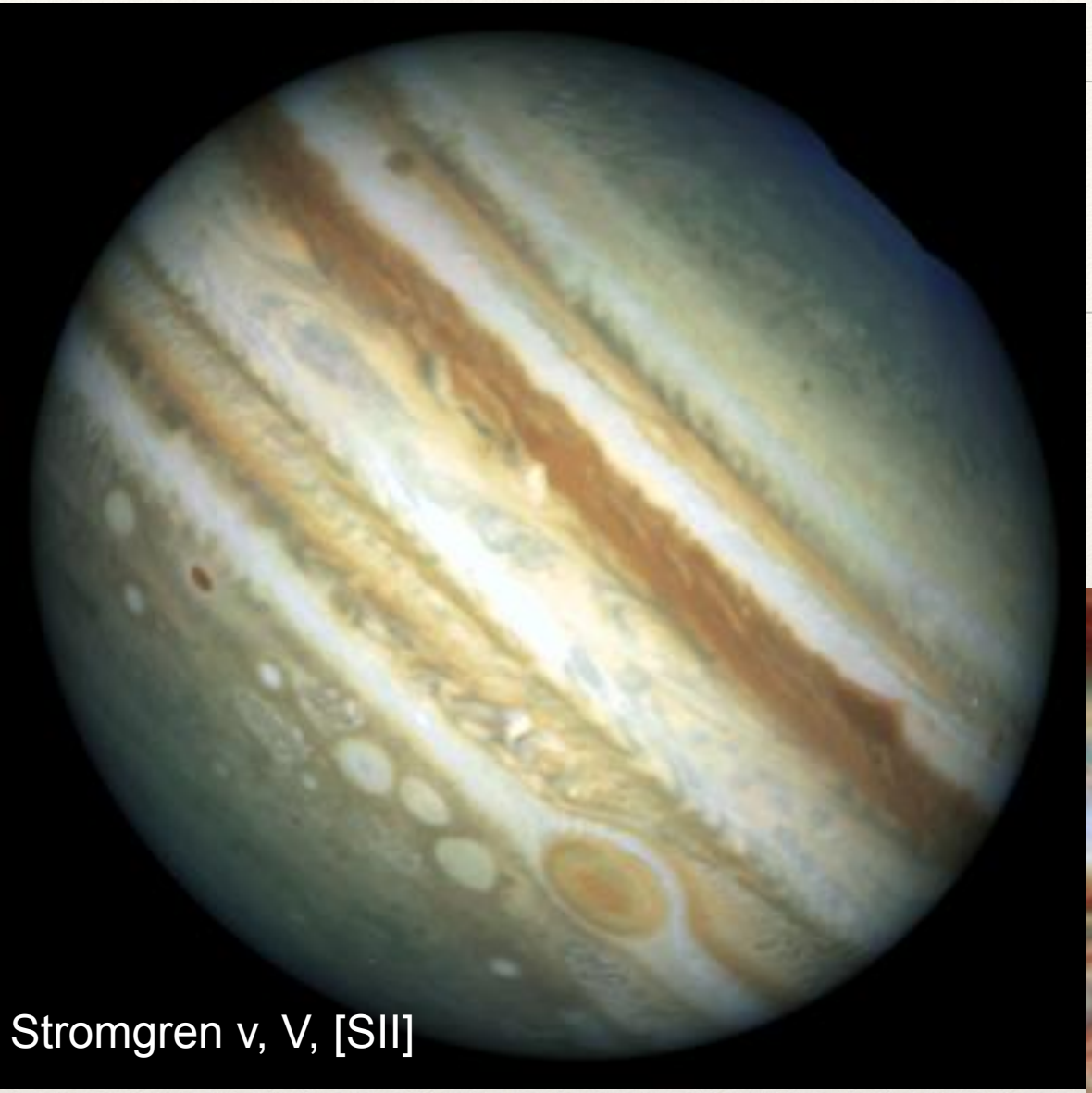


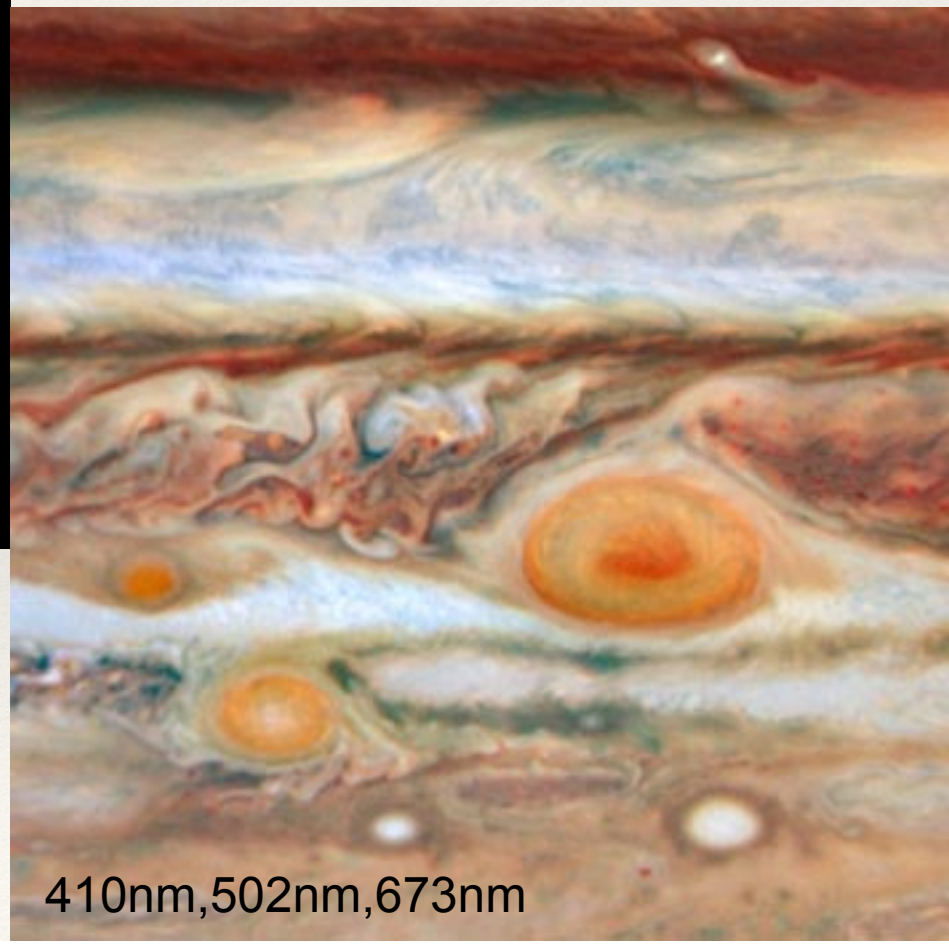




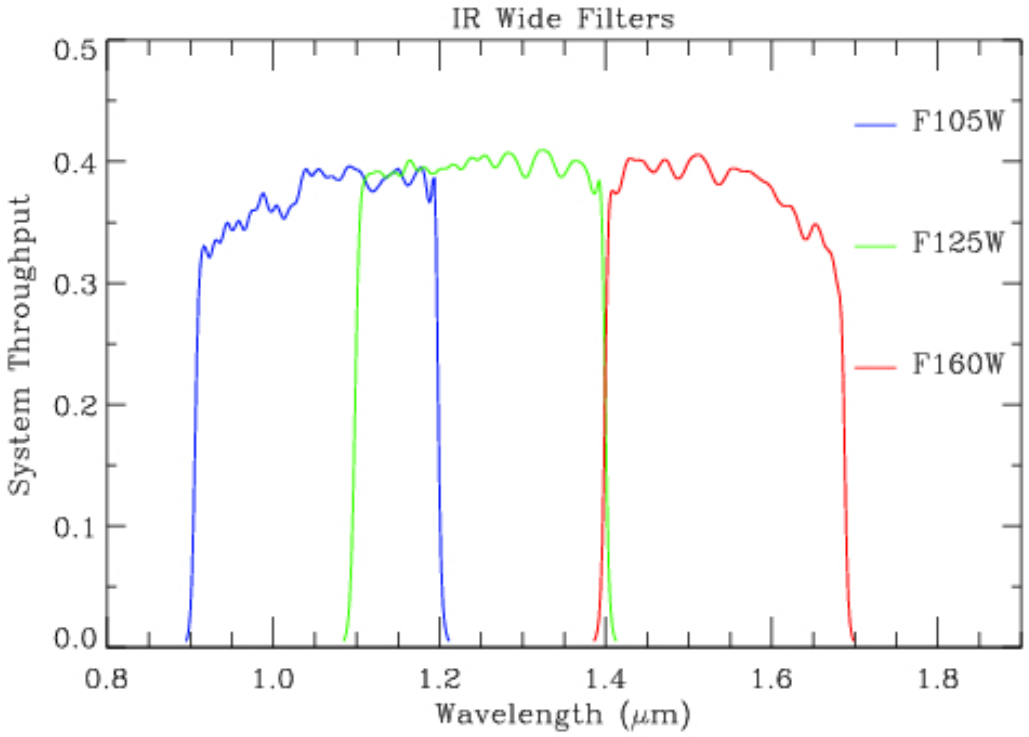
WFC3 Narrow band optical

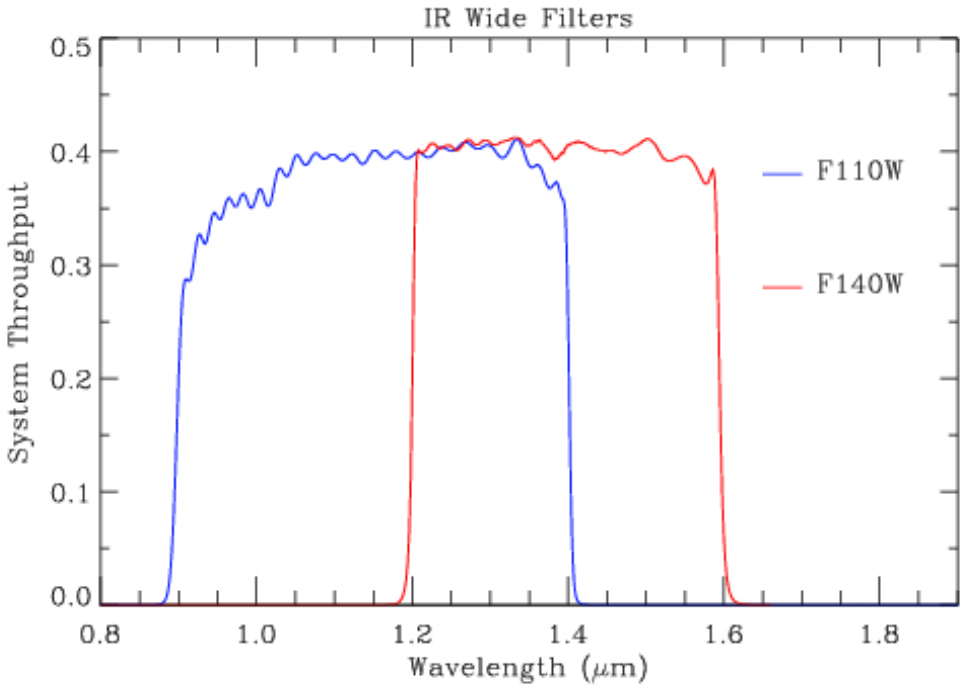



Stromgren v, V, [SII]


410nm,502nm,673nm

WFC3 for HST





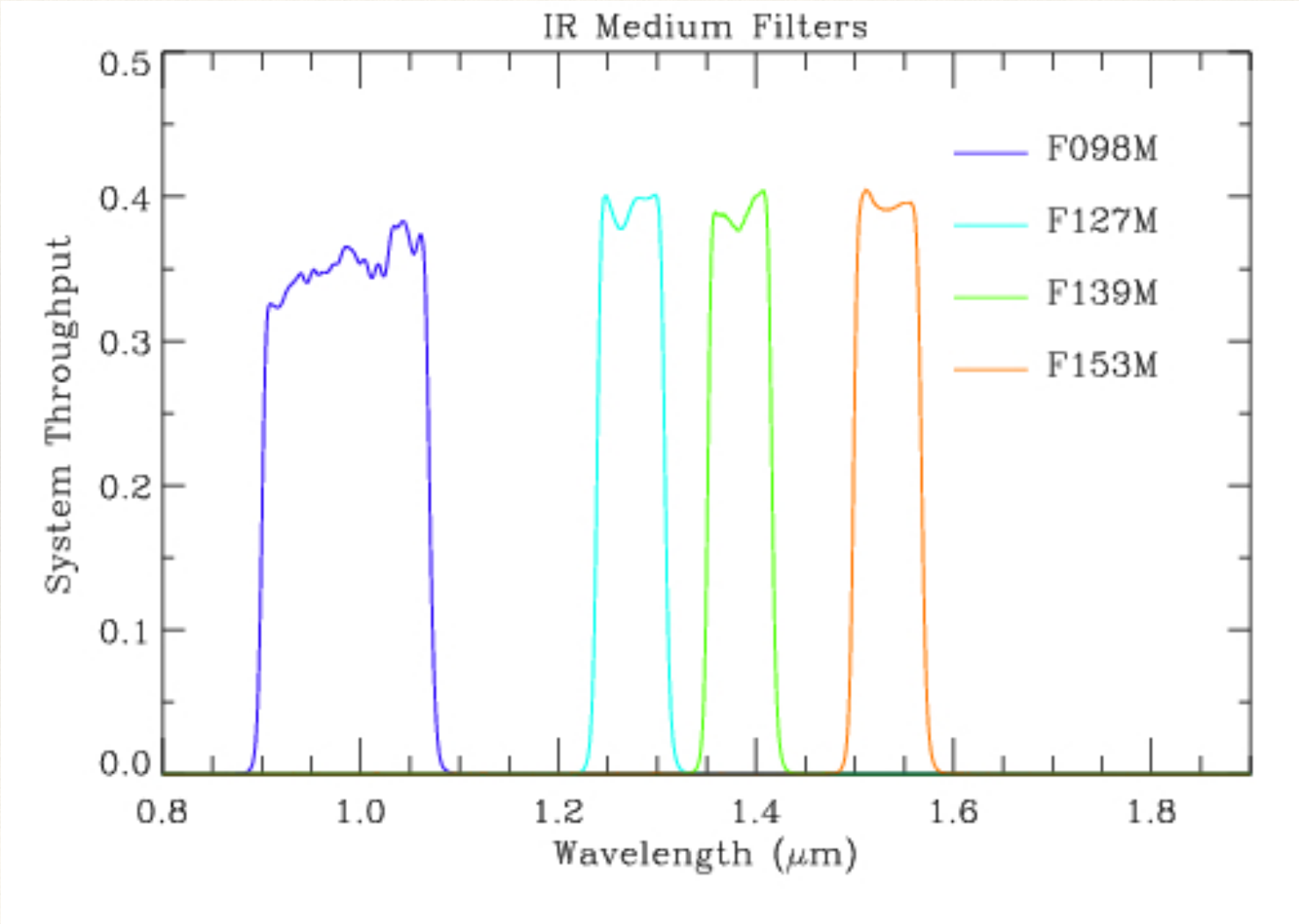
WFC3

Broad band IR

WFC3 for HST

WFC3

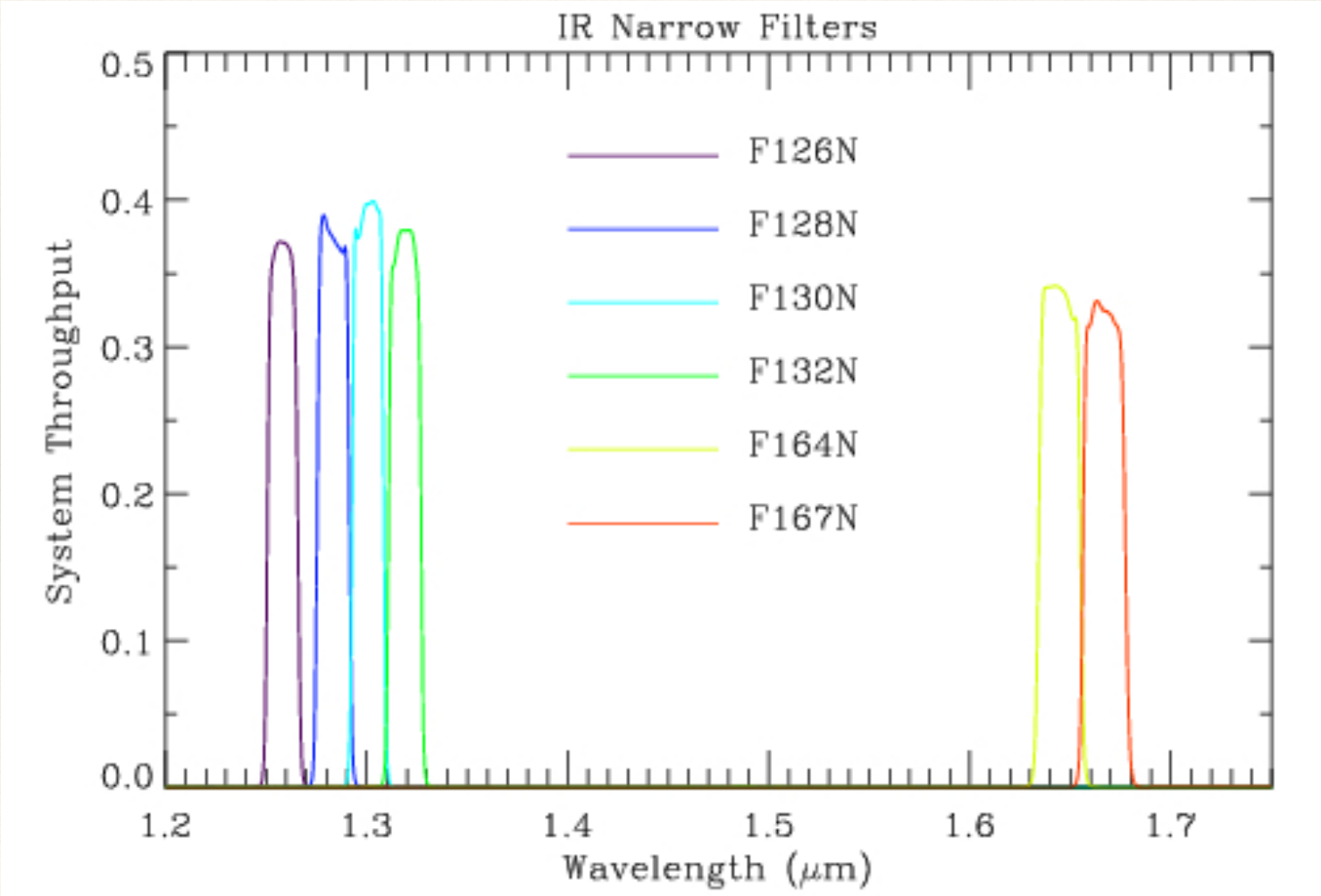
Medium band IR



WFC3 for HST

WFC3

Narrow band IR



Filter Wheels