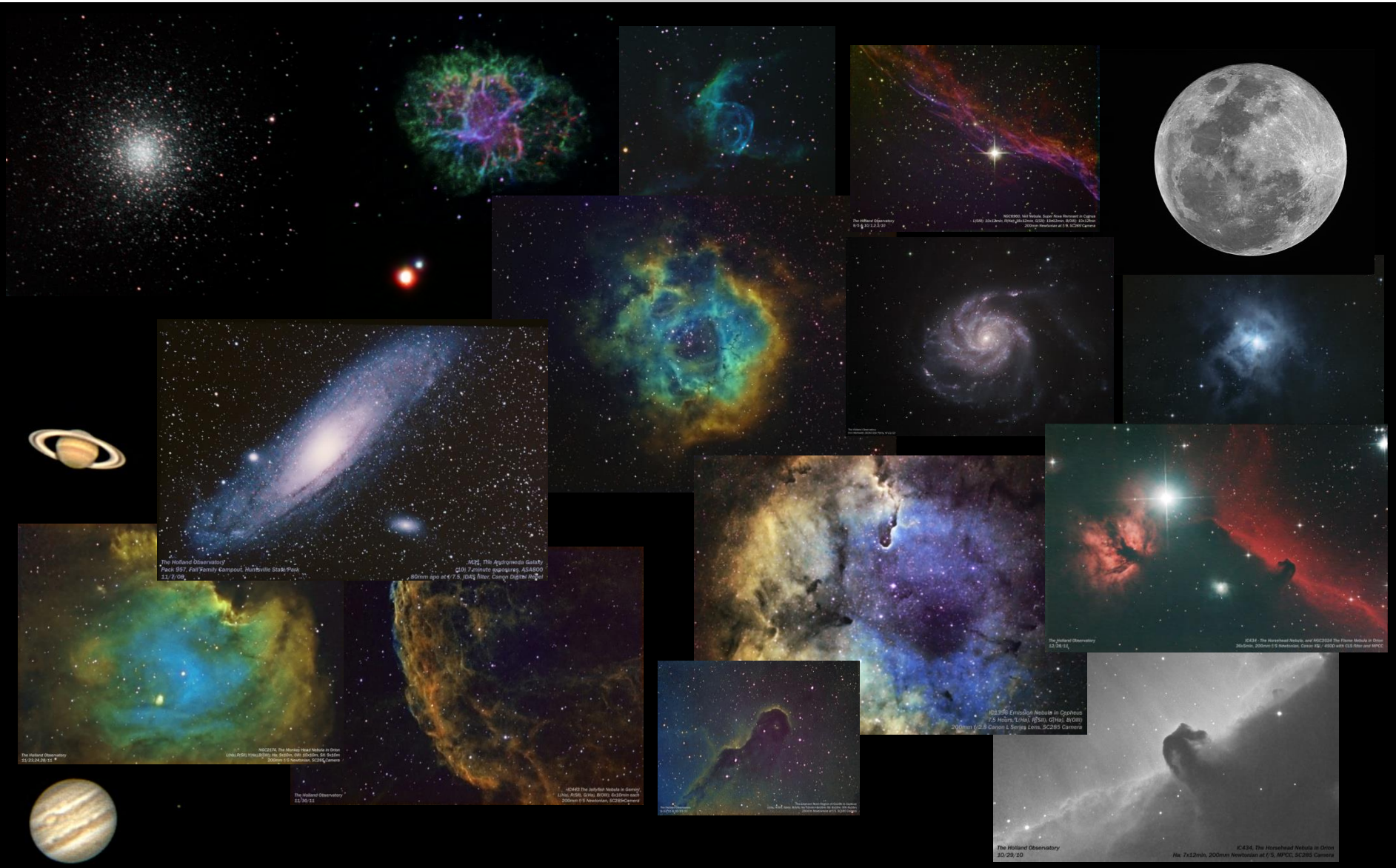
Astroimaging – From Easy to Less Than Easy



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Astroimaging – From Easy to Less Than Easy

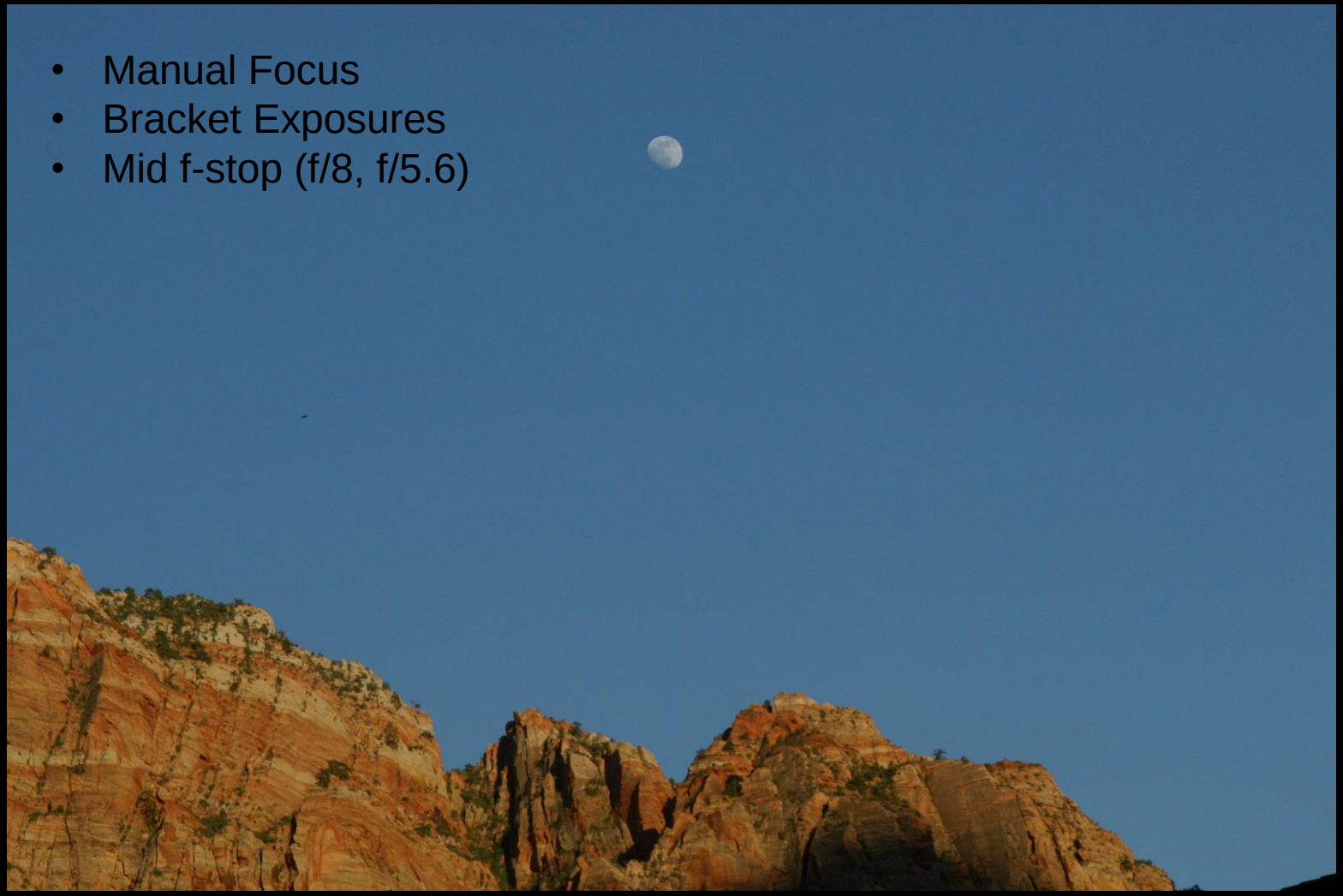
Amateur Astrophotography

MADE POSSIBLE BY ADVANCES IN:

1. Camera technology
2. High quality amateur telescopes
3. Telescope mounts
4. Computer technology
5. Astroimaging software
6. Information: online forums, books, magazines

Astroimaging – From Easy to Less Than Easy

Easiest – Single frame shot of the Moon



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Next Easiest – DSLR on Barn Door Tracker

Barn Door Tracker

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

1x4min

The Holland Observatory
Lake Tahoe, 7/4/08

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

The Milky Way over Lake Tahoe

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

1x3min

The Milky Way over Buffalo Trail Scout Ranch

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

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

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DSLR

MODIFIED

- Or -

UNMODIFIED

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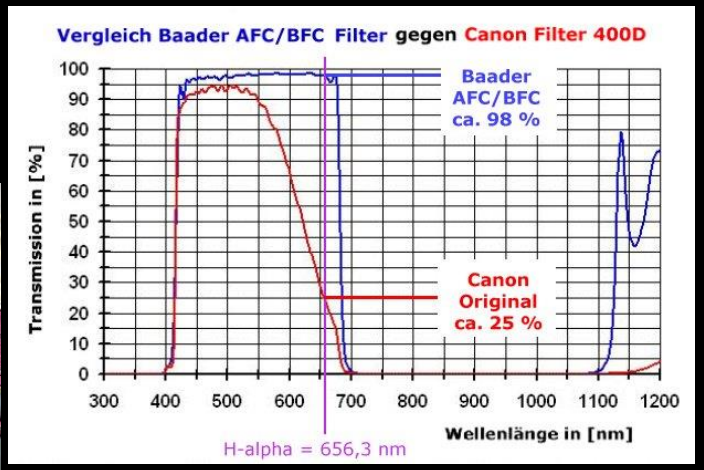
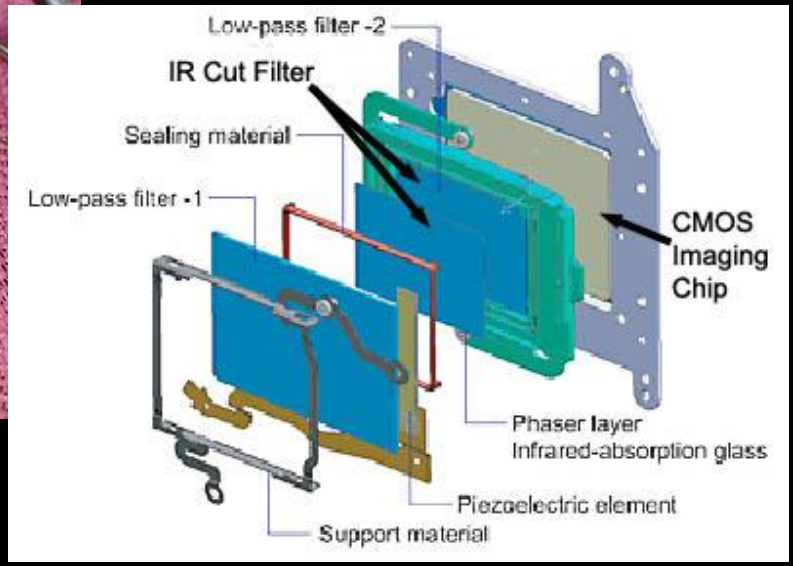
Modifying DSLR for Astrophotography





Replacing IR Cut Filter improves performance for Astrophotography.

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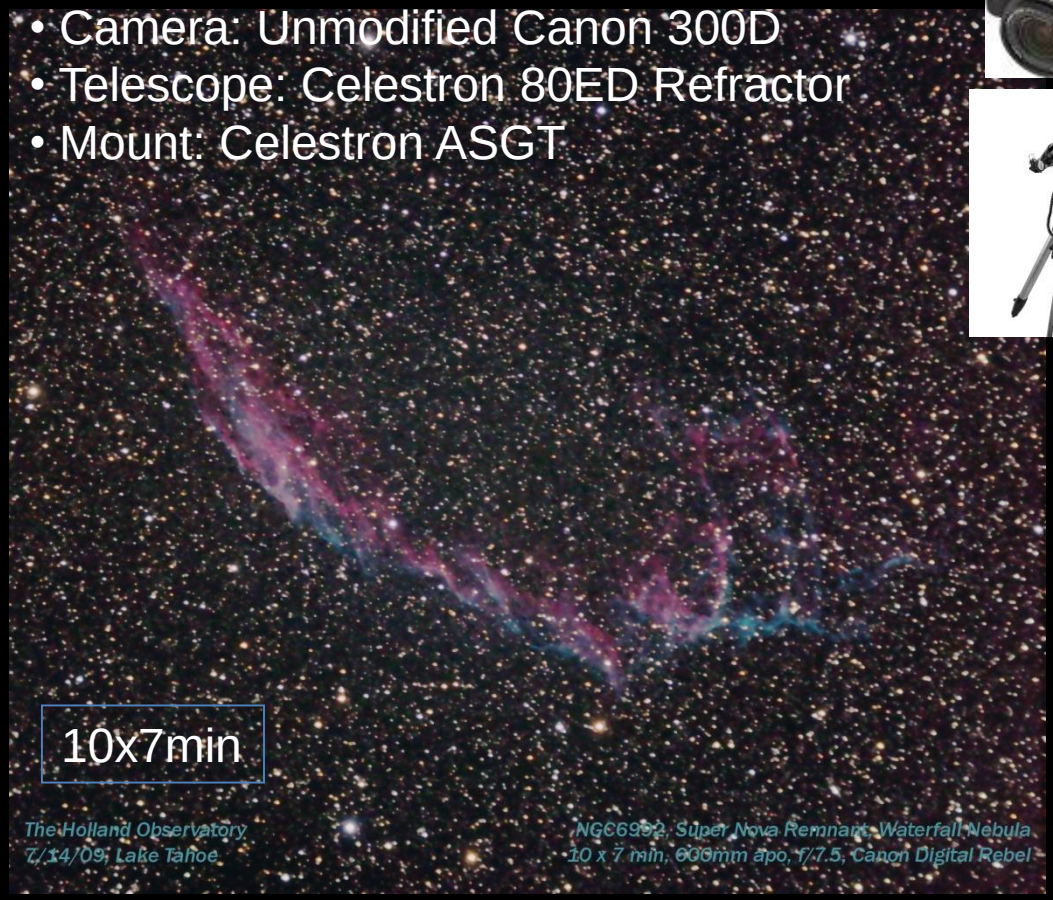
Images Taken with an Unmodified DSLR

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



NGC6992: The Waterfall Nebula (Super Nova Remnant)

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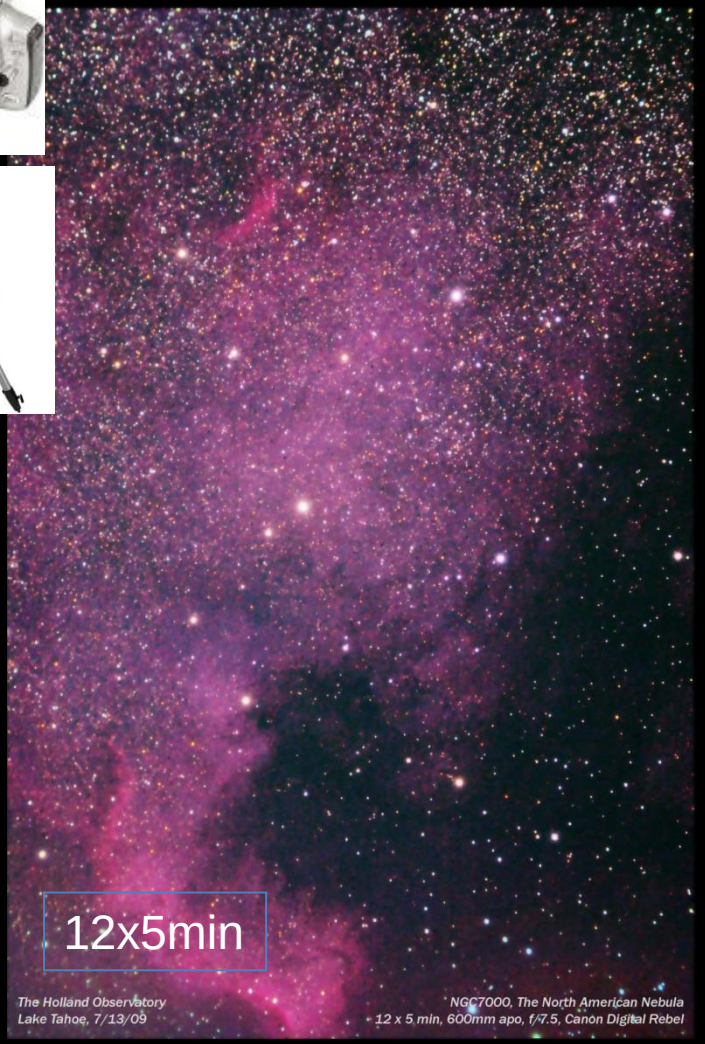

NGC7000: The North American Nebula

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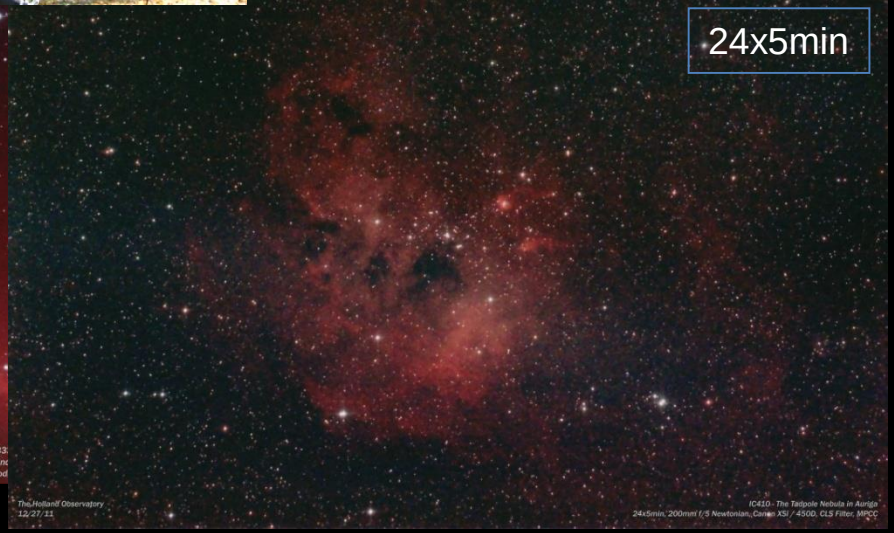
Images Taken with a Modified DSLR

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

NGC2174: Monkey Head Nebula

IC434: Horsehead, NGC2024: Flame Nebula



IC410: The Tadpole Nebula

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This point on =>

Going to need a telescope & telescope mount

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Next Easiest – DSLR Single Shot of the Moon

Randall's Picture of the Month: 2005

T-Thread Adapter

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

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Next Easiest – Planetary Imaging

Celestron Skyris

Orion Star Shoot Solar System Color Imager

Celestron NexImage

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)

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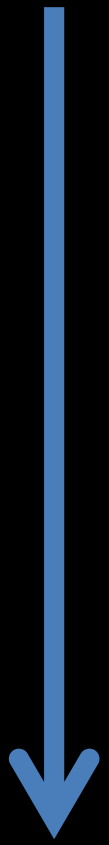

This point on =>

Going to need accurate tracking

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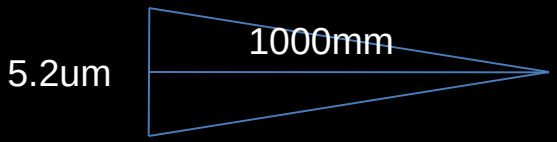
Telescope Mount

Mount Requirements:
1. Support telescope
2. Track sky accurately

Losmandy G-11
w/ polar align scope

How to calculate image scale / resolution:



$$2 \bullet \arctan\left(\frac{5.2um/2}{1000mm}\right)$$

- 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.

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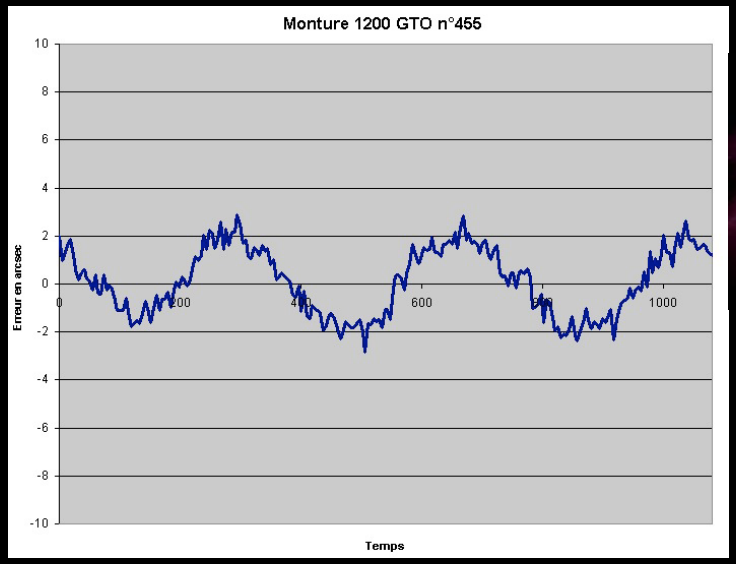
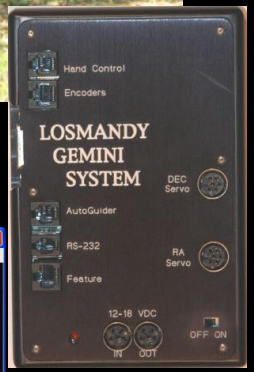
Even the best mounts still have some errors, e.g. periodic error -



Guide Telescope

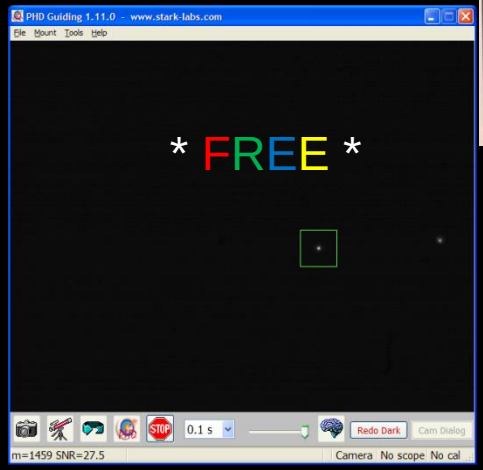
Guide Camera



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 Center,
NGC1977, Running Man Nebula Right

M42: The Orion Nebula, NGC1977 The Running Man Nebula

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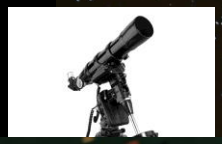
Astroimaging – From Easy to Less Than Easy

- 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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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
{ Ha: red line at right}

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Astroimaging – From Easy to Less Than Easy

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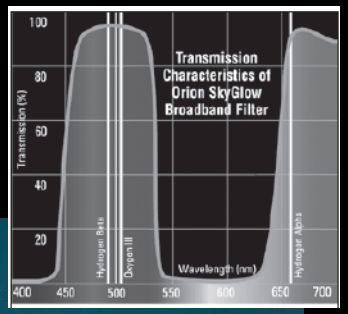
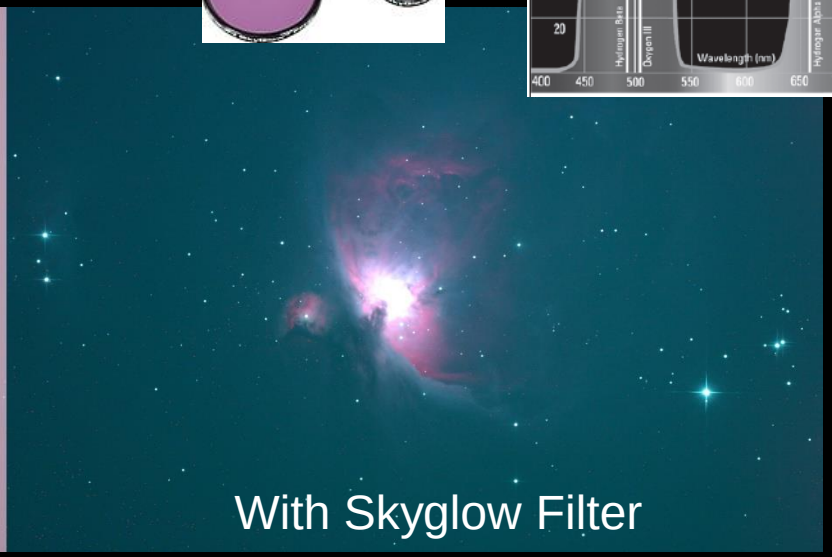
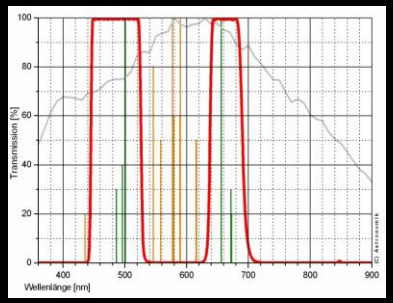
- Filter Options (cont'd)
  - Light pollution reduction filters
    - Can significantly help –

For Astroimager





Can significantly help – example 4 minute exposures



For DSLR

Astronomik
CLS
Clip-Filter

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

The Holland Observatory
4/15/10

M3: Globular Cluster

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

M101: Spiral Galaxy

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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

M20: Trifid Nebula

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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

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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

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

NGC7000: North America Nebula

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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

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

NGC2237-2239: Rosette Nebula

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Astroimaging – From Easy to Less Than Easy

Celestial Objects:

1. From home – some
2. Dark sky – all
   - Star party
   - Vacation
   - Etc.

Best approach –

- Practice at home before going to star party

+

- Many targets possible from backyard even with light pollution

Astroimaging – From Easy to Less Than Easy

JSC Astronomical Society

Fort McKavett:
3 Night Star Party – Spring & Fall

S. Douglas Holland

Astroimaging – From Easy to Less Than Easy

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