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Finding Planets Orbiting Bright Stars with SuperWASP-South

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Abstract

Over the past decade the Wide Angle Search for Planets (WASP) project has been at the forefront of the ground-based hunt for transiting planets. In that time, WASP has found many systems that push the boundaries of our understanding of planet formation and evolution. In recent years both the North and South installations have changed their observing strategies with the aim of discovering rarer objects to further fill gaps in our knowledge and test current theory. Here we look at the performance and potential of the new WASP-South instrument, which we modified to target brighter stars. We also present some new discoveries from this brighter, southern campaign.

1. Introduction

The next chapter of SuperWASP's already successful career is aimed at finding analogues of HD 209458 b [5, 3] and HD 189733 b [2] in the southern hemisphere. These two examples of planets orbiting exceptionally bright stars, both $V_{mag} \sim 7.7$, boast the most robust and stunning discoveries in the field of transiting hot-Jupiters. These include the detection of atmospheric chemical constituents [4, 8, 9], strong signatures of Rayleigh and Raman scattering [1] and even detection of the planetary radial velocity [7]. Such discoveries are made easier by the larger signal-to-noise ratio achievable with bright stars.

The dearth of southern sky counterparts to these two planets, illustrated in figure 1, is the motivation behind shifting WASP-South to observe brighter stars. The bright targets we expect to find soon will allow us to investigate more deeply the diversity and similarities between planetary systems. The availability of the VLT and soon the E-ELT in the southern hemisphere will enable more detailed study than ever before of these bright targets.

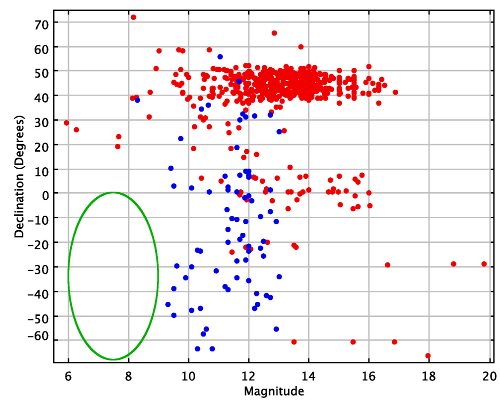

Figure 1: Plot of transiting planet host star magnitude against declination for SuperWASP (blue) and other surveys (red). The green ellipse highlights the lack of planets discovered above 9^{th} magnitude in the southern hemisphere. Data from exoplanets.eu.

2. First Results

In July of 2012 we replaced the lenses on WASP-South with smaller aperture lenses to monitor brighter stars without saturating. An example of the new photometric performance for a typical search field are shown in figure 2. The new data are compared to a similar field from a night with similar conditions using the previous lenses. The minimum precision needed to find hot-Jupiters orbiting sun-like stars is $\sim 1\%$.The previous setup achieves this for stars between magnitudes 9 and 12. The new setup can do the same for magnitudes 6 to 10.

An example of the signals the new instrument can detect is shown in figure 3. We show the lightcurve of a new eclipsing binary with very shallow primary and secondary eclipses. The primary eclipse has a depth of $\sim$ 4mmag, equivalent to a 0.6 R_{Jup} orbiting a sun-like star. The shallower depth of the secondary eclipse shows we can detect even smaller objects.

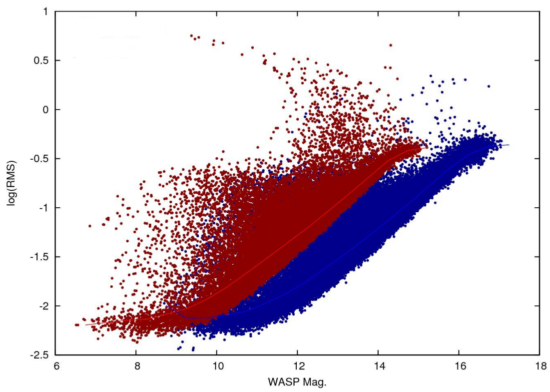

Figure 2: Plot comparing the Log(RMS) as a function of instrumental magnitude of stars from similar fields taken using the old (blue) and new (red) lenses. The median Log(RMS) is overplotted in light blue and light red for the corresponding coloured data. We can see the optimal performance of the two versions of the WASP-South instrument are similar but shifted to a brighter magnitude for the new data.

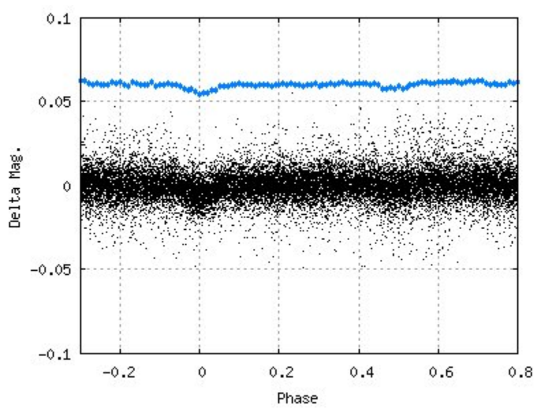

Figure 3: Phase folded plot of the lightcurve of a new eclipsing binary star with primary eclipse visible at phase 0. Secondary eclipse is also apparent at phase 0.5. The recorded depth of the primary eclipse is $\sim$ 4mmag; this is equivalent to a 0.6 R_{Jup} planet transiting a sun like star. The shallower secondary eclipse demonstrates our ability to detect even smaller targets.

3. Summary and conclusions

The new, upgraded WASP-South instrument has now been running for nearly 3 years. In this time we have collected data on stars with visual magnitudes ranging from just brighter than 6^{th} to around 12^{th} across nearly half of the sky. We have re-optimised the reduction pipeline for the new data and will present first results from our new observing strategy including: our operational changes, our assessment of the performance of the new instrument and new discoveries made in our search for rarer, bright objects.

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