The AAVSOnet Faint Star Monitors (FSMs)

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Legacy Fellow (AAS)

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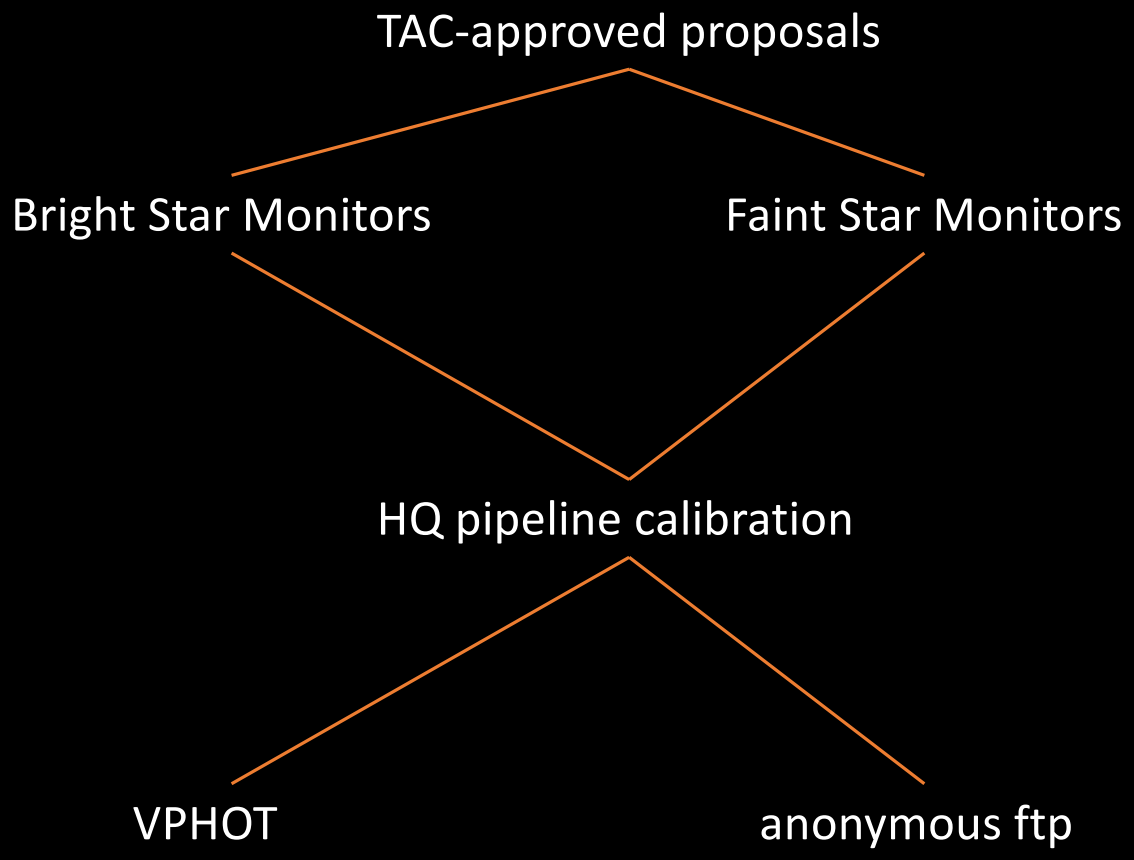
Acknowlegements

- Tzec Maun Foundation provided E180s & Paramounts for the Bright Star Monitors on long-term loan
- Dick Post funded camera purchases and other upgrade items
- John Centala made a large Qualified Charitable Distribution
- SBIG and QSI donated cameras. Most recently, QHY donated a QHY268M for BSM_TX
- DC3 Dreams and Diffraction Ltd. donated software
- Gary Walker built several enclosures
- Dozens of other volunteers and donors

AAVSOnet data flow



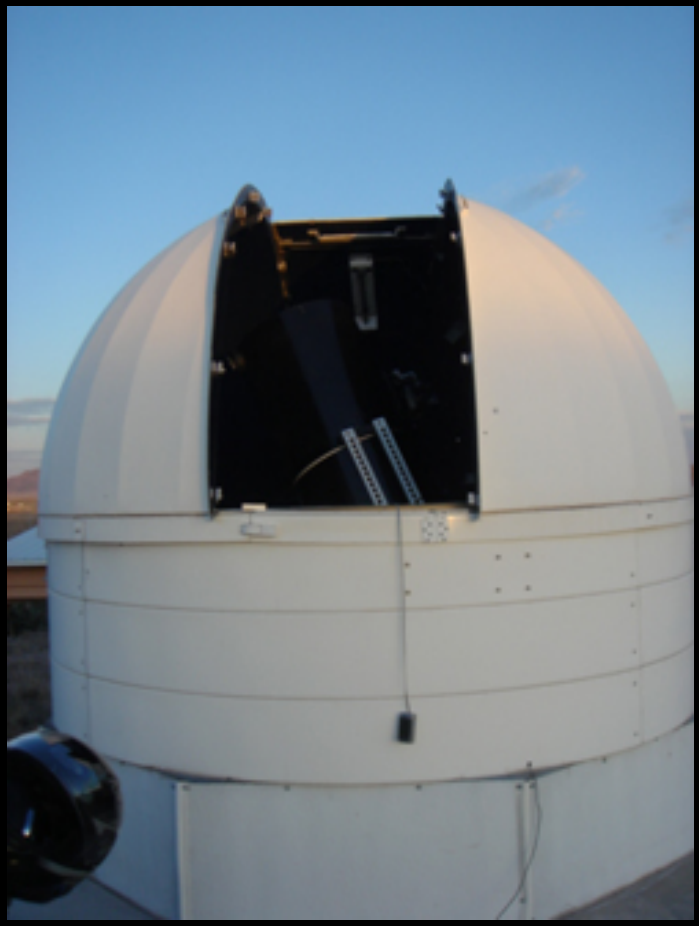
Faint Star Monitor (FSM) Goals

- Provide larger telescope aperture (~0.5m) than most amateurs have, especially in southern hemisphere
- Provide instrumentation beyond that of most amateurs
- Bring other organizations into closer ties with the AAVSO
  - Telescopes & (first-rate) sites belong to partner institution
  - AAVSO provided some hardware (cameras, filters)
  - AAVSO provided some refurbishment
  - AAVSO provided expertise

Sonoita Research Observatory (SRO)

- 50cm f/4 folded, corrected Newtonian
- Paramount ME, dome, on private property near Sonoita AZ
- Partnership with John Gross, Dirk Terrell (SwRI), Walt Cooney. Bob Denny (DC3 Dreams) big supporter with his time
- AAVSO provided STL-6303 camera, filter wheel, 8 filters
- We get 25% of time (actually works out to about 70%)
- Moving to Pie Town, NM in a month or two

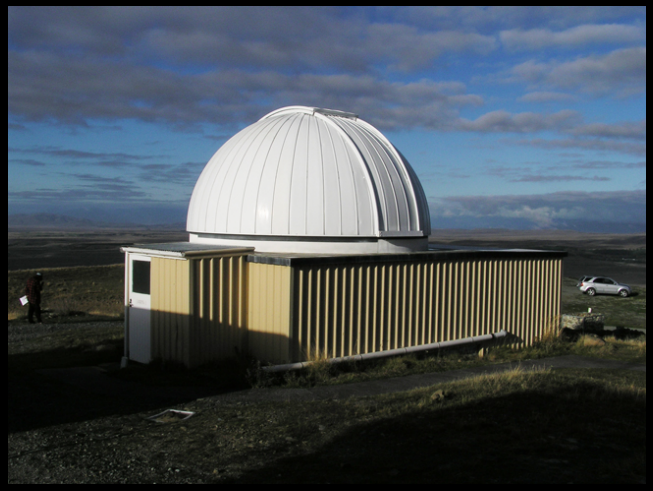
SRO



Mt. John University Observatory Optical Craftsman (OC61)

- Optical Craftsman 61cm f/16 fork-mounted Cassegrain in Ash Dome
- The AAVSO refurbished, automated telescope. Provided FLI PL09000 camera, filter wheel, 5 filters, along with an eShel spectrograph and Apogee camera
- New camera, filter wheel, mount drive control, computer, etc. have been purchased and will be shipped in December
- The AAVSO eShel spectrograph is available on shared-risk basis
- AAVSO gets 2/3 of telescope time (remainder mostly used by Karen Pollard for her observational astronomy class)
- Our only southern hemisphere FSM

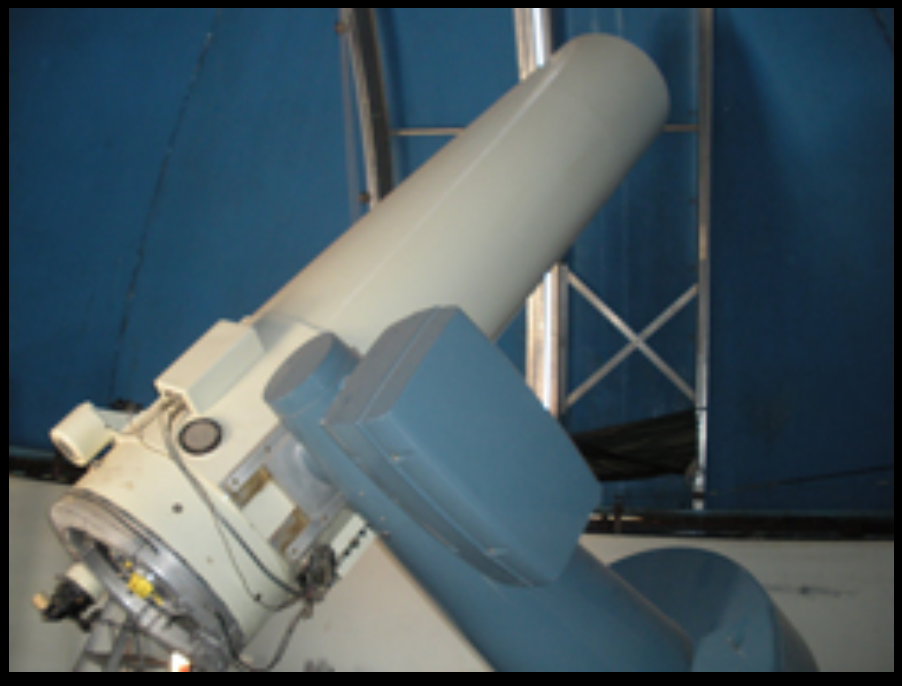
OC61



Tortugas Mountain Observatory 61cm (TMO61)

- Boller & Chivens 24-inch, originally f/15 Cassegrain, converted to f/5 Newtonian. Dome on TM, Las Cruces NM
- Owned and operated by New Mexico State University, Jon Holtzman (astronomy chair)
- The AAVSO refurnished and automated the telescope and provided original camera
- Jon has just installed a new QHY600, large filter wheel and new filters
- AAVSO gets 50% of telescope time
- By far the best seeing site in AAVSOnet (subarcsec)

TMO61



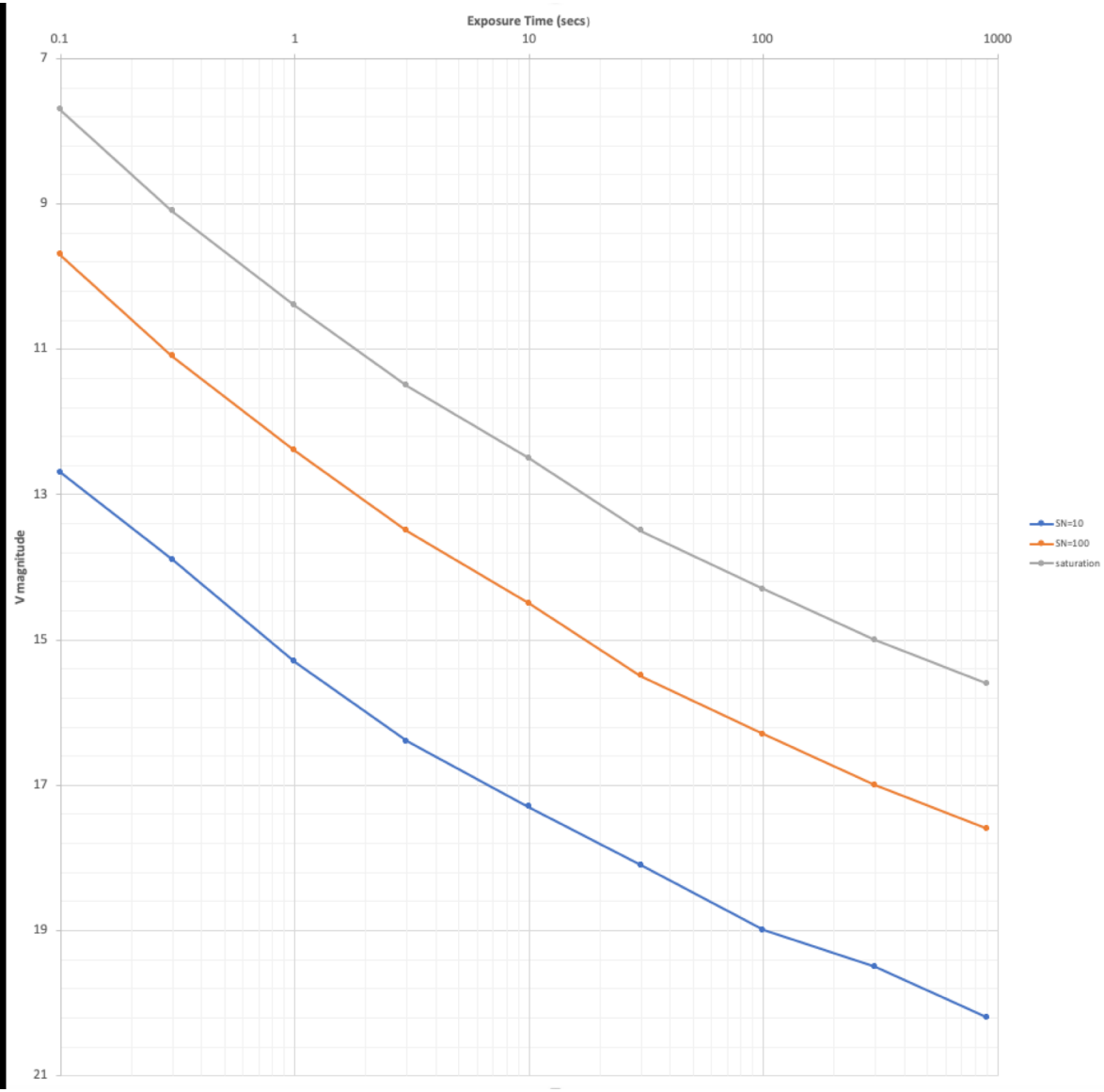
Madrona Peak Observatory (MPO61)

- Owned by widow of Mark Williams
- Operated by amateur team (Walt Cooney, Bill Flanagan, Bill Pellerin)
- RCOS 61cm, fork mounted, FLI PL1603, large filter wheel
- Good seeing (1-2arcsec) & dry climate
- No expense to AAVSO, but also no firm commitment of time yet
- Initial data in progress

MPO61

Faint Star Monitor Parameter Space

- Fainter stars than conveniently possible with BSMs
- Crowded fields (good seeing; lucky imaging)
- Bright-star spectroscopy in south
- U-band imagery possible
- Recommend projects with single imageset per night, but we've done time series when justified



From Richmond's
CCD SNR Calculator

Using AAVSOnet/FSM

- Submit simple proposal (https://app.aavso.org/aavsonet/proposal/)
- Proposal sent to Telescope Allocation Committee
- When approved, time allocated on appropriate telescope
- Images taken, calibrated, sent to VPHOT or ftp
- Email sent to observer to let them know data is available
- No hands-on access; fully automatic/robotic

Types of Observing

- Monitor, submit data to AAVSO (Legacy targets)
- Participate in AAVSO campaign (Alert Notices)
- Work as team on research projects for professional (CBA)
- Perform your own research, usually for publication (JAAVSO, presentation) Note: a professional mentor is useful
- Read the CCD Photometry Guide to learn how to make the observations. AAVSO has an on-line program (VPHOT) that is freely available to its members to analyze the data, and several other programs (like LesvePhot) produce properly formatted submission files.

Arne's Projects

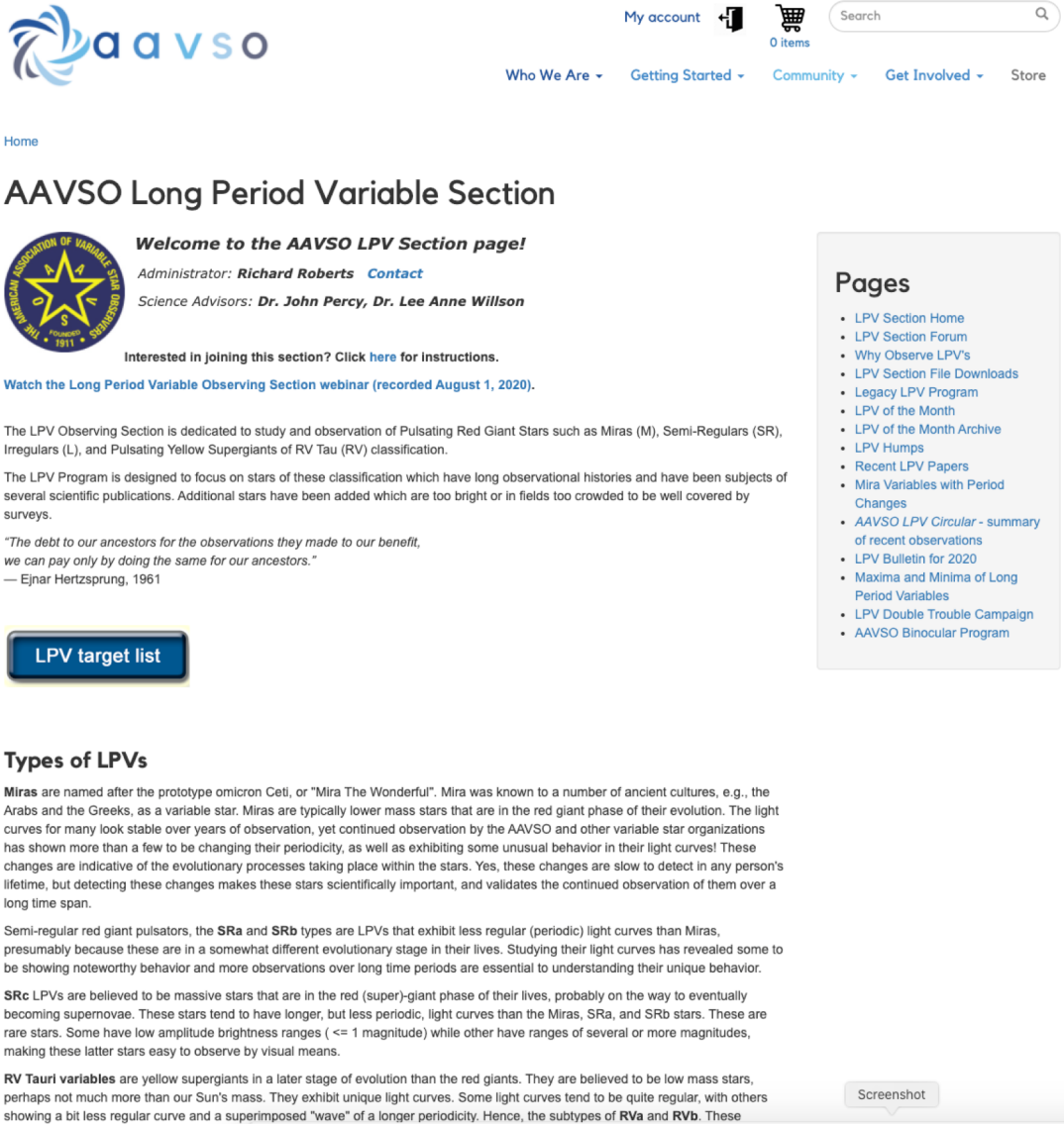
- Set of 66 projects using UBVRI and JHK data from USNO-Flagstaff
- Eclectic mix of northern targets
- Developed in 2000's, so some projects may be irrelevant now
- Was available via ftp; you can ask me for the zip file
- I'll volunteer to mentor anyone who starts one of these projects, as long as you also acquire new FSM data in support
- Many more such targets from my decade as Director; I'll add them as time permits

Types of Science Projects

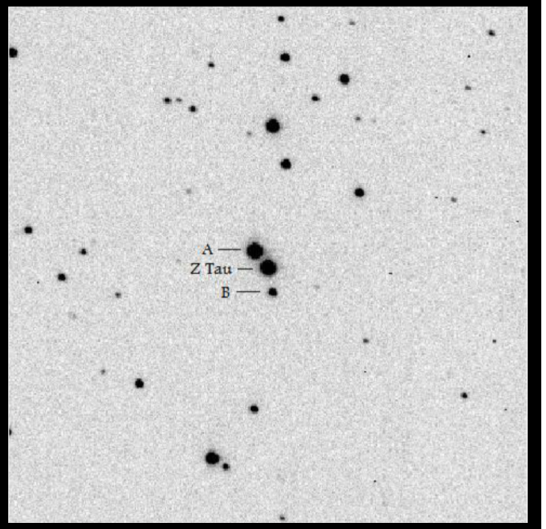
- Legacy Targets
- Campaigns
- Unusual types of common variables
- Transient Objects
- Exoplanets
- Your favorite project?

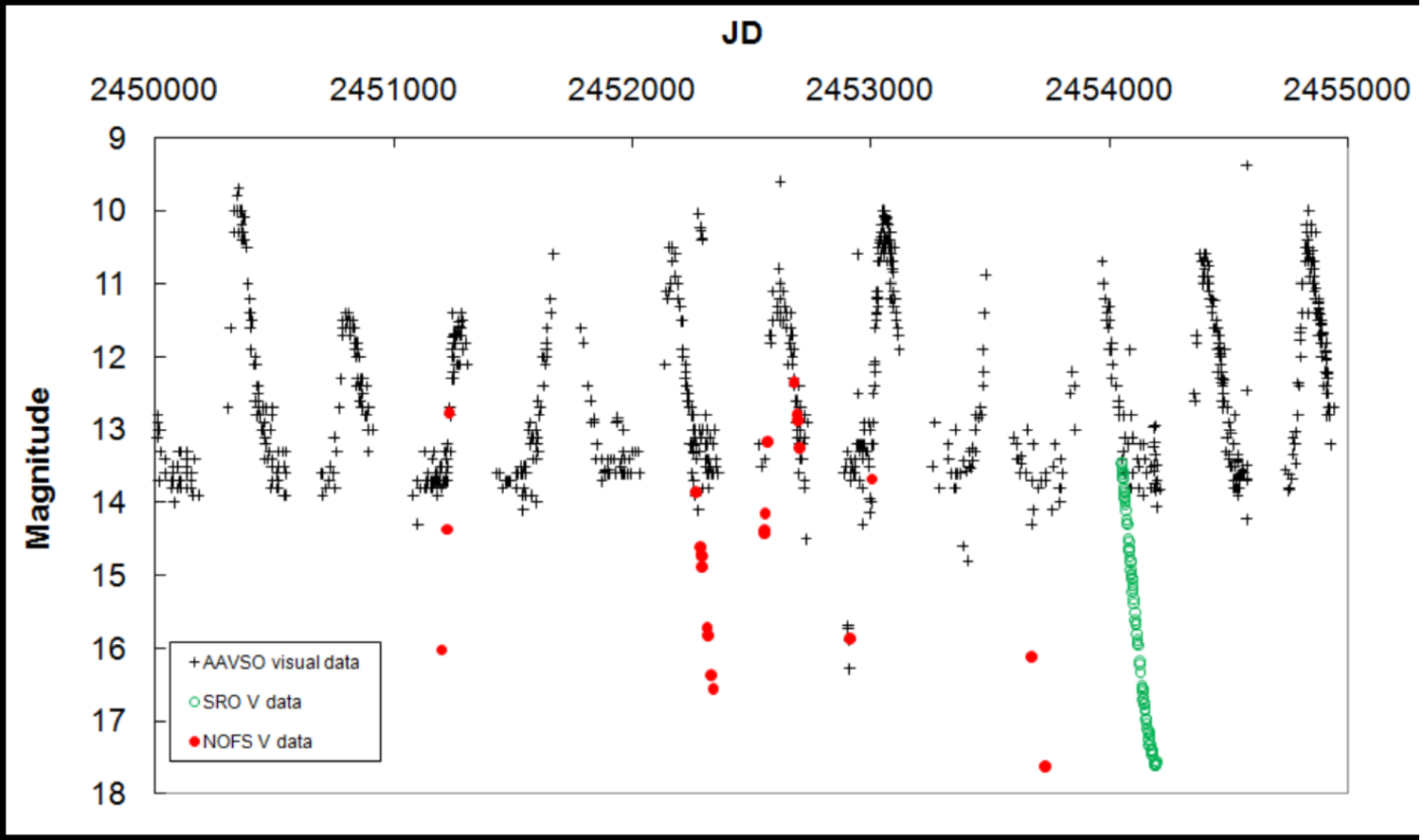
Legacy Targets

- Most observing sections have a (legacy) target list, stars with decades of coverage that needs to continue
- https://www.aavso.org/observation-planner-tool for recommended targets
- https://www.aavso.org/program-stars-need-observation includes many legacy targets
- Pick a few and submit a proposal to monitor them



Note: make use of the FSM advantages and observe crowded variable, or others at minimum rather than maximum





Z Tau

Credit: Cooney et al

Campaigns

- Specific monitoring targets, not usually from the legacy lists
- Dozens of targets are announced annually, usually with Alert Notices
- Mostly professional projects with specific data requirements
- Follow their guidelines; submit measures to AAVSO AID
- In some cases, you will be a coauthor or have a specific acknowledgement

Alert Notice 761: Monitoring b Per eclipse in December 2021

December 7, 2021

AAVSO Forum threads (scroll to the bottom of a thread for latest posts):
- Campaigns and Observation Reports: https://www.aavso.org/b-per-dec-2021-eclipse
- Eclipsing Binaries: https://www.aavso.org/b-per-dec-2021-eclipse-01

Please subscribe to these threads if you are participating in the campaign so you can be updated by the astronomers and by HQ. Join in the discussion or ask questions there!

Dr. Donald F. Collins (AAVSO member), Dr. Robert Zavala (US Naval Observatory, Flagstaff Station), Jason Sanborn (Lowell Observatory), and Dr. Anatoly Miroshnichenko (University N. Carolina, Greensboro) have requested high time-resolved observations of the bright star **b Persei** during the upcoming predicted primary eclipse of the AB inner pair. **The mid-eclipse prediction is centered on December 23.4 ± .5 UT. The observation window should last about 2 weeks: December 16, 2021, to December 30, 2021. It is important that observers observe several long time-series observations both *before* and *after* the eclipse as well as all parts of the eclipse.**

The b Persei system (HD 26961, HIP 20070, HR 1324, SAO 24531) consists of three stars in a hierarchical system. The A and B components are close-orbiting (1.5237 d period) in a low-inclined orbit that exhibits ellipsoidal variation: ~0.06 peak-to-peak magnitude variation centered on magnitude 4.6 with no eclipses (Stebbins 1923). The brightest star of the pair is spectral class A2V. Radial velocity studies (Hill et al. 1976) determined the existence of the third star that orbits the AB pair with a period of about 702 days in a highly eccentric orbit. AAVSO observers detected the first ever eclipse/transit involving the third star of the system in January-February 2013 campaign (*AAVSO Alert Notice 476*). (See *AAVSO Alert Notice 610* for the light curve of the first campaign).

Since the detection of the first eclipse of b Persei in 2013, 7 AAVSO campaigns have observed time-resolved eclipses (*AAVSO Alert Notices*: *507* (Jan 2015), *537* (Feb 2016), *563* (Dec 2016), *610* (Jan 2018), *655* (Oct 2018), *688* (Dec 2019), and *721* (Oct 2020)). The results of these campaigns are displayed in Figure 1 (secondary eclipses) and Figure 2 (primary eclipses). A secondary eclipse consists of the third star transiting behind the rapid orbiting inner AB pair that do not eclipse each other. A primary eclipse consists of the third star C transiting on the Earth side of the rotating AB pair and blocking some of the light from the inner stars. The deepest eclipses occur when the third star is totally ingressed in the brightest A type star of the inner pair.

The previous campaigns by AAVSO observers have revealed the following:

1. Both the primary and secondary transits show significant light curve dips in total observed brightness on the order of 0.1 mag to 0.4 mag.

2. The orbital period for the C star is 704.5 ± 0.5 d based on the time difference between successive transits of the same primary/secondary phase of the C orbit. The previously published orbital period is 702 d (Hill 1976). Our estimate of the C period has changed since the Oct. 2020 Alert Notice as more transits have been observed.

3. Radial velocity observations by Anatoly Miroshnichenko, which separate the short period RV oscillations from the long period RV oscillation, have indicated that the four events shown in Figure 1 were secondary eclipses in which the C star transits behind the A-B pair. We have also observed three primary eclipses: March 2016, February 2018, and January 2020 (Figure 2). In the primary eclipses the C star temporarily blocks some of the light from the close-orbiting A-B pair. Figure 2 also indicates a prediction of the light curve for the December 2021 primary eclipse.

4. Each transit (or eclipse) is different – due to the lack of a simple commensurate relationship between the short period A-B stars and the long period of the of the AB-C triple system.

5. The deepest relative minimum observed occurred during the primary eclipse of January 2020 at mJD 1867.4 (Figure 2). The solid curve in Figure 2 (the simple model) calculates the result if the C star (spectral class F, luminosity 2 x Lsolar) is fully ingressed over the "disk" of the primary star A (spectral class A, luminosity 10 x Lsolar).

Work has been started on a multi-parameter modeling to enable fitting to many of the star's attributes as well as the dates using all events. Promising results in terms of algorithm speed (Lagarias et. al. 1998) have been achieved with individual events.

AAVSO Forums for Alert Notice 761

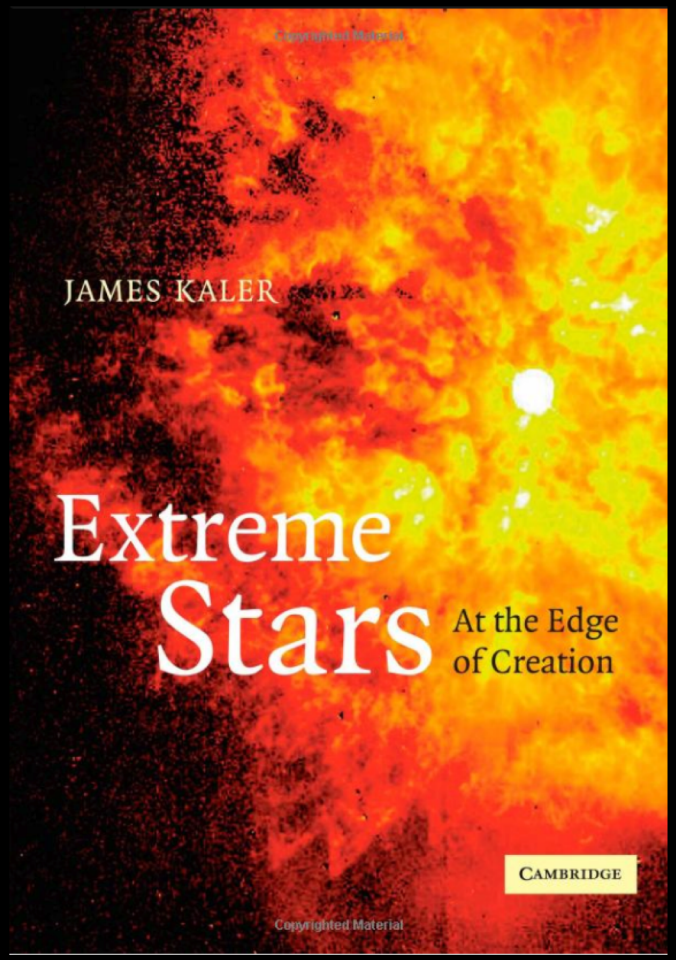
- Campaigns and Observation Reports: https://www.aavso.org/b-per-dec-2021-eclipse
- Eclipsing Binaries: https://www.aavso.org/b-per-dec-2021-eclipse-01

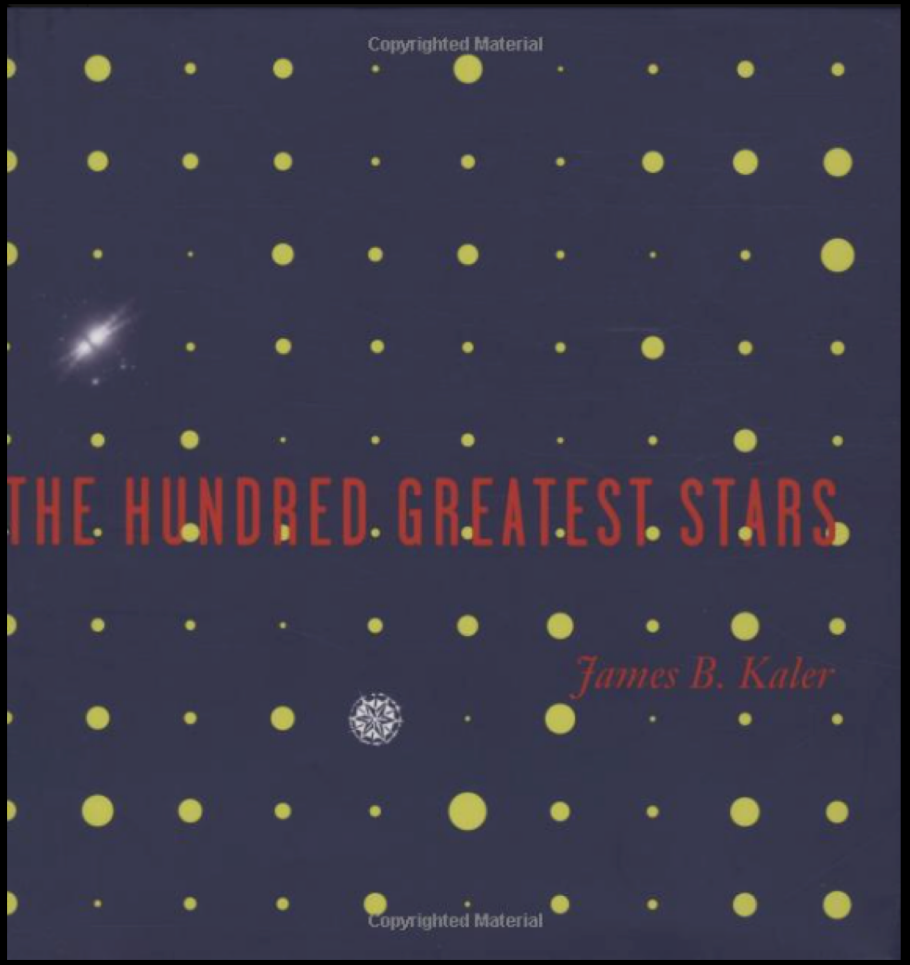
Screenshot

Typical Alert Notice

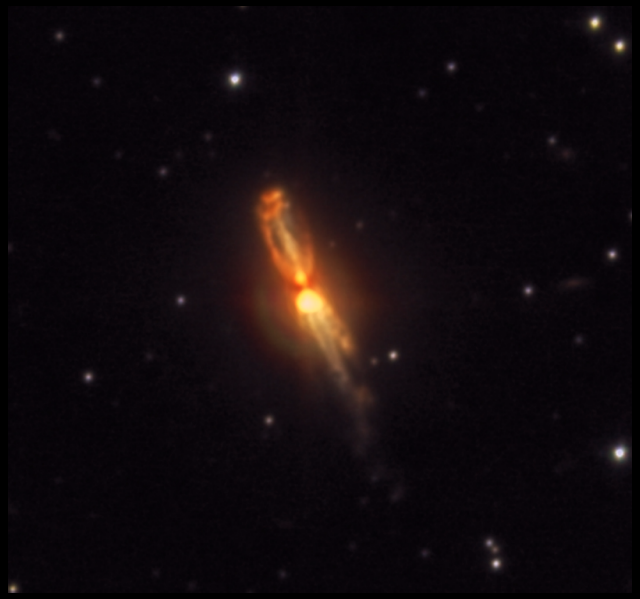
Exotic Variables

- There are always unusual examples of any common variable
- Often more fun to observe!
- Jim Kaler has picked out a bunch of these
- GCVS “notes” often yield interesting targets

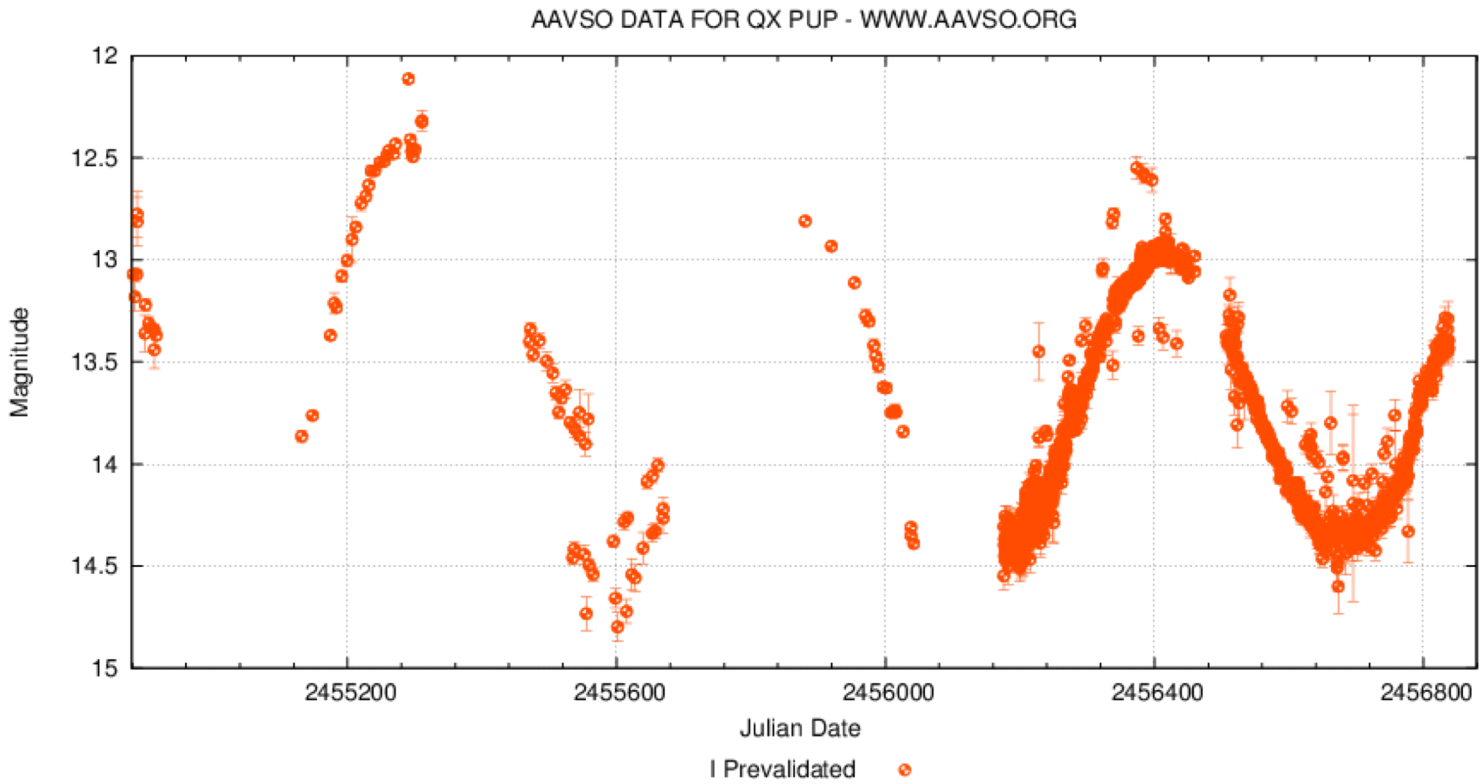

JAMES KALER
Extreme Stars
At the Edge of Creation
CAMBRIDGE

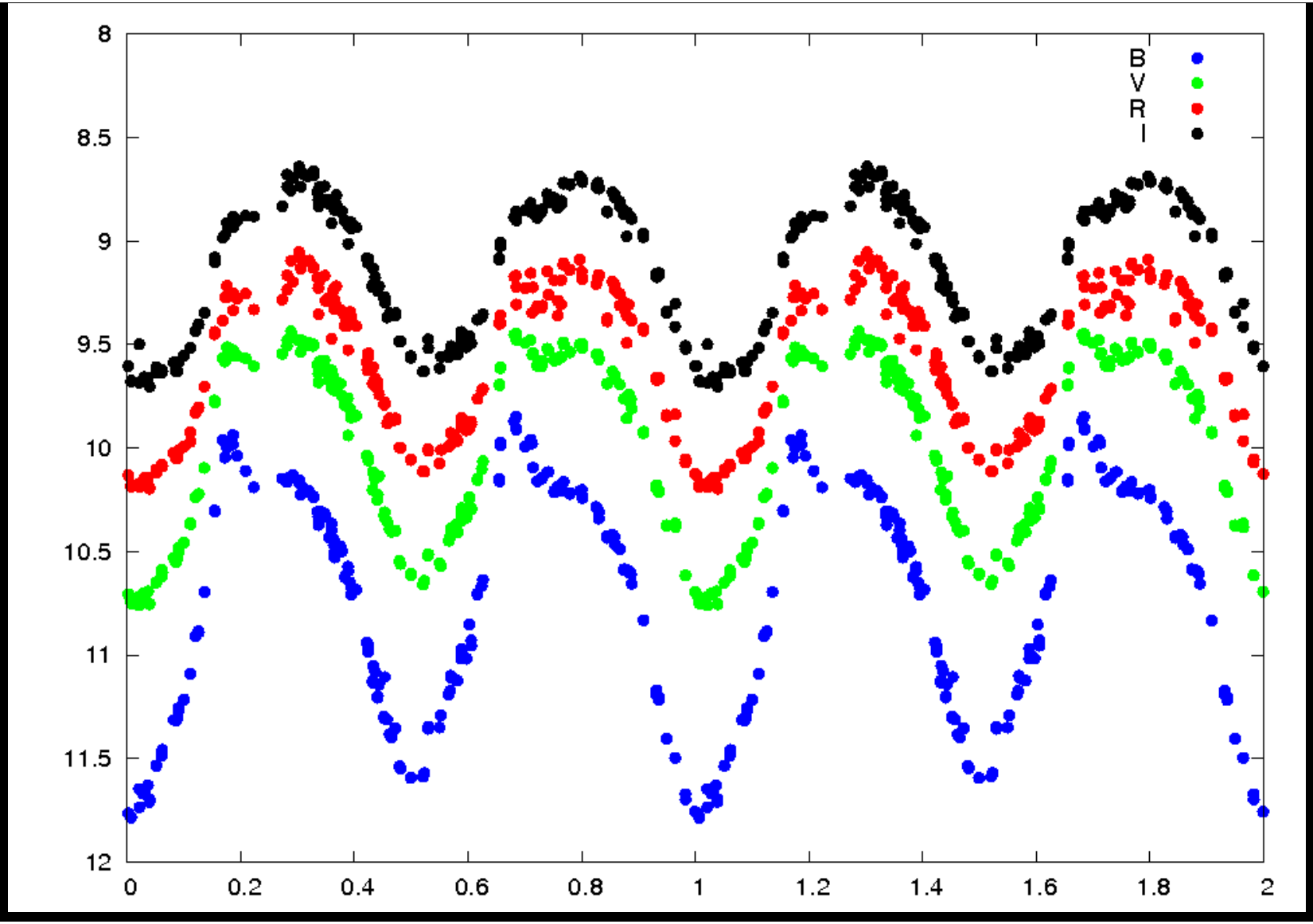

THE HUNDRED GREATEST STARS
James B. Kaler

QX Pup
(Calabash
Nebula)
USNO 1.0m
BVI



QX Pup
USNO
1.55m
JHK

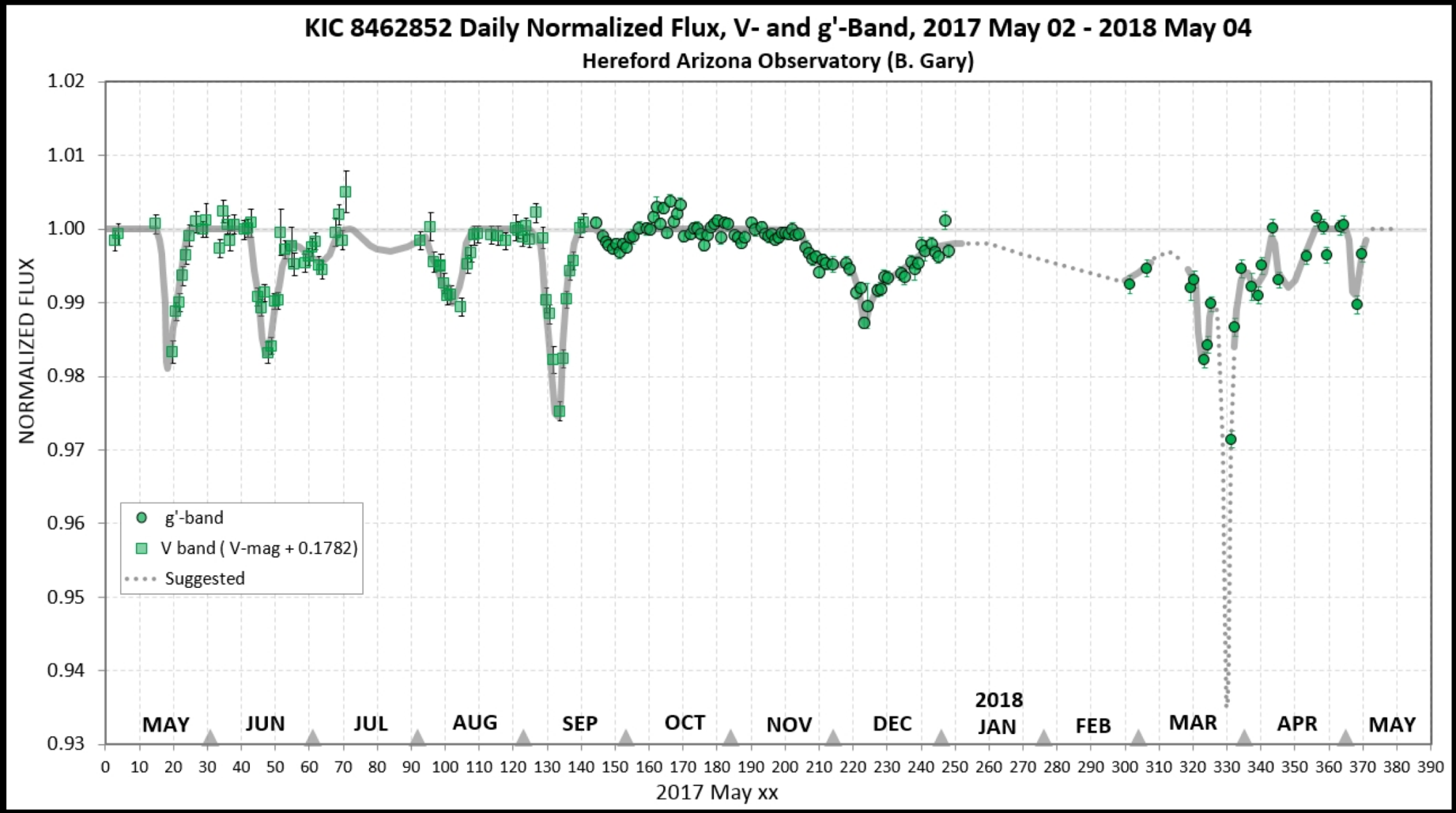

AAVSO DATA FOR QX PUP - WWW.AAVSO.ORG
Magnitude
12
12.5
13
13.5
14
14.5
15
2455200
2455600
2456000
2456400
2456800
Julian Date
I Prevalidated



W Vir

SRO 35cm

Credit:
Templeton
et al.

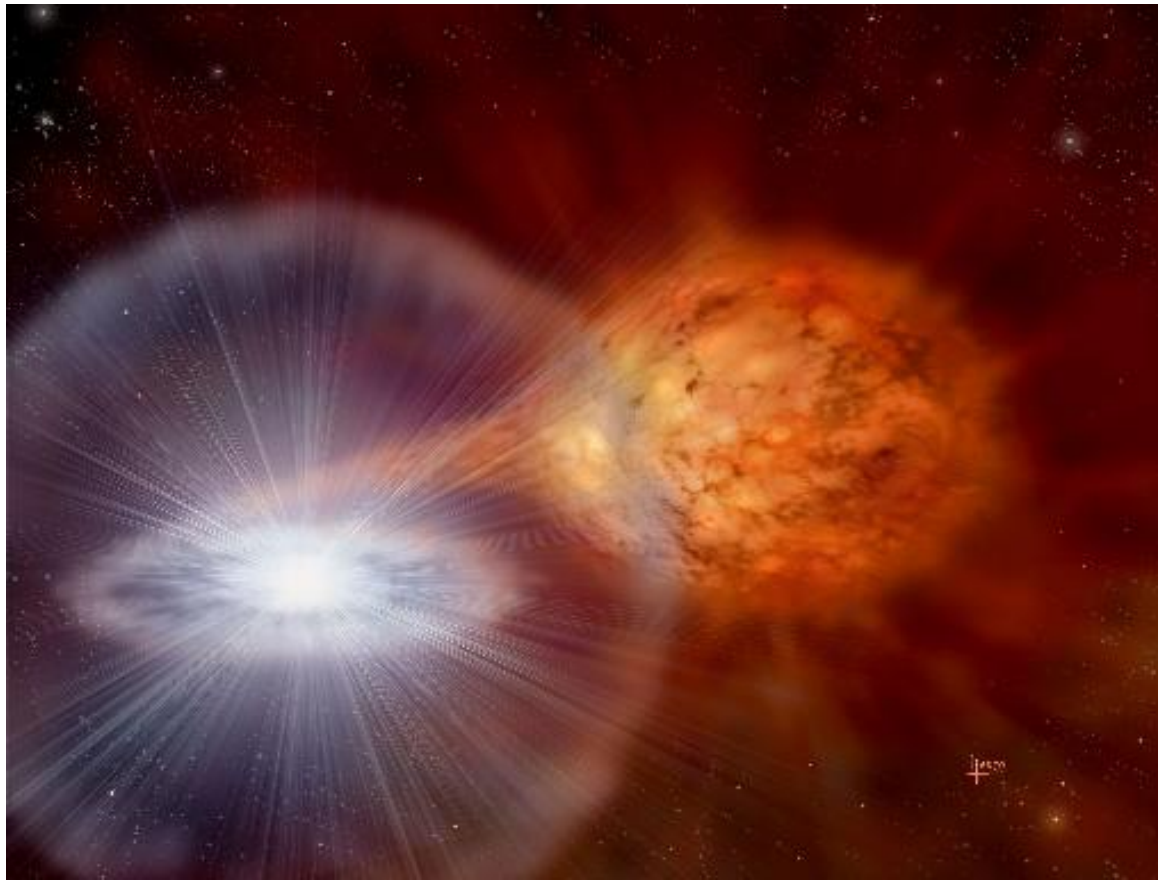


KIC 8462852 (Tabby's Star)

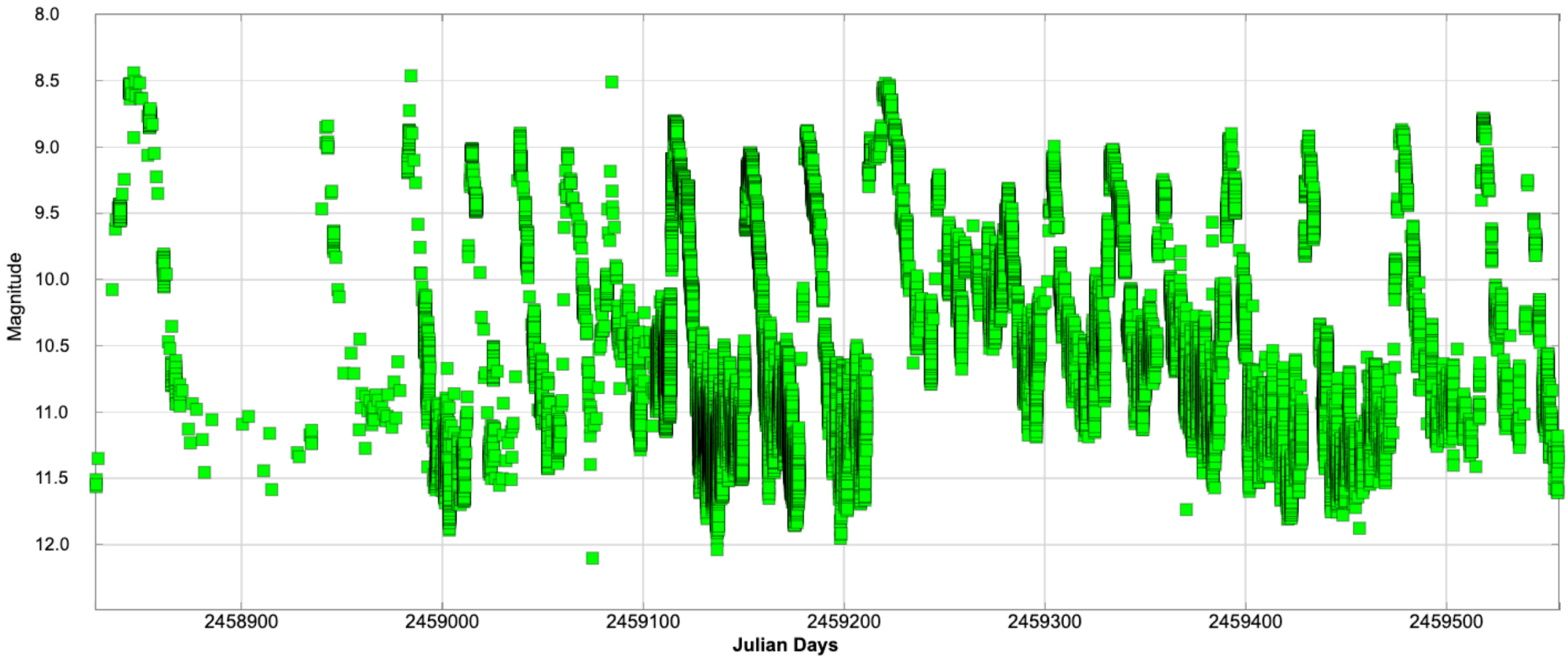
Transient Objects

- Flare stars (not covered here; too big of a time sink for FSM)
- Novae (~2 dozen/year)
- Supernovae (~100/year useful with FSM)
- GRB optical afterglows (dozen afterglows/year visible with FSM)
- Microlensing events (few/year)
- Gravitational wave events optical counterparts (only one known!)
- Not covered very well by surveys

Cataclysmic variables (CVs)

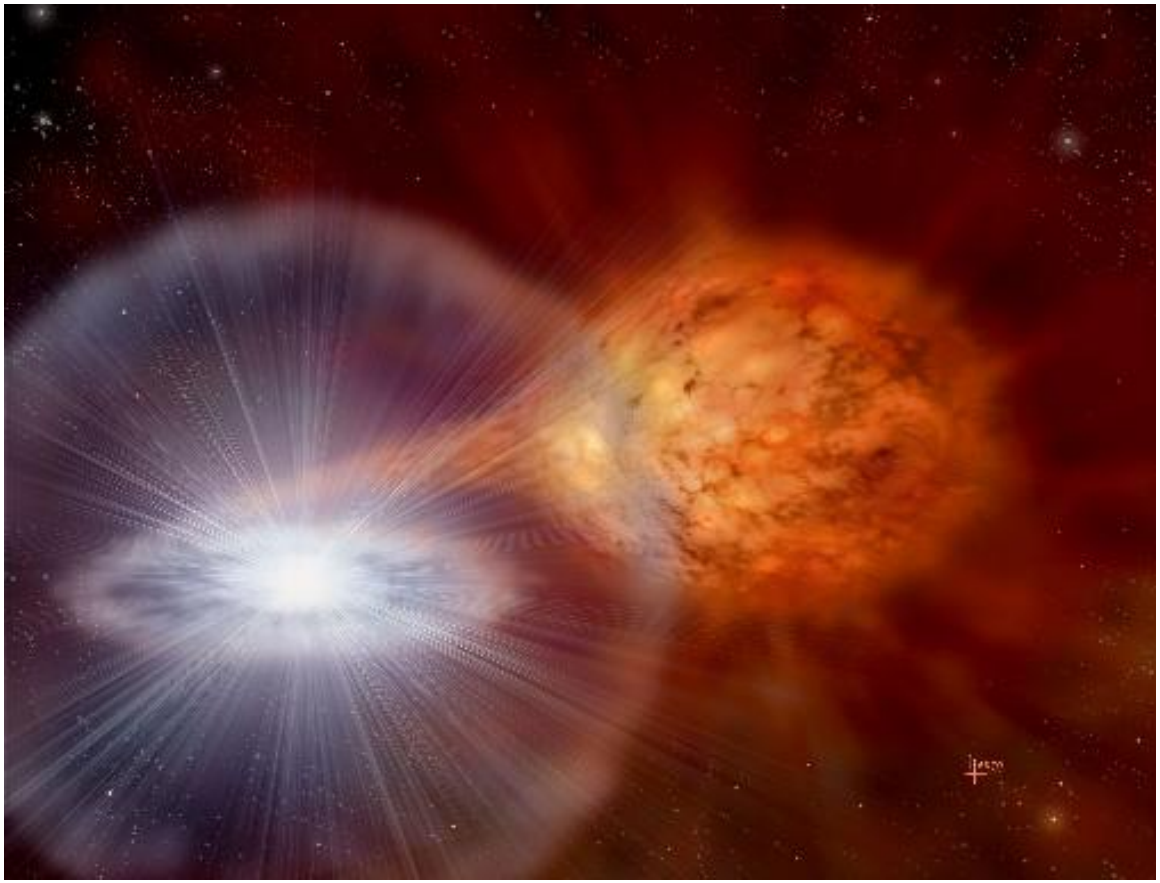


Credit: David Hardy/PPARC



2 years of SS Cyg

Novae



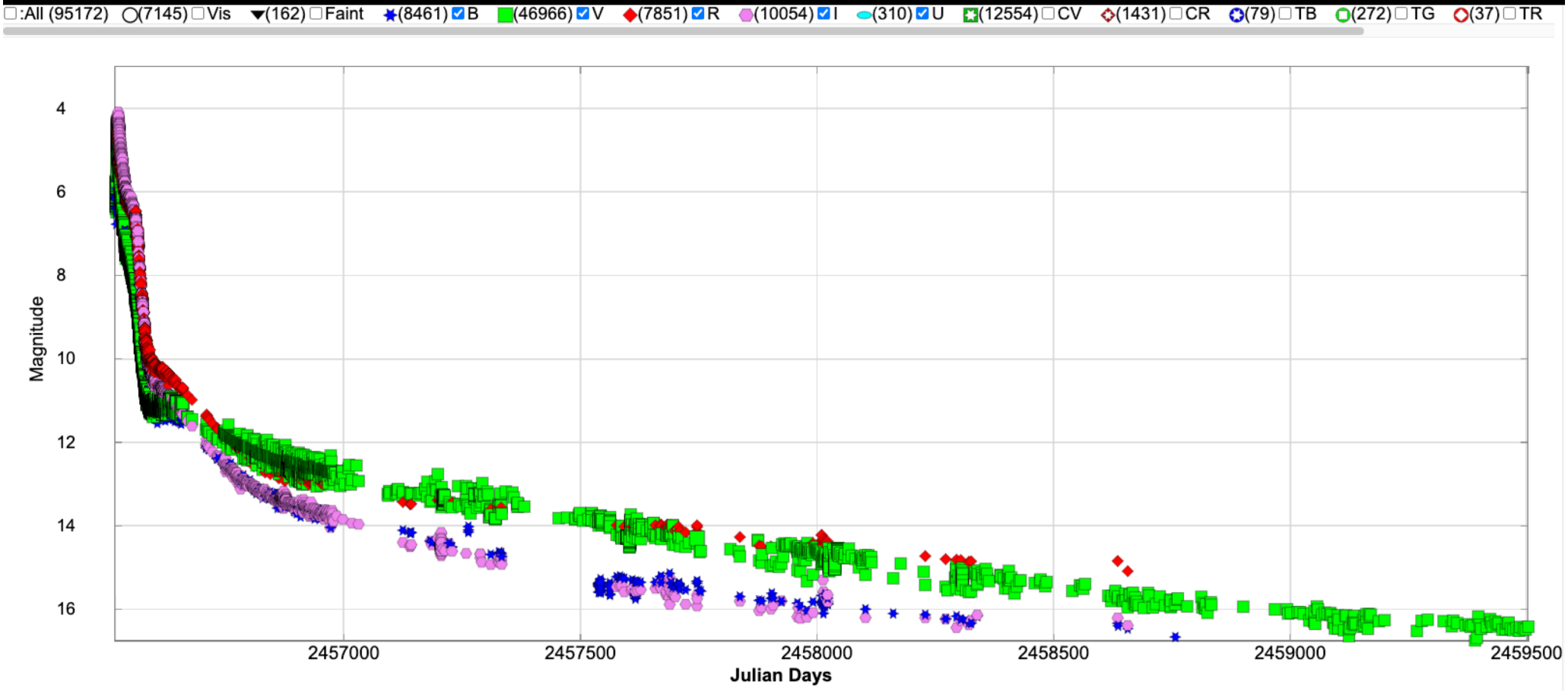
Credit: David Hardy/PPARC

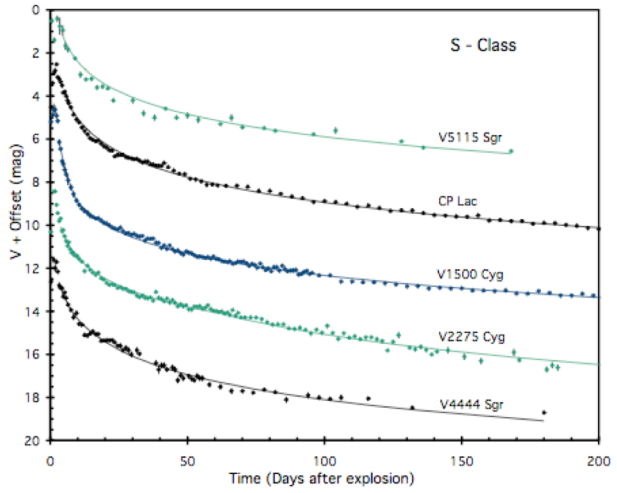
Nova Her 2021
(V1674 Her)

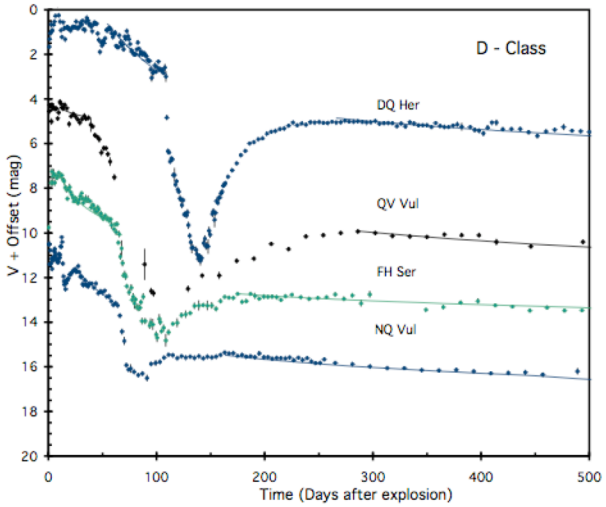
Credit: Jaeger

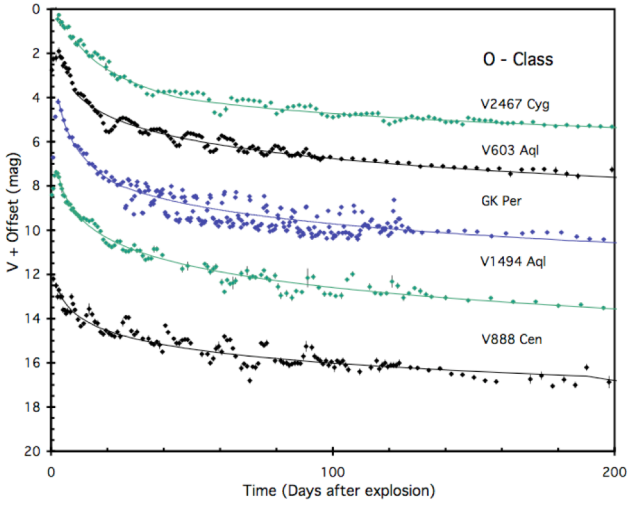
A decade of V339 Del

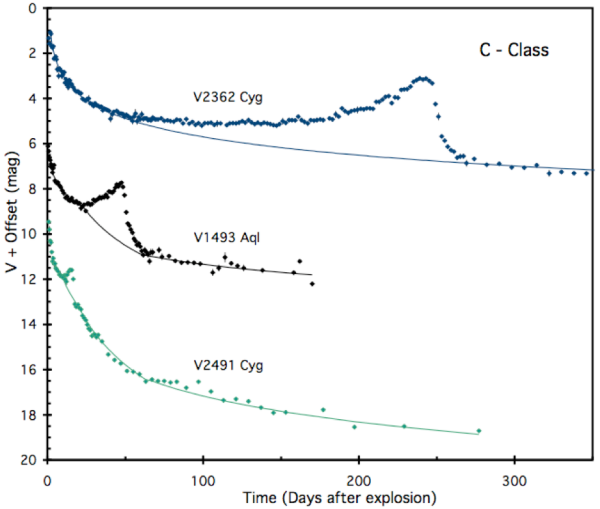
Nova Del 2013
AID: 73,300 BVRI obs









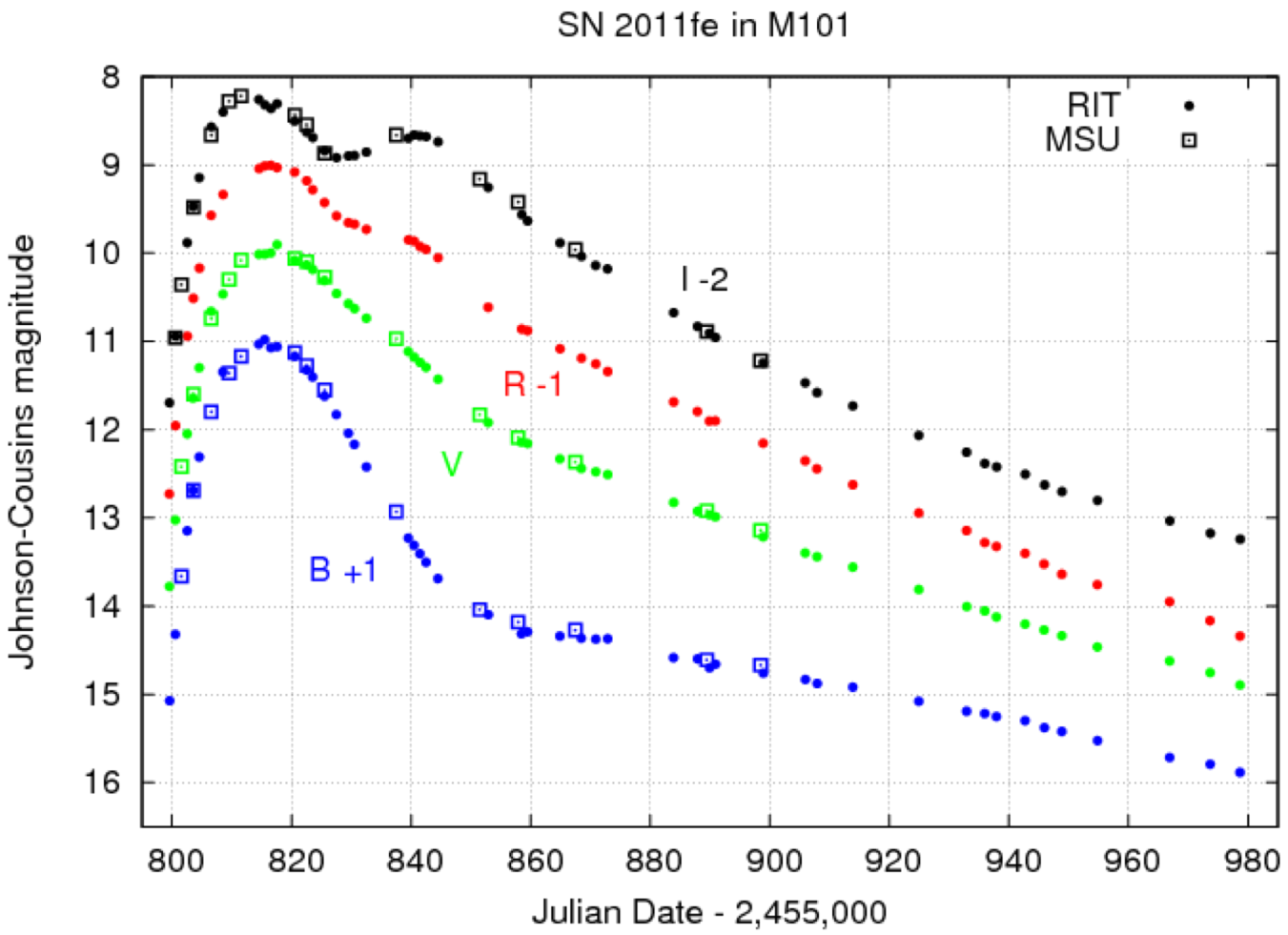


Nova light curve types

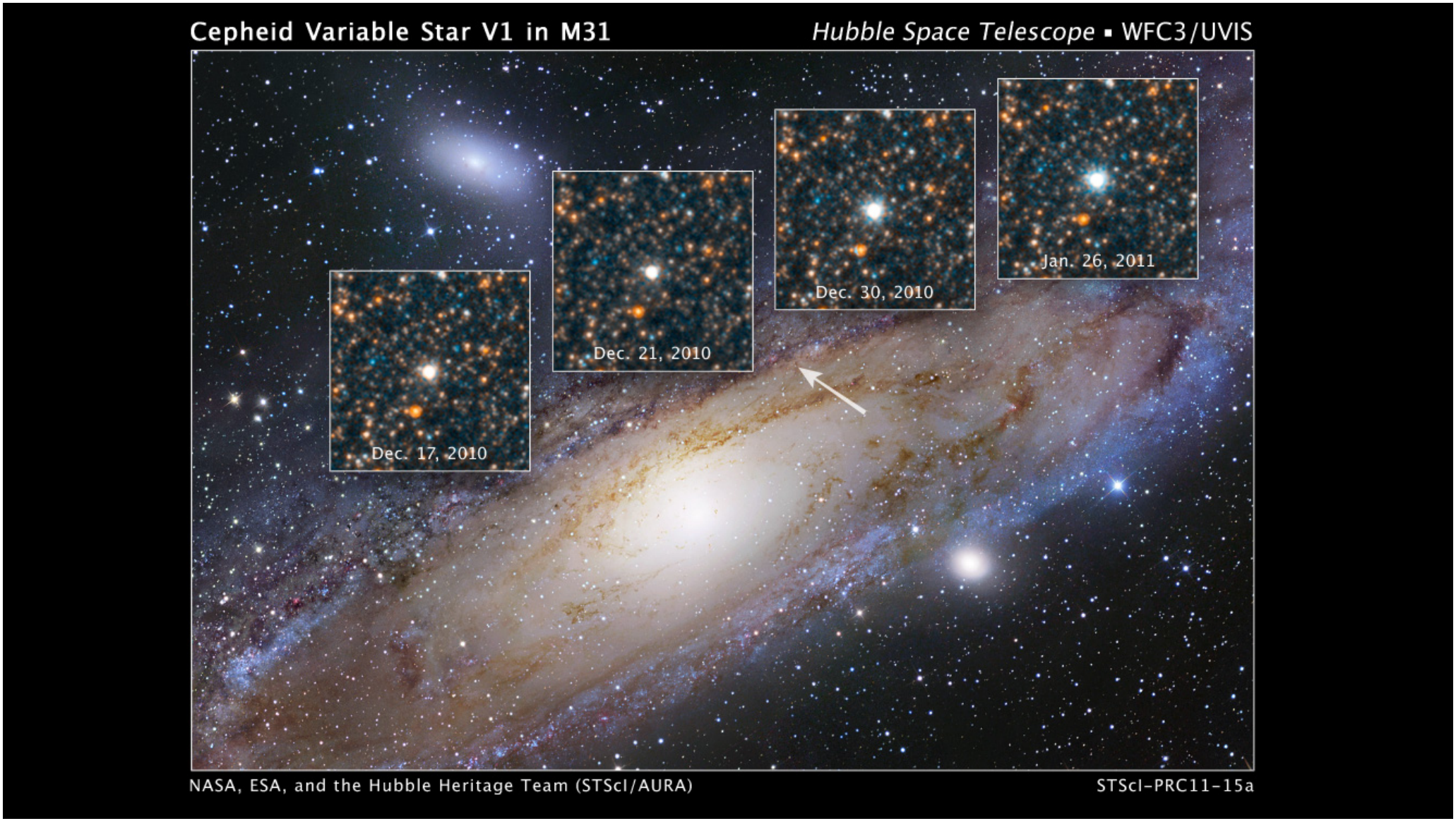
Credit: B. Schaefer

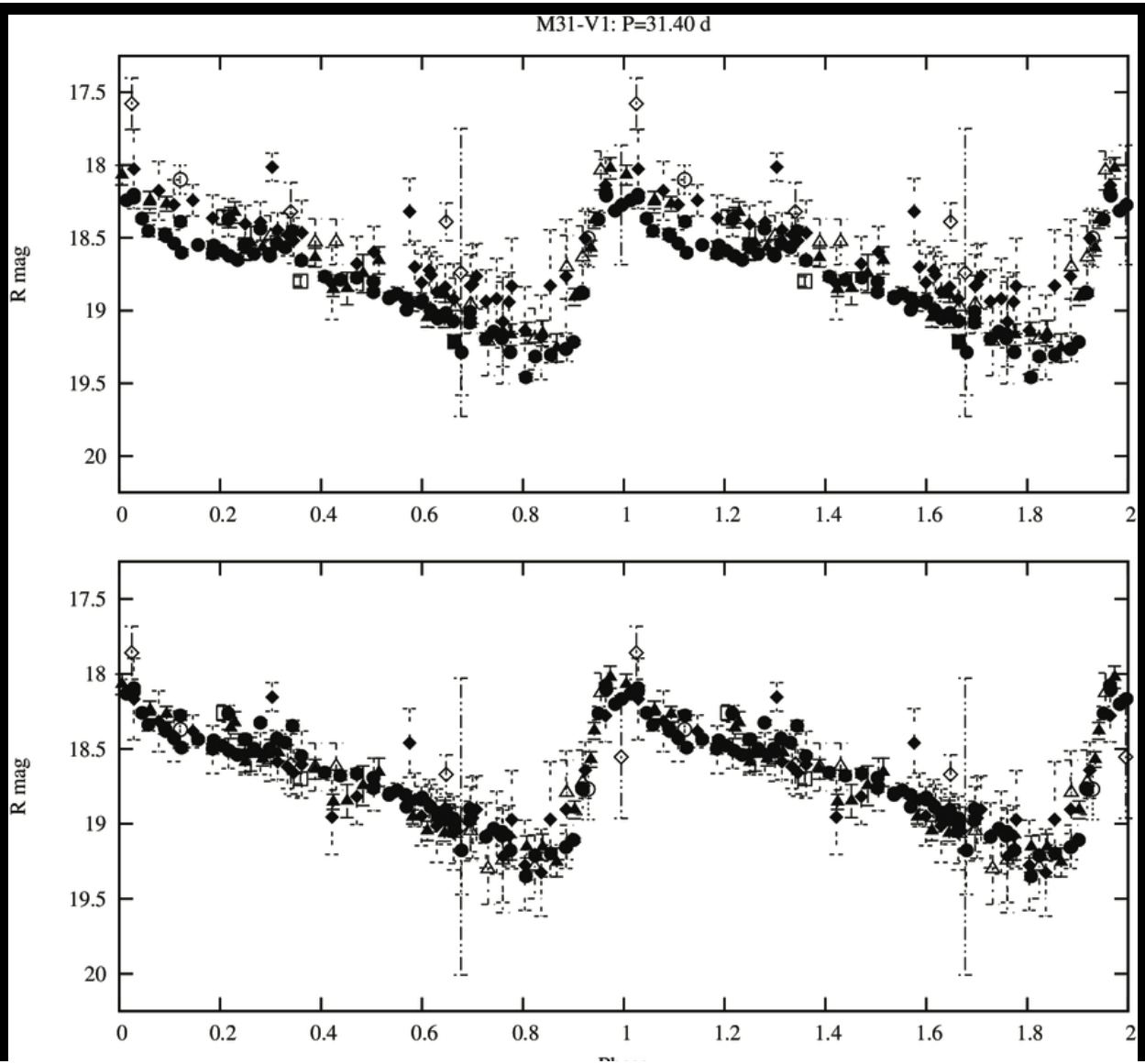
M101 + SN2011fe

Credit: Albert Duin



Credit: Richmond (RIT)

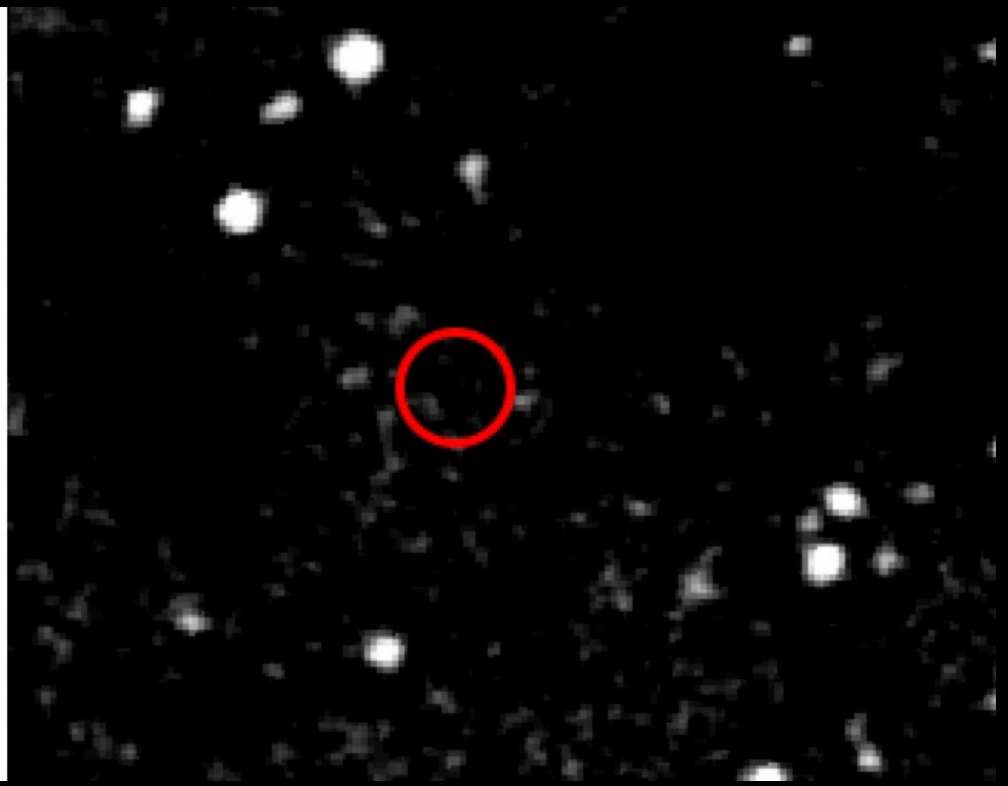

Cepheid Variable Star V1 in M31
Hubble Space Telescope ▪ WFC3/UVIS
Dec. 17, 2010
Dec. 21, 2010
Dec. 30, 2010
Jan. 26, 2011
NASA, ESA, and the Hubble Heritage Team (STScI/AURA)
STScI-PRC11-15a



M31 V1 light curve from AAVSO

Credit: Templeton et al

M31N 2008-12a

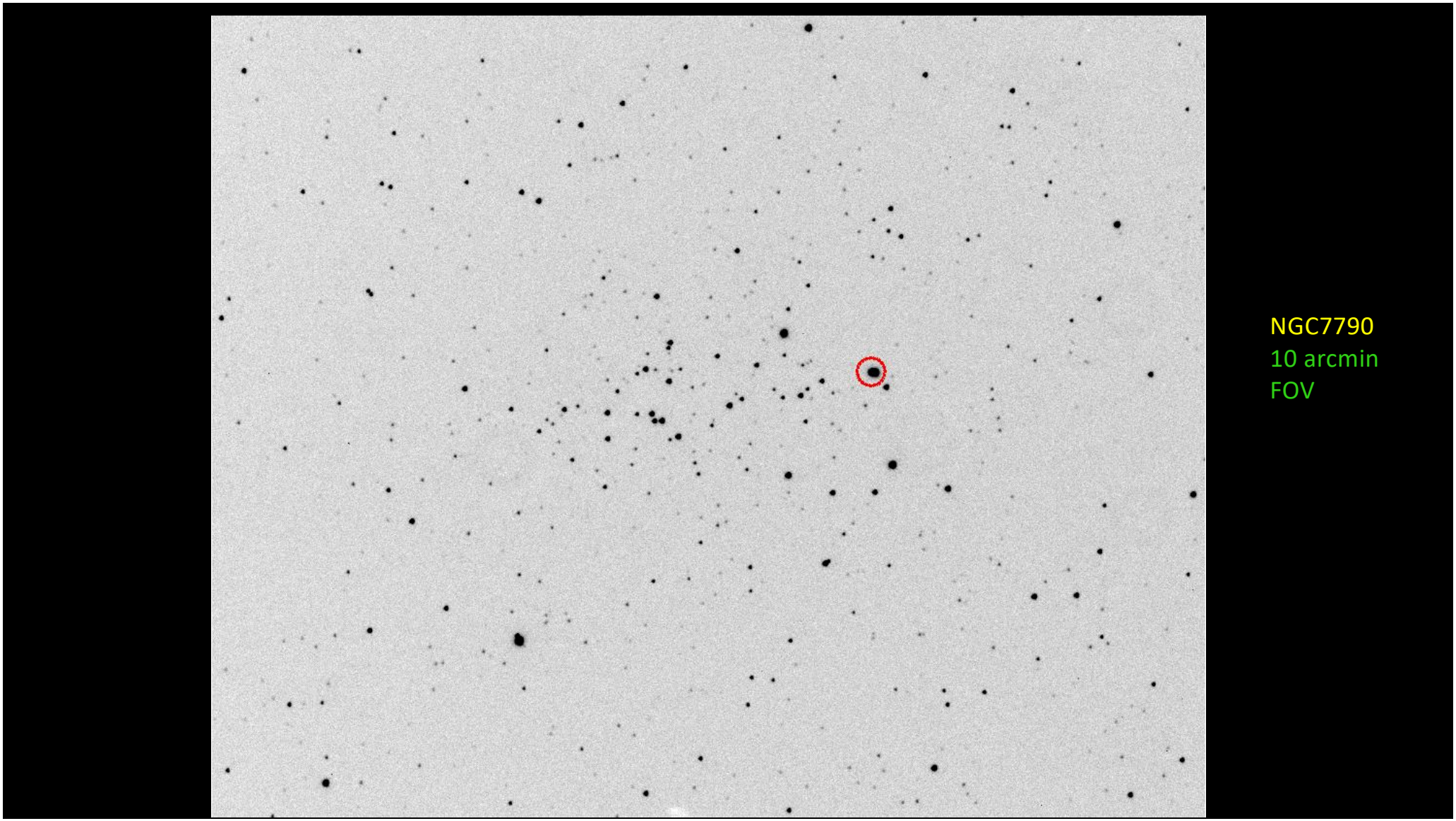


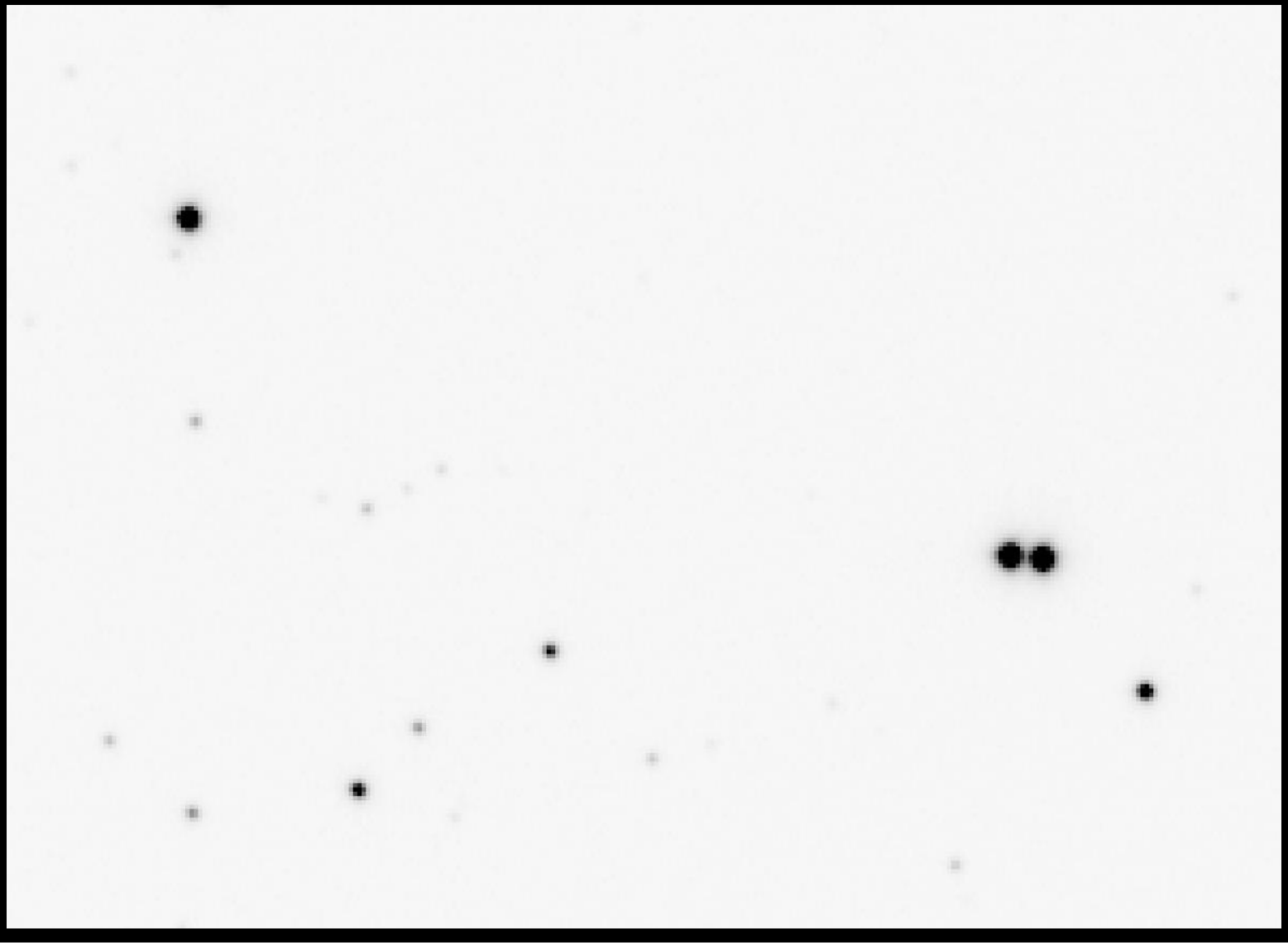
V=18.4 in outburst; V=24 in quiescence. Recurs every year

Credit: Catapano, Guido, Izzo

Crowded fields

- CE CasA (B is west by 2.6arcsec)
- 23:58:09.50 +61:12:49.0
- 10.63 < V < 11.15
- P = 5.1410583d
- NGC7790 (4 cepheids on a 40arcmin chart; measurable every time you use this as a standard field)


NGC7790
10 arcmin
FOV



CE/CF Cas

NOFS 1.55m

2 arcmin FOV

GRB 120119A afterglow

- 08:00:06.94 -09:04:53.7
- Z = 1.73
- Burst at 04:04:30.21UT
- PROMPT sez fade until 2mins, then flat/rise to 14mins, then stronger fade
- Imaged by K35; first exposure at 04:06:29
- 10 60-sec, 5 180-sec R
- DC3 Dreams VOEvent server; client in ACP
- See https://gcn.gsfc.nasa.gov/ for GCN notice info

GODDARD SPACE FLIGHT CENTER

GCN Help/FAQ
GCN What's New
NASA Homepage

SEARCH NASA

GCN HOME | ABOUT GCN | BURST/TRANS INFORMATION | MEMBERSHIP | ARCHIVES | SEARCH GCN FOR BURSTS

GCN: The Gamma-ray Coordinates Network (TAN: Transient Astronomy Network)

03 Nov 2021: The Time-domain Astronomy Coordination Hub (TACH) project is pleased to announce a new community tool to access the archive of GCN Notices and Circulars. The GCN Viewer ingests new notices and circulars in real time, and associates events detected by multiple facilities, providing useful categorization and searchability. This first public release of the GCN Viewer provides this functionality, and new features will be added with forthcoming releases. The new TACH archive of the GCN Notices & Circulars is accesible through the GCN Viewer at https://heasarc.gsfc.nasa.gov/tachgcn

Posted 23 Mar 2020 (last updated 18 Oct 20):
Due to the policies and constraints during the CoronaVirus pandemic,
my response to your requests and questions may not be as fast as normal.
Example: changes to your site_configuration may take up to 7 days (instead of the usual 2-4 days).
Being at home teleworking, requires making the site_config file change a remote operation instead of the normal on-site operation.
Which is doable, but I try to keep that method to a minimum. I will wait longer to do the file change
or I will use a weekly 4-hr pass to do work on-site.

The GCN system distributes:

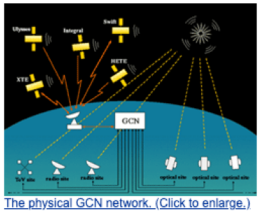
1. **Locations of GRBs and other Transients (the Notices)** detected by spacecraft (most in real-time while the burst is still bursting and others are that delayed due to telemetry down-link delays).
2. **Reports of follow-up observations (the Circulars)** made by ground-based and space-based optical, radio, X-ray, TeV, and other particle observers.

These two functions provide a one-stop shopping network for follow-up sites and GRB and transient researchers.

The GCN system can be explored using the links above and below.

- About GCN/TAN provides a number of 'Introductions' from different points of view. 'Technical Details' (found on the About GCN/TAN page) describes the various services and products of GCN/TAN and how they are generated.
- 'Burst Data Archives' are available under Burst & Transient Information, which record the inputs and outputs of GCN/TAN automatically and are updated in real-time.
- You can also Search for past Bursts/Transients and webtext.

Invitation to subscribe to the Notices or Circulars here. unsubscribe here.
Make a modification to an existing Notices site configuration here.
Invitation to producers to incorporate your events into GCN here.



The physical GCN network. (Click to enlarge.)

Latest Gamma-Ray Bursts

GCN Circulars Archive Circs by Burst
GCN Reports Archive

System Status

System Status: Latest update: 17 Mar 2021 (UT)

What's New

What's New: Latest update: 31 Jul 2020 (UT)

The GCN/TAN contact is: Scott Barthelmy, scott@milkyway.gsfc.nasa.gov, (301)-286-3106 (or scottgcn@gmail.com if the Goddard email is down).

A service of the HEASARC at the Astrophysics Science Division (ASD) at NASA's GSFC.

- Astronomy Questions? Ask a High Energy Astronomer.
- NASA-specific Questions? Try the NASA Homepage or start at the NASA site map.
- Curator: Teresa Sheets
- Responsible NASA Official: Phil Newman

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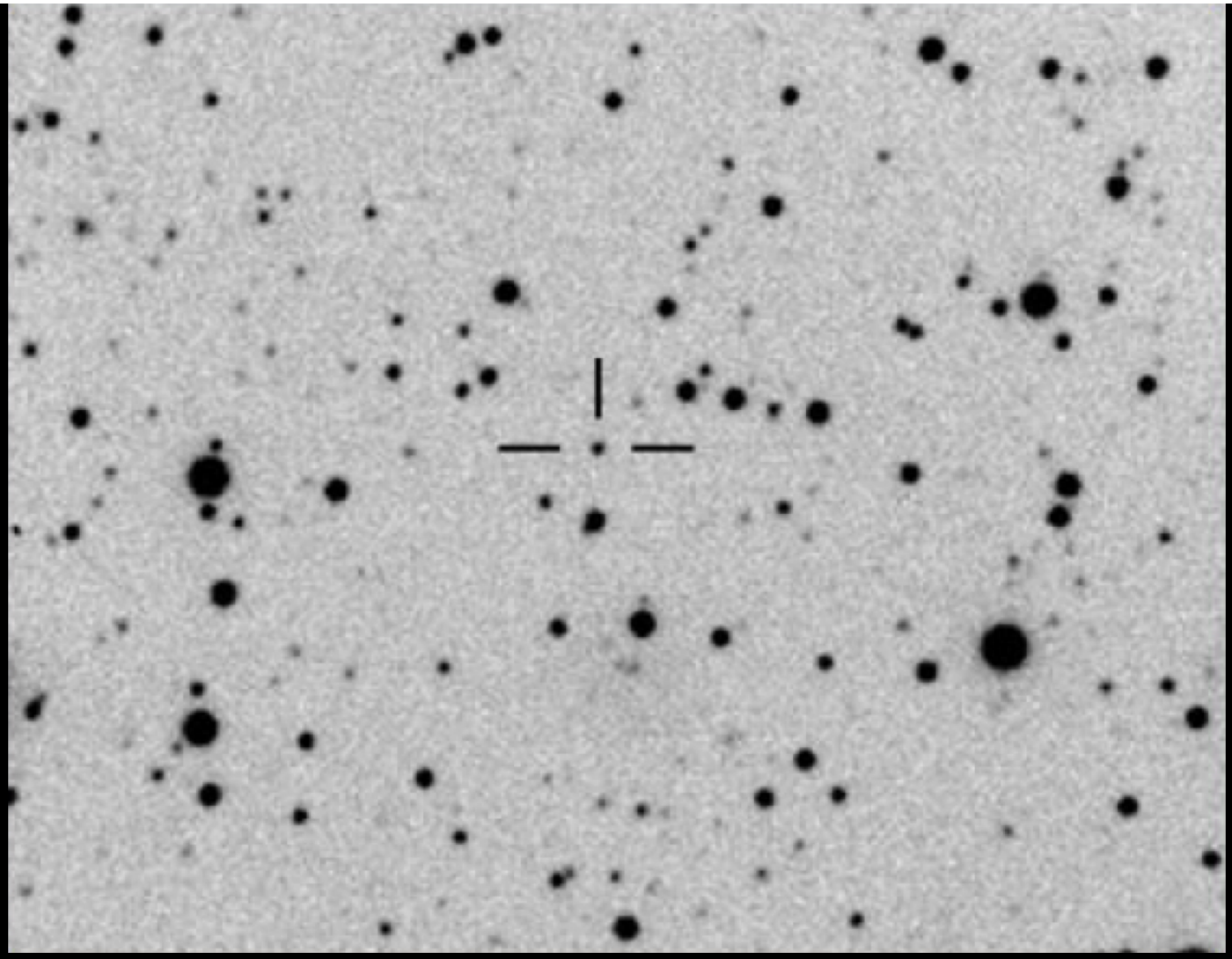
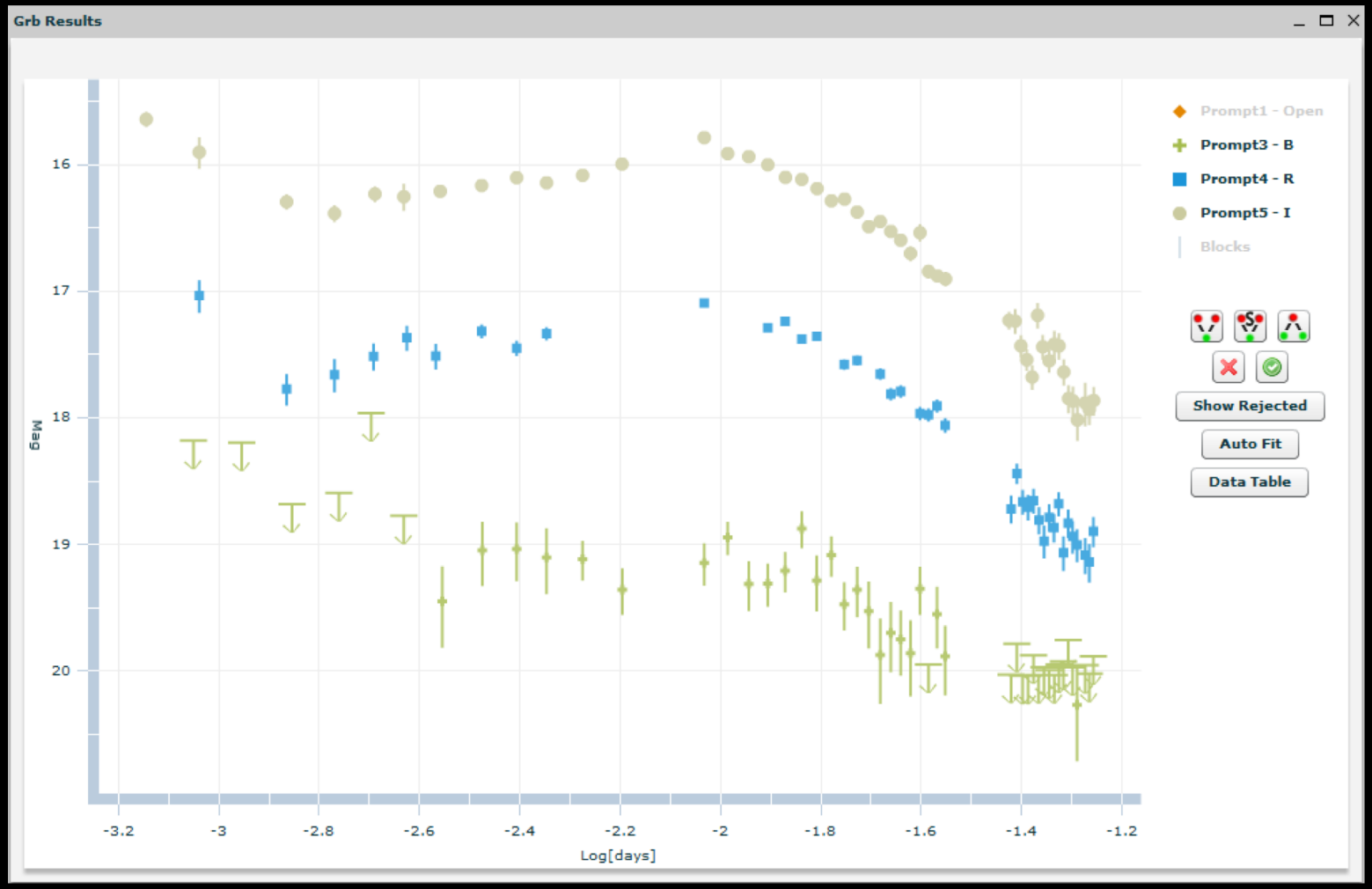
This file was last modified on Wednesday, 03-Nov-2021 15:08:02 EDT

GCN web page
(now handles many other transient systems)



GRB120119A (D. Rich)



GRB120119A (PROMPT)

Exoplanet Transits

- Like eclipsing variables, except with dark object
- Planets are small compared with host star, so transits are small dip (<0.02mag, often MUCH less)
- TESS needs lots of help – TESS Follow-up Observing Program (TFOP)
  - Join via AAVSO web site
  - See Collins et al. 2018 AJ 156, 234 (https://arxiv.org/pdf/1803.01869.pdf)

Home

Exoplanet Section

Welcome to the AAVSO Exoplanet Section

Section Chair: Dennis M. Conti, Ph.D. Contact

Interested in joining this section? Click here for instructions.

Learn about *NASA's Exoplanet Watch*!

ANNOUNCEMENT: With the launch of TESS (Transiting Exoplanet Survey Satellite), follow-up ground-based observations will be an important part of the TESS process to confirm candidate exoplanets. In particular, such observations will help distinguish false positives from true exoplanet transits.

The AAVSO is pleased to announce that it has established a program that will facilitate the participation of its members in this process. More information on this program can be found by clicking here.

Introduction

Thank you for visiting the web page of AAVSO's Exoplanet Section!

Astronomers now believe that most stars have one or more planets orbiting around them. These planets are called "exoplanets" (extrasolar planets). As an exoplanet orbits its host star, the light from that star will vary by some amount. The small change in light of this host star can be observed from Earth if the planet's orbit is in line-of-sight with an Earth-based observer and if the planet is large enough and close enough to its host star that a dip in the star's light can be detected. Changes in the star's light can also be indicative of a star flare, or the passage of an exoplanet in front of a star spot (much like our own Sun's sunspot).

AAVSO's Exoplanet Section is established to provide amateur astronomers with best practice techniques for conducting exoplanet observations, as well as to act as a central coordination point for professional/amateur exoplanet collaboration efforts. For example, upcoming space missions, such as TESS (Transiting Exoplanet Survey Satellite), will be requiring extensive involvement by the amateur astronomer community in conducting followup exoplanet observations.

For AAVSO Exoplanet Observers who would like to help refine the ephemerides of already confirmed exoplanets (such as their period, transit midpoint, and transit depth), a target list of some 68 confirmed exoplanets has been culled from NASA's Exoplanet Archive that are believed to be observable by those with a modest complement of instrumentation (i.e., a minimum 8" aperture telescope, a monochrome CCD camera, at least one standard photometric filter, and reasonably good autoguiding and seeing conditions). This target list was derived using the following criteria for each exoplanet:

1. It is a confirmed, transiting exoplanet.
2. It is the first planet discovered in a multi-planetary system (i.e., with the suffix "b");
3. Its orbital period is less than three (3) days.
4. Its V magnitude is brighter than magnitude 14.
5. Its transit depth is greater than 0.5% (i.e., 5 parts-per-thousand, or 5 mmag).

A plain text file of this target list can be downloaded from AAVSO Exoplanet Target List. A user-friendly transit finder developed by Eric Jensen of Swarthmore College can be used to determine which targets on this target list produce a transit at a user-specified location on a given night or range of nights (see here).

Some resources that are available to assist amateur astronomers in conducting exoplanet observations include:

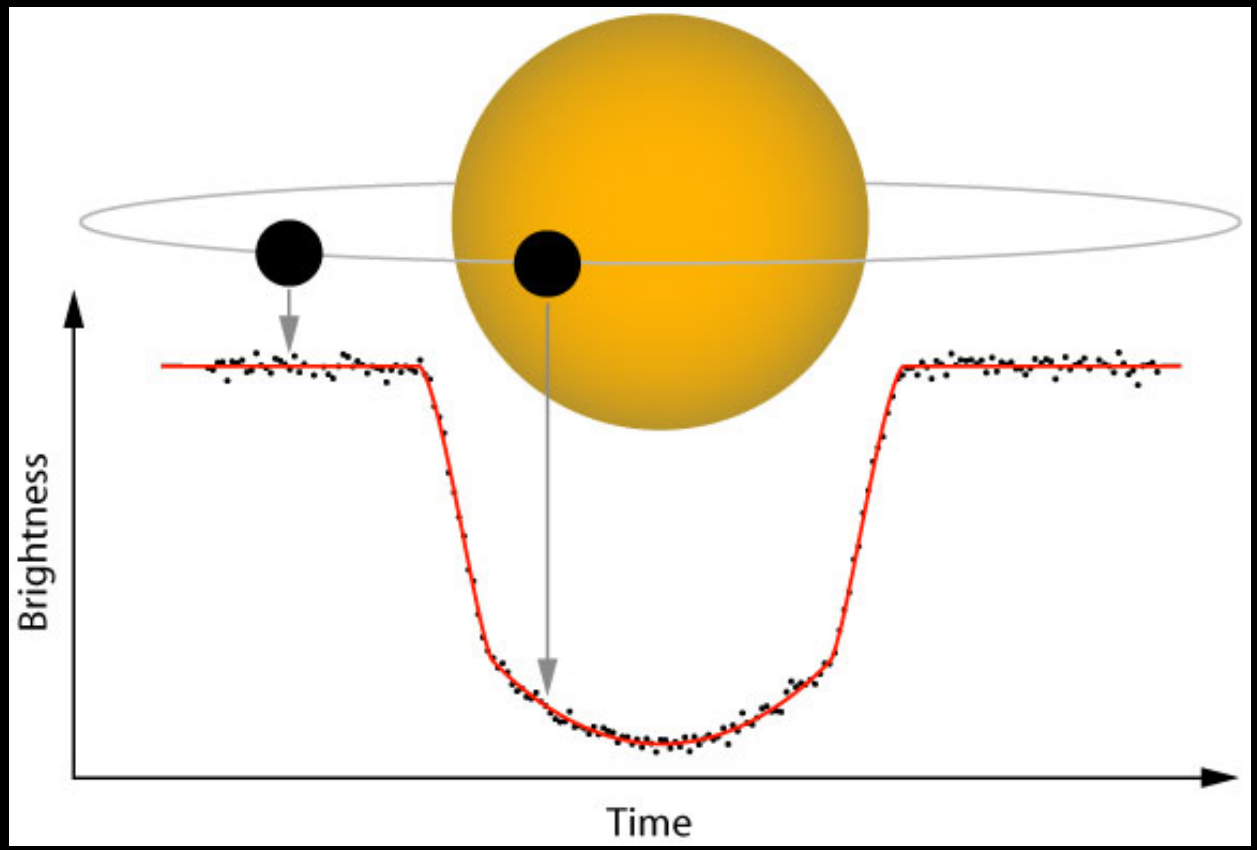
1. "A Practical Guide to Exoplanet Observing," which includes best practices for exoplanet observing, as well as a tutorial on using AstroImageJ. The latest version of the Guide, as well as sample exoplanet observation images and other tutorial material, can be found here.

Exoplanet Resources

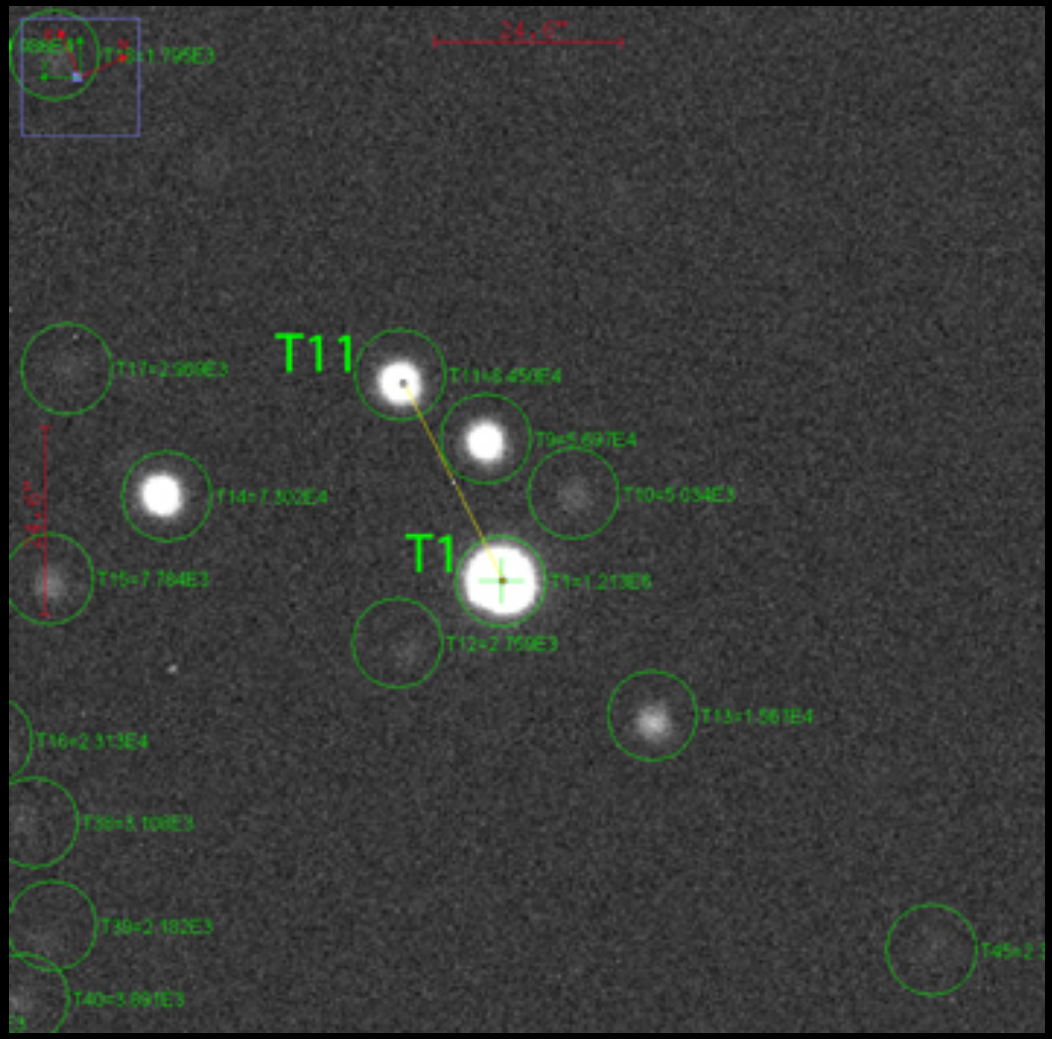
- Data Upload Tool
- Exoplanet Forum
- Target List
- Exoplanet Observing Manual
- NASA's Exoplanet Watch
- CHOICE course info
- AstroImageJ
- Videos

Screenshot

Exoplanet section webpage



Typical exoplanet transit



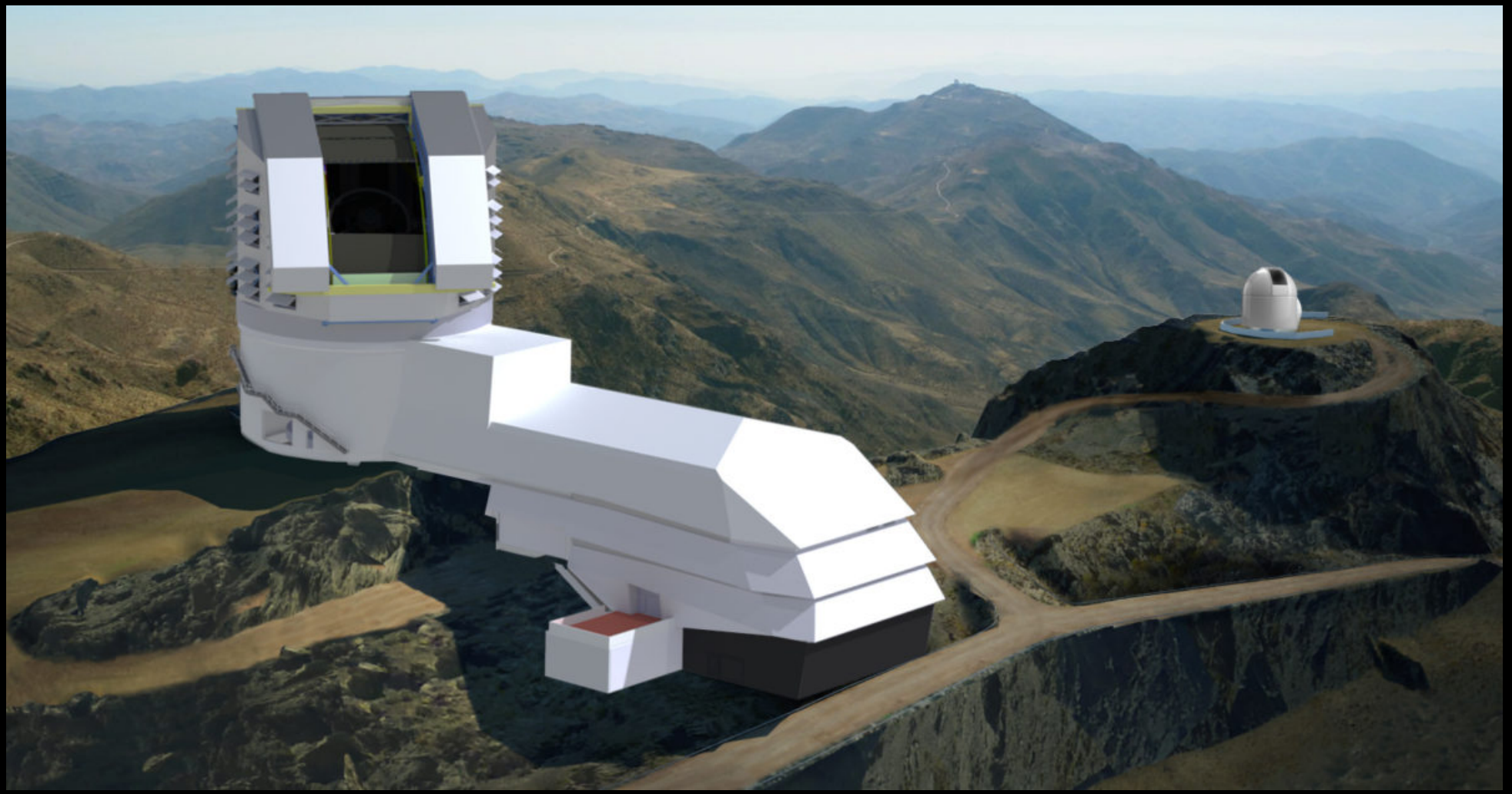
T11 is EB

TESS Pixel

Credit: Collins 2018

Large Synoptic Survey Telescope (LSST, Rubin)

- 8.4m aperture; survey starts 2022-2023
- 3.2Gpix camera; 3.5deg FOV, 0.2arcsec pixels, 15sec exposures
- 18<R<24 per exposure; cover southern sky to +30 every few nights
- 10 million alerts/night
- 10 years = 500 petabytes of data
- Followup absolutely essential (ex. saturation at 18mag)



Summary

- Professional surveys both limit and extend small-telescope science
- FSMs are scientific quality systems
- Plenty of scientific opportunities for using FSM
- Lots of AAVSO resources
- Simple proposal procedure
- Come join the fun!