

# An Introduction to Imaging - Taking the first steps...

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October 8, 2021



Back in the days of film camera options were fairly limited...



Homebuilt  
4x5 Sheet Film Camera  
50mm f/11 Refractor Lens  
(Polaroid Film Back)

Kodak Brownie  
Target 620  
Box Camera

Voigtlander Bessa I  
120 Roll Film Camera

Olympus OM-1  
35mm SLR



# Telescopes: Visual vs. Imaging



Visual tends to emphasize the largest scope you can manage on an adequate mount...

Bigger is usually better.



Imaging emphasizes a more modest scope on the best mount you can manage; physically and financially...

Bigger is rarely better.

You are seeking a balance of camera, mount, telescope, and budget.

## Converging to a solution with what you have...



My first 'modern' imaging system: a 4.5" f/4 Orion StarBlast on a Meade DS-2000 mount (borrowed from a DS-2130) and a Meade DSI color camera.

I used a 15' USB repeater cable on the camera and a 14' Ethernet extension cable on the handbox so that I could control the camera and telescope from inside my house.

I used this system for about a year before moving up to my first 'real' imaging platform.

# Starting Point: An 8" altaz-mounted SCT and a Stock DSLR



Fairly common 8" altaz mounted SCT



DSLRs offer an excellent balance of cost, quality, capability, versatility, simplicity, and opportunity for growth.

They can be used for deepsky, lunar, and planetary imaging, and once modified and used with the right techniques their performance can rival modern cooled astro cameras.

They can be used as stand-alone, with a computer, or operated remotely.

# To connect the camera to your telescope you will need...



- A) EOS to t-Thread Adapter
- B) t-Tread to 1.25" Nosepiece
- ...Or...
- C) t-Thread to 2" Nosepiece
- D) 1.25" IR Blocking Filter
- ...Or...
- E) 2" IR Blocking Filter
- F) Remote Switch or Interval Timer

EOS to t-Thread adapters are often sold with a nosepiece pre-assembled as a unit

A 2" nosepiece is preferred as it provides a solid support and reduces vignetting

An *imaging* light pollution or multi-band filter can be substituted for the IR blocking filter

# Things you will need...





# Things You May Want...

AC Adapter



Photographer's Puffer Bulb

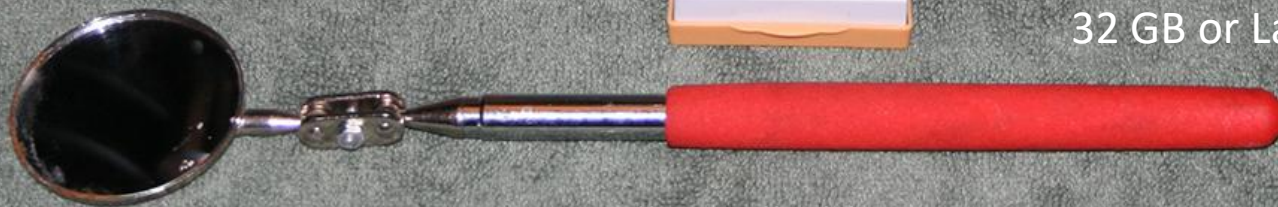
Spare Batteries



High Capacity Memory Card  
32 GB or Larger



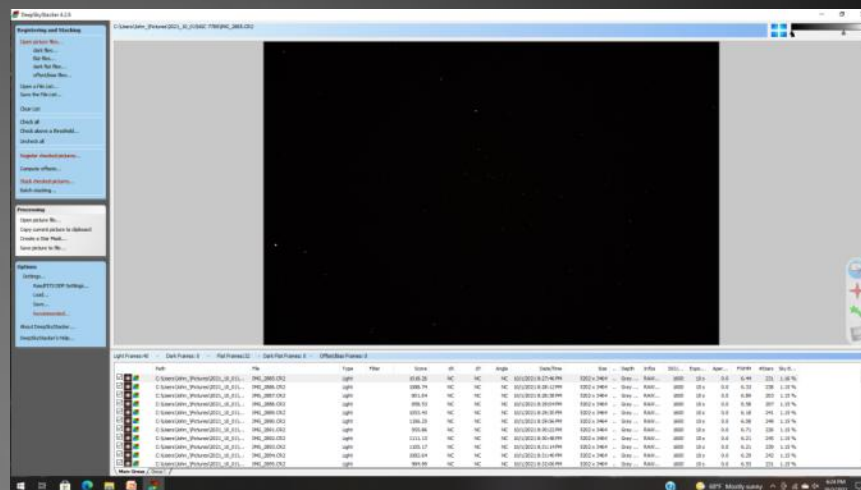
Small Handheld Mirror



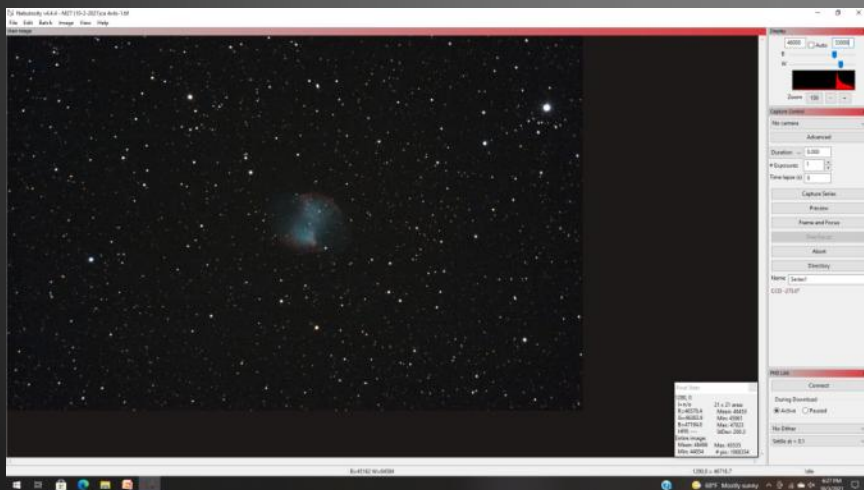
# Software for checking, stacking, and processing your images...



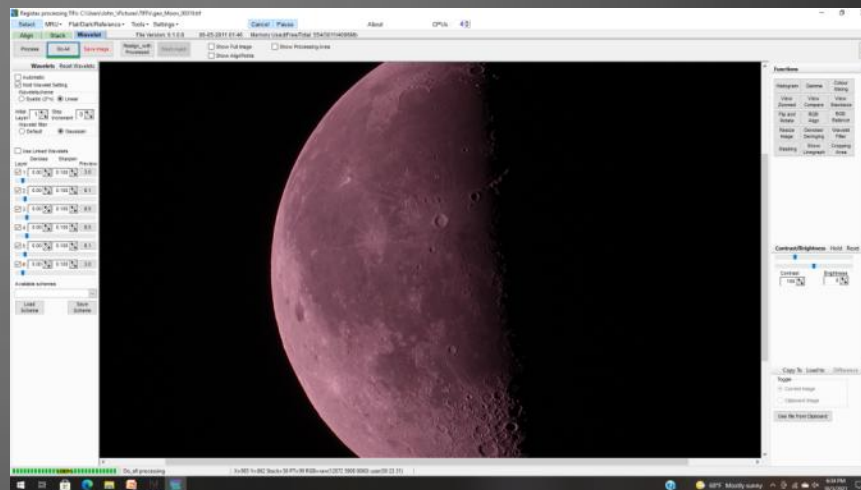
Checking: Digital Photo Professional or View NX



Stacking: Deep Sky Stacker



Processing: Nebulosity  
Soon to be released as Open Source



For Lunar and Planetary Imaging: AutoStakkert and/ or Registax

# Getting ready for your first night out...

Become familiar with your camera and you equipment.

Set everything up in daylight and practice taking and previewing images of distant objects.

You should be very familiar with controlling your camera

- Changing the ISO and exposure
- Previewing images
- Calling up the histogram
- Zooming in and out
- Turning the live view on and off and zooming in and out.

It is helpful to practice enough that you can find the buttons in the dark or with the help of a red headlamp.



# Camera Settings – Deepsky

Camera Mode: Manual

Quality: RAW

Image Preview: Off

Auto power off: Off

Auto rotate: Off

Sensor Cleaning/Auto cleaning: Disable

High ISO Noise Reduction: Disable

Long Exposure Noise Reduction: On

Flats:

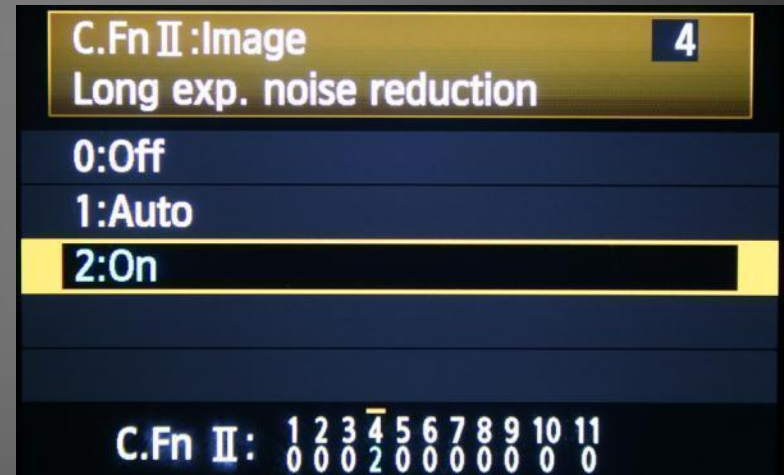
- Gain: ISO 1600
- Exposure 1/250 sec or longer

Frame & Focus

- Gain: ISO 6400
- Exposure 1-2 seconds

Images

- Gain: ISO 1600
- Exposure 10 seconds or longer



# Interval Timer Settings



Startup Delay: 0 seconds

Length: 1 second (holds the shutter button for 1 second)

Interval: 26 seconds

- 10 second exposure +
- 10 second dark +
- 6 seconds for image transfer

Number of exposures: 40

Beep: Off

Total time for 40 images:  $40 \times 26 \text{ sec} = 1,040 \text{ sec} = 17.3 \text{ minutes}$

Note: use the 'hold' button to take single frames

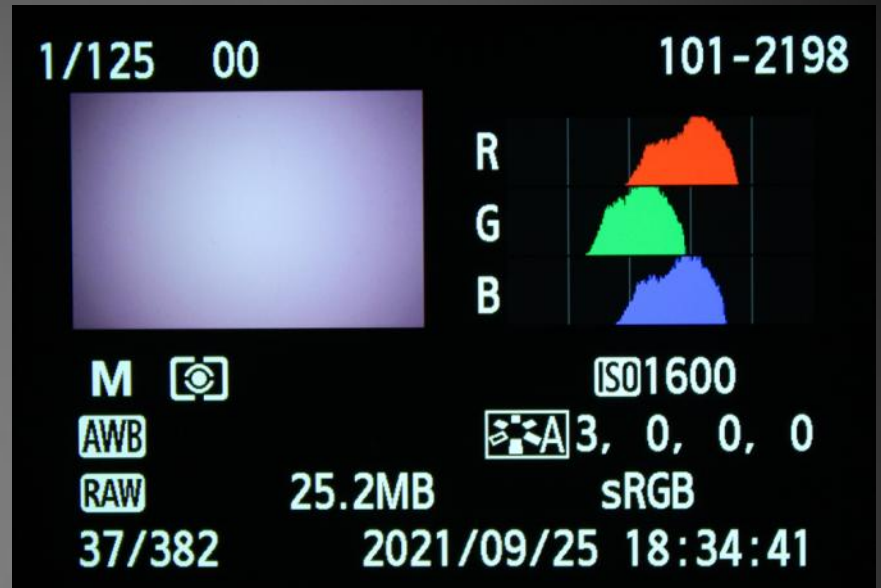
# Putting it all Together...



Align the finder and camera in daylight.

Set the rough focus near infinity by focusing on a distant target.

# Taking Flats



Near the onset of dusk, cover the scope with a clean white cloth.

Using ISO 1600, set the exposure so that the histogram lies between 25% and 75% and no faster than 1/250 sec.

Take 16-32 flats saved as RAW.

Remove the cloth and align your mount as you normally would.

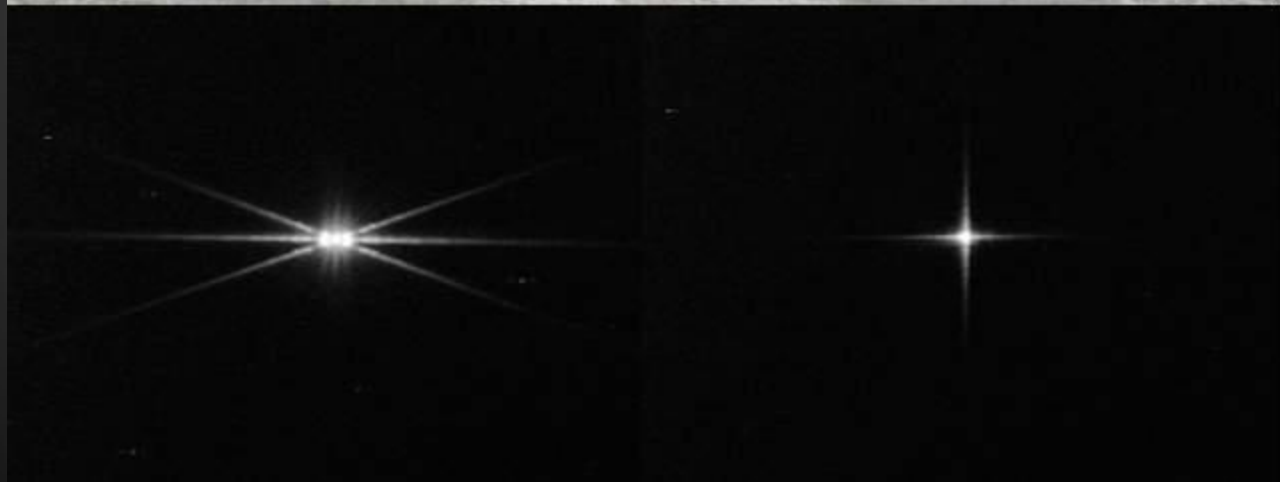
# Setting the Focus using a Focusing mask...



Focusing using Live View with a Bahtinov mask...

If you don't have Live View you can take a series of 1 sec test shots and use the preview function to zoom in on the focusing star.

***Always set the focus turning the knob CCW!***



Bahtinov Mask

Modified Hartmann Mask



## Framing & Centering...



Frame the field by taking a series of short exposures (1-2 sec) using the highest useable gain (ISO 6400) making small changes between each frame until the field is centered



Pause between each frame to allow the tracking to settle

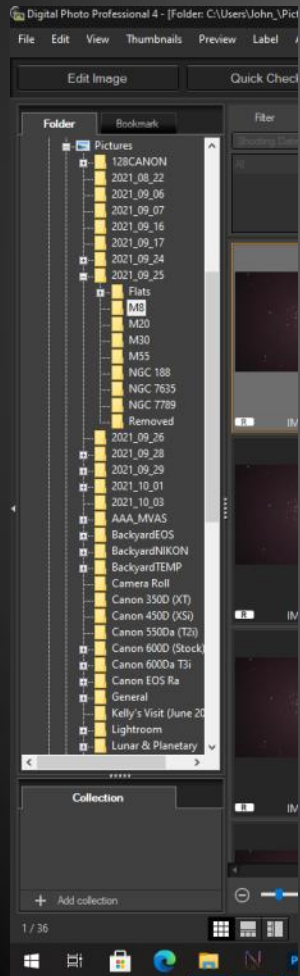


Once framed, reset the gain (ISO 1600) and exposure (10 sec) and start the interval timer



# Sorting the Source Images

- Separate the source images into individual folders
- Move rejected images into a temporary folder
- Preview each image, removing the images that show trailing or other flaws
- Try not to be too picky, ideally you will keep at least 50% of your source images



Elongated stars, poor tracking...



Airplane, satellite tracks...

# Stacking and Calibrating the Source Images

The screenshot displays the DeepSkyStacker 4.2.6 software interface. The main window shows a list of image files in the 'Main Group' and a table of image metadata. Three dialog boxes are open:

- Register Settings (Left):** Shows the 'Actions' tab with options: 'Register already registered pictures' (unchecked), 'Automatic detection of hot pixels' (unchecked), and 'Stack after registering' (checked). A slider is set to 100% for 'Select the best % pictures and stack them.' A yellow box contains the text: 'Don't forget to add and check dark and offset frames before stacking.'
- Register Settings (Right):** Shows the 'Advanced' tab with a 'Star detection threshold' slider set to 5%. A button 'Compute the number of detected stars' is visible. The 'Reduce the noise by using a Median Filter' checkbox is checked.
- Stacking Parameters (Bottom):** Shows the 'Result' tab with 'Mosaic Mode' selected. A preview window shows a star field with a green box. Text below the preview reads: 'The result of the stacking process contains all the light frames of the stack.'

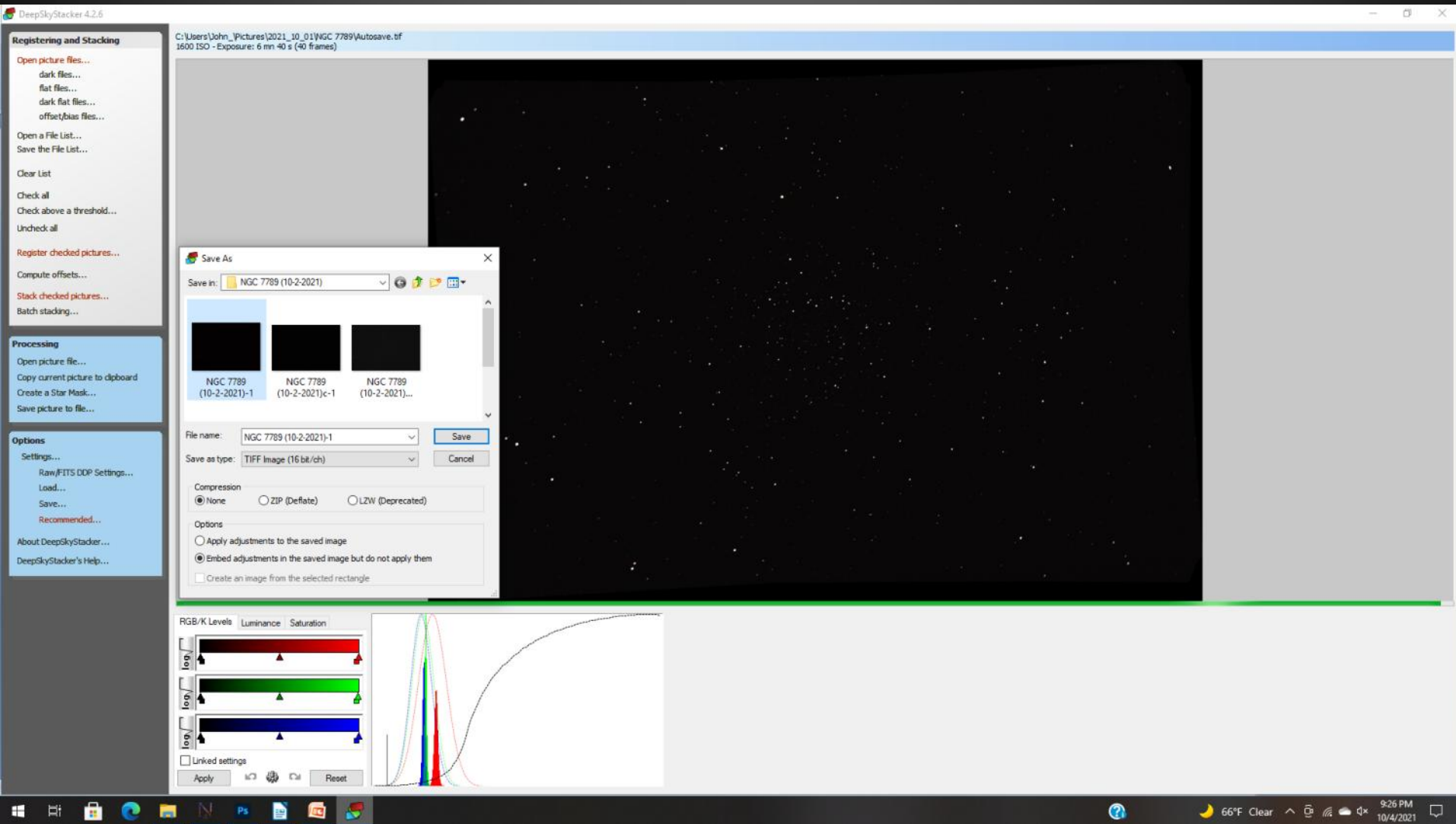
The main window's metadata table includes the following data:

Date/Time	Size	Depth	Info	ISO/...	Expo...	Aper...	PW/PM	#Stars	Sky B...
10/1/2021 8:27:46 PM	5202 x 3464	..	Gray ...	RAW...	1600	10 s	0.0	6.44	231 1.15 %
10/1/2021 8:28:12 PM	5202 x 3464	..	Gray ...	RAW...	1600	10 s	0.0	6.33	238 1.15 %
10/1/2021 8:28:38 PM	5202 x 3464	..	Gray ...	RAW...	1600	10 s	0.0	6.09	203 1.15 %
10/1/2021 8:29:04 PM	5202 x 3464	..	Gray ...	RAW...	1600	10 s	0.0	6.58	207 1.15 %
10/1/2021 8:29:30 PM	5202 x 3464	..	Gray ...	RAW...	1600	10 s	0.0	6.18	241 1.15 %
10/1/2021 8:29:56 PM	5202 x 3464	..	Gray ...	RAW...	1600	10 s	0.0	6.08	249 1.15 %
10/1/2021 8:30:22 PM	5202 x 3464	..	Gray ...	RAW...	1600	10 s	0.0	6.71	226 1.15 %
10/1/2021 8:30:48 PM	5202 x 3464	..	Gray ...	RAW...	1600	10 s	0.0	6.21	245 1.15 %
10/1/2021 8:31:14 PM	5202 x 3464	..	Gray ...	RAW...	1600	10 s	0.0	6.21	239 1.15 %
10/1/2021 8:31:40 PM	5202 x 3464	..	Gray ...	RAW...	1600	10 s	0.0	6.29	242 1.15 %
10/1/2021 8:32:06 PM	5202 x 3464	..	Gray ...	RAW...	1600	10 s	0.0	6.55	231 1.15 %

Open picture files, load flat files, check all, register checked pictures...

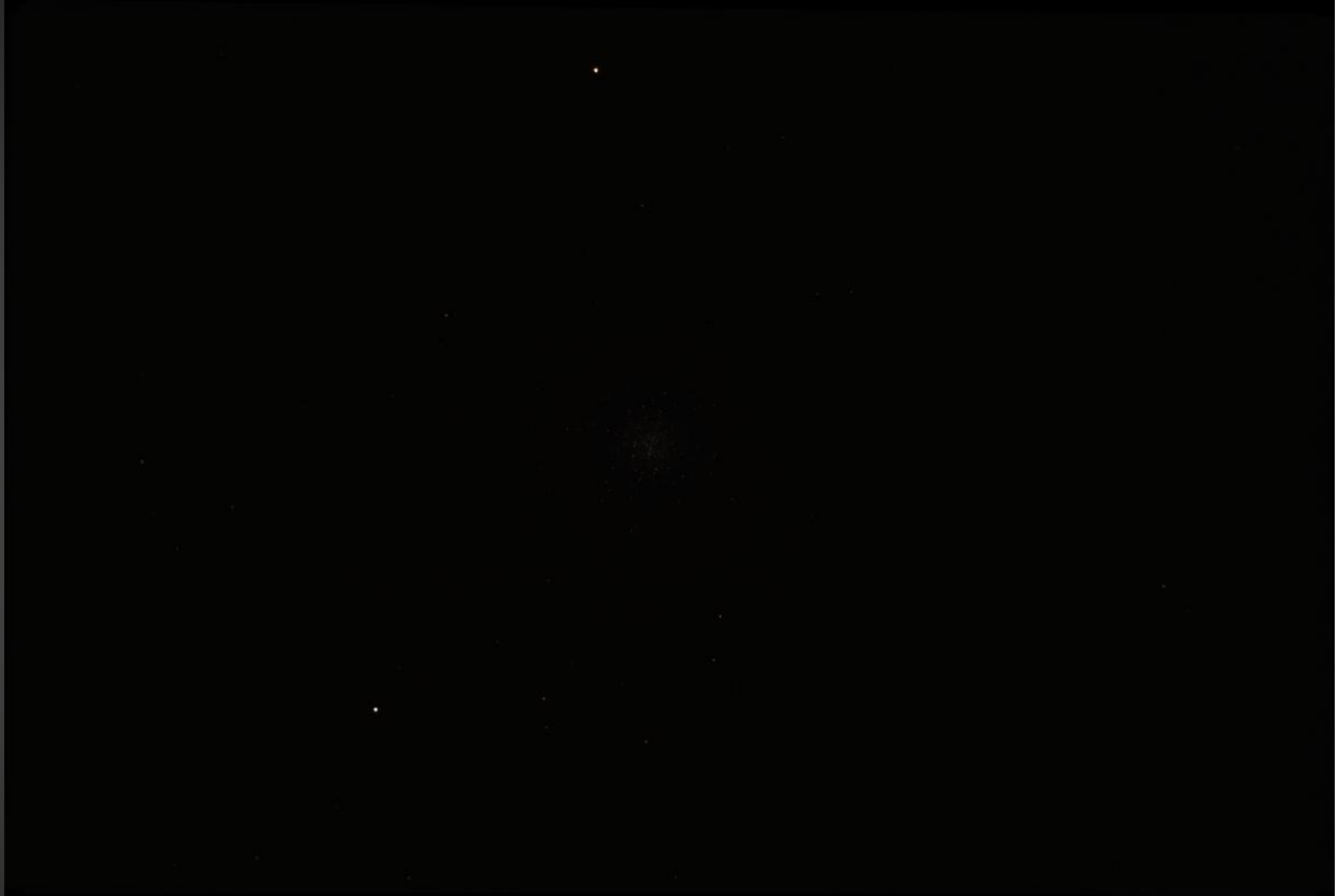
Register settings; Actions, Advanced/Star detection threshold, Stacking parameters/Result/Mosaic mode

# Saving Your Stacked Image...



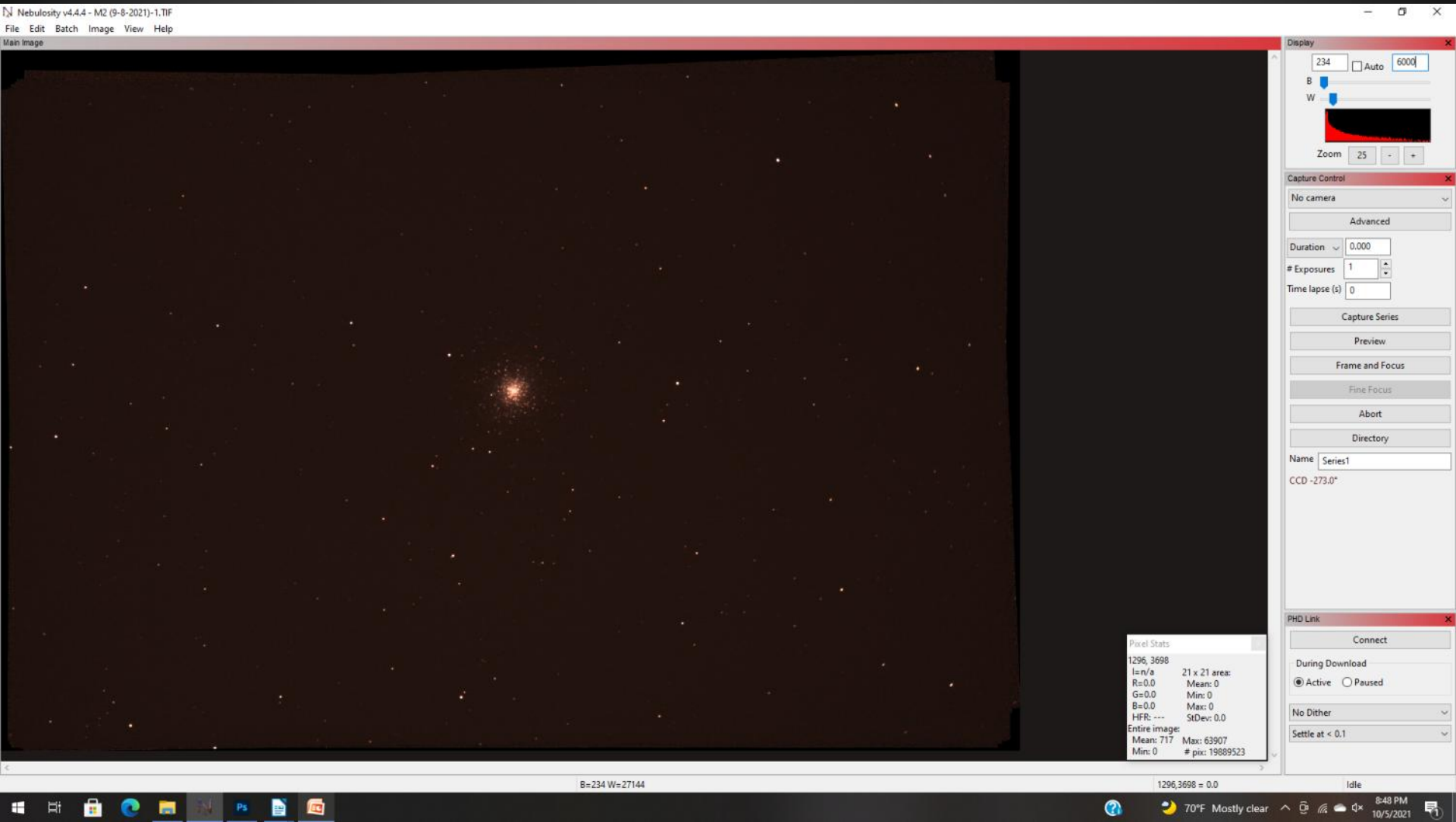
After you first image set has been stacked you can use the Master Flat...

# Processing the Stacked Image



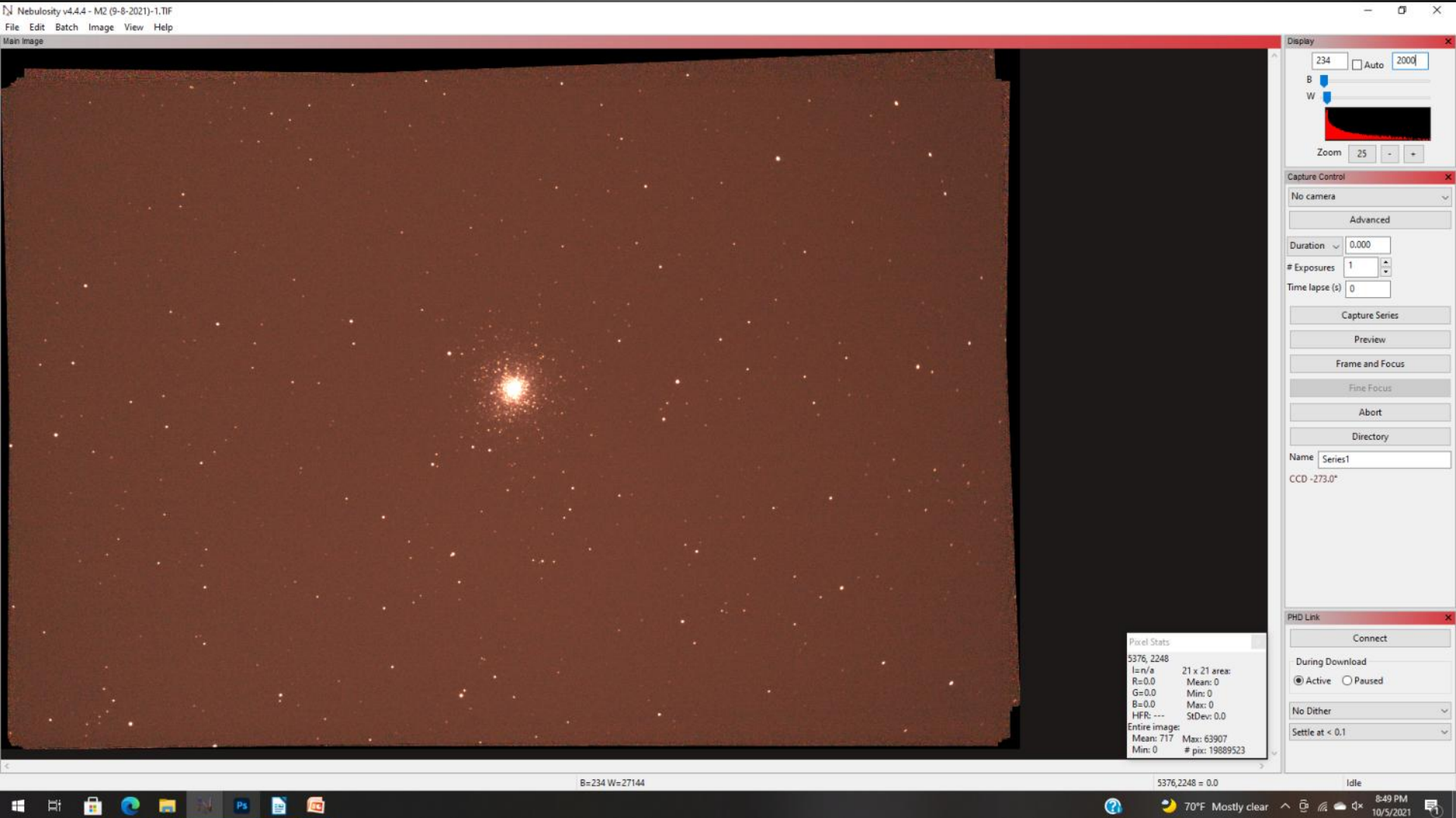
M2: 24 x 10s, ISO 1600  
From my first night out with the LX90

# Basic Processing in Nebulosity



Brightened to show the cluster a little better... scaled 25% to show the entire frame.

# Basic Processing in Nebulosity



Brightened to show the edges of the field...

The rough edges are the result of drift and field rotation.

The field looks reasonably smooth with no dust motes.

# Basic Processing in Nebulosity

The screenshot displays the Nebulosity v4.4.4 software interface. The main window shows a large image of a star field with a bright central star. The interface includes a menu bar (File, Edit, Batch, Image, View, Help) and a toolbar. On the right side, there are several control panels:

- Display:** Shows a zoom level of 25 and a preview window.
- Capture Control:** Includes a dropdown menu for "No camera", a "Duration" field set to 0.000, "# Exposures" set to 1, and "Time lapse (s)" set to 0. It also has buttons for "Capture Series", "Preview", "Frame and Focus", "Fine Focus", "Abort", and "Directory".
- PHD Link:** Includes a "Connect" button, a "During Download" section with "Active" selected, and "No Dither" and "Settle at < 0.1" options.

A "Pixel Stats" window is open in the bottom right corner, displaying the following data:

Pixel Stats	
5126, 2684	
l= n/a	21 x 21 area:
R= 827.0	Mean: 709
G= 591.0	Min: 564
B= 547.0	Max: 844
HFR: ---	StDev: 47.5
Entire image:	
Mean: 751	Max: 59839
Min: 213	# pix: 1681433

The Windows taskbar at the bottom shows the system tray with the date 10/5/2021 and time 8:52 PM.

The first step is to crop the edges to give us a clean field to work with...



# Basic Processing in Nebulosity

The screenshot displays the Nebulosity v4.4.4 software interface. The main window shows a grayscale image of a star field with a bright central cluster. The interface includes a menu bar (File, Edit, Batch, Image, View, Help) and a toolbar. On the right side, there are several control panels:

- Display:** Shows brightness (B) set to 234 and width (W) set to 2000. A zoom level of 25 is also indicated.
- Capture Control:** Shows "No camera" selected, "Advanced" mode, "Duration" set to 0.000, "# Exposures" set to 1, and "Time lapse (s)" set to 0. Buttons for "Capture Series", "Preview", "Frame and Focus", "Fine Focus", "Abort", and "Directory" are visible.
- PHD Link:** Shows "Connect" button, "During Download" status with "Active" selected, and "Settle at < 0.1".

A "Pixel Stats" window is open in the bottom right corner, displaying the following data:

Pixel Stats	
5126, 2488	
l=n/a	21 x 21 area:
R=852.0	Mean: 955
G=957.0	Min: 827
B=1317.0	Max: 1109
HFR: ---	StDev: 52.9
Entire image:	
Mean: 1004	Max: 65535
Min: 336	# pix: 16811433

The Windows taskbar at the bottom shows the system tray with the date and time: 8:53 PM, 10/5/2021.

Next, we apply the first of several automatic color balances to get the colors about right. The image appears over-exposed because I left the brightness turned up, but this is only on the display, the actual source image is still fairly dark.

# Basic Processing in Nebulosity

The screenshot displays the Nebulosity v4.4.4 software interface. The main window shows a zoomed-in view of a star cluster. A 'Pixel Stats' window is open in the bottom right corner, displaying the following data:

Pixel Stats	
3398, 1896	
l=n/a	21 x 21 area:
R=1014.0	Mean: 1020
G=1070.0	Min: 901
B=879.0	Max: 1136
HFR: ---	StDev: 43.0
Entire image:	
Mean: 1004	Max: 65535
Min: 336	# pix: 16811433

The software interface includes a menu bar (File, Edit, Batch, Image, View, Help), a toolbar, and a right-hand panel with various controls. The 'Display' panel shows a zoom level of 100%. The 'Capture Control' panel shows 'No camera' selected. The 'PHD Link' panel shows 'Connect' and 'Active' options.

If you zoom in 100% you see that we are over-sampled and there's a bit of noise in the background. At this level it doesn't look too bad, but it will get worse as we enhance the image. We can take improve all of these issue by binning the image 2x2.

# Basic Processing in Nebulosity

The screenshot displays the Nebulosity v4.4.4 software interface. The main window shows a dark field of stars with a bright central cluster. The interface includes a menu bar (File, Edit, Batch, Image, View, Help) and a toolbar. On the right side, there are several control panels:

- Display:** Shows image dimensions (3042 x 2808), a zoom level of 100, and a histogram.
- Capture Control:** Includes a dropdown for 'No camera', an 'Advanced' section with 'Duration' set to 0.000, '# Exposures' set to 1, and 'Time lapse (s)' set to 0. Buttons for 'Capture Series', 'Preview', 'Frame and Focus', 'Fine Focus', 'Abort', and 'Directory' are present.
- PHD Link:** Features a 'Connect' button, a 'During Download' section with 'Active' selected, and a 'Settle at < 0.1' dropdown.

A 'Pixel Stats' window is open in the bottom right corner, displaying the following data:

Pixel Stats	
1280, 226	
I: n/a	21 x 21 area:
R: 3575.0	Mean: 3725
G: 3559.0	Min: 3458
B: 3686.0	Max: 3957
HFR: ---	StDev: 91.1
Entire image:	
Mean: 4010	Max: 65535
Min: 2979	# pix: 1049139

The Windows taskbar at the bottom shows the system tray with the date and time: 9:02 PM, 10/5/2021, and weather: 70°F Mostly clear.

Binned 2x2 sum, auto color balance, binned 2x2 average, auto color balance again. At this point I would ordinarily export the image over the PhotoShop for final processing, but we can finish this using curves in Nebulosity.

# Basic Processing in Nebulosity

The screenshot displays the Nebulosity v4.4.4 software interface. The main window shows a star field image with a bright star cluster in the center. The interface includes a menu bar (File, Edit, Batch, Image, View, Help) and a toolbar. On the right side, there are several control panels:

- Display Panel:** Shows image dimensions (28782 x 55692), a histogram, and a zoom level of 100.
- Capture Control Panel:** Includes a dropdown for camera selection (No camera), an Advanced section with Duration (0.000), # Exposures (1), and Time lapse (0). It also has buttons for Capture Series, Preview, Frame and Focus, Fine Focus, Abort, and Directory.
- PHD Link Panel:** Includes a Connect button, a During Download section with Active/Paused radio buttons, and a Settle at < 0.1 dropdown.

A Pixel Stats window is open in the bottom right corner, displaying the following data:

```
Pixel Stats
1280, 818
l=n/a      21 x 21 area:
R=30455.1  Mean: 30463
G=29803.8  Min: 29668
B=31513.4  Max: 31344
HFR: ---   StDev: 319.9
Entire image:
Mean: 31078Max: 65535
Min: 27927 # pix: 1049139
```

The Windows taskbar at the bottom shows the system tray with the date and time (9:07 PM, 10/5/2021) and weather information (70°F, Mostly clear).

Automatic curves and automatic brightness...

## Final Image using Nebulosity



Pre-sorted, stacked in Deep Sky Stacker, processed in Nebulosity.  
Cropped, color balanced, binned sum, binned average, curves, saved as BMP.

Pre-processed in Nebulosity, finished in Photoshop...



M2, 24x10s, ISO 1600

# Closing Thoughts...



You can put together a reasonably good starter system largely from parts that you may already have.

The key is taking the first step and gaining some experience.

That will give you a basis for making decisions on where you go from here.

Experience is the absolute best tool in your toolbox

Also, remember the most important rules...

**Rule #1: there are no rules, only guidelines.**

**Rule #2: see Rule #1.**

Never let anyone tell you what you are doing is wrong, there is no One True Way.

Start at the beginning, take it one step at a time, and enjoy the ride!

# Questions?



M27, 37x10s, ISO 1600