



UNCOVERING HIDDEN DWARF NOVAE IN TESS

R ETHIRAJULU AND M FAUSNAUGH

Department of Physics and Astronomy, Texas Tech University, Lubbock, Texas, United States

DEPARTMENT OF
PHYSICS &
ASTRONOMY

TEXAS TECH
College of Arts & Sciences

I. INTRODUCTION

Cataclysmic variables (CVs) are close binary systems in which a white dwarf gains material from a companion star. In a subclass called **Dwarf Novae** (DN), this material forms an accretion disk around the white dwarf. **Instabilities** in the disk cause transitions between a cooler, faint state and a hotter, bright state, producing **recurrent outbursts**.

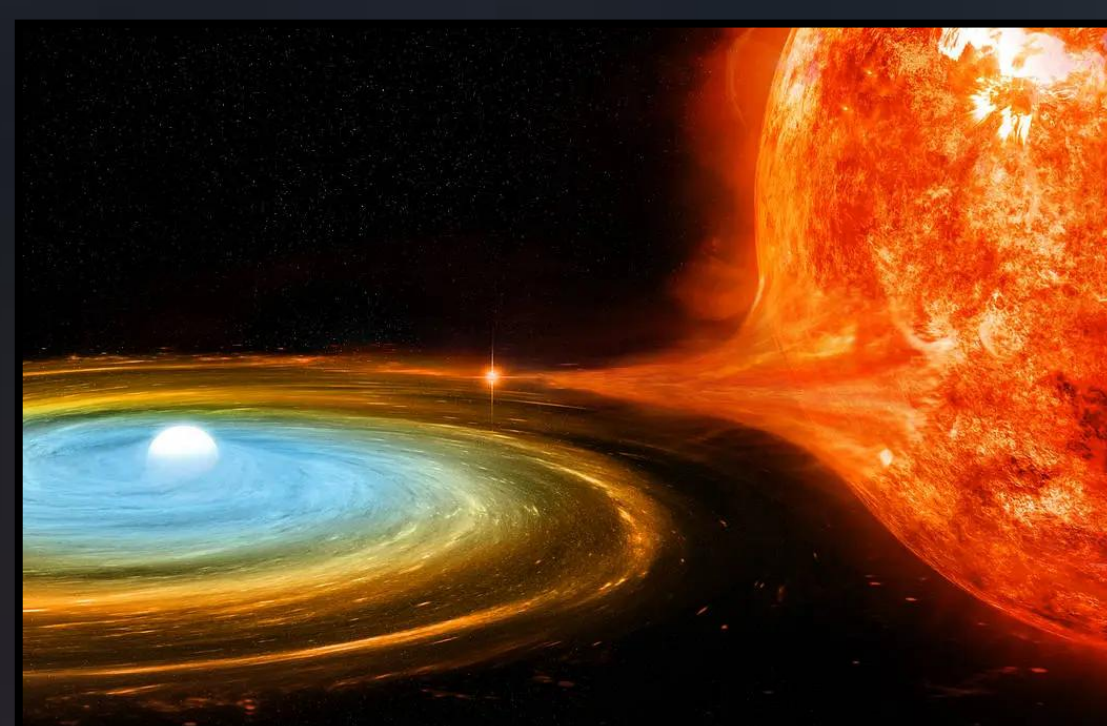


Figure 1. Artist's depiction of a cataclysmic variable system with a white dwarf accreting matter from a companion star through an accretion disk.

II. MOTIVATION

- **Expand the known sample:** Identify new dwarf nova candidates to enlarge the sample available for research, enabling more detailed studies.
- **Understand accretion physics:** Study outburst amplitudes and durations to investigate how matter flows through accretion disks.
- **Test theoretical predictions:** Compare system parameters and outburst properties to test accretion-disk models.

III. DATA ACQUISITION

TNS

The Transient Name Server records reported astronomical transients and their sky positions. It provided our starting source list: we examined TNS sources that fell within TESS's field of view and had available TESS light curves.

TESS

The Transiting Exoplanet Survey Satellite repeatedly observes large regions of the sky. We examined light curves generated from its observations to track the brightness of selected sources over time and search for dwarf-nova outbursts.

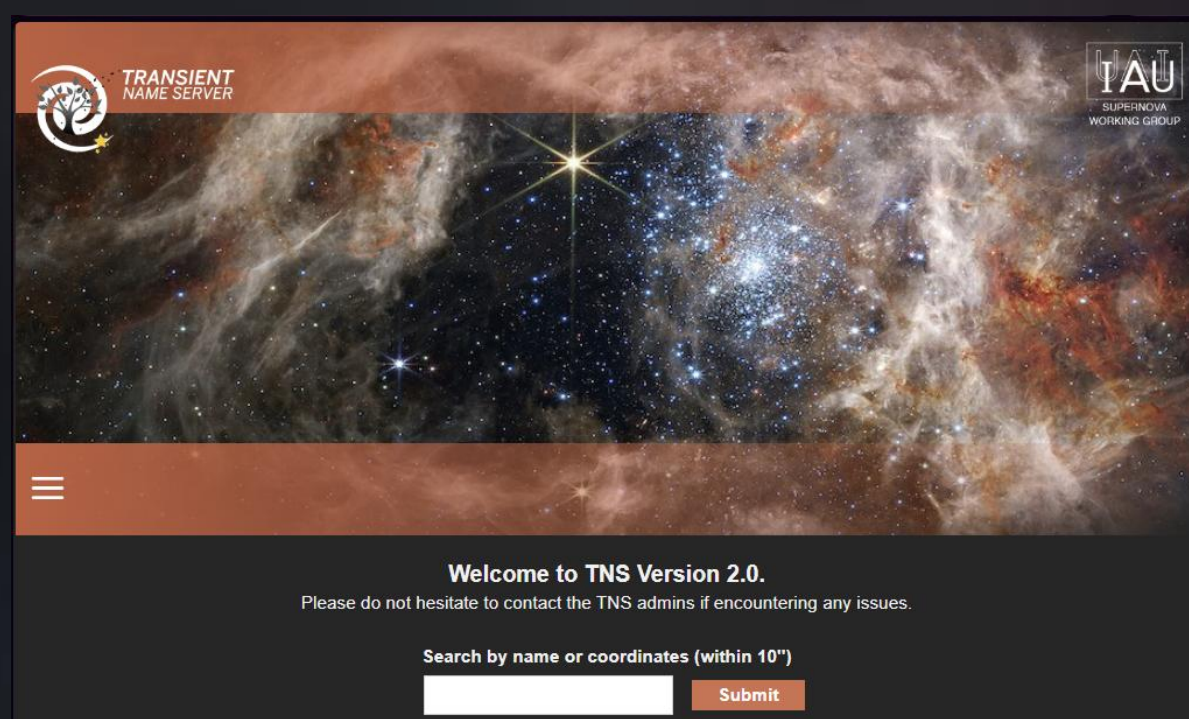


Figure 2. Landing page of TNS server

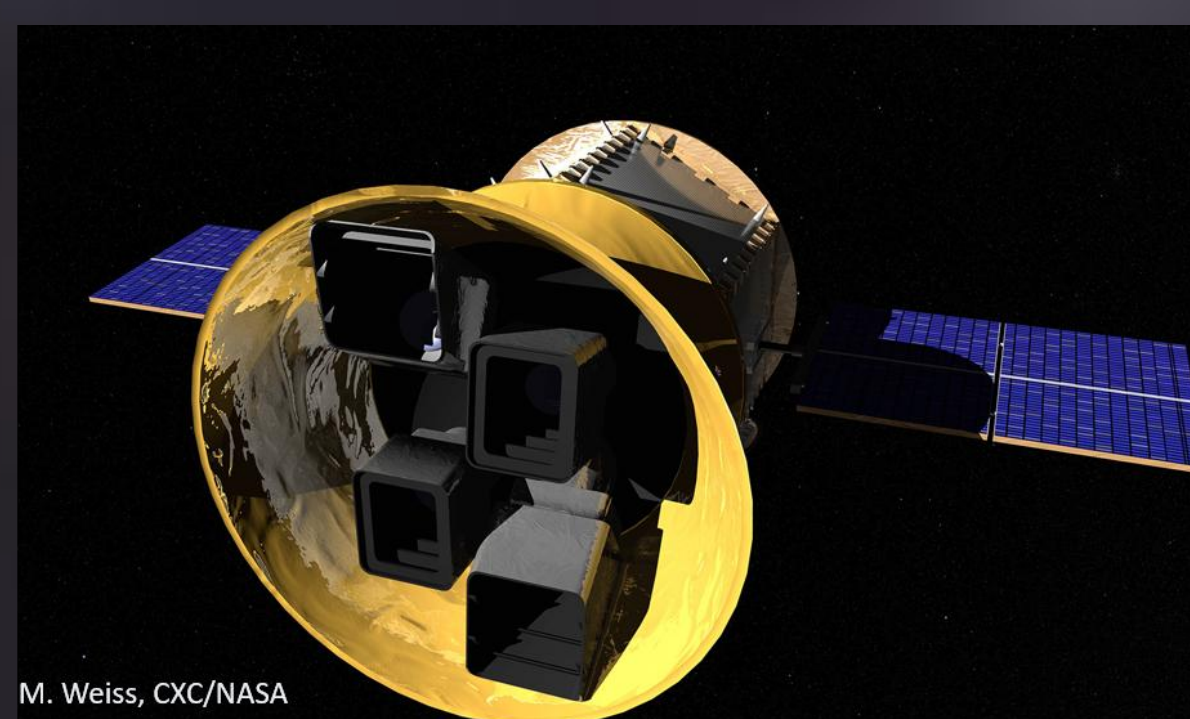


Figure 3. 3D model of TESS telescope

IV. DATA SELECTION

We visually inspected the TESS light curves of **10,584** TNS sources for dwarf-nova outburst structures. These include **normal outbursts**, characterized by a rapid rise followed by a slower decline, and **super-outbursts**, which show an extended bright phase before the final decline, as illustrated in the figure. This selection yielded **144** dwarf nova candidates for further analysis.

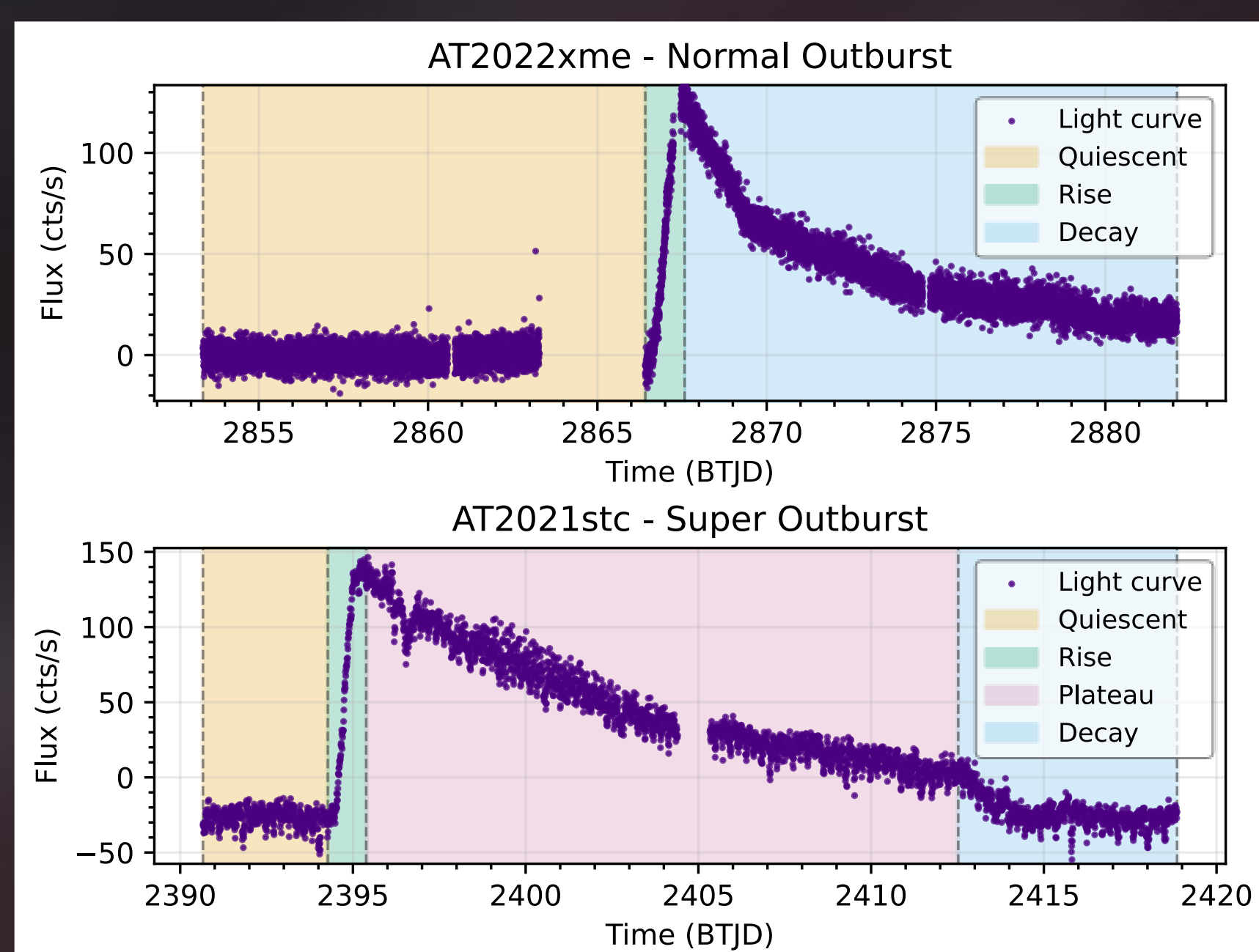


Figure 4: Purple points show TESS flux measurements in counts per second against time (BTJD). Top: AT2022xme exhibits a **normal-outburst** profile, with a rapid rise from quiescence—the faint state between outbursts—followed by a slower decline. Bottom: AT2021stc shows a **superoutburst-like** profile, with a rapid rise followed by an extended, gradually fading bright phase and a sharper final decline toward quiescence.

V. ANALYSIS

1. Period Analysis

We divided each light curve into **pre-rise**, **rise**, and **post-rise** regions. These regions were detrended separately to remove outburst trends, then joined to form a combined light curve. We calculated **Lomb-Scargle** periodograms for the detrended pre-rise, post-rise, and combined datasets to check whether the same periodic signal persisted across them. For sources showing eclipses, we used VARTOOLS's **-killharm** command to model and subtract the eclipse signal, then repeated the period search to investigate additional periodic variations.

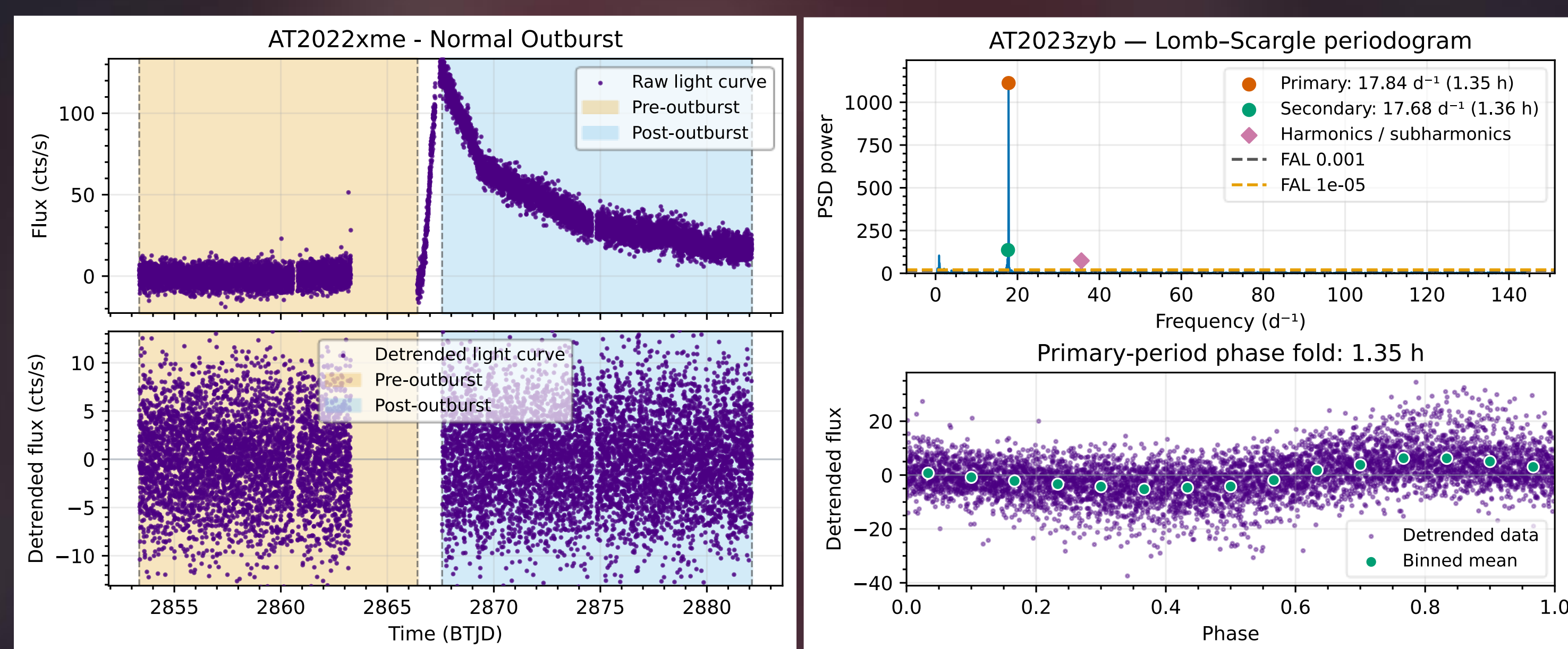


Figure 5: AT2022xme - Original light curve (top) and detrended data (bottom). Yellow and blue shading mark the pre-rise and post-rise regions, respectively. Figure 6: AT2023zyb - Lomb-Scargle periodogram (top), showing a dominant period of 1.35 h. Dashed lines indicate false-alarm thresholds. The light curve folded on the dominant period (bottom) shows the repeating brightness modulation.

2. Outburst Timings

We fitted a fast-rise, exponential-decay (**FRED**) model to normal outbursts and a **modified FRED** model with an intermediate plateau to superoutbursts. These fits provided rise times (t_r) and decay timescales (t_d), along with plateau durations for superoutbursts, where sufficient data were available.

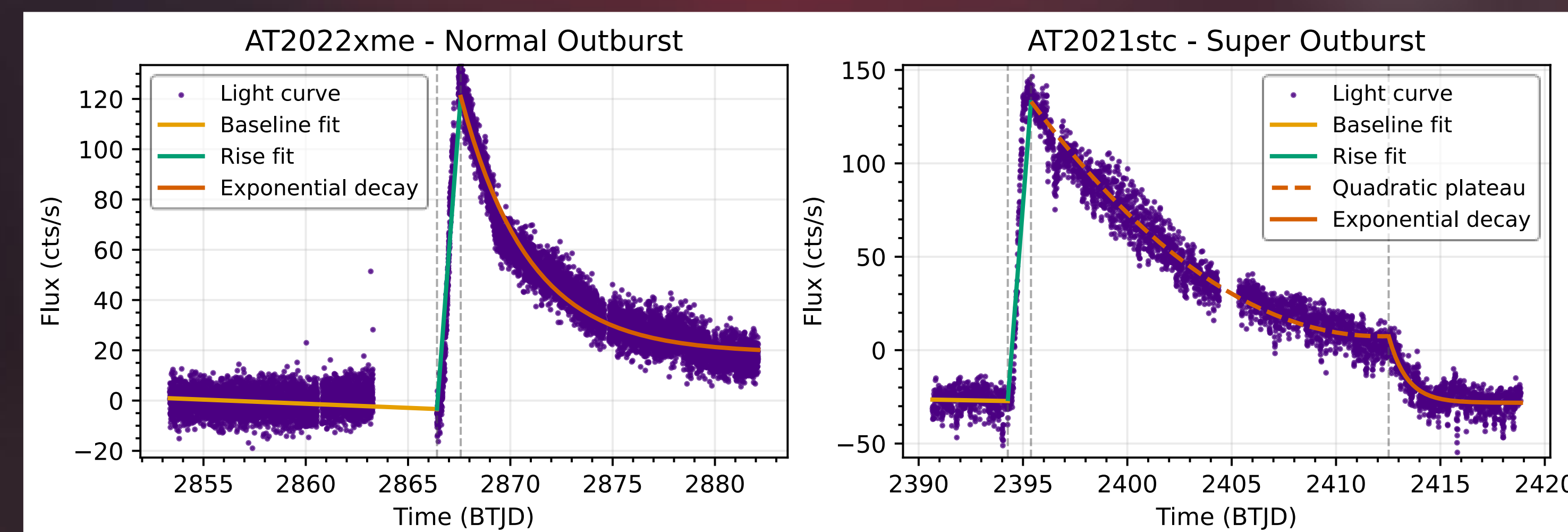


Figure 7: Outburst model fits for AT2022xme (left) and AT2021stc (right). Purple points show TESS flux measurements. The normal outburst is fitted with baseline, linear-rise, and exponential-decay components; the superoutburst includes an additional quadratic plateau between the rise and final decay. Vertical dashed lines mark the adopted phase boundaries.

VI. GAIA COUNTERPARTS

We identified Gaia counterparts for **64 of the 144** sources using a 2-arcsecond search radius around their sky coordinates. For counterparts satisfying the astrometric quality criterion **RUWE** < 1.4 , we estimated **distances** from Gaia parallaxes using Bayesian inference. For sources with Bayesian distance estimates, we calculated absolute magnitudes (M_G) and distances from the Galactic plane ($|z|$). We also estimated mass-accretion rates ($\dot{M}_{tr}$) using adopted assumptions and fiducial white dwarf parameters.

VII. RESULTS

From **10,584** TESS transient light curves, we identified **144** dwarf nova candidates, obtained periods for **96**, and measured rise times for **76**. We found 64 Gaia counterparts, derived Bayesian distances for **50**, and estimated mass-accretion rates for **34** sources.

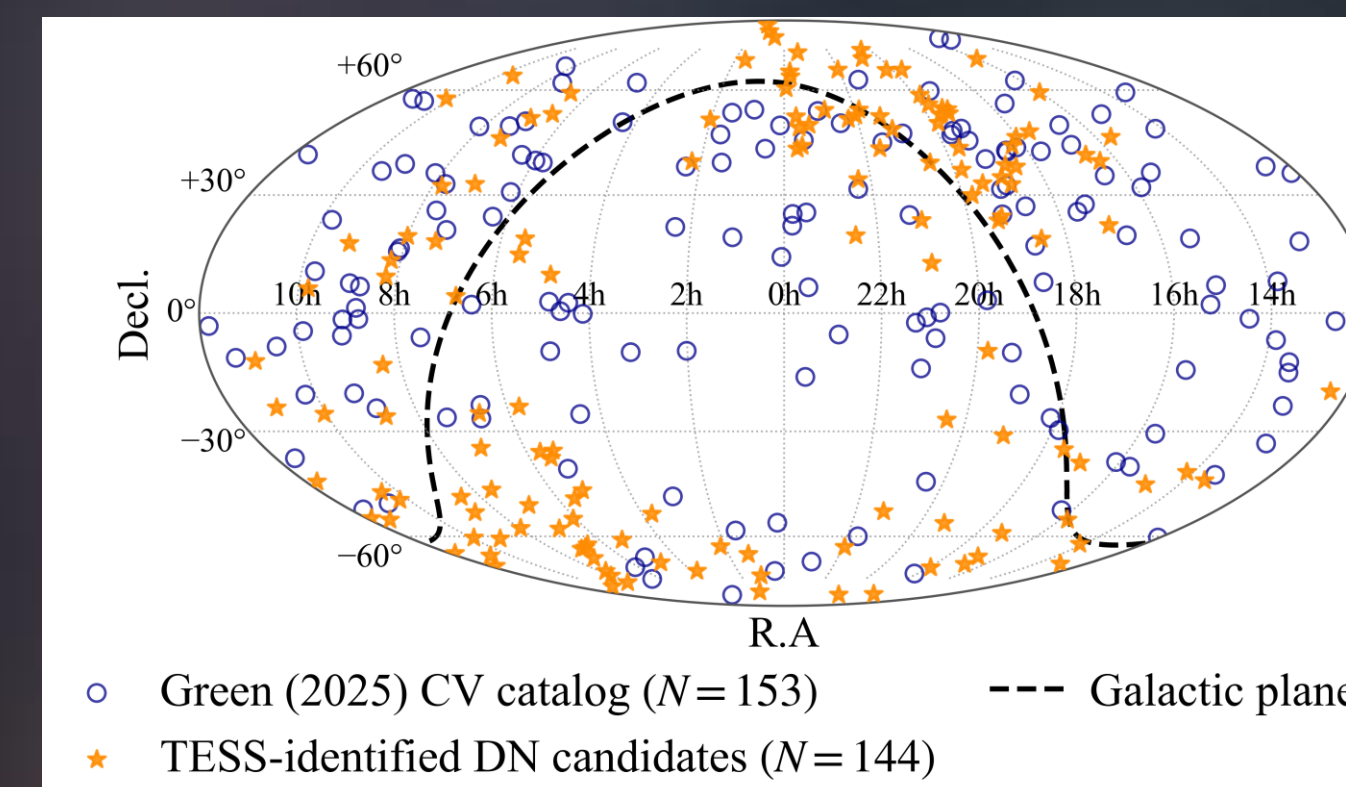


Figure 8: Sky distribution of the 144 TESS-identified dwarf nova candidates (orange stars) and 153 sources from Green et al. (2025) (blue circles). The Mollweide projection shows right ascension and declination, with the Galactic plane marked by the black dashed line.

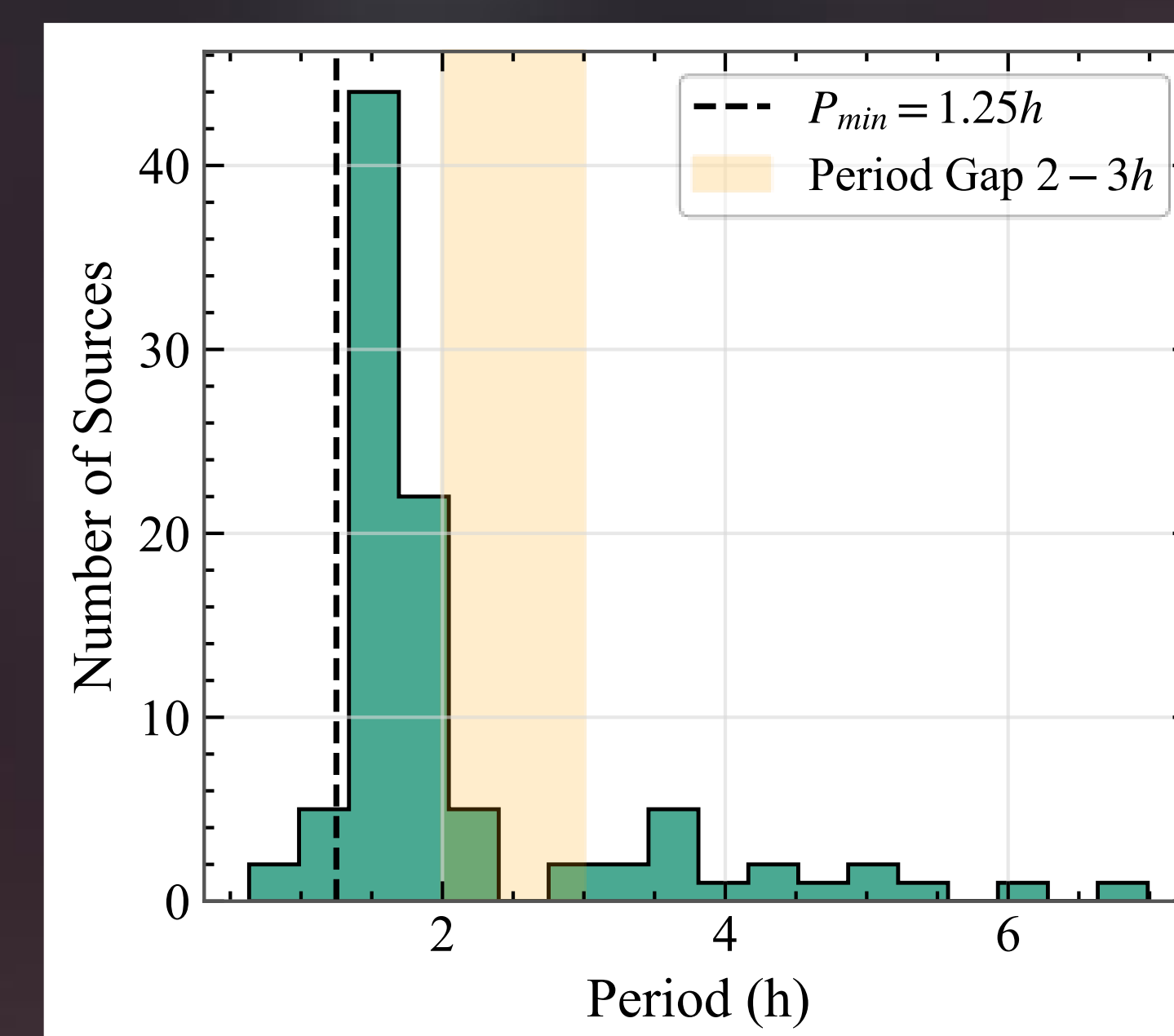


Figure 9: **Period distribution:** Orbital periods for 96 dwarf nova candidates, concentrated below 2 hours with a tail extending to approximately 7 hours. The dashed line marks the period minimum (P_{min}) of 1.25 hours (Warner, 1995), and the shaded region indicates the 2–3-hour period gap.

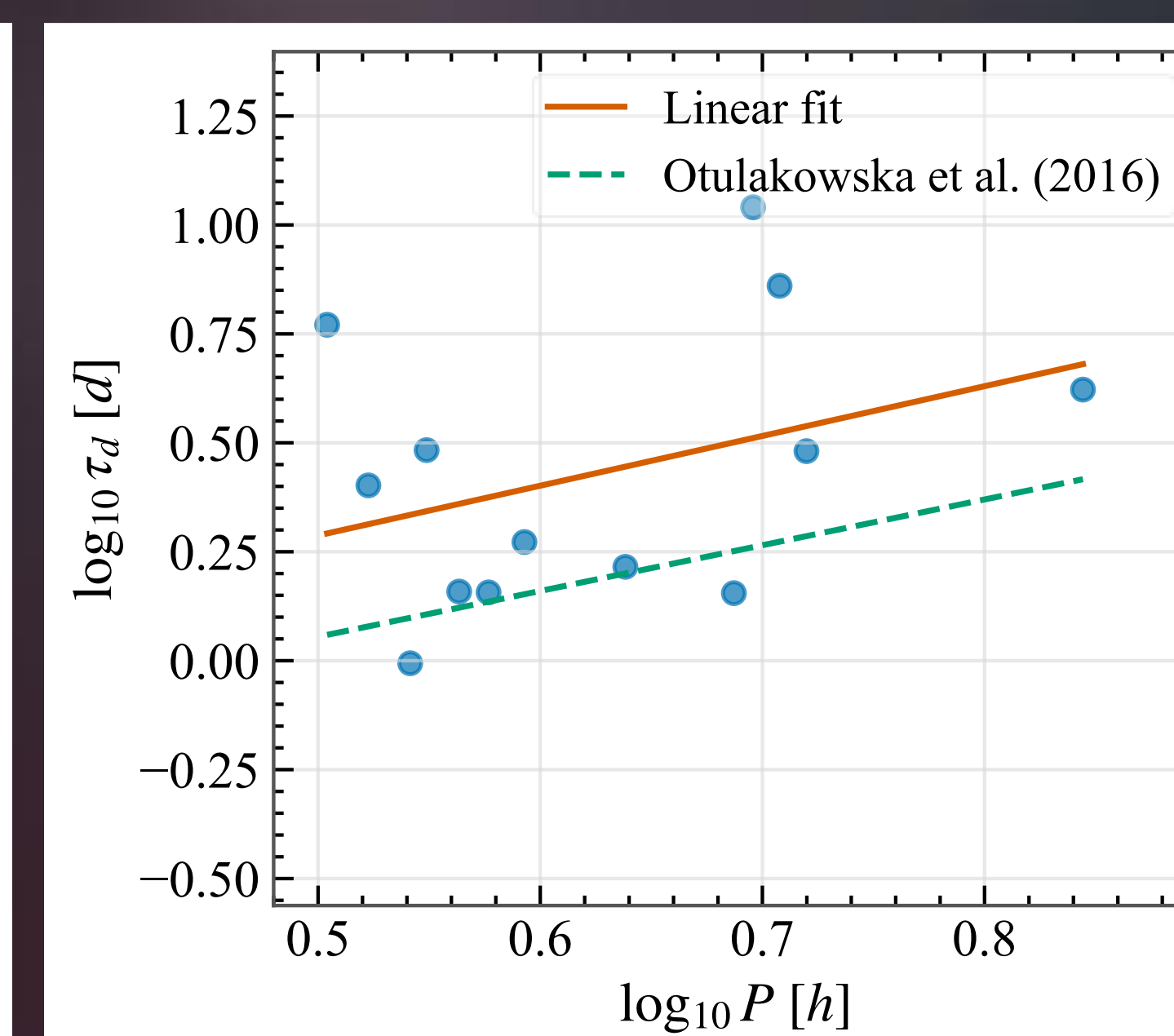


Figure 10: **Decay timescale versus period:** Exponential decay timescale τ_d , versus orbital period (P_{orb}), shown in logarithmic coordinates. The solid orange line represents our linear fit, while the dashed green line shows the relation from Otulakowska et al. (2016).

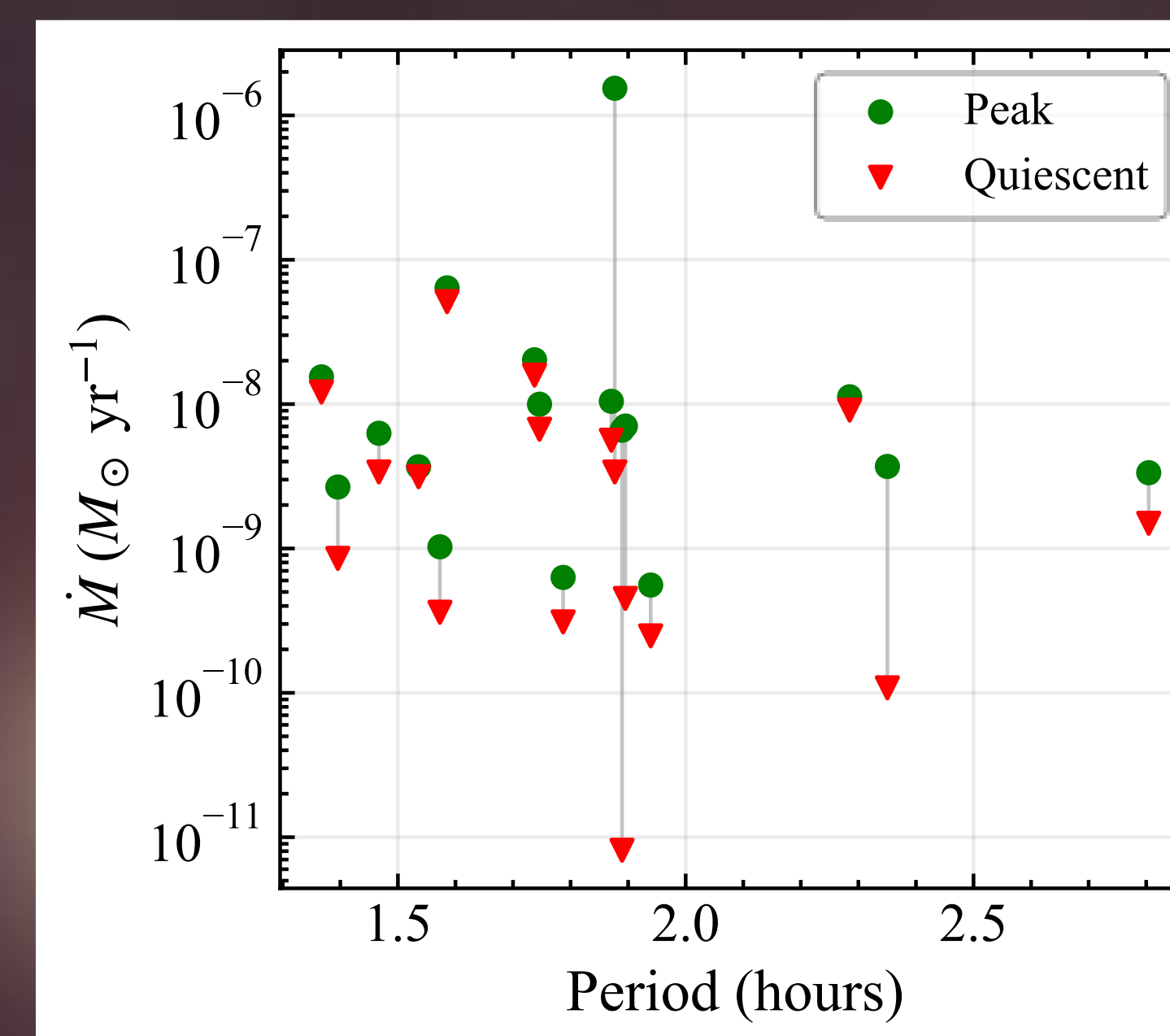


Figure 11: **Estimated mass-accretion rates:** Peak (green) and quiescent (red triangles) accretion-rate estimates versus orbital period. Lines connect measurements for the same source. Estimates assume fiducial white-dwarf parameters (M_{WD} and R_{WD}) and a fixed bolometric correction $B.C.$; quiescent values represent upper limits under these assumptions.

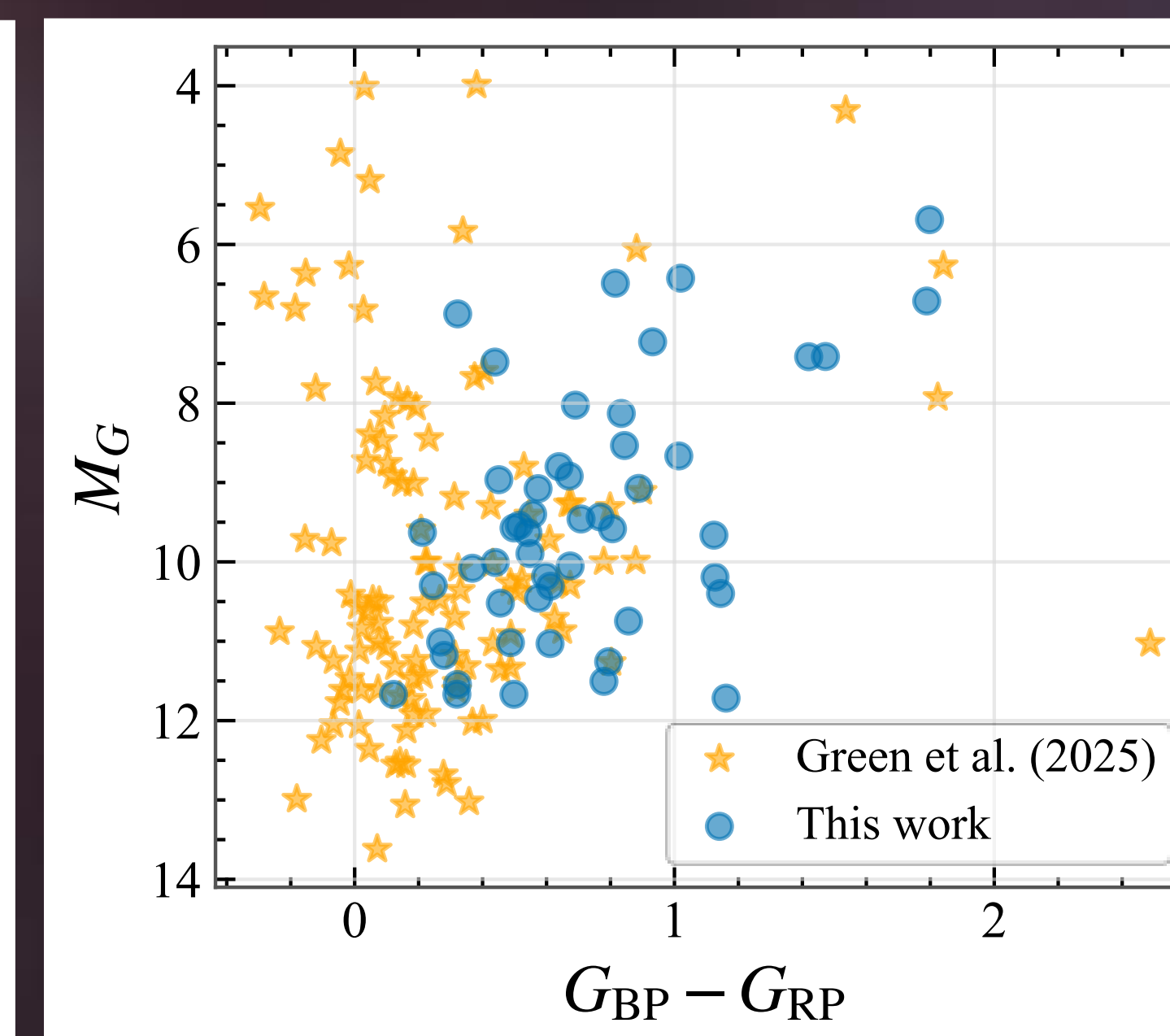


Figure 12: **Gaia color-magnitude diagram:** Our dwarf nova candidates (orange stars) with accepted Gaia distances (blue circles) compared with the ultracompact binary sample of Green et al. (2025) (orange stars). The axes show Gaia color ($G_{BP} - G_{RP}$) and absolute magnitude (M_G), with brighter sources toward the top.

VIII. FUTURE WORK

- **Obtain multiband photometry** to track outburst color changes unavailable from TESS's single-band observations.
- **Measure quiescent magnitudes** to improve outburst measurements and comparisons with published relations.
- **Acquire spectra** to resolve uncertainties in candidate classification, composition, and orbital periods.
- **Assess gravitational-wave detectability with LISA** for candidates with $P_{orb} < 1hr$.