The Open University

FALSE POSITIVES FROM BLENDED BINARIES IN THE SOUTHERN PLATO FIELD

JOHN BRAY, ULRICH KOLB
ROB FARMER, PAM ROWDEN

BACKGROUND

- Two "long look" fields are proposed : a southern PLATO field (SPF) and a northern PLATO field (NPF)
- Unresolved eclipsing binaries are a potentially significant source of false positive (FP) planetary transits (PTs)
- Exact field locations are a balance between maximising targets (hence PTs) and minimising FPs
- Our goal is to assist in selecting the location of the two PLATO "long look" fields in particular by estimating the ratio of PTs to FPs for different potential field locations

METHOD

Concept

- Compare the theoretical PT/FP ratio for varying longitudes and latitudes in the allowed PLATO field areas

Initial analysis

- Analyse the proposed southern PLATO field area using our existing stellar and Galactic population synthesis data

Strategy

- Use the current data from modelling the Galaxy using the BiSEPS code – **Bi**nary **S**tellar **E**volution **and P**opulation **S**ynthesis code and analyse the PT/FP ratios for various field locations

ASSUMPTIONS

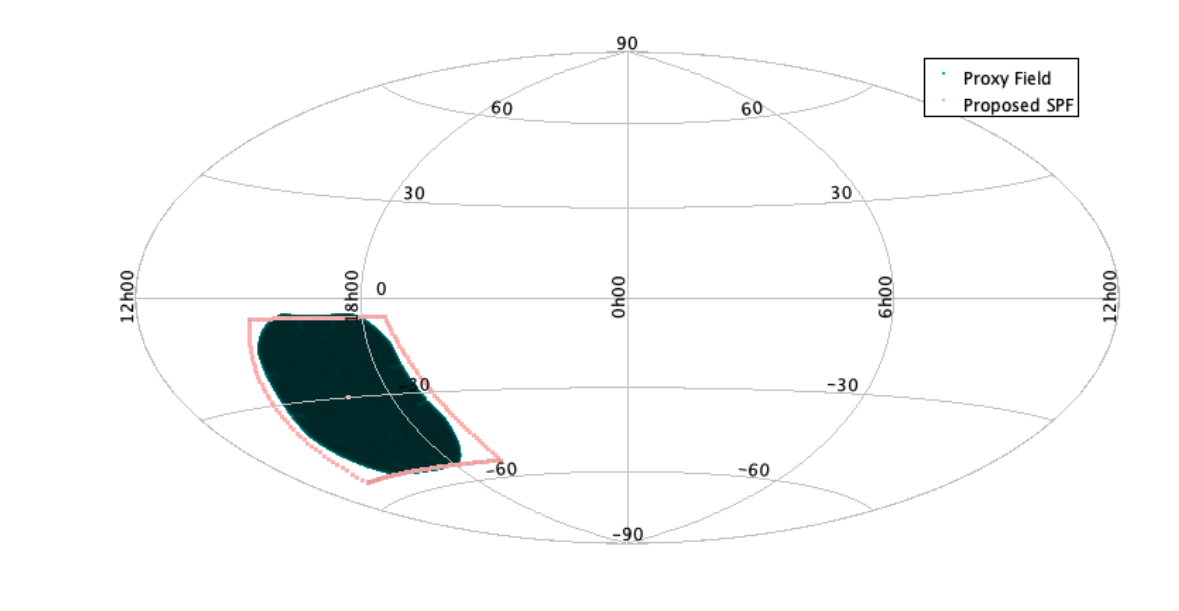
Population model

- Galactic populations based on Kroupa IMF and SFR of one binary or one single star with M >= 0.8 $M_{\odot}$ per year
- Double disc structure, with double exponential stellar density and metallicity Z = 0.020 (thin disk) or Z = 0.0033 (thick disk)
- Extinction calculated following Drimmel et al 2003
- Random inclination angles assigned for both seeded planets and binary systems

Detector characteristics

- PLATO pixel size 15 arcsecs
- Photometric performance follows Catala, updated with PLATO Instrument Noise Budget as of 2016

FIELD CREATION



- Stellar populations were created using the BiSEPS code, calibrated by Rob Farmer to reproduce the Kepler Input Catalogue from a synthetic Kepler field (Farmer, Kolb and Norton 2013)
- Planetary populations were generated by Pam Rowden, to deliver a synthetic observed planet sample from the synthetic Kepler field which is consistent with the observed Kepler planet detections (Rowden PhD thesis 2019). Conservative planet distribution used.

(Coordinate data courtesy Valerio Nascimbeni INAF - Istituto Nazionale di Astrofisica)

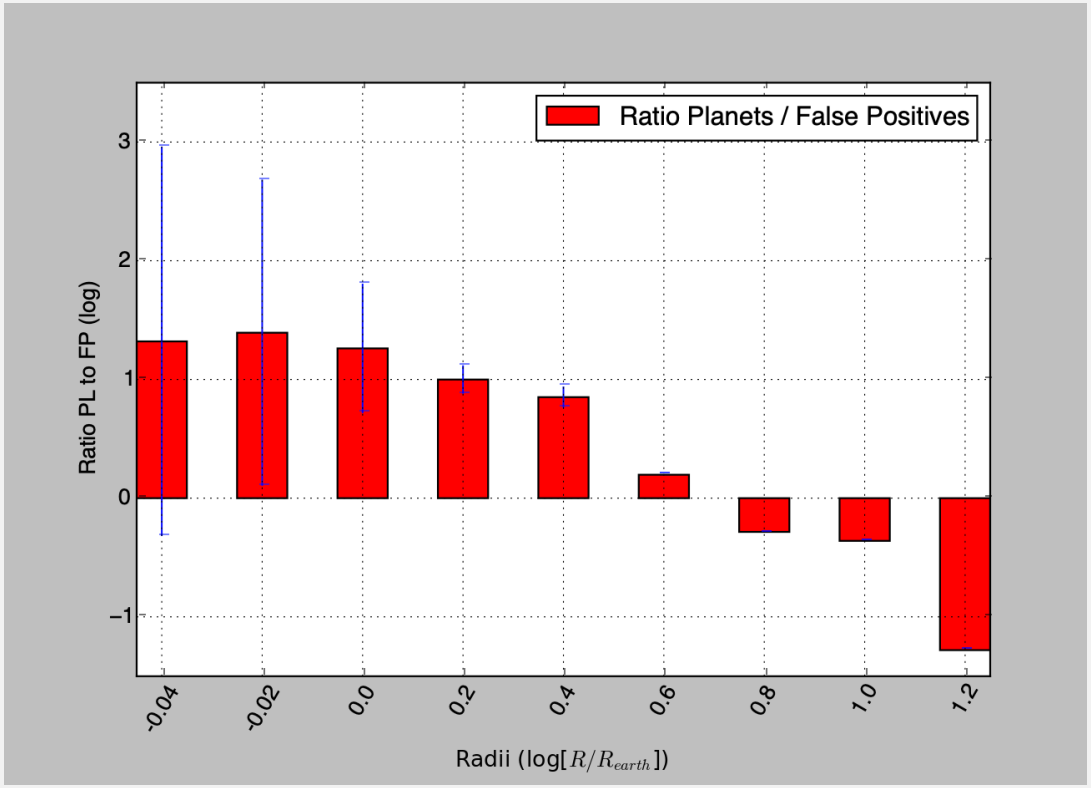
FULL FIELD ANALYSIS - P5

First approximation

- A 2400 deg^2 area (l=228 - 278 and b= -7 to - 54) is used as a proxy for the SPF
- This area was analysed for PTs and FPs from eclipsing blended binaries (EBBs) by planet radius and period

Results

- PT/FP for SPF P5 targets shown (Note: period data merged for plot shown)



ANALYSIS BY SEGMENT – P5

Analysed segments of b = -7 to -54 with widths of l = 5 from 228 to 278

- Planets show a flat distribution in linear space
- EBBs show a flat, to slightly increasing distribution in linear space (with increasing l)
- Variations in l most likely due to spiral arm structures

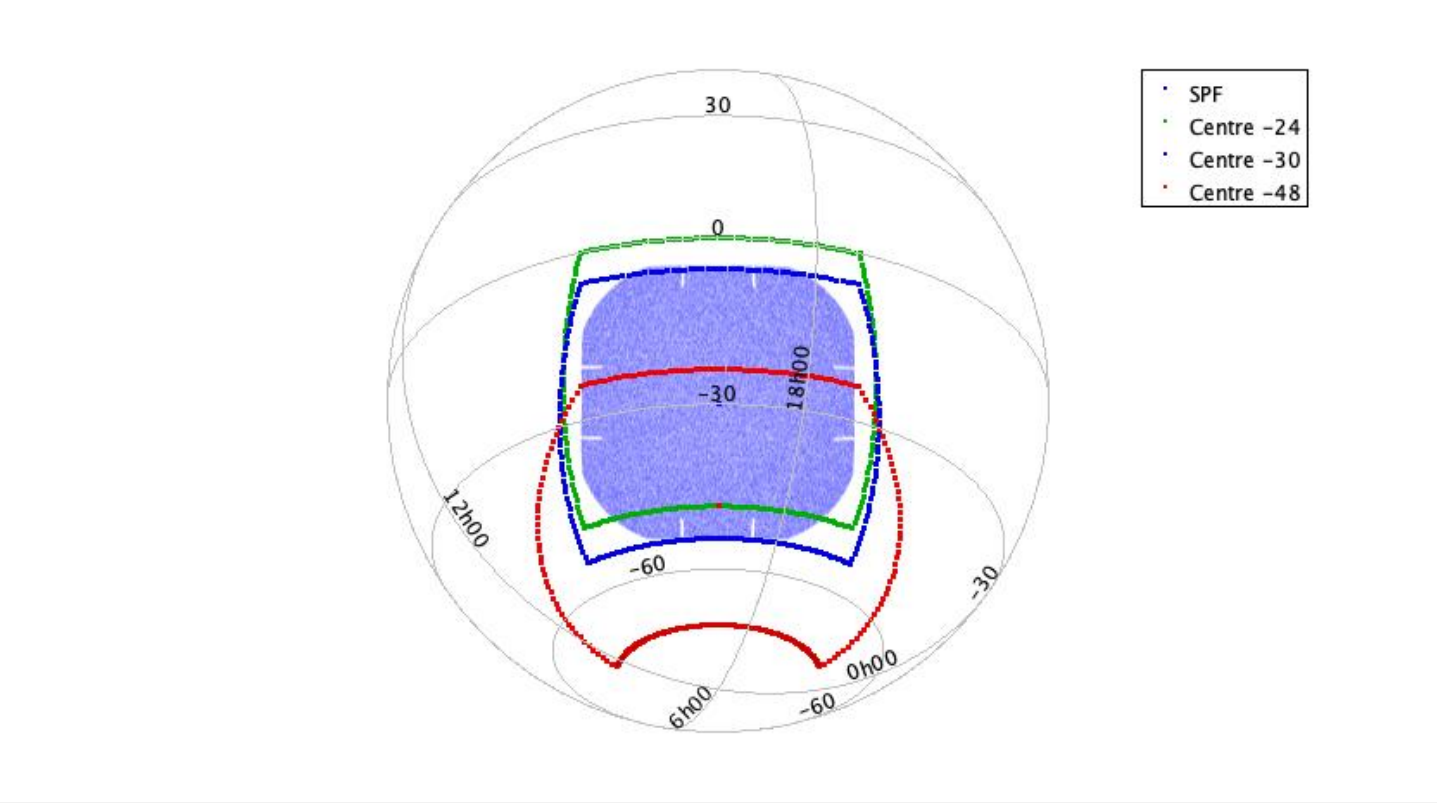
Analysed segments of l = 228 – 278 with widths of b = 4 from -7 to -54

- Significant variation

As a first approximation we assume no stellar or planetary variation with longitude

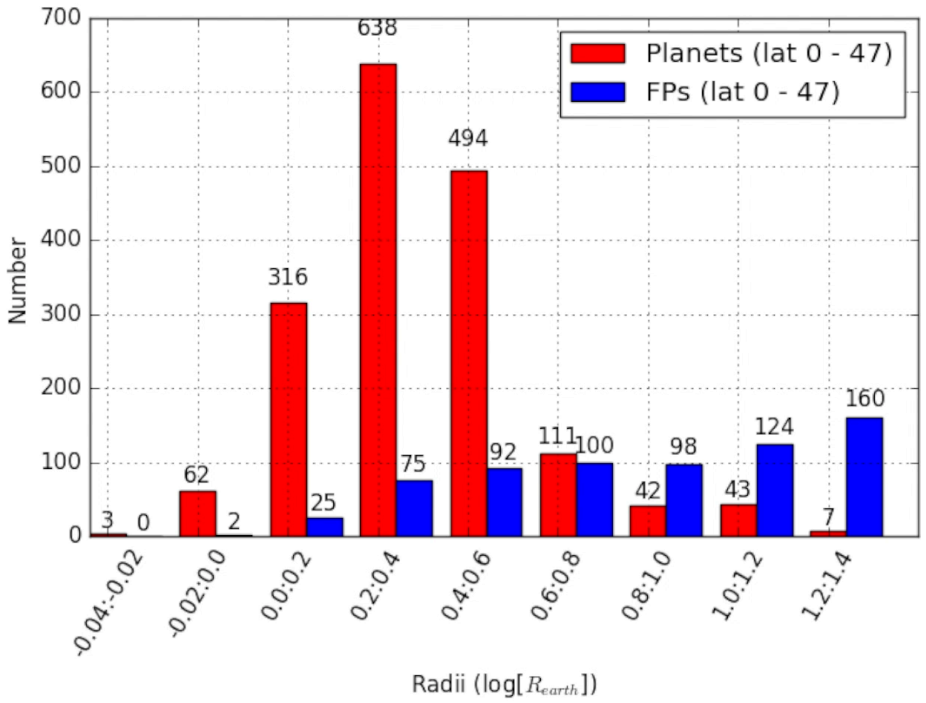
TEST SQUARES

- Three of the 2,400 deg^2 test squares analysed with centres located at l= 253 and b= -24, -30, -48



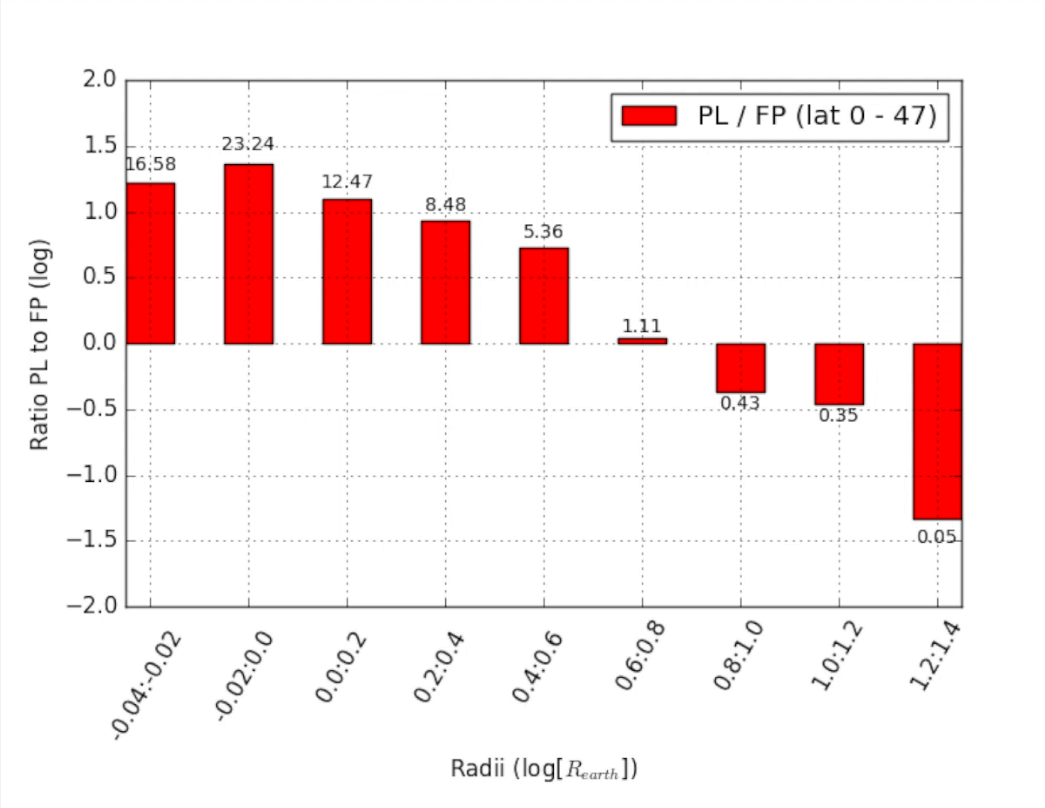
RESULTS

- Planet and False Positive Numbers



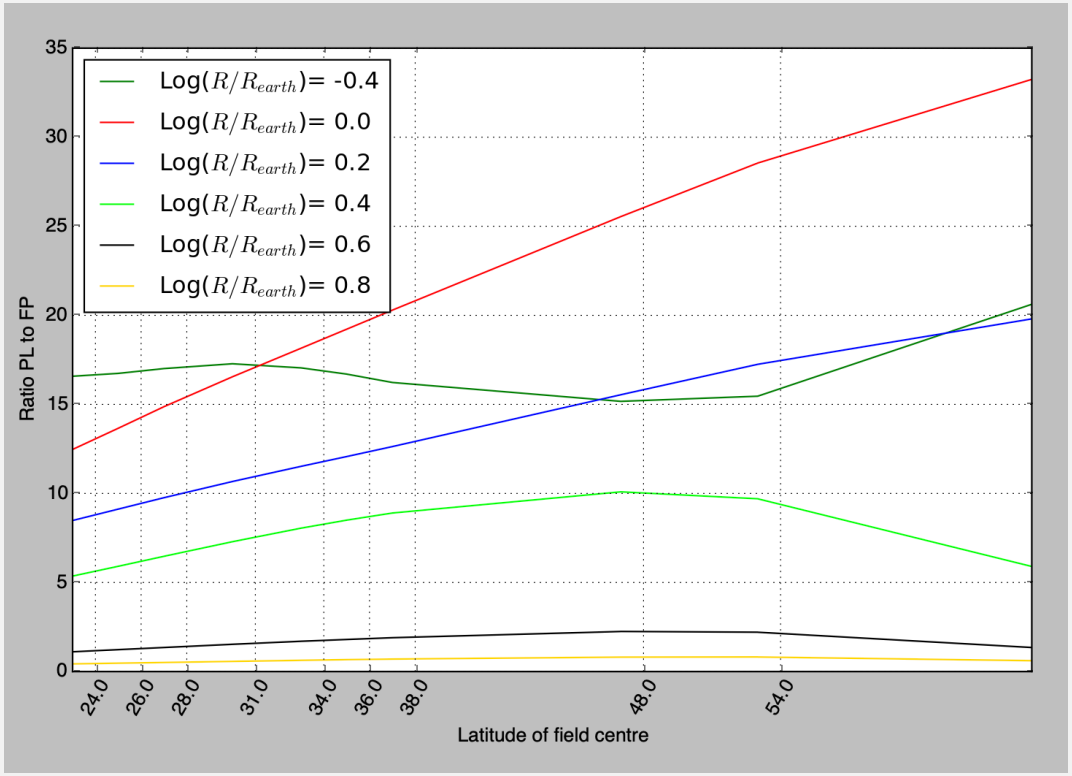
RESULTS

- Planet and False Positive Numbers



RESULTS

- The number of PTs and the EBBs reduces with increasing b, ***but*** PTs reduce more slowly
- Hence the ratio of PT/FP increases with latitude ***but*** planet detections drop significantly



SUMMARY

- We modelled the SPF stellar and planetary content using population synthesis techniques, and determined the expected false positive rate from blended eclipsing binaries relative to the planet detection rate
- For the P5 sample analysed, higher latitudes result in fewer target stars, and hence fewer PTs, but also fewer FPs – this results in a generally more favourable PT to FP ratio especially for smaller radii planets
- There is a higher PT/FP ratio for planets of radii $\log(R/R_{earth})= 0$ to 0.4, at higher latitudes but this is at the expense of reduced PT numbers overall
- Initial analysis suggests the overall, ratio of PTs to FPs are relatively constant