# An update on the CHARA - AAVSO Collaboration

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# Outline

- About the AAVSO
- Observing capabilities
- How to request data
- Data usage guidelines
- Year one results
- Other things of interest

# The American Association of Variable Star Observers (AAVSO)


The mission of the AAVSO is “to enable anyone, anywhere, to participate in scientific discovery through variable star astronomy”

We achieve this mission through pro-am collaboration, strategic partnerships, educational activities, and data stewardship.

# AAVSO by the numbers

Key Numbers

- Started in 1911
- **1,200 members**
- **800 observers**
- **200 volunteers**
- 6 staff + 3 contractors
- $1M/year budget

Education and Public Outreach

- **Webinars reached 9,500 people**
- **8 CHOICE courses** with an average of 125 participants annually
- **7 Observing Manuals in 13 languages**
- **Mentoring Program**

Contributions to Science

- Data used in **380 publications/year (263 peer-reviewed!)**
- Photometry database (**59M observations**)
- Curated variable star metadata (**2.3M**)
- Spectra (**12k observations**)
- Exoplanet Transits (**4.5k**)
- Sunspot Counts (**250k**)
- Peer-reviewed Journal - JAAVSO

Other Activities

- Annual variable star meeting
- Proceedings
- Workshops

# Characteristics of AAVSO participants

Come from different backgrounds

- High school to retired career professionals
- All interested in astronomy
- All want to contribute to science

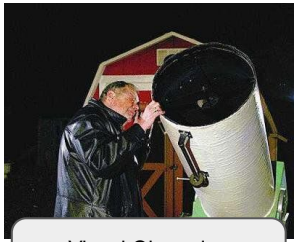
Have a range of capabilities:

- Need education, training, and guidance (10%)
- Work with professional astronomers (80%)
- Conduct independent research (2-10%)

Utilize vastly different instruments

- Detectors: Eyes to CCD/CMOS cameras
- Optics: None to meter class telescopes.
- Tools: Robotic telescopes, photometers, spectrographs, speckle cameras, software.


2023 Annual Meeting - Credit Bob Stephens



Visual Observing
Roger Kalh

0.8 m telescope
Mario Motta

Home built solar scope
Santanu Basu

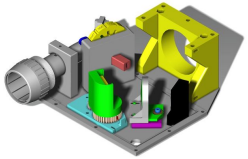
# Amateur astronomers are *extremely* capable

SAS 2023 Proceedings

- DIY FlexSpec1 Spectrograph
- Speckle interferometry (Mt. Wilson)
- Exoplanet light curve modeling
- DART impact monitoring
- Ammonia characterization on Jupiter

BAV Magazine Spectroscopy

- Spectropolarimetry with a home-built, 3D-printed instrument



CAD Layout for optical components of the FlexSpec 1.

JAAVSO 51.2 (peer reviewed)

- Exoplanet transit modeling
- RS Cra - reclassification, not an EA binary
- Times of minimum for hundreds of EBs

JAAVSO 51.1 (peer reviewed)

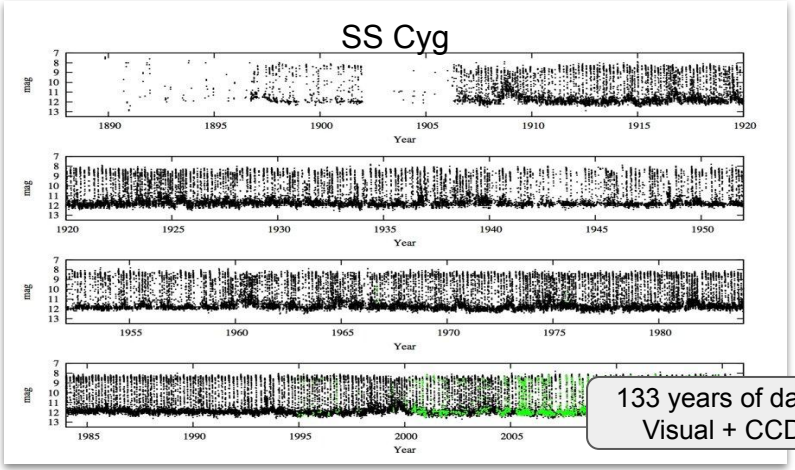
- Exoplanet transit modeling
- Photometry + spectroscopy of flare stars.

Research from today's amaetur astronomers is comparable to that of professionals from 1990-2010.
Low cost hardware and open-source software facilitates their research.

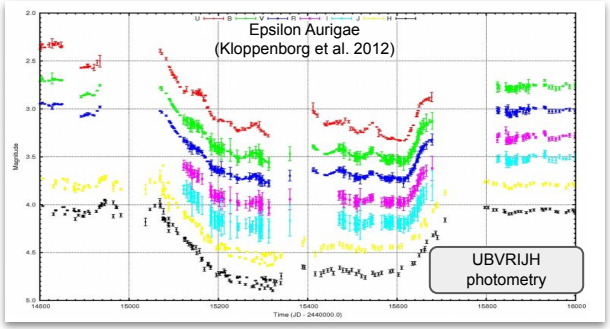
# Photometric Capabilities

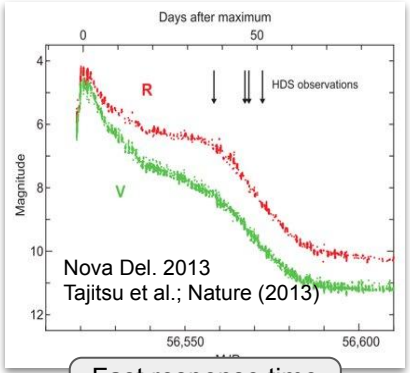
| Instrument | Filters | Range [magnitudes] | Precision [magnitude] | Commonality of resource | Principal Geographic Coverage | Notes |
|---|---|---|---|---|---|---|
| Visual | Eye | 0 - 16+ | 0.100 - 0.200 | Abundant | Worldwide | |
| CCD/CMOS | Johnson Cousins UBVRI | 2 - 19+ | 0.010 - 0.050 | Abundant | Worldwide | U filter very uncommon |
| CCD/CMOS | Sloan ugriz | 2 - 19+ | 0.010 - 0.050 | Rare | Worldwide | Mostly on AAVSOnet |
| PEP | Johnson Cousins UBVRI | U: -1 - 7<br>BVRI: -1 - 8 | 0.005 - 0.010 | Rare | North America, Europe | |
| PEP | Optec JH | -4 - 4 | 0.010 - 0.020 | Very Rare | North America, Australia | Fewer than 15 exist |

# Photometry database examples

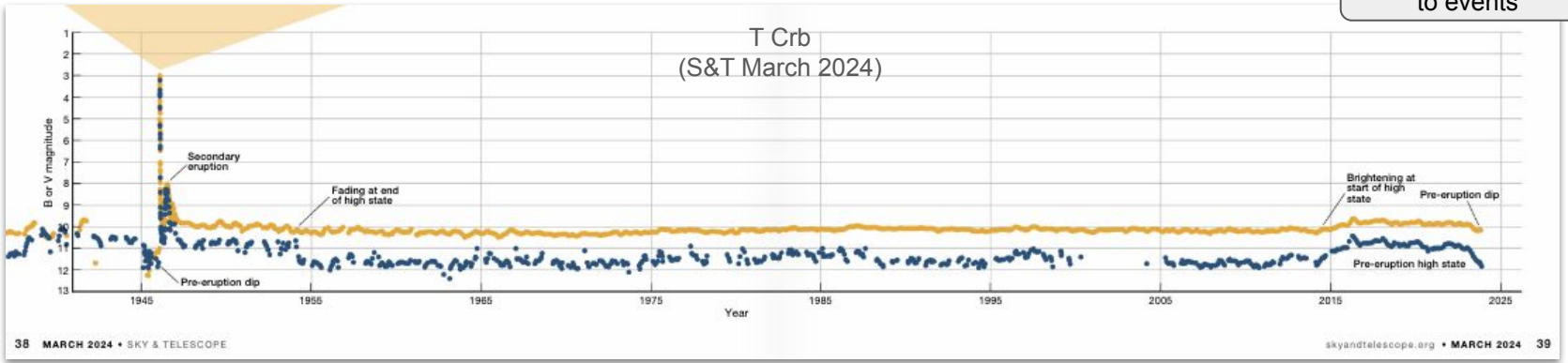



133 years of data!
Visual + CCD




Fast response time
to events



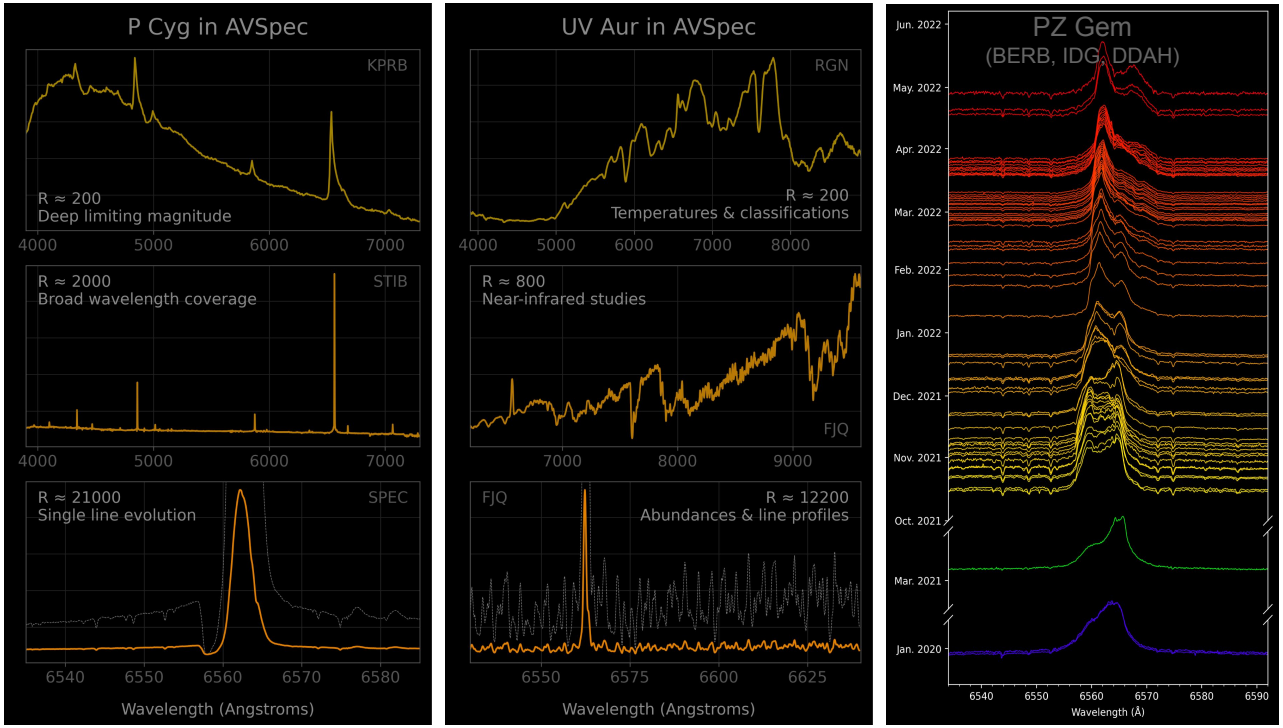
# Spectroscopic Capabilities

| Instrument | Type | Mag Limit | Resolution | Wavelengths [Angstroms] | Spectral Range [Angstroms] | Commonality of Resource | Principle Geographic Coverage | Notes |
|---|---|---|---|---|---|---|---|---|
| SA100/200 | Widefield Slitless | V = 10-14 | 100-200 | 3600-10,000 | Full | Common | Worldwide | Includes zero order. Stars can overlap. |
| Alpy 600 | Slit | V = 10-14 | 600-1000 | 3700-7500 | Full | Common | North America, Europe | |
| LISA, LOWSPEC | Slit | V = 10-14 | 1000-4000 | 4000-7000 | 2000-3000 | Common | North America, Europe | |
| eShel | Echelle | V = 6-8 | 10,000 | 4500-7000 | Full | Very Rare | North America, Europe | |
| LHIRES III | Slit | V = 6-8 | 10,000 - 20,000 | 4000-7000 | 251-155 | Common | North America, Europe | |
| Shelyak Whoppshel | Echelle | V= 9 | 30,000 | 3920-7500 | Full | Very Rare | North America, Europe | Fewer than 10 exist |

# Spectroscopic Database - AVSpec

Quality Control

- Every spectrum inspected by AAVSO
- Feedback provided to improve results




GORDON AND BETTY MOORE FOUNDATION

# How to request AAVSO observing time

From the CHARA (internal) proposal form

- Check the box!

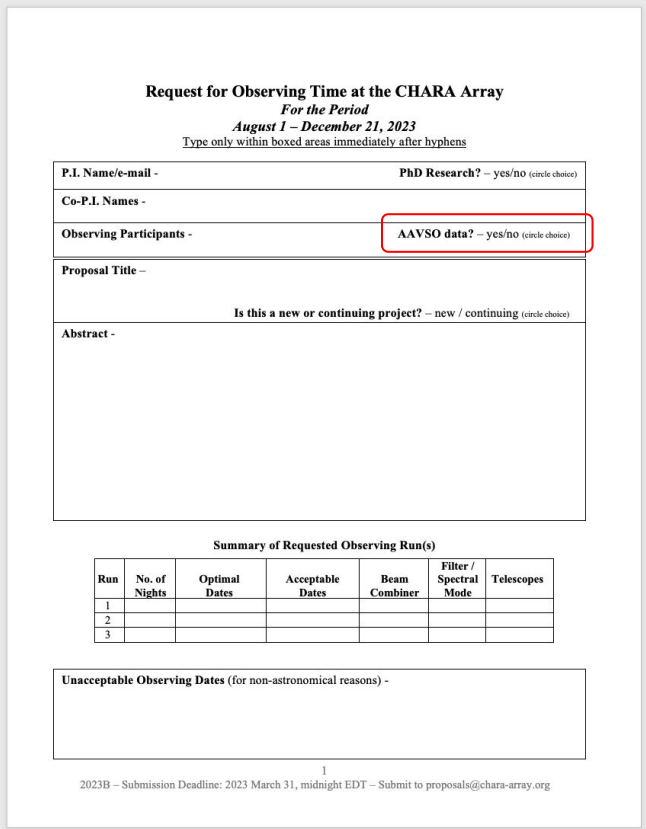
If you get CHARA time

- AAVSO will send you an email with instructions.
- Fill out the form and send it back.

Otherwise

- Visit https://www.aavso.org/observing-campaigns
- Email the proposal form to the address below

Starting in April we'll have a web application for this process.



**Request for Observing Time at the CHARA Array**

***For the Period***

***August 1 – December 21, 2023***

Type only within boxed areas immediately after hyphens

**P.I. Name/e-mail -** **PhD Research?** – yes/no (circle choice)

**Co-P.I. Names -**

**Observing Participants -** **AAVSO data?** – yes/no (circle choice)

**Proposal Title –**

**Is this a new or continuing project?** – new / continuing (circle choice)

**Abstract -**

**Summary of Requested Observing Run(s)**

| Run | No. of Nights | Optimal Dates | Acceptable Dates | Beam Combiner | Filter / Spectral Mode | Telescopes |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | | | | | | |
| 3 | | | | | | |

**Unacceptable Observing Dates** (for non-astronomical reasons) -

1

2023B – Submission Deadline: 2023 March 31, midnight EDT – Submit to proposals@chara-array.org

Observing Campaign Manager
Elizabeth Waagen
eowaagen@aavso.org

# AAVSO Data Usage Guidelines

1. Include the following in your acknowledgements:

   "We acknowledge the use of data from the AAVSO International Database in this research. We express our gratitude to the worldwide network of observers who made these data possible."

2. In AAS journals, use “AAVSO” as a facility keyword.
3. Please consider adding observers as co-authors on your paper.
   a. Drop Elizabeth Waagen an email to get observer contact information: eowaagen@aavso.org

Data Usage Guidelines:
https://www.aavso.org/data-usage-guidelines

# Collaboration year one results

CHARA 2023B proposals

- 5 approved CHARA proposals w/ box checked
- 1 CHARA PI responded to our emails
- 2 additional CHARA-related proposals

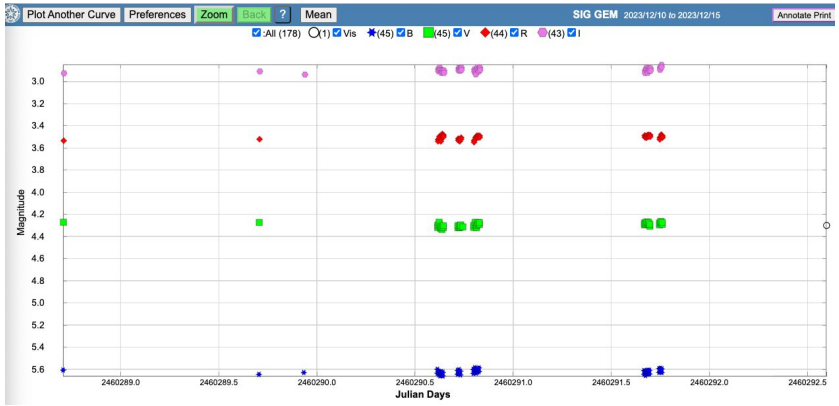
CHARA 2024A proposals

- 4 approved CHARA proposals w/ box checked
- 3 CHARA PIs responded!
- 1 program already running!

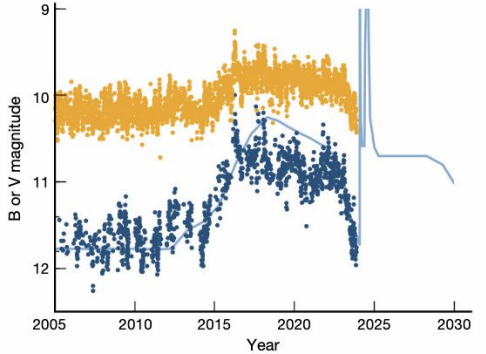
Data Acquired

- Sig Gem
  - BVRI photometry during 8-day TESS run
  - 166 points obtained, 1 observer
- ARMADA
  - BVR photometry on 75 non-variable stars
  - 53 / 75 observed
- T CrB
  - 1 photometry point every 12 minutes on average

Sig Gem - AAVSO

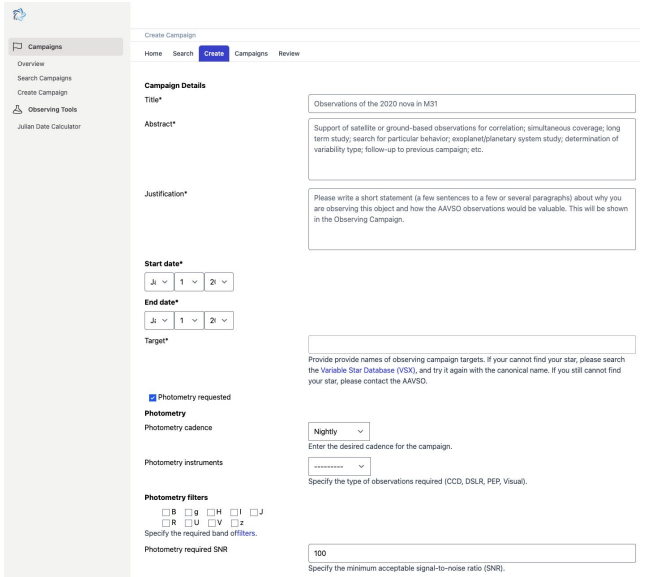



T CrB - S&T March 2024

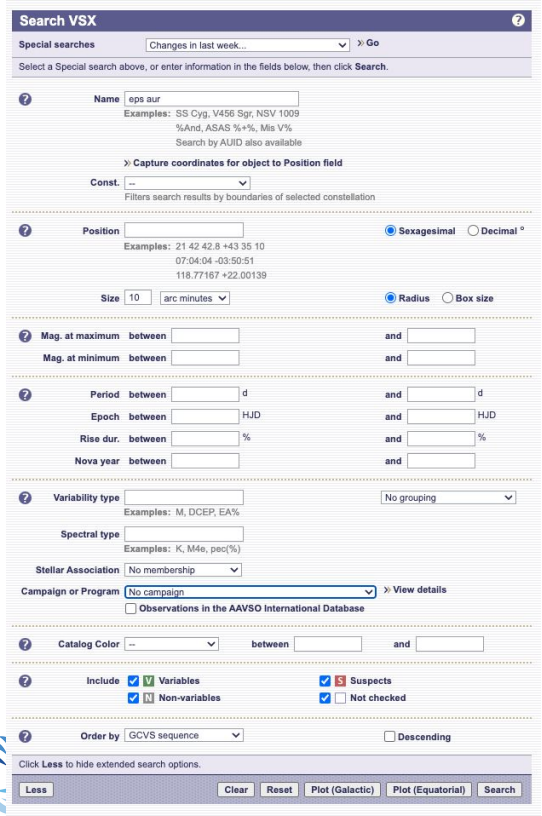


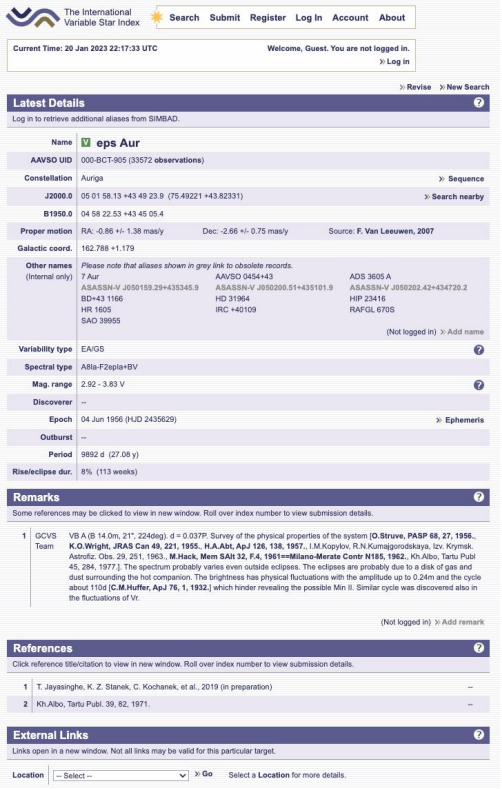
# Lessons Learned

- AAVSO wasn't set up for survey programs
  - Testing a new engagement method using AAVSOnet
- Poor response from PIs
  - Can CHARA share object lists? No.
  - Simplified AAVSO proposal process
  - Created a new app for campaigns (see right). Ready for 2024B.
- Poor uptake by observers
  - Testing new campaign promotional methods (blog posts, social media announcements, direct email)
  - Creating new project-focused observing programs
  - Adding objects to AAVSOnet as a backup
- Communication and oversight
  - New application reminds staff to check in on campaigns regularly
  - Instituted monthly status reviews



# Stellar metadata: Variable Star Index (VSX)



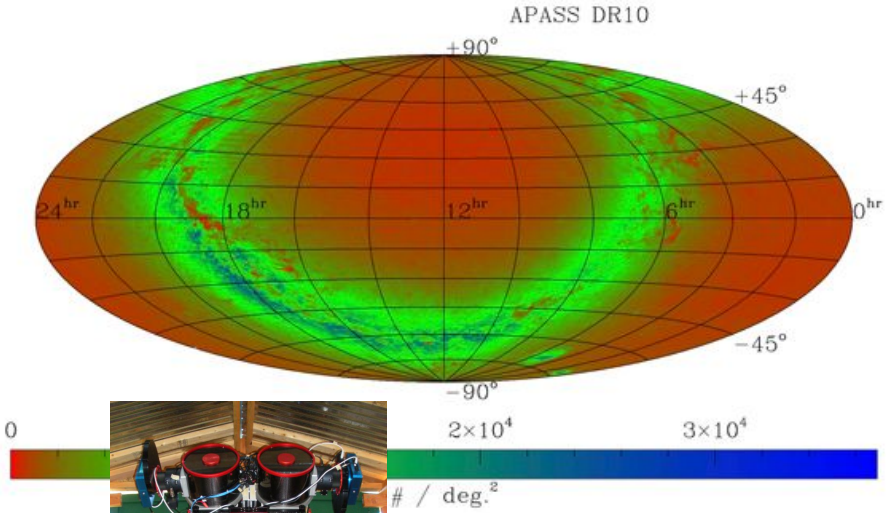



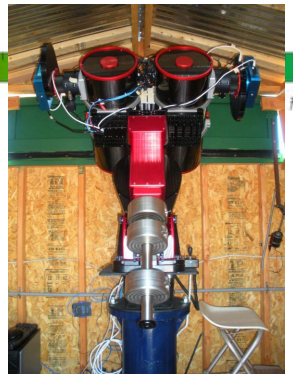

Think of VSX as ADS for variable stars.

- 2.3 M entries (all known variables of > 1 milli-mag or more)
- Query by name, coordinates, min/max magnitude, period, variability type, spectral type, stellar associations, campaigns
- External Links point to 30 separate databases, including survey programs.

Visit aavso.org/vsx/

# AAVSO Photometric All-Sky Survey (APASS)



About the survey:

- Bridges the gap between Tyco2 and SDSS
- Valid from 7 - 17th magnitudes
- Eight filters:
  - Johnson B, V
  - Sloan u', g', r', i', z', and Z
- Photometry on 128 million objects.
- 510,000 images taken as of DR10

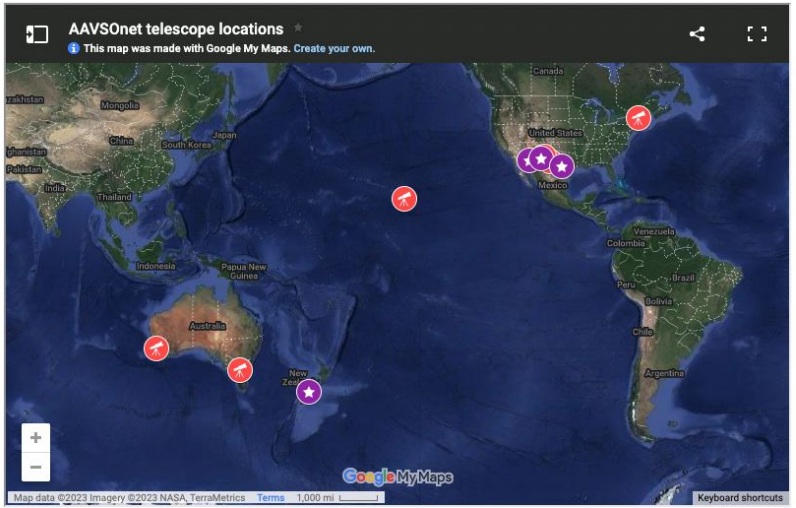
Where can you get it?

- DR10 on AAVSO.org
- DR9 on VizieR  and Virtual Observatory

Funded by Robert Martin Ayers Sciences Fund, NSF AST 1412587, and the AAVSO endowment

# Use our telescopes

- 8 robotic telescopes worldwide
  - 5 – Bright star monitors (7” apertures)
  - 3 - Faint star monitors (24” apertures)
  - Johnson-Cousins, Sloan, H-alpha filters
  - Spectrograph coming soon
- Time requested by proposal
- All proposals reviewed by TAC
- Data can be downloaded or sent to VPhot for processing.
- **Member-only benefit**




We are always open to adding additional telescopes to the network and have partnered with universities to do so. Contact us if you are interested!

# AAVSO’s 113th Annual Meeting

US Space and Rocket Center
Huntsville, AL
Nov. 8 - 10, 2024