SEARCHING FOR EXTRASOLAR PLANETS FROM UNSW.

J. L. Christiansen, M. C. B. Ashley, J. K. Webb, M. G. Hidas, *University of New South Wales, Kensington, NSW, 2052, AUSTRALIA (jessiec@phys.unsw.edu.au).*

The UNSW Automated Patrol Telescope has been undertaking a search for extrasolar planets using the transit method. We show light curves from two recent promising candidates; spectroscopic follow-up using the ANU 2.3m shows that the companions are possibly low mass stars rather than planets, although more data will be needed to be certain. We outline future improvements to our transit search: a hardware upgrade scheduled for 2006, and the application of trend-filtering algorithms to the existing data.

Latest Results

The Automated Patrol Telescope is a 50-cm optical telescope sited at Siding Spring Observatory (SSO), Australia. From February to May 2005 we observed a pair of fields centred on 12h 0′, -36d 0′, obtaining 22 nights of good data (RMS < 4mmag for stars brighter than 10th magnitude). Lightcurves for close to 3000 stars brighter than 13th magnitude were compiled, and two promising candidates designated UNSW-TR-13 and UNSW-TR-14 were discovered. UNSW-TR-13 displayed 2 complete and 3 partial transits, with a depth of 40mmag and a period of 2.283 days (Figure 1(a)). UNSW-TR-14 displayed 7 total and 3 partial transits, with a depth of 30mmag and a period of 0.640 days (Figure 1(b)). For comparison, Figure 1(c) shows a transit of TrES-1, the first (and only to date) transiting planet discovered with a small, wide field-of-view telescope. It is clear that the APT is reaching the required level of precision to detect transiting extrasolar planets.

Unfortunately time and weather constraints resulted in a failure to capture our candidates in transit with the ANU 40-inch telescope at SSO, however we were able to obtain follow up observations with the DBS instrument on the ANU 2.3m telescope, also at SSO. Spectral classification of the candidate host stars was performed using template spectra from the UVILIB library (Pickles, 1998) — the host stars of candidates UNSW-TR-13 and UNSW-TR-14 were classified as G5V and G2V respectively. Radial velocity curves were derived, constrained with the period and phase data taken from the lightcurves, and are shown in Figure 2. UNSW-TR-13 is found to probably be orbited by an $0.09M_\odot$ M dwarf, and UNSW-TR-14 appears to have a small $0.033M_\odot$ brown dwarf companion.

Improvements - Hardware

With the assistance of an ARC grant a new CCD camera has been commissioned for the APT, for installation in 2006. This new CCD will increase our field of view from $2^\circ \times 3^\circ$ to $7^\circ \times 7^\circ$. Due to the increased number of data points, as a result of the larger sky coverage and improved time-sampling (the new CCD quantum efficiency will be three times higher than the old, resulting in reduced exposure times), we expect to increase our chances of detecting planets at the current level of precision by a factor of nearly 5. However we would also expect to see higher precision photometry from the reduced undersampling of the stellar PSFs and improved CCD technology, which would significantly increase our chances of locating smaller amplitude transits.

Improvements - Software

We are currently developing a trend-filtering algorithm based on one described by Kovacs *et al*. (2005) to remove residual systematics from our data. Although it is generally easy to gauge with the eye which signals are real and which are systematics, implementing a period-finding program to hunt for low amplitude transits when there are significant residual systematics is very inefficient, as it leads to a high number of spurious detections with periods around n days, where n is a small integer. The basic operation of the algorithm is to use a subset of the stellar lightcurves as templates for construction of the lightcurves of the remaining stars; any systematics common to the stars and the template group should be theoretically removed. Although we are still implementing the final algorithm, preliminary results show a dramatic reduction in systematics, accompanied by a slight increase in the RMS noise, as shown in Figure 3.

References

Alonso, R., *et al*., 2004, ApJ., 613, L153
Kovacs, G., Bakos, G., Noyes, R. 2005, MNRAS, 356, 557
Pickles, A. J., 1998, PASP, 110, 863

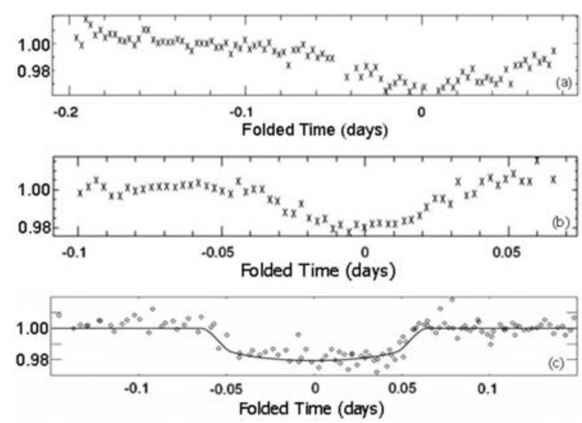

Figure 1: Panel (a) shows a sample transit from the lightcurve of UNSW-TR-13, panel (b) shows a sample transit from UNSW-TR-14 and for comparison, panel (c) shows a transit (taken with the 10cm PSST instrument) of TrES-1, the first planet to be discovered with the transit method (Alonso et al 2004).

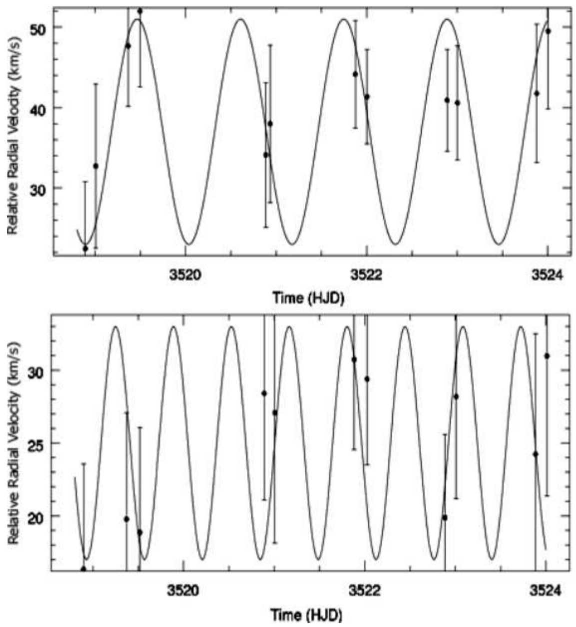

Figure 2: The top panel shows the derived radial velocity curve for UNSW-TR-13, with an amplitude of 14 km/s and a period of 2.283 days. The bottom panel shows the same for UNSW-TR-14, with an amplitude of 8 km/s and a period of 0.640 days.

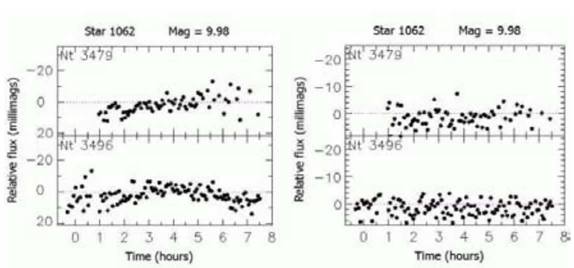

Figure 3: An example of the trend-filtering algorithm at work. The left panel shows the original lightcurve, and the right panel shows the corrected lightcurve.