

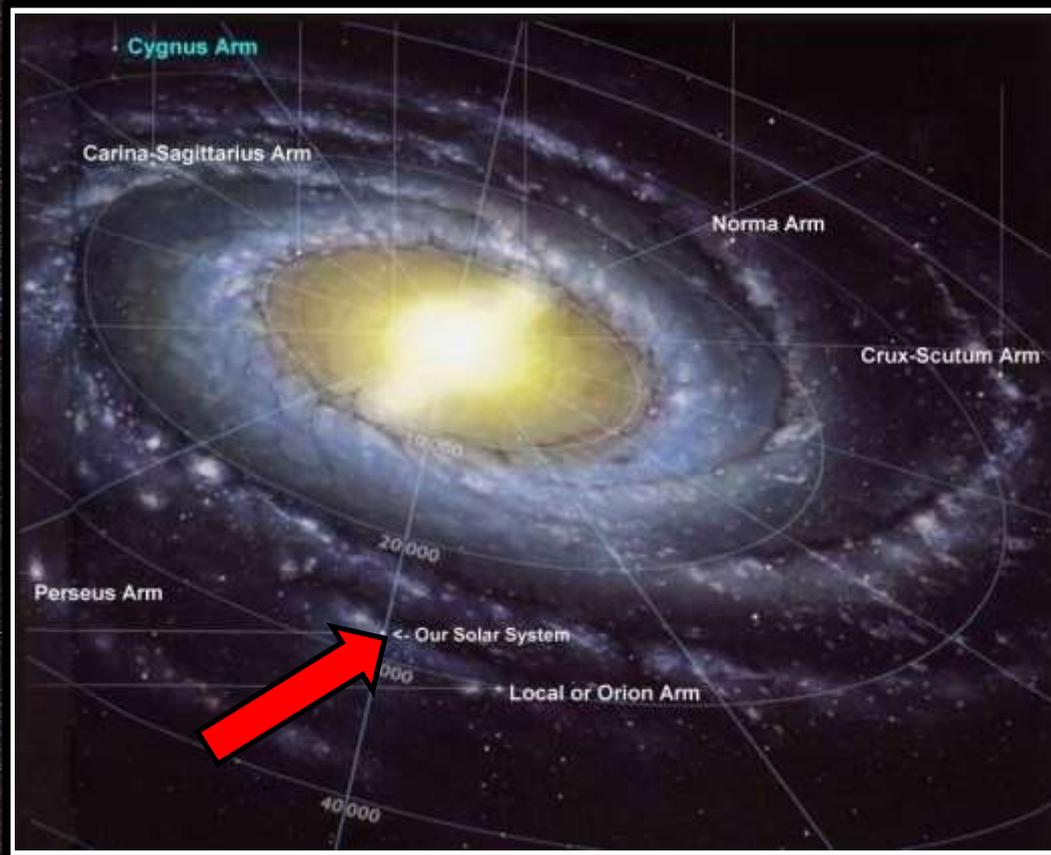
DSLR ASTROPHOTOGRAPHY OF THE MILKY WAY & STAR TRAILS

An Overview of DSLR Astrophotography

By: Bill O'Neil

THE MILKY WAY

- ▣ At its center is a black hole called Sagittarius A Star.
- ▣ Appx 4,020,000 x sun, at 26,000 ly, 60,000,000 km.
- ▣ To us, the Milky Way appears as a densely packed band of stars running from horizon to horizon.



MY FIRST MILKY WAY PHOTO

Canon t3i

Rokinon 16mm f/2

15 sec x 20

f/2

ISO 3200

Wallpack Valley NJ



MY LAST MILKY WAY PHOTO

Canon 6d

Sigma 24mm f/1.4

13 sec x 30

f/1.4

ISO 1600

Jackson Lake

Grand Teton National
Park

2018



STAR TRAILS

This is when we take a long exposure and do not compensate for the movement of the Earth.

Canon 6D

Sigma 24mm f/1.4

30 sec x 100

f/1.4

ISO 1600

Lusscroft Farms

Wantage NJ





Canon 6D, Sigma 24mm f/1.4 - 15 sec x 140, f/1.4, ISO 1600
The 3 Brothers, Yosemite National Park

PLANNING



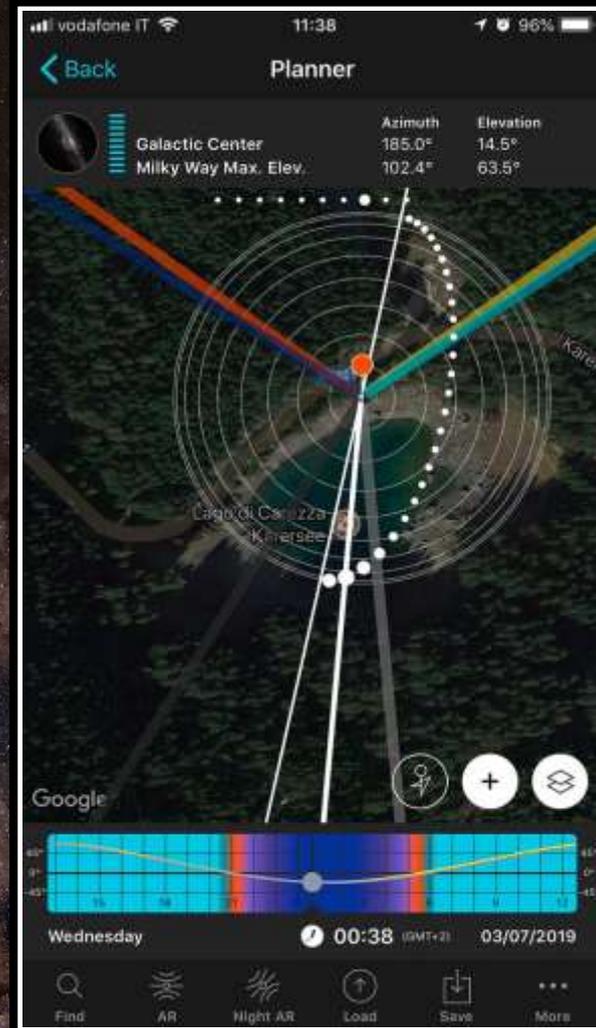
LOCATION & WEATHER

- ▣ Try to find a dark spot with a good view to the south
 - There is no substitute for dark skies!!
 - [Dark site finder](#) or [Light Pollution Map](#)
- ▣ For wide field astrophotography it will need to be clear of clouds!
 - Check local & astronomical weather forecasts
- ▣ Check moon phase, rise and set.
 - No moon for Milky Way, some moon for star trails but not full moon.
- ▣ [Clear Outside](#) & [Photopills](#) Apps will cover all weather and site planning.
- ▣ Photopills tutorial
 - [How To Find And Plan The Milky Way](#)

PLANNING APPS



[Clear Outside](#)



[Photopills](#)

YOU ARE GOING TO HATE THIS THING!!!



Canon 7D Mii, Sigma 150-600mm (at 600mm) 1/1600, f/6.3, ISO 800

THERE IS NO SUBSTITUTE FOR DARK SKIES

Canon 6D

Sigma 24mm f/1.4

15 sec x 20

f/1.4

ISO 3200

Olmsted Point

Yosemite National

Park

2016



THERE IS NO SUBSTITUTE FOR DARK SKIES

Canon 6D

Sigma 24mm f/1.4

15 sec x 20

f/1.4

ISO 1600

Olmsted Point

Yosemite National
Park

2017



**IT CAN BE DONE
FROM
NEW JERSEY**

Canon 6D

Sigma 24mm f/1.4

15 sec x 20

f/1.4

ISO 1600

Lusscroft Farms

Wantage NJ

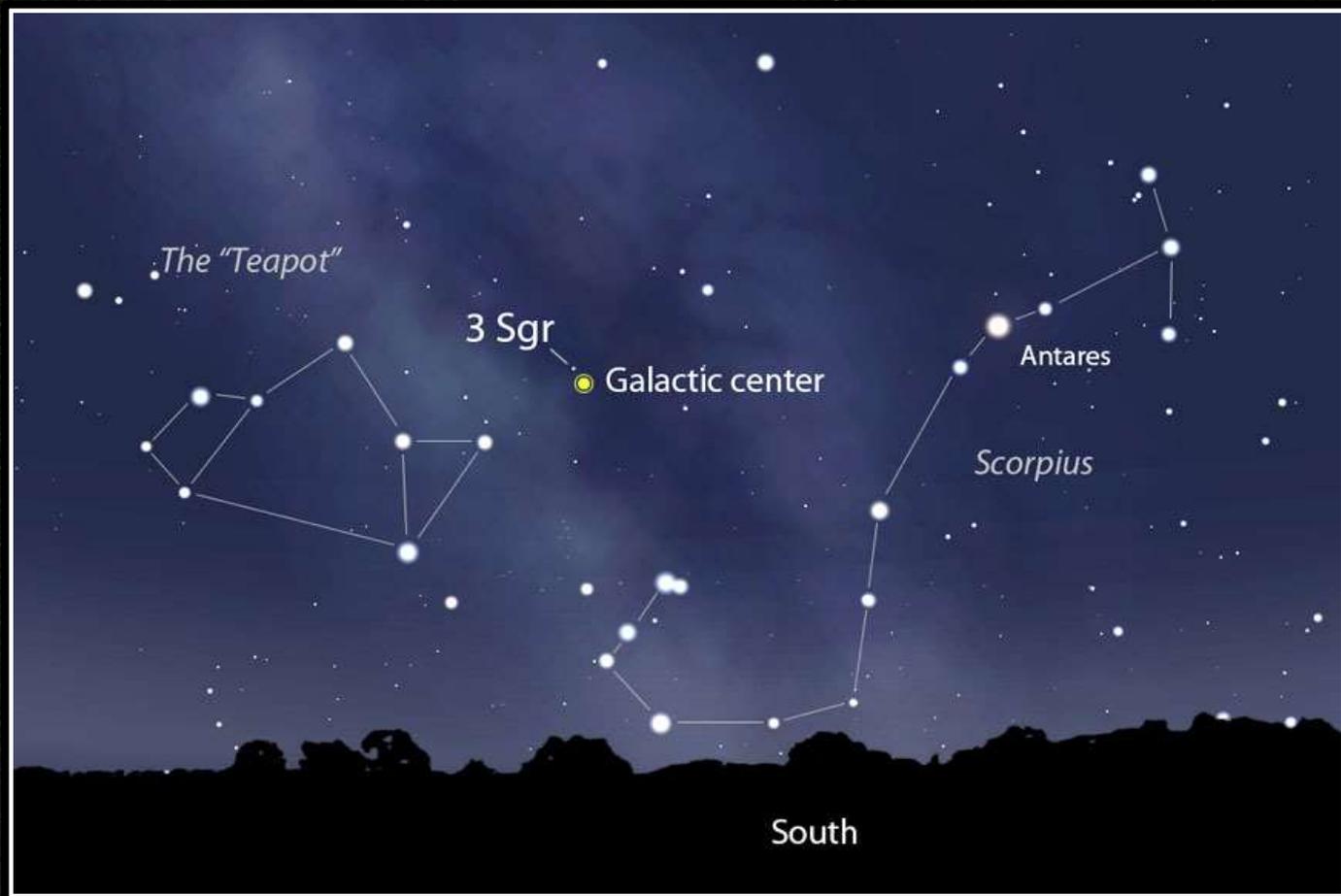




FIND IT IN THE
SKY

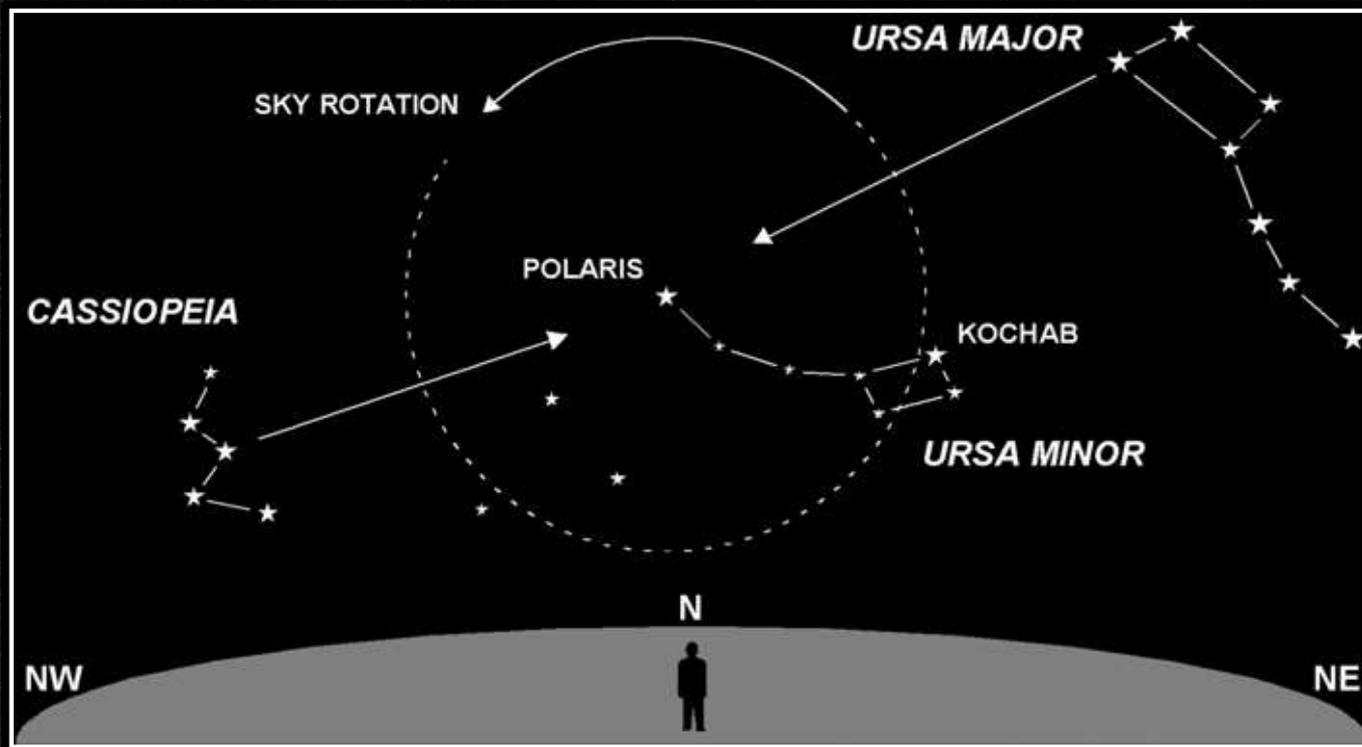
SOUTH FOR THE MILKY WAY

- Just look South! The Milky Way is very large and can be seen with the naked eye in a dark location.



NORTH FOR STAR TRAILS

- ▣ For circular trails you will need to find north.
 - The sky rotates around Polaris (north star)
 - Trails don't always have to be circular, you can shoot them in any direction.



EQUIPMENT



BASIC EQUIPMENT LIST

- ▣ DSLR Camera
- ▣ Wide angle lens, FAST
- ▣ Tripod, STURDY
- ▣ Intervalometer
- ▣ Memory Card
- ▣ **Red** head light
- ▣ Gaffers or painters tape
- ▣ Hand warmers
- ▣ Star chart / map
- ▣ Smart phone with planetarium app
- ▣ Extra batteries
- ▣ Warm clothes
- ▣ Lawn chair
- ▣ Coffee, water, etc...



FAST WIDE ANGLE LENS

**Rokinon
14mm f/2.8**



**Rokinon
24mm f/1.4**



**Sigma
24mm f/1.4**



BEST

- ▣ Prime is preferred over zoom lens
- ▣ Get fast as possible, f/2.8 or faster

[Astrophotography 101 - Lens Guide and Recommendation](#)

SETTING UP YOUR CAMERA

Start same as you would for any other landscape shot with the following extra steps.

- ▣ **FROM HERE ON, RED LIGHT ONLY!!!!!!**
 - **It takes 25 minutes to get full night vision adjusted**
- ▣ Tape over your view finder, light WILL leak in.
- ▣ Tape hand warmer under lens for dew prevention.
- ▣ Hang weight to stabilize tripod.
- ▣ Remove any straps/dangling parts.
- ▣ To aim, just look over the top of the lens. We will adjust with test shots later.



CAMERA SETTINGS

THE 500 RULE FOR EXPOSURE

- ▣ Formula for setting initial max shutter time so stars will appear round.

$$500 \div (\text{crop factor} \times \text{focal length}) = \text{exposure}$$

- ▣ Example problem: Canon 6D - 1.0 CF, 24mm f/1.4 lens

$$500 \div (1.0 \text{ CF} \times 24\text{mm FL}) = 20.83 \text{ sec}$$

NPF RULE FOR EXPOSURE

- ▣ More accurate

$$\frac{(35 \times f/\text{stop}) + (35 \times \text{pixel size})}{\text{Focal length} \times \text{Crop}} = \text{exposure}$$

- ▣ Example problem: Canon 6D - 1.0 CF, 24mm f/1.4 lens

$$\frac{(35 \times 1.4) + (35 \times 6.45)}{24 \times 1.0} = 11.44 \text{ sec}$$

[Astrophotography 101 - Eliminating Star Trails](#)

FOCUSING

- ▣ Pre-focus to infinity in day light with auto focus.
 - Use your live view screen + zoom in
 - **AF off**, and tape your focus ring in place
- ▣ Live view focus at night.
 - Zoom in on bright star in live view
 - **AF off**, manually focus the star until it appears as small and sharp as possible.
 - Use gaffers tape to hold focus ring.
- ▣ As you come to focus, small dim stars will suddenly appear and will disappear as you move out of focus.

CAMERA SETTINGS

▣ Camera settings

- Mode: **BULB**
- Long exposure noise reduction: **OFF**
- High ISO noise reduction: **OFF**
- Shutter drive: **SINGLE SHOT**
- Photo format: **RAW**
- Creative mode: **STANDARD**
- Image preview: **OFF**

▣ Lens

- Mode: **MANUAL**
- OS: **OFF**

▣ Exposure settings

- **Shutter speed:**
MW = 500/NPF rule
ST = 15 sec to 30 sec
- F/ stop: **1.4 - 2.8**
- ISO: **1600 - 6400**
- White balance: **DAYLIGHT** or **4500K**
- Exposure comp: **±0**

COMPOSING

The background of the image is a deep space photograph showing the Milky Way galaxy. The galaxy's core is visible as a bright, hazy band of light stretching diagonally across the frame. The surrounding space is filled with a dense field of stars of various colors, including white, yellow, and blue. The overall tone is dark and cosmic.

COMPOSING THE MILKY WAY

Framing: landscape early season, portrait for later

8mm (APS-C) - 14mm (Full Frame)

30 seconds

12mm (APS-C) - 18mm (Full Frame)

27 seconds

16mm (APS-C) - 24mm (Full Frame)

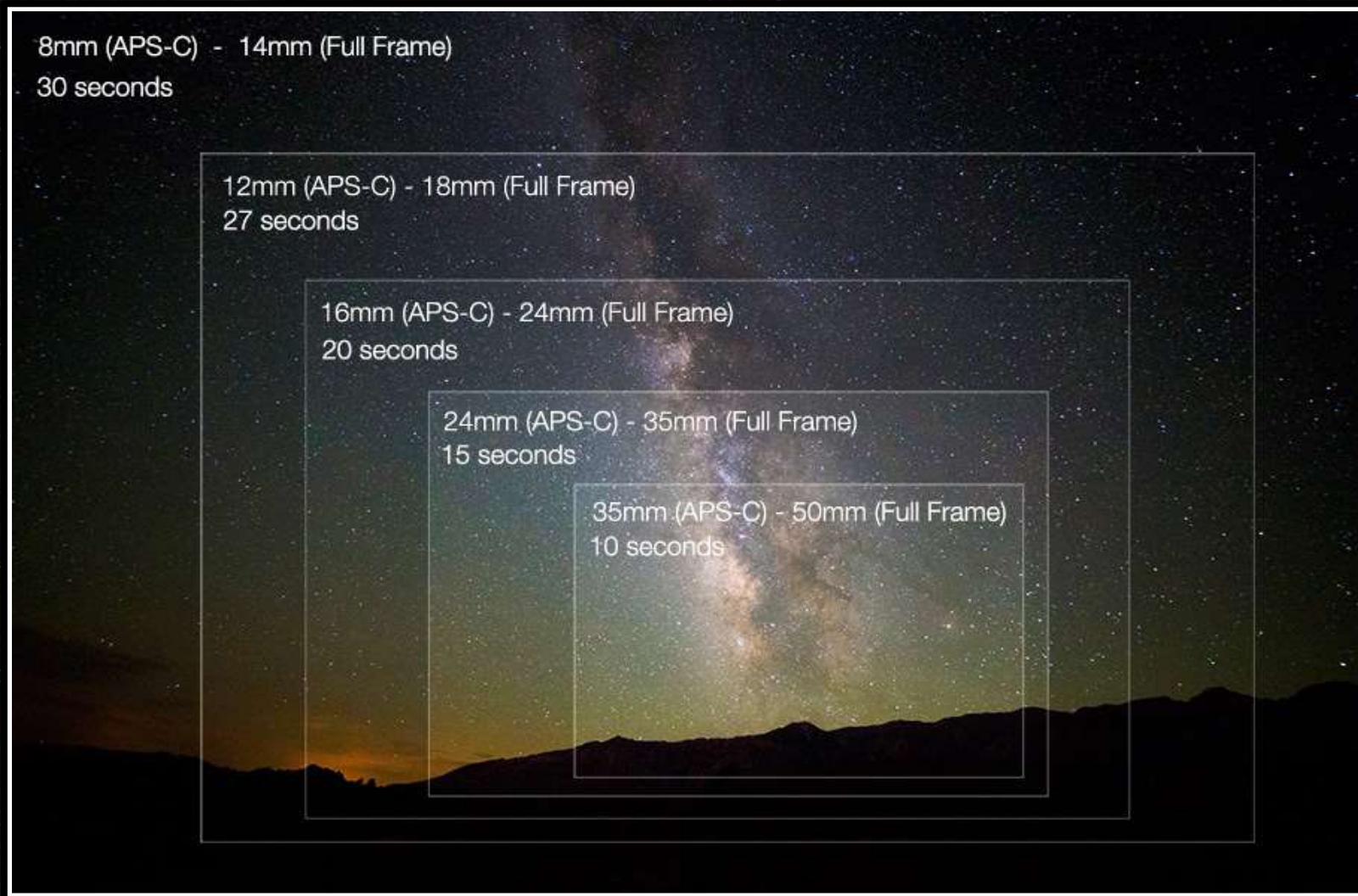
20 seconds

24mm (APS-C) - 35mm (Full Frame)

15 seconds

35mm (APS-C) - 50mm (Full Frame)

10 seconds



COMPOSING THE MILKY WAY

The best shots of the
Milky Way are looking
South

Canon 6D

Sigma 24mm f/1.4

15 sec x 20

f/1.4

ISO 1600

Lusscroft Farms

Wantage NJ





COMPOSING THE MILKY WAY

**But looking to the North
can make some nice
shots too!**

Canon 6D

Sigma 24mm f/1.4

15 sec x 20

f/1.4

ISO 1600

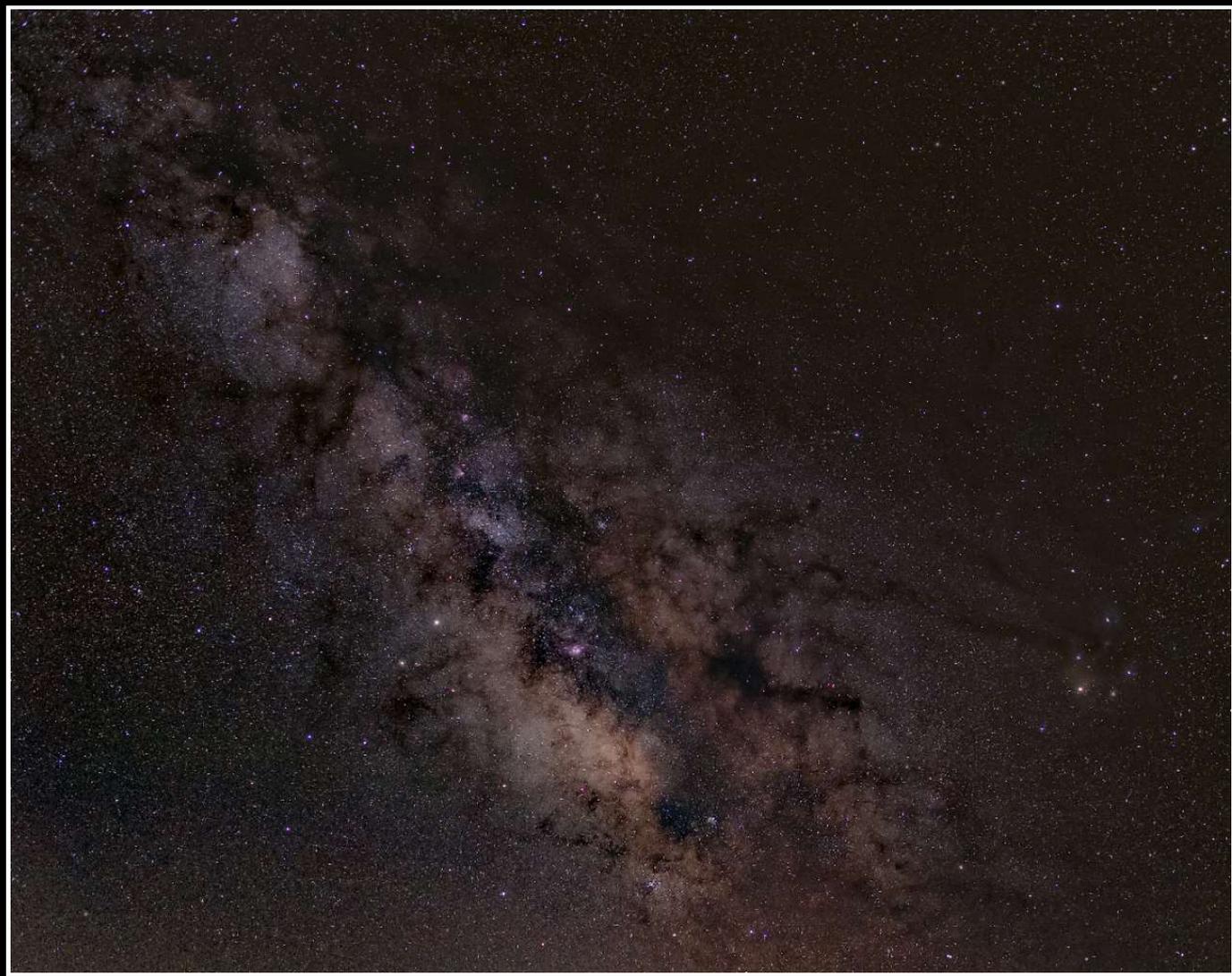
Lusscroft Farms

Wantage NJ

COMPOSING THE MILKY WAY

Canon 6d, Sigma 24mm f/1.4, 15 sec x 20, F/2.8, ISO 3200

Losscroft Farm, Wantage, NJ



COMPOSING STAR TRAILS

Experiment with
different times, direction,
lighting

Looking North
Moon light
About 30 minutes
Lusscroft Farms
Wantage NJ





COMPOSING STAR TRAILS

Experiment with
different times, direction,
lighting

Looking South

No moon, some clouds

About 40 minutes

Sherman Lake

Warrensburg NY

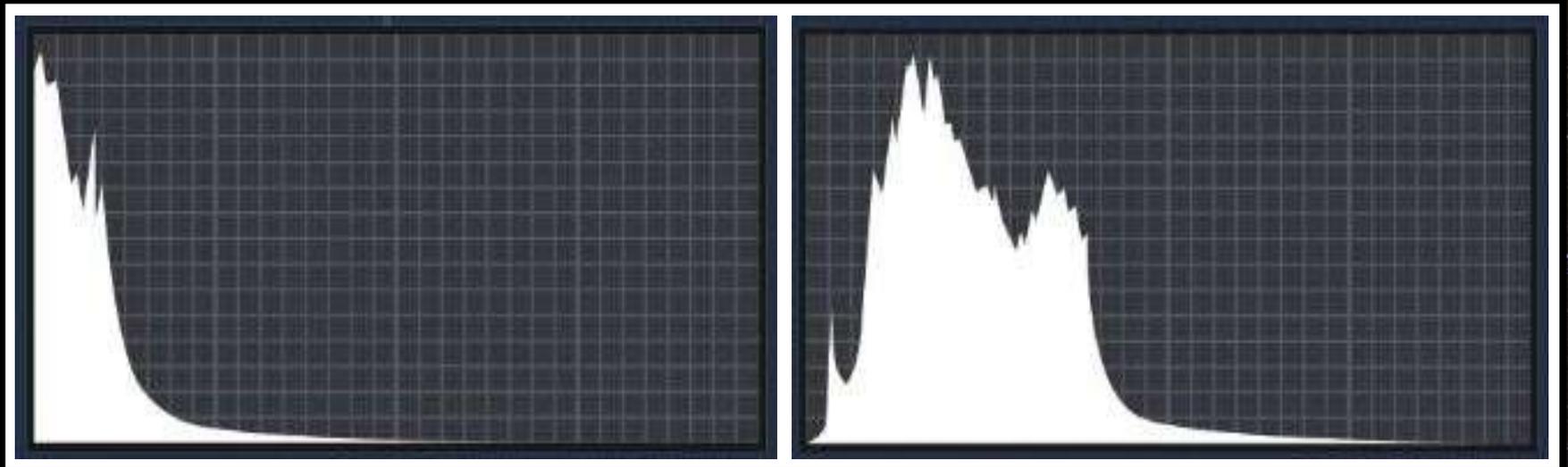
COMPOSING STAR TRAILS

Looking West, no moon, about 40 minutes



TEST SHOTS

- ▣ Check your composition and re-compose as needed.
 - After all, we only aimed down the side of the lens
- ▣ Check histogram for exposure
 - Don't go by what you see on your preview screen.
 - Make sure you are "off the wall"
 - ▣ Fix: increase exposure, ISO and/or F-stop



BAD

GOOD

TEST SHOTS

- ▣ Check your focus!!! Use zoom on preview screen.
 - Refocus as needed
- ▣ Check for elongated stars (zoom center and corners)
 - Set faster shutter speed
- ▣ Check for astigmatism (zoom into corners)
 - Stop down lens

FOCUS



SHUTTER



ASTIGMATISM



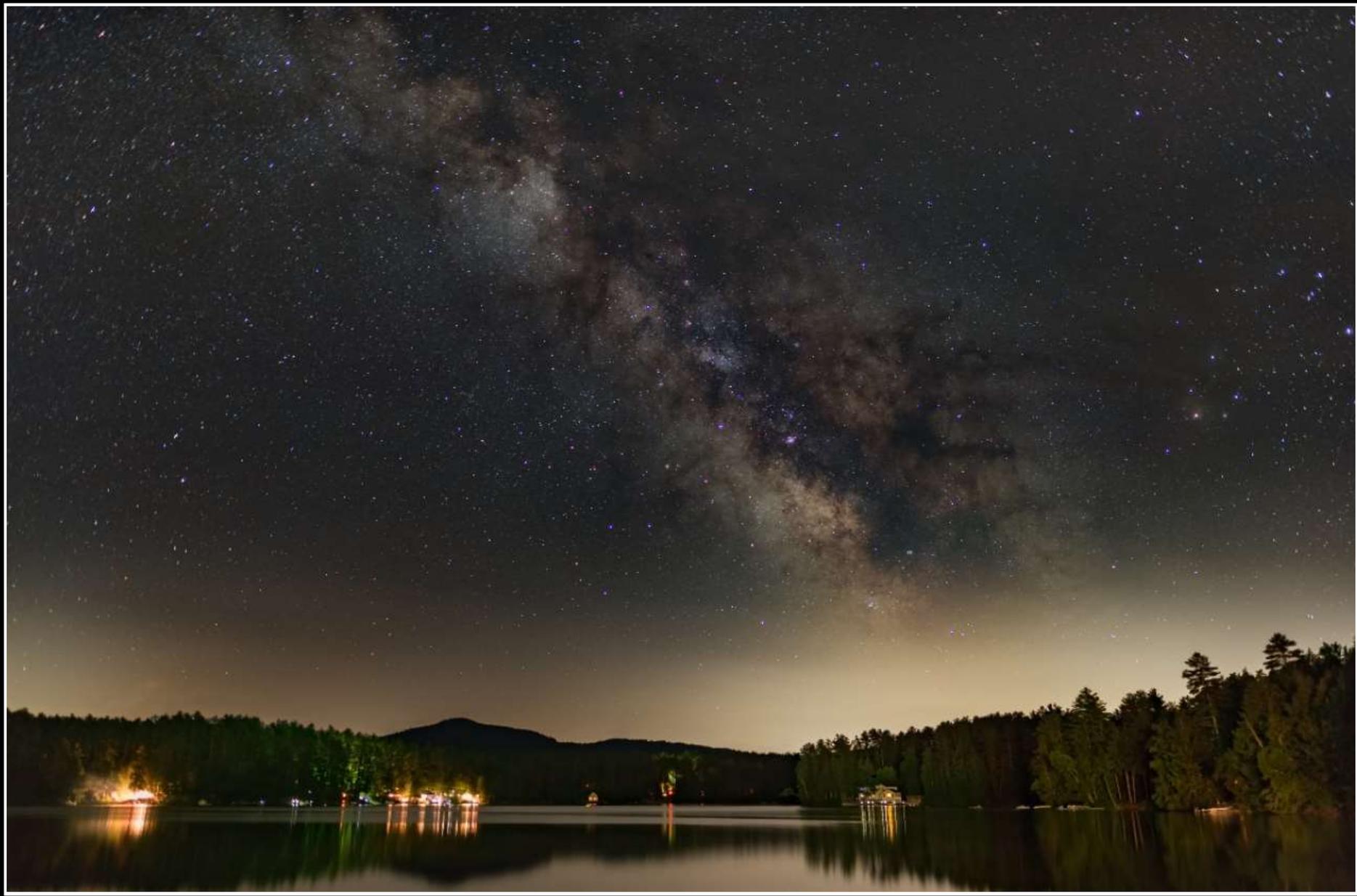


TAKING THE PHOTOS

SHOOT THE MILKY WAY

- ▣ For the best results you will need to take a sequence of shots, between 16 and 30 that will be “stacked”
- ▣ Program a sequence into your Intervalometer.
 - Start delay: **5 sec**
 - Exposure time: **15 sec (adjusted from test shooting)**
 - Pause: **2 sec**
 - Number of shots: **20**
- ▣ Double check you are in **BULB** mode and press start

NOW, ENJOY THE NIGHT SKY



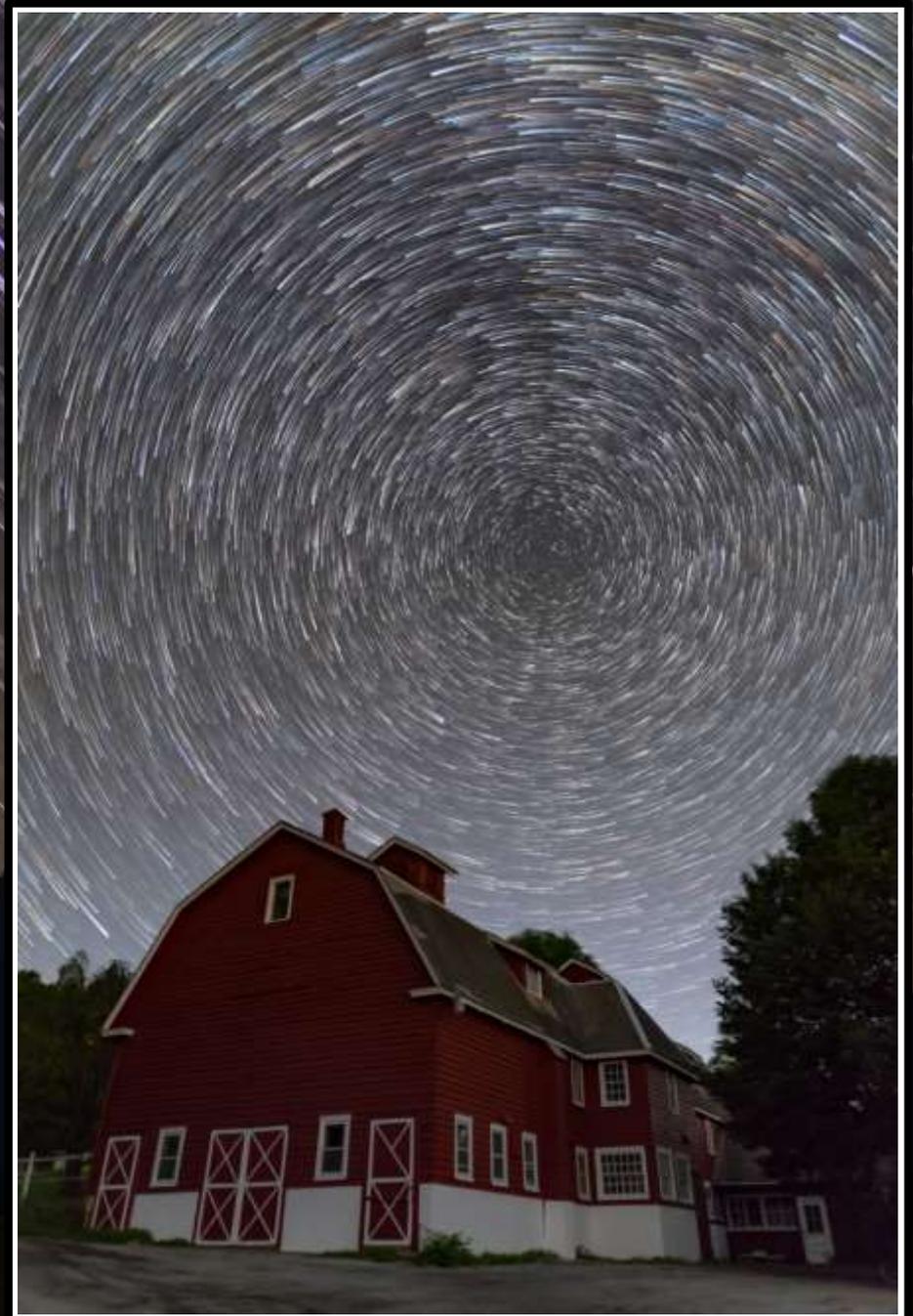
SHOOTING STAR TRAILS

- ▣ Don't forget a test shot or two
- ▣ Program a sequence into your Intervalometer.
 - Start delay: **5 sec**
 - Exposure time: **30 sec**
 - Pause: **2 sec**
 - Number of shots: **120 (30 sec x 120 = 60 min)**
- ▣ Take lots of 15s to 30s shots, do not take 1-60 min shot.
 - Sensor will heat up and **HEAT = NOISE**
- ▣ Make sure there are no gaps between photos!!!
 - ▣ Any gaps will make your trails look like a dotted line when you stack them. (2 sec is ok)

**NOW, ENJOY THE
NIGHT!!!**

**Canon 6D
Sigma 24mm f/1.4
30 sec x 120
24 mm f/1.4
ISO 1600**

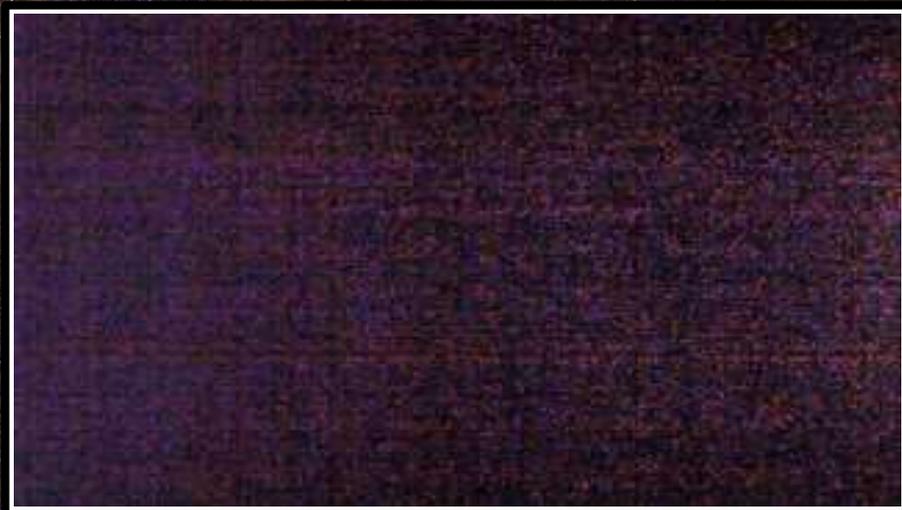
**Looking North
No moon,
About 60 minutes
Lusscroft Farms
Wantage NJ**

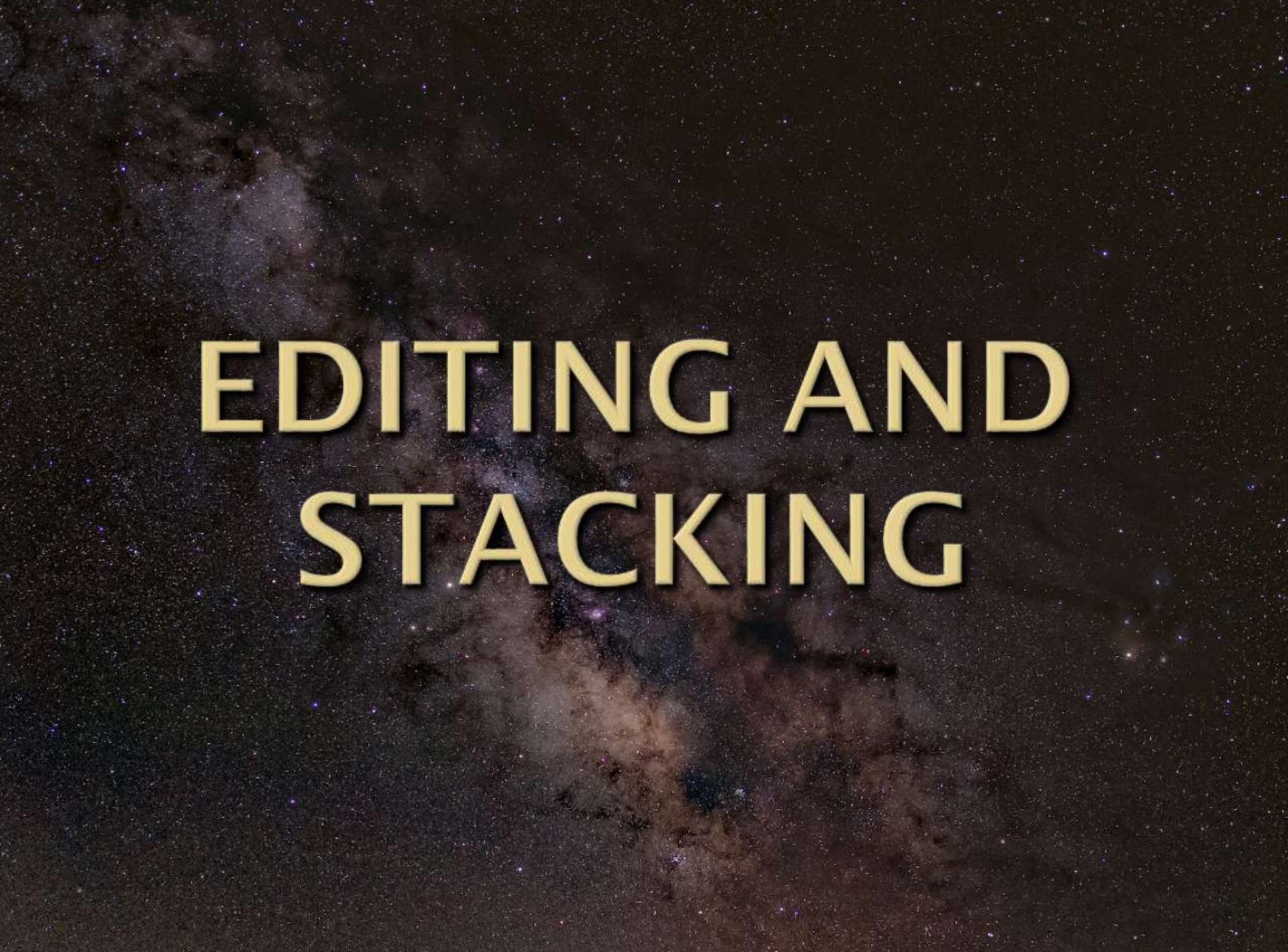


DARK FRAMES

- ▣ Dark frame subtraction can be used during stacking to remove noise.
- ▣ Cover the lens so **NO** light can enter the camera.
- ▣ Take a series of pictures at the same **exposure time**, **ISO**, and **temperature** as your MW images.
 - Take at least 10 darks for them to be useful.
- ▣ Best time to take them is right after your imaging run so sensor temp is the same.

Sequator and
StarStax can
both use dark
frames





EDITING AND STACKING

STACKING MILKY WAY IMAGES

- ▣ These Milky Way is very dim and we need to turn up the brightness in post to bring it out.
 - This also brings out the noise.
- ▣ Stacking is taking a set of images, aligning them with each other, and then averaging them together.
 - This greatly reduces the noise in the photo.



PRE-STACK EDITING TIPS

- ▣ Use Dehaze and Clarity sliders to bring out detail.
- ▣ Adjust White Balance, Tint, Vibrance and Saturation.
 - Try to get the sky at top of photo to be almost black.
 - Top to bottom Gradient Filter to even out sky color.
- ▣ Noise reduction.
 - Milky Way, no. Star trails, a little
- ▣ Make your edits to one image and “Sync” them to the rest in your sequence.
- ▣ Export photos as .tif’s, & keep them in order.

[Apalapse, Editing Milky Way Photos in 2 Minutes](#)

[Loneyspeck, How to Process Milky Way in Lightroom](#)

MILKY WAY STACKING SOFTWARE

- ▣ [SEQUATOR](#) - Free stacking software for PC only
- ▣ You Tube tutorials:
 - [Milky Way Mike \(NJ based\)](#)
 - [Peter Zelinka: Sequator - Astro Stacking Program](#)

- ▣ [STARRY LANDSCAPE STACKER](#) - stacking software for MAC only. (\$40)
- ▣ You Tube tutorials:
 - [Starry Landscape Version 1.7](#)
 - [Loneyspeck](#)
- ▣ Works just like SEQUATOR

PHOTOSHOP STACKING

- ▣ More complicated process, and takes longer
- ▣ However, can yield better results, and allows you more control.
- ▣ Good to learn because it can be used for any type of long exposer photography, waterfalls, clouds, etc.
 - Can stack foreground in star trail images to reduce noise.
 - Can be used if you don't have an Neutral Density filter with the added benefit of noise reduction.

[Loneyspeck, Noise Reduction with Image Stacking](#)

STARSTAX

- ▣ StarStax is a free star trail stacking program
 - You don't have to use all your images, try stacking different amounts for different length trails.
 - Try "Gap Filling" in the right dropdown menu
 - I highly recommend "Comet Mode" and try different lengths.
 - All presentation pictures are done in Comet Mode

[AmazingSky, How to Photograph and Process Star Trails](#)
Stacking trails in StarStaX is at 17:00

STAR TRAIL EDITING TIPS

- ▣ Try taking 10 good images in your set and stack them in Photoshop with the foreground aligned.
 - Use a layer mask to paint in the star trails from your trails photo.
 - This is a great way to get rid of noise.
- ▣ If you took some Milky Way photos try star trailing them. What the heck, you have the photos

DEEP SKY OBJECTS

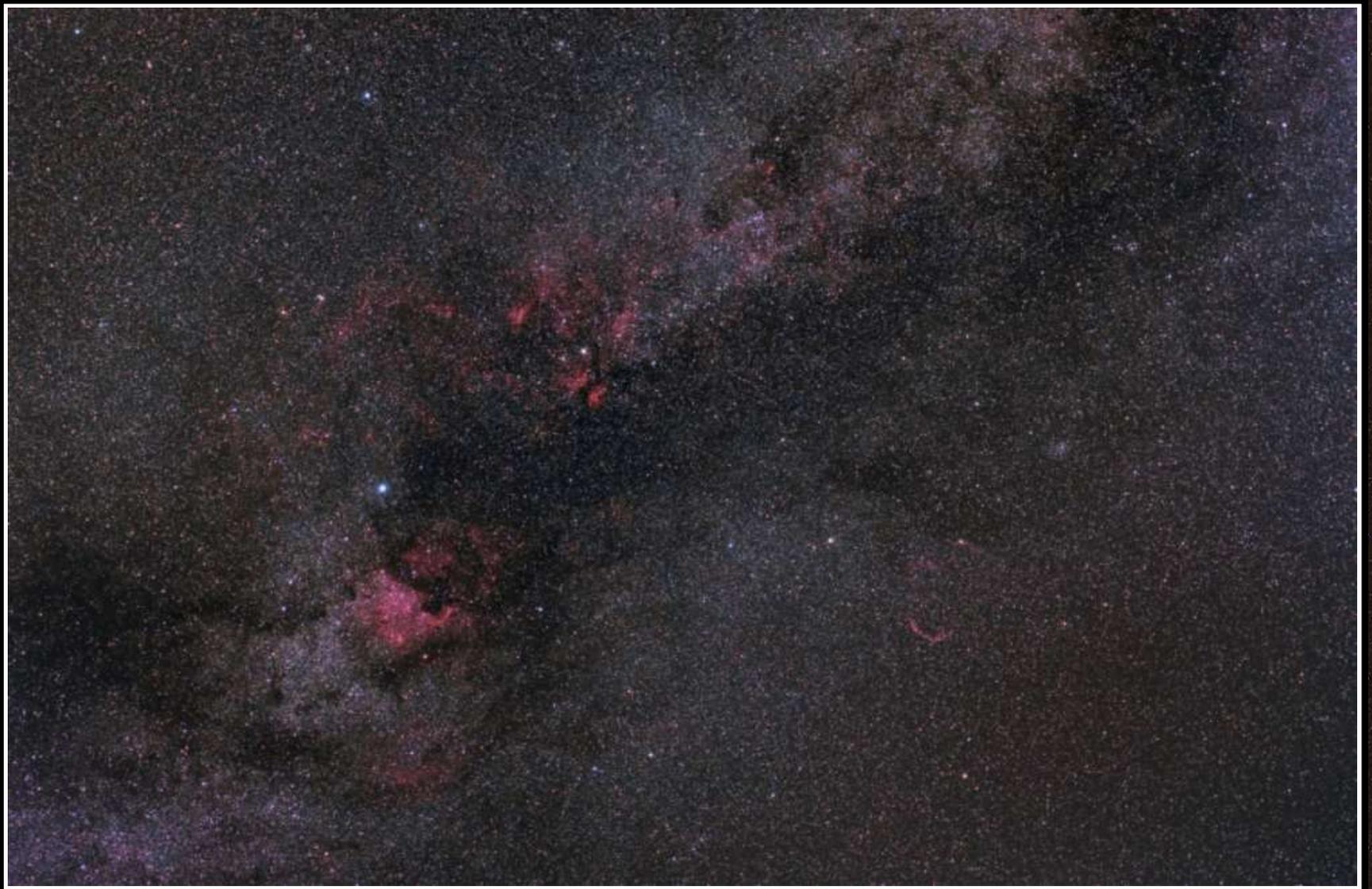


DEEP SKY OBJECTS

- ❑ DSO's are basically Nebula and Galaxy's or anything outside our solar system.
- ❑ You take multiple long exposures and stack them, to make 1 long total integration time.
 - Example: 60 shots x 2 min exp = 120 min TI
- ❑ This is all done for better signal to noise ratio (SNR)
- ❑ You will need some type of device to track the sky.
- ❑ Most DSO's are dim, not small. Most can be photographed with a 200mm - 500mm telescope/lens.

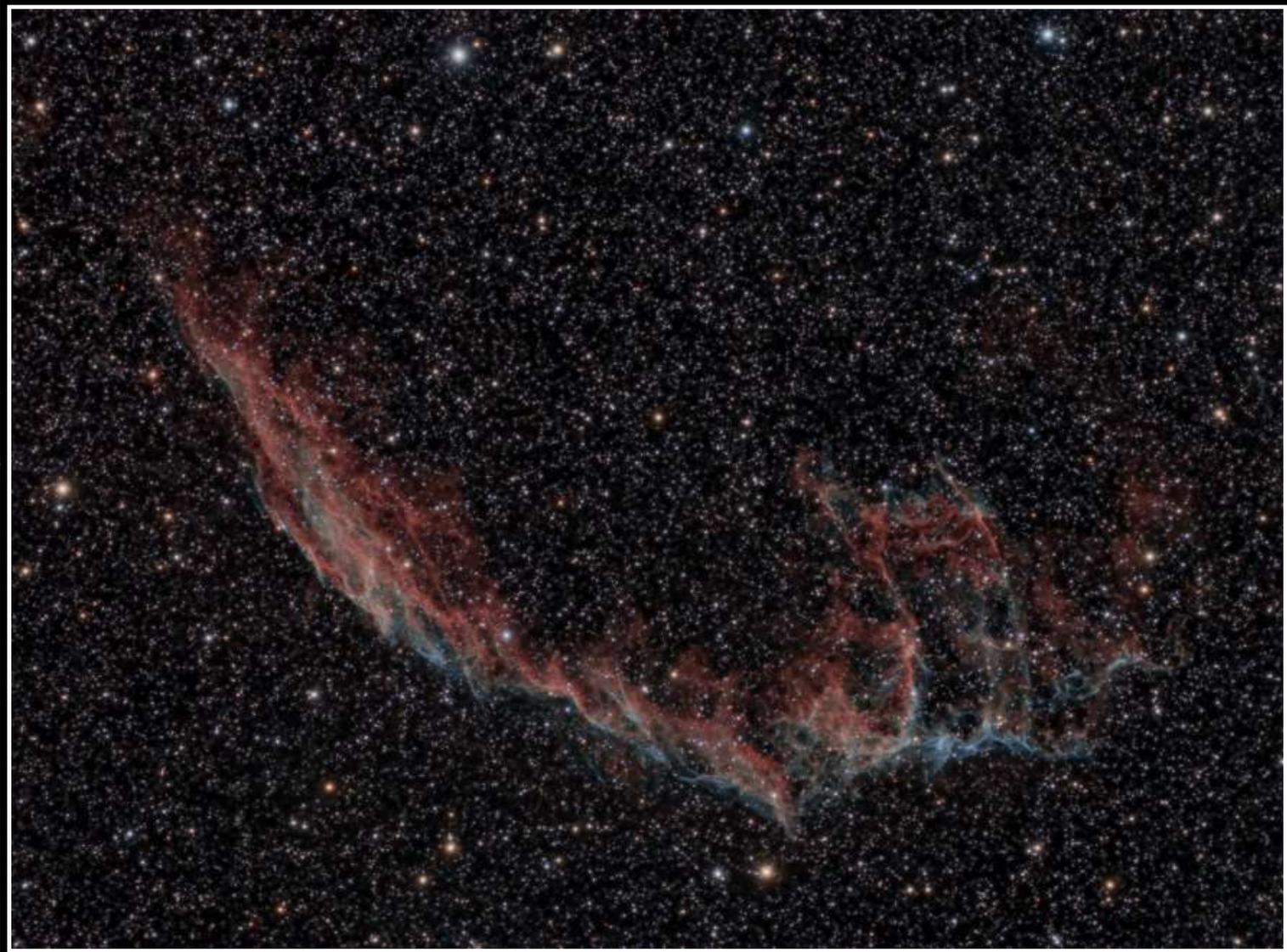
DEEP SKY OBJECTS

Cygnus Region, Canon 6D, 50mm f1.4, 120 min



DEEP SKY OBJECTS

NGC 6992 Eastern Vail, ASI294, 478mm f5.9, 210 min





DEEP SKY OBJECTS

M-31 Andromeda, Canon t3i, 300mm f5, 120 min



DEEP SKY OBJECTS

M-42 Orion, Canon 6D, 500mm f6.3, 150 min



DEEP SKY OBJECTS

M-42 Orion, Canon 6D, 500mm f6.3, 150 min



DEEP SKY OBJECTS

M-42 Orion, Canon 6D, 50mm f/2.8, 45 min



EQUIPMENT FOR DSO ASTROPHOTOGRAPHY

- ❑ Cameras - TEC cooled, color or mono.
- ❑ Telescopes - Named for their aperture, use lenses or curved mirror, unlike lens designed for one purposes
- ❑ Star trackers - Carry less weight, and are usually un-guided.
- ❑ German Equatorial Mount - huge payloads more precise and guided.



ZWO ASI 294
Sony 4/3
11 mp, 14 bit
TEC cooling
($\Delta T = 35^{\circ}\text{C}$)

DSLR T-ring
adapter



TELESCOPES



81mm f/5.9 Triplet Refractor



203mm f/10 Schmidt-Cassegrain



254mm f/3.9
Newtonian

MOUNTS

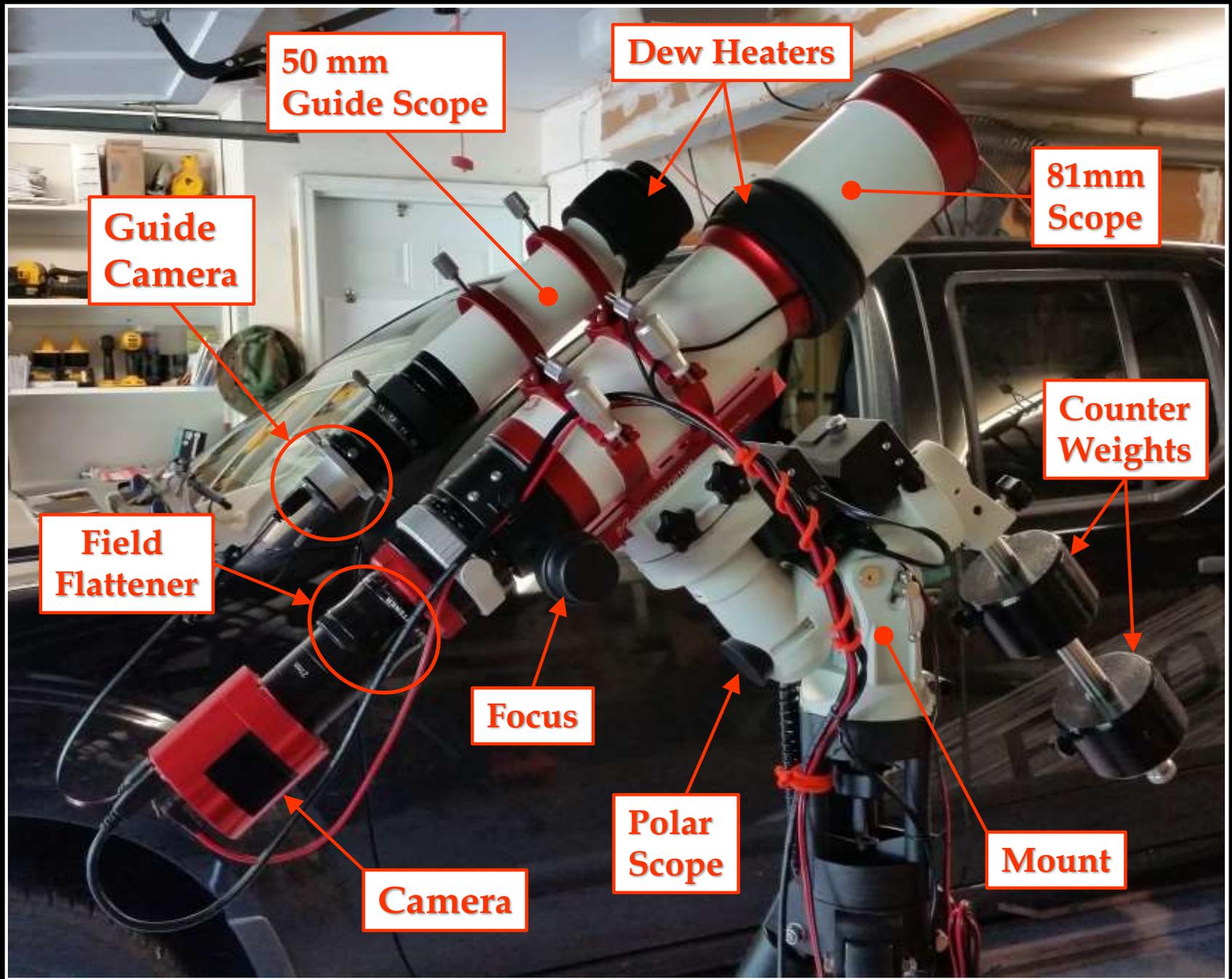
Ioptron Star tracker-11 lbs, Canon t3i, Tamron 70-300



MOUNTS

Ioptron CEM25-28 lbs, ASI294 (4/3-11mp) WO-GT81





**50 mm
Guide Scope**

Dew Heaters

**81mm
Scope**

**Guide
Camera**

**Counter
Weights**

**Field
Flattener**

Focus

**Polar
Scope**

Mount

Camera

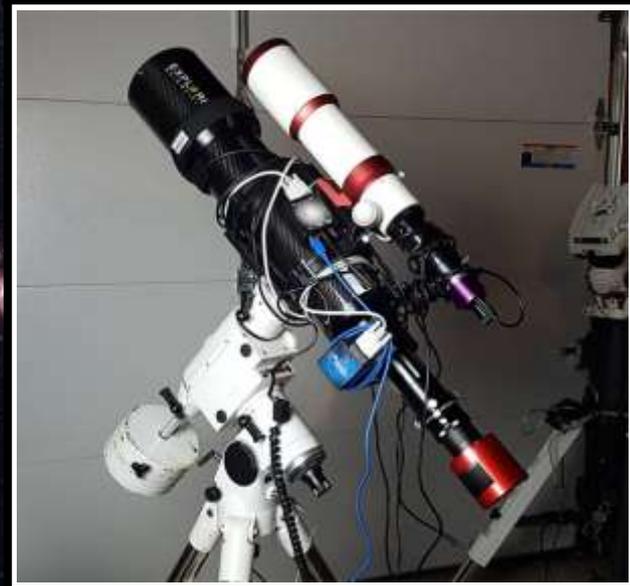
DEEP SKY OBJECTS EQUIPMENT

- ▣ If you want to learn more about DSO Astrophotography please visit [ASTROBACKYARD You Tube channel](#) and [web site](#).
 - [Astrophotography Equipment: Beginner Setup \[Deep Sky\]](#)



Trifid Nebula M-20

By: Trevor Jones, [AstroBackyard](#)



ED102CF Telescope

Trevor Jones, [AstroBackyard](#)

THANK YOU AND

CLEAR SKIES!!!



LINKS TO TUTORIALS

MILKY WAY SHOOTING

- ❑ **Milky Way Mike, Mastering The Lights Of The Night Sky - Lecture For Beginner and Intermediate Photographers**
 - <https://youtu.be/-HLfG1MRDEM>
- ❑ **Ryan Fowler Photography, How to use an intervalometer tutorial**
 - <https://youtu.be/jDAgHOXhJsc>
- ❑ **Mike Perea Photography, Learn Milky Way Photography in 5 Minutes! Includes Photopills**
 - https://youtu.be/KiTiJo_R70
- ❑ **Photog Adventures, How to use PhotoPills to plan your Milky Way Photography**
 - <https://youtu.be/nXk-2BrxySw>

MILKY WAY SHOOTING

- ▣ Eyes on the Sky, Stellarium: Getting started
 - <https://youtu.be/bYF7SR99ZOw>
- ▣ Astrophotography 101 - Lens Guide and Recommendation
 - <https://youtu.be/vlL14iQNm4U>
- ▣ Astrophotography 101 - Eliminating Star Trails, 500/NPF rule
 - <https://youtu.be/CgmdfI328Oo>

PHOTOPILLS

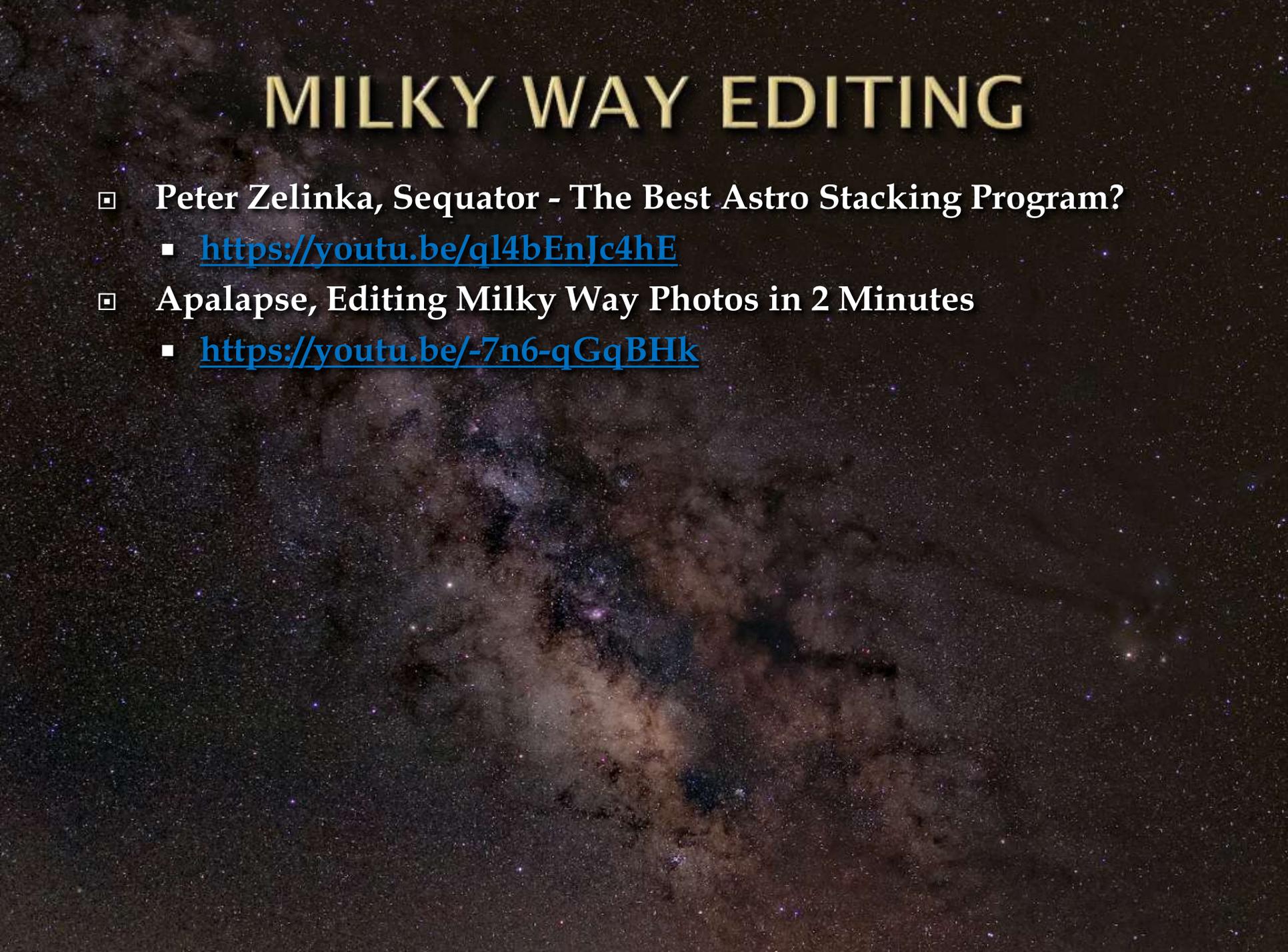
- ▣ PhotoPills: How To Find And Plan The Milky Way
 - <https://youtu.be/MMbKEq-zr18>
- ▣ PhotoPills: How to Plan Any Star Trails Shot You Imagine
 - <https://youtu.be/1qBCvfTEB9M>
- ▣ PhotoPills You Tube Channel
 - <https://www.youtube.com/channel/UCTZoEDicS XKJFBLNIPZOr0Q>
- ▣ Photog Adventures: How to use PhotoPills to plan your Milky Way Photography
 - <https://youtu.be/nXk-2BrxySw>
- ▣ David Johnston: How to Use PhotoPills For Your Landscape Photography Planning
 - <https://youtu.be/KuvTPoeIqC0>

MILKY WAY EDITING

- ▣ **Starry Landscape Stacker Version 1.7**
 - <https://youtu.be/YQe3H-I5leM>
- ▣ **Loneyspeck, Noise-Free Astrophotography with Starry Landscape Stacker (macOS)**
 - <https://youtu.be/AQOfTTGWEDo>
- ▣ **Loneyspeck, How to Process Milky Way in Lightroom**
 - <https://youtu.be/6sBrQ6yAcNI>
- ▣ **Loneyspeck, Noise Reduction with Image Stacking**
 - <https://youtu.be/Rydg7JGTAbw>
- ▣ **Milky Way Mike (NJ based) Sequator - FREE PC Milky Way Stacking software that reduces noise**
 - <https://youtu.be/C-MCvbYj-hA>

MILKY WAY EDITING

- ▣ Peter Zelinka, Sequator - The Best Astro Stacking Program?
 - <https://youtu.be/q14bEnJc4hE>
- ▣ Apalapse, Editing Milky Way Photos in 2 Minutes
 - <https://youtu.be/-7n6-qGqBHk>



RESOURCES TO DOWNLOAD

- ▣ Dark site finder <http://darksitefinder.com/map/>
 - Light pollution map - web
- ▣ Light pollution map: <https://www.lightpollutionmap.info/>
 - Light pollution map - web
- ▣ The Photographer's Ephemeris <http://photoephemeris.com/>
 - Sun, moon position, darkness times, landscape planning - app/web
- ▣ Clear Dark Sky.com <http://www.cleardarksky.com/csk/>
 - Astronomy weather - web
- ▣ Clear Outside App <https://clearoutside.com>
 - Astronomy weather, darkness times, moon phase - app

RESOURCES TO DOWNLOAD

- ❑ **Stellarium** <https://stellarium.org/>
 - Planetarium - app/web
- ❑ **Photopills** <https://www.photopills.com>
 - Milky way, landscape, sun moon position – app (\$10)
- ❑ **Sequator** <https://sites.google.com/site/sequatorglobal/>
 - Astrophotography stacking - software/free
- ❑ **Starry Landscape Stacker**
<https://sites.google.com/site/starrylandscapistacker/homes://>
 - Astrophotography stacking - software/\$40
- ❑ **StarStaX** <https://www.markus-enzweiler.de/StarStaX/StarStaX.html>
 - Star trail software - free

STAR TRAILS TUTORIAL

- ▣ **AmazingSky, How to Photograph and Process Star Trails**
 - https://youtu.be/-fMsYd_6jk0
 - ▣ **Equipment for star trails: 1:03**
 - ▣ **Choosing your shooting method: 2:03 (use method 2)**
 - ▣ **Programing Intervalometer 3:25**
 - ▣ **Other settings 5:16**
 - ▣ **Focusing: 6:19**
 - ▣ **Processing 7:45**
 - ▣ **Developing single image 9:39**
 - ▣ **Stacking trails in PS 14:40**
 - ▣ **Stacking trails in StarStaX 17:00 (Best method)**
 - ▣ **Advanced Stacker Plus PS action set 22:32**
 - ▣ **Making time-laps 29:21**
 - ▣ **Wrap up 33:07**

DEEP SKY OBJECTS

- ▣ **AstroBackyard** You Tube channel.
 - https://www.youtube.com/channel/UCn3npsPixgoi_xLdCg9J-LQ
- ▣ **AstroBackyard** web site.
 - <https://astrobackyard.com/>
- ▣ **AstroBackyard**, Astrophotography Equipment: Beginner Setup [Deep Sky]
 - <https://youtu.be/8Z9YssmGruQ>
- ▣ Dylan O'Donnell, Star Stuff You Tube channel.
 - <https://www.youtube.com/user/erfmufn>
- ▣ Chuck's Astrophotography, You Tube channel
 - <https://www.youtube.com/channel/UCC1lh0nUmlREEvoskaq9b3A>
- ▣ The Astro Imaging Channel, You Tube channel
 - <https://www.youtube.com/channel/UCiR5AmROq4YcXF8hCxxZQ-g>