Identification of Candidate Be/X-Ray Binaries in the SMC using Archival Swift Data

Thomas Gaudin

BeXRB 2024– 7/31/24

S-CUBED: The Swift SMC Survey

- Designed to discover and monitor BeXRBs:
  - Weekly observing cadence
  - 142 observed tiles
  - ~60s exposures
  - Utilizes both UVOT and XRT
- 1900+ X-ray sources detected to date
- Several new BeXRBs found

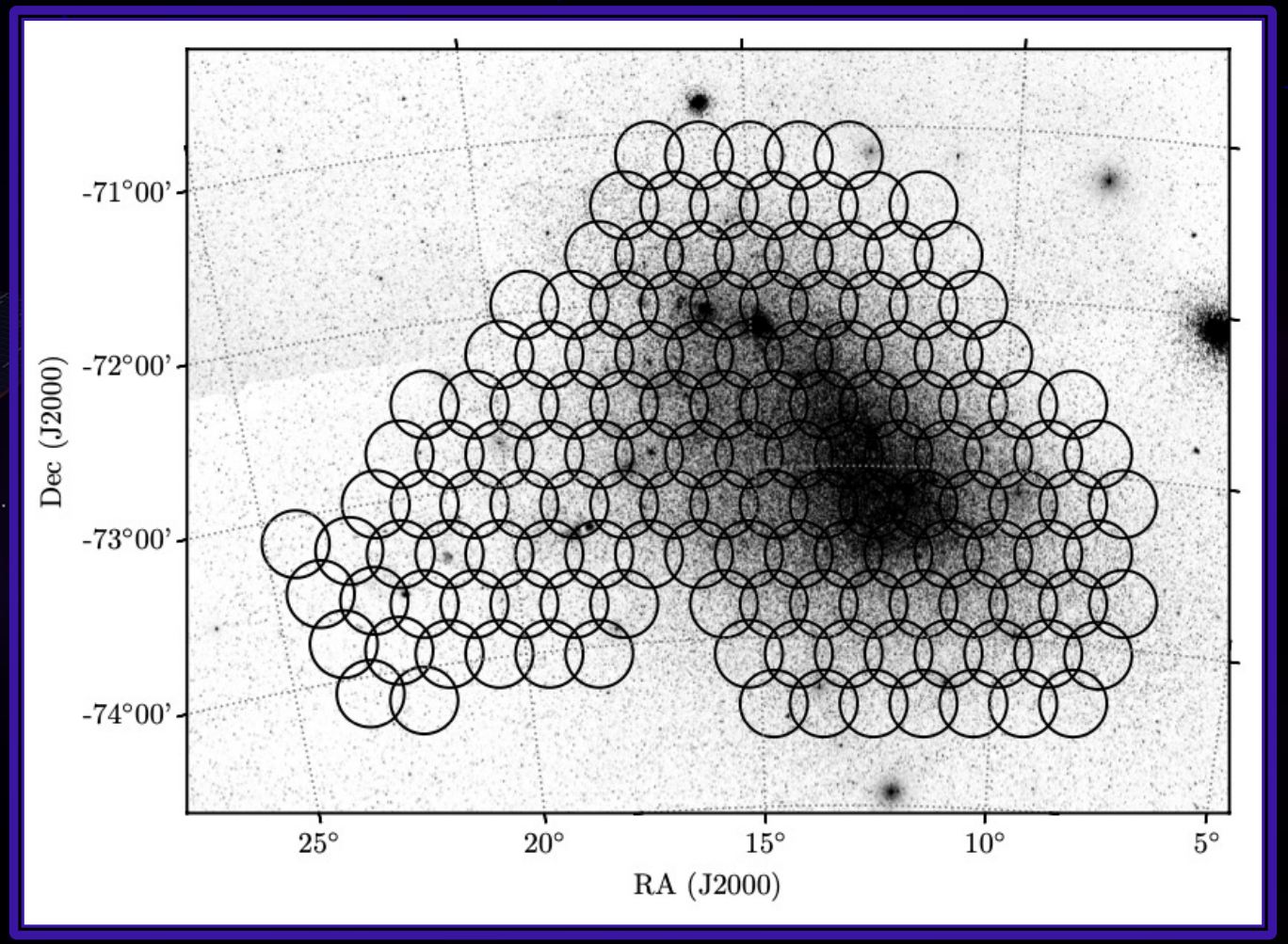

Image Credit: Kennea et al. 2018

The Search for Quiescent BeXRBs

BeXRBs are primarily identified via X-ray outbursts and emission line spectroscopy

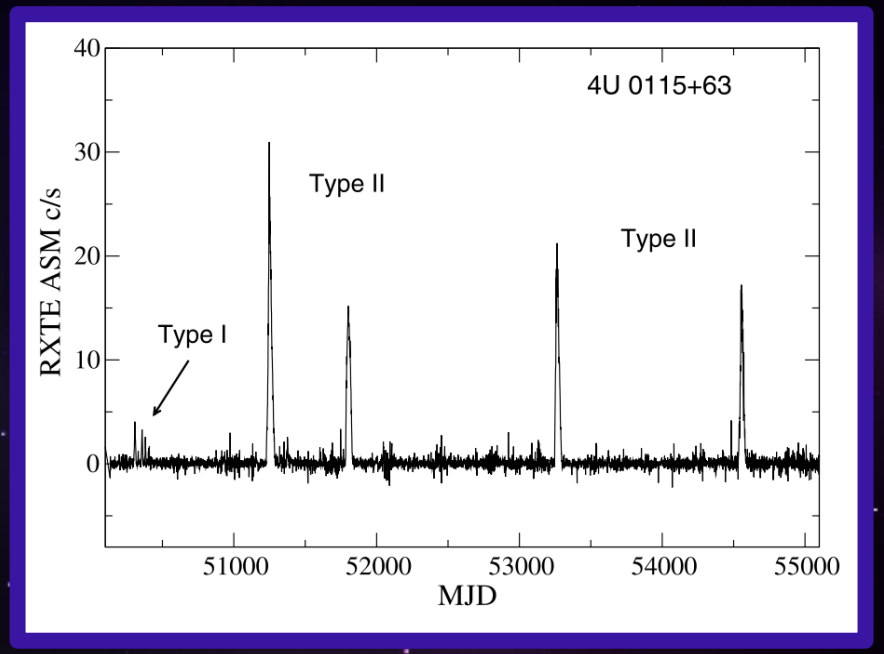

Image Credit: Reig 2011

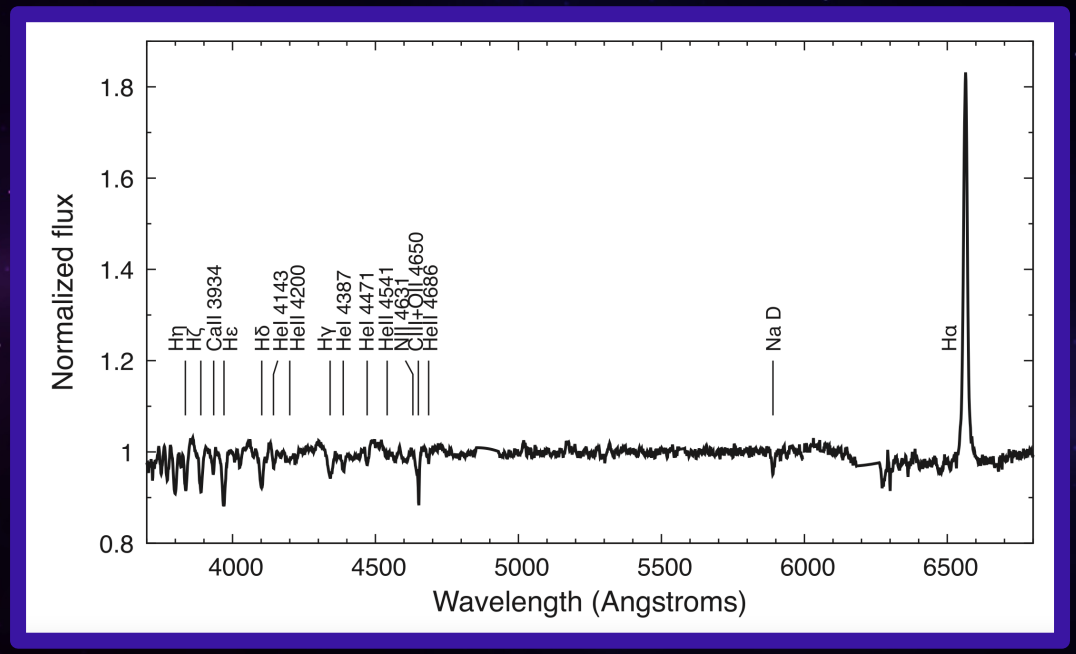

Image Credit: Coe et al. 2023

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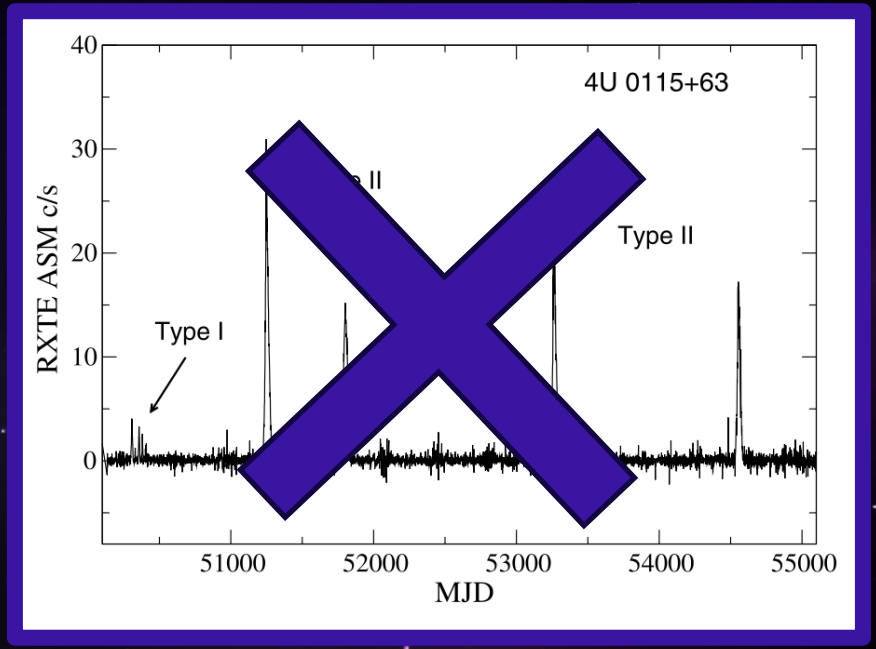

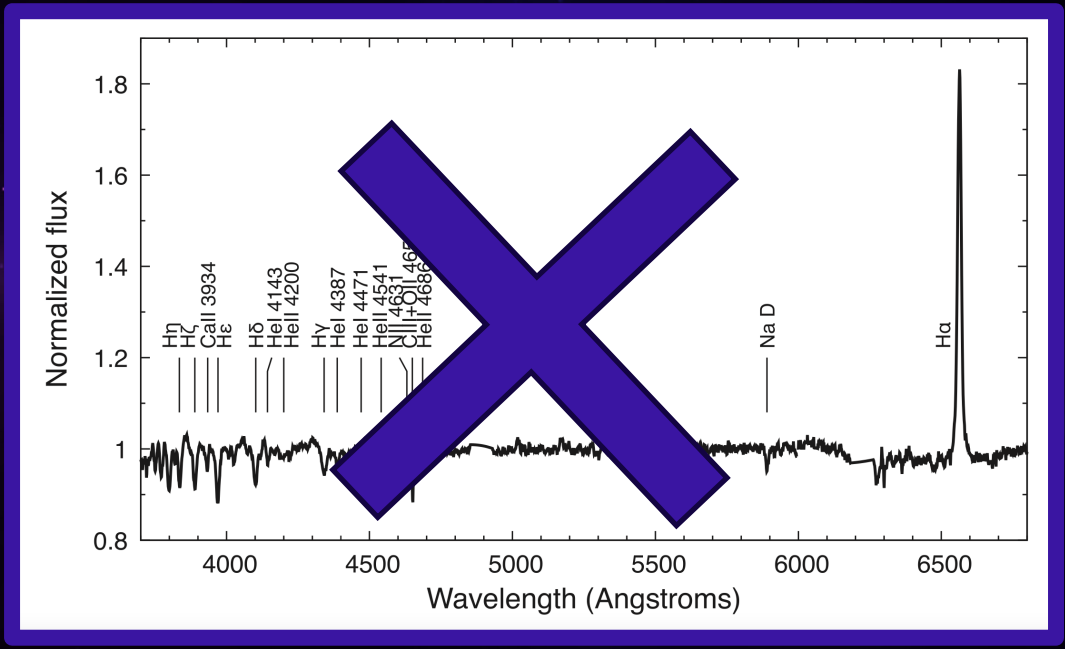

How do you identify BeXRBs that have never gone into outburst?

We need a new method!

Archival Analysis Method

Candidate Identification

- Sources were filtered based on their X-ray properties in the **S-CUBED Database**:
  - Remove all sources not flagged as “Good”
  - Remove all sources with a soft photon index ($\Gamma > 1.5$)
  - Keep all sources with no spectral fit

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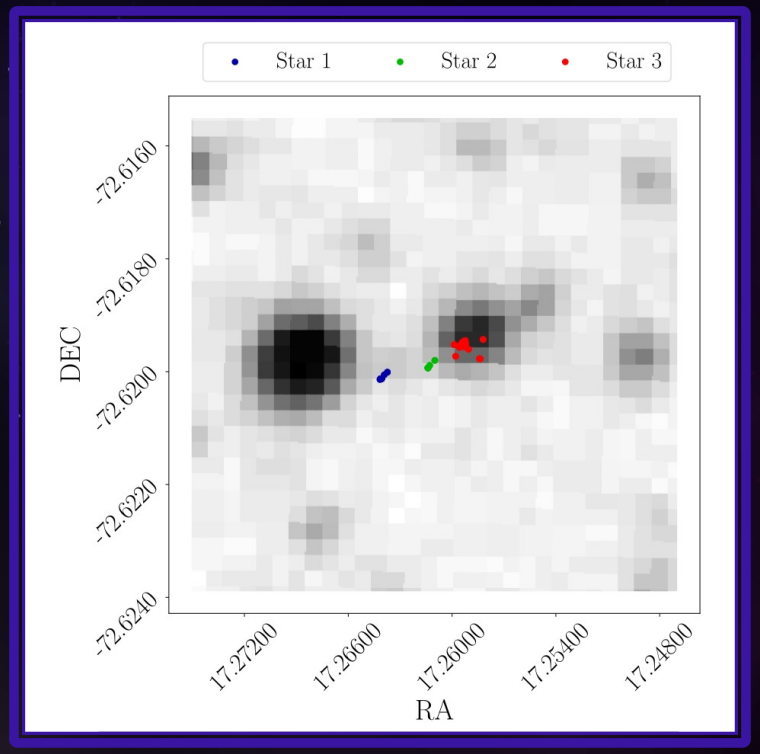
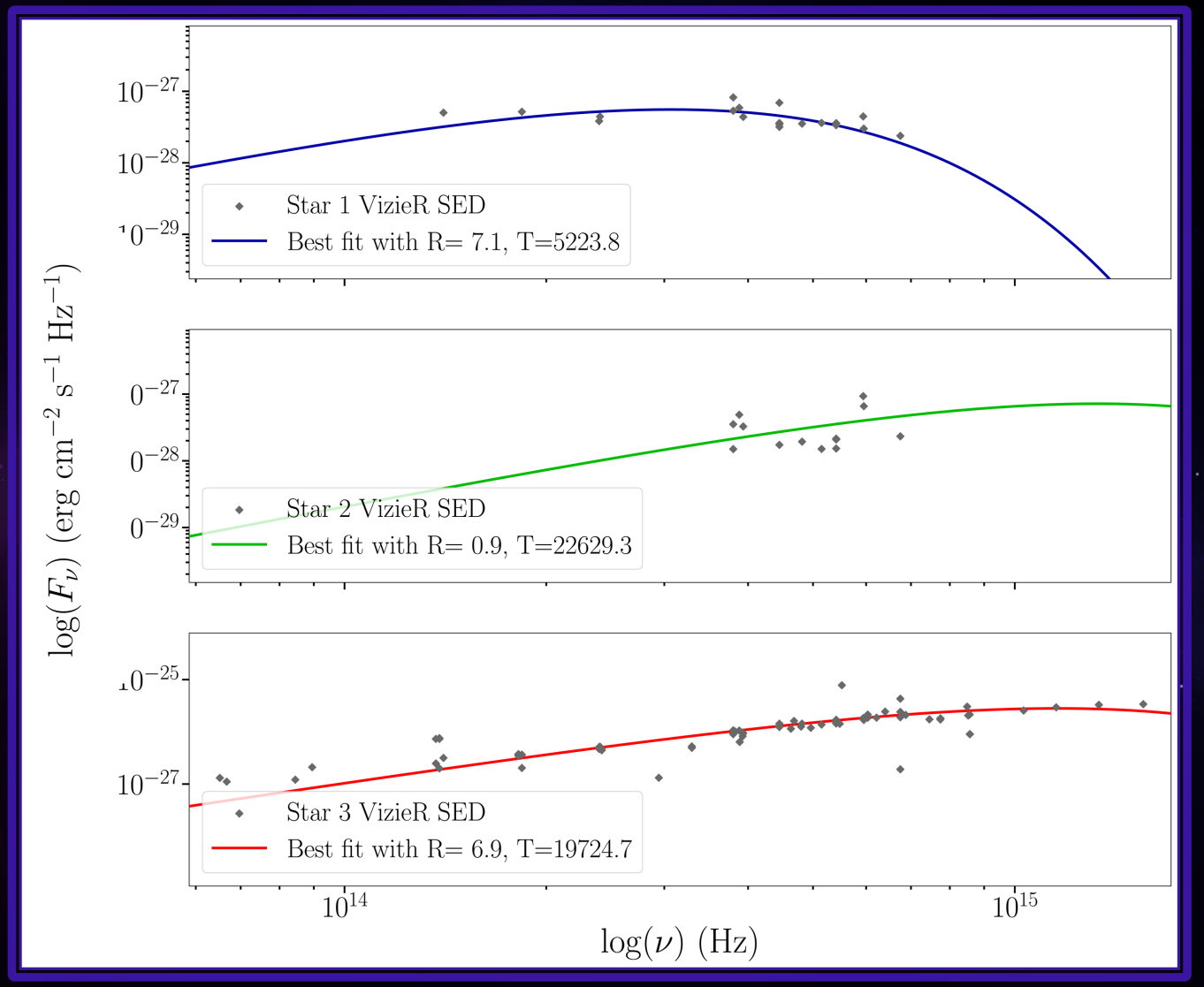
- Searched for bright stars ($11.0 < B < 17.0$) nearby using **VizieR**

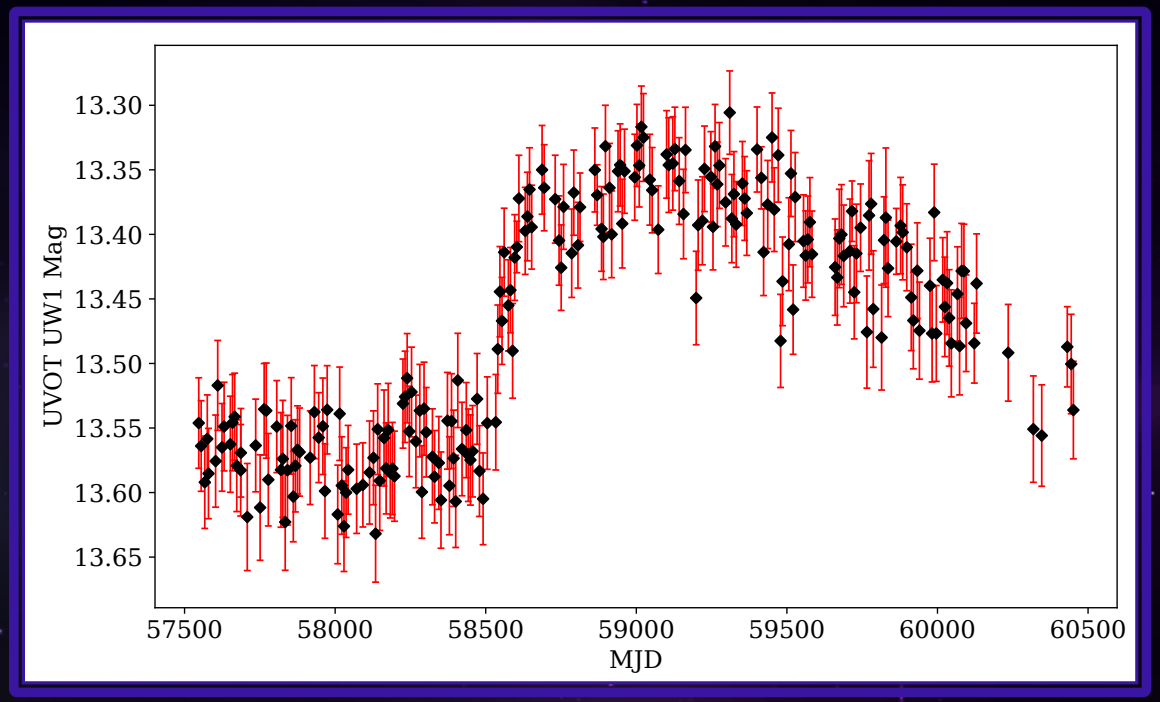
Determining Stellar Parameters: Curve Fitting

$$F(\nu, R, T) = \pi \left(\frac{R_*}{D}\right)^2 \left(\frac{2\,h\,\upsilon^3}{c^2}\right)\left(\frac{1}{e^{\frac{h\,\upsilon}{k\,T}} - 1}\right)$$

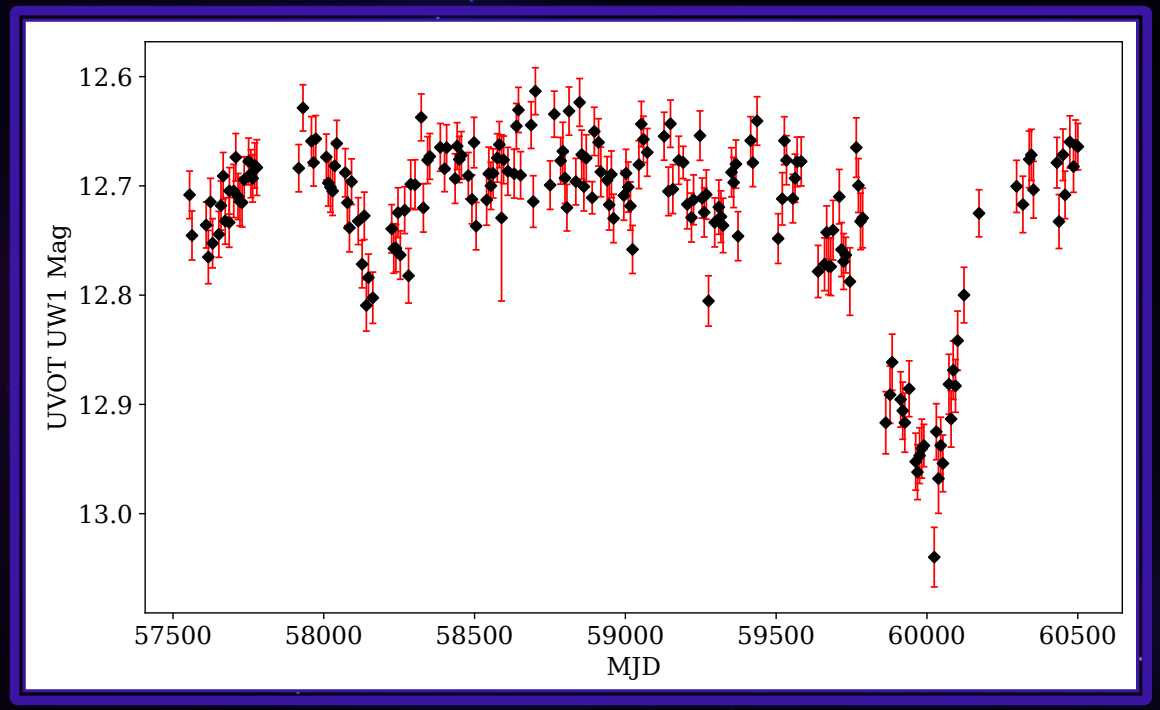




Ultraviolet Variability



SXP 146.6



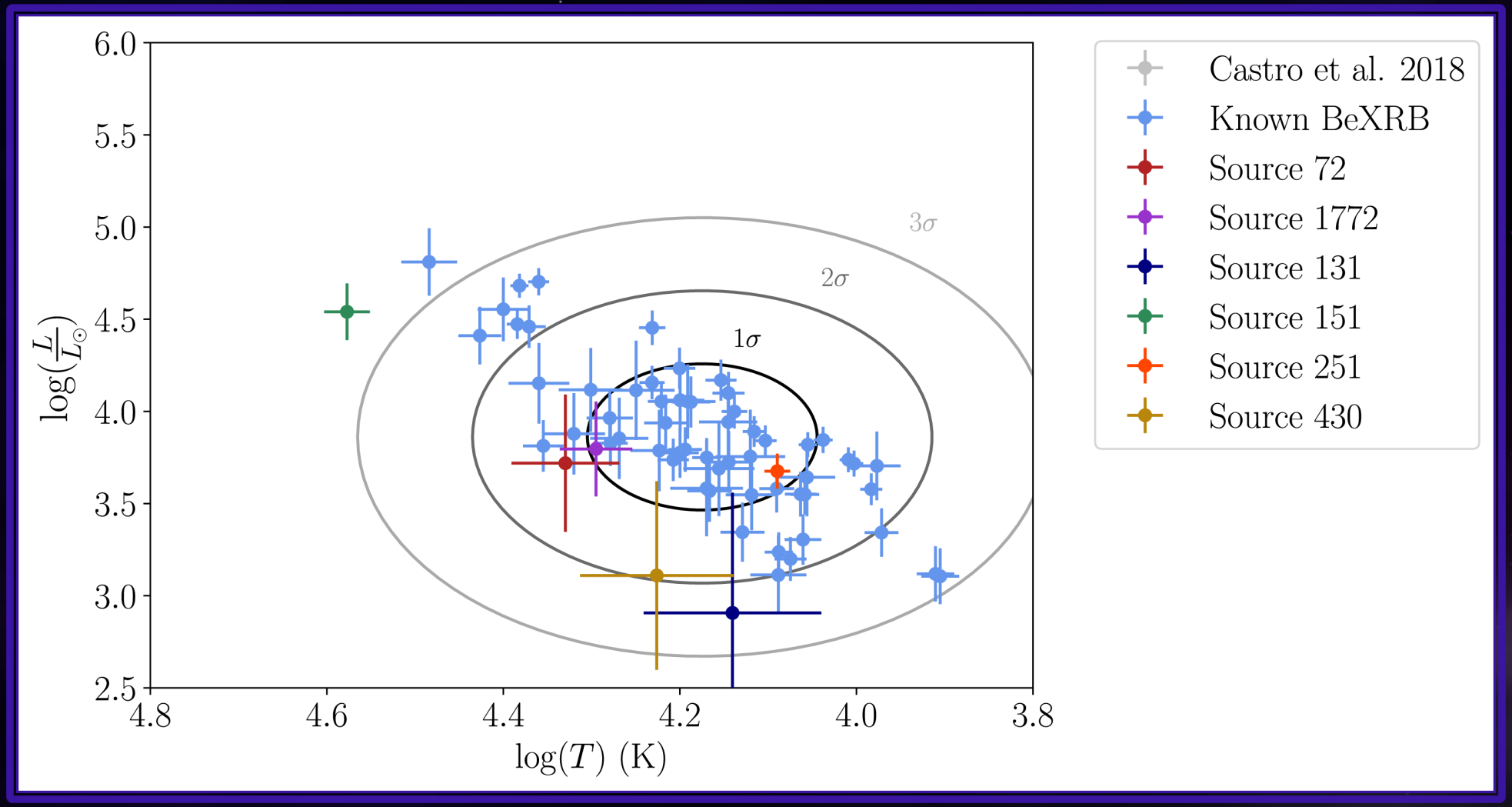
SMC X-2

Candidate Sources

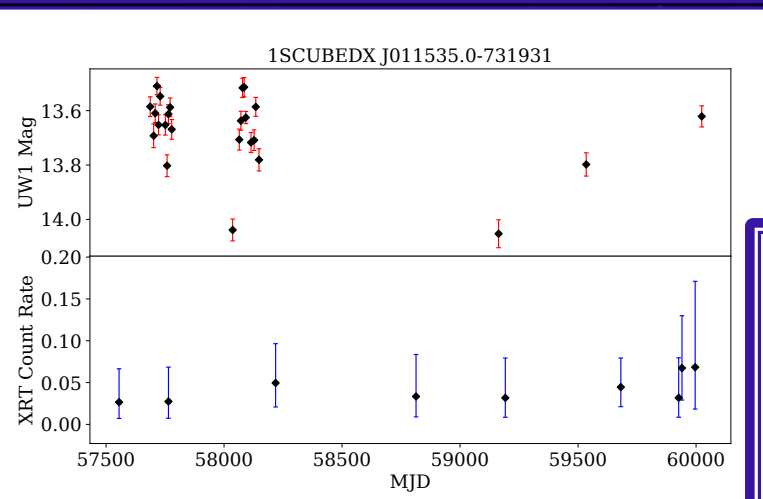
Companion Stellar Parameters

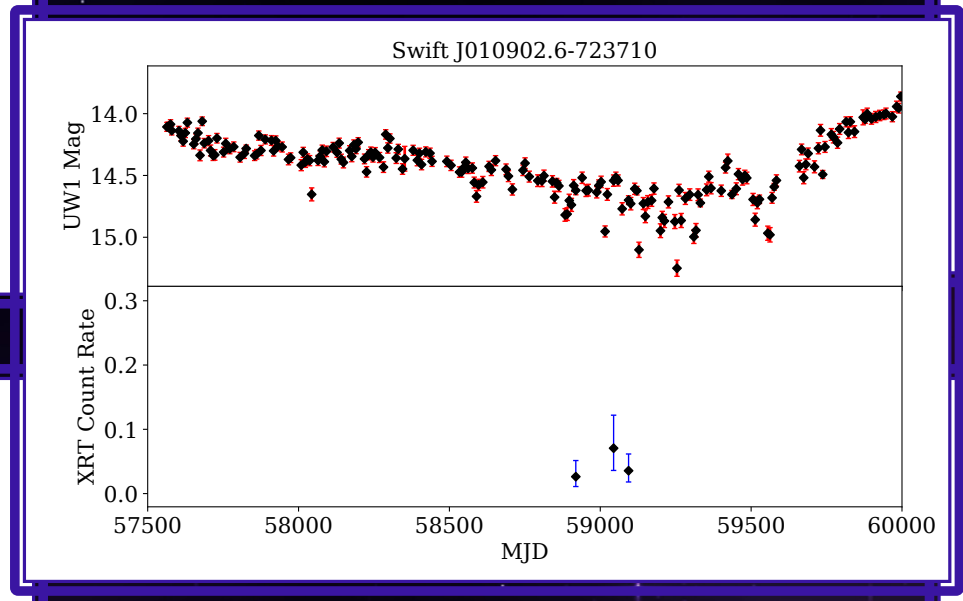
SC#	Source ID	Temperature (K)	Radius ($R_\odot$)
72	1SCUBEDX J005606.0-722749	22500 ± 2700	5.1 ± 0.66
131	1SCUBEDX J010203.7-715130	13800 ± 2900	5.0 ± 1.3
151	1SCUBEDX J011535.0-731931	37800 ± 2200	4.42 ± 0.25
251	1SCUBEDX J003802.8-734458	12300 ± 400	15.4 ± 0.6
430	1SCUBEDX J005708.8-724202	16800 ± 3400	4.3 ± 1.0
1772	Swift J010902.6-723710	19700 ± 1800	6.9 ± 0.68

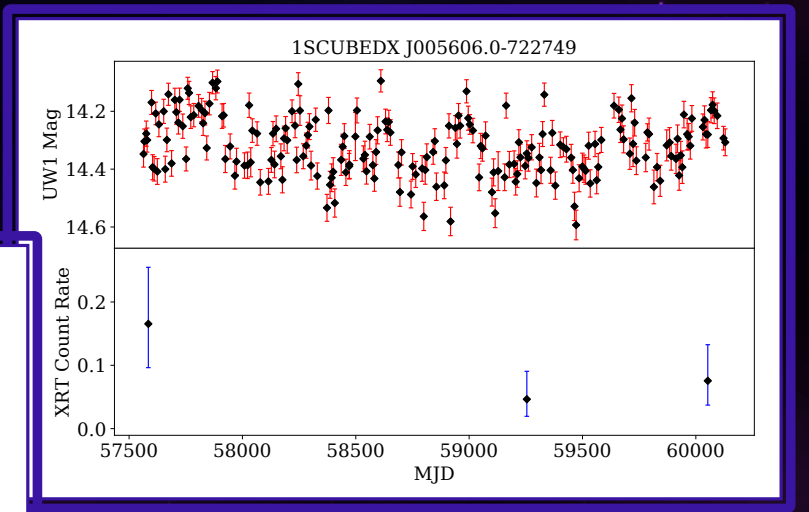
Companion Stellar Parameters

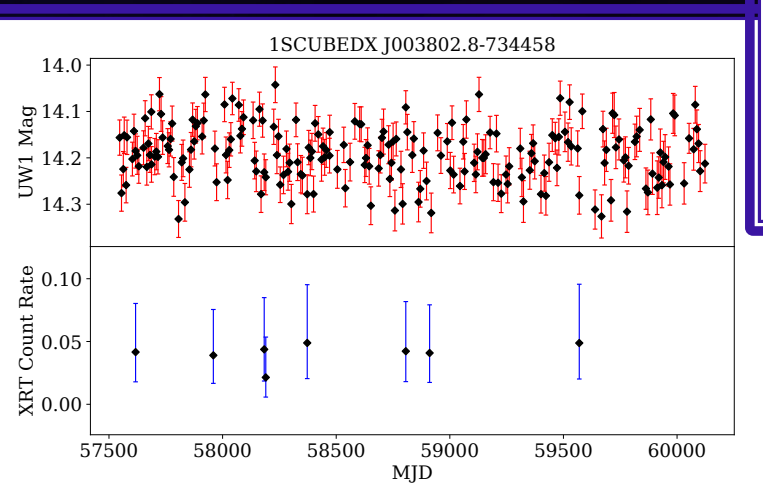


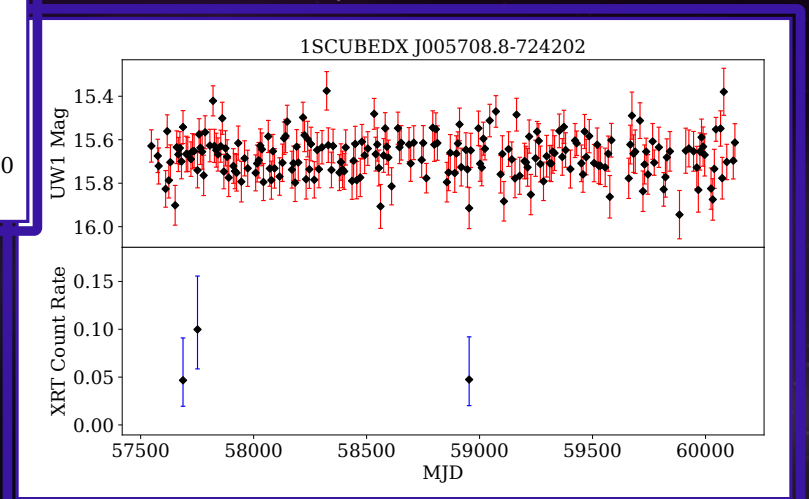
UV Light Curves











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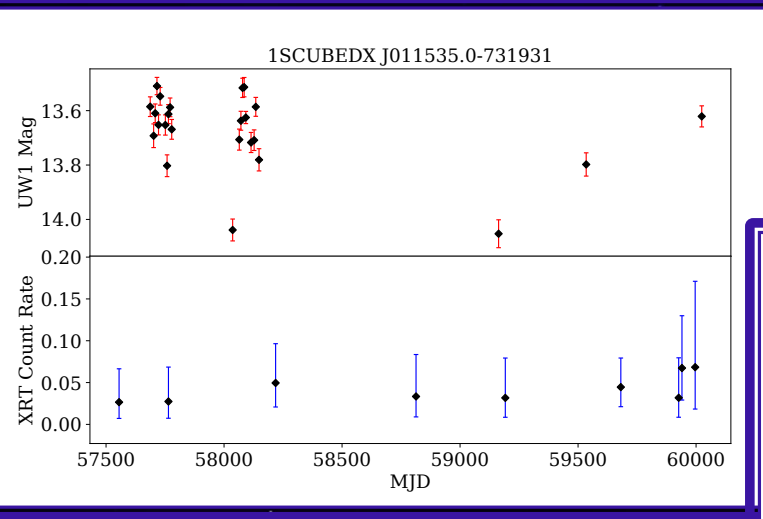
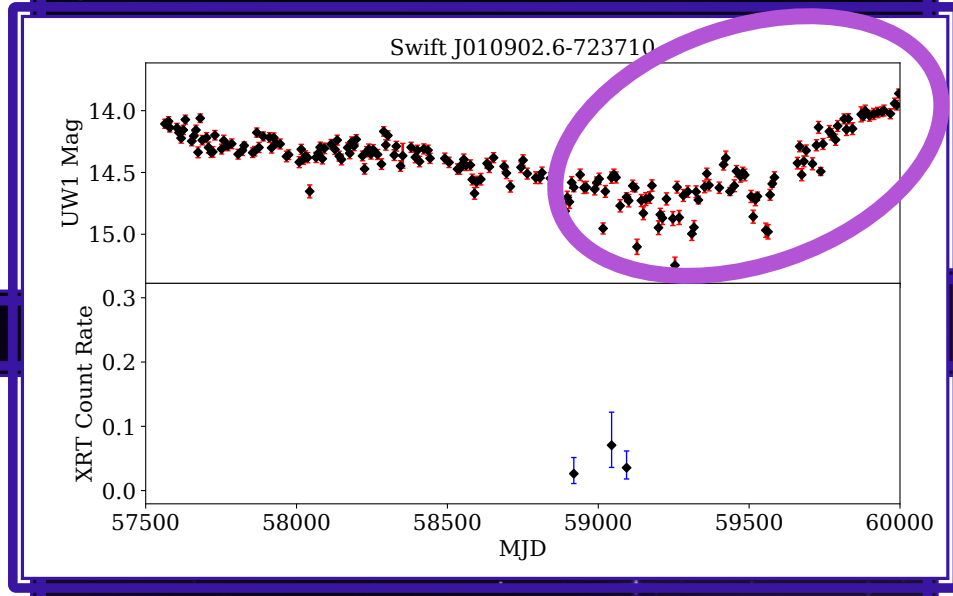
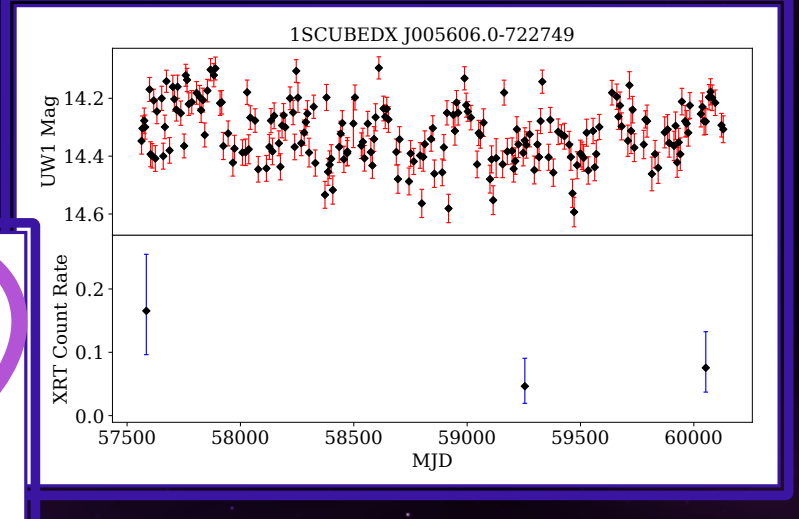
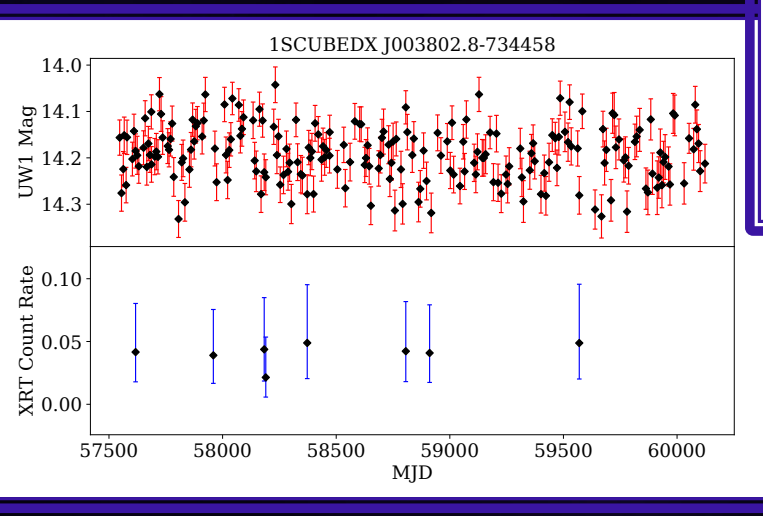
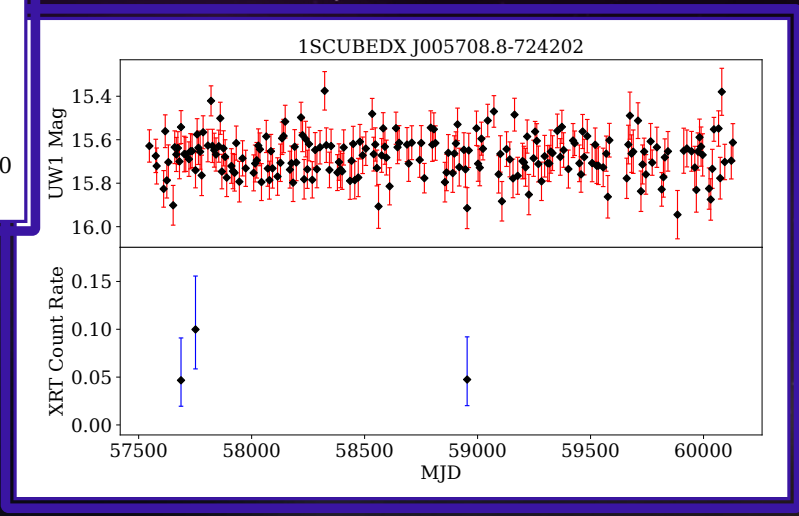




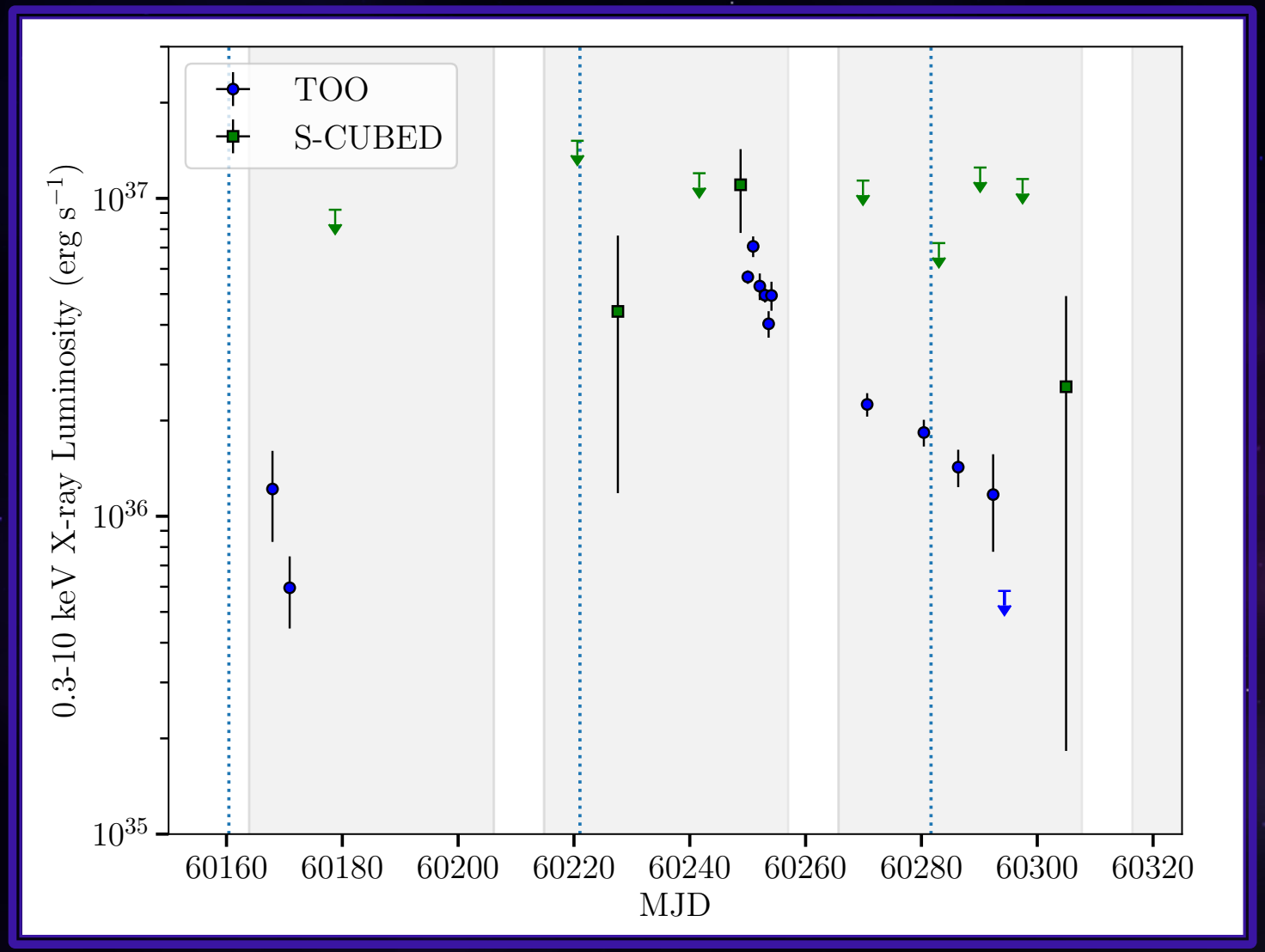






The Outburst of Swift J010902.6-723710

X-Ray Light Curve

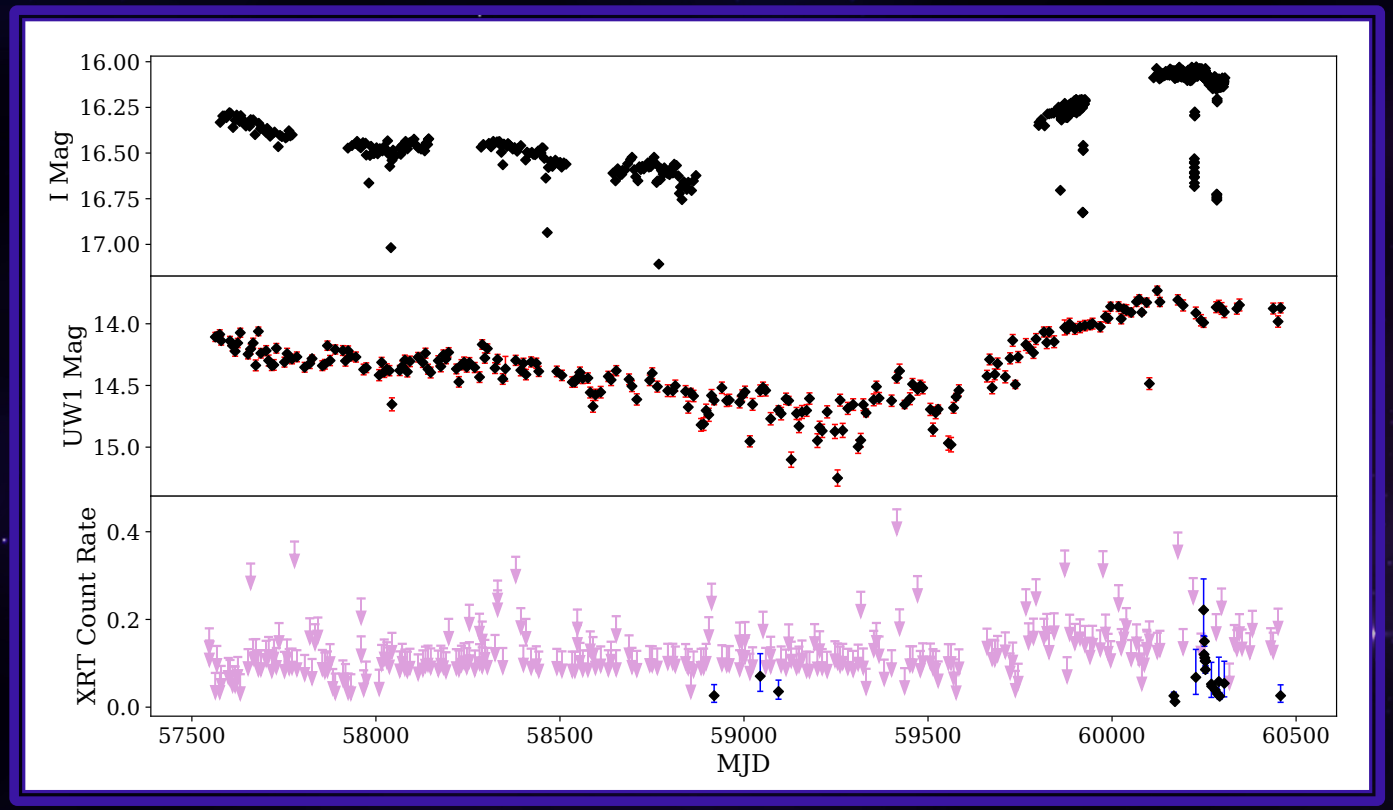


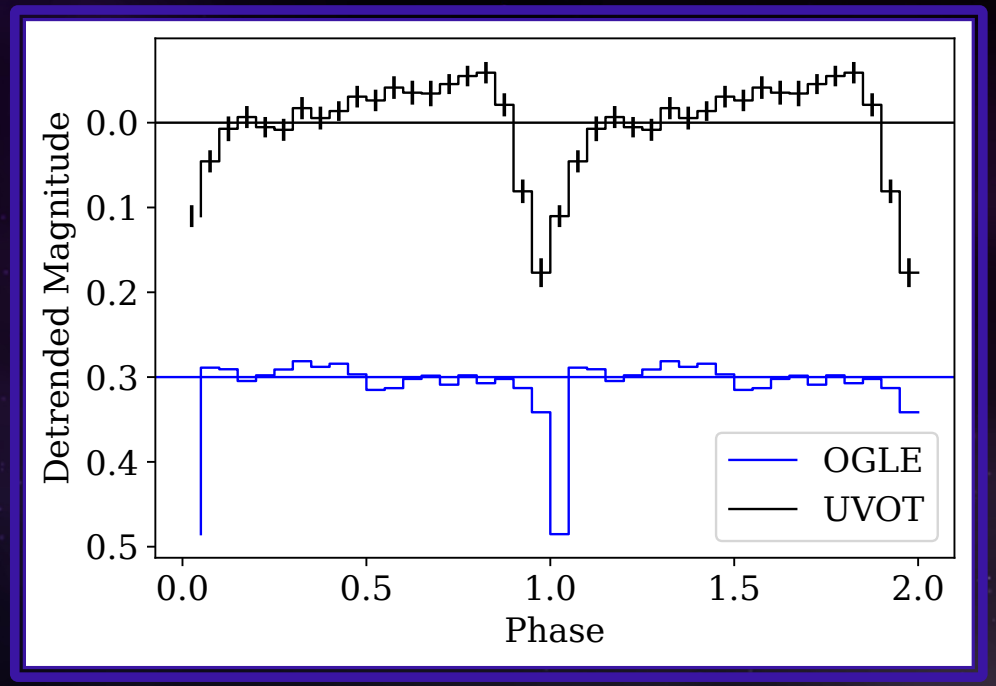
Pulsar Spin Period: 182s
Decay time: ~77 Days

A Rare Eclipsing BeXRB

Orbital Period: 60.623 days

Size of Eclipsing Body: 3.3 $R_\odot$





Conclusions

- We establish a new method for the detection of Be/X-ray Binaries using a combination of Swift SMC Survey data and Archival IR-UV data
  - Relies on UV variability and SED-fitting of blackbody curves to SMC stars
- We argue for the detection of 6 new candidate Be/X-ray Binaries using this new method
- We present the confirmation of one of these systems via X-ray outburst
  - SXP 182 becomes the 3rd confirmed eclipsing BeXRB

Paper on the newly discovered SXP 182 is now on ApjL!