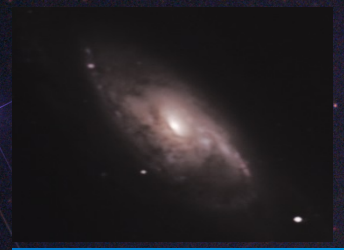
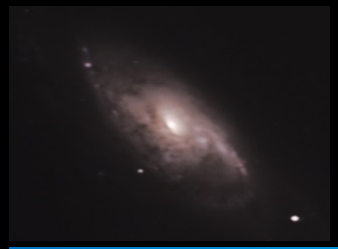


Fun with Photons – Imaging the Night

22 July 2017

John Sojka Jr.
DoD Space and Intel, NoVAC Member



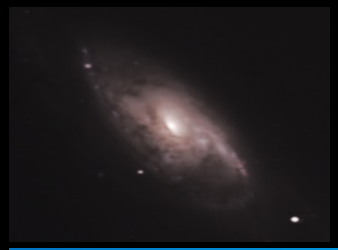
Fun with Photons – Imaging the Night

Summary

This session is an introduction into the fascinating world of night time photography. It will include the basic camera settings, and techniques necessary for imaging targets during the night with camera equipment you already own. The session will cover camera sensor basics, so attendees can understand the camera settings and learn how and why to adjust them. By the end of the session, attendees will be able to image objects at night without a flash, light painting, the moon, star trails, the Milky Way and a deep space object.

Biography

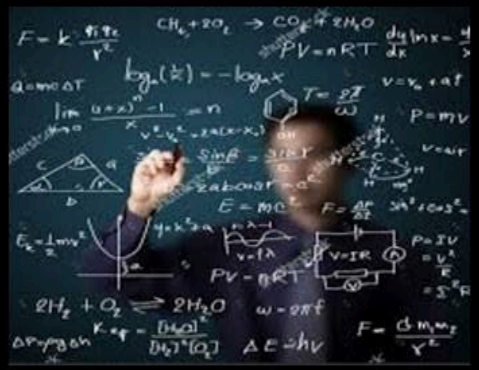
John Sojka is a Department of Defense professional working in the realm of Space and Intelligence. Mr. Sojka is an amateur astronomer who had the privilege of using his astrophotography skills professionally for his Agency. His astrophotography journey started in 2010 with his Agency's involvement in the NASA LCROSS Mission. He was selected to image the plume on the moon generated by the LCROSS impactor. Subsequently, he received the honor of assisting the Smithsonian National Air and Space Museum in a successful Deep Space Imaging program for the public and has been a featured speaker at Almost Heaven Star Parties. Mr. Sojka's passion for astronomy started with his father when he was a boy. His father was instrumental in building several observatories and reflector telescopes. Mr. Sojka still uses his father's home-made 10" reflector telescope to this day.



Fun with Photons – Imaging the Night

Astrophotography

What my friends think I do



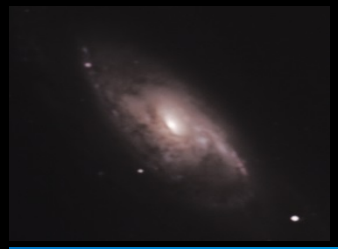
What my mum thinks I do

What society thinks I do

What I actually do

www.MyAstroSpace.com

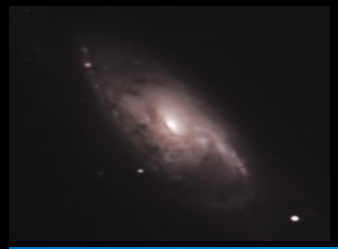
Share If You Can Relate!



Fun with Photons – Imaging the Night

Photograph:

A **photograph** or **photo** is an **image** created by **light** (Photons) falling on a light-sensitive surface, usually photography film or an electronic medium such as a **CCD** or a **CMOS** chip. ~Wikipedia



Fun with Photons – Imaging the Night

Three most important settings for Nighttime Imaging

Shutter Speed:

Is the length of time film or a digital sensor, inside the camera, is exposed to light usually in fraction of a second or seconds.

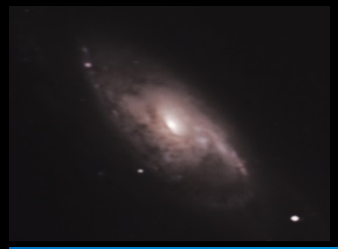
ISO:

The sensitivity of the image sensor to light. It increases the sensor gain by multiplying the photons captured by ISO Number / 100

Aperture:

The amount of light allowed through a lens to the sensor controlled by a diaphragm.

Open it fully by selecting your lowest F-Stop



Fun with Photons – Imaging the Night

Light:

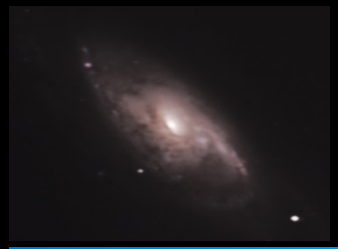
Light is electromagnetic radiation within a certain portion of the electromagnetic spectrum. The word usually refers to visible light, which is visible to the human eye and is responsible for the sense of sight. Visible light is usually defined as having wavelengths in the range of 400–700 nanometers (nm). ~Wikipedia.

But what is it?

- A ray?
- A Frequency?
- A Wave?
- A bunch of tiny, sub-atomic particles?

Answer:

Its all of them! Light travels in little packets called **PHOTONs** that contain the properties of all of them. This is called quantum Wave-Particle duality. **Cameras collect photons!**



Fun with Photons – Imaging the Night

Photons

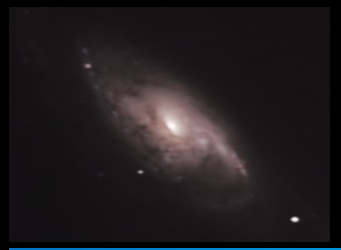
Photons

Photons

Photons

Photons

Photons



Fun with Photons – Imaging the Night

We are not actually taking a picture or image of a person. We are collecting the **photons** reflecting off the person to create an image.

Fun with Photons – Imaging the Night

The weaker the light (less photon output), the longer we must expose (collect **photons**)

Fun with Photons – Imaging the Night

Camera must have adjustable F-Stop, ISO and Shutter Speed

Usually Requires Telescope

Point & Shoot

$100 - $500

Smartphone

$200 - $600

DSLR (CMOS)

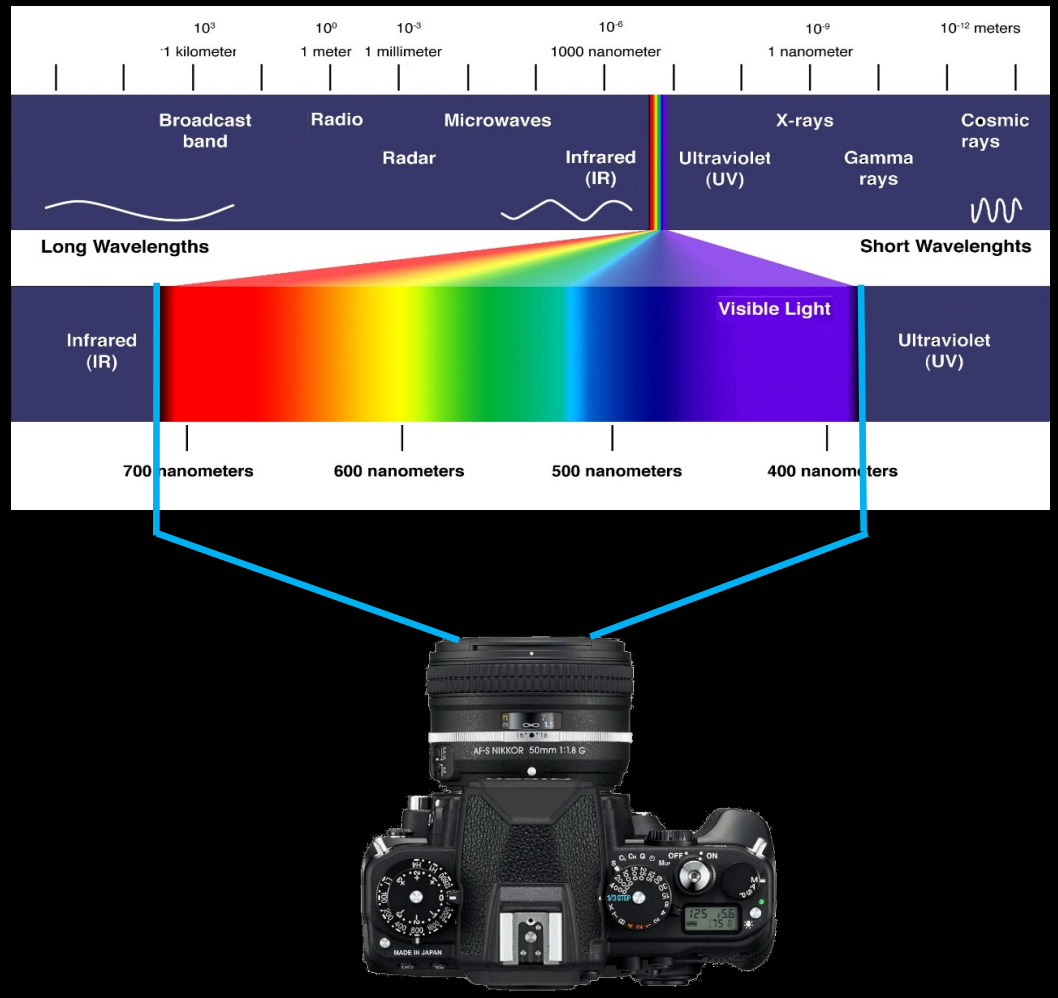
$400 - $2,000

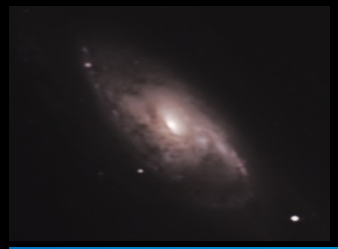
Deep Space (CCD)

$1,000 - $10,000+

$ COST

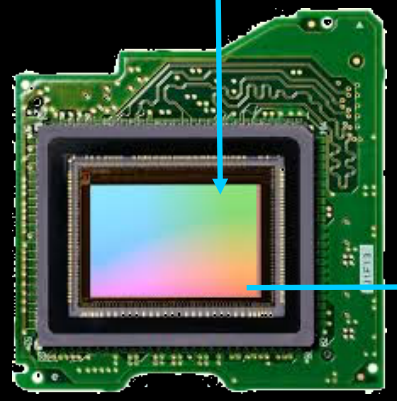
Fun with Photons – Imaging the Night



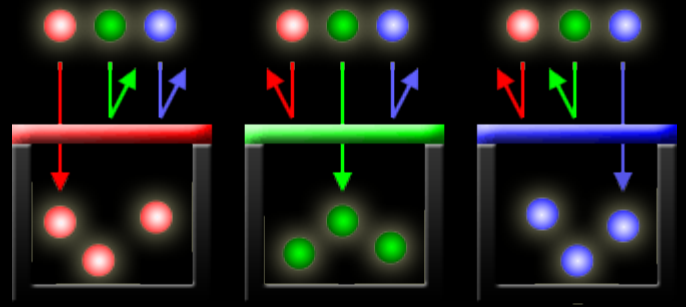


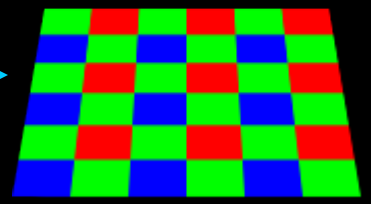
Fun with Photons – Imaging the Night

Photon Collection and ISO Explained

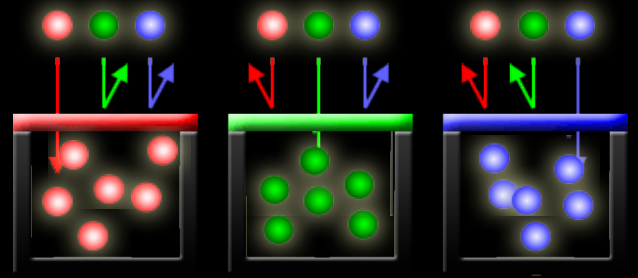


ISO: 100 = 3 Photons Collected

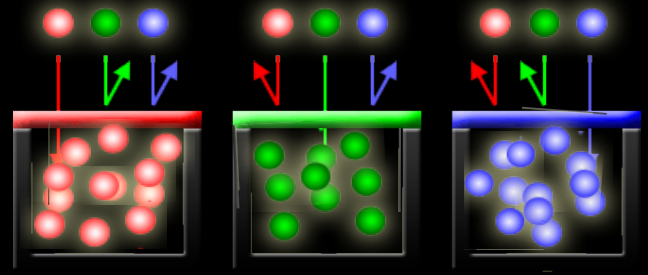


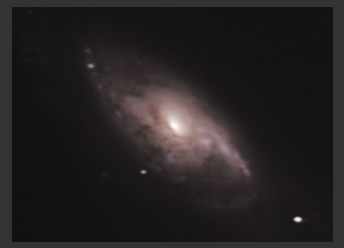


ISO: 200 (200 / 100) x Number of Photons = Gain of 6



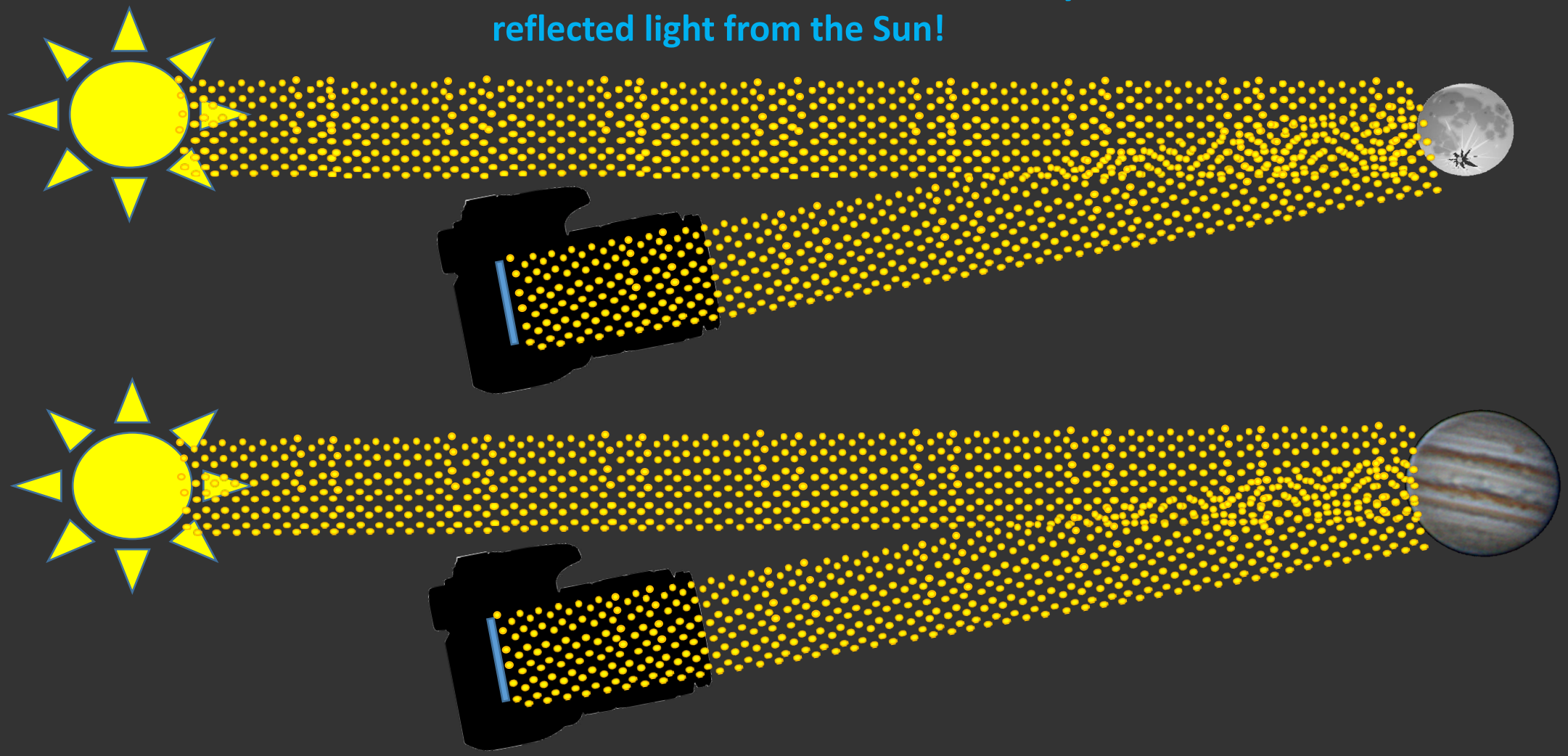
ISO: 400 (400 / 100) x Number of Photons = Gain of 12

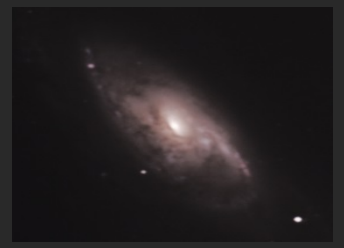




Fun with Photons – Imaging the Night

The Moon and Planets Do Not Emit Photons. They need reflected light from the Sun!

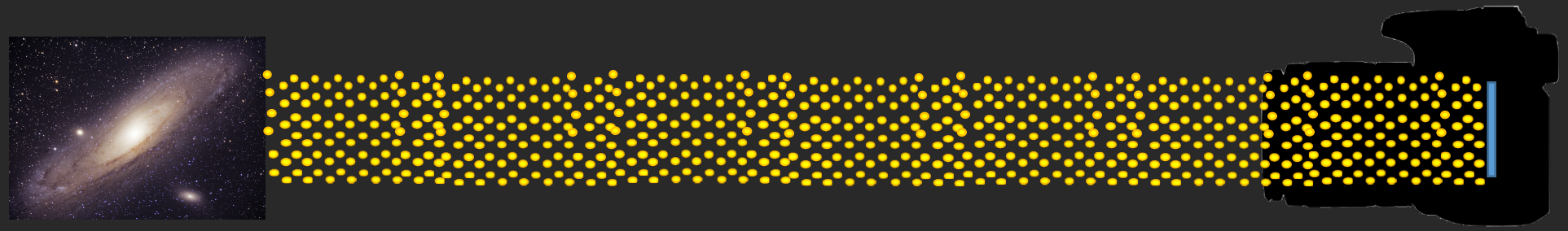




Fun with Photons – Imaging the Night

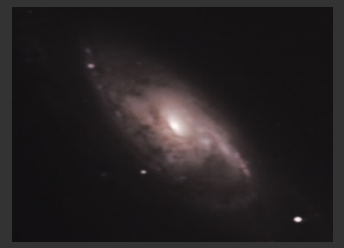
Space Objects Emitting their own photons

The Sun and Stars



Galaxies

Nebulae



Fun with Photons – Imaging the Night

Hardware

Camera System using Lens

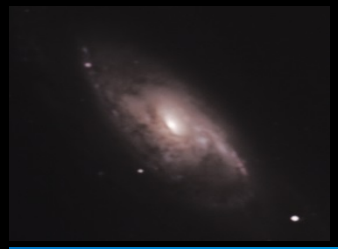
- Camera *(You will need a T-adapter)*
  - Any DSLR
  - Any Point and Shoot Digital Camera
  - Any SmartPhone with adjustable ISO and Shutter speed
- Lenses
  - Any Lens (55mm – 300mm)
- Mount
  - Any Tripod

$400 - $8,00

Camera System using Telescope

- Telescope
  - 6” or greater reflector
  - 3” or greater refractor *(APO)*
- Mount *(Has to be a motorized, go to with tracking):*
  - Equatorial Mount <-
  - Alt-Azimuth
  - Dobsonian
- Camera
  - Planetary Camera *(webcam)*
  - DSLR *(You will need a T-adapter)*
  - *Dedicated Deep Space CCD Camera*

$3,200 - $Unlimited

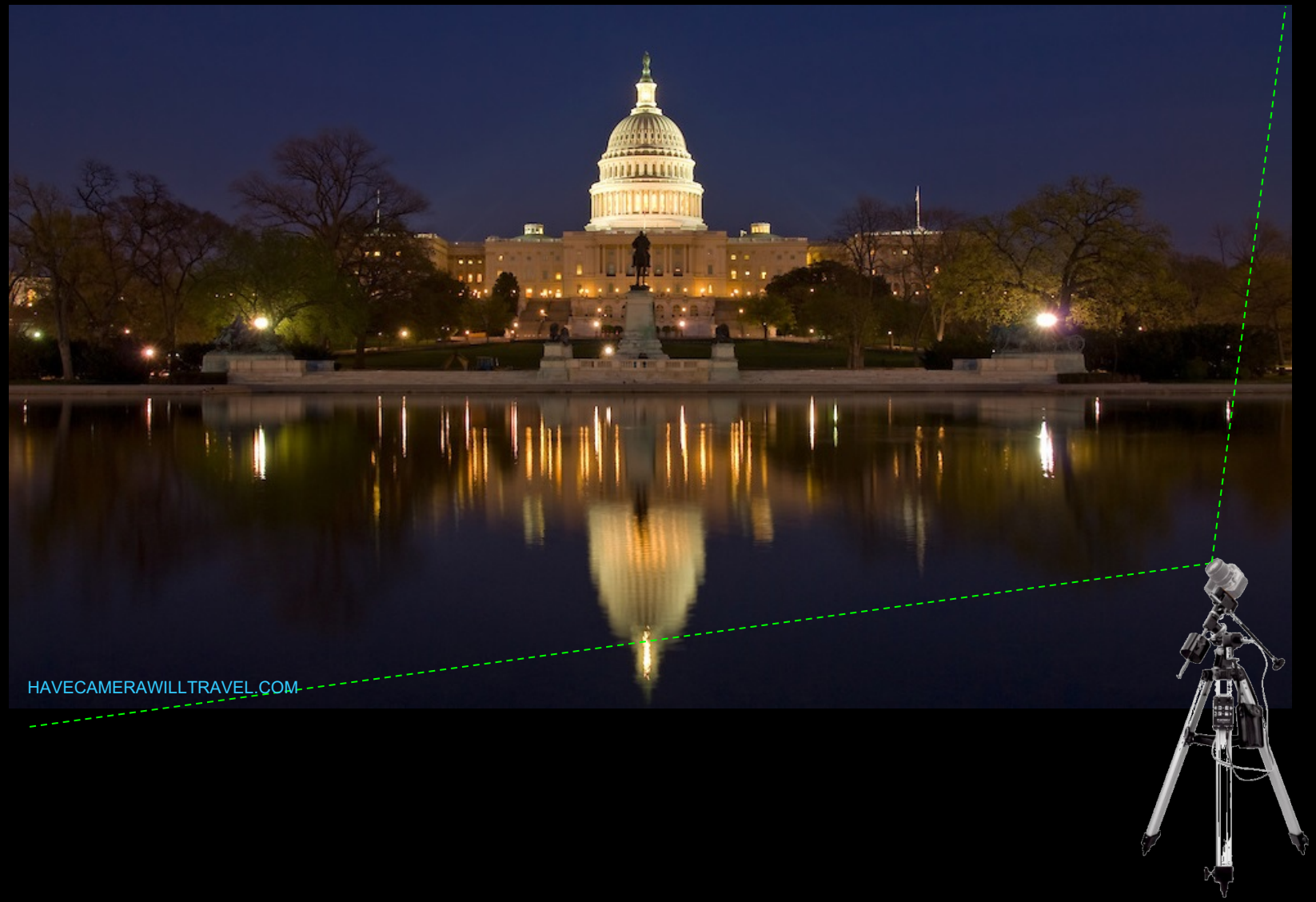


Fun with Photons – Imaging the Night

Nighttime Camera Settings

- **Manual or Bulb**
- **ISO: 800 - 1600**
- **F-Stop: Lowest Number**
- **White Balance: Auto**
- **Auto Rotate: Off**
- **Auto Focus: Off**
- **Image Format: Raw / LRGB**
- **Flash: Off**
- **Autofocus: Off**
- **Mirror Flip: On**
- **Long Exposure Noise Reduction: On** *(For images 3 minutes or less)*

Fun with Photons – Imaging the Night



- Any Digital Camera
- Any Mount / Tripod
- Set ISO: 1600
- Set Exposure time *(shutter speed)* to 1 sec.
- Point and focus on Target
- Use Timer or Intervalometer
- Don’t move camera!
- Make corrections by adjusting ISO or Exposure time.

Fun with Photons – Imaging the Night

ISO: 800

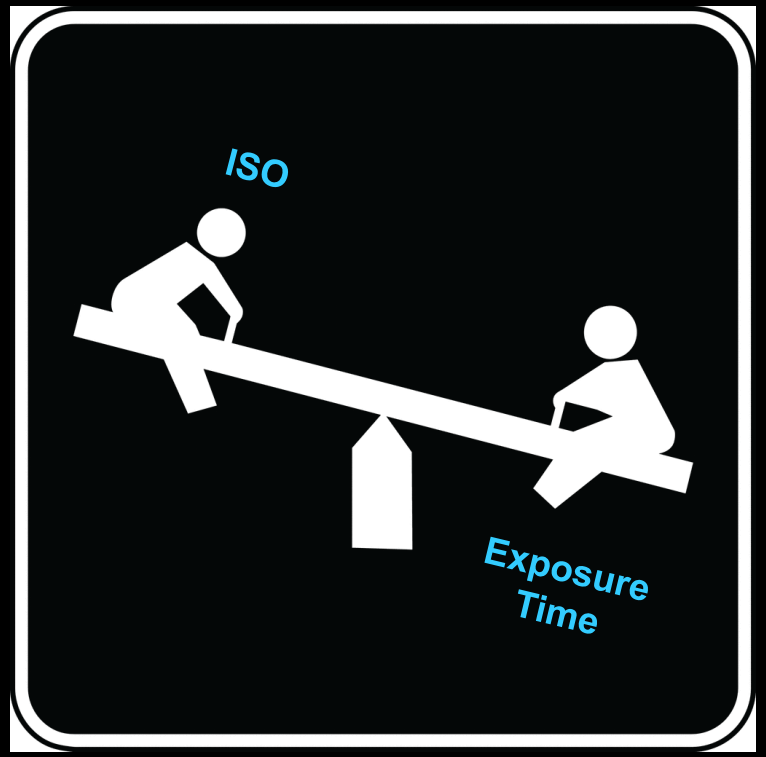
Exposure: 1 second

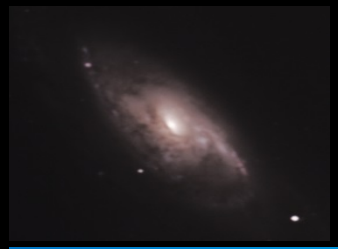
ISO: 1600

Exposure : 1 second

ISO: 3200

Exposure: 1 second





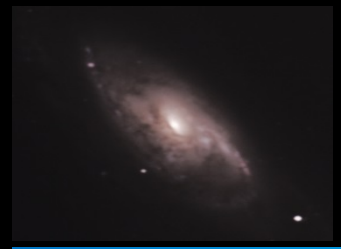
Fun with Photons – Imaging the Night

What if something moves? Like Traffic?

Fun with Photons – Imaging the Night

Light Painting

COLORADO CAPTURES

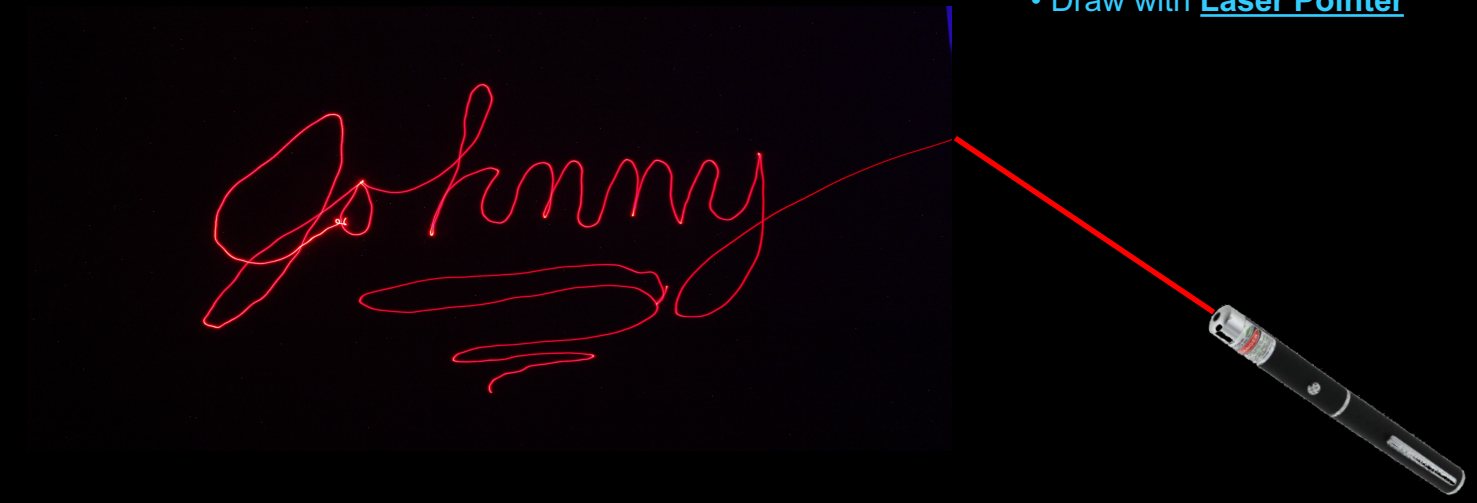


Fun with Photons – Imaging the Night

Light Painting

Lasers

- Canon 5D Mk II on Tripod
- ISO: 800
- 15 Second Exposure
- Manual Focus on wall
- Turn off lights
- Draw with **Laser Pointer**



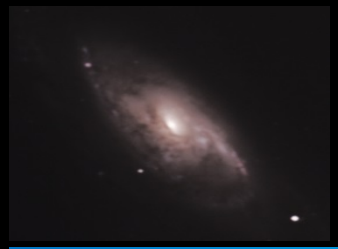
Fun with Photons – Imaging the Night

Light Painting

Light Brushes

Fun with Photons – Imaging the Night

Light Painting



Fun with Photons – Imaging the Night

Beginner Astroimaging

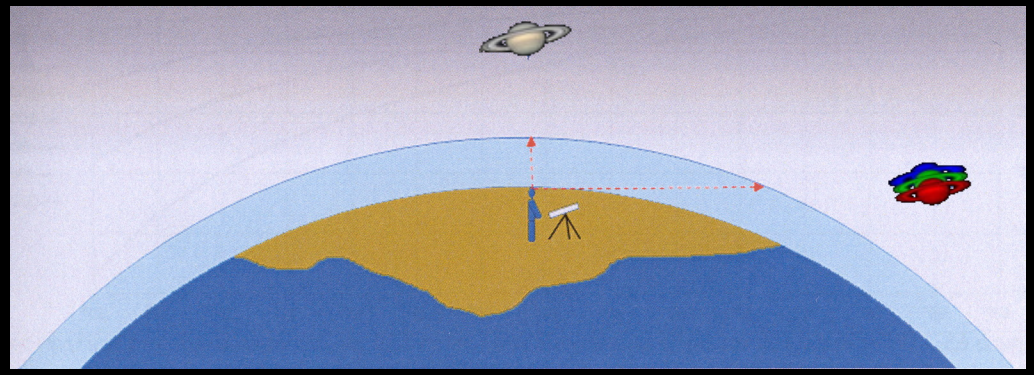
Conditions

Ideal	Poor
Clear	 Overcast
Cool	 Wind
Dark	 Moon
Dry	 Sky Glow
Stable Atmosphere	 Heat
	 Humidity

Fun with Photons – Imaging the Night

Beginner Astroimaging

Angler and Atmospheric Effects



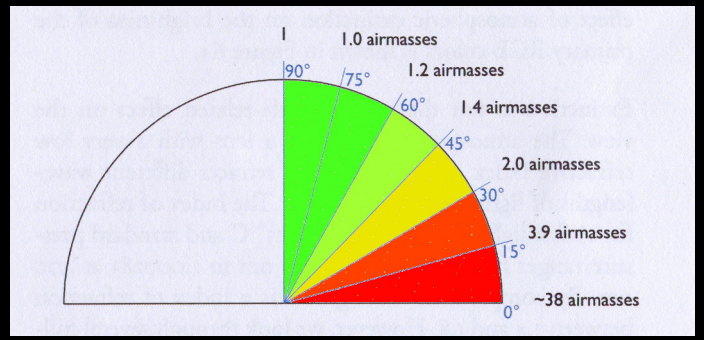
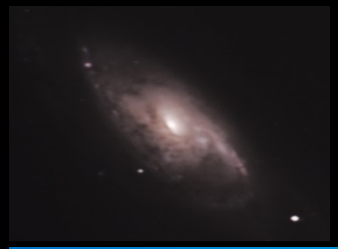
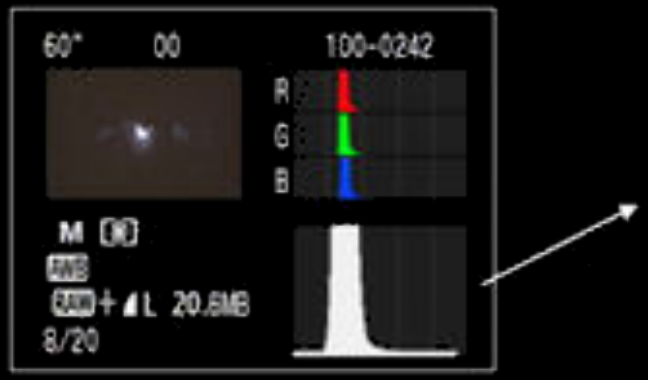


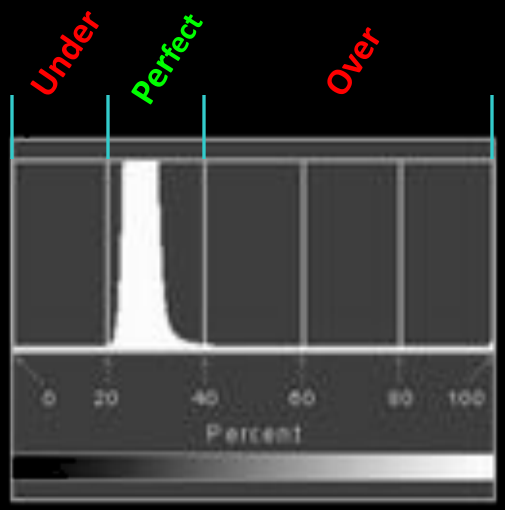
Image 30° above horizon leaving 120° of sky to image

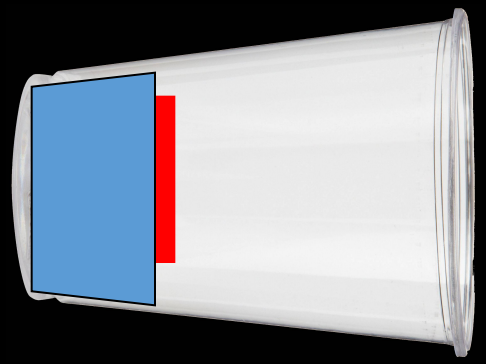


Fun with Photons – Imaging the Night

Exposure





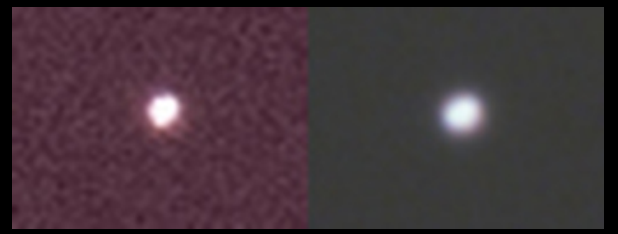


Higher ISO Setting

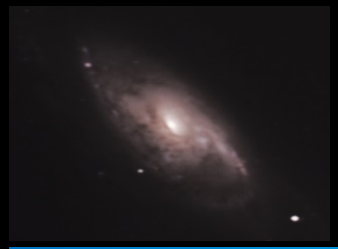
Pro	Con
Shorter Exposure Battery Conservation	Less Color Depth More Color Noise

Lower ISO Setting

Pro	Con
More Color Depth Less Color Noise	Longer Exposure Battery Life Reduced Noise from Heat



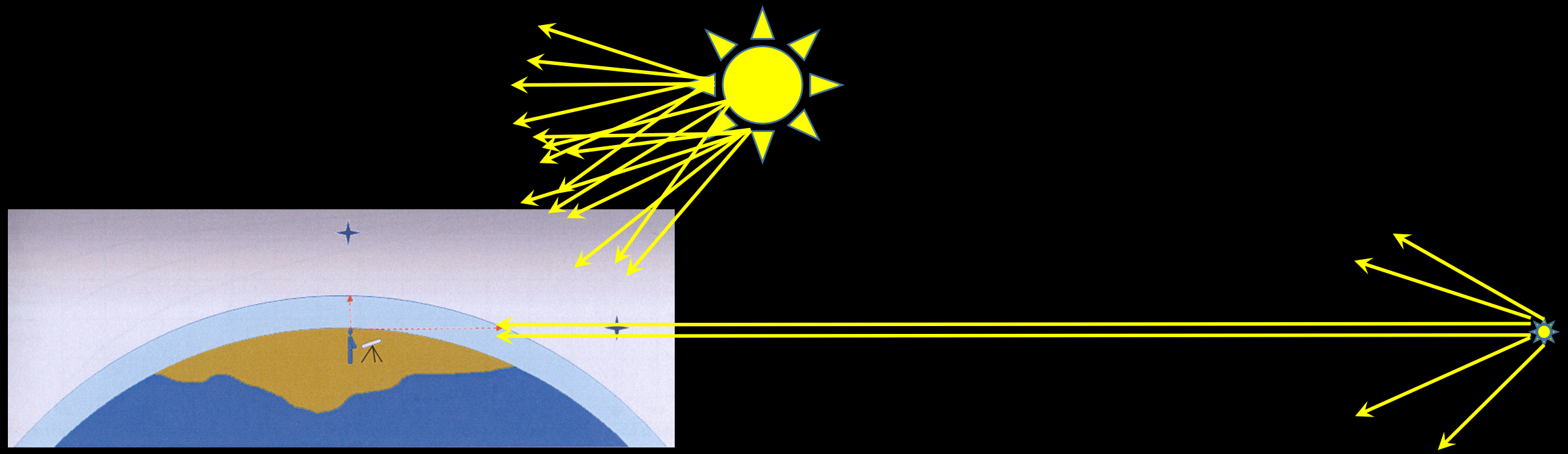
ISO: 12800 - vs - ISO: 400

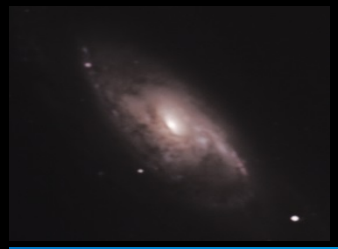


Fun with Photons – Imaging the Night

Infinity Focus ∞

Infinity Focus is used to focus light of parallel rays. Point sources as far away as distant stars, nebula and galaxies guarantee parallel rays. All non-parallel rays have diverged and the ones reaching your eyes and optics are parallel.

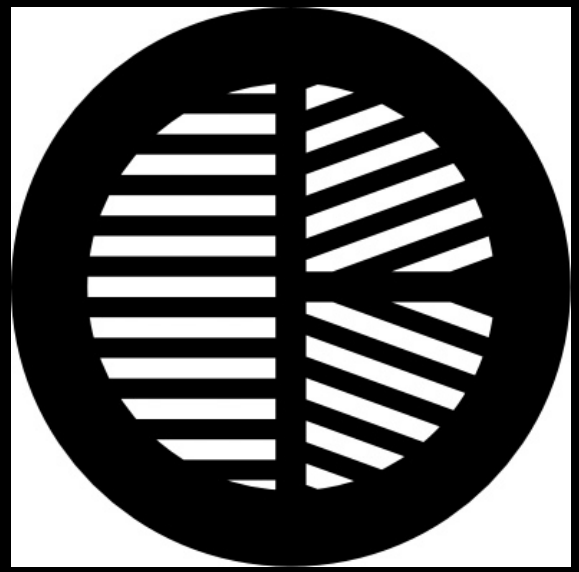




Fun with Photons – Imaging the Night

Accessories

Bahtinov Mask *(Focus on Infinity)*

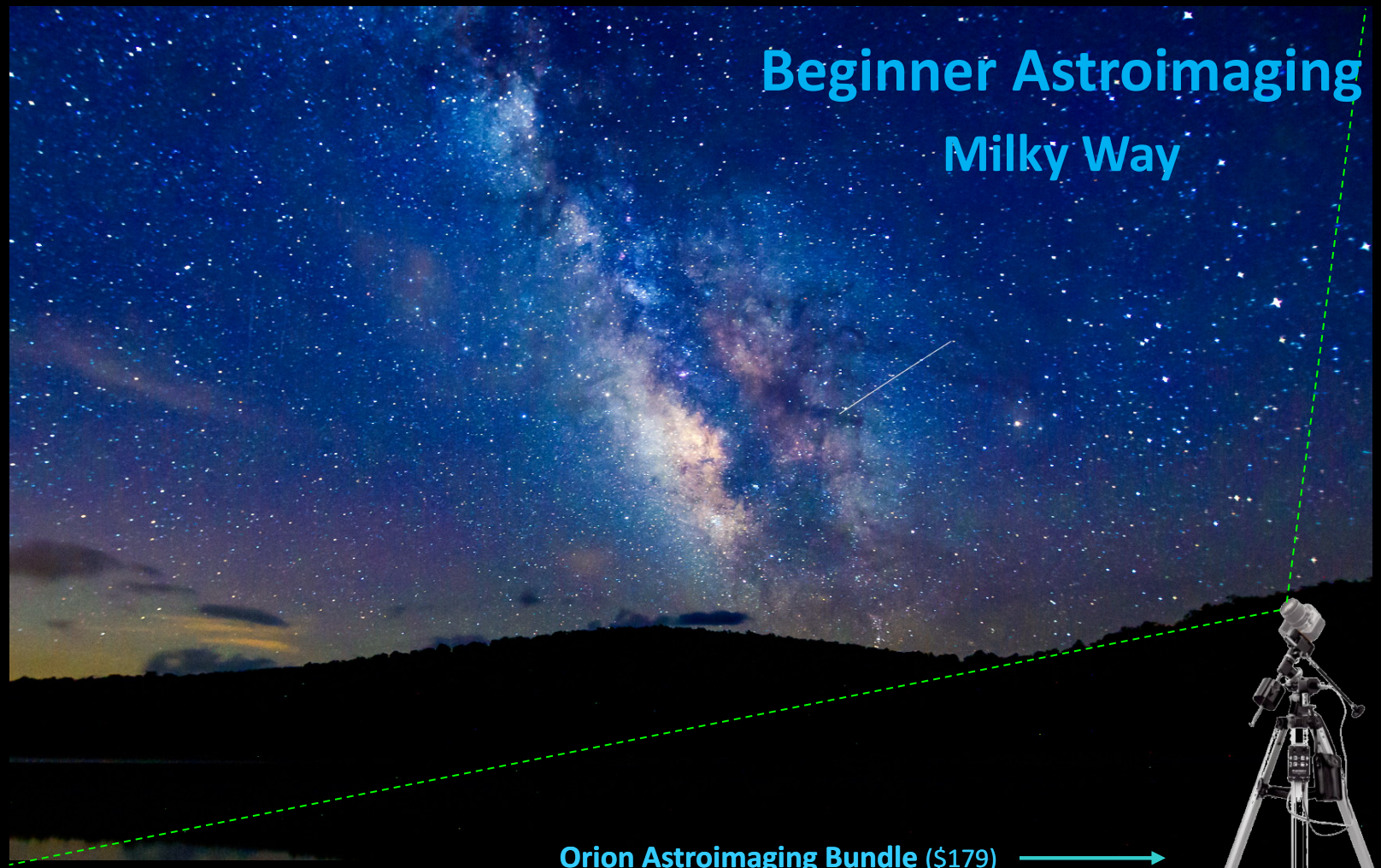


Fun with Photons – Imaging the Night

Accessories

Remote Timer (Intervalometer) **/ Switch**

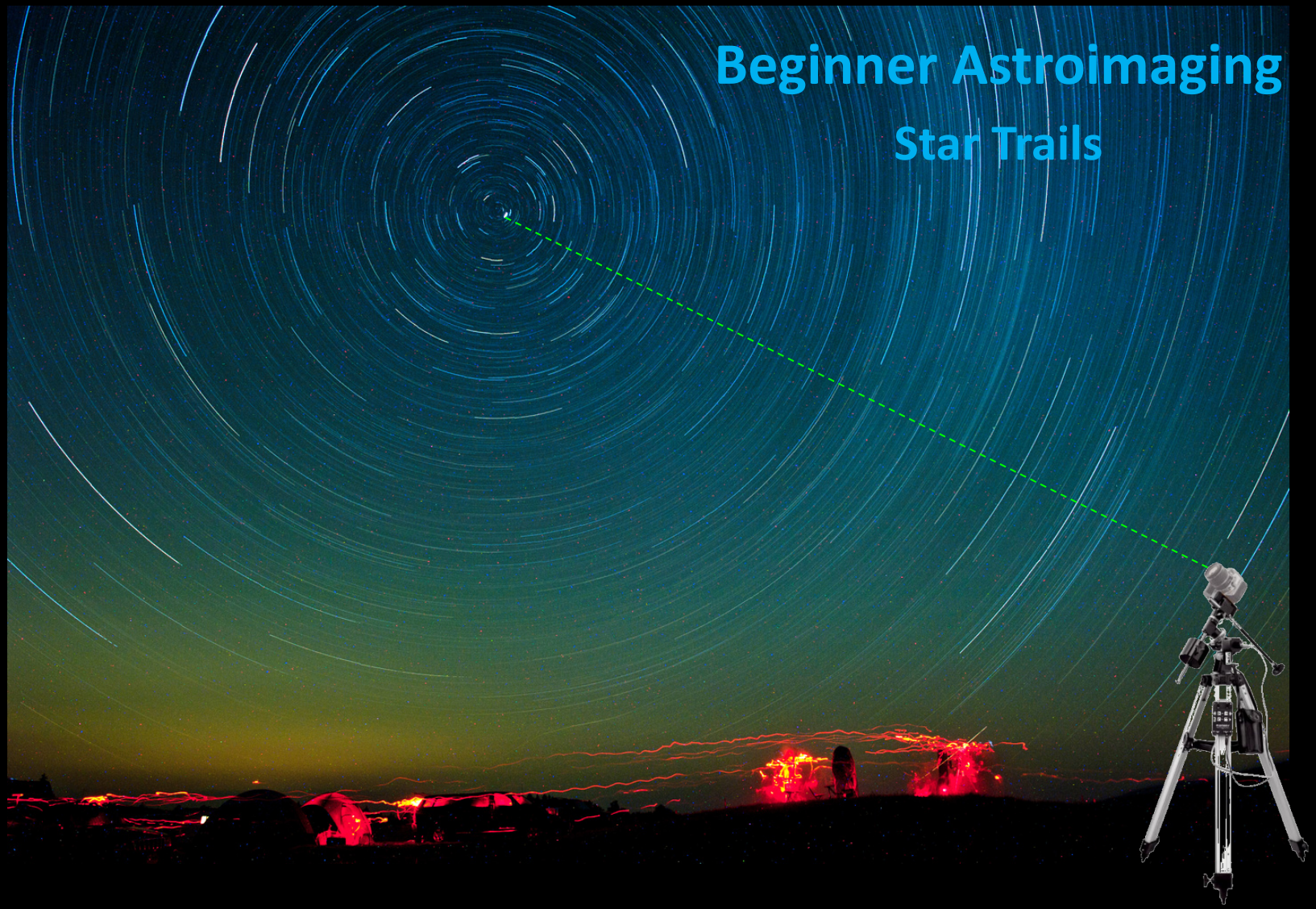
Fun with Photons – Imaging the Night



Orion Astroimaging Bundle ($179)

- Any Mount
- Any Camera
- Best Lens f/1.5-f/3, 15-30mm
- Set ISO: 1600-3200
- Exposure Time: Use 500 Rule
  Exposure Time = 500/fl Lens
  (500/20mm Lens = 25 sec exposure)
- Recommend Remote Switch
  or timer to prevent Vibration
- Point at Milky Way
- Focus at Infinity
- Take a picture for computed exposure time
- Post process image in any photography application

Fun with Photons – Imaging the Night



- Any Mount
- Any Camera
- Set ISO: 400 - 800
- Point at Polaris (North Star)
- Focus on Polaris or Infinity
- Optional Intervalometer
- Take 5 min exposures for 2+ hrs
- No more than 5 seconds between the 5 min exposures (gaps)
- Don’t move camera!
- Combine in **PhotoShop Star Trails Action** or **Star Trails**

Fun with Photons – Imaging the Night

Mount Camera to Telescope

Projection

T-Adapter

T-Ring (Brand Specific)

Prime Focus

Eye Piece or other element

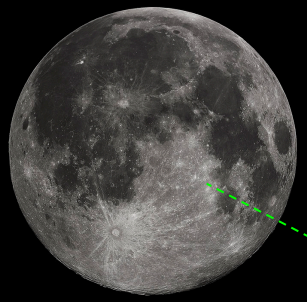
A Focal

(Projection)

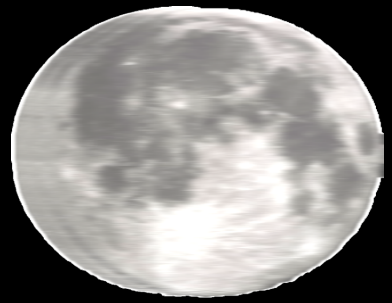
Fun with Photons – Imaging the Night

Beginner Astroimaging

The Moon

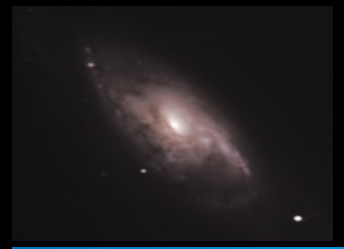


Shutter speed 1/200
(too high)



Shutter speed 1/60
(too low)

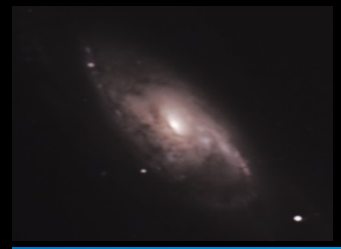
- Any Camera
- Lens (100 – 300 mm) or Telescope
- Any Mount / Tripod
- Set ISO: 100 – 200
- Set Shutter Speed: (1/125)
- Point at Moon
- Focus Manually
- Optional Intervalometer
- Take Shot
- Adjust ISO and Exposure time as necessary



Fun with Photons – Imaging the Night

- Any Mount
- Any Camera
- Use 100mm+ lens or telescope
- Set ISO: 1600
- Point at Orion Nebula (M42)
- Focus on Infinity
- Use Timer or Intervalometer
- Take a 15 second Exposure
- Don’t move camera!

YOU WILL CAPTURE SOMETHING! *(Adjust ISO and Exposure time as necessary)*



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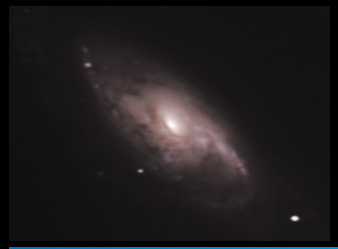
Orion Nebula (M42)

- Telescope: Explorer Scientific 127ED
- Mount: Sky-Watcher NEQ-6 Equatorial
- Autoguider: Sky-Watcher Synguider
- Camera: Canon 5D MKII
- ISO: 800
- 58 Total Light Frames (subs)
  - 36 x 5 min lights
  - 22 x 5 min lights with Lumicon Deep Sky Filter
- 18 Dark Frames
- 18 Flat Frames
- 18 Bias Frames
- Stacking Software: Deep Sky Stacker
- Finishing Software: PaintShop Pro CS6



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Sub Frames

Light Frame – The Image of your target object

Dark Frame – An image taken at the same ISO, Exposure Time and under the same environmental conditions as your light frames, but with the lens cap on. They are used to subtract thermal and random noise from the light frame. Dark Frame Subtraction improvement is the square root of the number of dark frames taken *(i.e. 16 removes thermal noise by a factor of 4, 25 by a factor of 5 and so on…)*

Flat Frame – An image taken with the same focus, camera orientation, and optical setup as the lights. Do not remove camera from your telescope! They are used to remove vignetting, dust donuts, smudges and other imperfections in the optical train. The image is taken against a neutral, white background *(i.e. Point telescope at a white computer screen, or place a white t-shirt over the aperture and point it at clear sport in the sky during the day. Set your camera to AV mode and take an image which is 1/3 to 1/2 of your histogram).*

	Cap On/Off	ISO Same as Lights	Exposure Time same as Lights	Number of Subs	Remove from Telescope
Lights	Off	N/A	N/A	21+	No
Dark	On	Yes	Yes	16+	Yes
Flat	Off	Yes	No	9+	No
Bias	On	N/A	No	9+	Yes
Dark Flats	On	Yes	No	9+	Yes

Bias Frame – An image taken at the same ISO as your light frame, but at the highest shutter speed (Usually 1/4000 or 1/8000 second). Bias frames used to remove the CCD or CMOS chip readout signal from the light frames

Dark Flat Frame – An exposure the same length as the flat frame but with the lens/scope covered up. It reduce the noise in the flat frames. Dark Flats are not often used when shooting Bias Frames

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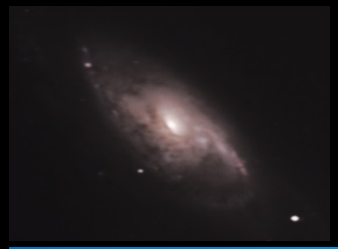
Advanced Astroimaging

Equipment

- Equatorial Mount
- Guide Scope / Auto guider
- Modified Ha DSLR or Hi-res mono CCD camera with color filter wheel
- Imaging Scope: 3” – 6” APO Refractor or 6” or greater Reflector f/7 or less.
- Remote Timer / Switch

- Photoshop or comparable imaging software
- Extra batteries and power supplies
- Field Flatner, coma corrector and focal reducer
- Filters – Ha, Hb, OIII, SII
- Dew Heater / Hand Warmers



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Questions?