Imaging the Universe:  
Is Anyone Else Out There

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Butler College Life Skills Seminar

http://www.princeton.edu/~rvdb
I’ve Always Loved Photography

DSLR on a Tripod
What Got Me Interested in Astrophotography
Fancier Equipment

1. Mount

2. Camera
   Computer
   Software

3. Telescope (OTA)
Move equipment outside.
Ready To Go...
Small and Portable Alternative...
Our Solar System
SuperMoon...
Daytime Moon
Lunar Eclipse (2010 Dec. 21)
Lunar Eclipse Montage
Jupiter and Saturn
Crescent Venus (Daytime!)
Venus Approaches the Sun
Venus Transit Weather
Jupiter in the Daytime
Disclaimer:
The Pictures Are Better Than The “Visual” View
Comets Come and Go...
Garradd
Comet 103p Hartley and Double Cluster
Nebulae In Our Home Galaxy (the Milky Way)
Crab Nebula
Lagoon Nebula
Swan Nebula
Dumbbell Nebula
Orion Nebula
Orion Nebula—Close Up
Orion Nebula—Driveway Version
Orion Nebula—Hubble Space Telescope
Starlight Express SXV-H9 on 10” RC at f/9
Hα (13 nm bandwidth)

06:20–06:22 EDT
6 × 5 seconds

SUNRISE at 06:23 EDT local time
06:22–06:36 EDT
33 × 1 seconds

SUNRISE at 06:23 EDT local time
06:36–06:47 EDT
118 × 0.2 seconds

SUNRISE at 06:23 EDT local time
Starlight Express SXV-H9 on 10” RC at f/9
Hα (13 nm bandwidth)
06:47–06:55 EDT
110 × 0.2 seconds

SUNRISE at 06:23 EDT local time
06:55–07:03 EDT
110 × 0.1 seconds

SUNRISE at 06:23 EDT local time
Back to Nighttime
Running Man Nebula
Rosette Nebula
Rosette Nebula—Driveway vs. Mt. Palomar

Driveway

Mt. Palomar (48-inch)
Little Dumbbell Nebula
Owl Nebula
Eskimo Nebula
Crescent Nebula
Veil Nebula
Bubble Nebula
Horsehead Nebula
Clusters Clustered Around The Milky Way
Galaxies Beyond Our Milky Way
M82 and M81
Whirlpool Galaxy
Whirlpool Galaxy—Supernova 2005cs
Whirlpool Galaxy
Whirlpool Galaxy—Supernova 2011dh
Sombrero Galaxy
NGC 4565
Is Anyone Else Out There?
Why Astrophotography?

Long Exposures, Permanent Record, Digital Enhancement, Light Pollution!
Astronomical CCD camera

- Pixel size: 6.45 × 6.45 microns
- Pixels: 1392 x 1040
- Quant. Eff.: ∼ 65%
- Readout Noise: ∼ 7 electrons
- Cooling: ∼ 30°C below ambient
- Download: 3.5 seconds
- Format: 16 bit
- Weight: 350g
Example

“Telescope”: 200mm f/3.5 Vivitar lens ($30)
Mount: Questar
Camera: Starlight Express SXV-H9
Filter: Dichroic Hα

Fundamental Principles

- *Focal length* determines *field of view*
- *F-ratio* determines *exposure time*

Total exposure time = 156 mins. Field of view = 2.5°.
Combatting Light Pollution

Narrow-Band Filters
Visual Astronomy vs. Astrophotography

- **Aperture** determines *photon flux*
- **Focal length** determines *field of view*
- **F-ratio** determines *exposure time*
Further Reading...
Let The Movie Begin
Backup Slides
Biases