

# New Eclipses from the Former Eclipsing Binary QX Cas

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## 1 DDT Justification

QX Cas (TIC 326815804) is a formerly eclipsing binary star system, whose  $P=6.005$ d eclipses were found to no longer be detectable in 2003 (Bonaro et al. 2009, Guinan et al. 2012). However, eclipses have been detected in TESS Sector 018 for QX Cas, with a period of  $P=1.042$ d, as well as low-amplitude signal at the original 6.005d period. Additional 2-minute cadence data is needed to help determine if these new eclipses belong to QX Cas or a faint background source, and if the original orbital period can be detected with greater fidelity. Since this discovery was based on serendipitous analysis of the Sector 018 data, it was not known at the time of the recent Cycle-3 proposal. We request this system be added to short cadence observations in the upcoming Sector 024.

## 2 Scientific Justification

A rare class of eclipsing binary stars are systems that have ceased eclipsing. The change in eclipse amplitude over years to decades occurs from a rapid precession of the system's inclination, typically due to interaction with a relatively close third stellar component. These objects are a valuable look at young, dynamically evolving hierarchical triple systems.

Eclipses from QX Cas were observed to disappear in ground-based observations after 2003 (Bonaro et al. 2009), following over 40 years of slowly declining eclipse depths and changing system inclination (Guinan et al. 2012). The current inclination of the system is likely  $\sim 70^\circ$ , and no eclipse signature is expected again for several centuries. However, detecting the  $P=6.005$ d orbital period (formerly the eclipse period) via modulations due to starspots or tidal distortion of the stars would be useful in constraining the current system orientation and characterizing possible mass loss or dynamical evolution.

We examined the TESS short cadence light curve of QX Cas from Sector 018, and found three surprising results, leading to this DDT proposal: **1)** starspot modulation is seen with a period of  $P\sim 1.7$ d and flux amplitude of  $\sim 2\%$ , **2)** an eclipsing binary signature is seen with a period of  $P=1.042$ d, and **3)** weak power in the Lomb-Scargle periodogram is detected around the original  $P=6.005$ d orbital period. Additional TESS monitoring will help determine if the original orbital signal is stable and in-phase with archival observations.

The nearby star TIC 2047793341 ( $\text{sep}=3.66''$ ) is  $\sim 24\times$  fainter than QX Cas, and could conceivably be responsible for the 0.7% amplitude,  $P=1.042$ d eclipse signature. However, for this interloper to solely produce the  $\sim 2\%$  amplitude,  $P=1.7$ d starspots observed it would have to exhibit an unlikely 45% flux modulation. If these two shorter period features *do* belong to QX Cas, then the system would be composed of an extremely tight hierarchical triplet of stars, with a likely fourth star causing the slow inclination evolution previously seen.

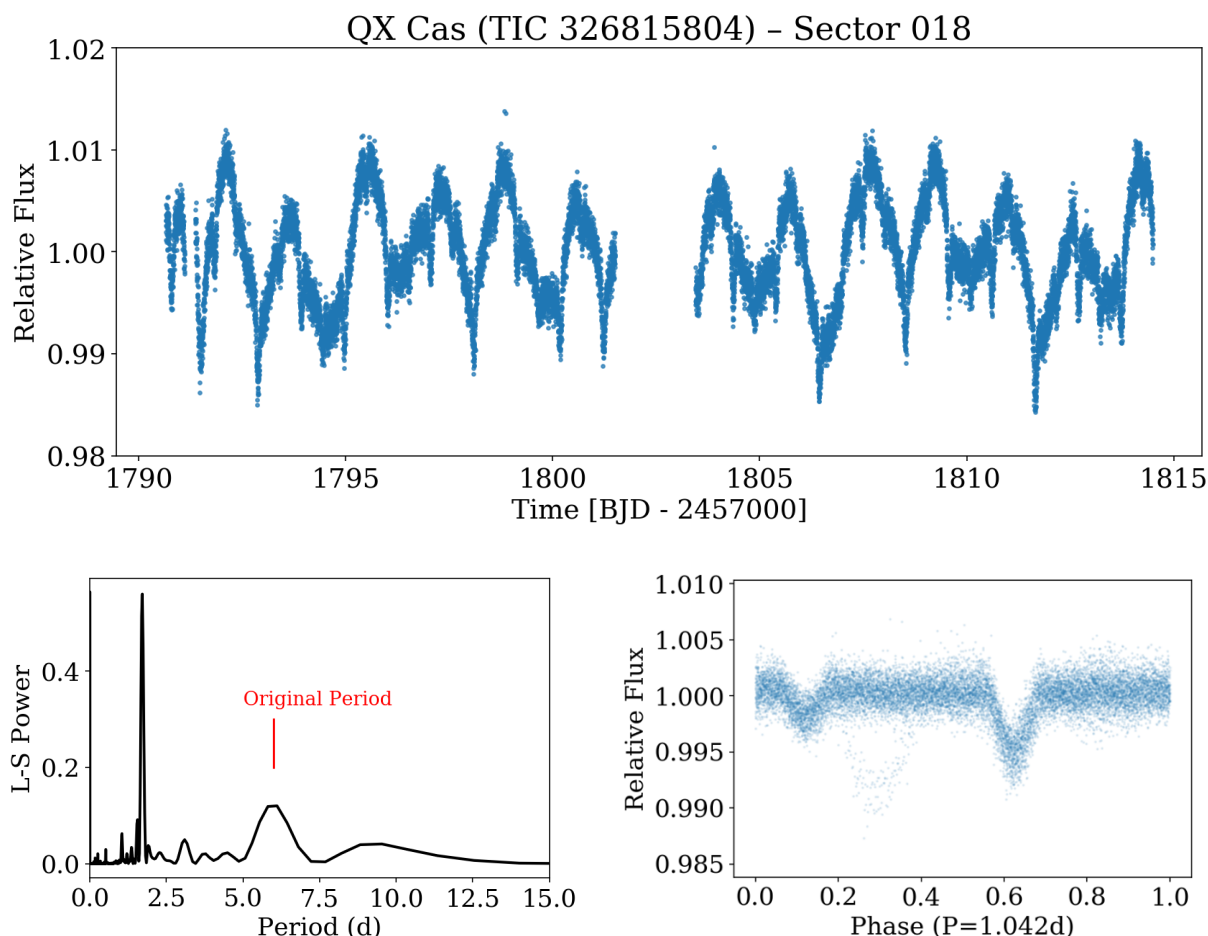
### 3 Target Justification and Feasibility

QX Cas is fairly bright ( $T=9.98\text{mag}$ ), and has previously been targeted for short cadence observations in Sector 018, as shown in Figure 1. The realignment of TESS Sector 024 pointing to avoid scatter light means QX Cas is predicted to be visible on Camera 4 according to the “Web TESS Viewing Tool”.

### 4 References

Bonaro, M. et al., BAAS v41, p301 (2009)

Guinan, E. F., Engle, S. G., & Devinney, E. J. JAAVSO, 40, 467 (2012)



*Figure 1 – **Top:** TESS Sector 018 PDCSAP\_FLUX light curve for QX Cas, showing substantial variability. **Bottom Left:** Lomb-Scargle Periodogram for this data. A small amount of power is apparent at the 6.005 day orbital period. **Bottom Right:** QX Cas light curve phased at the 1.042 day period, showing a clear eclipsing binary signature. It is unclear if this is from a background star (e.g. TIC 2047793341,  $T=13.38\text{mag}$ ,  $\text{sep}=3.66''$ ) or QX Cas (TIC 326815804,  $T=9.98\text{mag}$ ).*