

Astroimaging – From Easy to Less Than Easy

Amateur Astrophotography

MADE POSSIBLE BY ADVANCES IN:

1. Camera technology
2. High quality amateur telescopes
3. Telescope mounts
4. Computer technology
5. Astroimaging software



Astroimaging – From Easy to Less Than Easy

- What You Can Expect: Types of celestial objects within reach

Planets



Galaxies



Nebulae



Comets



Star Clusters



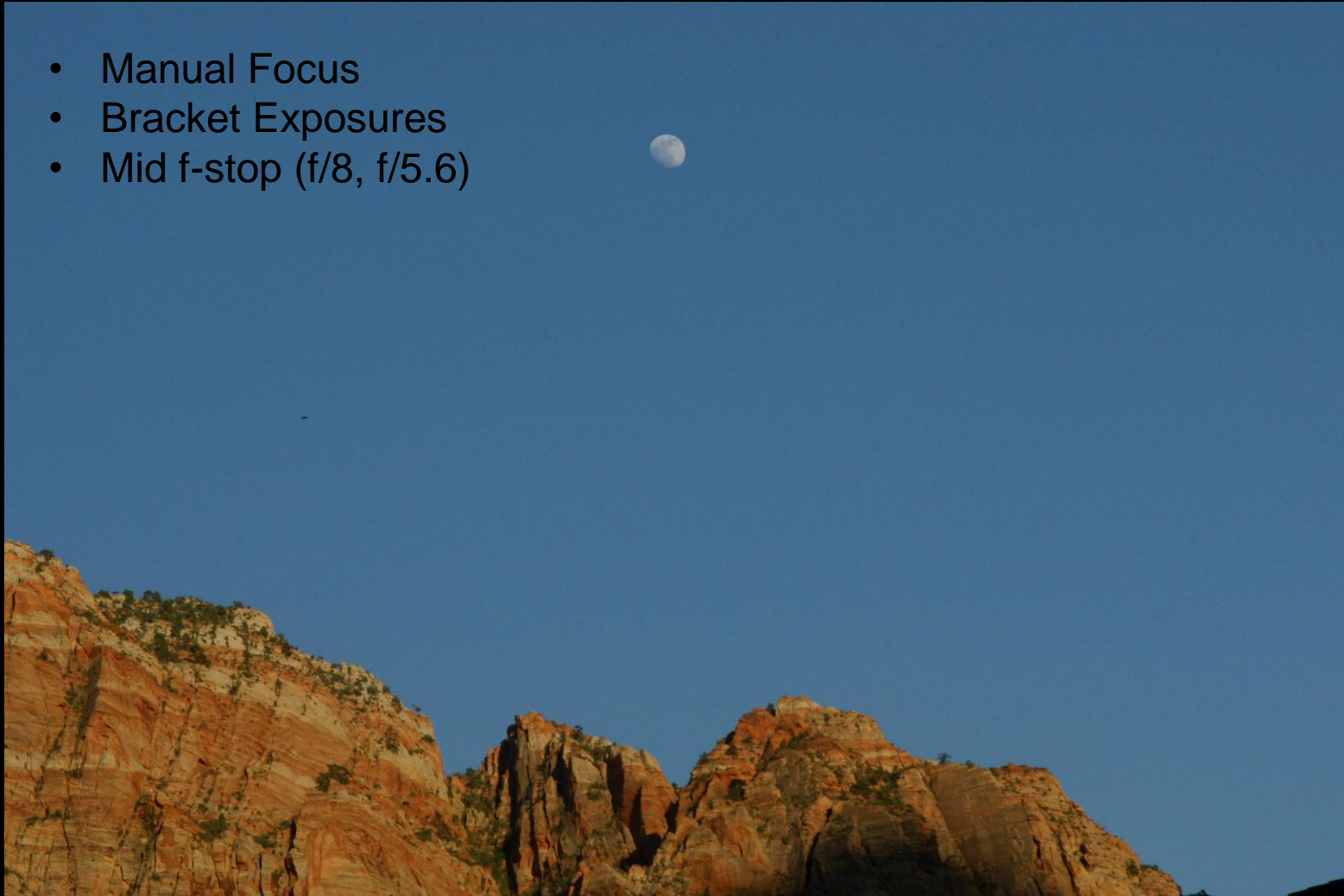
Constellations



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Easiest – Single frame shot of the Moon

- Manual Focus
- Bracket Exposures
- Mid f-stop (f/8, f/5.6)



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Next Easiest – DSLR on Barn Door Tracker



Barn Door Tracker

S. Douglas Holland

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- Camera: Unmodified Canon 300D
- Telescope: 18-55mm kit lens
- Mount: Barn Door Tracker



The Holland Observatory
Lake Tahoe, 7/4/08

The Milky Way over Lake Tahoe

S. Douglas Holland

1x4min

(1) 4 minute exposures, Barndoor tracker,
ASA400, f/5.6, 18mm Lens
Canon Digital Rebel

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- Camera: Modified Canon 450D
- Telescope: Sigma 17-70mm lens
- Mount: Barn Door Tracker



The Holland Observatory
Buffalo Trail Scout Ranch
7/13/12

The Milky Way over Buffalo Trail Scout Ranch

1x3min

The Milky Way over BTSR, Aquila Area with Sagittarius near Mountain
(1) 3min Exposure, Barn Door Tracker
Canon 450D (modified), 17-70mm Sigma Lens at 17mm, f/2.8

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DSLR



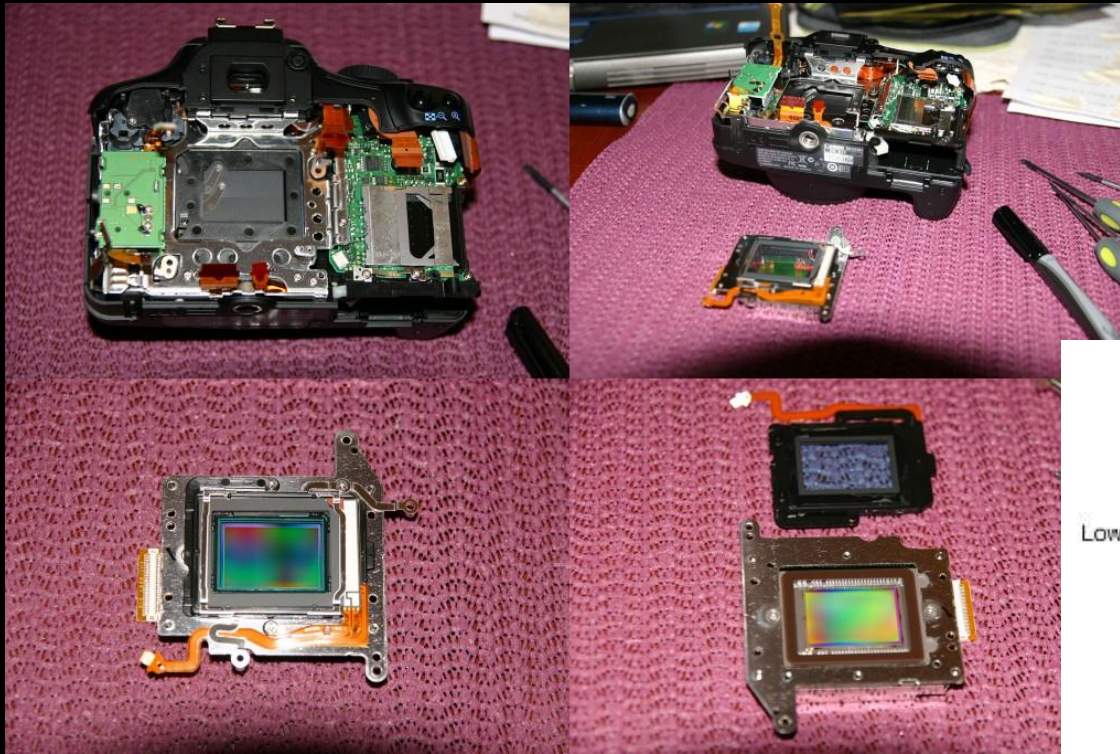
MODIFIED

- Or -

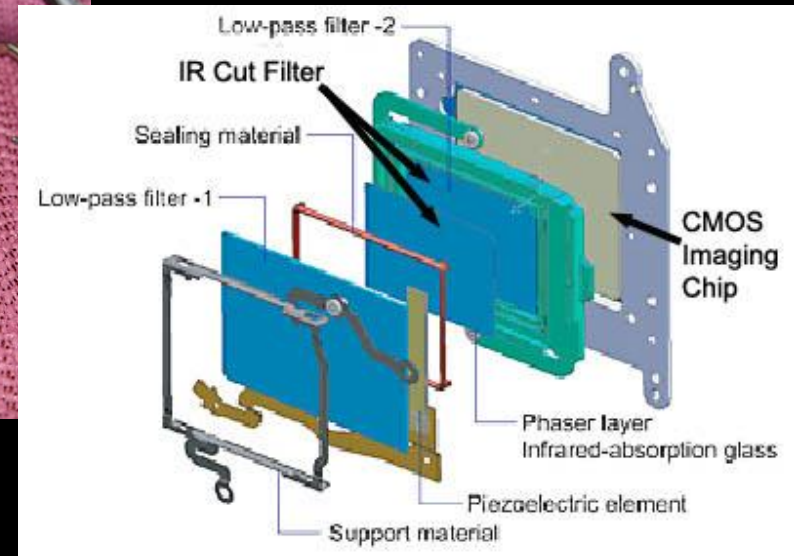
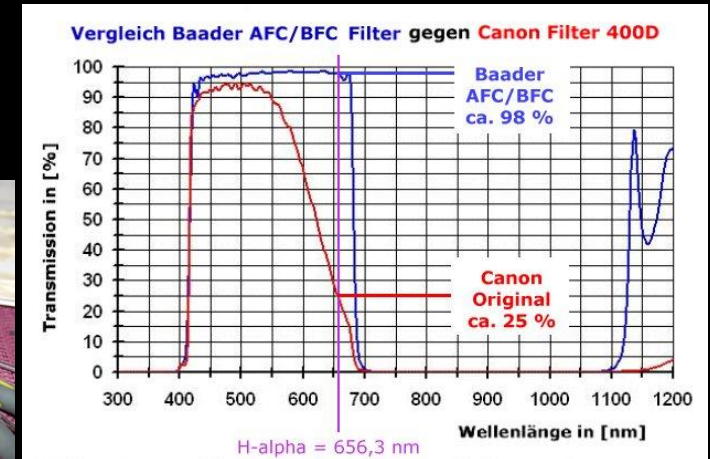
UNMODIFIED

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Modifying DSLR for Astrophotography



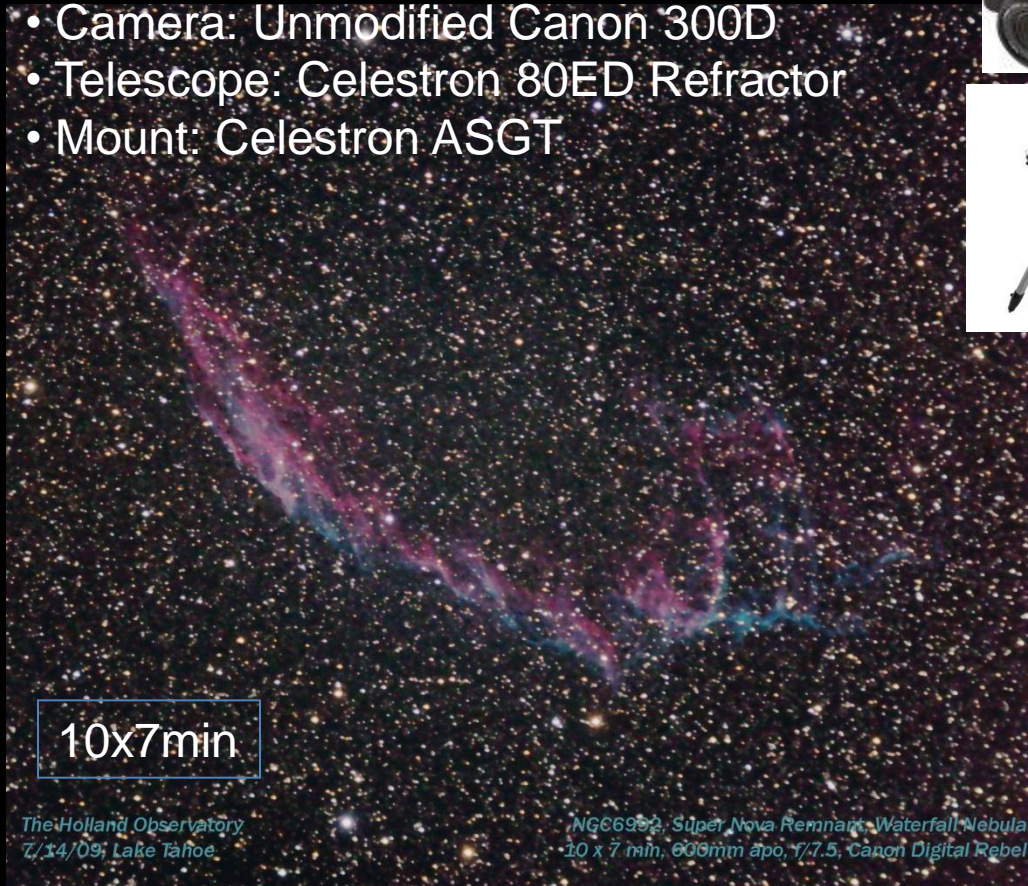
Replacing IR Cut Filter improves performance for Astrophotography.



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Images Taken with an Unmodified DSLR

- Camera: Unmodified Canon 300D
- Telescope: Celestron 80ED Refractor
- Mount: Celestron ASGT

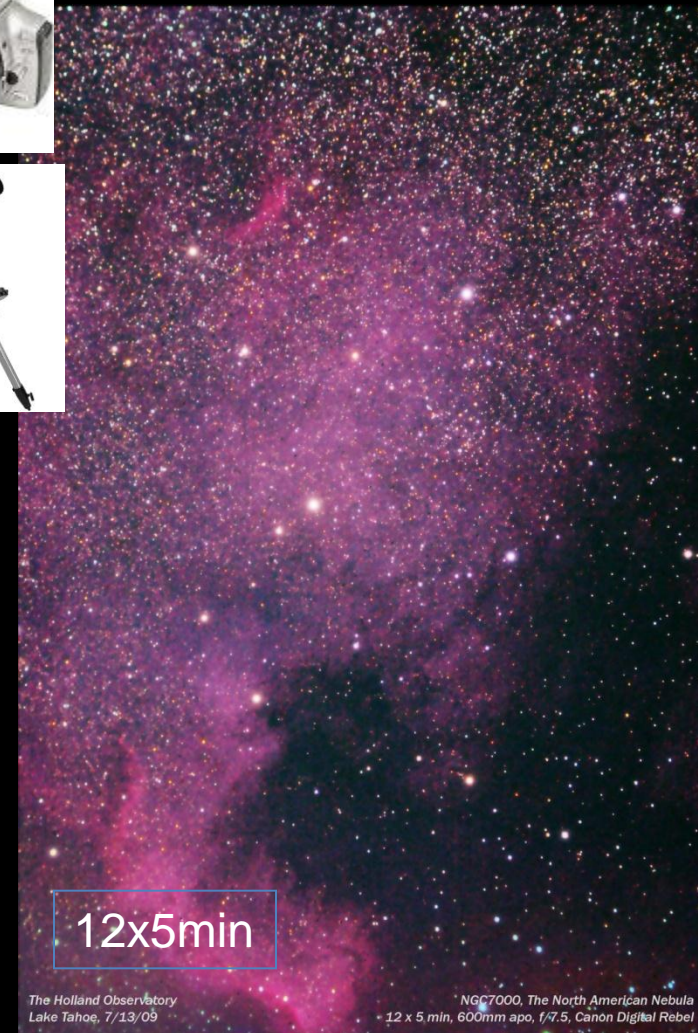


The Holland Observatory
7/14/09, Lake Tahoe

NGC6992, Super Nova Remnant, Waterfall Nebula
10 x 7 min, 600mm apo, f/7.5, Canon Digital Rebel

NGC6992: The Waterfall Nebula (Super Nova Remnant)

S. Douglas Holland



The Holland Observatory
Lake Tahoe, 7/13/09

NGC7000, The North American Nebula
12 x 5 min, 600mm apo, f/7.5, Canon Digital Rebel

NGC7000: The North American Nebula

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Images Taken with a Modified DSLR

- Camera: Modified Canon 450D
- Telescope: Celestron 8" Newtonian
- Mount: Losmandy G-11
- Filter: Astronomik CLS



The Holland Observatory
12/23/13

Orion's Belt Star Alnilak, Emission Nebula IC434 surrounding Dark Nebula B3
Emission Nebula NGC2024 - The Flame Nebula, Blue Reflection Nebula NGC2023 unc
40x5min, 200mm f/5 Newtonian, Baader MPCC, CLS Filter, Baader Filter Mod

IC434: Horsehead, NGC2024: Flame Nebula



27x5min

NGC2174: Monkey Head Nebula

in Orion
r, MPCC

24x5min

The Holland Observatory
12/27/11

IC410: The Tadpole Nebula in Orion
24x5min, 200mm f/5 Newtonian, Canon X5 / 4500, CLS Filter, MPCC

IC410: The Tadpole Nebula

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This point on =>

Going to need a telescope & telescope mount



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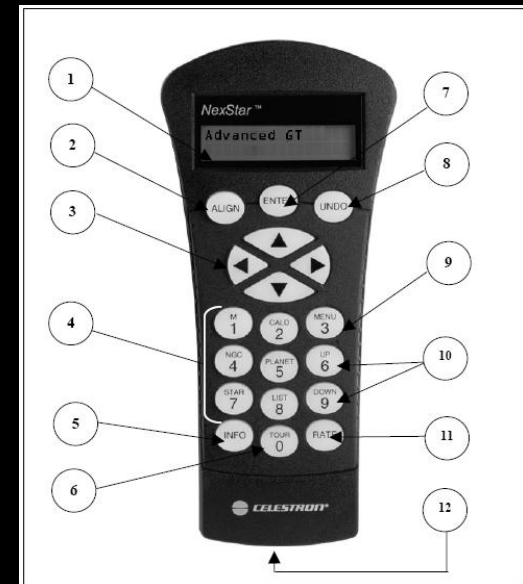
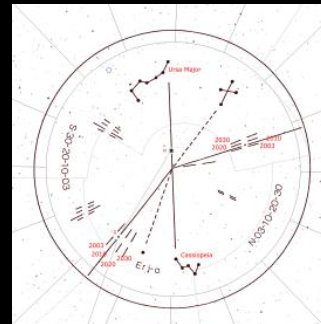
Setting up your telescope and mount -

- Polar Alignment Options:
 - North Celestial Pole Polar Alignment Scope
 - Quick, easy. Good enough for many targets



– GoTo Setup

- User will center 2 or more bright stars allowing scope computer to create an accurate map of the sky



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Next Easiest – DSLR Single Shot of the Moon



T-Thread Adapter

- Camera: Unmodified Canon 300D
- Telescope: Celestron 8" Newtonian
- Mount: Celestron ASGT
- Accurate tracking not required

Randall's Picture of the Month: 2005

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Total Lunar Eclipse
December 20th - 21st, 2010
The Holland Observatory
200mm Newtonian at f/5
Canon Digital Rebel w/ MPCC

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Next Easiest – Planetary Imaging

How it is done:

1. Tracking is not critical
2. Mounts in place of eyepiece
3. Nights of good seeing (low air turbulence) are required
4. Hundreds of images taken, stored as movie (AVI)
 - Note – limited by planet rotation
5. Best selected, aligned and stacked (e.g. Registax software – **Free**)



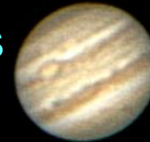
Celestron Skyris



Orion Star Shoot Solar System Color Imager



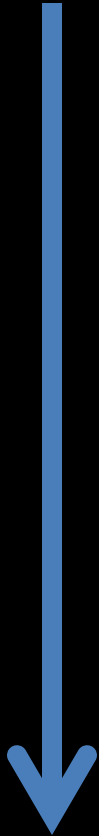
Celestron NexImage



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This point on =>

Going to need accurate tracking



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Telescope Mount

Mount Requirements:

1. Support telescope
2. Track sky accurately



Losmandy G-11
w/ polar align scope

- Problem: Image pixel size corresponds to approx. 1 arc second (1") of angle
- It is difficult to get a mechanical telescope mount to track accurately for long exposure pictures within around 1" of accuracy. Otherwise, pixels are smeared due to tracking errors. **Good optics are of no use with a bad mount.**

How to calculate image scale / resolution:



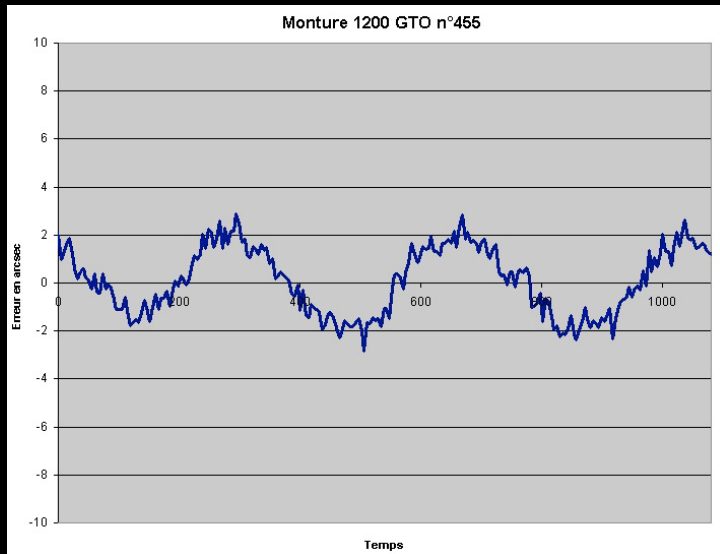
$$2 \cdot \arctan\left(\frac{5.2\mu\text{m} / 2}{1000\text{mm}}\right)$$

Image Scale: the angle subtended by one pixel

- Example: a 5.2um pixel (Canon 450D) with a 1000mm fl telescope has an image scale of **1.07"**.

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Even the best mounts still have some errors, e.g. periodic error -



Guide Telescope



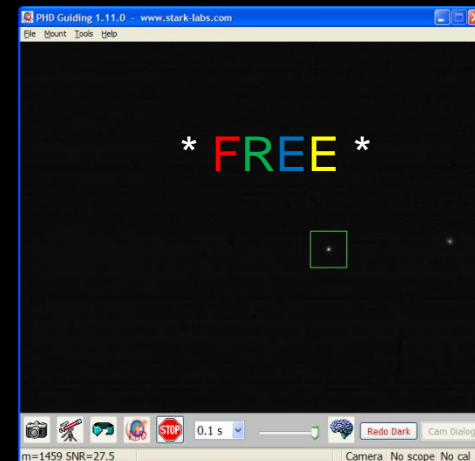
Guide Camera



Need method of correcting the tracking errors:

1. Guide scope and guide camera to lock on star
2. Send corrections to mount - Autoguiding

Autoguiding Software



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Next Easiest – Bright Deep Sky Objects with DSLR

- Camera: Unmodified Canon 300D
- Telescope: Celestron 8" Newtonian
- Mount: Celestron ASGT

7x4min



*The Holland Observatory
Camp Bovay, 2/17/07*

M42: The Orion Nebula, NGC1977 The Running Man Nebula

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*M42, The Orion Nebula Center,
NGC1977, Running Man Nebula Right*

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- Camera: Unmodified Canon 300D
- Telescope: Celestron 80ED Refractor
- Mount: Celestron ASGT



10x7min

The Holland Observatory
Pack 957, Fall Family Campout, Huntsville State Park
11/7/08

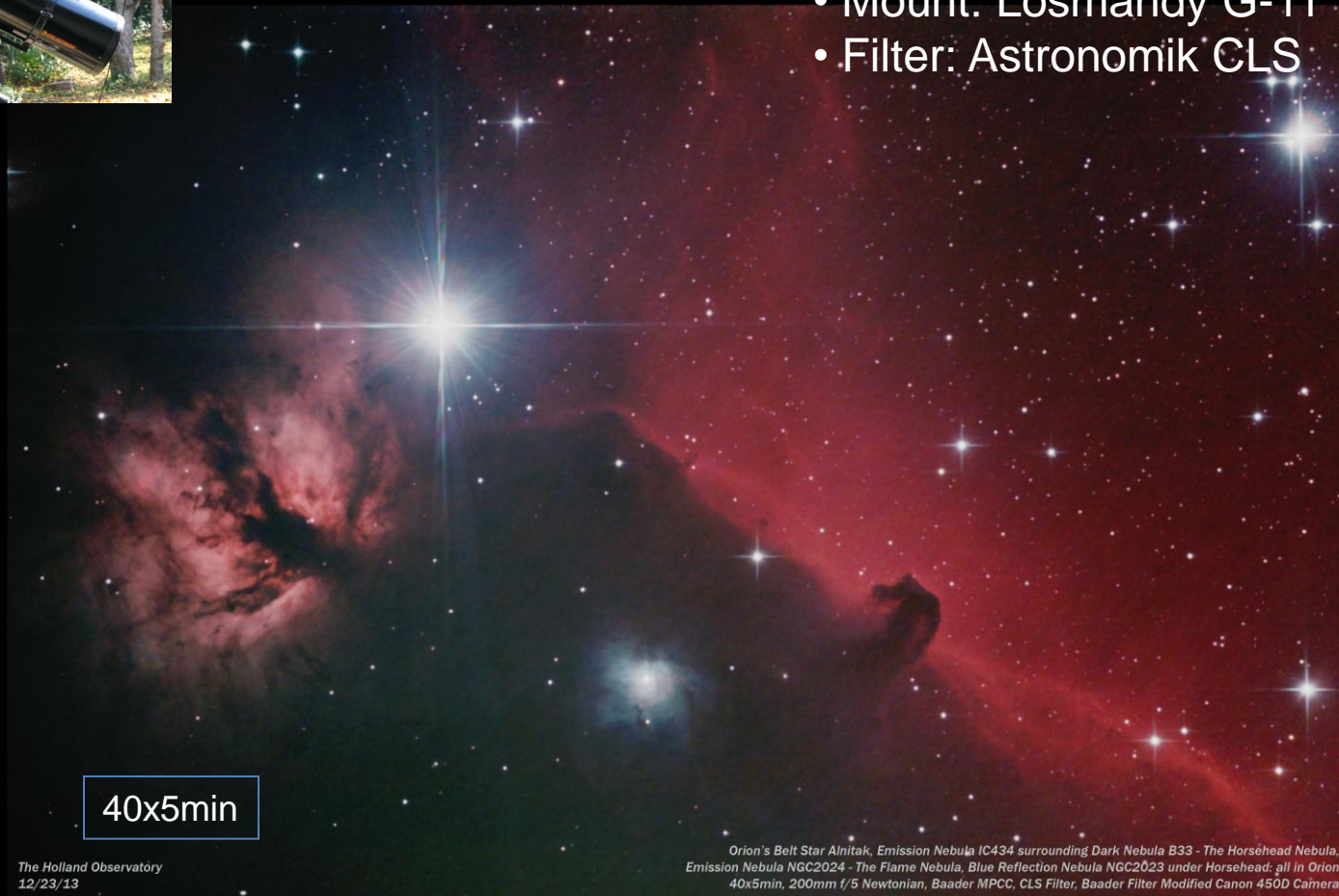
M31: The Andromeda Galaxy

M31, The Andromeda Galaxy
(10) 7 minute exposures, ASA800
80mm apo at f/7.5, IDAS filter, Canon Digital Rebel

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- Camera: Modified Canon 450D
- Telescope: Celestron 8" Newtonian
- Mount: Losmandy G-11
- Filter: Astronomik CLS



40x5min

The Holland Observatory
12/23/13

Orion's Belt Star Alnitak, Emission Nebula IC434 surrounding Dark Nebula B33 - The Horsehead Nebula, Emission Nebula NGC2024 - The Flame Nebula, Blue Reflection Nebula NGC2023 under Horsehead; all in Orion
40x5min, 200mm f/5 Newtonian, Baader MPCC, CLS Filter, Baader Filter Modified Canon 450D Camera

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- Camera: Modified Canon 450D
- Telescope: Canon EF 200mm Lens
- Mount: Celestron ASGT
- Filter: None

Antares / Scorpius Area

5x3min

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Next Easiest – Dim Deep Sky Objects with Astroimager

How it is done:

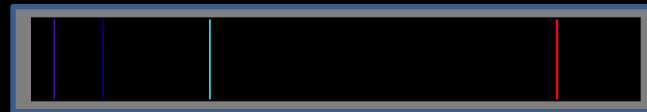
1. Best cameras are monochrome: filters required
2. Cameras are cooled to reduce thermal noise (2x for each 6°C)
3. Images are taken along with closely matched calibration frames (more critical than DSLR)



RGB Filters + L



Narrowband Filters



Hydrogen Spectral Series
{ H α : red line at right }

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- Filter Options

Narrowband Imaging – Many targets show more features in narrowband than in RGB / regular visible light images.



NGC2174 - RGB

NGC2174 - Narrowband

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- Filter Options (cont'd)

Light Pollution from Imaging Site

Object to right =====>

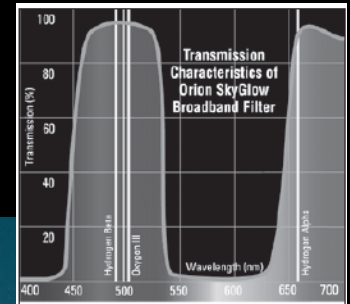
Located in front yard of imaging site



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- Filter Options (cont'd)
 - Light pollution reduction filters
 - Can significantly help –

For
Astroimager

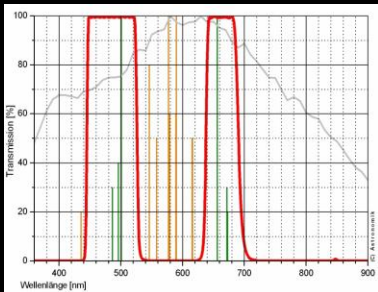


Without Skyglow Filter



With Skyglow Filter

Can significantly help – example 4 minute exposures



For DSLR

Astronomik
CLS
Clip-Filter

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Flame Nebula

Near Infrared



RGB

Narrowband



← Nebula do well in NIR too!

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- Camera: CCD (Sony ICX285 Sensor)
- Telescope: Celestron 8" Newtonian
- Mount: Losmandy G-11
- Filters: LRGB



L: 42x1min, R: 6x2min, G: 8x2min, B: 8x2min

M3: Globular Cluster

The Holland Observatory
4/15/10

*M3, Globular Cluster in Canes Venatici
200mm Newtonian, f/5, LRGB, SC285 Camera
L: 42x1min, R: 6x2min, G: 8x2min, B: 8x2min*

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Astroimaging – From Easy to Less Than Easy

- Camera: CCD (Sony ICX285 Sensor)
- Telescope: Celestron 8" Newtonian
- Mount: Losmandy G-11
- Filters: LRGB



L: 11x5min, R: 5x5min, G: 5x5min, B: 6x5min

The Holland Observatory
Fort McKavett JSCAS Star Party, 4/11/13

M101: Spiral Galaxy

M101 Spiral Galaxy in Ursa Major
LRGB - L: 11x5min, R: 5x5min, G: 5x5min, B: 6x5min
200mm Newtonian at f/5, SC285 Camera

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Astroimaging – From Easy to Less Than Easy

- Camera: CCD (Sony ICX285 Sensor)
- Telescope: Celestron 8" Newtonian
- Mount: Losmandy G-11
- Filters: LRGB



L: 7x5min, R: 4x5min, G: 3x5min, B: 2x5min

The Holland Observatory
Texas Star Party, 5/7/13

M20: Trifid Nebula

M20 - The Trifid Nebula in Sagittarius
LRGB, L:7x5min, R:4x5min, G:3x5min, B:2x5min
200mm Newtonian f/5, SC285 Camera

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Astroimaging – From Easy to Less Than Easy

- Camera: CCD (Sony ICX285 Sensor)
- Telescope: Celestron 8" Newtonian
- Mount: Losmandy G-11
- Filters: LRGB



L: 7x5min, R: 2x5min, G: 4x5min, B: 2x5min

The Holland Observatory
Texas Star Party, 5/10/13

M51: Whirlpool Galaxy

M51 - The Whirlpool Galaxy in Canes Venatici
LRGB, L:7x5min, R:2x5min, G:4x5min, B:2x5min
200mm f/5 Newtonian, SC285 Camera

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Astroimaging – From Easy to Less Than Easy

- Camera: CCD (Sony ICX285 Sensor)
- Telescope: Celestron 80ED Refractor
- Mount: Celestron ASGT
- Filters: LRGB



L: 7x4min, R: 4x4min, G: 4x4min, B: 1x4min

The Holland Observatory
7/6&8/13

NGC6992 / 6995: Veil Nebula

NGC6992 / 6995 - The Veil Nebula / Waterfall Nebula in Cygnus
LRGB: L: 7x4min, R: 4x4min, G: 4x4min, B: 1x4min
80ED Refractor at f/7.5, SC285 Camera

Astroimaging – From Easy to Less Than Easy

- Camera: CCD (Sony ICX285 Sensor)
- Telescope: Celestron 8" Reflector
- Mount: Celestron ASGT (pic G11)
- Filters: Narrowband (SII, Ha, OIII)



SII: 14x10min, Ha: 12x10min, OIII: 11x10min

M1: The Crab Nebula (Super Nova Remnant)

The Holland Observatory
11/18/09, 12/18/09, 12/19/09

M1, The Crab Nebula in Taurus
LRGB - R:SII (14 x 10min), G:Ha (12x10min), B:OIII (11 x 10min)
200mm f/5 Newtonian, SC285 Camera

Astroimaging – From Easy to Less Than Easy

- Camera: CCD (Sony ICX285 Sensor)
- Telescope: Celestron 8" Reflector
- Mount: Losmandy G-11
- Filters: Narrowband (SII, Ha, OIII)



SII: 15x10min, Ha: 12x10min, OIII: 10x10min

M16: Eagle Nebula

The Holland Observatory
4/21, 22, 23/12

M16, The Eagle Nebula in Serpens
LRGB, L(Ha), R: SII 15x10min, G: Ha 12x10min, B: OIII 10x10min
200mm Newtonian f/5, SC285 Camera, MPCC

Astroimaging – From Easy to Less Than Easy

- Camera: CCD (Sony ICX285 Sensor)
- Telescope: Canon EF 200mm Lens
- Mount: Losmandy G-11
- Filters: Narrowband



SII: 12x10min, Ha: 6x10min, OIII: 9x10min

IC1848: Baby Nebula

IC1848 - The Baby / Soul Nebula in Cassiopeia
LRGB - L:Ha(6x10min), R:SII(12x10min), G:Ha(6x10min), B:OIII(9x10min)
Canon 200mm L Lens at f/2.8, SC285 Camera

The Holland Observatory
10/8/13 & 11/2/13

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Astroimaging – From Easy to Less Than Easy

- Camera: CCD (Sony ICX285 Sensor)
- Telescope: Canon EF 200mm Lens
- Mount: Losmandy G-11
- Filters: Narrowband



SII: 16x10min, Ha: 6x10min, OIII: 15x10min

The Holland Observatory
10/7,8/13

NGC7000: North American Nebula

NGC7000 - The North American Nebula in Cygnus
Narrowband, SII: 16x10min; Ha: 6x10min; OIII: 15x10min
200mm Canon L Series Lens at f/2.8, SC285 Camera.

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Astroimaging – From Easy to Less Than Easy

- Camera: CCD (Sony ICX285 Sensor)
- Telescope: Canon EF 200mm Lens
- Mount: Losmandy G-11
- Filters: Narrowband



SII: 13x3min, Ha: 20x3min, OIII: 20x3min

The Holland Observatory
1/27 - 28/12

NGC2237-2239: Rosette Nebula

NGC2244, 2237 - 2239, The Rosette Nebula in Monoceros
I(Ha), R(SII), G(Ha), B/OIII - Ha: 20x3min, SII: 13x3min + 40x4min; OIII: 20x3min
200mm f/2.8 Canon L Series Lens, SC285 Camera

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JSC Astronomical Society

Meets 2nd Friday of Each Month, 7:30

USRA Building



Fort McKavett: 3 Night Star Party – Spring & Fall

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Texas Star Party
Once a Year: May
Fort Davis



TSP upper field photo courtesy of Ron Ronhaar and Todd Hargis, 2009

Astroimaging – From Easy to Less Than Easy

- References
 - The New CCD Astronomy by Ron Wodaski
 - The Handbook of Astronomical Image Processing by Richard Berry and James Burnell
 - Best book to understand theory of image calibration, comes with AIP4WIN software
 - The 100 Best Astrophotography Targets by Ruben Kier
 - Photoshop Astronomy by R. Scott Ireland
 - Telescopes, Eyepieces, Astrographs by Smith, Ceragioli & Berry
 - Tells the pros and cons of different telescope designs
- Visit my web page:
 - www.holland-observatory.net