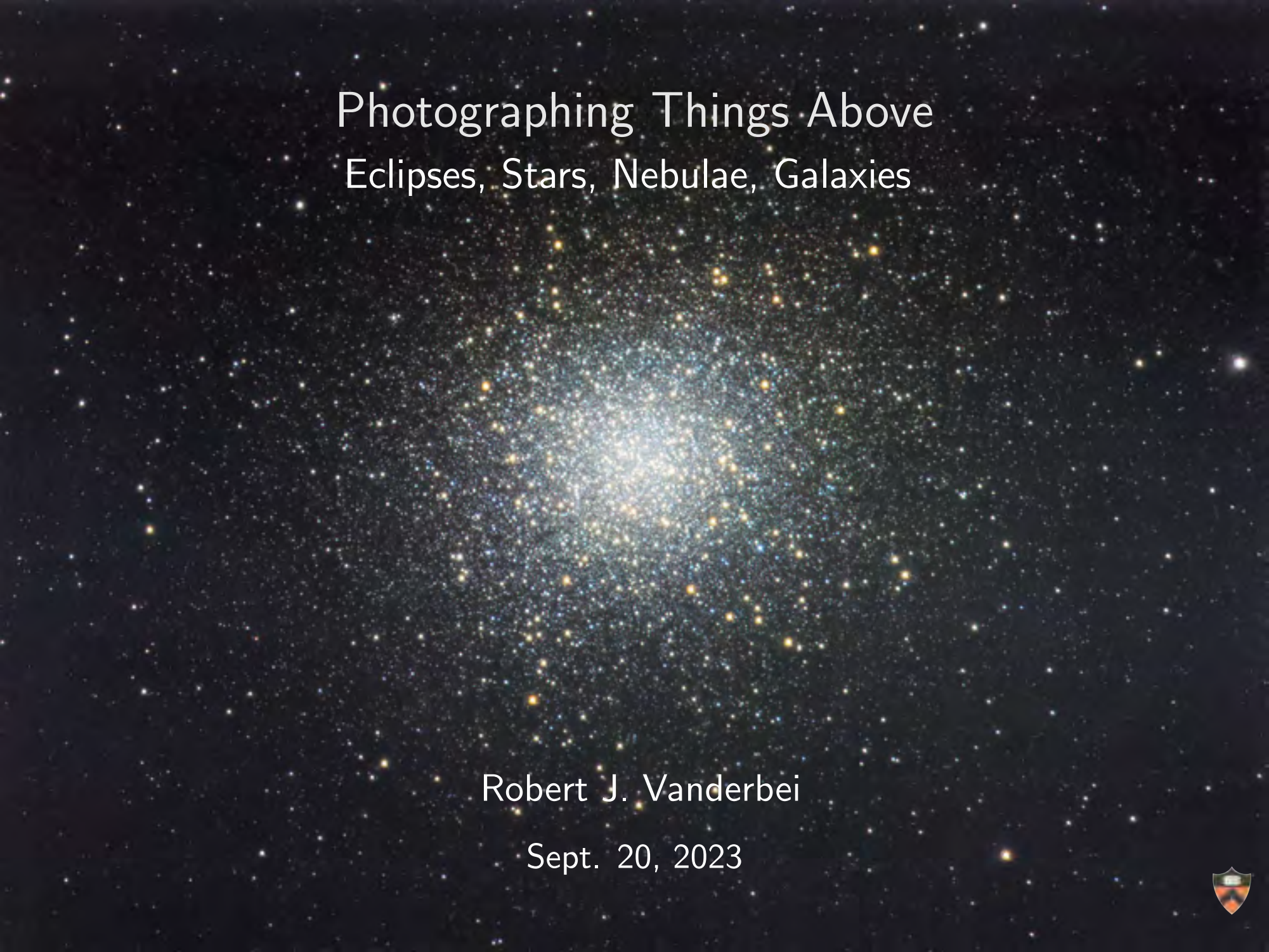


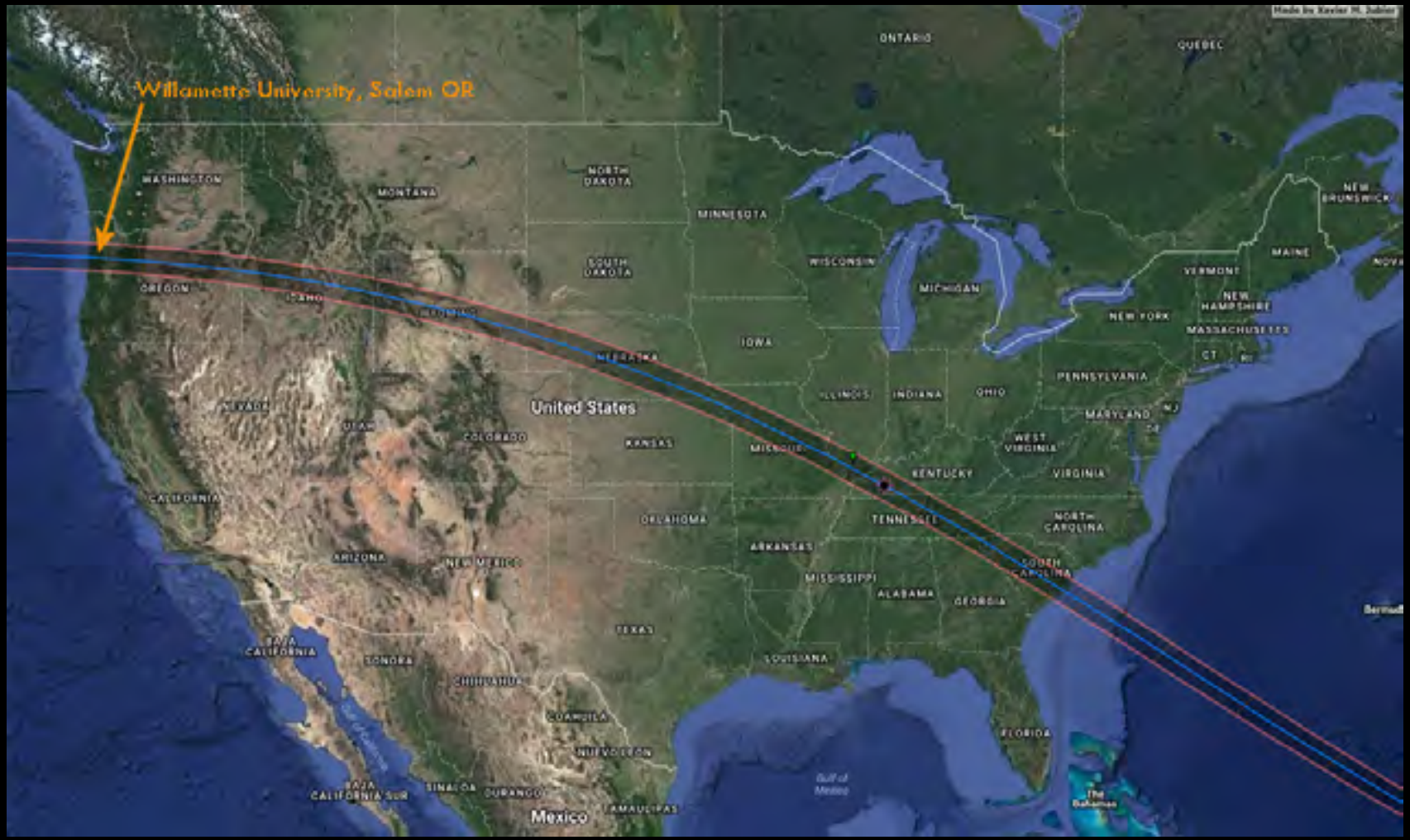
Photographing Things Above

Eclipses, Stars, Nebulae, Galaxies

Robert J. Vanderbei

Sept. 20, 2023

The Path of Totality in 2017



Expert Advice...

Don't be distracted by your camera.

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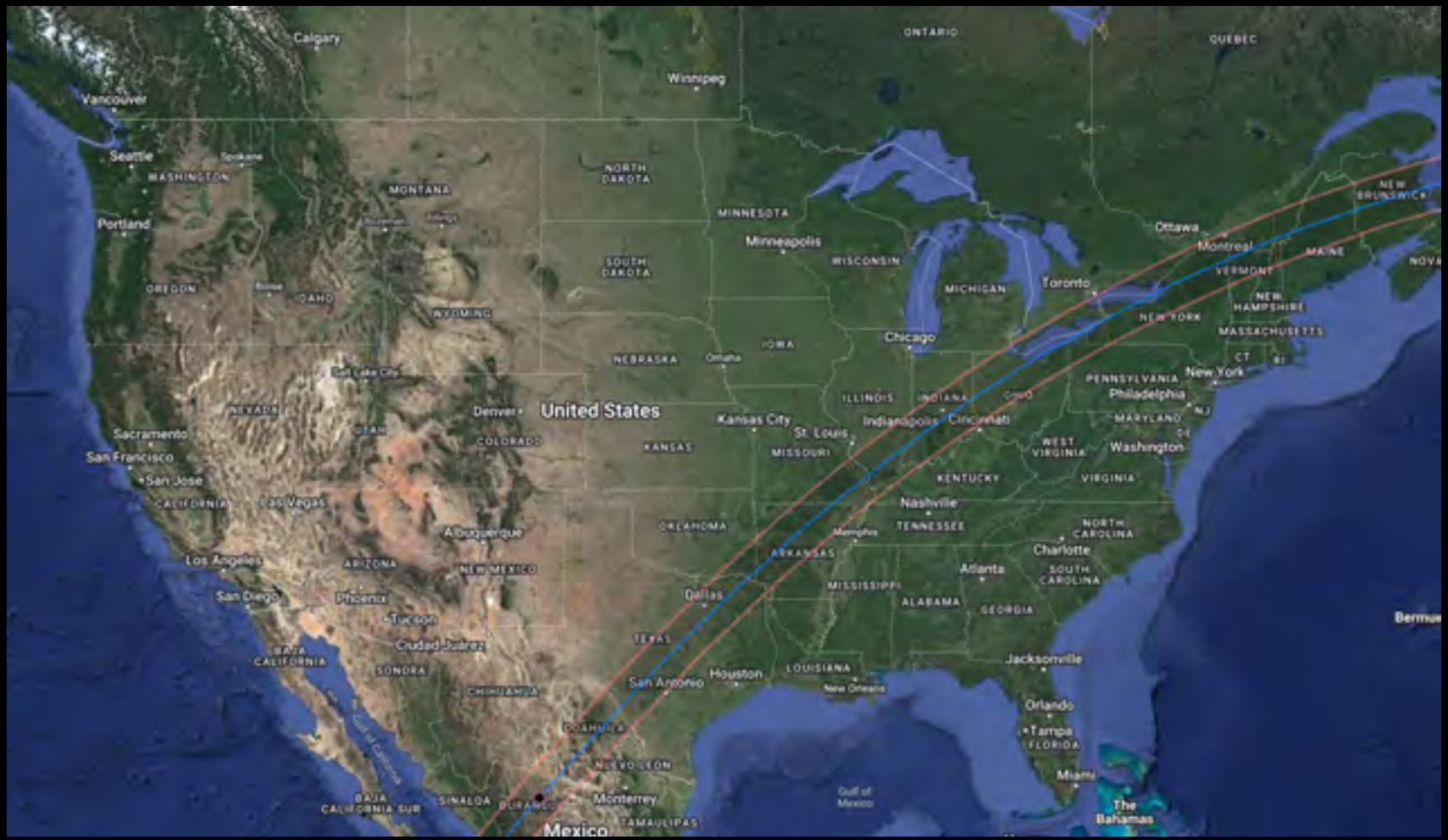
Best to use a Canon/Nikon DSLR on a tripod with a telephoto lens.

Be sure to buy/use a solar filter.

The Path of Totality on April 8, 2024

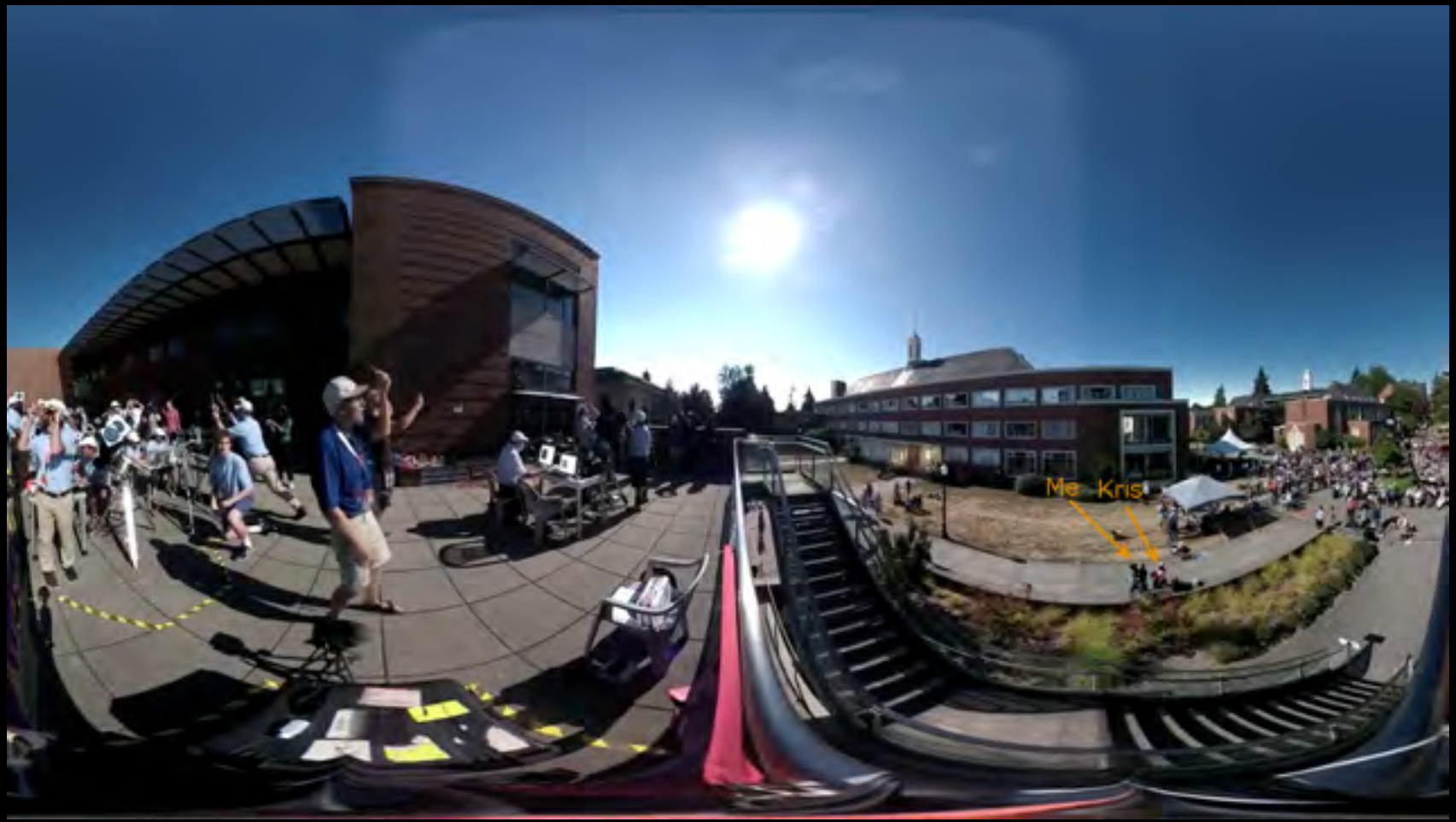


Equipment

Equipment

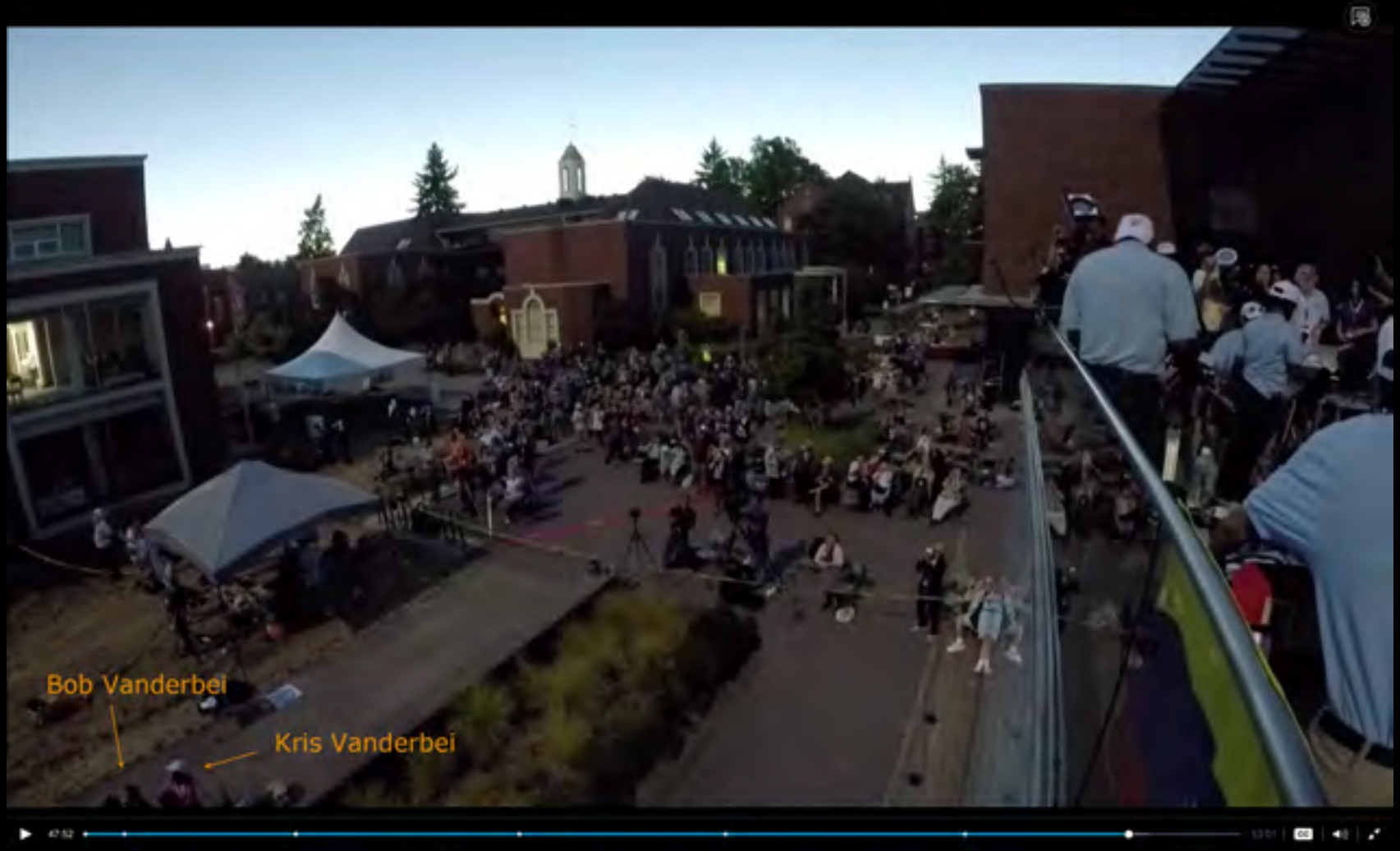
Equipment

Before Totality

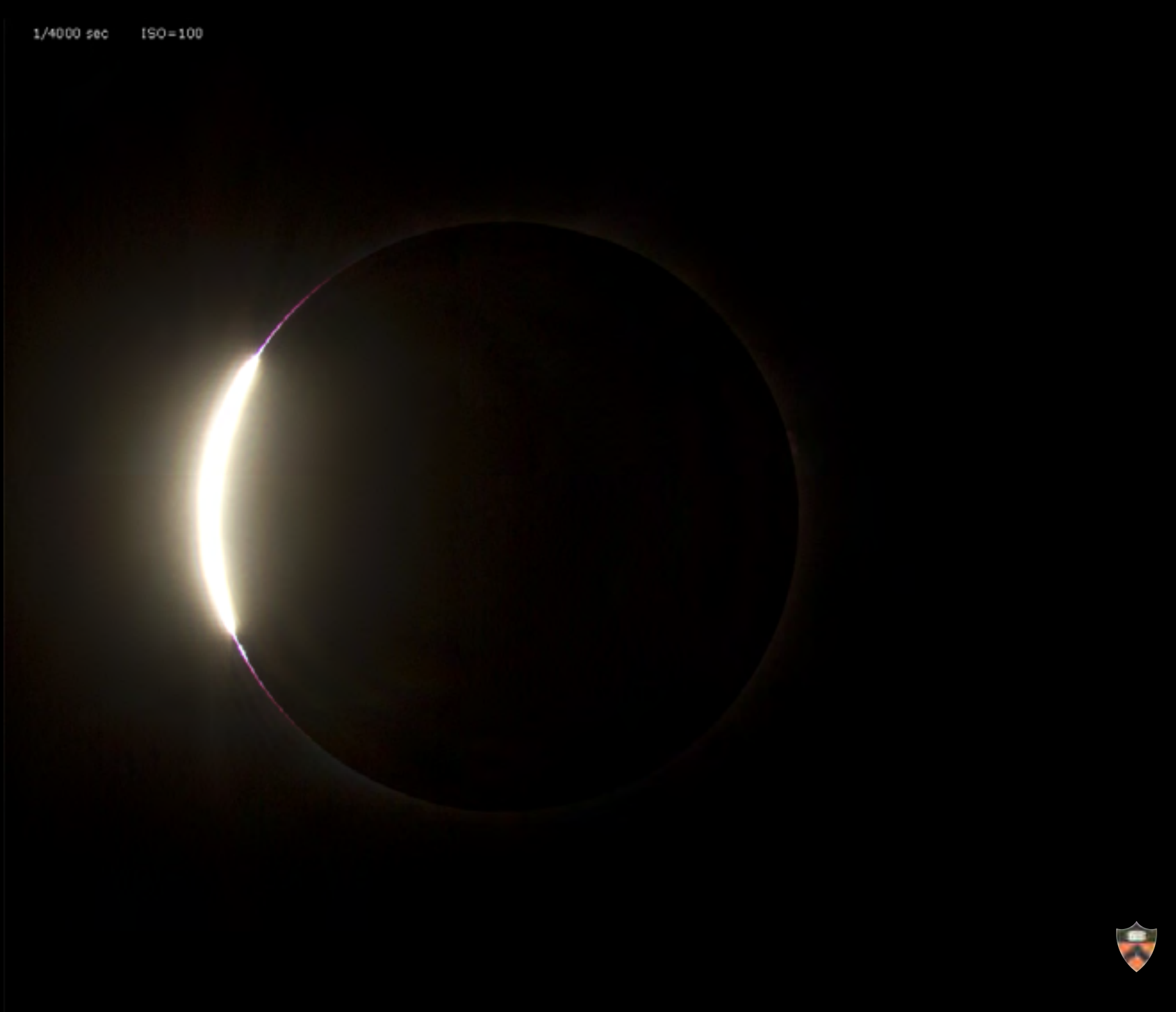


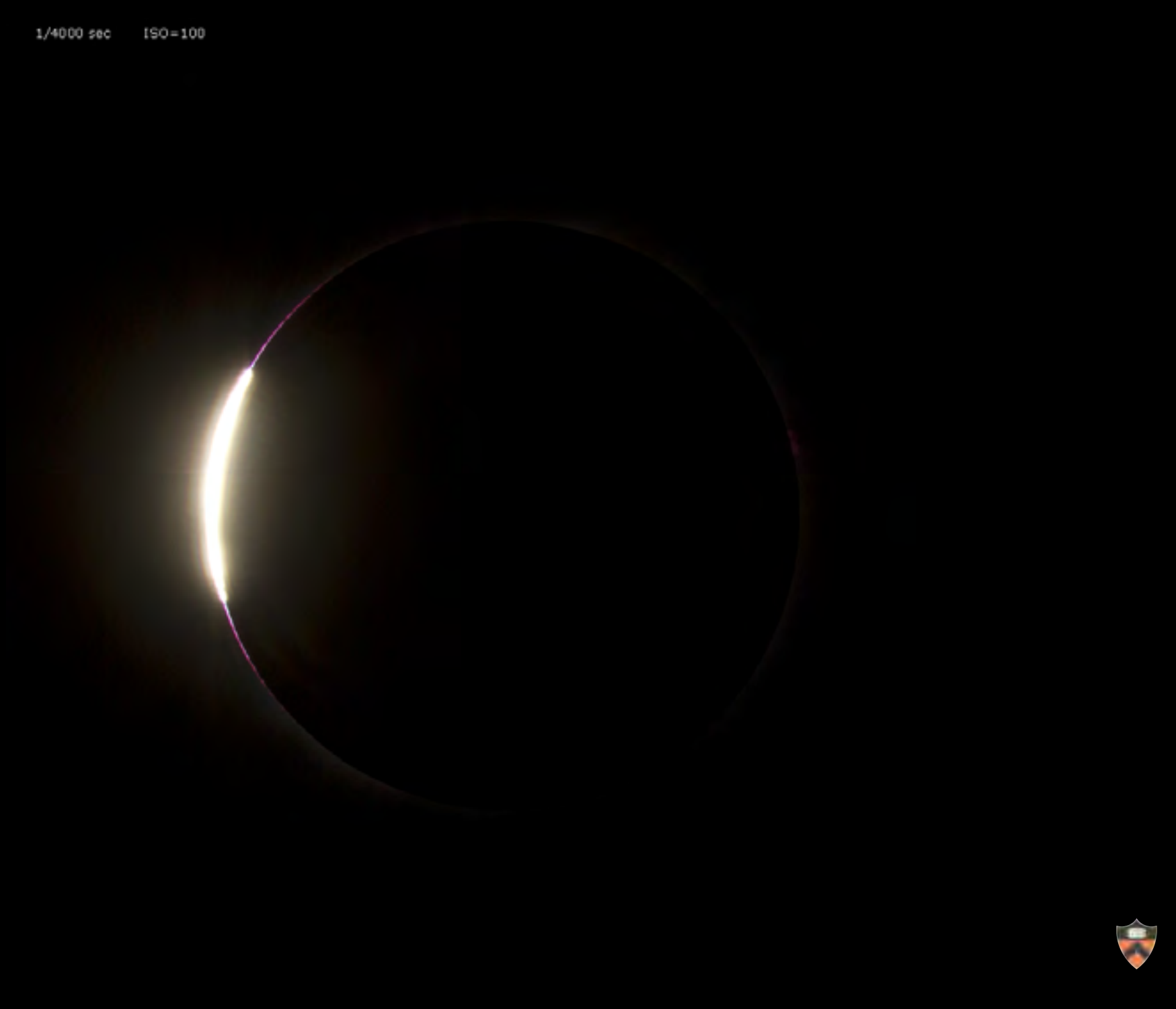
Time Lapse

Nova PBS



1/2000 sec ISO-200


1/4000 sec
ISO=100


1/4000 sec
ISO=100


1/125 sec
ISO=100

1/2000 sec ISO=100


1/4000 sec
ISO=200


1/1000 sec
ISO=200


1/1000 sec
ISO=200


1/250 sec
ISO=200


1/250 sec
ISO=200


1/60 sec
ISO=200


1/15 sec
ISO=200


1/8 sec
ISO=200


1/30 sec
ISO=200


1/30 sec
ISO=200


1/125 sec
ISO=200


1/125 sec
ISO=200


1/500 sec
ISO=200


1/500 sec
ISO=200


1/2000 sec
ISO=200


1/2000 sec
ISO=200


1/4000 sec
ISO=200


1/4000 sec
ISO=200


1/125 sec
ISO=100


1/4000 sec
ISO=100


1/4000 sec
ISO=100


1/2000 sec
ISO-200

Pinhole Cameras

DSLR on a Tripod

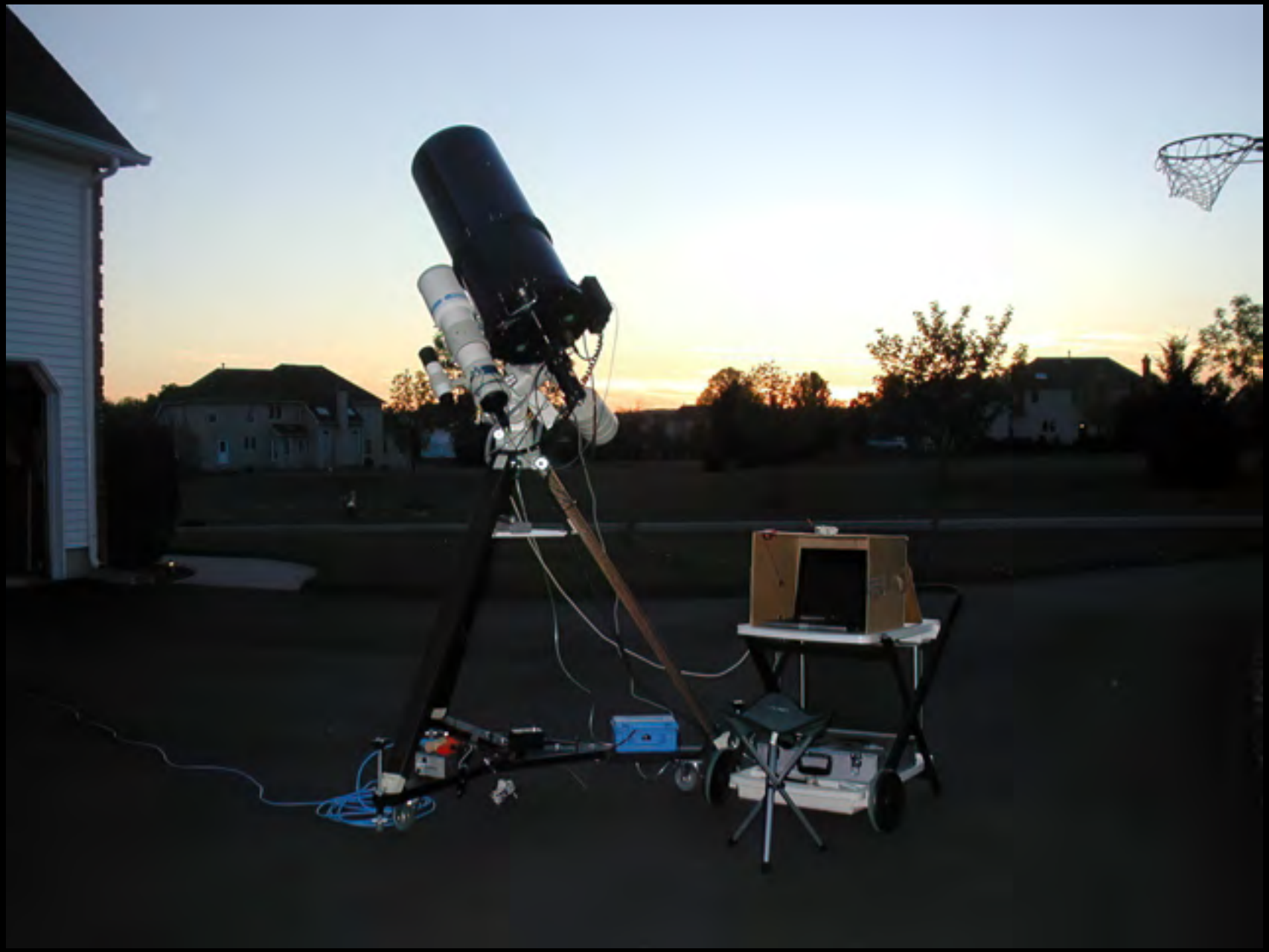
Pointing North

Ritchey-Chretien and Takahashi FSQ

1. Mount
2. Camera
   Computer
   Software
3. Telescope

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

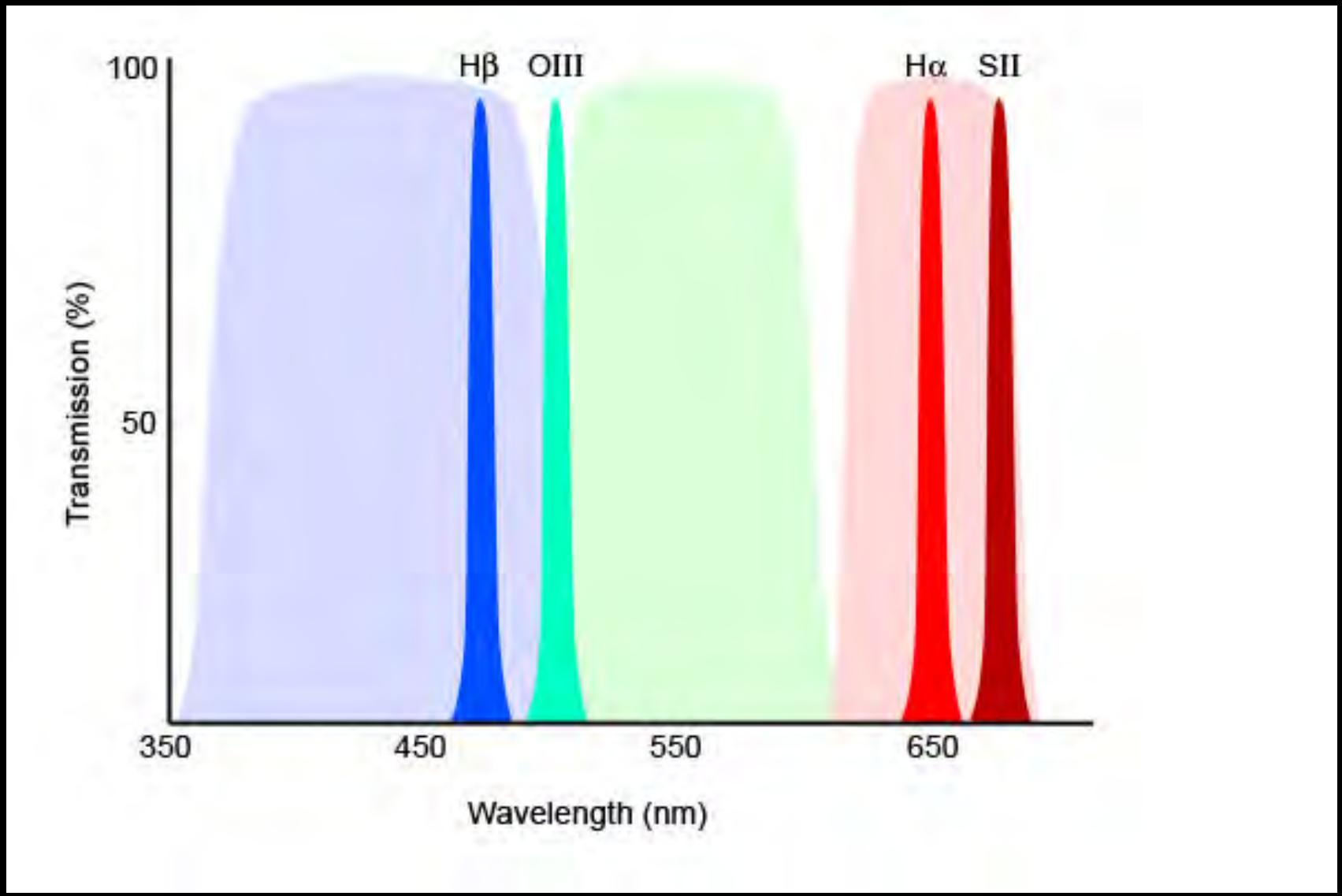
Long Exposure

Light Pollution Subtracted

Astronomical CCD camera

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

Combatting Light Pollution – Narrow-Band Filters



Example

"Telescope": 200mm f/3.5 Vivitar lens ($30)

Mount: Questar

Camera: Starlight Express SXV-H9

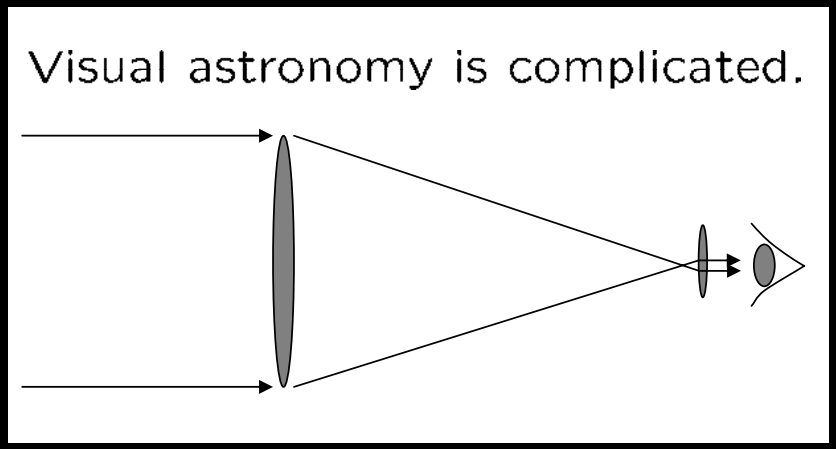
Filter: Dichroic Hα

Fundamental Principles

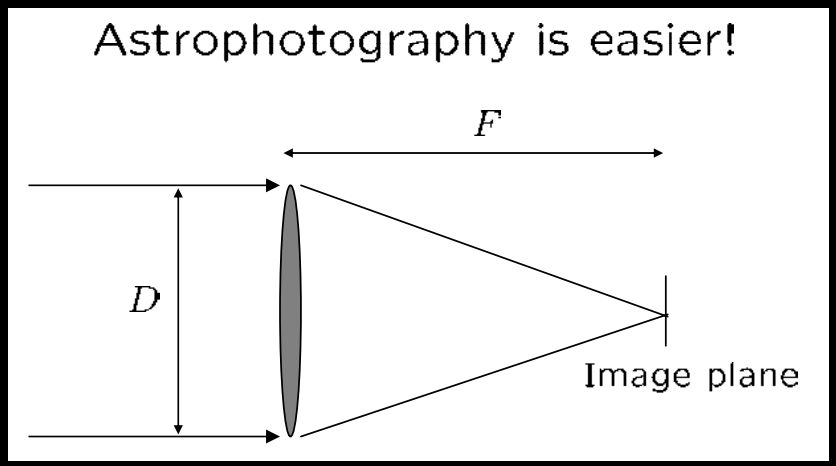
- *Focal length* determines *field of view*
- *F-ratio* determines *exposure time*

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

Visual Astronomy vs. Astrophotography



- *Aperture* determines *photon flux*



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M1 – Crab Nebula

M13 – Great Globular Cluster in Hercules

M16 – The Eagle Nebula (aka Pillars of Creation)

M27 – Dumbbell Nebula

M31 – The Andromeda Galaxy

M42 – Great Orion Nebula

M45 – Pleiades (aka Subaru)

Western Veil Nebula

Eastern Veil Nebula

Veil Nebula

Bubble Nebula

Helix Nebula

Elephant Trunk

IC434 – The Horsehead Nebula

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:* Hα=266min, O-III=66min
- *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:* Hα=90min, O-III=80min
- *Sub-Exposures:* 10-minute, guided

- *Distance:* 1360 ± 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:* $1,344 \pm 20$ 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:* Hα=60min, O-III=60min. *Exposure:* Hα=52min, O-III=24min
- *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:* Hα=350min, O-III=230min
- *Sub-Exposures:* 10-minute, 20-minute, guided

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

Helix Nebula

- *What:* Planetary nebula
- *When:* Oct. 2, 2008
- *Where:* Driveway
- *Telescope:* 4" Takahashi FSQ
- *Camera:* Starlight Xpress SXV-H9
- *Exposure:* Hα=86min, O-III=54min
- *Sub-Exposures:* 2-minute, guided

- *Distance:* 714 ± 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:* Hα=156min
- *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