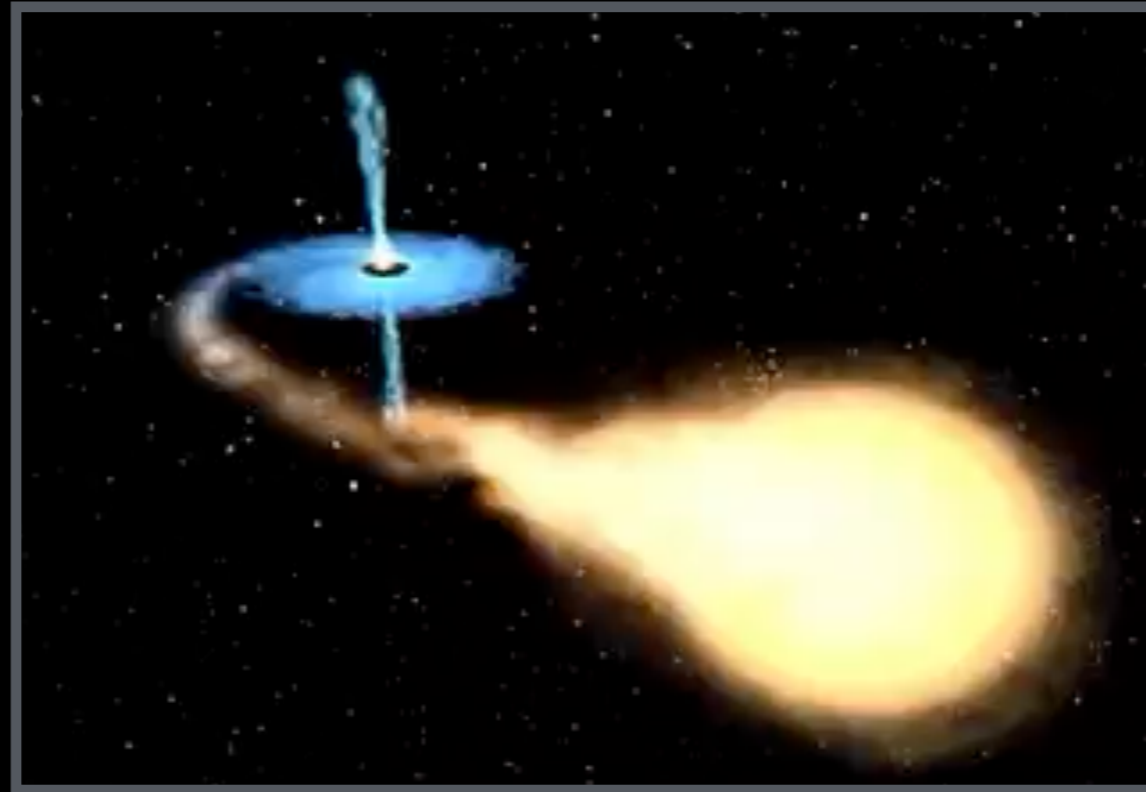


Radio Variability from Quiescent Black Hole X-ray binary Jets

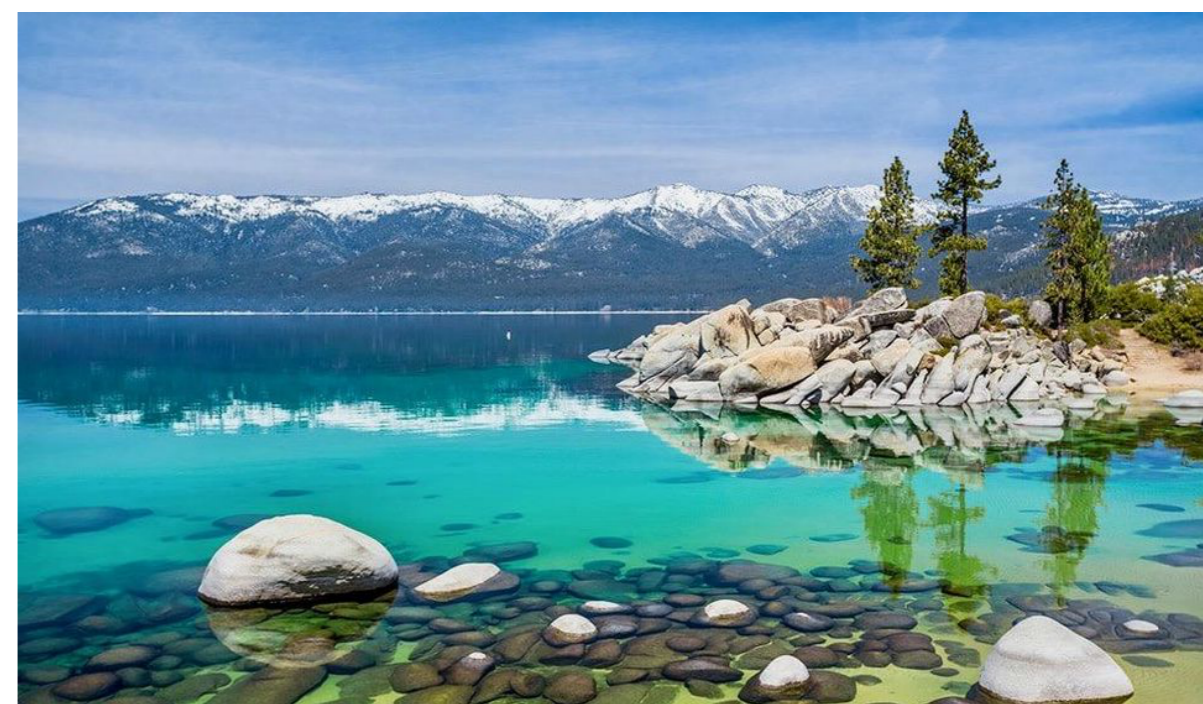


Rich Plotkin
University of Nevada, Reno



Graduate school at the University of Nevada Reno

- Research programs in:
 - Atomic, Molecular & Optical Physics
Derevianko, Tscherbul, Weinstein, Williams,
Lee, Covington, Neill
 - Plasma / High Energy Density Physics
Mancini, Safronova, Kantsyrev, Ivanov, Bauer,
Sawada, White
 - Atmospheric Physics
Arnott, Lareau, new search to open soon
 - New hires in condensed matter & astronomy
Barlas, Plotkin
- In the “Biggest little city in the world”
 - 45 minutes from Lake Tahoe
 - Skiing
 - Hiking
 - Mountain biking

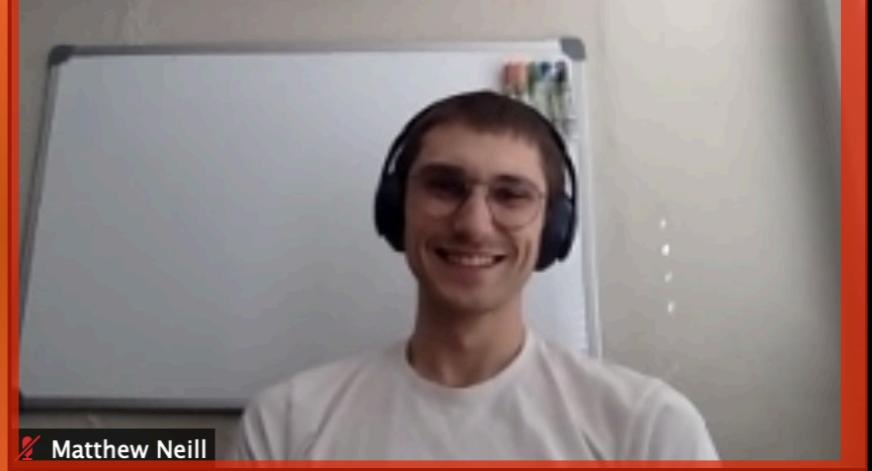


**Aarran Shaw
(postdoc)**



Aarran Shaw

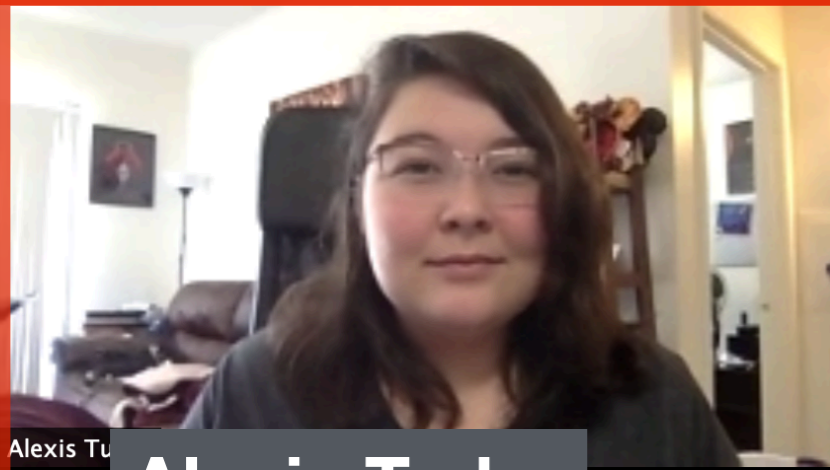
**Matthew Neill
(sophomore)**



Matthew Neill

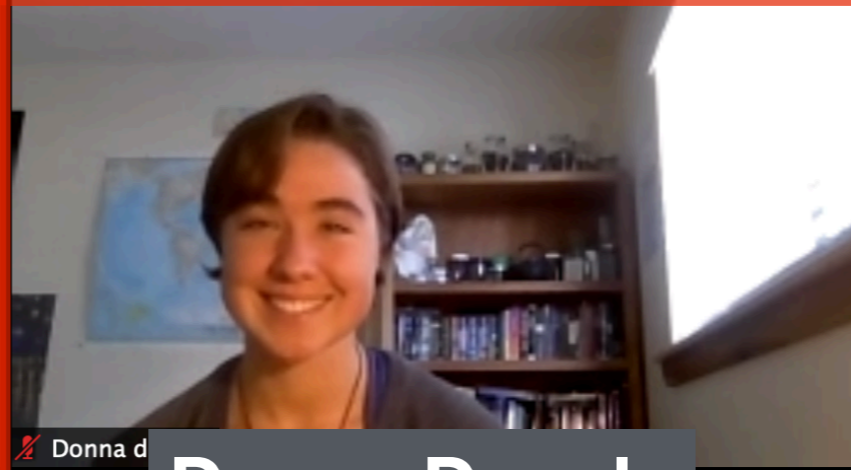


Richard Plotkin



Alexis Tu

**Alexis Tudor
(CS grad)**

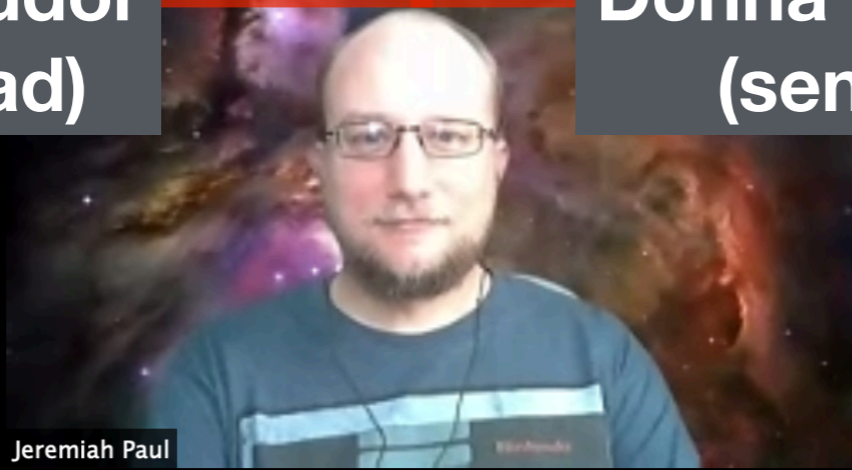


Donna d

**Donna Depolo
(senior)**



Ava Covington



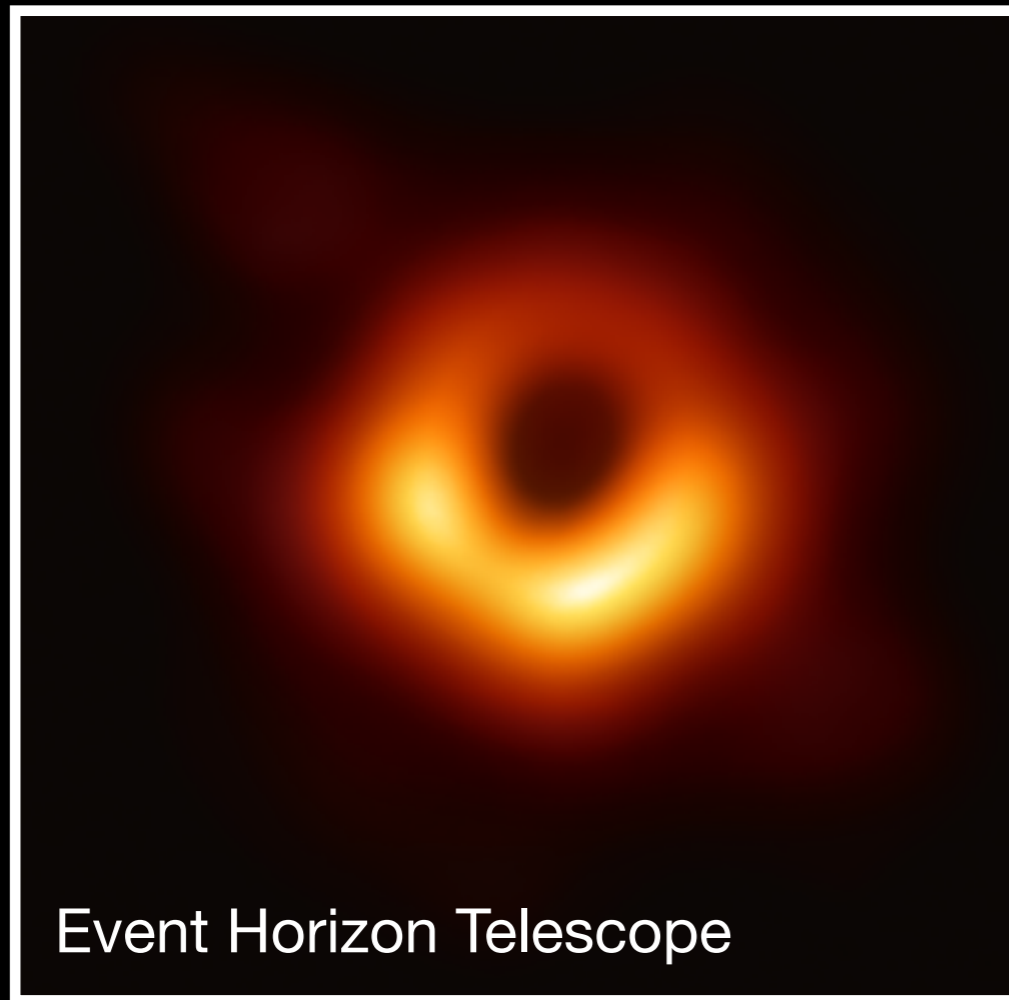
Jeremiah Paul



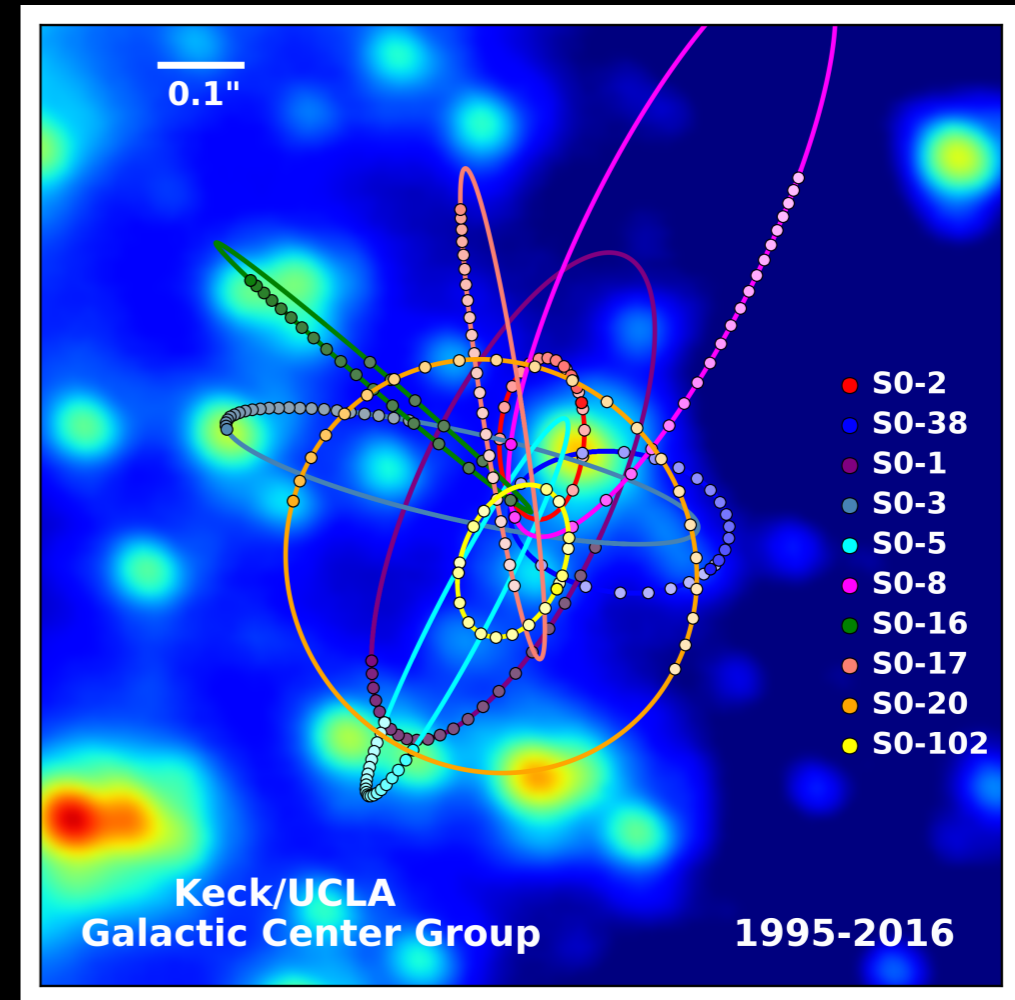
Milo Owens

Why Care About Quiescence?

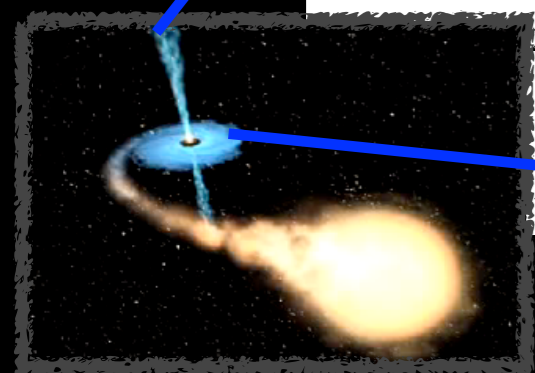
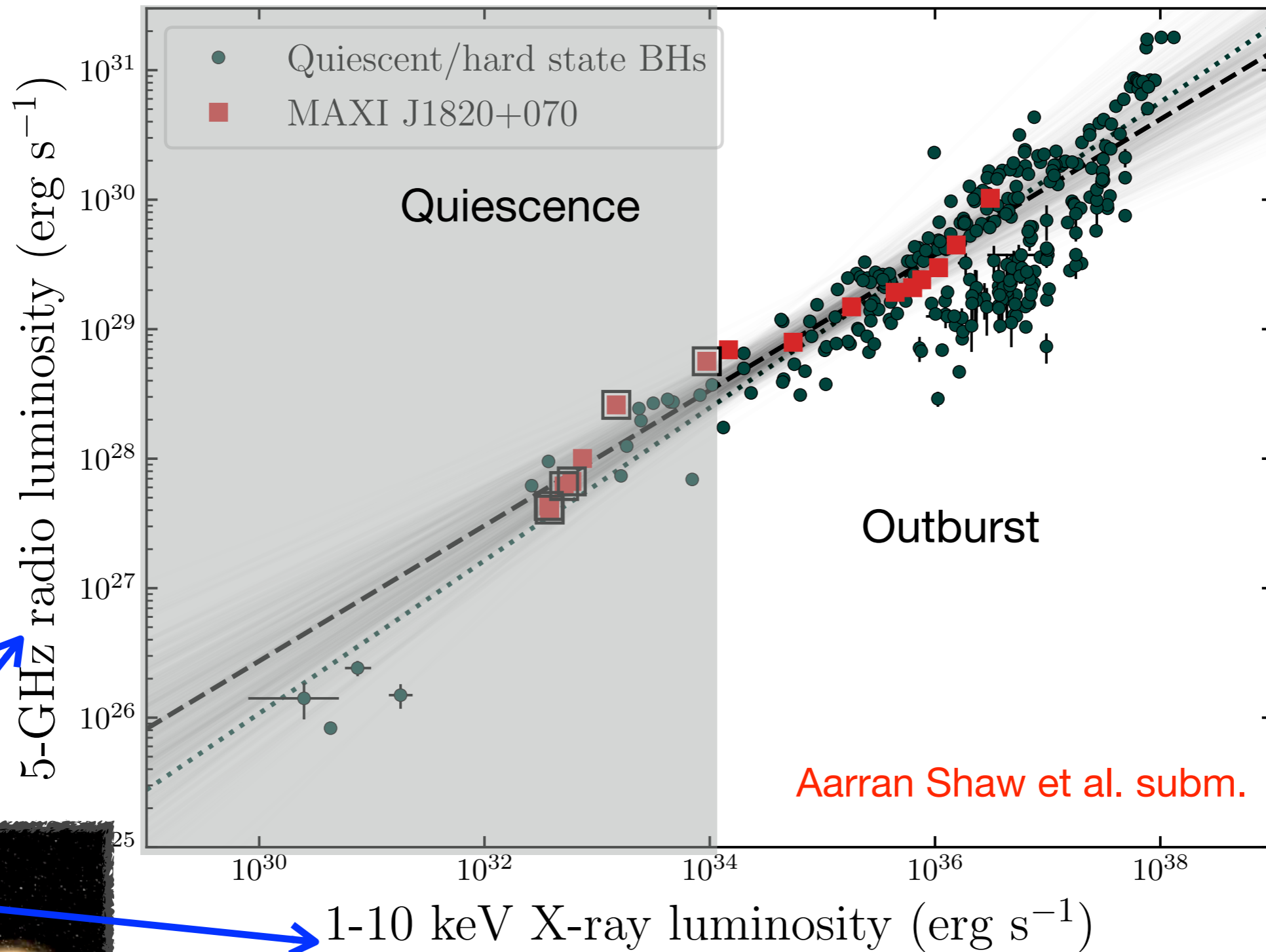
M 87



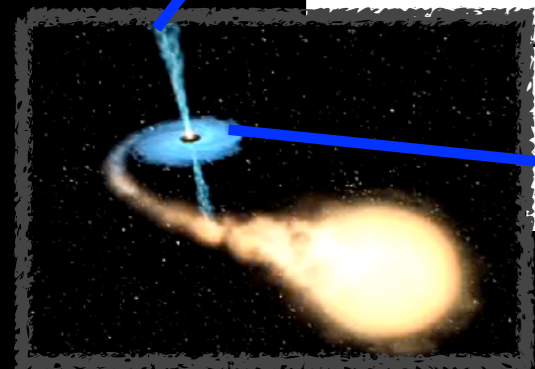
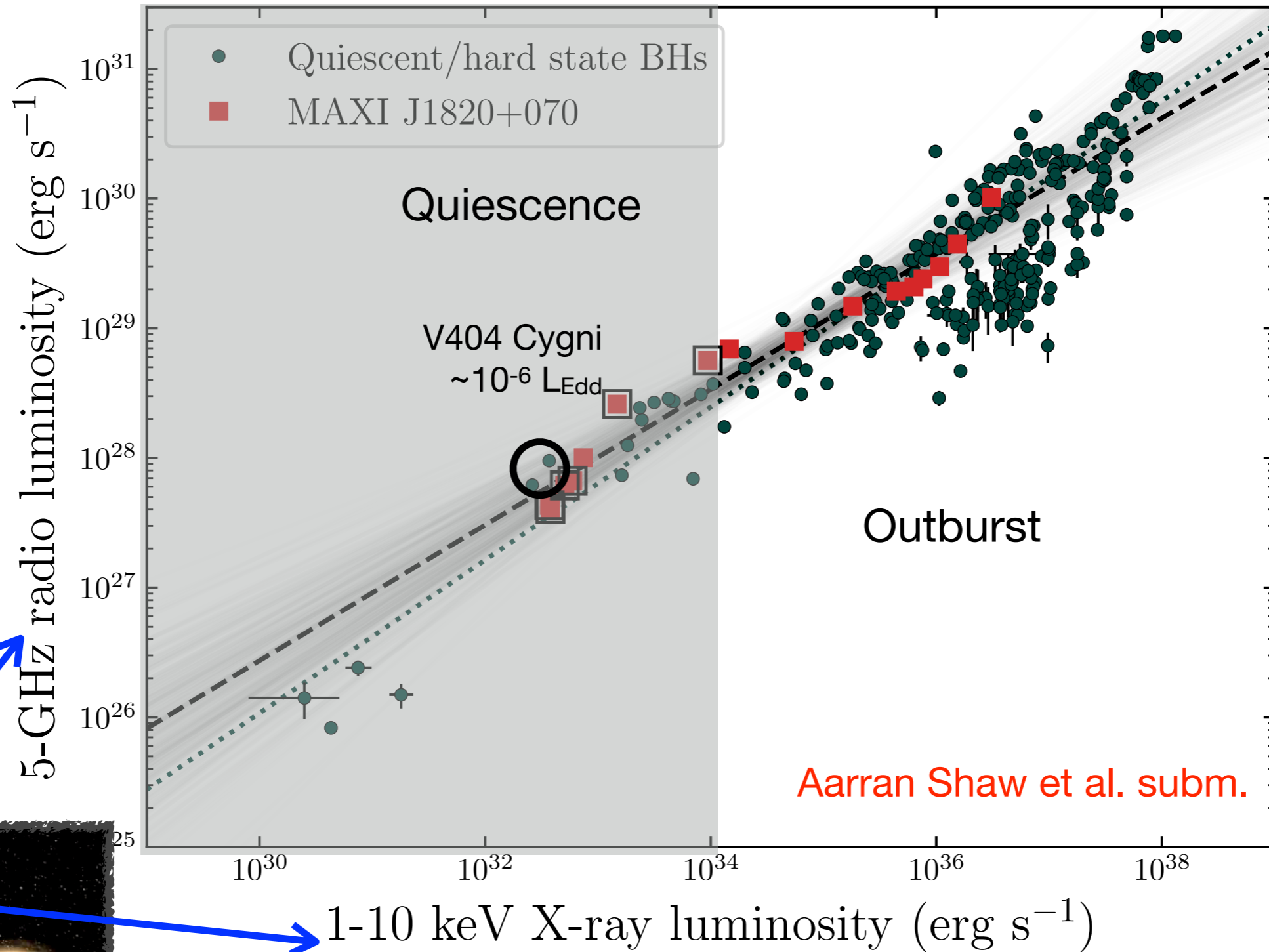
Sgr A*



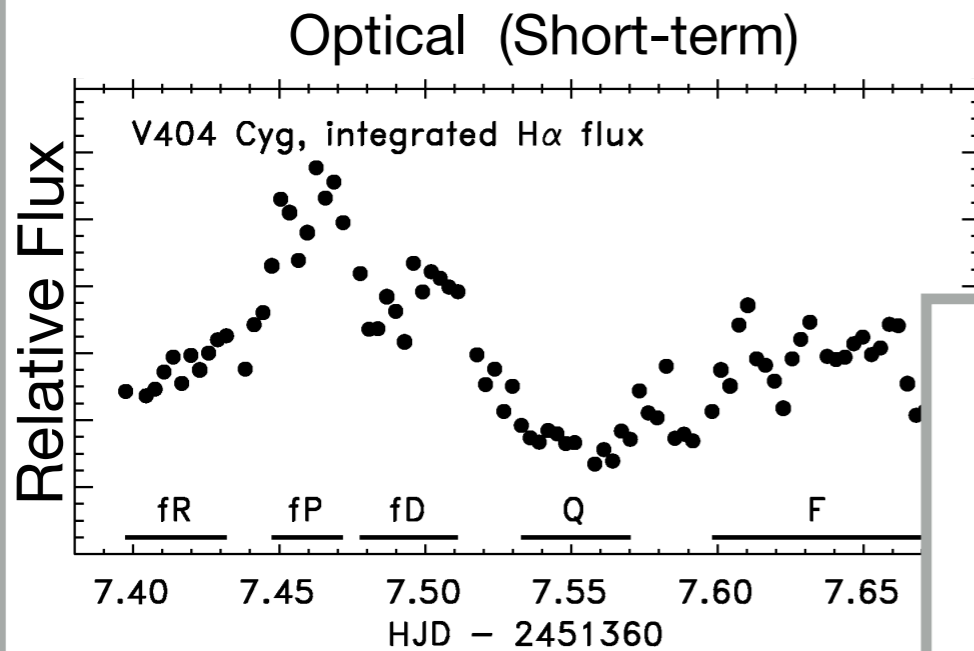
Strategy 1: Track the Decays of XRB Outbursts



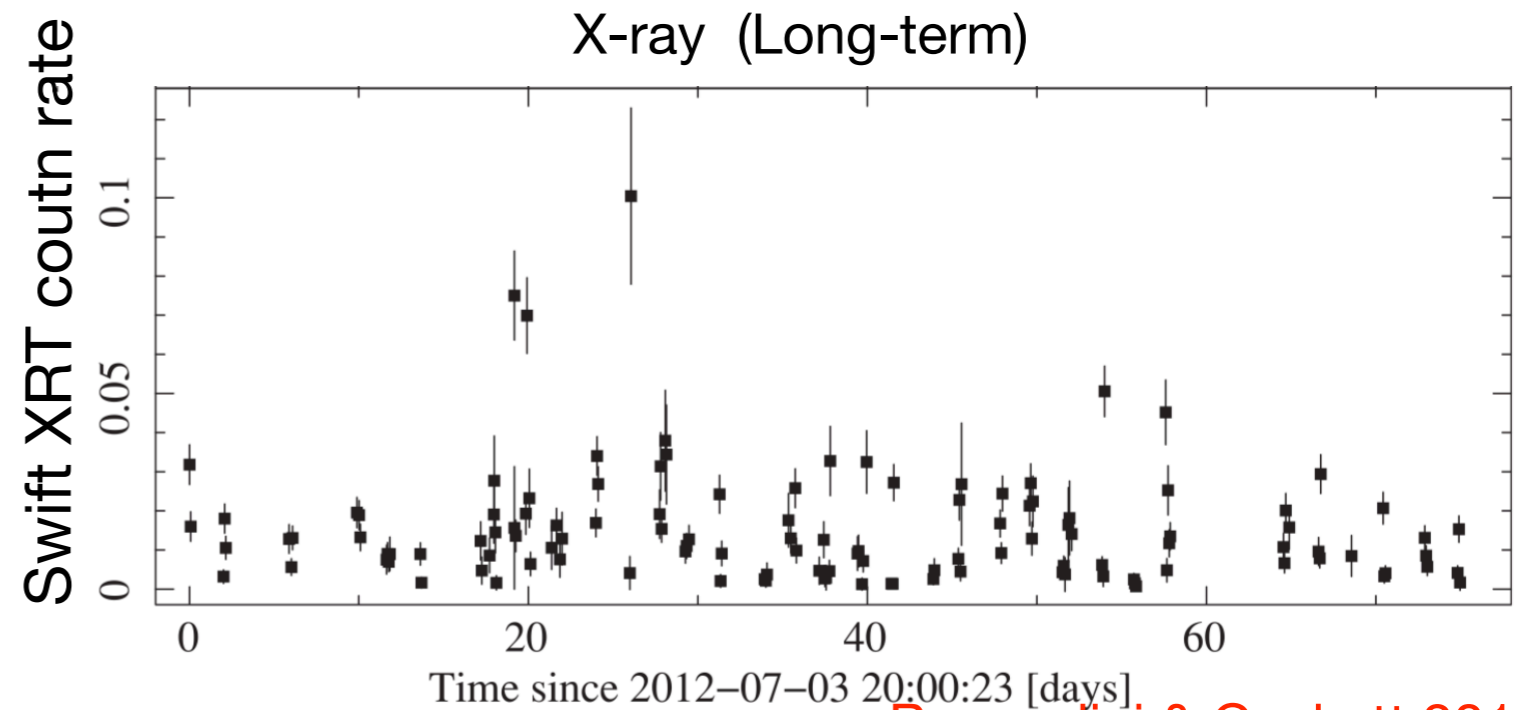
Strategy 1: Track the Decays of XRB Outbursts



Strategy 2: Monitor Quiescent XRBs Directly: *MW Variability is well established, on all timescales*



Hynes et al. 2002



Bernardini & Cackett 2014

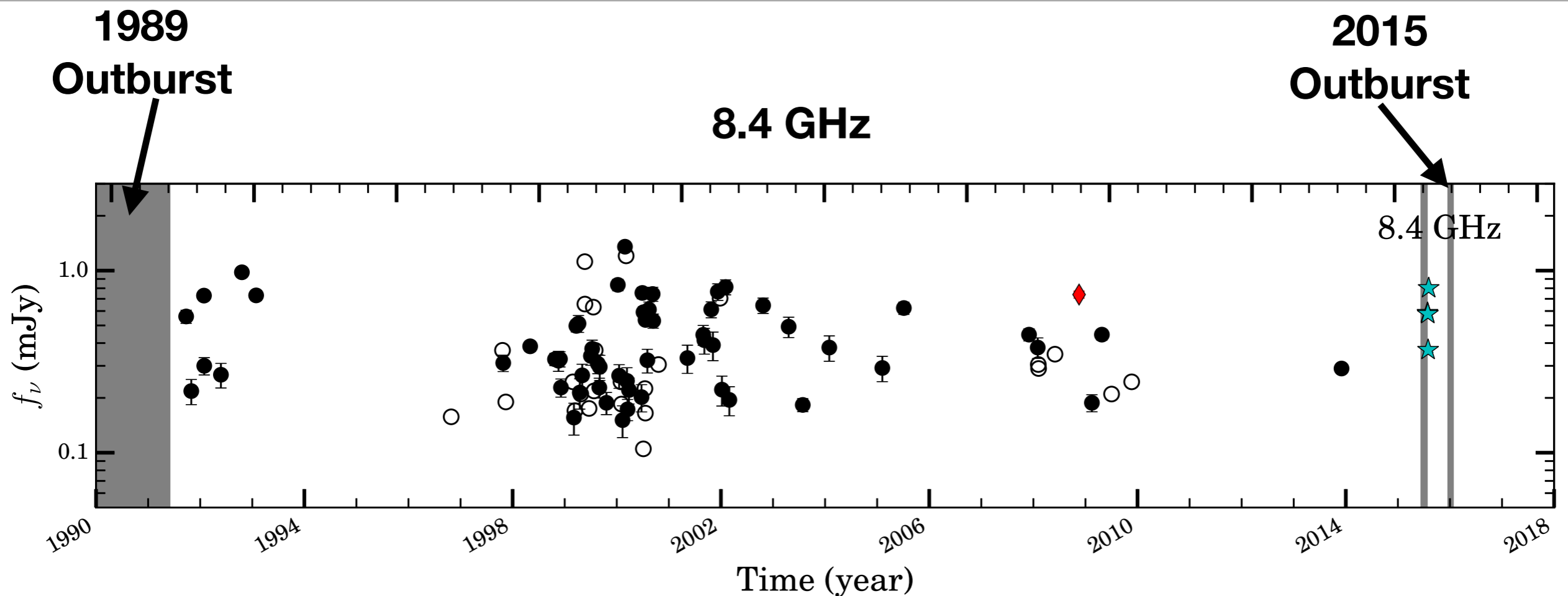


V404 Cygni: Two Decades of Radio Observations in VLA Archive

140 Observations over 5 frequencies (1991 → 2015).

All data reduced by Seth Bruzewski & Andrew Bundas

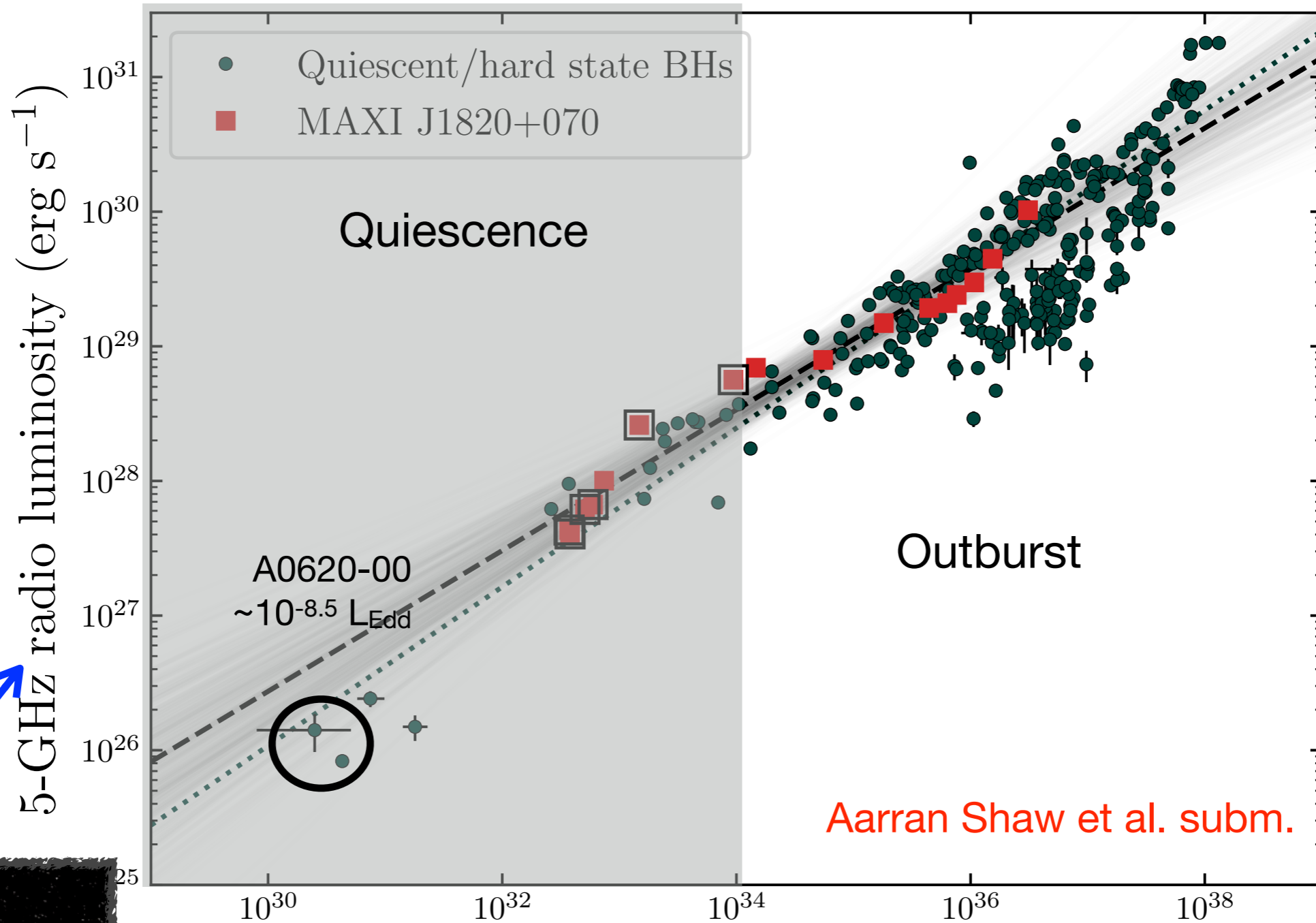
(w/ L. Chomiuk and Jay Strader)



Factor 2-3 variability.

Suspicion it's caused by shot noise (i.e., damped random walk)

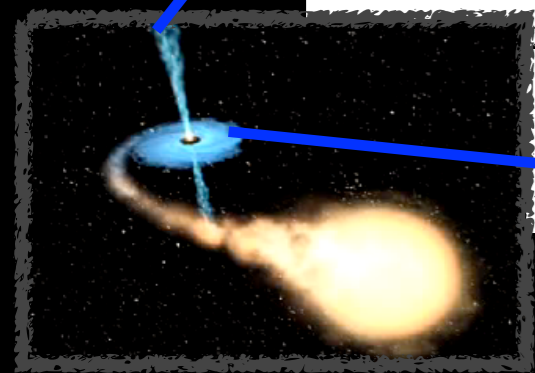
Plotkin et al. 2019



Aarran Shaw et al. subm.

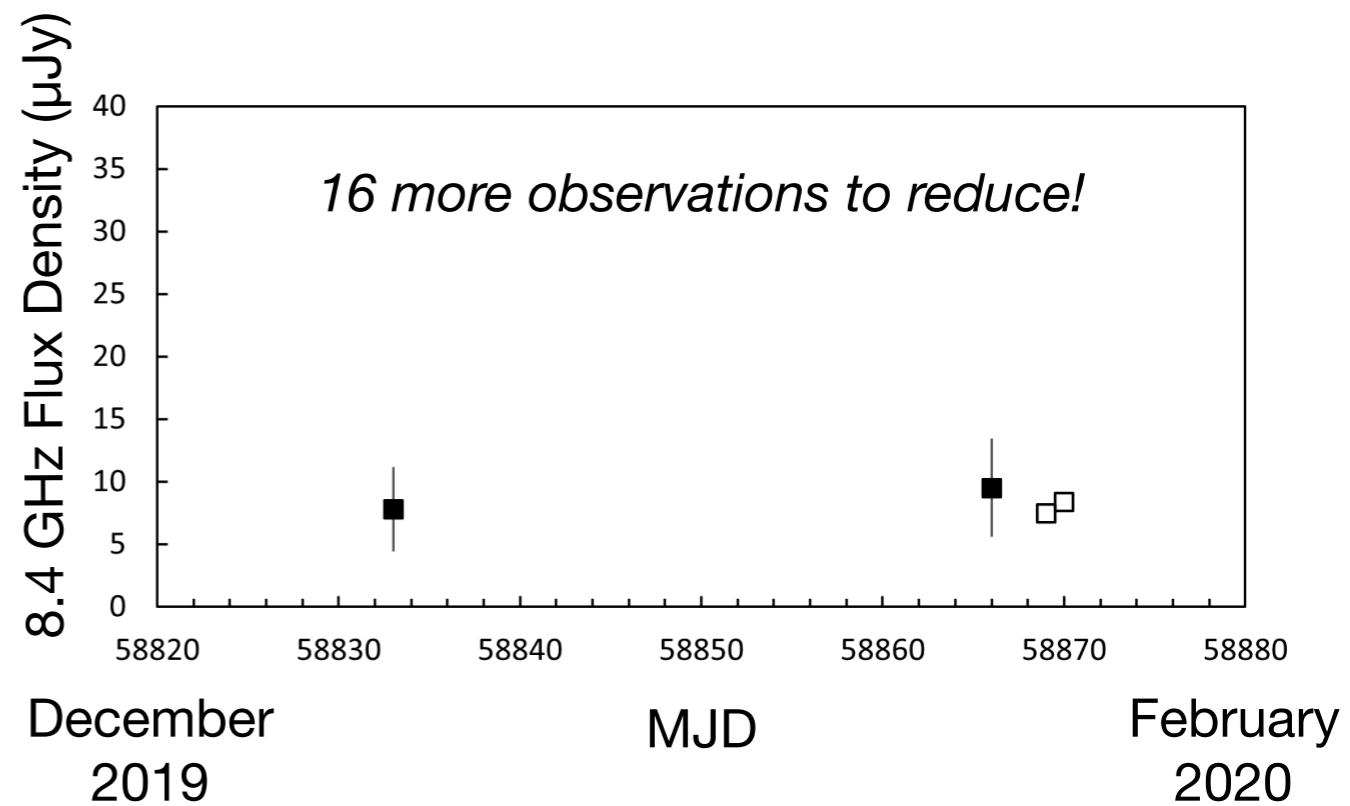
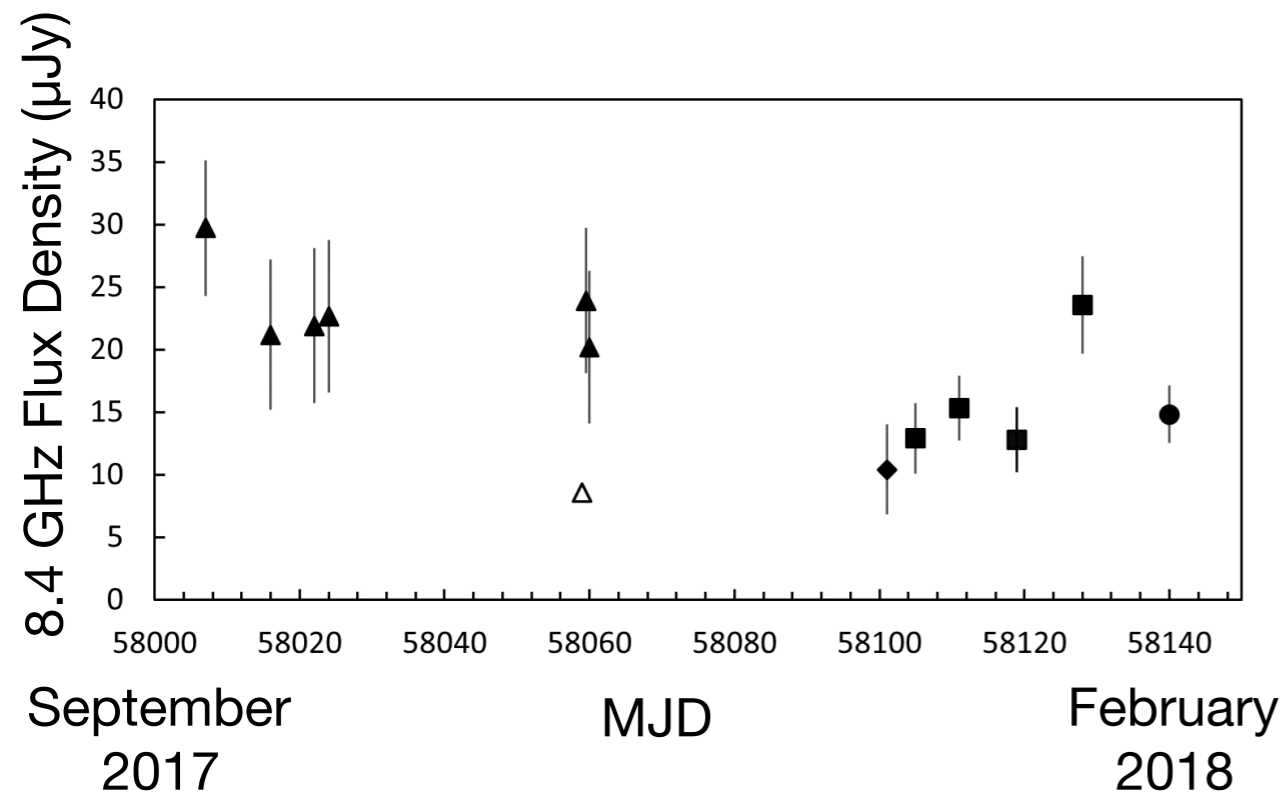
5-GHz radio luminosity (erg s^{-1})

1-10 keV X-ray luminosity (erg s^{-1})



Started Monitoring A0620 w/ VLA in 2017

*A0620-00's radio jet appears variable, and fading on long timescales
(also see Dincer+18, Gallo+19)*



Figures from Donna Depolo (UNR)

Coordinated Optical Coverage of A0620-00 (0.7m robotic telescope in Eastern Nevada)

Optical Light Curve
(made with Photometry+)

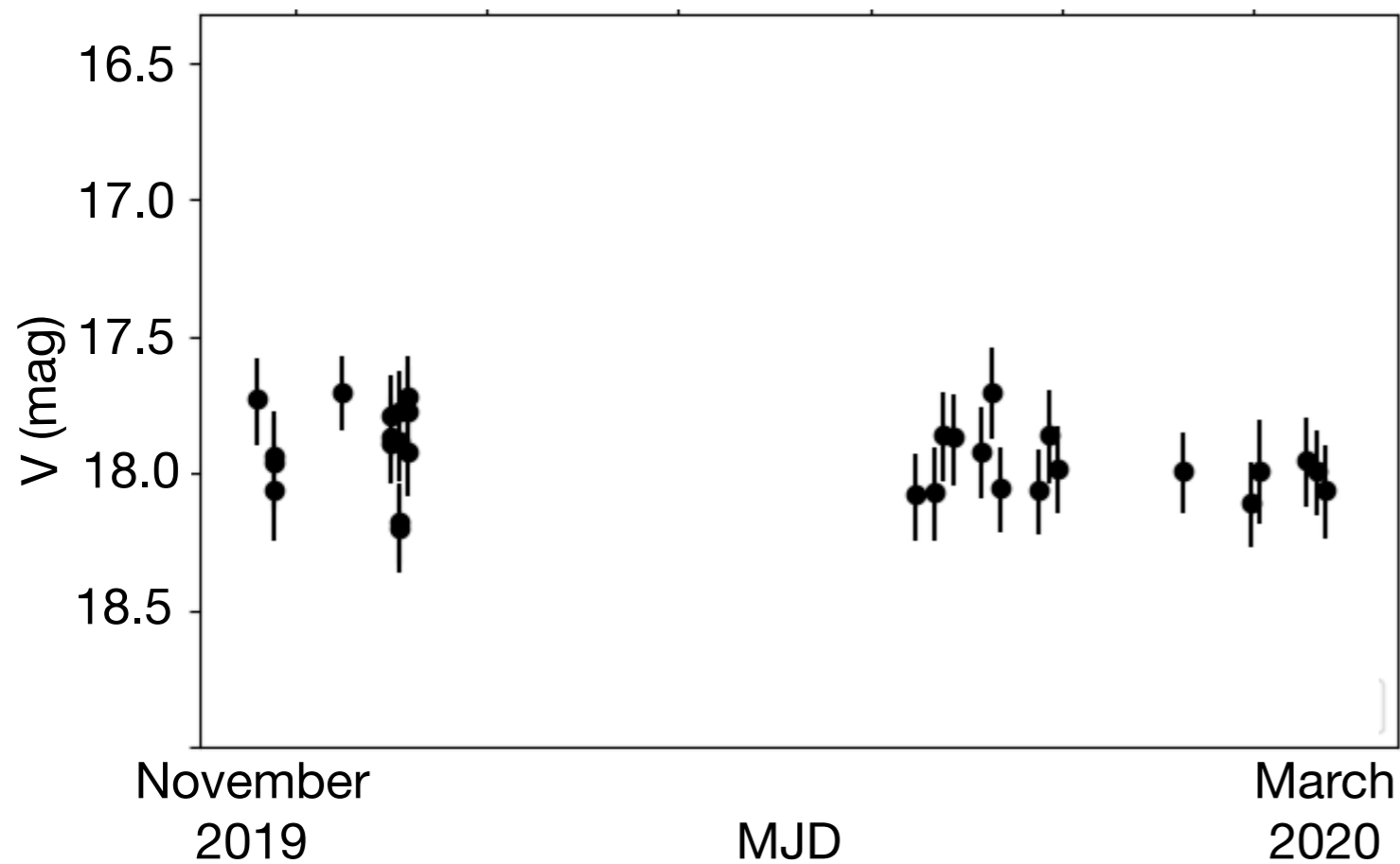


Figure from Matthew Neill (UNR)

greatbasinobservatory.org
(0.7m robotic telescope)



Photometry+

(python/astropy-based, open source)

Alexis Tudor Masters Thesis in Human-Computer Interaction

Photometry+

Home My Projects About Settings Help

Project Name:*

Target Star Coordinates*

Right Ascension

Declination

Calibration File Uploads

Settings (Optional)

Astrometry.net API Key:

Calibrate image?

Subtract bias from dark?

Background Subtraction?

Catalog to search:

Filter to search:

If other filter:

Plot light curve with line?

Upload Main FITS File

OR

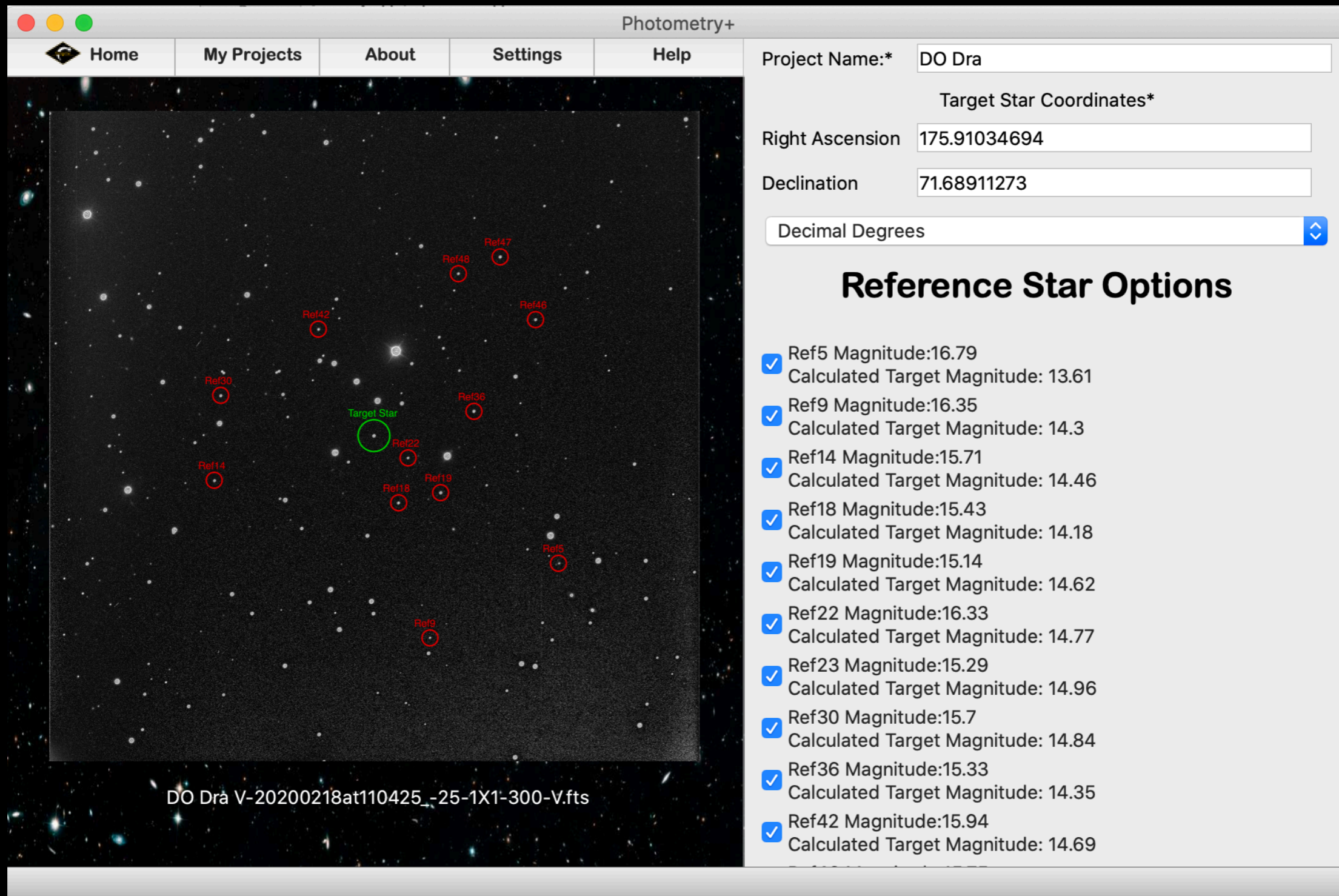
Upload Folder Containing Main FITS Files

/Volumes/ThesisDrive/photometry-plus copy October 22/DO Dra
V-20200218at110425_-25-1X1-300-V.fits

Photometry+

(python/astropy-based, open source)

Alexis Tudor Masters Thesis in Human-Computer Interaction



The screenshot displays the Photometry+ software interface. The main window shows a star field with several stars marked as reference stars (Ref14, Ref18, Ref19, Ref22, Ref30, Ref36, Ref42, Ref46, Ref47, Ref48) and one star marked as the Target Star (circled in green). The interface includes a navigation menu (Home, My Projects, About, Settings, Help) and a control panel on the right. The control panel contains input fields for Project Name (DO Dra), Target Star Coordinates (Right Ascension: 175.91034694, Declination: 71.68911273), and a dropdown menu set to Decimal Degrees. Below this is a section titled 'Reference Star Options' with a list of stars and their magnitudes, each with a checked checkbox.

Photometry+

Home My Projects About Settings Help

Project Name:* DO Dra

Target Star Coordinates*

Right Ascension 175.91034694

Declination 71.68911273

Decimal Degrees

Reference Star Options

- Ref5 Magnitude:16.79
Calculated Target Magnitude: 13.61
- Ref9 Magnitude:16.35
Calculated Target Magnitude: 14.3
- Ref14 Magnitude:15.71
Calculated Target Magnitude: 14.46
- Ref18 Magnitude:15.43
Calculated Target Magnitude: 14.18
- Ref19 Magnitude:15.14
Calculated Target Magnitude: 14.62
- Ref22 Magnitude:16.33
Calculated Target Magnitude: 14.77
- Ref23 Magnitude:15.29
Calculated Target Magnitude: 14.96
- Ref30 Magnitude:15.7
Calculated Target Magnitude: 14.84
- Ref36 Magnitude:15.33
Calculated Target Magnitude: 14.35
- Ref42 Magnitude:15.94
Calculated Target Magnitude: 14.69

DO Dra V-20200218at110425_-25-1X1-300-V.fts

Summary

Quiescent radio jet variations are non-negligible

- At least factor of 2-3 variability.
- Implications for discovering new black hole populations through the radio
 - from XRBs to IMBHs.
- Keep an eye out for Photometry+ next year.