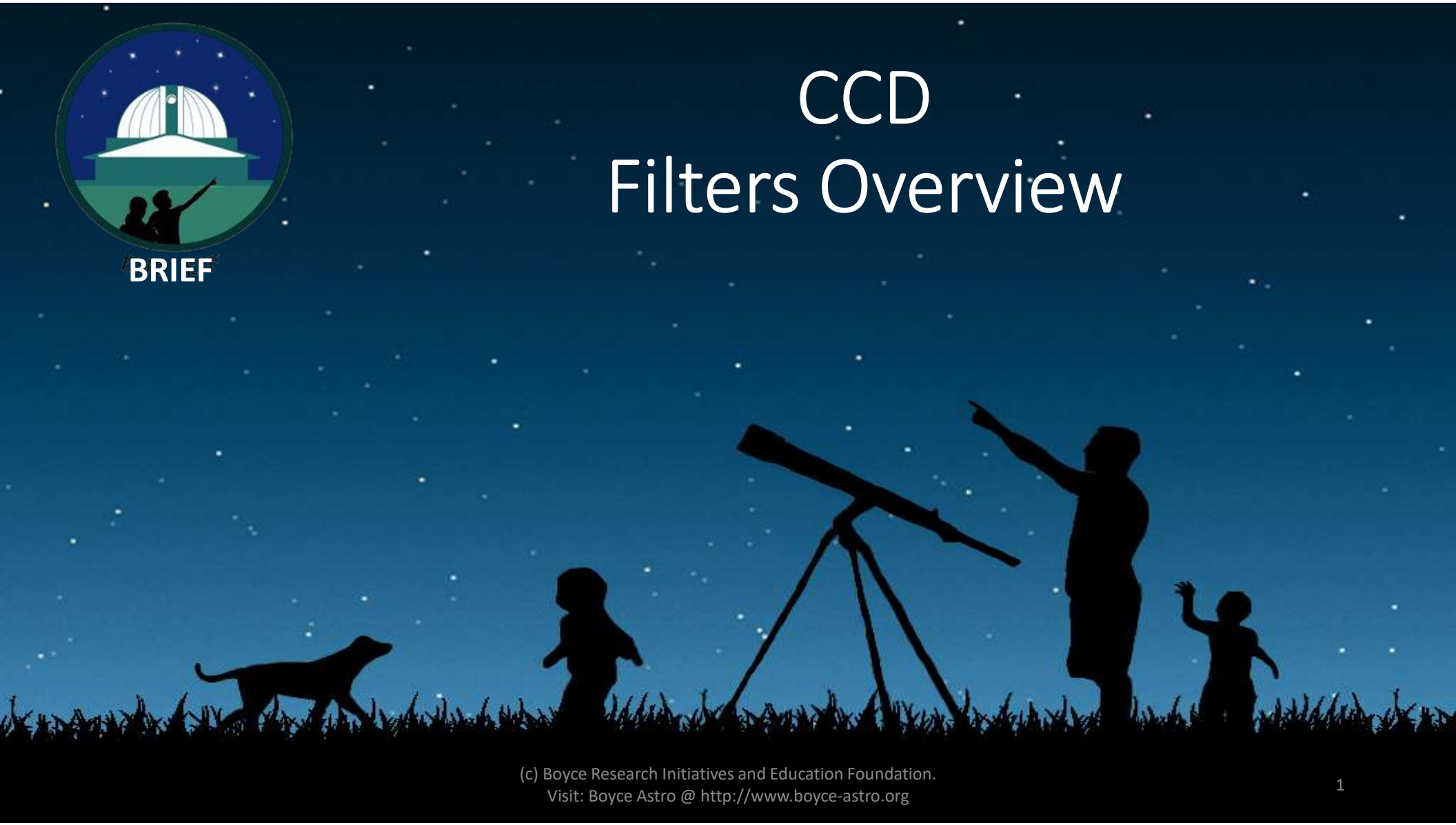
BRIEF

CCD
Filters Overview



Overview

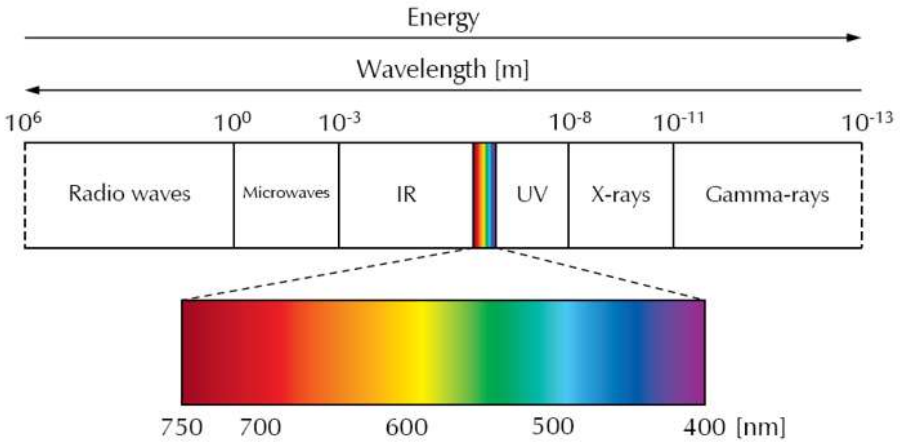
All CCD cameras collect one thing: Photons.

The result is a matrix containing a number of photon counts per pixel.

As a result, a CCD camera is neither black and white, or color. It is simply a “photon recorder”.

To get information from our target, and to make color pictures, we use Filters. These block certain EM Wavelength passbands, and allow others through depending on your specific need.

We will introduce Filters that help us achieve our goals, here.



Filters

As learned in the last slide, different object's temperature impacts their EM output. Filters allow us to manipulate that fact.

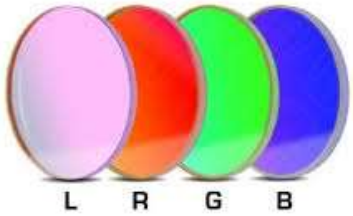
Filters allow us to separate, and isolate incoming light by limiting the wavelength of light hitting the CCD chip.

This allows the measurement of the EM spectrum from an astronomical object at well–defined points specific to the need. EX: Longer vs. Shorter Wavelengths

Filters can provide additional physical information about the object that you're observing, and increase the usefulness of your observations.

Using filters can be valuable but in some cases will permit less signal to the CCD chip. As a result, exposure times may be longer. It is a trade off.

Filters come in many varieties, but for scientific value it is best to standard photometric filters.

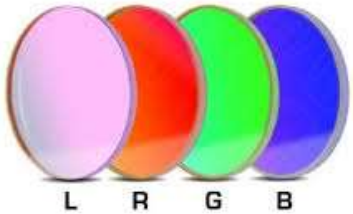


Filters

There are typically three cases where unfiltered observations are useful:

- Where all wavelengths are equally bright. Ex: hot objects like Cataclysmic Variables in outburst
- When the object is very faint, and you need all photons to reach the CCD camera. Ex. Gamma ray bursts, or where period-determination is the essential goal.

For work with BRIEF, we will use standardized photometric filters.



Filter Types

There are many filter manufacturers. In order to standardize data acquired across multiple platforms, standardized filter sets were created. We'll cover two of them.

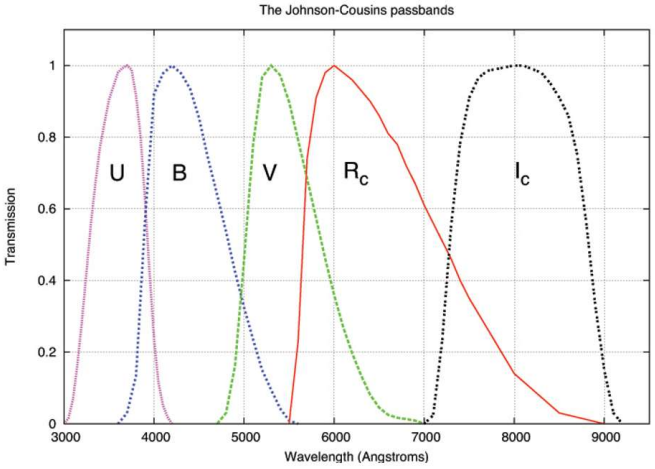
Johnson & Cousins

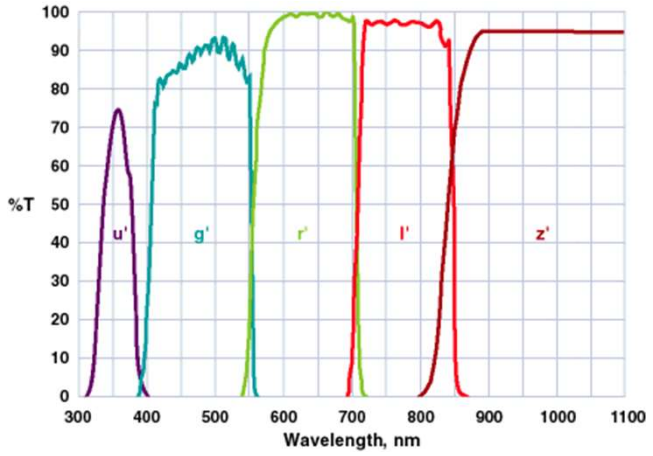
Derived from the Johnson-Morgan UBV Photometric System where B-V, and U-B are calibrated against an A0 star, free of Interstellar Reddening

Cousins defined the R and I passbands, thus the Rc and Ic

SLOAN (a.k.a. SDSS Filters)

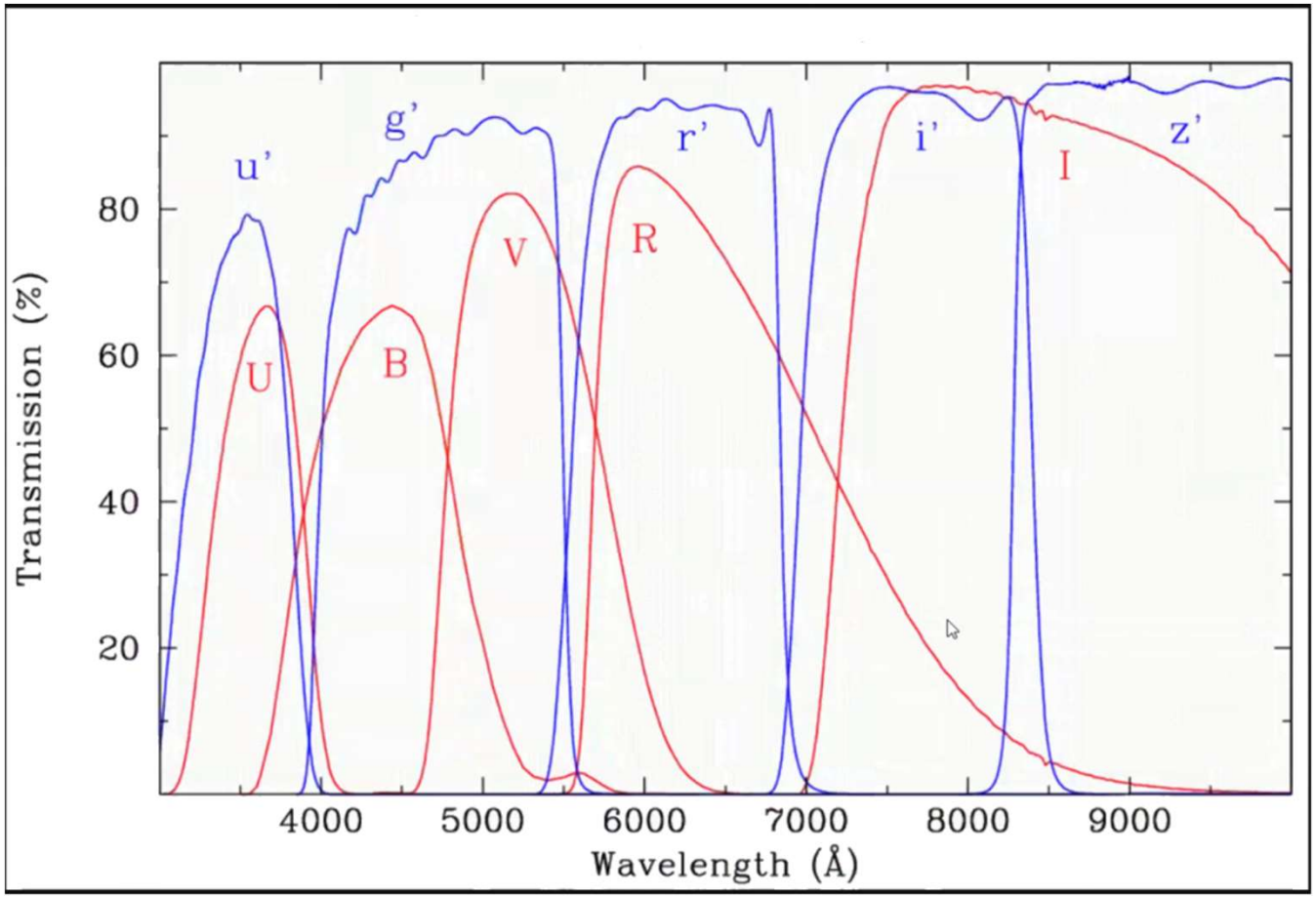
Filters: u' g' r' i' z'
Developed for Sloan Digital Sky Survey primarily for galactic surveys
Characterized by sharp cut offs





CCD Filters - UBVRI and JC

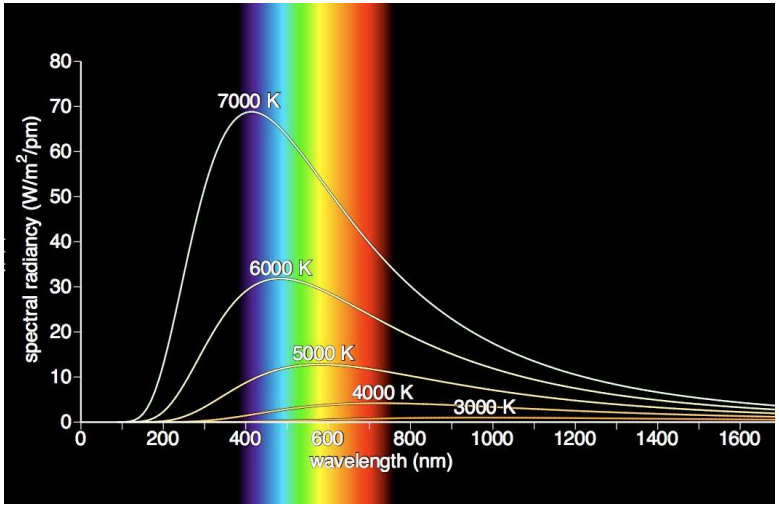
Comparison: JC & SLOAN

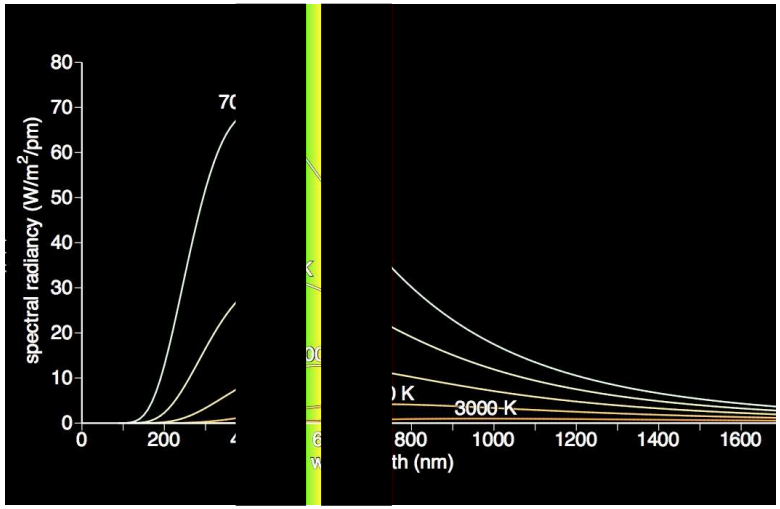


Filter Example of Use

For a given star, its temperature determines its color: the hotter, the bluer, the colder, the redder.

We use filters to block out undesired light.





Filter Example of Use

The image below on the left, is a particular Double Star system imaged through a Luminance Filter (allowing all light bands through). The one on the right, is the same Double Star imaged through a Red Filter (allowing ONLY the red light to pass through). Note the difference?

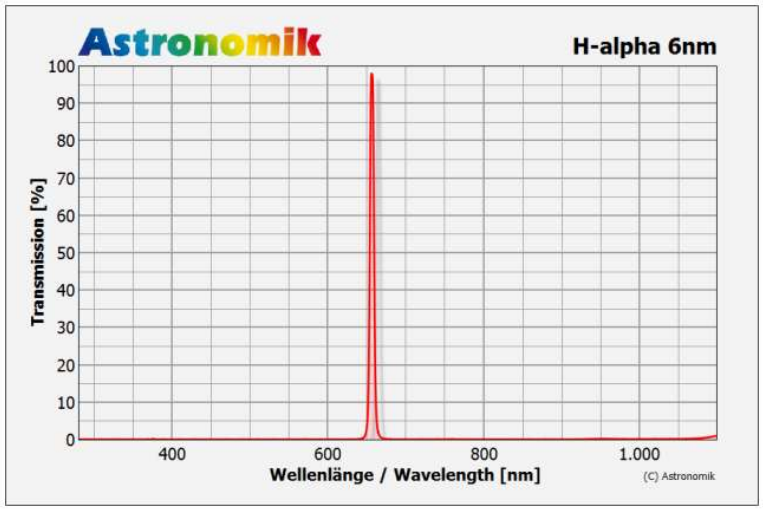
Luminance Filter

Red Filter

Other Filter Types

H-Alpha Filter

Focuses strictly on a single bandpass: 656 nm
Good for emission nebulae, the Sun, and separation of Double Stars

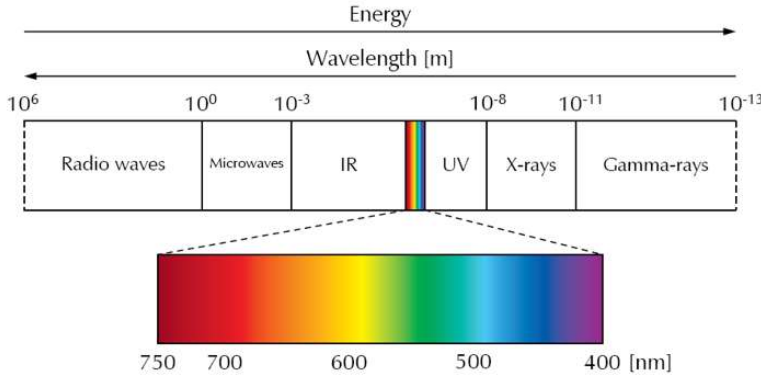


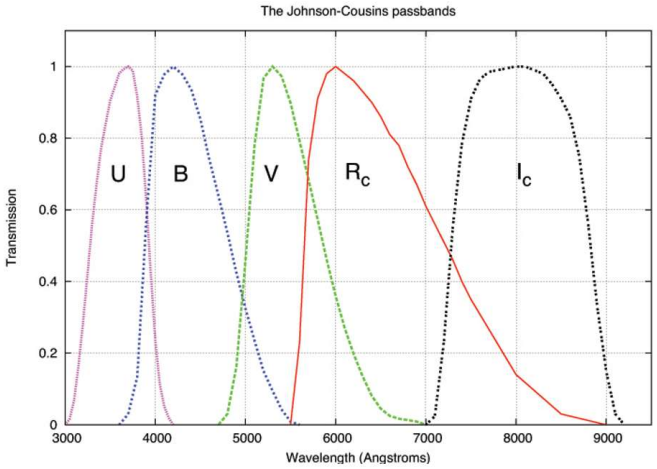
Summary

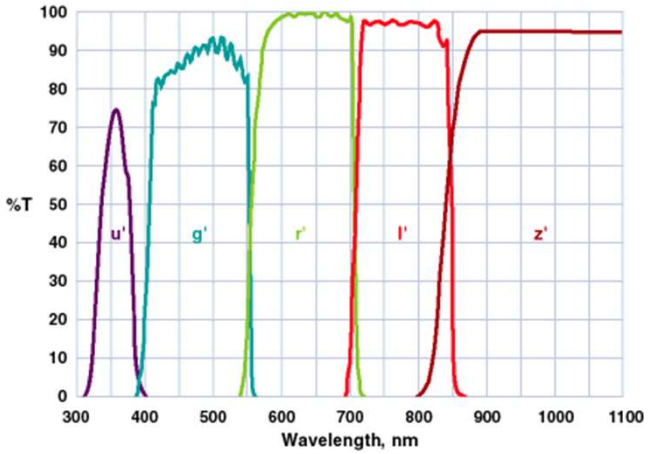
All objects produce light through out the EM spectrum

Filters allow us to manipulate this incident light whether for pretty pictures or scientific study

The two most prominent filter systems are the JC and SLOAN sets







Questions?

Review

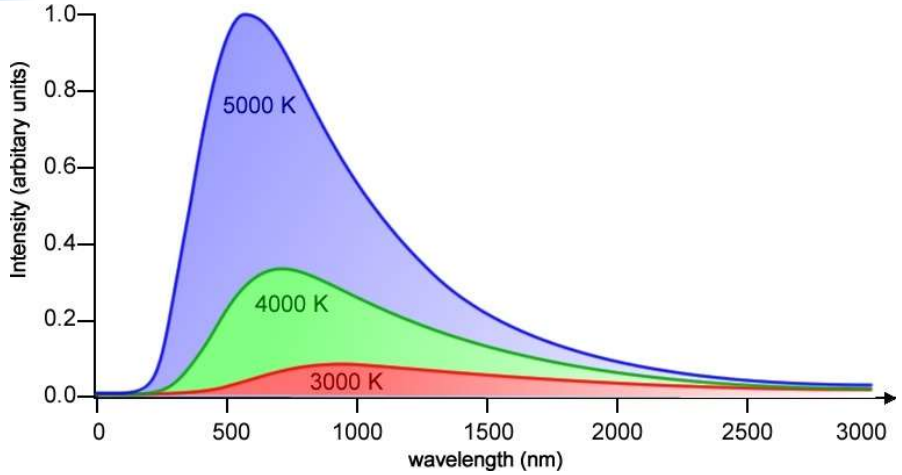
Black Body Radiation:

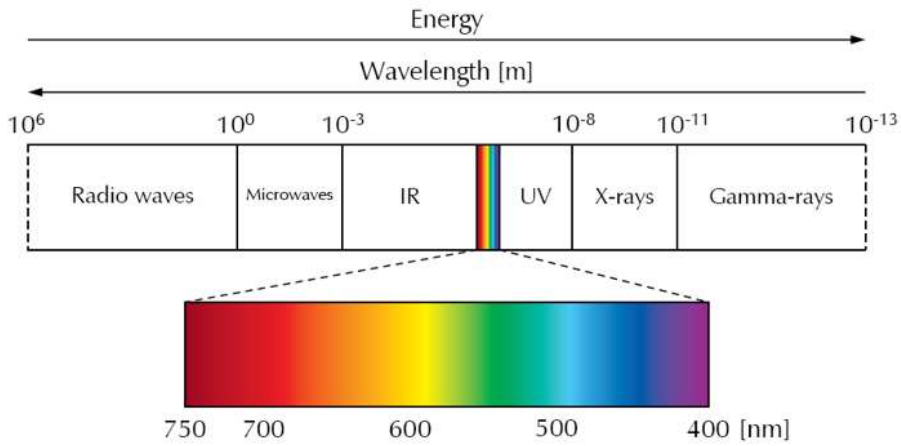
An idealistic object that absorbs all energy falling on it

Emits a continuous EM spectrum dependent on its temperature

Wien's Law of Displacement: $\lambda_{\max} = \frac{b}{T}$

The Black Body radiation (EM) output varies inversely proportional to the temperature (NOTE: *b* is Wien's constant)

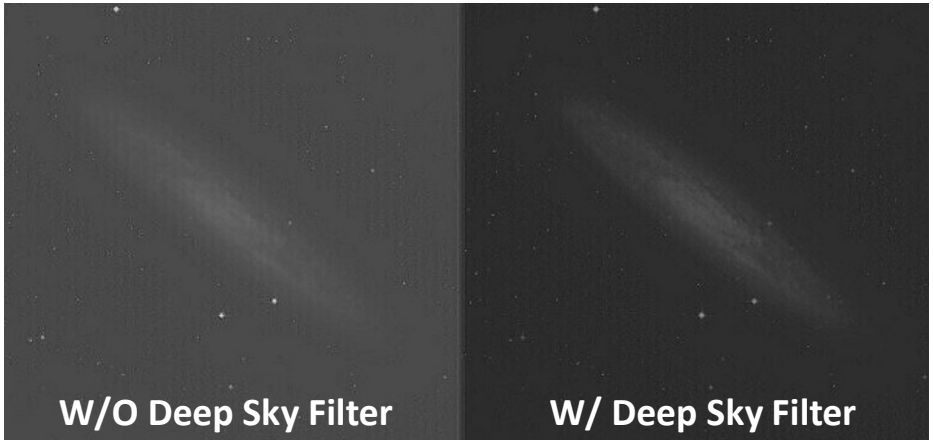




Other Filter Types

Deep Sky Filter

Enhances Nebula, galaxies and star clusters by eliminating common light-pollution band passes



O-III Filter

Bandpass of 10nm focused on the OIII line ~500nm

Good for diffuse Nebulae