Beginner Astrophotography

How I started with a shoelace and some velcro

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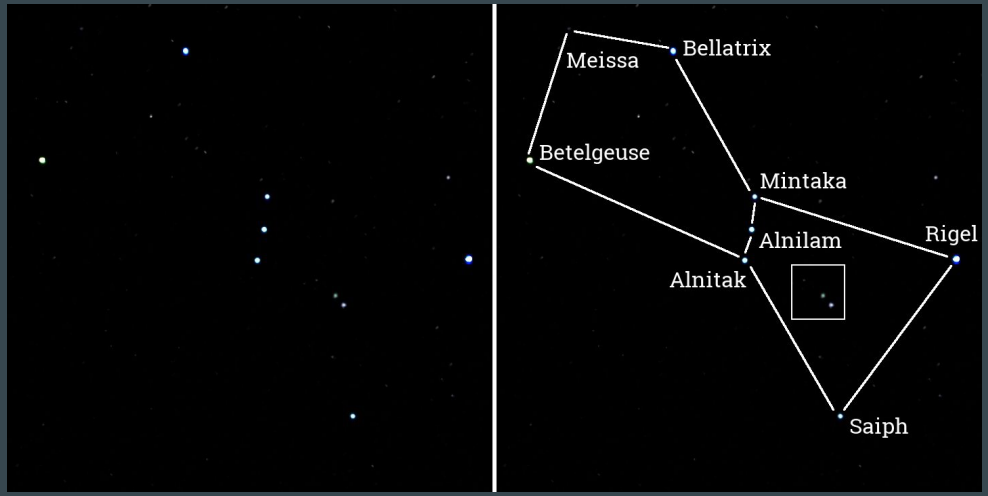
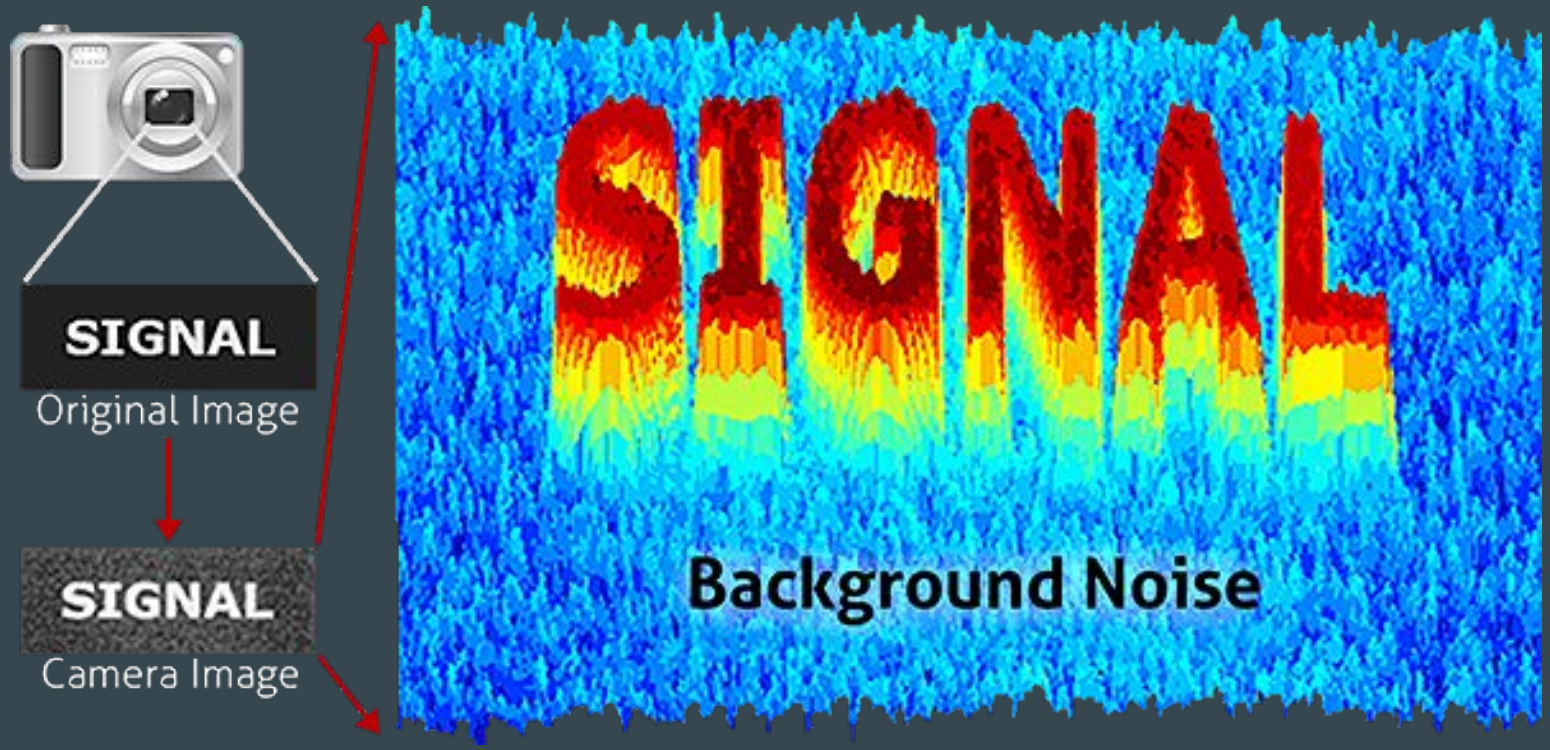
www.jondolan.io/astro

My first astrophoto



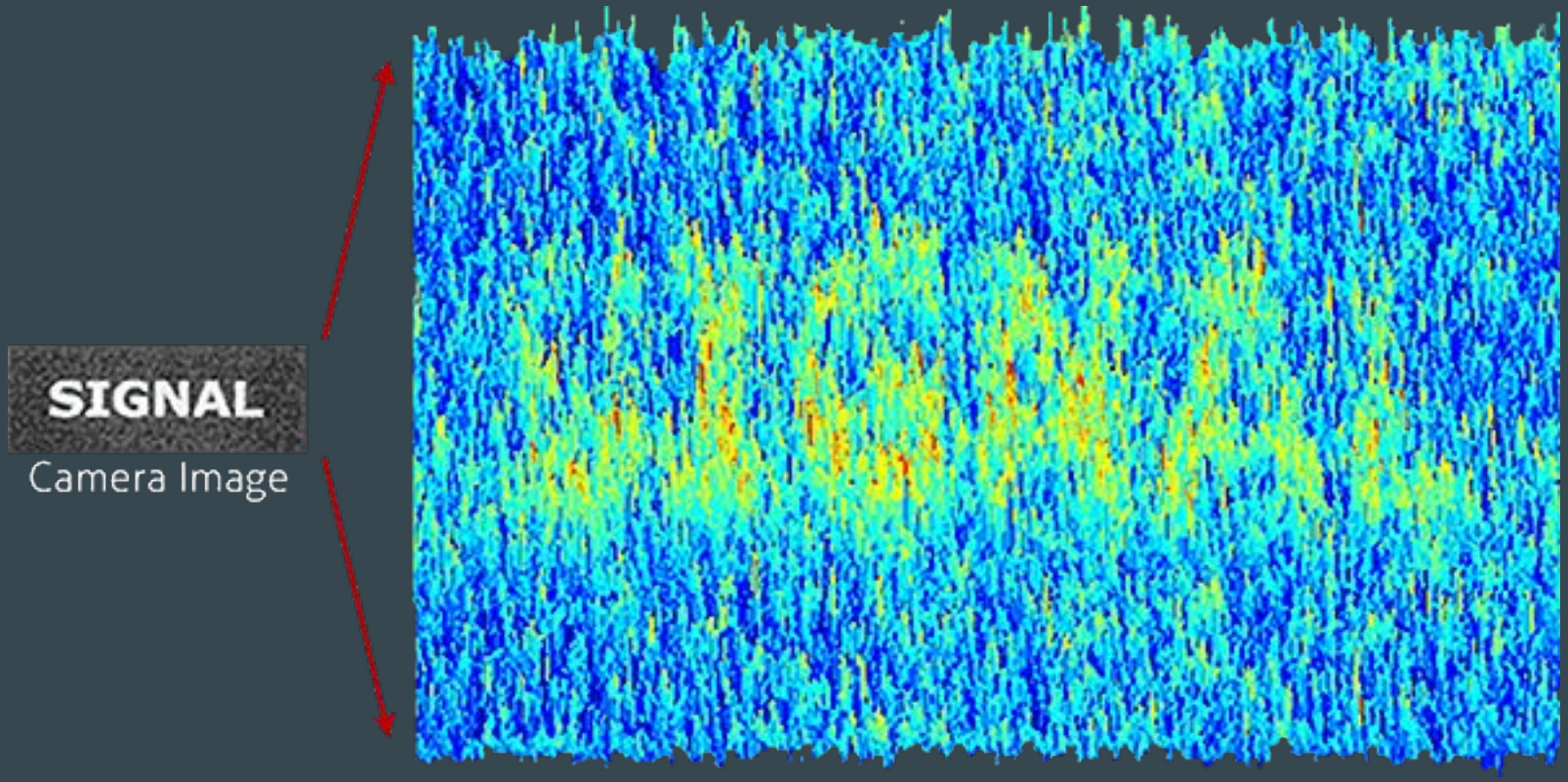
Noise reduction with “dark frames”

What is noise?



https://www.cambridgeincolour.com/tutorials/image-noise.htm

Low SNR



https://www.cambridgeincolour.com/tutorials/image-noise.htm

https://www.slrlounge.com/iphone-5-vs-iphone-4s-low-light-comparison-and-review-by-austin-mann/


Nikon
8x42 6.3°

My Thirty Seconds of Fame

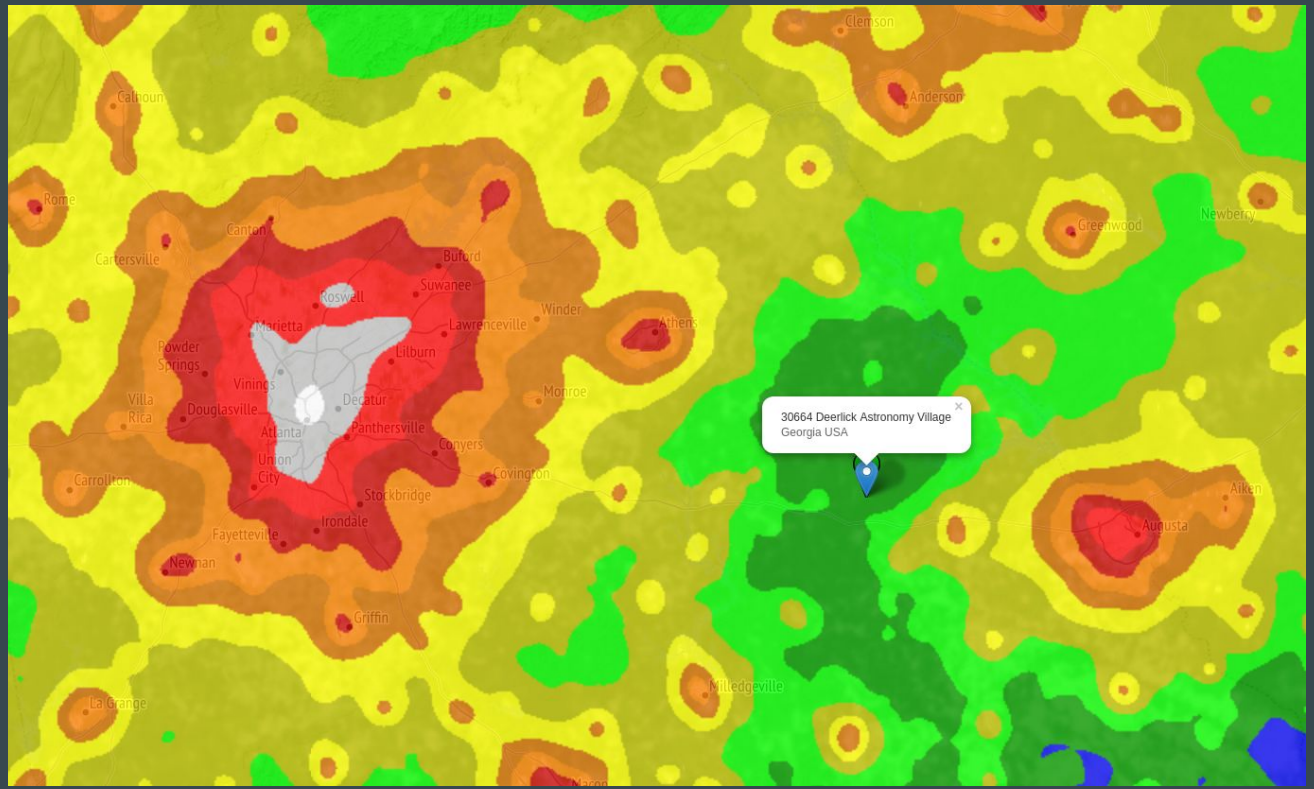
Or not...

A 3D printed upgrade

30 More Seconds of Fame

First steps with a DSLR

Location location location



http://darksitefinder.com/maps/world.html#4/39.00/-98.00

The benefit of stacking

https://adamwoodworth.com/tutorials/star-stacking-for-pinpoint-stars-and-low-noise

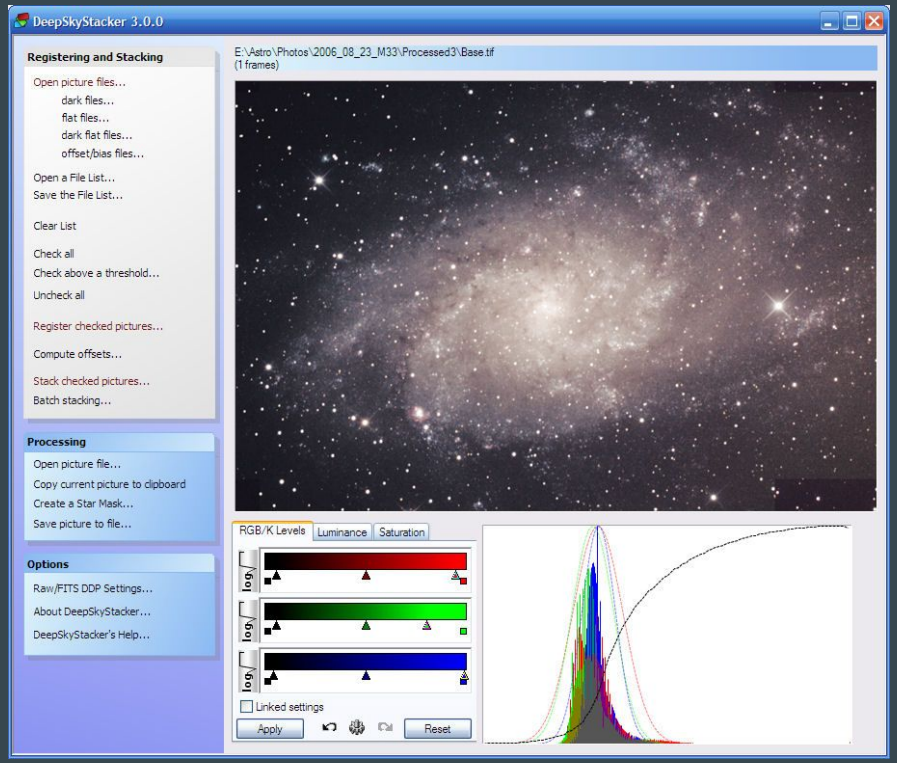
My first attempt at stacking

YouTube tutorials (Lonely Speck) and manual alignment in Photoshop

Better ways to stack

- DeepSkyStacker
- Starry Landscape Stacker (Mac)

- What are these darks, flats, and bias frames anyways?
  - Learn more at rawastrodata.com

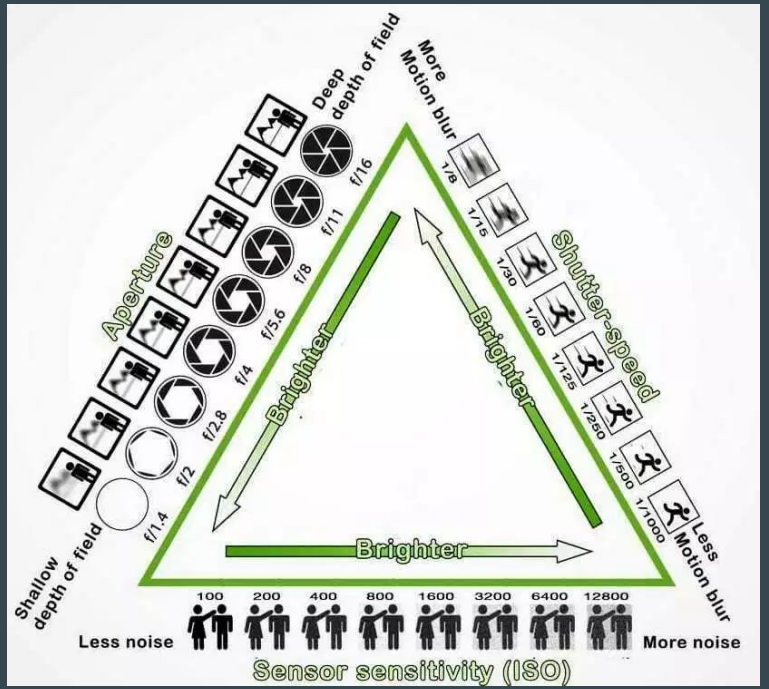


Getting to know your camera

Everywhere you look, you'll find different advice

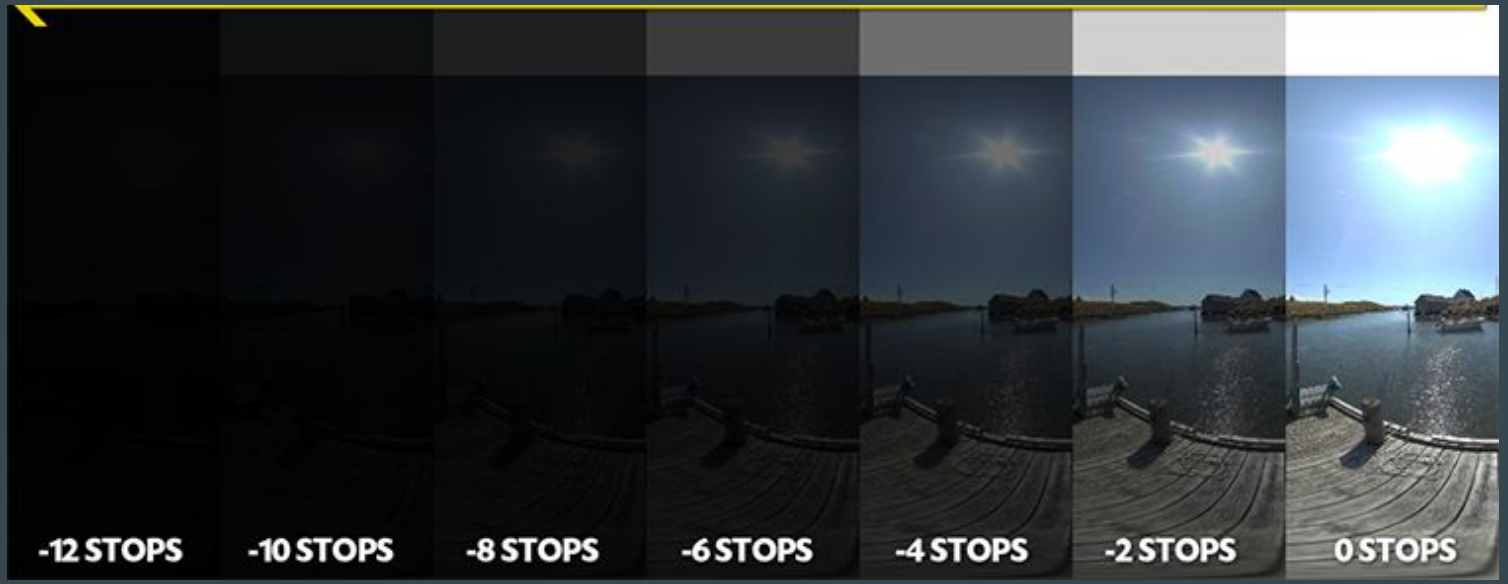
- The most "debated" setting is the ISO sensitivity
- Aperture is generally all the way open
- Shutter speed follows the 300 rule for crop sensors

- Learn more about ISO at dslr-astrophotography.com

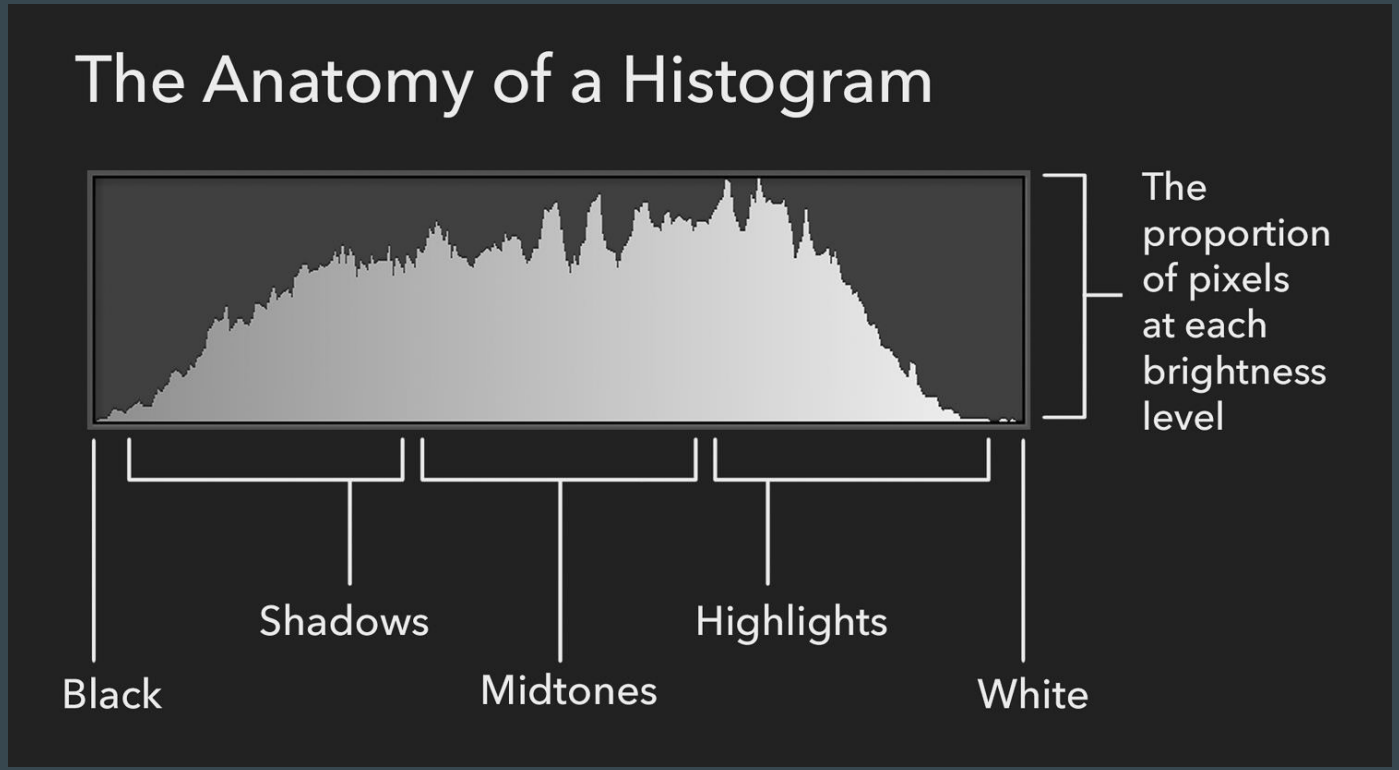


Dynamic Range

“The range in which a camera can capture the brightest and darkest spots of an image without loss of detail” (source)



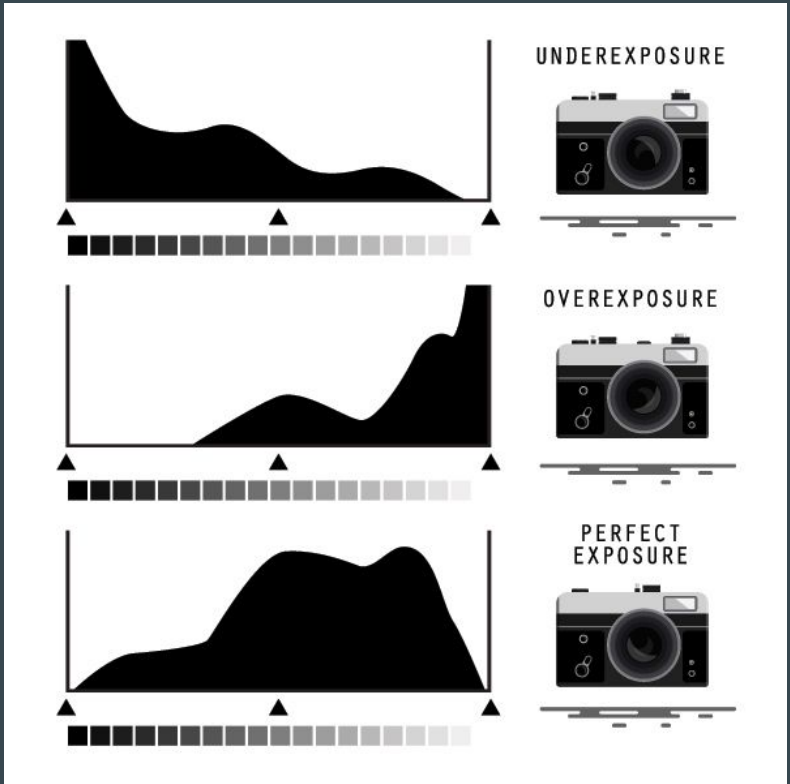
The Histogram



https://photographylife.com/landscapes/what-are-histograms-a-photographers-guide

Histogram clipping - losing data and dynamic range

- Underexposed images lose data in the blacks and shadows
- Overexposed images lose data in the whites and highlights
- Perfect exposure maximizes the range of the data you collect



https://photographypro.com/histogram/

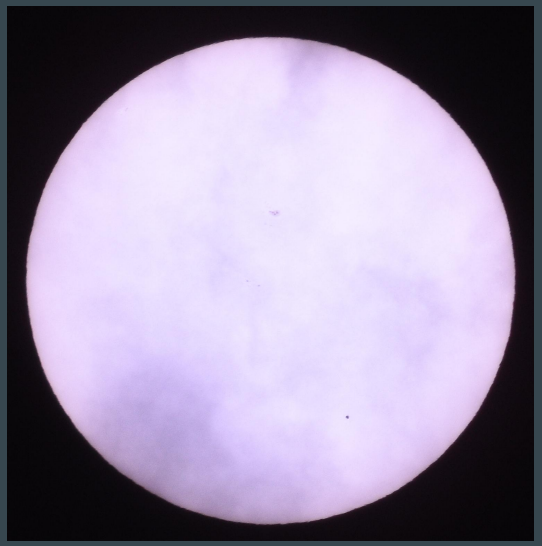
3 Main Types of Astrophotography

Widefield

Milky Way, constellations
star trails

Deep Space Objects

Nebulae, galaxies



Solar System

Sun, Moon, planets,
ISS

Different Tools for the Job

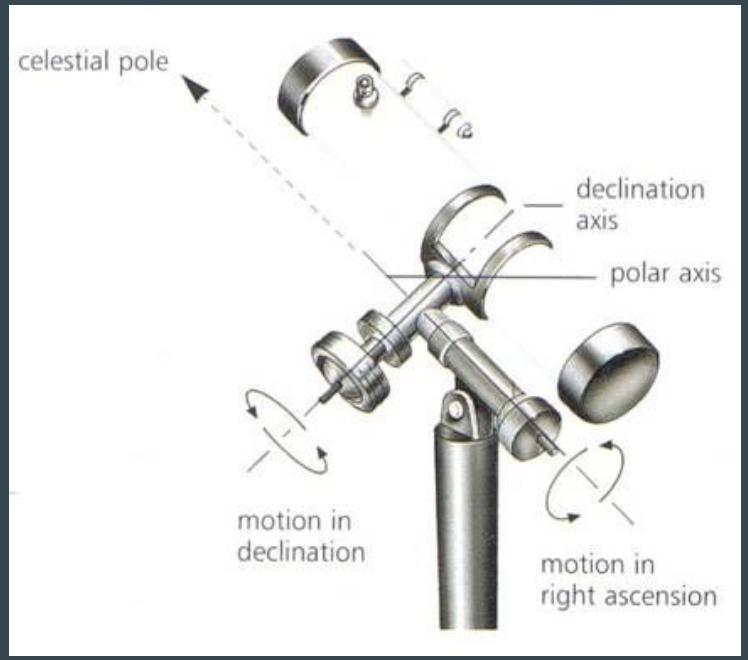
The importance of focus

An often overlooked but arguably **the most important** part of night sky photography, and hard to do correctly!

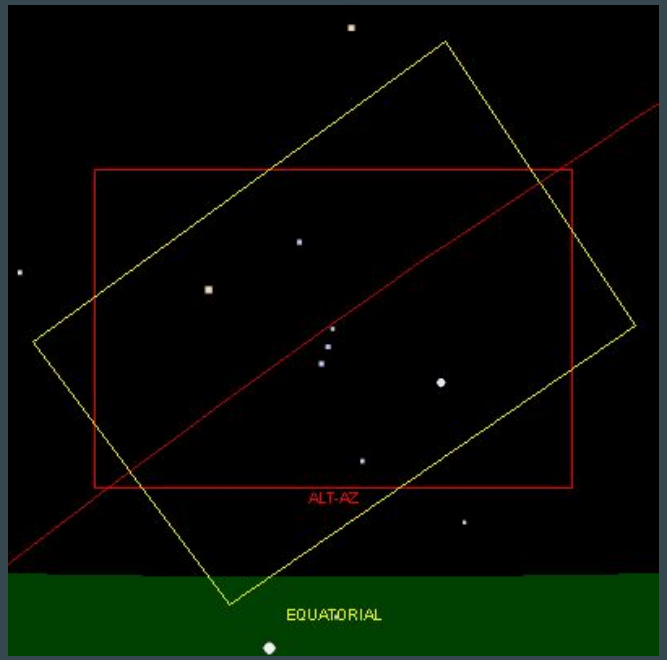
- No amount of post processing can fix bad focus
- Solution: a 3D printed Bahtinov mask

Guiding with Equatorial Mounts

Equatorial mounts move to cancel out the earth's rotation



http://www.naasbeginners.co.uk/Articles/Equipment/Eqatorial_Mount/Equatorial.htm



https://calgary.rasc.ca/field_rotation.htm

Adding in auto guiding

A separate system intended to correct your mount's movement over time

The path forward

Open source, open hardware - INDI, Ekos, and a Raspberry Pi

What is INDI?

- The Instrument Neutral Distributed Interface
- A complete replacement for those old, finicky ASCOM drivers
- Designed for a wide range of support with plugins for anything you can imagine
  - Telescopes - Orion, Celestron, Meade, EQMod, Bisque, Explore Scientific, Losmandy, ...
  - CCDs - Altair, Apogee, libgphoto (Nikon, Cannon, Sony, Pentax, cell phones and tablets), webcams, QHY, SBIG, ZWO, ...
  - Focusers, filter wheels, domes, ...
- Used in professional and amateur settings and is completely open source under the LGPLv2

What is Ekos?

- Ekos is an observatory control and automation tool built on the INDI standard
  - Telescope control and GOTO
  - Plate solving for accurate GOTOs necessary for multi-night shooting (astrometry.net)
  - Built-in autoguiding support and ability to use PHD2 externally
  - Polar alignment tool with plate solving
  - Automated imaging scheduler for light, dark, flat, bias frames
  - Automated focusing, even between images if required
  - And lots more...

What is a Raspberry Pi?

- A “credit card sized computer” great for running Ekos in the field
  - Raspberry Pi consumes ~2W, a cheap low powered laptop would be closer to 6-7W
- Has WiFi built-in on newer models
- Can plate solve with Astrometry.net to accomplish polar alignment and then run Ekos for sequencing PHD2 for autoguiding simultaneously

- 1.4GHz 64bit quad core ARM Cortex-A53 processor
- 1GB SRAM
- Dual band 2.4GHz and 5GHz wireless LAN, Bluetooth 4.2/BLE

Demo

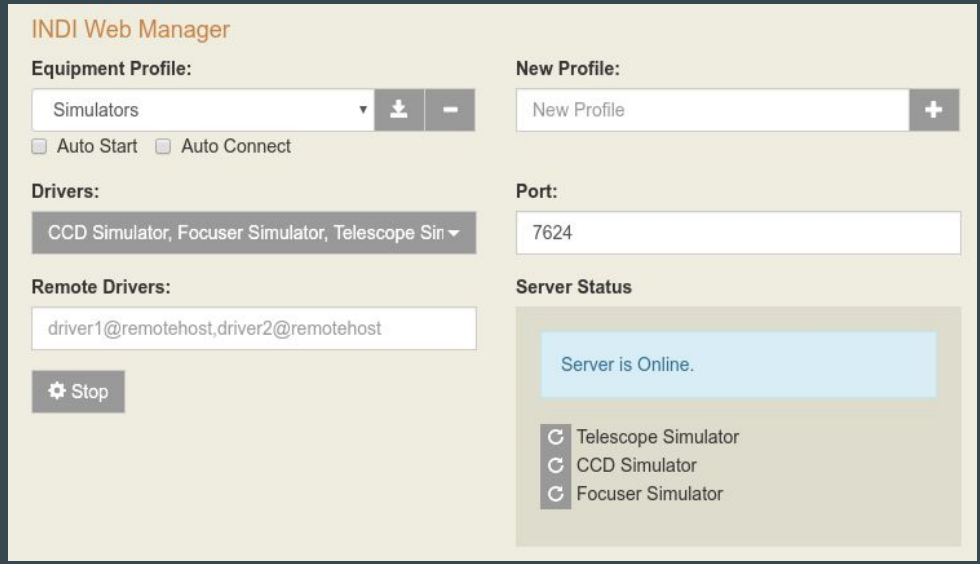
Putting it all together

- The Raspberry Pi runs the automated polar alignment procedure with plate solve to achieve arcsecond alignment accuracy
- A ZWO CCD autoguider connected to PHD2, which is automatically started and monitored by Ekos throughout the imaging process
- Create imaging sequences in Ekos to acquire dark, bias, and light frames with a small pixel dither

- Post processing needs an entire other lecture to cover, but the basic workflow is Deep Sky Stacker -> Photoshop -> Astronomy Tools Action Set -> Lightroom for final export

Future work

- Fine tuning the whole process even more, and contributing to the INDI community
- Improving upon the INDI Web Manager to provide a level of control similar to within the Ekos GUI itself
- Create an “image” that can be burned to an SD card and run on the Pi out of the box, similar to AstroPiBox



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