Predicting the yield of long-period planets in *TESS*

Toby Rodel (They/Them), **Daniel Bayliss** (He/Him), **Samuel Gill** (He/Him)

We present a study of the yield for the *TESS*[1] mission, focusing on longer-period transiting exoplanets (P>25days). We use real Year 1 *TESS* data with injected transits to create sensitivity maps which we combine with known *Kepler*[2] occurrence rates. We define a realist detection probability using a gamma function that considers the number of transit events in the data. We predict a total of 1485^{+912}_{-605} exoplanet detections, of which 241^{+129}_{-102} have periods greater than 25 days. This yield is slightly greater than the TOI discoveries to date from Year 1 of *TESS* SPOC lightcurves of which there are 836 TOIs, 50 of which have periods greater than 25 days.

1. Introduction

- *TESS* has discovered numerous transiting exoplanets around bright stars, although relatively few of these have periods > 25 days (Fig 1).
- Longer period exoplanets are likely to only appear as a single transit event (**monotransit**) in *TESS* data.
- Our new *TESS* yield study is is the first to use the 1.2 million Year 1 SPOC lightcurve data and including monotransits.

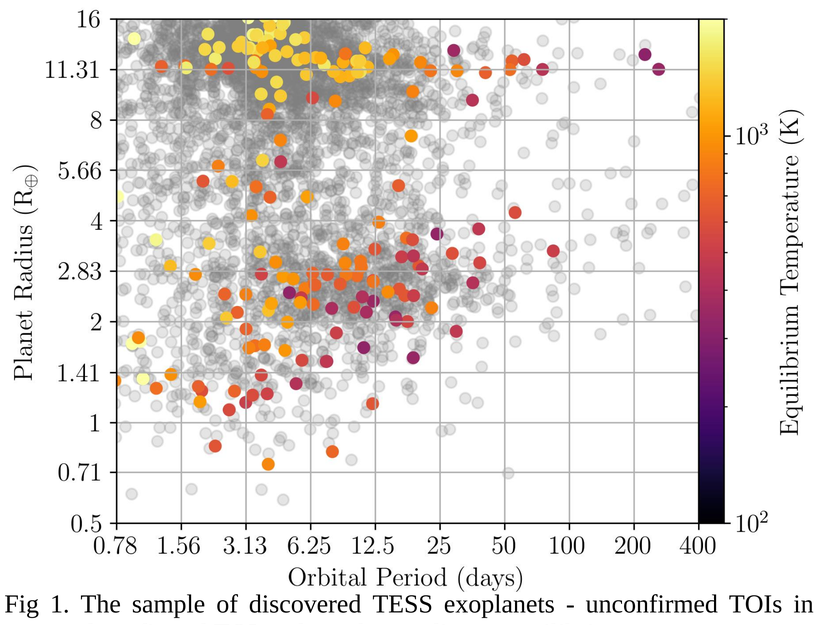


Fig 1. The sample of discovered TESS exoplanets - unconfirmed TOIs in grey and confirmed TOIs coloured according to equilibrium temperature.

2. TIaRA Pipeline

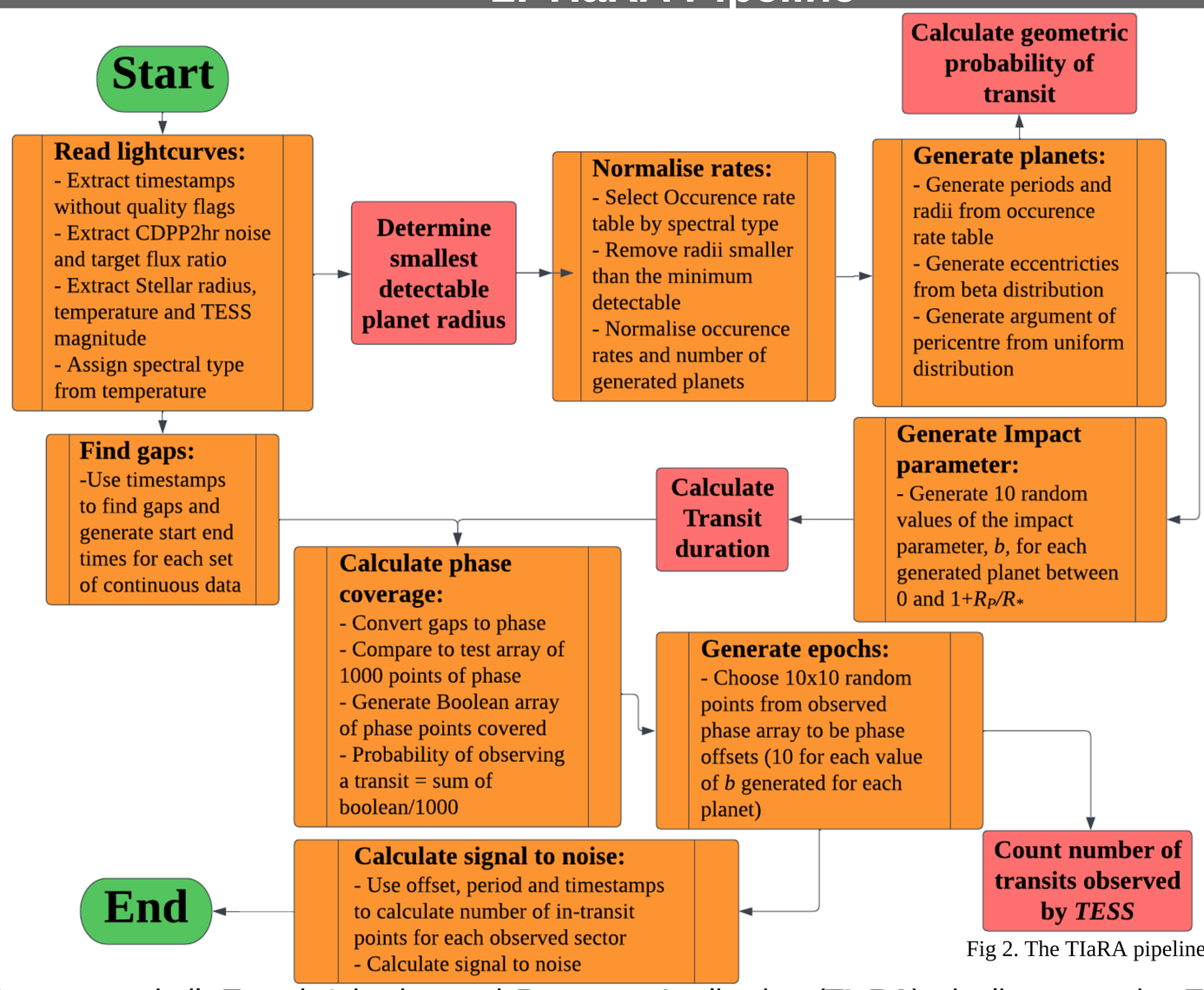
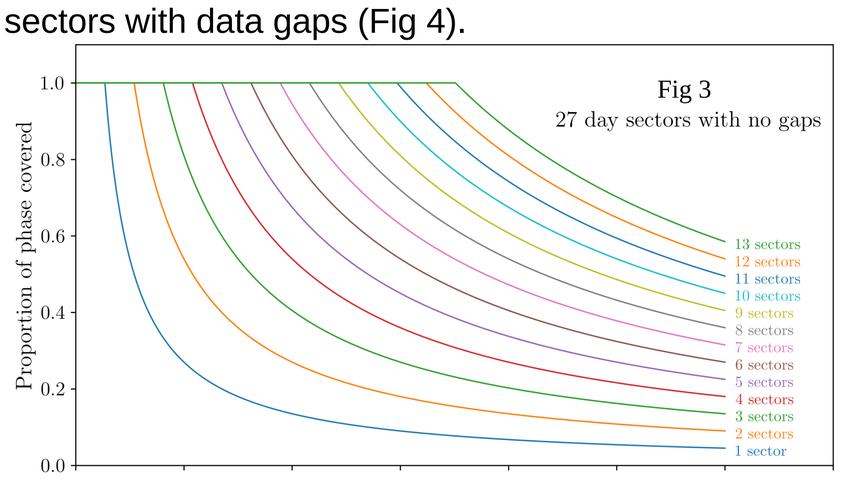


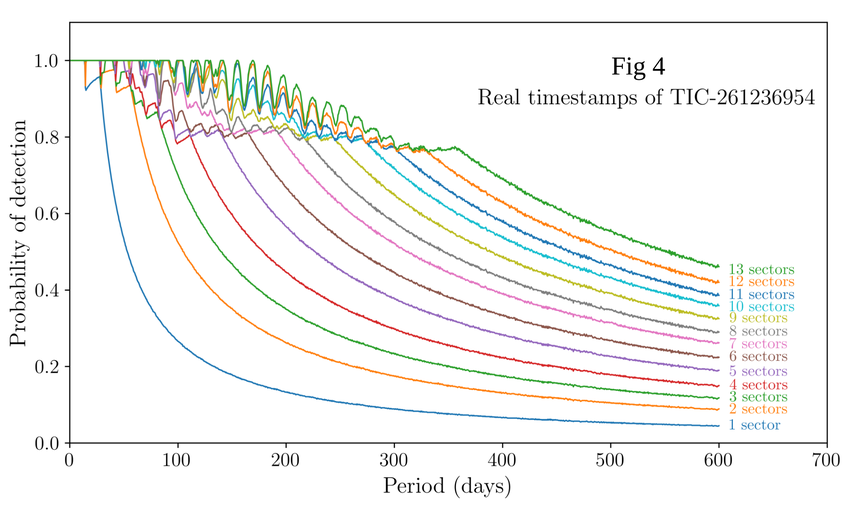
Fig 2. The TIaRA pipeline

Our custom-built Transit Injection and Recovery Application (**TIaRA**) pipeline uses the *TESS* Science Processing Operations Centre (SPOC) 30/10 minute full-frame lightcurves to realistically simulate transit signals produced by different types of transiting planets.

3. Window Function

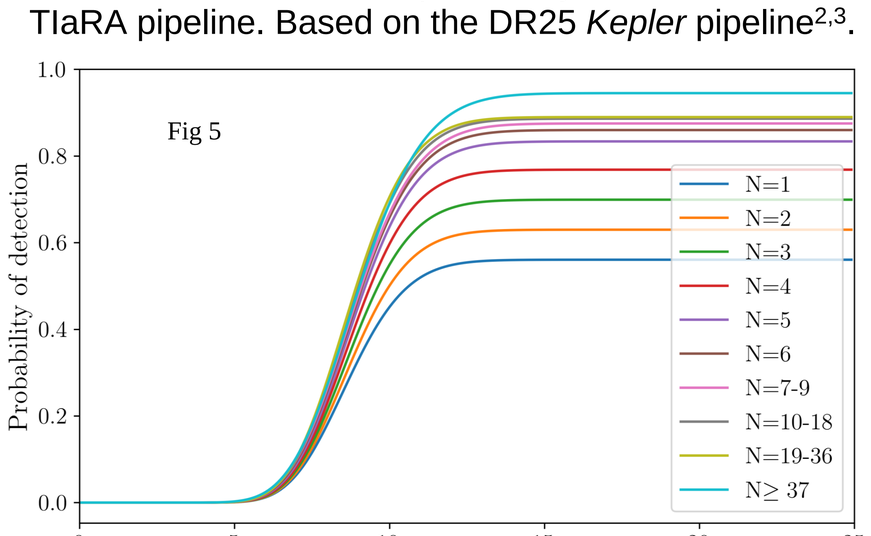
The difference in window functions between the idealized TESS sectors (Fig 3) and the real TESS sectors with data gaps (Fig 4).





4. Probability of Detection

The gamma cumulative probability distribution function used to characterize the probability of detection in our TIaRA pipeline. Based on the DR25 *Kepler* pipeline[2,3].



5. Results and Conclusions

- Using the TIaRA pipeline and occurrence rates from the Kepler mission[5,6], we determine a grid of predicted TESS exoplanet discoveries from ~1.2 million stars with SPOC lightcurves in year 1 of *TESS* (Fig 6).

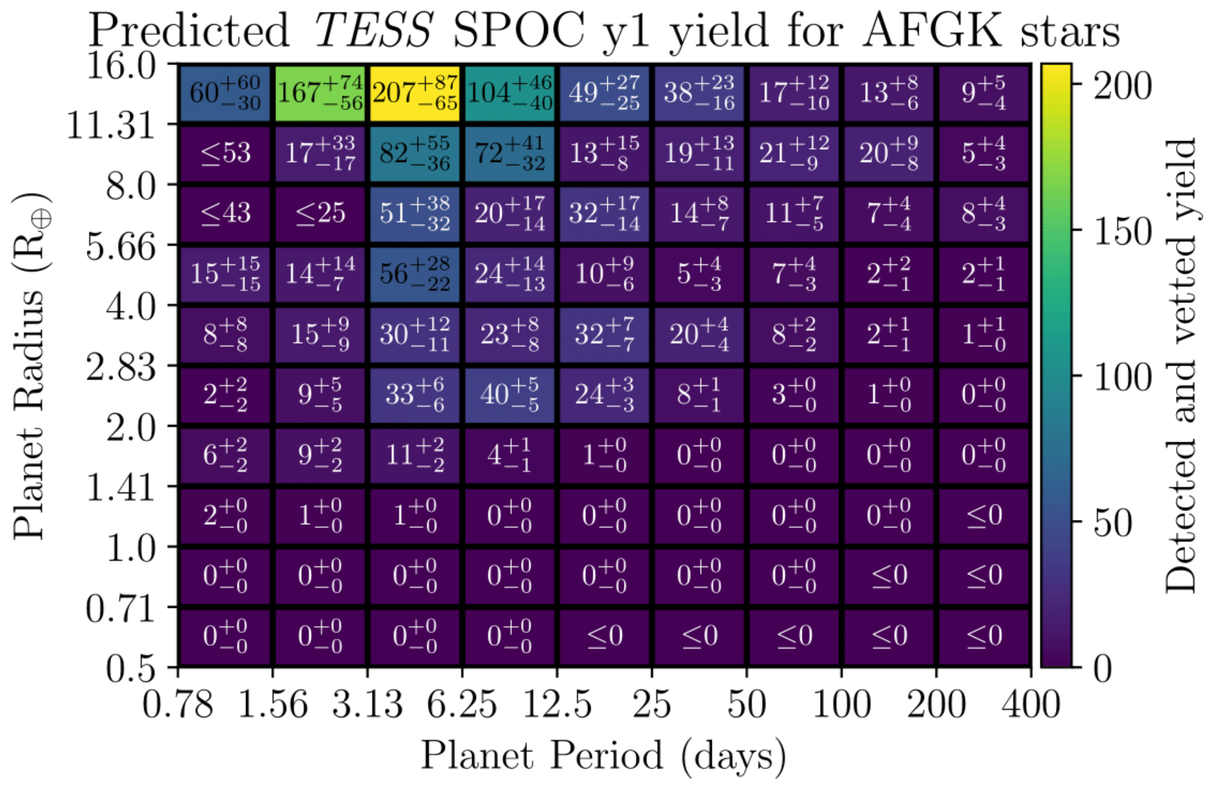


Fig 6. Our predicted yield of detected exoplanets from the Year 1 *TESS* SPOC data.

- In total we predict 1485^{+912}_{-605} discoveries around AFGK stars from the first year of *TESS* SPOC lightcurves, which is 1-sigma above the 836 TOIs from SPOC year 1 targets[7].
- We predict 241^{+129}_{-102} discoveries with P>25 days, the vast majority of which will be monotransits, note this is larger than the 50 TOIs with P>25 days in the 1st year of SPOC data[7].
- We plan to apply our pipeline to calculate the expected yields of exoplanets from TESS Year 2, the two extended missions (Year 3-4 and Years 5-7).
- The TIaRA pipeline is also capable of calculating yields from lightcurves for any transit survey, we envisage it will be useful for predicting yields for the upcoming PLATO mission[8] either using simulated lightcurves pre-launch or real lightcurves post-launch.

6. References

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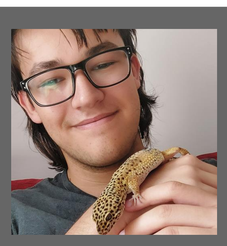

Toby Rodel
(They/Them)

University of Warwick
MSc Research student

Author contacts

Toby.Rodel@warwick.ac.uk

0009-0009-2175-7284

University of Warwick page:

Personal Wesbite/Blog: