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of CALIFORNIA

Launching a Variable-Star Observing Program at The Geissberger Observatory

February 22nd, 2017

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Part I: Context

Part II: Targets

Part III: Equipment

Part IV: Proficiency

Part V: Future

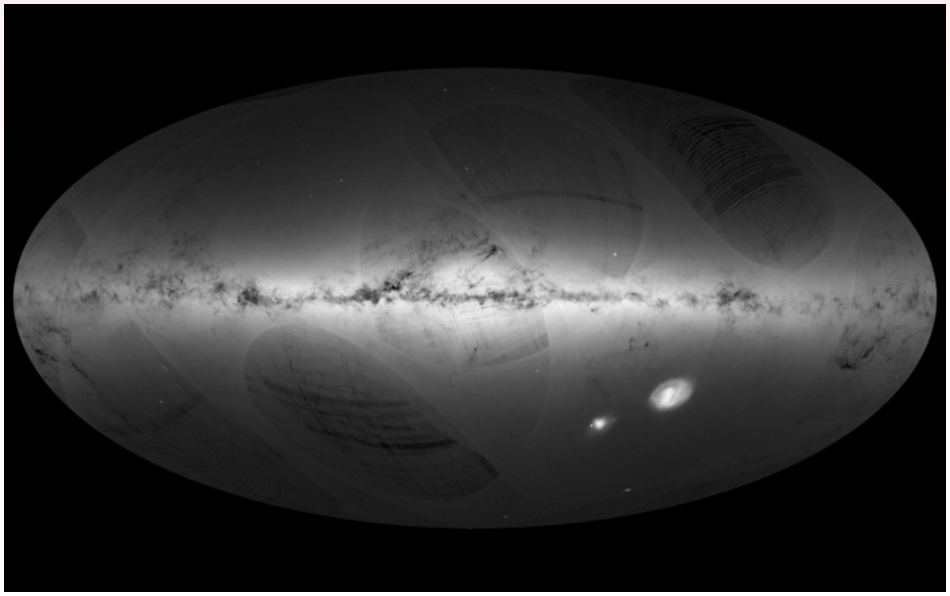
Part VI: Gratitude

The Age of Large Surveys

- Sloan Digital Sky Survey
  - Apache Point Observatory, New Mexico, 9,000', 2.5m Instrument
  - 30 4-Megapixel Cameras Continuously Photographing with Multiple Filters
  - 400,000,000 Objects.
  - Spectroscopic Surveys of 3,000,000 Objects.

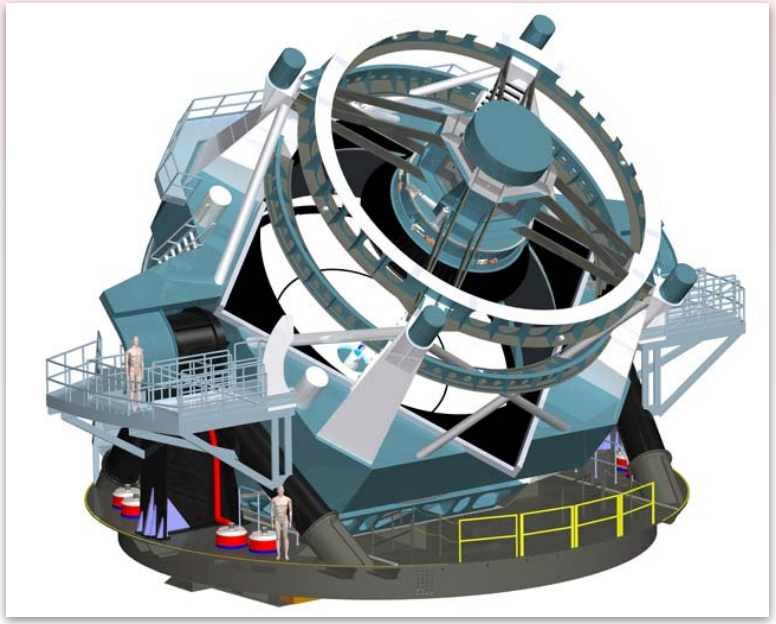
The Age of Large Surveys

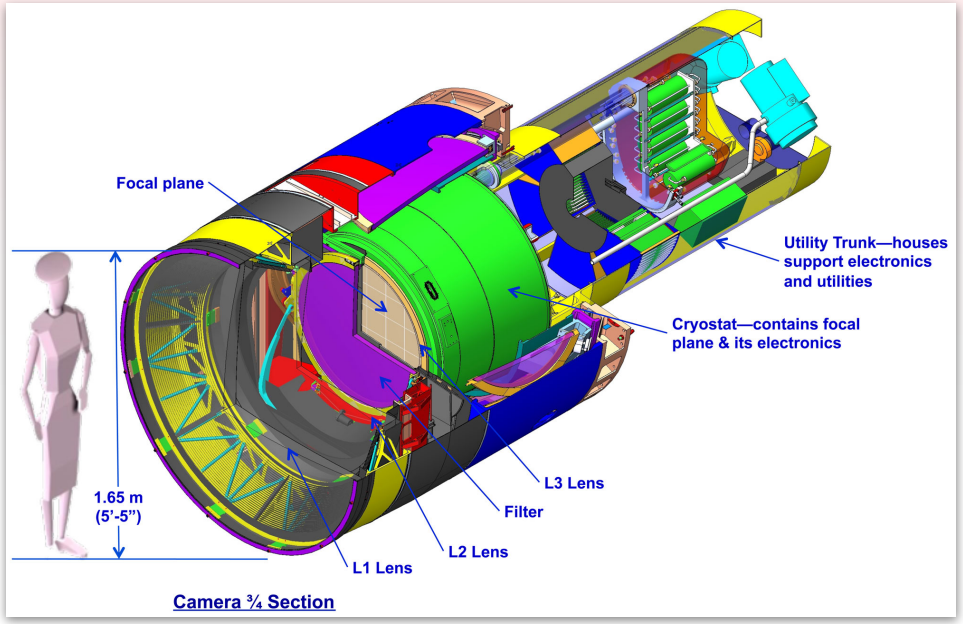
- GAIA Space Telescope
  - European Space Agency
  - 1 Billion Stars, 100,000,000 Radial Velocities
  - 10 Mirrors, 10nm Tolerances, 1 Giga Pixel Camera
  - 7 Micro Arcsecond Ultimate Accuracy
  - More Info: GAIA FAQ



The Age of Large Surveys

- Large Synoptic Survey Telescope (LSST)
  - NSF/DOE, 8800' Elevation in Chile
  - 8.4 m Mirror, 3.2 Gigapixel Camera
  - Recording The Entire Sky Visible to the Telescope, 2x / week
  - Design and Funding Begun 2011, Primary Mirror Complete 2016, Dome and Summit Complete 2017, Project Complete 2022, Science Begins 2023





Q. Time to Fold the Tent?

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The Cepheids

- Leavitt, 1908; Pickering and Leavitt, 1912

HARVARD COLLEGE OBSERVATORY.

CIRCULAR 173.

PERIODS OF 25 VARIABLE STARS IN THE SMALL MAGELLANIC CLOUD.

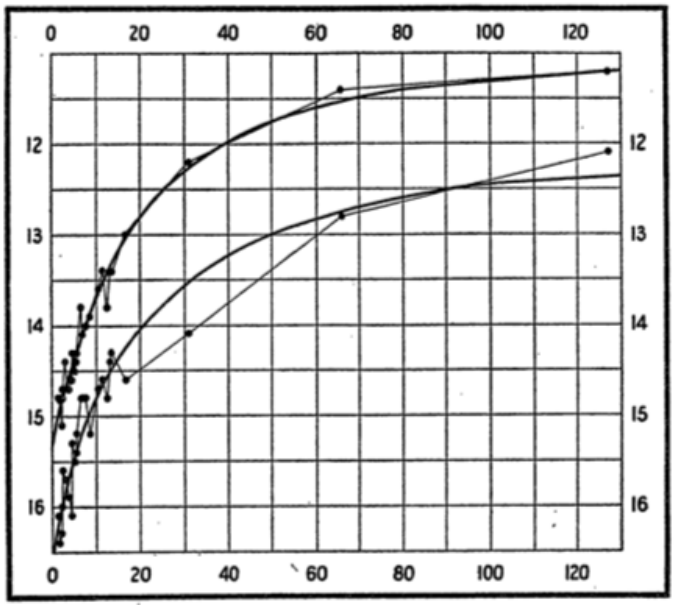

FIG. 1.

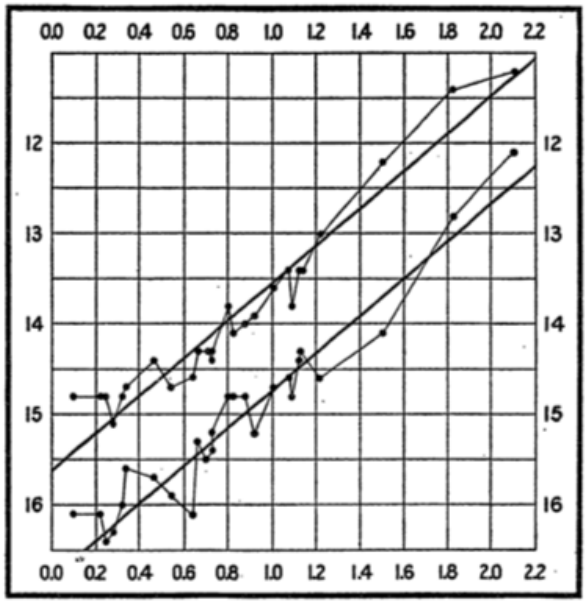

FIG. 2.

The AAVSO

- Founded by Pickering, 1911

HARVARD COLLEGE OBSERVATORY.

CIRCULAR 166.

COOPERATION IN OBSERVING VARIABLE STARS.

THE method of observing variable stars in use at this Observatory is described in H.C. 112. Of the 372 variables of long period, included in Table I which, in general, have a range of at least three magnitudes and are of the magnitude 9.0, or brighter, at maximum, 257 are north of declination −20°. Nearly all of the latter have been observed at least once a month, except when too near the Sun. During the years 1906 to 1910, about seventeen thousand observations have been made by astronomers connected with this Observatory, of which twelve thousand have been made by Mr. Leon Campbell. Six thousand observations have been kindly communicated by other astronomers. Also, a very large number of observations have been obtained by the members of the Variable Star Section of the British Astronomical Association, and by many individual observers. To avoid unnecessary duplication and to secure the best results, some form of cooperation seems advisable. In the past comparatively

Hubble's 1929 Paper

A RELATION BETWEEN DISTANCE AND RADIAL VELOCITY AMONG EXTRA-GALACTIC NEBULAE

By Edwin Hubble

Mount Wilson Observatory, Carnegie Institution of Washington

Communicated January 17, 1929

Determinations of the motion of the sun with respect to the extra-galactic nebulae have involved a K term of several hundred kilometers which appears to be variable. Explanations of this paradox have been sought in a correlation between apparent radial velocities and distances, but so far the results have not been convincing. The present paper is a re-examination of the question, based on only those nebular distances which are believed to be fairly reliable.

Distances of extra-galactic nebulae depend ultimately upon the application of absolute-luminosity criteria to involved stars whose types can be recognized. These include, among others, Cepheid variables, novae, and blue stars involved in emission nebulosity. Numerical values depend upon the zero point of the period-luminosity relation among Cepheids,

Hubble's Result

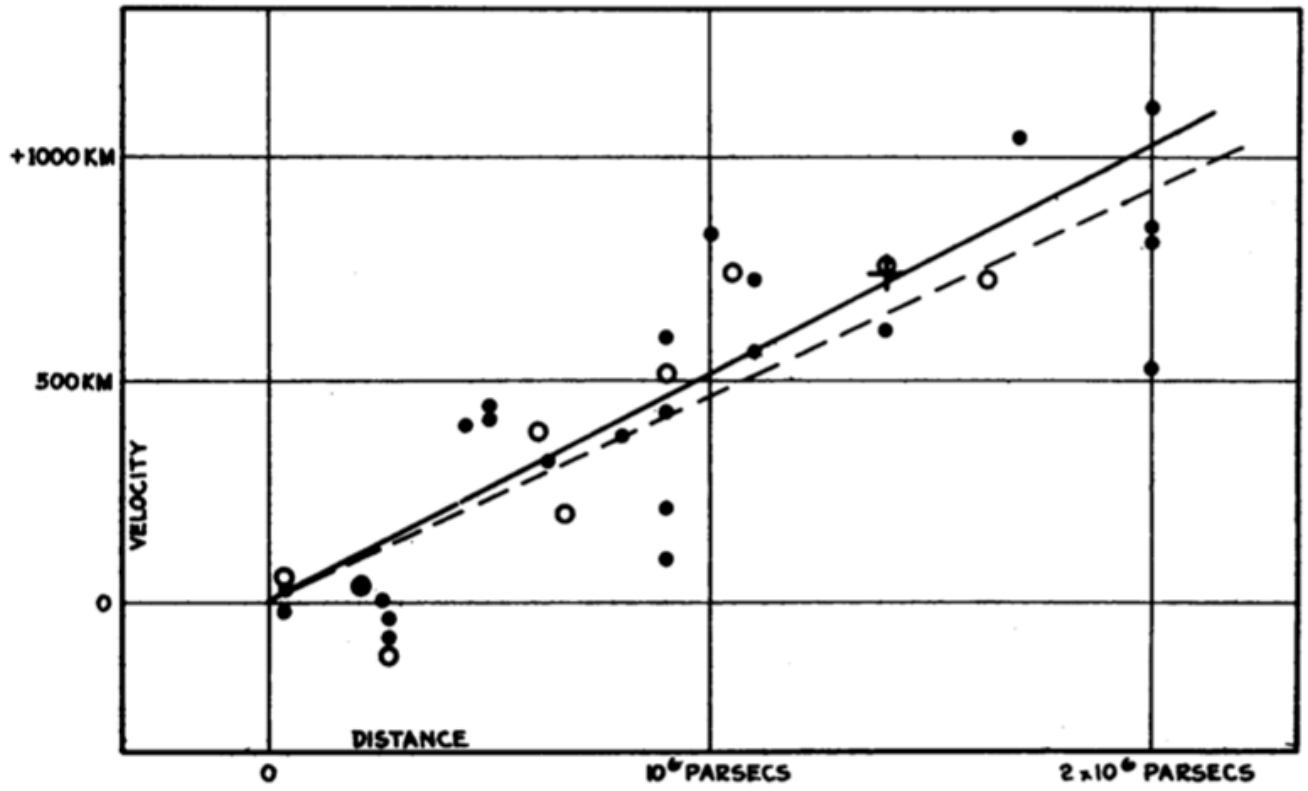

FIGURE 1

Velocity-Distance Relation among Extra-Galactic Nebulae.

Fast Forward to the 105th Meeting of the AAVSO

L to R: Brian Hill, Geissberger Observatory, Saint Mary's College of California; Octavi Fors, Evryscope Survey, University of North Carolina; Steven Levine, Lowell Observatory, University of Wisconsin; Linda Schmidtobreick, ESO, Santiago, Chile; Alessandro Ederoclite, Observatorio Astrofísico de Javalambre, Spain

Q. Time to Fold the Tent?

A. ....

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"The availability of easily accessible survey data, perhaps with access to professional astronomers, gives a boost to [the] AAVSO—large modern astronomical surveys are your friend!"

Q. Time to Fold the Tent? A. ....

"The advent of large optical surveys has provided means to select extremely interesting targets...."

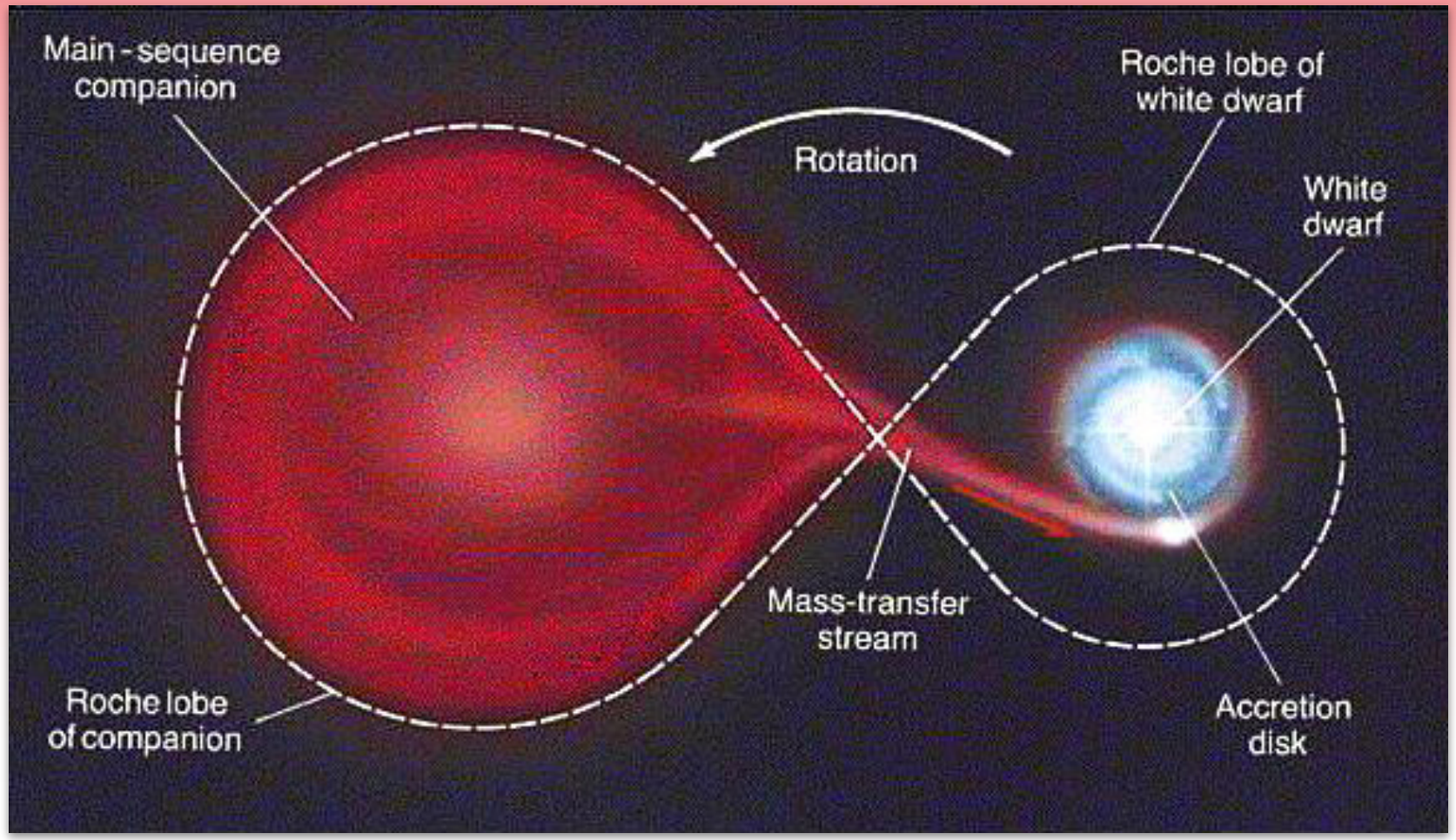
"The availability of easily accessible survey data, perhaps with access to professional astronomers, gives a boost to [the] AAVSO—large modern astronomical surveys are your friend!"

—Željko Ivezić, University of Washington, Chair of the LSST Science Team, addressing the 105th Meeting of the AAVSO from Seattle

What are These "Extremely Interesting" Targets?

- RR Lyrae Variables (the Cepheid Variables are by now Extremely Well Studied)
- Eclipsing Binaries
- Cataclysmic Variables (SW Sextantis is the Prototype, see paper by Linda Schmidtobreick)
- Transiting Exoplanets
- Dippers

SW Sextantis Type Cataclysmic Variable — Artist's Concept



Credit: Chandra X-Ray Observatory, http://chandra.harvard.edu/edu/formal/snr/images/dwarf.jpg

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"The Geissberger"


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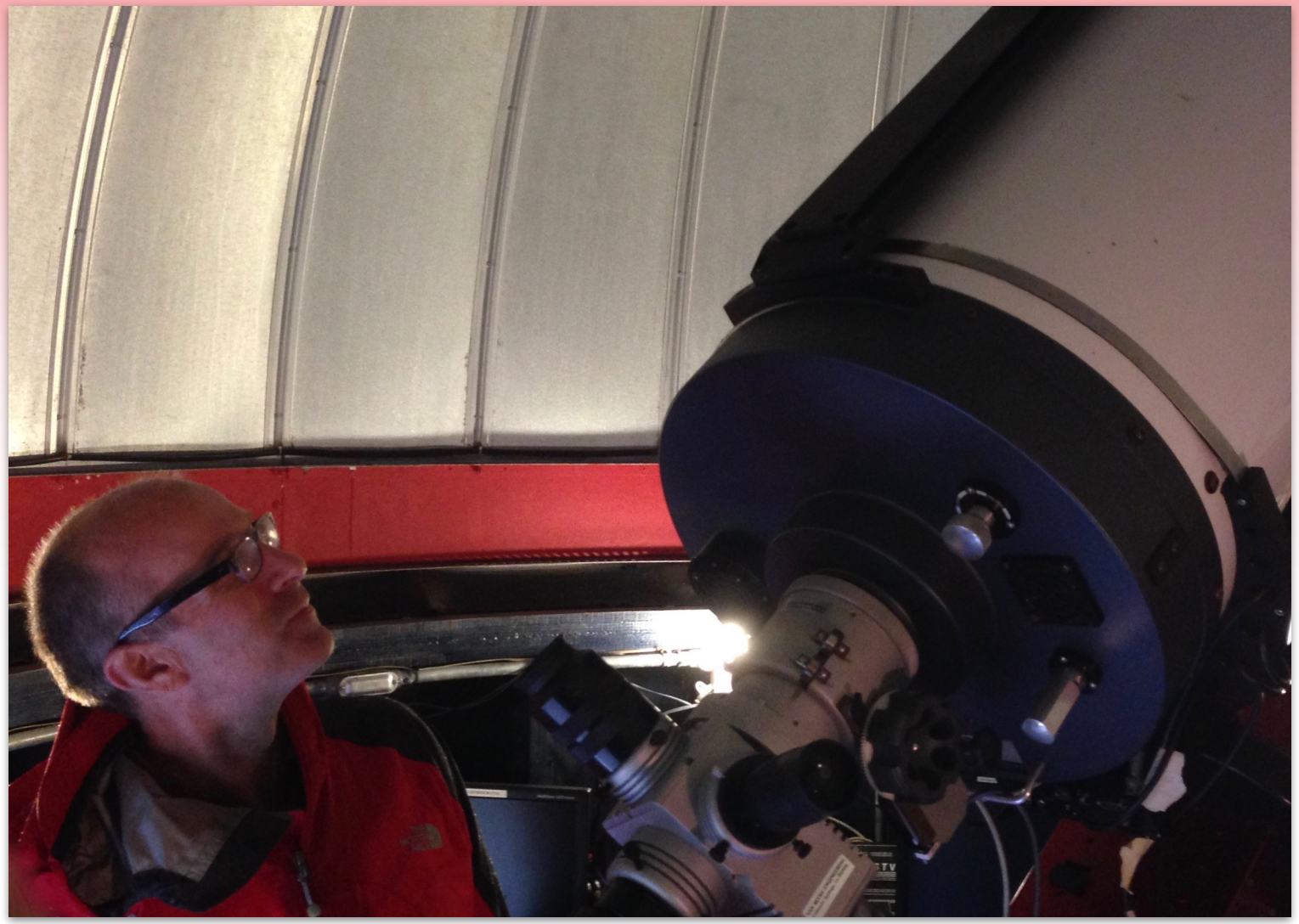
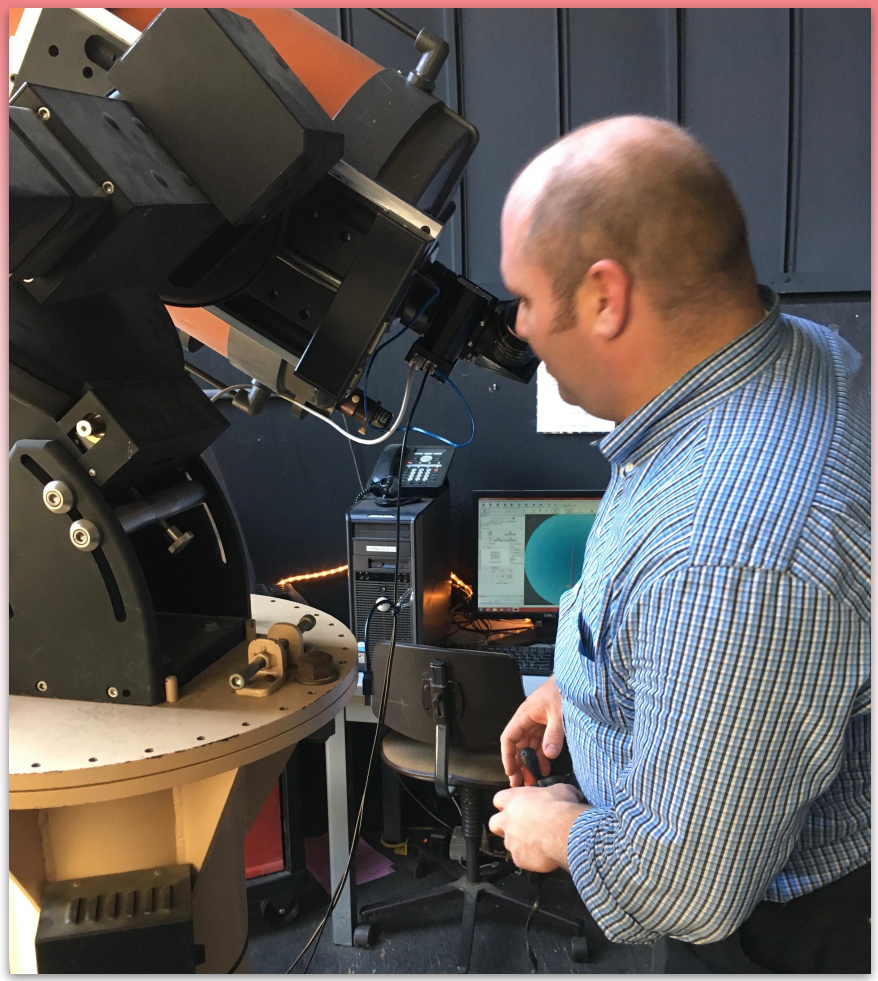
Inside the Dome



Components

- Meade 16" (0.4 meter) LX200R, "Advanced Ritchey-Chrétien"
- Paramount ME Mount, 150 Pound Instrument Payload, 7 arc-second tracking accuracy
- Software Bisque The SkyX Professional Edition Controlling Mount, Dome, Focuser and Camera

Directions for Mount and Dome Operation



Tom Scarry, Physics & Astronomy Department Technician, California State University, Sacramento (on Left and at Telescope), and Prof. Chris Ray, Saint Mary's College of California

"Mama Geissberger"

- Questar 7" Titanium Maksutov Cassegrain, Zerodur Mirror (as used in Keck I and Keck II), Broadband and Low Reflection Coatings
- Paramount MYT Mount, 50 Pound Instrument Payload, 7 arc-second tracking accuracy
- Software Bisque The SkyX Professional Edition For Control of Mount, Filter Wheel and Camera

"Baby Geissberger"

Principal Components (Pictured):

- Tele Vue 102mm f/8.6 Apochromat Refractor
- Paramount MYT Mount

Not Pictured:

- Tele Vue Pronto 70mm Guide Scope
- ZWO EFWMini Electronic Filter Wheel
- Astrodon Sloan 1.25" Filters, r, g, i, z (Matching the Sloan Digital Sky Survey)
- ZWO ASI-1600 MM-Cooled Camera, 16 Megapixels, Monochrome, CMOS

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December

"Infant Geissberger"

Tele Vue Pronto 70mm, 480mm, f/6.8, SONY NEX-6 (16 Megapixel, Color, CMOS, not Cooled), Paramount MYT

The Pleiades, Tele Vue Pronto 70mm, 480mm, f/6.8, SONY NEX-6 (16 Megapixel, Color, CMOS, not Cooled),
Paramount MYT

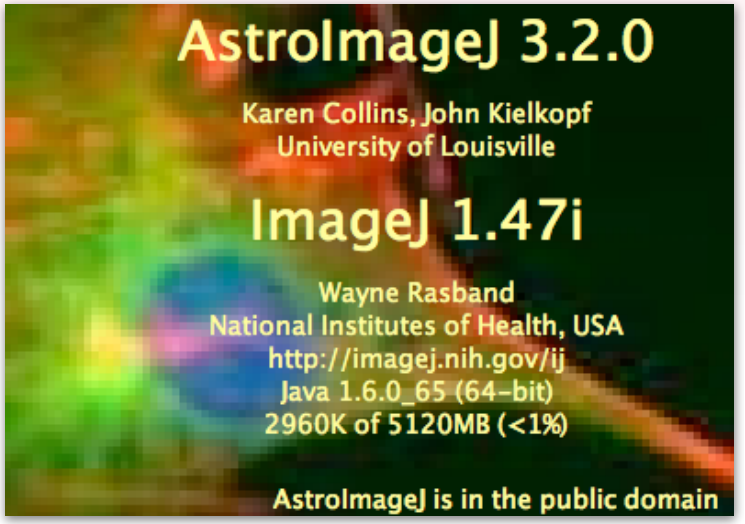
Orion Nebula, Tele Vue Pronto 70mm, SONY NEX-6,
16 Megapixel, Color, CMOS, Not Cooled, 30-second Exposure

Meh?

Proficiency: Processing and Analysis

- PixInsight, Mac/Linux/ Windows, 230€ Per Seat, Mostly Astrophotography Users

- AstroImageJ, Windows/ Mac (on latest macOS, some workarounds), Free with Source, Mostly Photometry Users, Many AAVSO Members!

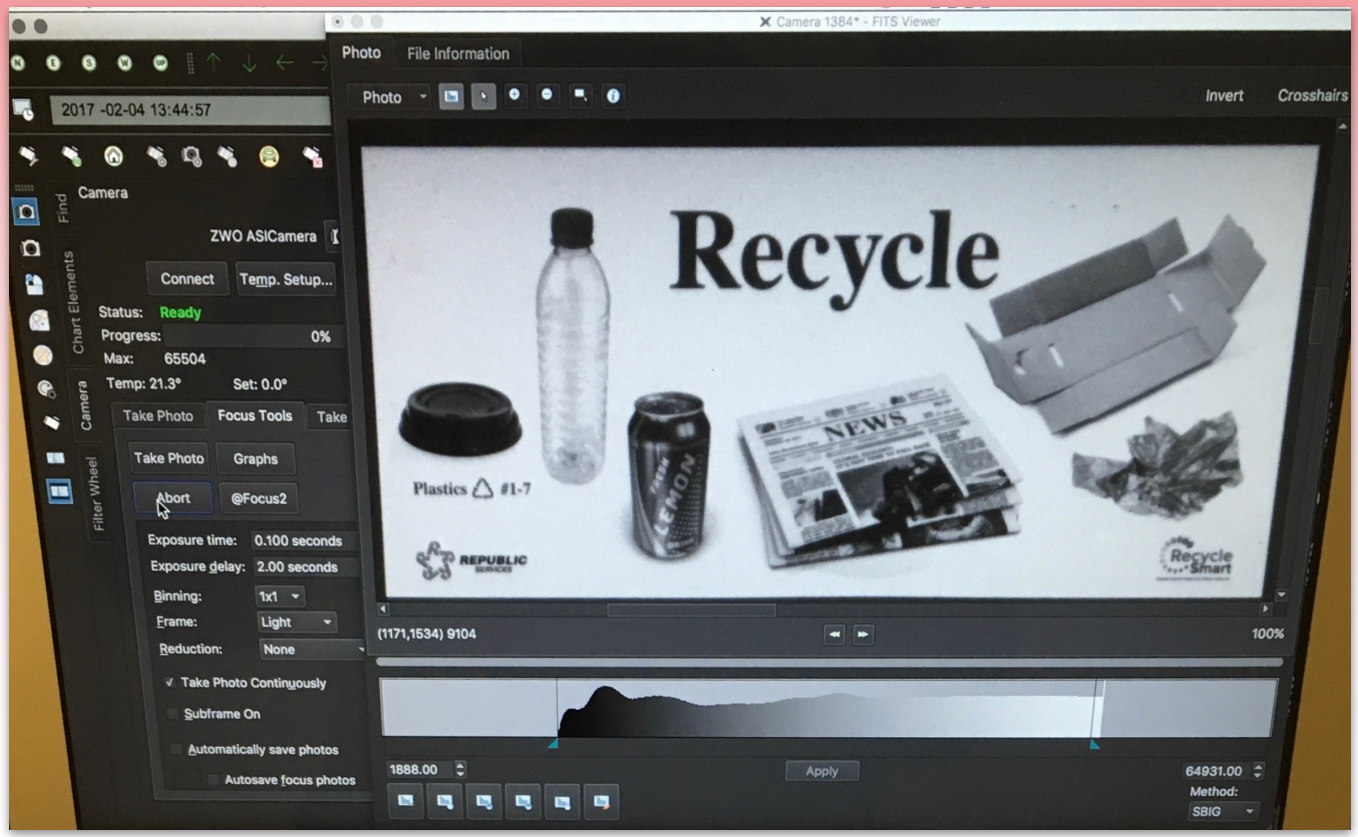


January

Poor Man's Optical Bench

Hallway with Recycling Bin at Far End

Poor Man's Optical Bench



"Plastics ♻ #1-7" Easily Readable

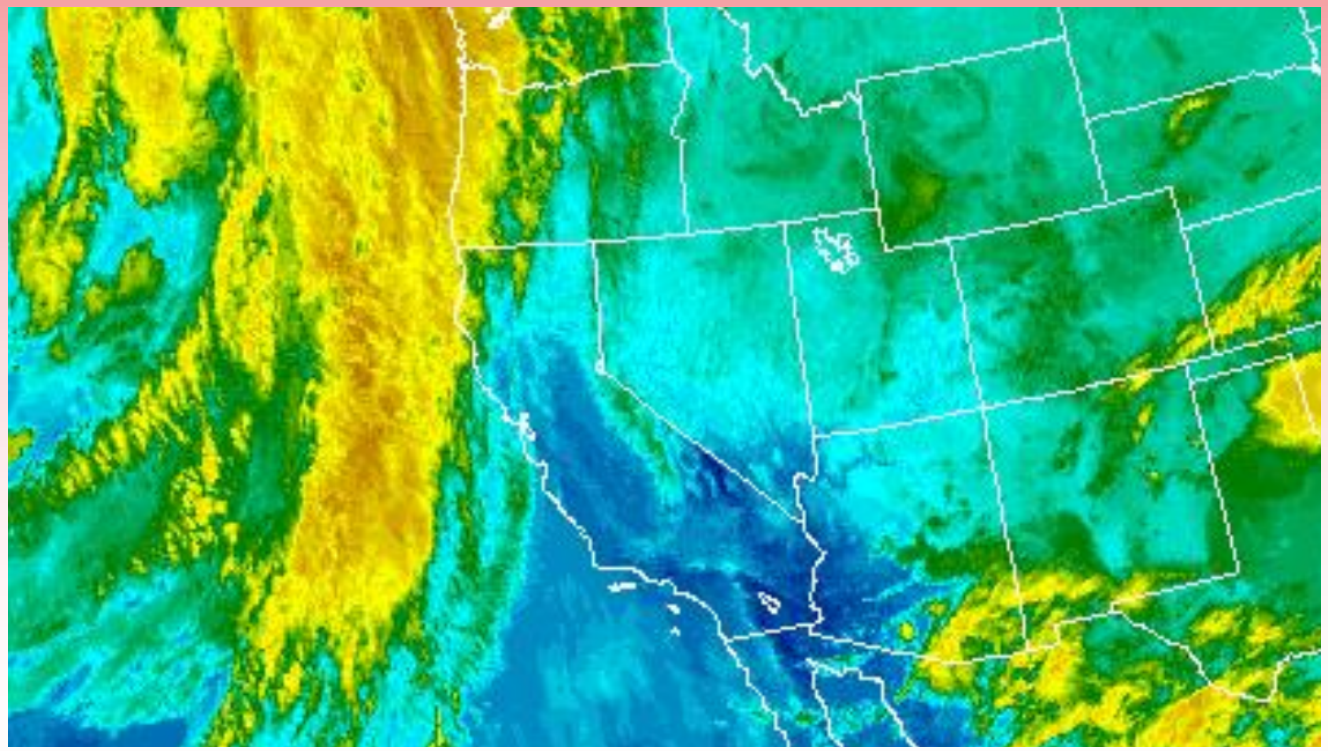
Las Vegas Astronomy Association "Star Party"
Death Valley, January 27-28, 2017

Proficiency: Setup and Pointing

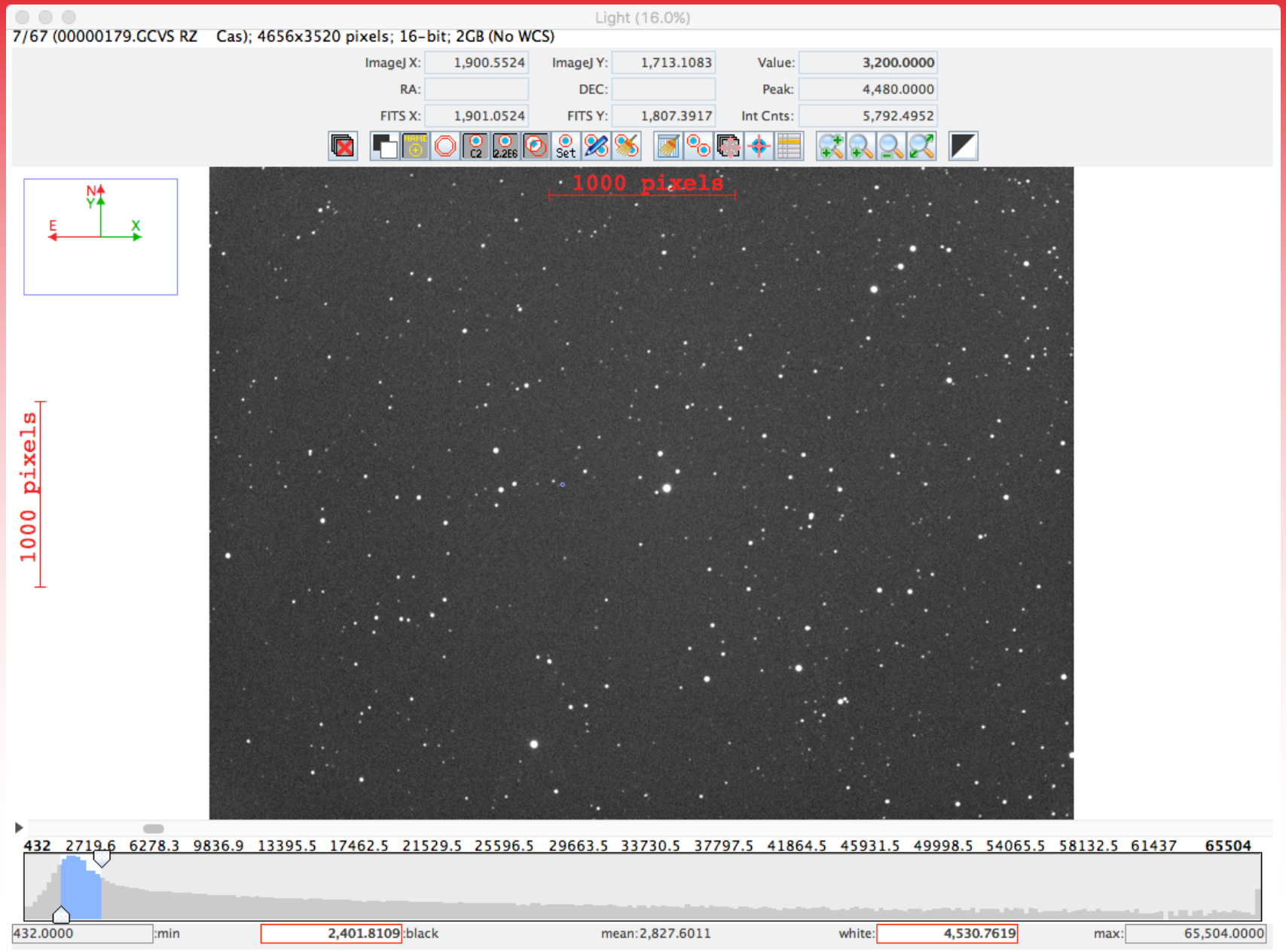
- Accurate Pointing on Dirt is Educational
- Gained Proficiency at Mount Calibration and Pointing
- Purchased Telrad Finder
- How to Host & Run a Star Party
- Met OptCorp and Meade Representatives

February

Incoming Atmospheric River (L)
Baby Geissberger (R)

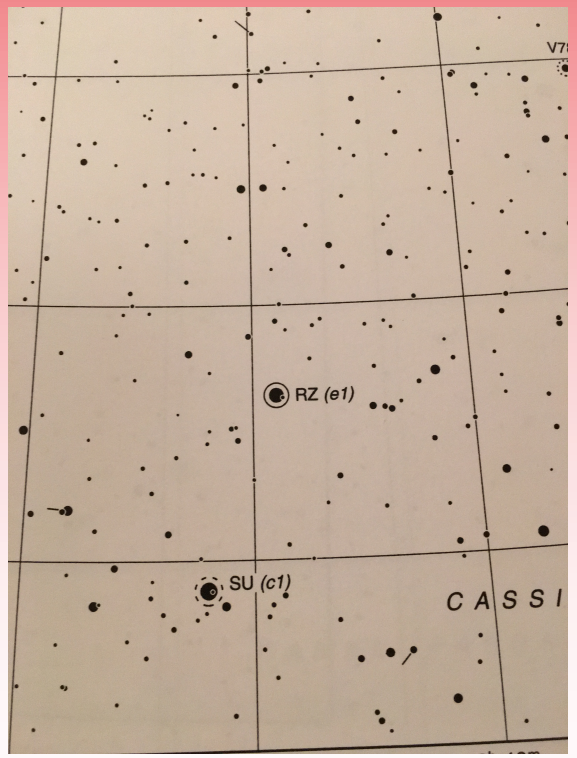


Target for Saturday, February 11th is RZ Cas
Eclipsing Binary, V-Band Magnitude 6.18 to 7.72



Tele Vue 102mm, Astrodon GG-495 (Blue Blocker) Filter, ZWO ASI 1600 MM-Cooled CMOS Camera (Cooling Off), 30-Second Exposure

Gaining Proficiency



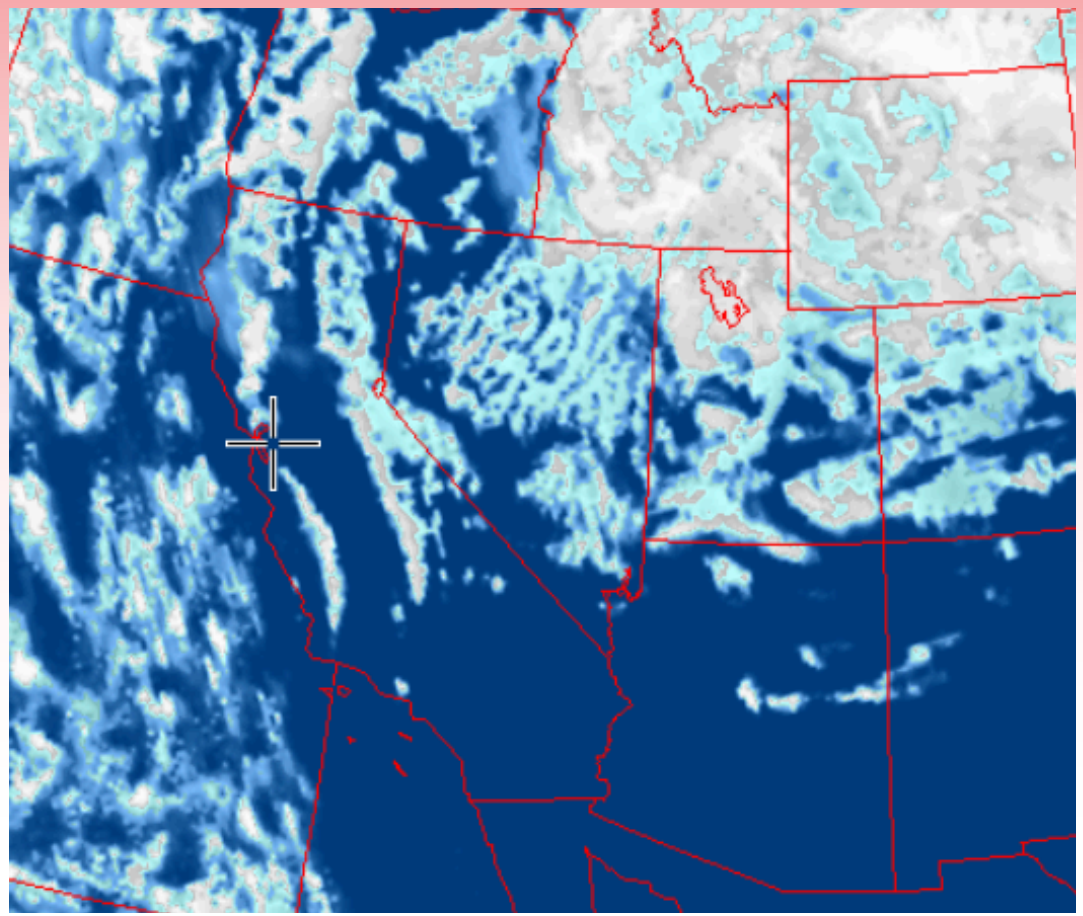
- Confirming Targeting Ability
- Getting Better At Orienting and Reading Dim Star Fields

Most Recent Observing Night

- Tuesday, February 14th
- Target U Cep
- Solved Exposure Problems
- High Haze Came and Went

Next Observing Nights

- Wanted to Have Results for You
- If I did, this talk would have been titled, "First Results from a Variable-Star Observing Program at the Geissberger Observatory."
- Thursday and Friday, February 23rd and 24th?
- Current forecast for Thursday Afternoon at Right



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This Semester

- Continue: Gaining Proficiency
- In-Progress: AAVSO Certification for Exoplanet Photometry
- Team: Justin Robinson, Katherine Damiano and myself (and Hans de Moor if we can get lure him away from his astrophotography gear)
- Committed to Getting Variable-Star Photometric Results — per our Physics 185 Independent Study Petition
- Learning to Operate (what Today I called) "Papa Geissberger" in Addition to "Mama" and "Baby Geissberger"

Longer-Term Future

- Harder Targets
  - Eclipsing Binaries are the Easiest (Choose Bright w/ Short Period)
  - Exoplanets and Dippers
  - Collaborating with the Large Surveys (Alert & Follow-Up Networks)
- Computational/Theoretical Work
  - Simulating Dippers?
  - Enhancing Photometry Software?
  - Smoothing Data Processing Pipelines?
  - Combing Through Data From the Big Surveys — LSST?

Longer-Term Future

- Is this an Astronomy Program?
  - No, modern Astronomy is Astrophysics
  - Well-Rounded Physics Major
    - Know Some Astrophysical Methods
  - Fits Best with Computational Physics Concentration
- Astronomy Nights!?! Star Parties!?!
  - Tighten Relationship to Lamorinda Community
  - Build Relationship with East-Bay Astronomers, like the Mount Diablo Astronomical Society
  - Serve Communities Beyond Lamorinda

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I am Grateful to...

- Prof. Ron Olowin for having the vision and patience to Create the Geissberger Observatory and for Trusting me with the Keys to his Equipment (and his Office!)
- To the Geissbergers who Gave Generously to Create an Observatory in Memory of Norma Geissberger
- To the Brothers and the Administrators and Others in the Saint Mary's Community who Had to Have Weighed in on The Building of an Observatory on the Beautiful Hillside Above Campus — and Apparently Approved ;)
- To the Facilities Department for Keeping the Observatory Equipment Dry and the Road to the Observatory Maintained
- To the Students in My Astro Classes Who Have Patiently Dealt with the Rough Edges on my Lectures and Labs

I am Grateful to...

- Tom Scarry for His Work in Putting Our Observatory Together, Keeping it Running, and for Inviting us to CSUS for a Training
- To The Physics Department for Trusting that a Good Use of Some of this Year's Funds Would be To Get a Paramount MYT to Carry (what today I referred) to as "Mama Geissberger" and "Baby Geissberger"
- To Prof. Hans de Moor for Patiently Training Me and Helping me on a Near Daily Basis for Months
- To Katherine Damiano and Justin Robinson for Choosing Photometry for their Senior Independent Study — and for TA'ing the Lecture and the Labs
- To Anna Karelina for Taking on Leading the Astronomy Labs this Semester
- To All of You for Your Interest in Today's Talk — and I hope your Participation in Advancing Astrophysics in Coming Semesters


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