DSLR on a Tripod
Ritchey-Chretien and Takahashi FSQ

1. Mount

2. Camera
   Computer
   Software

3. Telescope (OTA)
Move equipment outside.
Ready To Go...
The Pictures Are Better Than The “Visual” View
Why Astrophotography?

Long Exposures, Permanent Record, Digital Enhancement, Light Pollution!

Visual Experience

Long Exposure

Light Pollution Subtracted
Astronomical CCD camera

- Pixel size: $6.45 \times 6.45$ microns
- Pixels: $1392 \times 1040$
- Quant. Eff.: $\sim 65\%$
- Readout Noise: $\sim 7$ electrons
- Cooling: $\sim 30^\circ\text{C}$ below ambient
- Download: $3.5$ seconds
- Format: 16 bit
- Weight: $350\text{g}$
Combatting Light Pollution

Narrow-Band Filters

![Graph showing the transmission percentage across different wavelengths for Hβ, OIII, Hα, and SII.](image-url)
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°
Visual Astronomy vs. Astrophotography

- **Aperture** determines photon flux
- **Focal length** determines field of view
- **F-ratio** determines exposure time
M1 – Crab Nebula
M13 – Great Globular Cluster in Hercules
M16 – The Eagle Nebula (aka Pillars of Creation)
M27 – Dumbbell Nebula
M42 – Great Orion Nebula
M45 – Pleiades (aka Subaru)
Western Veil Nebula
Eastern Veil Nebula
Veil Nebula
Bubble Nebula
Elephant Trunk
Running Man Nebula
Rosette Nebula
Rosette Nebula
Pelican Nebula
Thank You
Questions?
A Little About Me

- Born/Raised: Grand Rapids, MI
- Undergrad: Chemistry, 1976, Rensselaer Polytechnic Institute (RPI)
- Grad: Applied Math, 1981, Cornell
- Postdocs:
  - NSF Fellow, Math, NYU
  - Visiting Lecturer, Math, Univ. of Illinois Urbana/Champaign
- Industry:
  - AT&T Bell Labs, Math Research Center
- Academia: Princeton, 1990-present
- Hobbies/Passions:
  - Soaring
  - Tennis
  - Astronomy
  - Photography
  - Math/Computation
  - Local Warming, Purple America, etc.
M1 – Crab Nebula

- **What:** Supernova remnant
- **When:** Oct. 27, 2006
- **Where:** Driveway
- **Telescope:** 10” Ritchey-Chretien
- **Camera:** Starlight Xpress SXV-H9
- **Exposure:** Luminance=60min, Hα=140min, O-III=20min
- **Sub-Exposures:** 20-minutes, guided

- **Distance:** 6500 ± 1600 lightyears
- **Diameter:** 11 lightyears
M13 – Great Globular Cluster in Hercules

- **What:** Gravitationally bound cluster of stars
- **When:** Oct. 27, 2006
- **Where:** Driveway
- **Telescope:** 10” Ritchey-Chretien
- **Camera:** Starlight Xpress Trius SX-694
- **Exposure:** Luminance=6min, Red=8min, Green=6min, Blue=6min
- **Sub-Exposures:** 20-second, unguided

- **Distance:** 22,000 lightyears
- **Diameter:** 168 lightyears
M16 – The Eagle Nebula (aka Pillars of Creation)

- **What:** Young star cluster and diffuse emission nebula
- **When:** June 26 2005, July 17 2006, July 8 2007
- **Where:** Driveway
- **Telescope:** 10” Ritchey-Chretien
- **Camera:** Starlight Xpress SXV-H9
- **Exposure:** $\text{H}_\alpha = 266\text{min}$, $\text{O-III} = 66\text{min}$
- **Sub-Exposures:** 4-minute, 6-minute, 10-minute, guided

- **Distance:** $5,700 \pm 400$ lightyears
- **Pillar Height:** 9.5 lightyears
M27 – Dumbbell Nebula

- **What:** Planetary nebula
- **When:** Aug. 6, 2016
- **Where:** Driveway
- **Telescope:** 10” Ritchey-Chretien
- **Camera:** Starlight Xpress Trius SX-694
- **Exposure:** $\text{H}_\alpha = 90\text{min}$, $\text{O-III} = 80\text{min}$
- **Sub-Exposures:** 10-minute, guided

- **Distance:** $1360 \pm 200$ lightyears
- **Diameter:** 1.4 lightyears
M31 – The Andromeda Galaxy

- **What**: Nearby galaxy
- **When**: Oct. 26, 2008
- **Where**: Driveway
- **Telescope**: 4” Takahashi FSQ refractor
- **Camera**: Starlight Xpress SXV-H9
- **Exposure**: Luminance=80min, Red=40min, Green=40min, Blue=40min
- **Sub-Exposures**: 2-minute, unguided

- **Distance**: 2,500,000 lightyears
- **Diameter**: 220,000 lightyears
M42 – Great Orion Nebula

- **What:** Young star cluster and diffuse emission nebula
- **When:** Nov. 25, 2006
- **Where:** Driveway
- **Telescope:** 10” Ritchey-Chretien
- **Camera:** Starlight Xpress SXV-H9
- **Exposure:** Hα=32min, O-III=35min
- **Sub-Exposures:** 1-minute, guided

- **Distance:** 1,344 ± 20 lightyears
- **Diameter:** 24 lightyears
M45 – Pleiades (aka Subaru)

- **What:** Open star cluster
- **When:** Jan. 3, 2008
- **Where:** Driveway
- **Telescope:** 4” Takahashi FSQ refractor
- **Camera:** Starlight Xpress SXV-H9
- **Exposure:** Red=16min, Green=20min, Blue=122min
- **Sub-Exposures:** 2-minute, unguided

- **Distance:** 444 lightyears
Veil Nebula

- **What:** Supernova remnant
- **When:** July 25 2008, July 24 2008
- **Where:** Driveway
- **Telescope:** 4” Takahashi FSQ refractor
- **Camera:** Starlight Xpress SXV-H9
- **Exposure:** $\text{H}_\alpha=60\text{min}$, $\text{O-III}=60\text{min}$. **Exposure:** $\text{H}_\alpha=52\text{min}$, $\text{O-III}=24\text{min}$
- **Sub-Exposures:** 2-minute, 4-minute, unguided
- **Distance:** 1470 lightyears
- **Diameter:** 70 lightyears
Bubble Nebula

- **What:** Emission nebula w/ stellar wind
- **When:** Oct. 21 2006, Sept. 7 2016
- **Where:** Driveway
- **Telescope:** 10” Ritchey-Chretien
- **Camera:** Starlight Xpress SXV-H9 and Trius SX-694
- **Exposure:** $H\alpha=350\text{min}$, $O-\text{III}=230\text{min}$
- **Sub-Exposures:** 10-minute, 20-minute, guided

- **Distance:** $9,100 \pm 2000$ lightyears
- **Diameter:** $8 \pm 2$ lightyears
Helix Nebula

- **What:** Planetary nebula
- **When:** Oct. 2, 2008
- **Where:** Driveway
- **Telescope:** 4” Takahashi FSQ
- **Camera:** Starlight Xpress SXV-H9
- **Exposure:** $H\alpha=86$ min, $O-\text{III}=54$ min
- **Sub-Exposures:** 2-minute, guided

- **Distance:** $714 \pm 70$ lightyears
- **Diameter:** 5.7 lightyears
Elephant Trunk

- **What**: Star birth area in interstellar medium
- **When**: Aug. 29, 2016
- **Where**: Driveway
- **Telescope**: 10” Ritchey-Chretien
- **Camera**: Starlight Xpress Trius SX-694
- **Exposure**: $H\alpha=156\text{min}$
- **Sub-Exposures**: 6-minute, guided

- **Distance**: 22,000 lightyears
- **Diameter**: 168 lightyears
IC434 – The Horsehead Nebula

- **What:** Dark nebula (dust cloud)
- **When:** Oct. 8, 2004
- **Where:** Driveway
- **Telescope:** 4” Takahashi FSQ refractor
- **Camera:** Starlight Xpress SXV-H9
- **Exposure:** Hα=116min, G=18min, B=18min
- **Sub-Exposures:** 2-minute, unguided
- **Distance:** 1,400 lightyears
Running Man Nebula

- **What:** Bright reflection nebula
- **When:** Jan. 28, 2008
- **Where:** Driveway
- **Telescope:** 4” Takahashi FSQ refractor
- **Camera:** Starlight Xpress SXV-H9
- **Exposure:** Red=24min, Blue=100min
- **Sub-Exposures:** 2-minute, unguided

- **Distance:** 1,500 lightyears
- **Diameter:** 15 lightyears