

Galaxies Beyond Our Milky Way



M82 and M81



Distance: 11.7 million light-years



Whirlpool Galaxy

May 9, 2005



Whirlpool Galaxy—Supernova 2005cs

July 10, 2005



Whirlpool Galaxy—Supernova 2011dh

June 6, 2011



Whirlpool Galaxy

May 9, 2005



Sombrero Galaxy



NGC 4565



Deerlick Galaxy Cluster



Why Astrophotography?

Long Exposures, Permanent Record, Digital Enhancement, Light Pollution!



Visual Experience



Long Exposure



Light Pollution Subtracted



Old Astronomical CCD camera

- ▶ StarlightXpress SXV-H9
- ▶ Pixel size: 6.45×6.45 microns
- ▶ Pixels: 1392×1040
- ▶ Quant. Eff.: $\sim 65\%$
- ▶ Readout Noise: ~ 7 electrons
- ▶ Cooling: $\sim 30^\circ\text{C}$ below ambient
- ▶ Download: 3.5 seconds
- ▶ Weight: 350g



New Astronomical CMOS camera

- ▶ ZWO ASI2400MC-Pro
- ▶ Pixel size: 5.94×5.94 microns
- ▶ Pixels: 6072×4042
- ▶ Quant. Eff.: $\sim 80\%$
- ▶ Readout Noise: ~ 1.1 electrons
- ▶ Cooling: $\sim 35^{\circ}\text{C}$ below ambient
- ▶ Download: 0.125 seconds
- ▶ Weight: 1360g



Example

“Telescope”: 200mm f/3.5 Vivitar lens
(\$30)

Mount: Questar

Camera: Starlight Express SXV-H9

Filter: Dichroic H α

Fundamental Principles

- ▶ *Focal length* determines *field of view*
- ▶ *F-ratio* determines *exposure time*

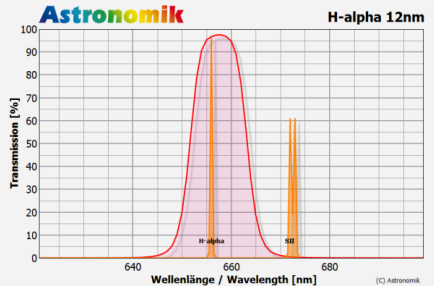
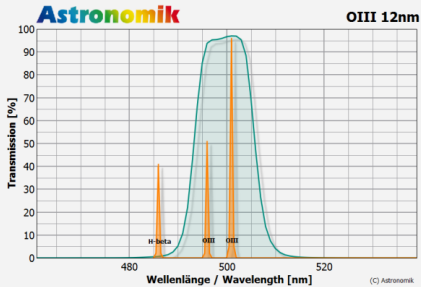


Total exposure time = 156 mins.
Field of view = $1.9^\circ \times 2.5^\circ$.



Combatting Light Pollution

Narrow-Band Filters

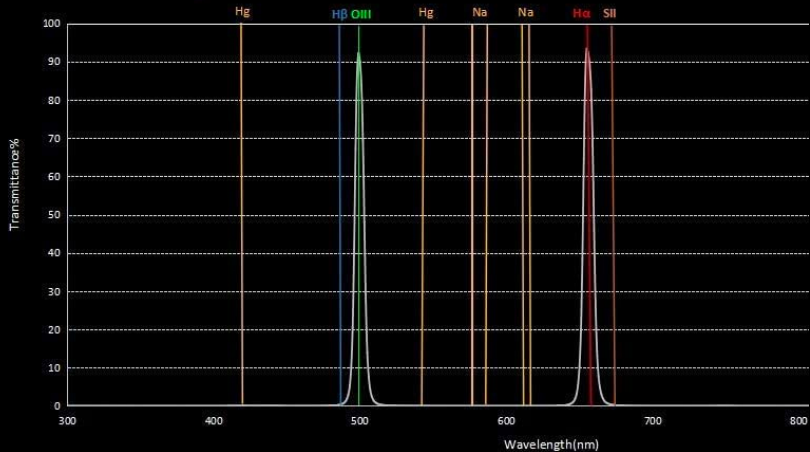


L-Extreme Filter

7nm



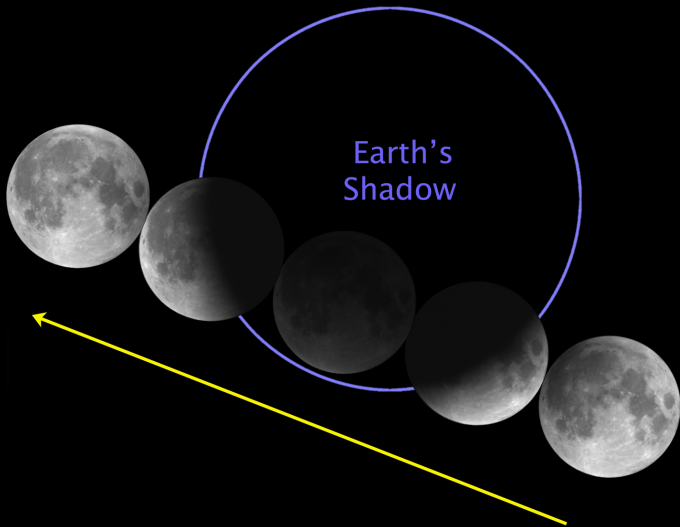
OPTOLONG L-eXtreme Filter



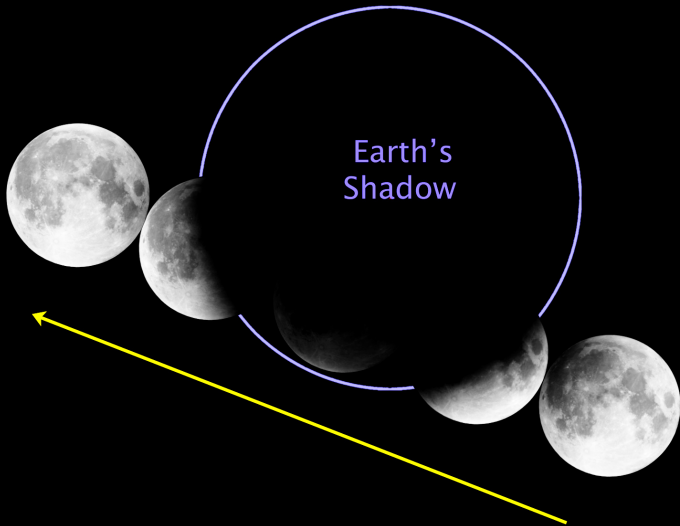
Is The Earth Flat?

A Picture's Worth a Thousand Words...





How Aristarchus measured the size of the Moon.



How Aristarchus measured the size of the Moon.

Lecture 9 Got to Here