

# Detecting Long Period Planets with WASP

Hugh Osborn<sup>1</sup>, Don Pollacco<sup>1</sup>

<sup>1</sup> University of Warwick, Gibbet Hill Road, Coventry, CV4 7AL

## Abstract

We present preliminary results on the potential of detecting long-period exoplanets from Single Transit Events (STEs) in 'stare' fields taken by the WASP-N survey telescopes. Analyses of red noise, simulated transit detection frequency and known planetary abundances show that  $3.0 \pm 2.4$  exoplanets on 10-50d orbits are detectable in WASP stare data from 2011 alone, with as many as  $29 \pm 23$  likely from 4yrs of observations.

## Introduction

Nearly all of the  $\sim 200$  transiting exoplanets discovered from the ground are larger than Jupiter and orbit with short periods ( $< 11$  days). Improvements in photometric precision to a few mmags/hr will enable smaller and longer-period planets to be detected.

Since 2011, WASP-N cameras have observed in 'Stare' mode, with cadence of  $\sim 1-2$ min. This significantly decreases noise, although 'red' systematic noise continues to dominate.

Previous period-limited planet searches phase-fold lightcurves searching for multiple transit events (Kovacs, 2002). However, high photometric precision can allow the detection of a single transit event (STE). These would not be limited by period, except due to the long-duration transits of distant Jupiters ( $> 50$ d) and the difficulty of radial velocity follow-up.

This poster details the potential of WASP to find planets with this method.

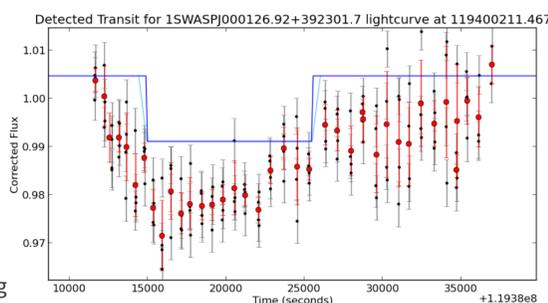


Figure 1: Detection of KELT-1a using the Single Transit Detection search

## Results

Red Noise analysis performed on 6000 stare field stars showed that 14<sup>th</sup> mag stars have noise of  $\sim 9$ mmag/hr. This was taken as the magnitude limit for STE detections.

The signals of 1100 transiting planets (depths from 0.1 to 6%, periods from 10-245d), were added to 3000 detrended light-curves. These were then analysed with an STE-detection program to assess the detection rate of planets as a function of period and depth.

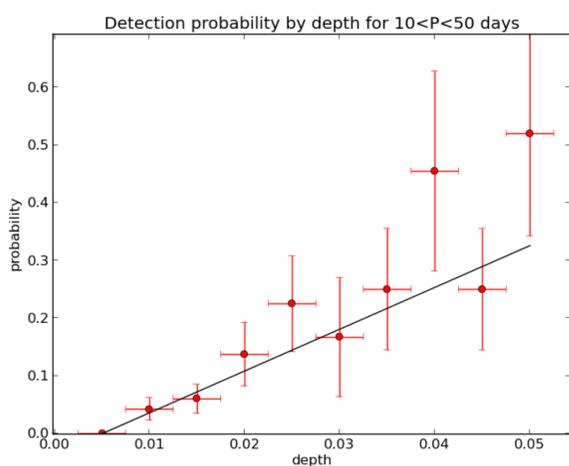


Figure 2: Detectability of simulated transits in Stare data

Detection rate decreased substantially with period due to the reliance on short transit durations. When limited to 10-50 day regime, detection rates for 1% transits were  $0.04 \pm 0.02$ , rising to  $0.14 \pm 0.06$  for 2% dips (Fig 2).

To estimate the number of transiting planets in this period range, planetary occurrence rates from Kepler (Fressin et al, 2013) for varying spectral type & planet type were used. After corrected for the transit probability, these were applied to the WASP stellar sample (Christian et al, 2006) producing planet frequency and minimum transit depths for each planet-star combination. Combined with the number of  $m_v < 14$  stars gives the expected number of transiting planets as a function of transit depth.

Two 'stare' fields are currently available from 2011 (330,000 stars) producing a detection rate of  $3.0 \pm 2.4$  planets (Fig 4). A further 17 fields have been observed since ( $\sim 3 \times 10^6$  stars) giving a combined detection potential of  $29 \pm 23$  planets.

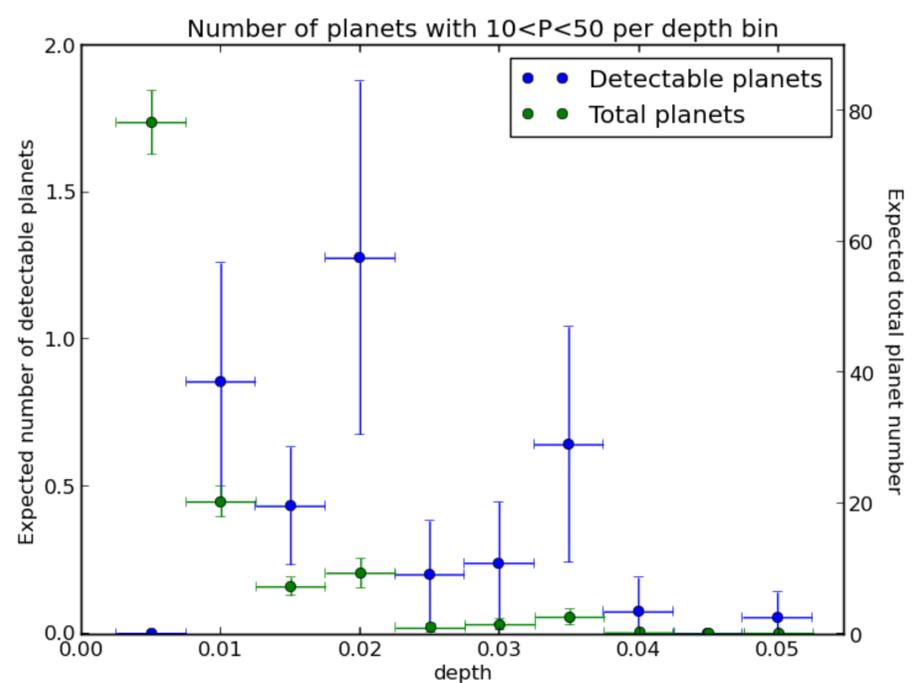


Figure 3: Total number of planets (green, secondary axis) and number of detectable planets (blue, primary axis) for two 2011 Stare fields (330,000 stars)

## Conclusion

The discovery of  $29 \pm 23$  exoplanet candidates around bright WASP stars would be a unique discovery. Such planets could be used to test planet formation theory & allow studies of a new regime of exoplanet atmospheres. However, further analyses of the stellar population and false positive rate are required to constrain these results.

A similar detection method will also be applied to the Next Generation Transit Survey (NGTS, Wheatley et al, 2012) and could potentially discover Neptune-sized planets in a single transit.

## References

- D. J. Christian et al (2006). "SuperWASP wide-field exoplanetary transit survey: candidates from  $23 \text{ h} < \text{RA} < 03 \text{ h}$ ". *MNRAS*, 372(3):1117
- F. Fressin, et al (2013). "The false positive rate of Kepler & the occurrence of planets". *ApJ*, 766(2):81
- Kovács, G. et al (2002). "A box-fitting algorithm in the search for periodic transits". *A&A*, 391, 369-377.
- D. Pollacco et al (2006). "The WASP Project". *PASP* 118(848)
- P. J. Wheatley et al (2013). "The Next Generation Transit Survey (NGTS)". *EPJ Web of Conferences*, vol. 47, p13002