Generating a Test Set for Machine Learning Detection of AM CVn Transients with TESS

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Abstract

The Transiting Exoplanet Survey Satellite (*TESS*) has observed nearly the entire celestial sphere since its launch in 2018. While the primary goal of the spacecraft is the identification of exoplanets, we will use the data to search for accreting white dwarf binaries (also known as AM CVns) using machine learning methods. This work details our attempts to generate a test set of AM CVn observational characteristics from known objects. We have performed photometry on several known AM CVns observed with TESS, cataloged their characteristics, and we have also identified several other possible transient objects of interest. The data set generated in this work will form the basis of the machine learning model we will use to detect AM CVns on a large scale.

Motivation

At the end of a mid sized star's lifetime, they become a white dwarf, a dense core of stellar matter. Often times white dwarfs are found in binary systems. For orbits < 70 minutes, we classify these binary systems as AM CVns where one star accretes mass from the other during the orbit (Rivera Sandoval et al. 2021). These binaries have light curves that show characteristics not seen in other compact systems, such as outbursting. We'd like to study these objects further in depth as they provide insight into stellar evolution.

Methods and Discussion

Our goal was to generate a set of photometric characteristics of known AM CVns and other transients. We investigated two data sets. One data set was of previously unidentified transients in *TESS* Sector 01 data (Ricker et al. 2014). We masked known stars and then visually identified "new" stars, also known as transients. Next, we used a list of known AM CVns and investigated *TESS* Sector 70 data.

We used `PYTHON` to obtain photometric light curves of each object from a daily co-add of imagery. These light curves have the background subtracted and the resulting flux normalized and are shown in the top plot of Figure 1. We then used the `PHOTUTILS` routine `APERSTATS` to provide the photometric characteristics of the AM CVn point spread function. These results are in Table 1.

We repeated these methods of the non-AM CVn transients and catalogued the mean `APERSTATS` value for both groups. These characteristics will be used to automatically identify transients of different sub-types in the future. We plan to apply these methods across all *TESS* Sectors in the future.

References

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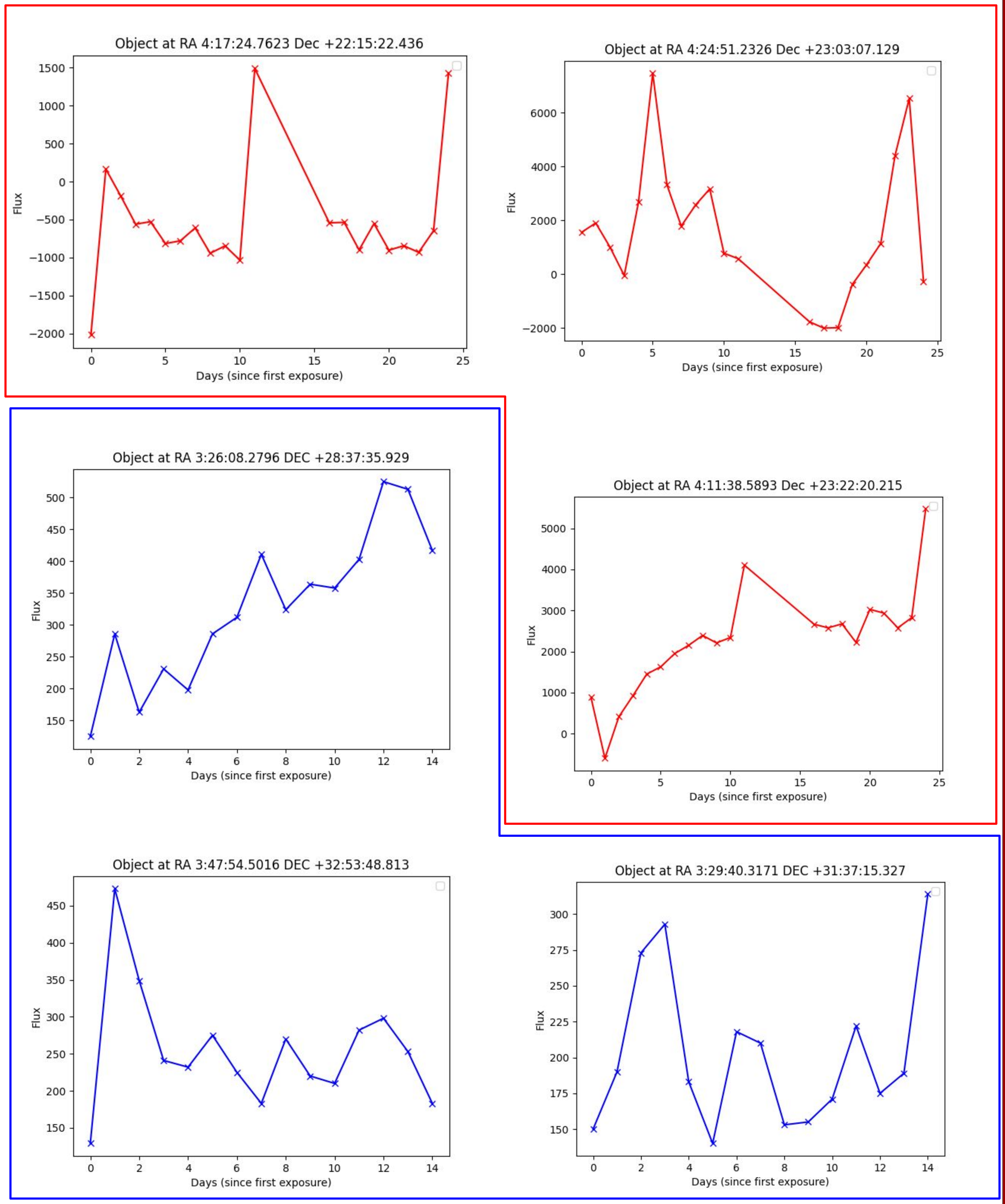

Figure 1: 6 representative light curves for 3 AM CVn transients (red boxes) and 3 other transients (blue boxes). The light curves have been binned into 1 day intervals for clarity.

	Summed Pixel Value	Mean Pixel Value	Fwhm (pix)	σ_A (pix)	σ_B (pix)	Eccentricity
Other Transients	2885	13	9.78	4.2	4.12	0.15
Known AM CVns	732128	19073	4.11	1.8	1.656	0.4

Table 1: Mean photometric characteristics for each sub-type of transients studied in our sample. We believe these characteristics may be useful for our machine learning in the future because of the stark differences between sub-types.

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