Flaring M-dwarfs in the TAOS II Fields

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TAOS II

The Trans Neptunian Automated Occultation Survey (TAOS II) is the successor to the Taiwanese-American Occultation Survey. It is designed to measure the size distribution of small (~1 km diameter) Kuiper Belt Objects (KBOs) to better model the evolution of the Solar System. The detection of these objects is very difficult because their magnitudes are extremely faint with typical magnitudes being greater than 28. This makes these small KBOs nearly invisible to even the strongest telescopes. However, as these objects pass across the line of sight of a distant star, they will produce a detectable decrease in the brightness of said star. TAOS II intends to detect these occultation events and to measure the size distribution of KBOs whose diameter lie between 0.5 - 30 km. TAOS II will operate three 1.3m telescopes at the Observatorio Astronómico Nacional in Baja California, Mexico. The system will monitor 10,000 stars simultaneously at a cadence of 20 Hz.

Photo credit: TAOS II - Transneptunian Automated Occultation Survey

Flaring M Dwarfs

Dwarf stars of type M and later are known for flaring. These flares are particularly bright in the U band of light. They become quite problematic when looking for very small objects at very large distances occulting even more distant stars. As such, they are an interesting topic to investigate in the context of the TAOS II project. We sought to determine the flare rate of these M-dwarf stars in the TAOS II fields by using the existing CFIS U-band data.

Methods

We accessed the CFIS U-band data of all of the stars located the 167 TAOS II fields. We then sorted through the data to select only the M-dwarf stars and got all of the available exposures of each star. Next, we performed aperture photometry using the Python package trippy (Fraser, W. *et al.*, 2016) to obtain the apparent magnitudes of the target in each exposure. We compared these magnitudes to the magnitudes which were measured by CFIS and performed statistical analysis to determine the deviation between the measured and established magnitudes. We determined the distribution of the deviations, and flagged any exposure with a deviation that was greater than 3 standard deviations from the mean as a 'potential flare'. We manually checked each exposure that was labelled a 'potential flare' to remove any that were two point sources very near each other, or that were contaminated by noise which would affect the magnitude measurement. The remaining exposures were deemed flare events. We then determined the mean exposure time, and the median number of exposures per star in order to determine the flare rate of the M-dwarf stars.

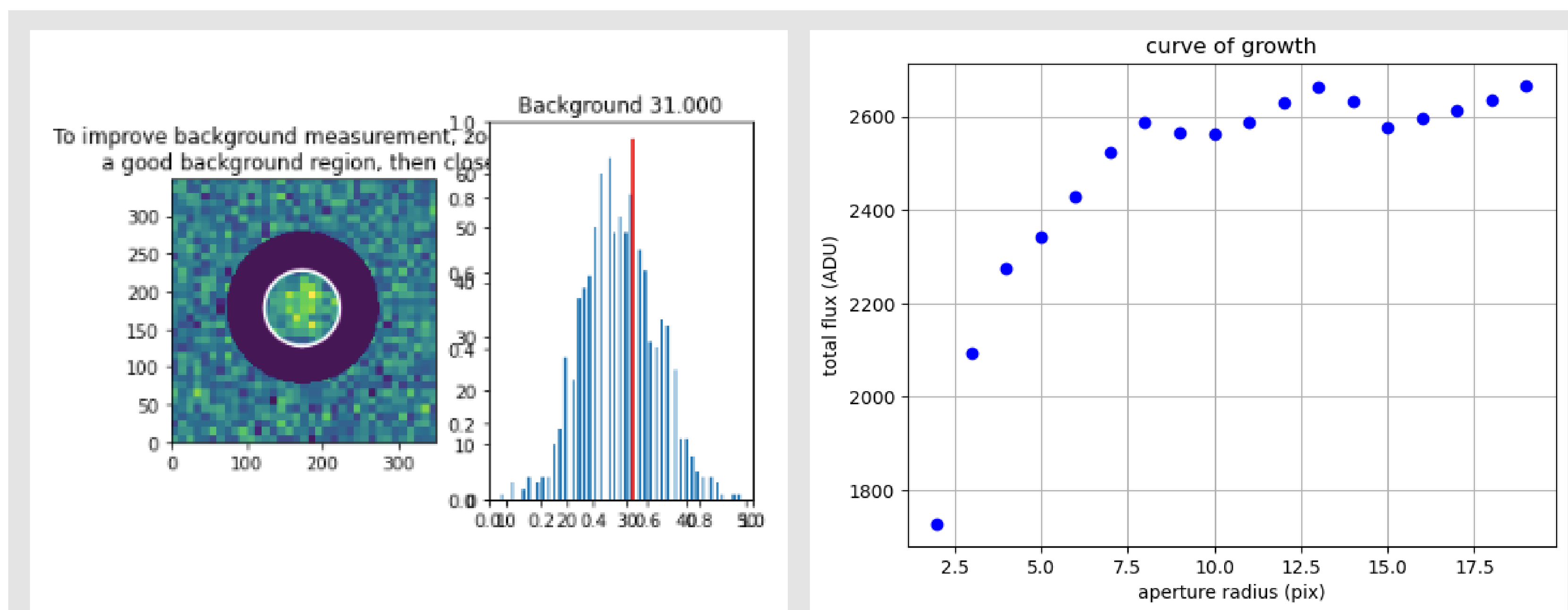

Figure 1. a) Trippy output. b) Curve of growth for total flux vs aperture radius. Used to estimate optimal aperture radius.

Results

We observed **93 flares** on the **3955 M-stars** in the TAOS II fields. There were **11972 exposures** which lasted an average of **80.096 s** each, and each star had a median of **3 exposures**. With this information, we were able to determine an upper and lower limit on the flare rate for these stars.

M Star Flare Rate Upper Limit

3.491×10^{-1} *flares/hr*

M Star Flare Rate Lower Limit

7.384×10^{-4} *flares/hr*

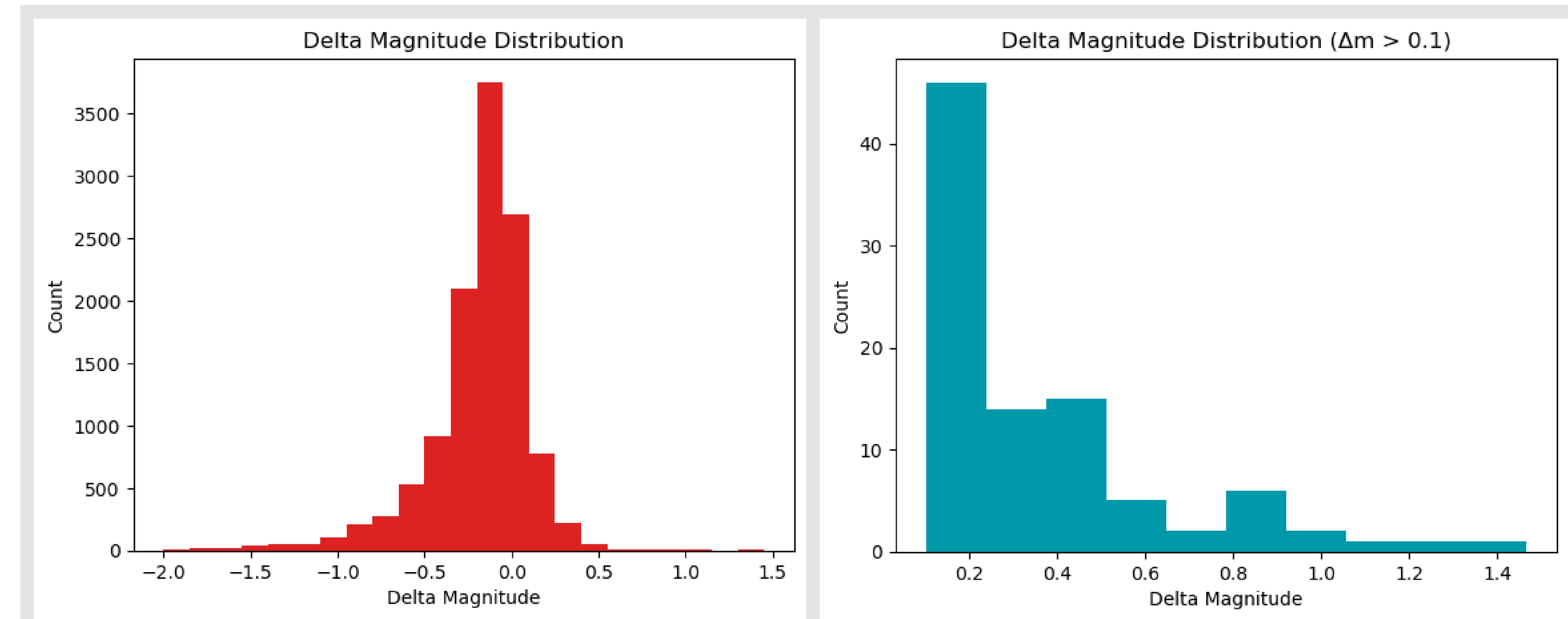

Figure 2. a) Delta magnitude distribution for TAOS II stars. b) Delta magnitude distribution for exposures with $\Delta m > 0.1$.

Future Work

The flare rates that we obtained for the TAOS II fields were far greater than what experts in the field would expect. We suspect that this may be the result of false positive noise sources. Our plan is to do a re-analysis using a different method to see if we can repeat these results. We also plan to examine the entire CFIS u-band dataset, instead of just the TAOS II fields. This will give us a more statistically significant result.

References

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