Citizen Science Project: Flares in Open Clusters

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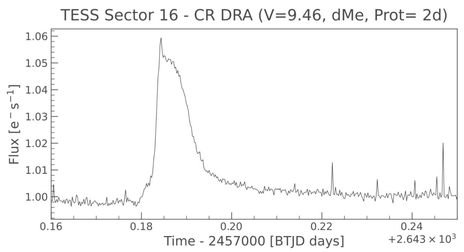
OVERVIEW

Stellar flares are violent eruptions driven by magnetic reconnection that can severely impact exoplanet atmospheres and distort transit signals.

Typical Flare Profile:



Characterizing these events requires high-cadence observations; however, space-based assets like TESS are often suffer from blending challenges in crowded fields. To address these limitations, we present a citizen science project that leverages a **network of 4-inch Unistellar eQuinox 2**. These scopes also offer better spatial resolution over TESS, mitigating its blending issues. These scopes will be operated by educators across Idaho.

We will attempt to isolate the flares' chromatic behavior across the blue, green, and red channels. The combined green and red channels can approximate the TESS bandpass, while the blue mirrors the Kepler peak. Preliminary analysis demonstrates that continuous 4-hour observation windows are sufficient to capture multiple, distinct flaring events on active objects. With this project, we could determine the flare rates for different young stars in open clusters.

Will this Project Work?

PRECISION

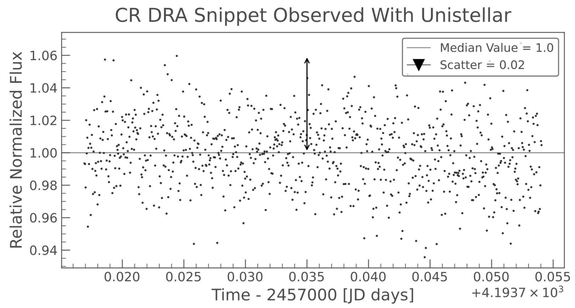
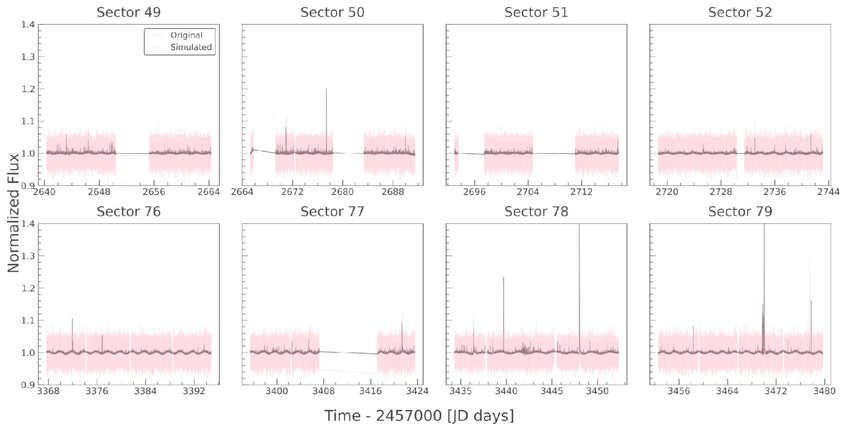


Figure 1: Light curve of the Unistellar observation for M dwarf CR DRA. In this figure, we calculate the scatter of the data points. We note that the exposure time for this object was 4 seconds, making the max counts at the center of the object less than 9000 (saturation limit ~60000 counts). Increasing the exposure time would most likely decrease the scatter and allow for more comparison stars.

Figure 2: All TESS sectors with 20s cadence. The black data is the original TESS data, while the pink data illustrate the photometric scatter by a Unistellar scope for comparison. Each line sticking up from the baseline flux is a flare. From this plot, we see that the Unistellar scopes could detect the larger flares exhibited by CR DRA. A longer exposure time could likely allow us to see smaller flares.



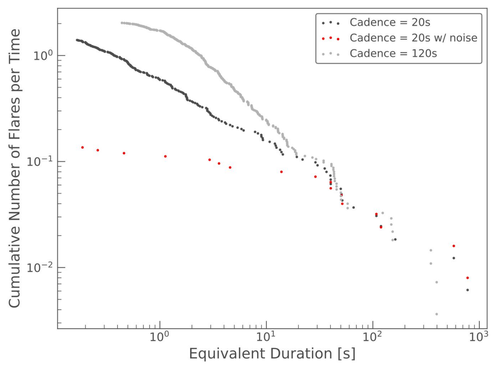


Figure 3: A flare frequency distribution (FFD) plot for TESS 20s cadence, TESS 120s cadence and TESS 20s cadence with the scatter calculated from the Unistellar scope. The 120s cadence data exhibit the most flares because it has the most sectors. The 20s cadence data more clearly exhibit lower energy flares(< equivalent duration). While 20s cadence with noise is worse at both. However, we plan to increase the exposure time and make sure each target has at least one other telescope. Even with the limited sensitivity of the Unistellar scopes, we expect to be able to recover population-level flare statistics.

FUTURE STEPS

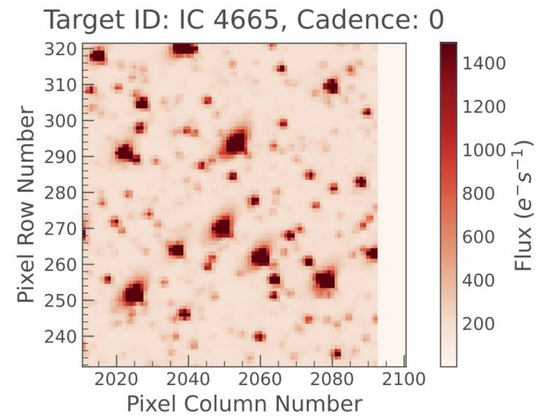


Figure 4: The goal is to use the Unistellar scopes this summer to observe an open cluster and allow for multiple telescopes for each object. Here we have a TESS FFI of the IC 4665 open cluster. Using the literature (e.g. *Prosser et al. 1993AJ....105.1441P*), we will be able to find targets to observe.

ACKNOWLEDGEMENTS

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