Determining Uncertainty in TESS Light Curves Using Eclipsing Binaries

***Jaide Swanson*[1]** *Keaton Bell*[1,2] *J.R.A. Davenport*[1]

1. University of Washington
2. NSF Astronomy and Astrophysics Postdoctoral Fellow

Project Motivation:

Large TESS pixels are susceptible to crowding as they record light from multiple stars. To account for this contamination in short, the additional light is subtracted off short cadence light curves by the Presearch Data Conditioning [1] pipeline (recorded as the header keyword CROWDSAP) to produce light curves centered on the average flux of the target stars. Without exact precision on this estimated CROWDSAP factor, measurements made from TESS light curves of transit depths and variability amplitudes will be affected by a systematic error [2]. To address this problem we are developing a process to independently determine this crowding metric by combining light curves of eclipsing binaries from TESS with ground based telescope data from ASAS-SN [3]. Our process allows for the precision of the CROWDSAP factor to be assessed, producing results that include levels of uncertainty that are advised to be incorporated in future analyses of TESS data for more reliable results.

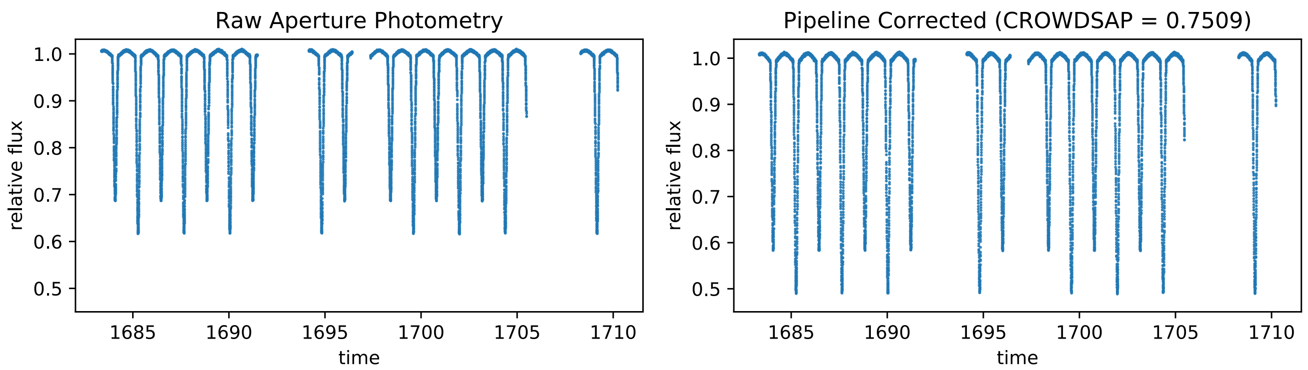

Fig 1: Simulated data displays an eclipsing binary light curve comparing the raw data (left) with PDC corrected data (right). The determined crowding metric alters relative flux values affecting subsequent measurements made from the data.

CROWDSAP Determination:

To determine our CROWDSAP estimation, parameters for stellar properties and an estimated crowding metric are sampled using **Emcee**'s [4] Markov Chain Monte Carlo implementation. Binary stellar parameters are generated from **Isochrones** [5] interpolator program for binary stellar properties to produce values for radii, absolute magnitude, and effective temperature. These parameters are passed to **ellc** [6] to generate model eclipsing binary light curves that are compared for quality of fit to both the TESS and ASAS-SN data. This process returns distributions for the convergent parameter values, including the CROWDSAP factor, which can be compared to the CROWDSAP value used by the PDC pipeline.

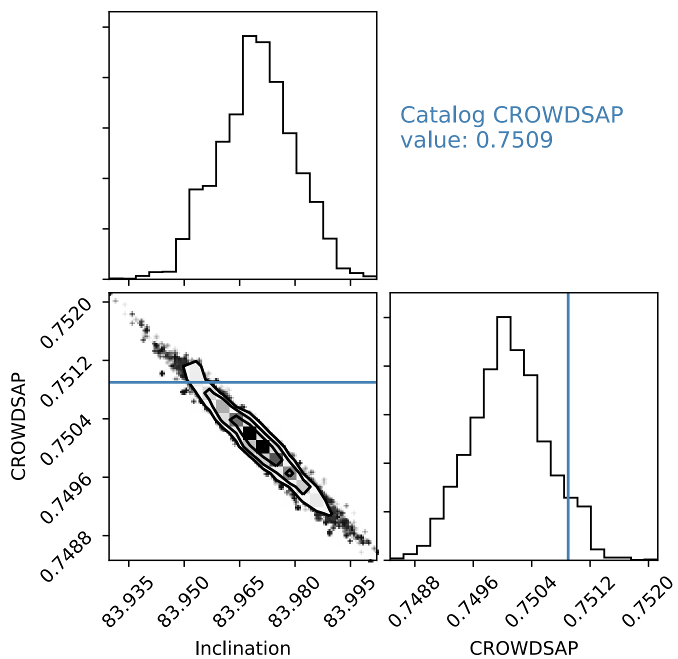

Fig 2: Utilizing simulated data, the process for determining the crowding metric returns the distribution of CROWDSAP values with convergent values less than the catalog value from which the relative uncertainty can be determined.

What's Next:

As our fitted light curve models prove successful, stars with different CROWDSAP values can be compared to our independently determined values to assess the unstated uncertainties on the pipeline values. This programs will be scaled up for larger numbers of eclipsing binary light curves, allowing for an independent determination of the level of systematic error introduced in the data processing pipeline as a function of light crowdedness. Though we are still in the preliminary trials of this project, we expect to achieve accurate results for the extrinsic error in the CROWDSAP header values that can be included in future studies done with TESS data.

References:

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