DETECTING DEEP, LONG-DURATION ECLIPSES IN WASP WITH MACHINE LEARNING

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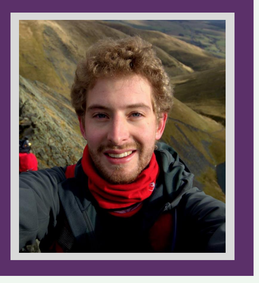
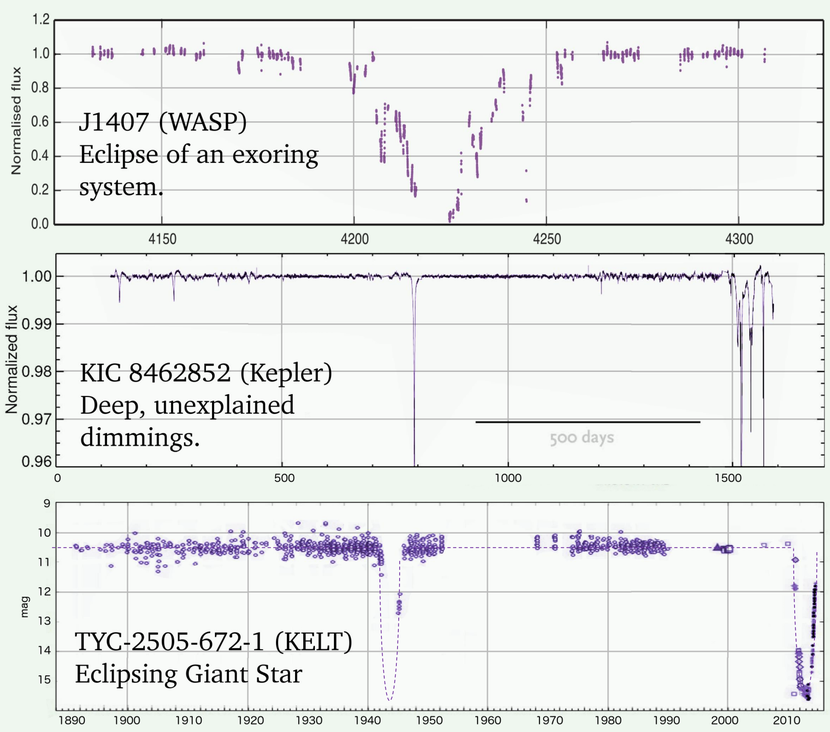


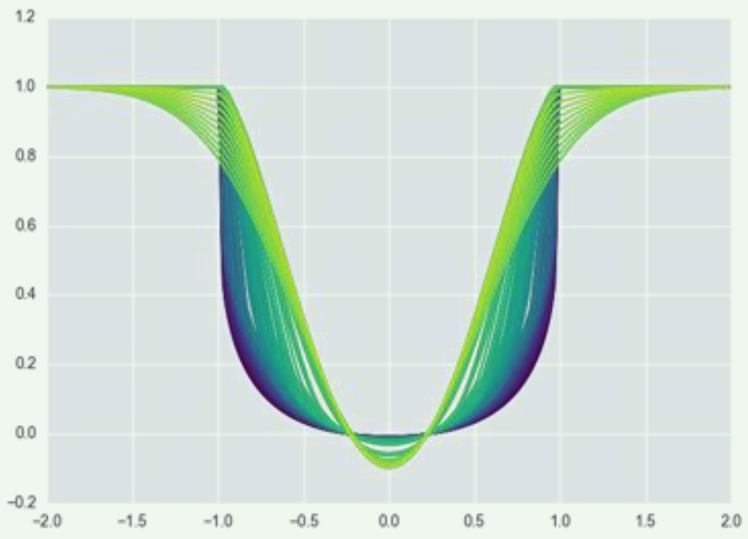
BACKGROUND

Deep, long-duration eclipses have been found around a variety of stellar types and from a range of mechanisms. They include dust disc interaction, circum-secondary material in eclipse and as-yet unexplained dimmings around main sequence stars.



SEARCH

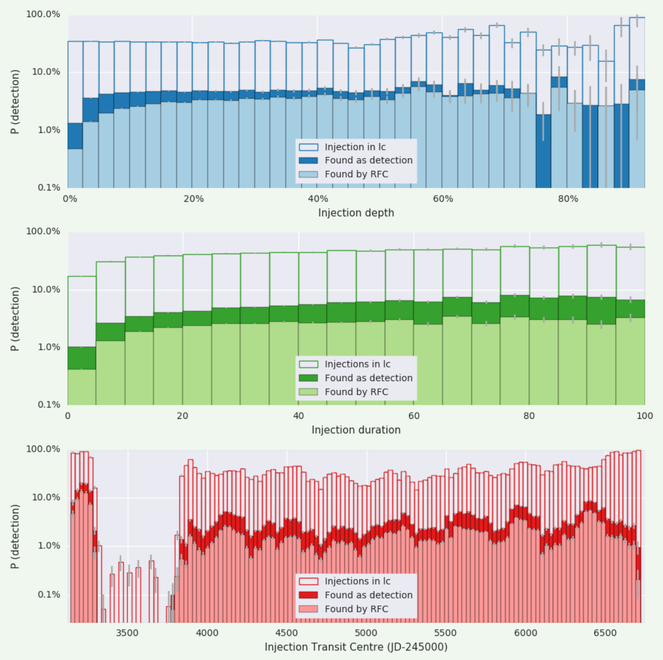
We undertook a targeted search of deep eclipses was performed on nightly averaged photometry of 2 million bright (<13.5 mag) star observed with WASP from 2004 to 2014. Injections of regular, deep eclipses with durations from 5 to 50 days were also performed to test the recovery process. 13M detections across 1.7M objects were found. A variety of statistics on each were collected: time, depth & duration of eclipse, noise statistics of the lightcurve, the number of simultaneous detections,. and χ^2 fits for both an eclipse model & a 'systematic' flux-drop model.



MACHINE LEARNING

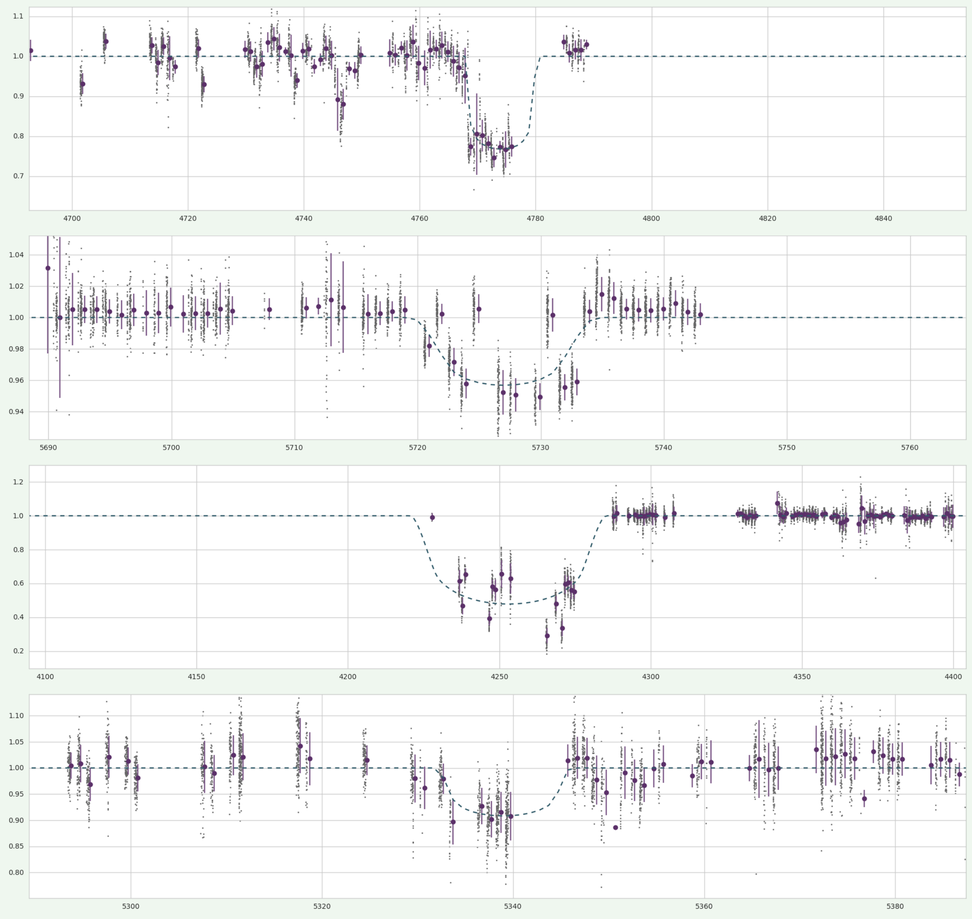
Random Forest classification:	No Eclipse	Eclipse
No injection	**13.5M**	722
Injection	33204	**35078**

In total XX eclipses were injected into YY% of all light curves. We applied the detection statistics to a Random Forest machine learning algorithm, with 3.5M candidates used as a training set and 13.5M as a test-set. The random forest found 50% of all injected eclipses, with a false positive rate of only 2%.



Performance of the initial search & subsequent random forest with injection parameters.

NEW CANDIDATE ECLIPSES

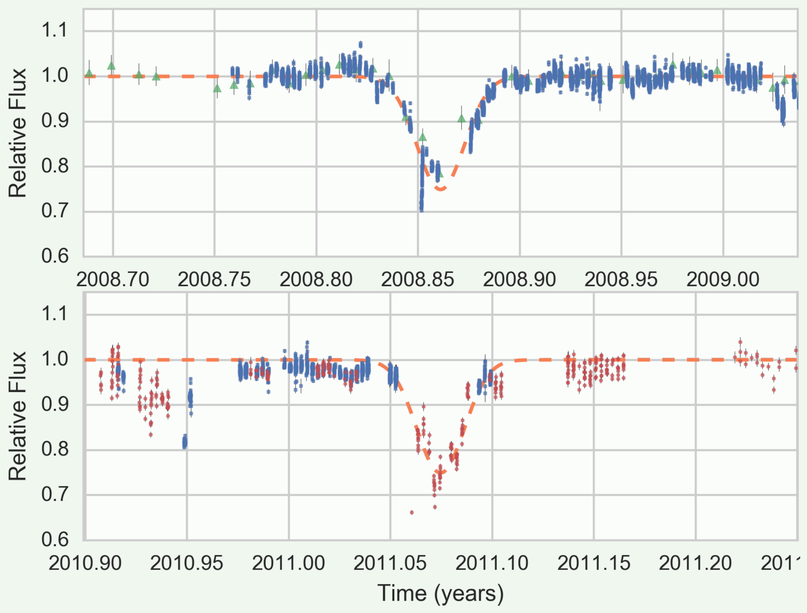


Applying lightcurves without injections to the random forest identified 300 new eclipse candidates. The majority were systematics. Four apparently real eclipses for which follow-up is ongoing are shown here.

Systematics detected:

- Missed injections (30 %)
- Variables (20%)
- Chip defects (20%)
- Moon (5%)
- EBs (5%)

PDS-110



Eclipses in 2008 (WASP) & 2011 (KELT). Potential periodic circum-planetary ring system. Repeats Sept '17

OCCURRENCE RATE

From the number of deep eclipses detected and the rate of injection recovery we are able to place upper limits on the occurrence rate of >10%/>15d eclipses to <10 per million stars per year.

REFERENCES

1. Mamajek, E., et al. *AJ* 143.3 (2012)
2. Boyajian, T.., et al *MNRAS* 457.4 (2016)
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4. Osborn, H. et al. *MNRAS* (2017) in prep

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