Exploring the Wonders of the Night Sky

An Introduction to Astro-Imaging

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Objectives

- Basics of astro-imaging
- Equipment overview
- Visual tour of the night sky (some astronomy)
- Special/one time events
What is needed

• Basic
  – Camera
  – Telescope
  – Computer
  – Image Processing Software
DSLR
Targets

Jupiter
Nov 2012
Jim Hannon

Comet-Panstarrs
April 2013
Marc Croce

Star trails

Lunar eclipse
Liam O’Brien

Cannon T4i with 40mm pancake lens
Lunar Planetary Imager
CCD Manufacturers

• Orion
• SBIG
• Starlight
• Celestron
• Atik

12/14/2014
CCD Cameras – Charged Coupled Device

Celestron Nightscape

CCD Sensor – 3760 x 2840 pixels (10.7 million)

~$1,500
• The longer the exposure – the more light fills up the bucket

• The more the bucket is filled – the brighter the cell – revealing dim features of the object
First View M13 – Through a telescope

M13 Great Globular Cluster in Hercules
Pic: Synth Skyscaper Maksutov-Cassegrain 127mm
Original img credit and copyright - Eddie Guscott
CCD View
M13 - Hercules Globular Cluster

"Graininess" is called "noise"

Uncertainty in the data

6 sec - initial image
CCD View

M13 - Hercules Globular Cluster
CCD View
M13 - Hercules Globular Cluster

after post processing
CCD View
M13 - Hercules Globular Cluster

Shef Robotham. -3-10min
CCD View

M13 - Hercules Globular Cluster

25,000 ly, 1 million stars, 150 ly across
Making a Quality Astro-Image

• Alignment, tracking and guiding
• Precise focusing
• Take long exposures and stack (Increases S/N )
• Noise reduction techniques (Calibration)
• Post Processing (Photoshop, Maxim DL, Nebulostiy, Astroart, etc.) – bring out hidden details
Benefits of Polar Alignment, Focusing and Guiding

M42 – Orion Nebula -1,300 ly, 24 ly across, features – Star cluster called Trapezium
Star forming area, both reflection and emission nebula

Light concentrated, maximize contrast between features – dramatically improve image quality
Long Exposures, Stacking and Calibration
NGC 1977 – Running Man Reflection Nebula

Single 4-min exposure

9-4-min exposures stacked and calibrated

1500 ly, 7 ly across

Photoshop Levels and curves

Reduced noise, increased depth, and reveal hidden features
**My setup**

**Hardware**
- Imaging scope
- Imaging Camera
- Guide scope
- Guide camera
- Focal reducer
- Electronic focuser
- RGB Filters

**Software**
- Image acquisition
- Focus support
- Guiding
- Track and stack
- Calibration
- Photoshop
The Night Sky
Open Clusters

“An open cluster is a group of up to a few thousand stars that were formed from the same molecular cloud and have roughly the same age.”
M45 - Pleiades

Shef Robotham

In Taurus - Open Cluster (over 1,000 stars), reflection nebula
Globular Clusters

“In contrast to open clusters, the more massive globular of stars exert a stronger gravitational attraction on their members, and can survive for many billions of years. Over 150 have been found in the Milky Way - 29 are listed in Messier’s catalog”

Inside a globular, where stars are only tenths of a light year apart, there would be thousands of stars as bright as Venus and Jupiter
Globular Clusters

M13 Shef

M3

M15
Galaxies
M101 – Pinwheel Galaxy

Spiral galaxies

Taken 5-15-11, 10-6 min lum images

Shef R.  10 min images

In Ursa Major - - at 25 million light years.
Caldwell 12 – Fireworks Galaxy

In Cygnus, 22 million ly – by Shef Robotham
NGC 4565 – Needle Galaxy

In Coma Berenices - at 30 million light years.
Taken 5-1-11, 25 -90sec unguided lum images
NGC 3628 – Hamburger Galaxy

In Leo – 35 million ly away
M82- Cigar Galaxy

An irregular galaxy - in the constellation Ursa Major at about 12 million light years take 5/20/09 (LX200) --- 4 min exposures - lrgb processed

taken 4/25/13 (ED80) --- 2min lum exposures

12/14/2014
M51 – Whirlpool Galaxy

A spiral galaxy in the constellation Canes Venatici at a distance of 23 million light years. Taken 4-16-09 -30 sec lum exposures. Companion –NGC 5195 passed through 500 million years ago. Companion NGC 5195

Supernova SN 2011dh

Taken 7/2011 by Shef Robotham single 25 min exposure
M31-Andromeda Galaxy

Single image, 12 - one minute exposures

18-3 minute exposures image, mosaic of 3 images

2.5 million ly away, 1 trillion stars
Reflection Nebulas

“Stellar clouds illuminated by the light of nearby star(s)”
Running Man Nebula
NGC 7023 – Iris Nebula

Reflection Nebula – 1,300 light years ---in Cepheus
6-10 min exposures 2012
Emission Nebulas

“A cloud of ionized gasses”
NGC-2024 Flame Nebula

Emission Nebula – Orion, 1,000 ly
NGC 281 - Pacman Emission Nebula

In Cassiopeia - 9,500 ly - 2012
-6 - 10 minute subs
An emission nebula, Bubble Nebula - in the constellation Cassiopeia at 7000 light years.
M17 – Swan (Omega) Nebula

In Sagittarius - emission nebula at 1,360 light years.

- Taken 7/7/09 - 30 sec lum images, DSI Pro II, LX 200, 30 sec images
- Taken 5/3/13 - 1 min lum images, DSI Pro II, ED80 using H-Alpha filter
- Jim Hannon 2012 – HA filter, DSI III, LRGB, 30 second images

Jim Hannon 2012 – HA filter, DSI III, LRGB, 30 second images
M20 – Trifid Nebula

An emission nebula in constellation Sagittarius at 7,600 light years.

Taken 8/15/2009 - 3 min lum exposures
LX200 8” scope

Shef – Nov 2012

Taken 5/31/2012 - 10 min lum exposures
ED80 - ~3”scope
M8 – Lagoon Nebula
In Sagittarius emission and dark nebula, at ~5,000 light years.

9/07 DSI II color camera -6 sec exposures. LX200

5/12 DSI PRO II -4 min lum exposures  ED80

2012 Marc Croce – DSLR camera -5 min exp
M8 Lagoon Nebula

5/3/13 DSI II Pro II 6mim H-Alpha filter ED80

Ha, SII, OIII filters – Hubble Pallete
M16 – Eagle (Pillars of Creation)

LX 200 DSI Pro II 35 – 2 min exposures

ED80 DSI Pro II 3 – 6 min H-Alpha exposures

Hubble – Pillars of Creation
Planetary Nebula

“A type of emission nebula formed by the expulsion of gasses from a star in the last stages of life, e.g. a white dwarf”
NGC 7293-Helix Nebula

Marc Croce

In Aquarius, planetary nebula, 700ly

Ha -12-3min
M57 – Ring Nebula

Shef R, 20 min exposure – cropped and resampled

Marc – Oct 2012

In Lyra, Planetary nebula, white dwarf, 2,300 ly
M27 – Dumbbell Nebula

A planetary nebula, in the constellation Vulpecula at 1,360 light years.

Taken 7/31/2009 -- 4 min lum exposures
LX 200 8” telescope

Marc – Oct 2012
M27 – Dumbbell Nebula

A planetary nebula, in the constellation Vulpecula at 1,360 light years.

Taken 5/31/12 – 10 min lum exposures ED80 (‘3” telescope)

2011 – Shef R. 20 min exposure (color)
Super Nova Remnants

“A stellar explosion caused by for example the collapse of the core of a massive star forming either a black hole or a neutron star”
M1 – Crab Nebula

In Taurus – Supernova remnant ~5,000 ly away
7-3minute
Veil Nebula

In Cygnus, supernova remnant, 1,470 ly
Leo Triplet

A two picture mosaic taken 5-5-11. Shows 3 spiral galaxies in constellation Leo
Marc Croce – 6/5/12 Venus transit

Mark Croce  DSLR- 6/5/12

Next occurrences – 2117, 2125
Sunspots

Jim Hannon - Sept 2012

JoeD Aug 2013

Intense magnetic activity
Marc Croce – Comets

Panstarrs
DSLR-
April 2013

Swift Tuttle I
March 1992
Dark Nebulas

“An interstellar cloud that is so dense that it obscures light from emission or reflection nebulae or the background stars”
IC 434 - Horse Head Nebula
If you don’t at first succeed ......

2007 – first view
15 sec

2007 – focal reducer
1 minute unguided

2008 – guided –
combined 10-2 minute exposures

2010 – ED80, polar
aligned, 7-4 minute
combined

2010 Photoshop Magic
IC 434 - Horse Head (Dark)Nebula

2010 – ED80, polar aligned, 7-4 minute combined
Signal to Noise Ratio

• Goal – count only electrons due to photons from target – eliminate all other “uncertainty/noise”
  – Cool camera – reduces noise
  – Apply Dark frames – reduces Dark Current, hot pixels
  – Apply Flat Field frames – addresses non uniformity in pixel sensitivity, dust motes and other image train defects
  – Take long exposures (integrations) – increase depth and increase S/N – less variations in longer exposures
  – Take multiple exposures and combine – increase S/N by square root of number of images combined