

# Imaging on a Budget

A deep-sky photograph of a starry field. The background is a dense field of stars of various colors and magnitudes. In the center, there is a bright, diffuse, yellowish-white core, likely the nucleus of a galaxy or a star cluster. The overall appearance is that of a rich stellar population.

A quick survey of DSLR Imaging

By

Richard Jakiel

# The DSLR vs. the CCD



## The DSLR..

- Relatively inexpensive
- Fairly large format
- No cooling needed
- Easier to Process
- Very versatile
- Can be used for “normal imaging”

## A CCD..

- Greater dynamic range
- More sensitive “QE”
- Higher resolution with monochrome CCD
- Narrow Band and filter imaging

# The Equipment Atlas



- The Digital Single Lens Reflex Camera
- Canon – widest variety of options, OTHO - Nikon “star killers”
- The “Live View” option
- Telephoto Lenses – the zoom question
- Tripod (should be stable)
- Remote shutter/control cable



# For long exposure – a different setup

- For Prime Focus and Piggy Back – need a tracking mount. Autoguider controlled the best
- “Live View” or Computer for focusing
- A DSUB controller or remote cable control
- T-ring + adapter (2-inch)
- Power supply (batteries and/or AC adapter)
- Memory cards or large computer HD



# DSLR Setup

- Note the various control and power attachments.





# Attachments and Laptop





Tripod Imaging

# Tripod Imaging



- No special setup – just camera + lens and tripod
- Usually short exposures (less than 30 seconds)
- Can use stacking to increase signal to noise (s/n)
- Good for conjunctions, the Moon, constellations, Milky Way and other subjects (i.e. – satellites)



# 300mm Lunar Images



# Piggy Back Imaging

M11 – 200mm Lens



# Piggy Back - Setup



- Camera + telephoto or Small Telescope as the lens.
- Larger scale and longer exposures
- Good focus is very important
- Excellent for Star Clusters, Milky Way Areas, Nebulae, large Galaxies and Galaxy clusters.

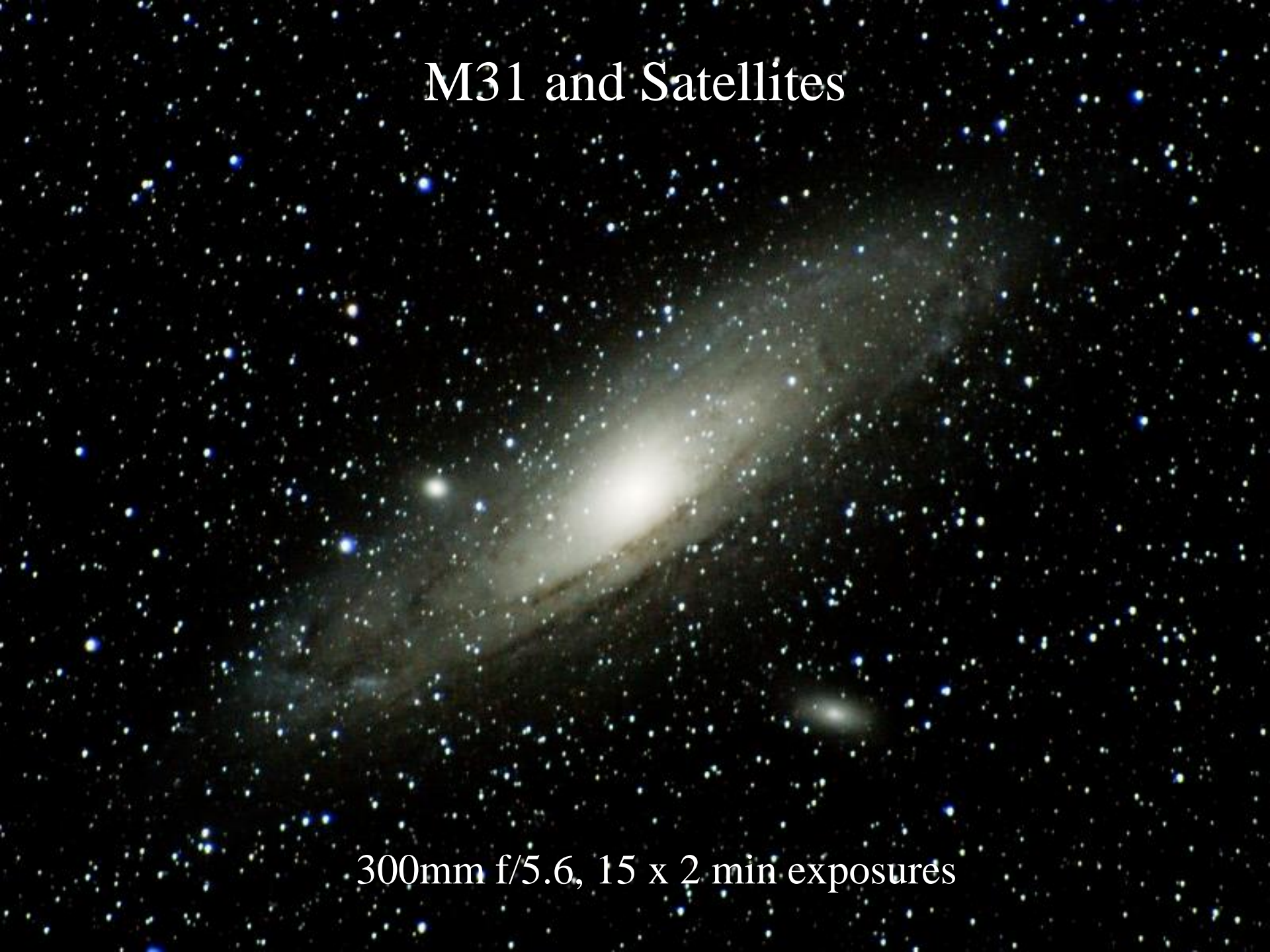


# Star Clouds around NGC 6520

The image displays a vast field of stars, characteristic of a star cloud or open cluster. The stars are densely packed, with a higher concentration in the lower-middle region where the cluster NGC 6520 is located. The stars vary in brightness and color, though most appear as white or yellowish points of light against the dark background of space. The overall appearance is that of a rich stellar population.



# M31 and Satellites



300mm f/5.6, 15 x 2 min exposures



# Nebulae near M8





# Prime Focus Imaging...



M27 - 8-inch f/4

# So what is Prime Focus Imaging?

- The DSLR is attached directly to the telescope
- Focus is *critical*. Computer programs can make this easy.
- Need good tracking – can be aided with an autoguider

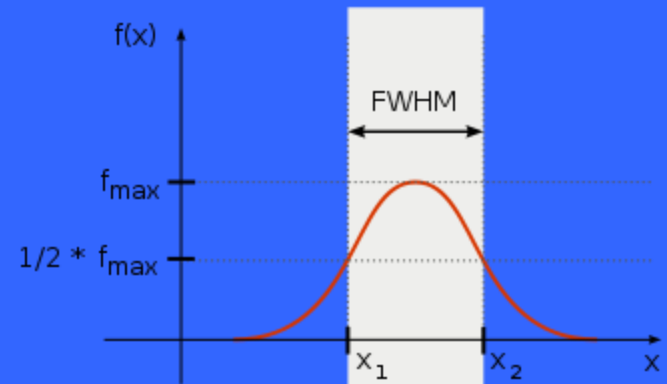




A Prime Focus Setup

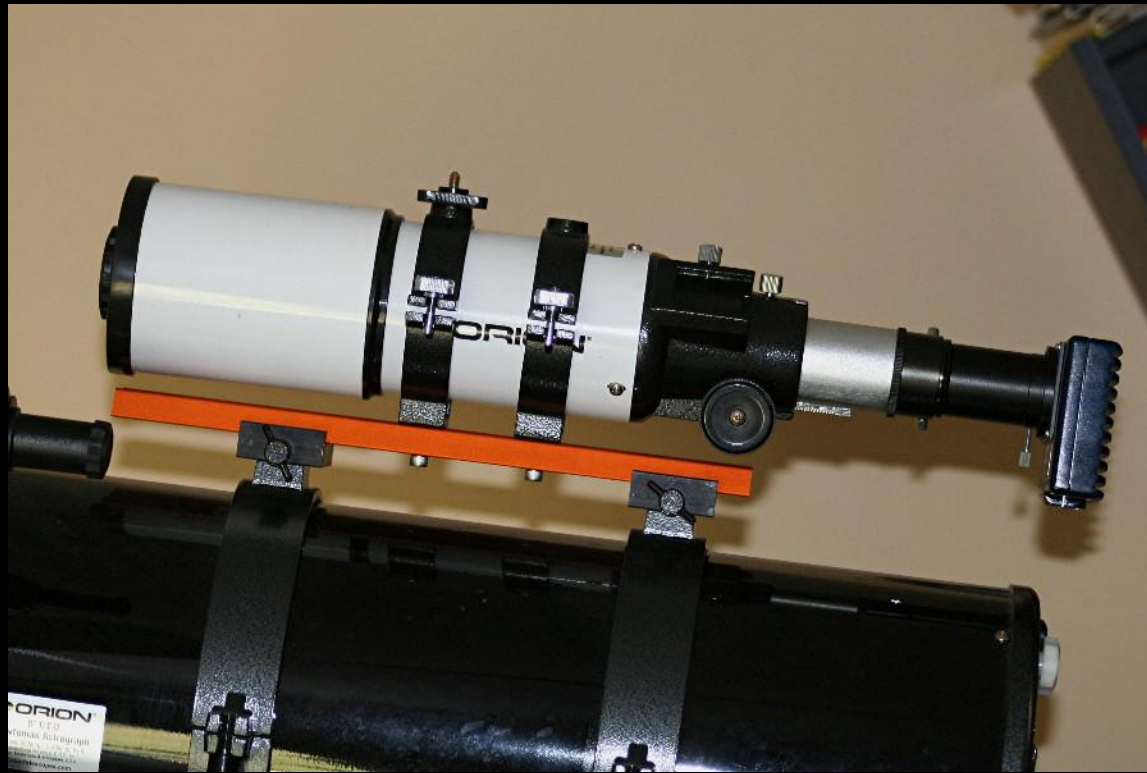


# Focus – is *critical* for nice images



- Use star clusters and/or areas with a good range of star magnitudes
- “*fwhm*” – or “full width, half max” function – is a way to determine the sharpness of the peak = focus!

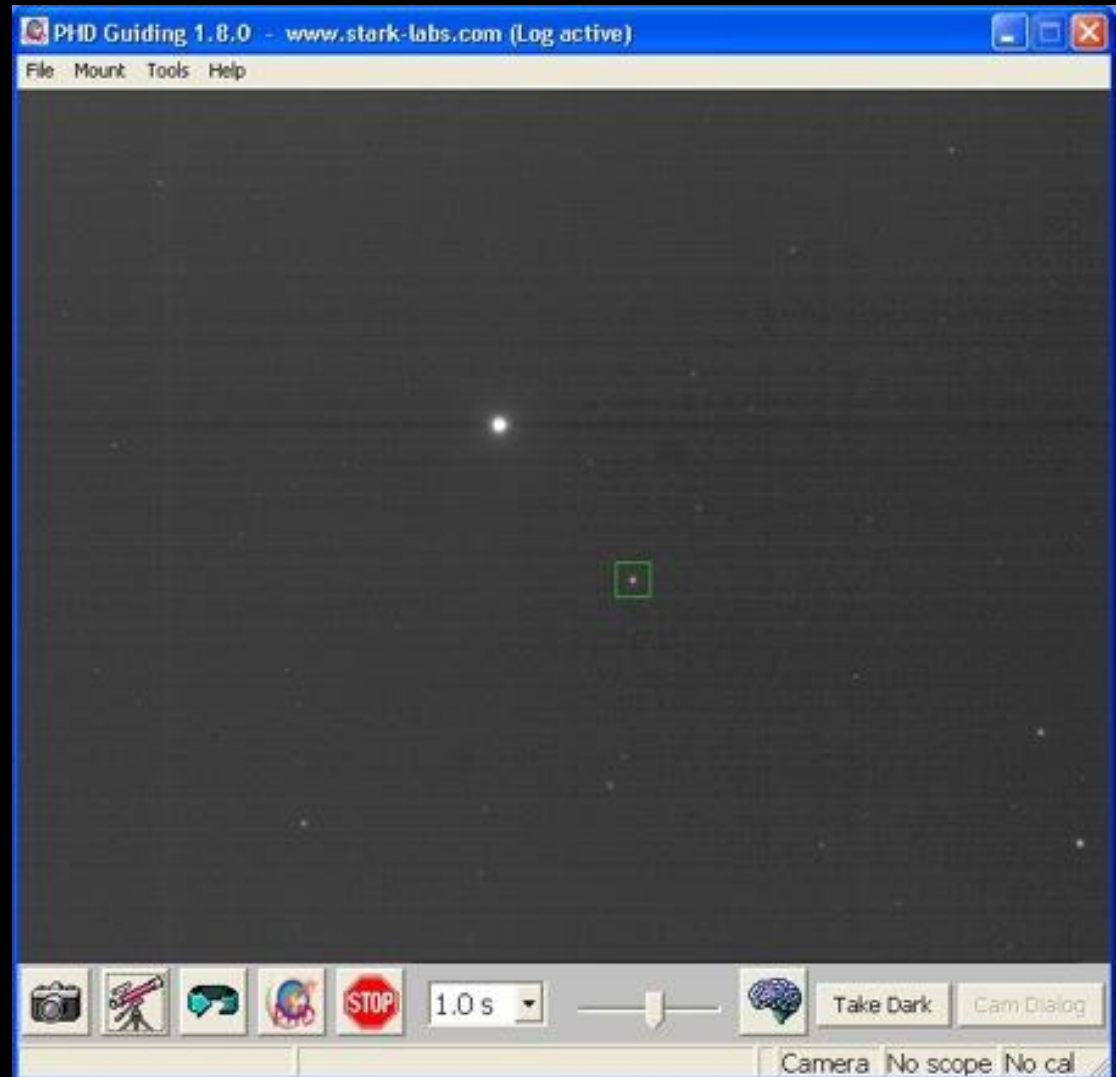
# Guiding – Autoguider setup..



- Autoguider = Guide scope plus a Guide Camera, usually mounted “piggyback”
- Guide scope – focal length no less than 1/3 the primary scope
- Camera – CMOS or CCD, when possible use a CCD as they have lower noise.

# Choosing a “Guide Program”

- The most “bang for the buck – PhD or “Push here Dummy”
- Able to use most dedicated guide cameras, plus a number of CCD’s and even planetary cameras
- Guiding exposures should be  $>1$  second
- Can take ‘dark frames’ to reduce noise in CMOS cameras



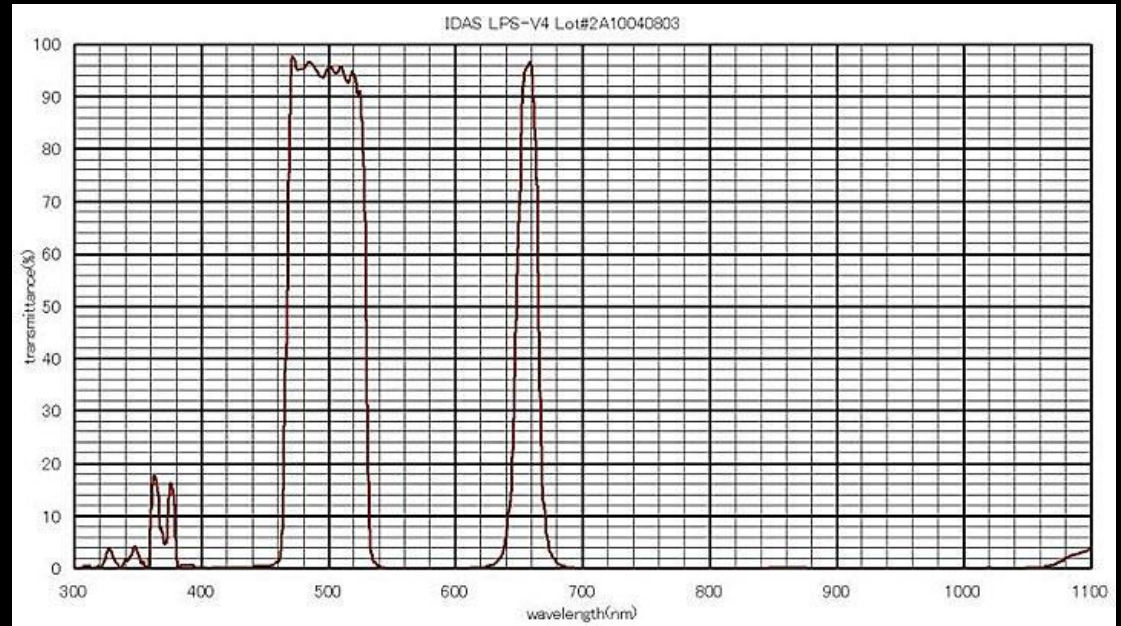


# Dark Frames and Flat Fields



- Dark frames – used to remove thermo noise generated by CMOS and CCD chips. Though DSLRS often have low noise, they are generally NOT cooled.
- Flat Fields – correct for vignetting and dirt/imperfections in the imaging train. Can be taken at twilight or other methods. ~ Average of 5 to 10 frames at 20 to 30 K ADU's

# Boosting your contrast – LPS filters



- Imaging from Suburbs – deal with a wide variety of light pollution sources
- LPS filters – *light pollution suppression filters* can boost contrast (or relative s/n by up to 3x. Works best under moderately polluted skies.
- But even those specifically made for DSLR's and CCD's can shift the color balance – needs to be adjusted during the processing.

# Imaging Tips..

- Use “raw mode” instead of .jpg or other compressed formats
- Take a series of *dark frames* to match exposure times and for changes in nightly temperature.
- Flat fields may be necessary if the optics and/or camera chip is dirty and/or unevenly illuminated.
- Try different ISO's other than the highest gain setting.
- Use stacking to reduce noise, boost signal and remove tracking errors.



# Image Gallery – M31 (8-inch f/4)





M13 – 80mm f/6

# M45 – the Pleiades





M83 in Hydra



# Putting the Red Back – The Modified DSLR

- DSLR's have a filter installed that blocks UV/IR and Hydrogen alpha
- This can be replaced with a clear filter or one that blocks IR/UV without removing the H-alpha signal.



M42 - unmodified



# M42 – modified DSLR





# M8 – Lagoon Nebula



The image displays the Eagle Nebula (M16), a prominent interstellar cloud in the constellation Minerva. The nebula is characterized by its reddish-orange hue, which is caused by the emission of light from ionized hydrogen gas. It is surrounded by a dense field of stars, many of which are bright and appear as white or yellow points of light. The overall appearance is that of a vast, star-forming region. The text "M16 – the 'Eagle Nebula'" is overlaid at the bottom of the image in a white serif font.

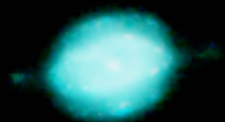
M16 – the “Eagle Nebula”



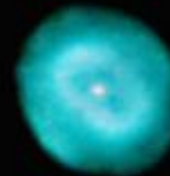
B33 – the Horsehead



# High Resolution Imaging of PNe



NGC 7009



NGC 7662

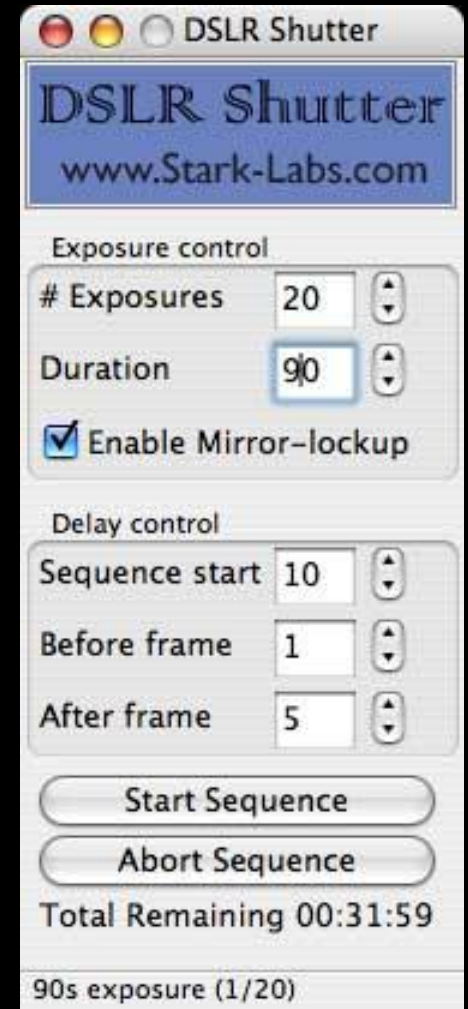
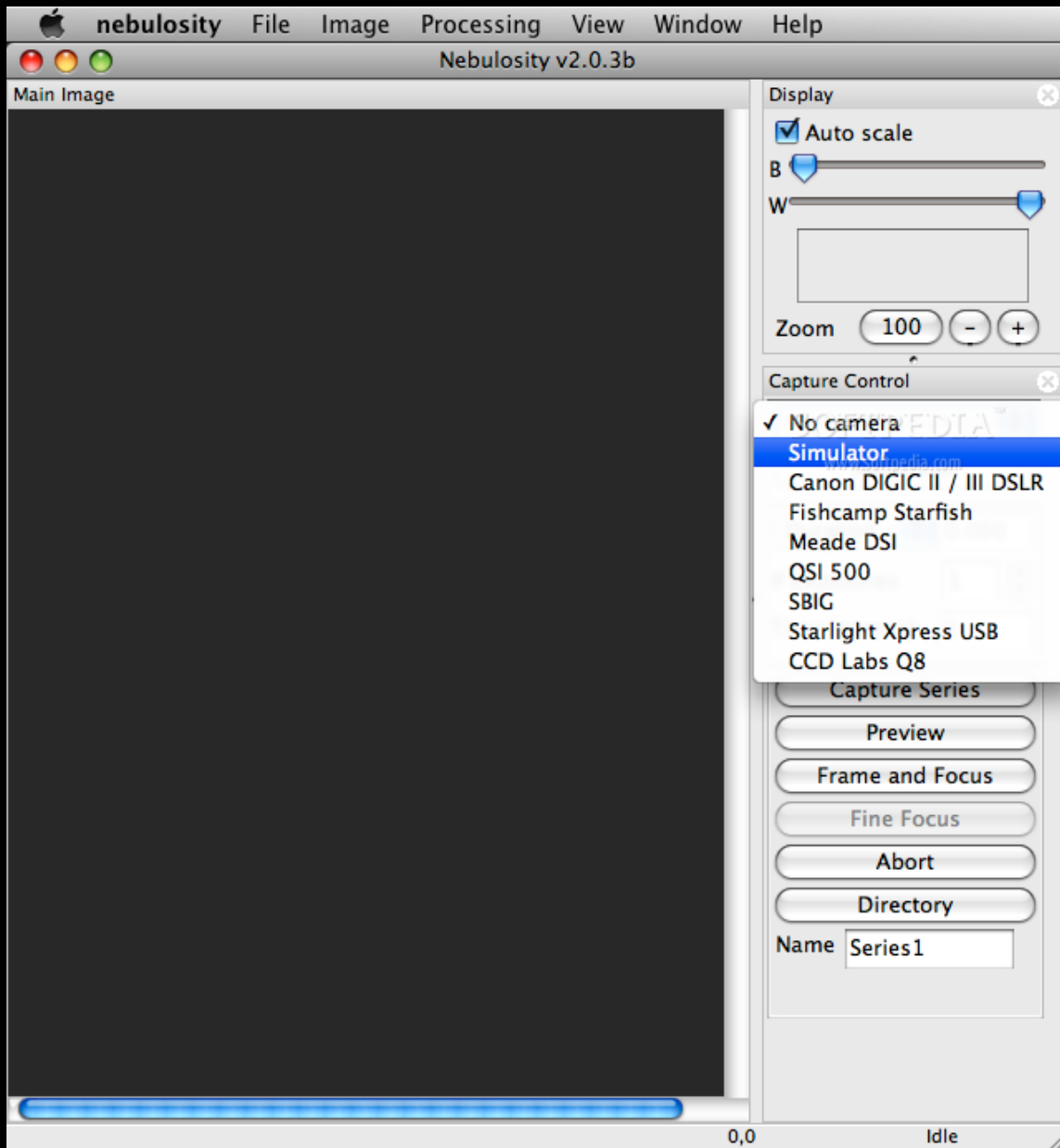
- Long Focal Length, a large stack of short exposures
- Can use programs like Registax to sharpen/process image
- Doesn't require autoguiding



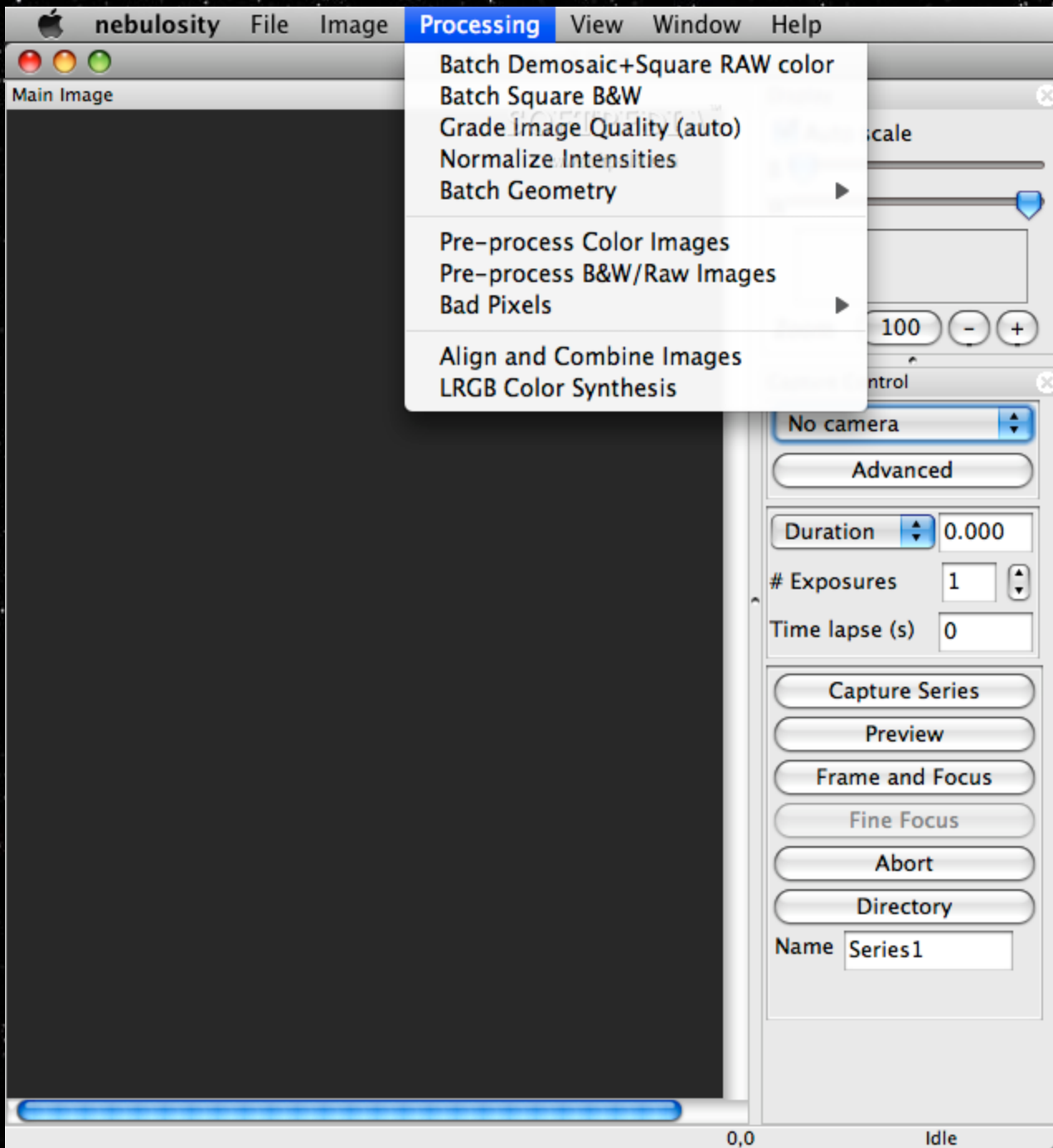
And now – part II...

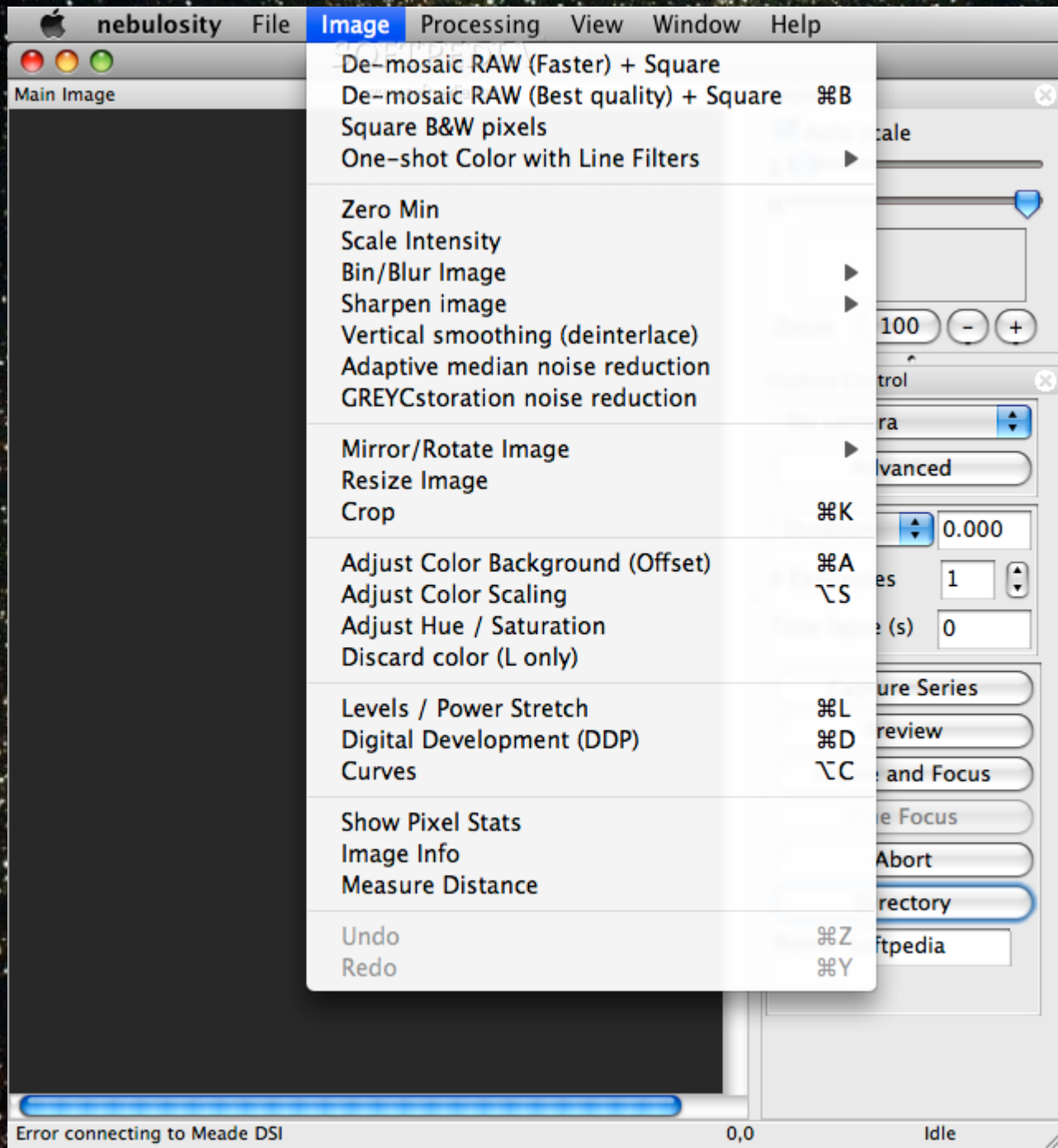
*Fun with Image Processing!*

# Nebulosity – Inexpensive & Easy to Use









- De-mosaic RAW (Faster) + Square
- De-mosaic RAW (Best quality) + Square ⌘B
- Square B&W pixels
- One-shot Color with Line Filters ▶
- Zero Min
- Scale Intensity
- Bin/Blur Image ▶
- Sharpen image ▶
- Vertical smoothing (deinterlace)
- Adaptive median noise reduction
- GREYCstoration noise reduction
- Mirror/Rotate Image ▶
- Resize Image
- Crop ⌘K
- Adjust Color Background (Offset) ⌘A
- Adjust Color Scaling ⌘S
- Adjust Hue / Saturation
- Discard color (L only)
- Levels / Power Stretch ⌘L
- Digital Development (DDP) ⌘D
- Curves ⌘C
- Show Pixel Stats
- Image Info
- Measure Distance
- Undo ⌘Z
- Redo ⌘Y

Error connecting to Meade DSI

0,0

Idle



A few more images – M51 (8" f/4)



# M65 and M66





# NGC 4725 (l) and 4718 (r)





The Rosette...

...the END!