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Recent Results from the Wide Angle Search for Planets (WASP) Prototype

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Abstract. WASP0 is a prototype for what is intended to become a collection of WASPs whose primary aim is to detect transiting extra-solar planets across the face of their parent star. We present some recent results from the WASP0 camera, including observations of the known transiting planet around HD 209458. The current status of the next generation camera (SuperWASP) located on La Palma is briefly outlined.

Over the entire sky, roughly 1000 stars brighter than 13th magnitude should exhibit lightcurve dips due to transiting extra-solar planets. These transiting planets can be discovered by using small wide-angle CCD cameras that measure tens of thousands of stars simultaneously.

WASP0 is an inexpensive prototype that was developed as a proof-of-concept for SuperWASP, whose primary aim is to detect transiting extra-solar planets. The WASP0 instrument is a wide-field (9-degree) 6.3cm aperture F/2.8 Nikon camera lens, Apogee 10 CCD detector (2K $\times$ 2K chip, 16-arcsec pixels) which was built by Don Pollacco at Queen's University, Belfast. WASP0 has had two successful observing runs at two separate sites. The camera was mounted piggy-back on a commercial 8-inch Celestron telescope during its observing run at La Palma, Canary Islands from 20th June until 20th August, 2000. It was most recently mounted on a 10-inch Meade at Kryoneri, Greece between October, 2001 and May, 2002. Field stars towards Draco were regularly monitored for two months during the observations from La Palma in 2000 and more recent observations from Greece have targeted the Hyades open cluster.

The reduction of wide field optical images requires special care since there are many spatially dependent aspects which are normally presumed to be relatively constant across the frame. The most serious issues arise from vignetting and barrel distortion produced by the camera optics which alter the position and shape (and often blending) of stellar profiles. The current WASP reduction pipeline uses the Tycho-2 catalogue to obtain a 7-parameter astrometric fit for

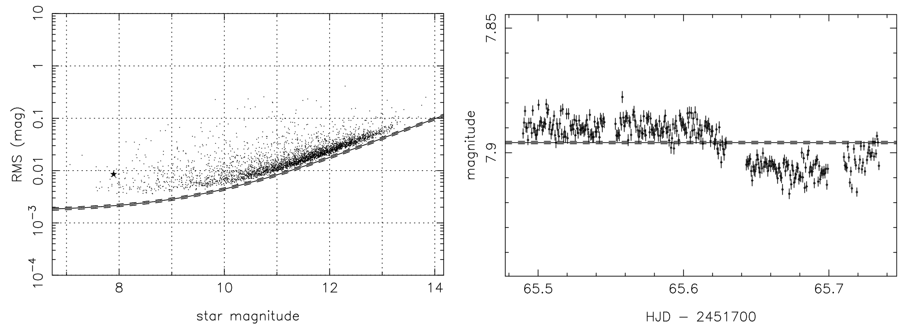

Figure 1. Photometric accuracy vs star magnitude for 3500 stars (left) and a single planetary transit of HD 209458 (right).

each frame. The astrometric solution then transforms catalogue positions from USNO-B for the current field to CCD pixel x,y positions and also calculates barrel distortion and heliocentric time corrections. A custom-written aperture photometry code computes the flux in a circular aperture centred on the positions of the objects in the catalogue and renormalises the weights of the edge pixels to take into account the large pixel size.

Shown in Figure 1 (left) is an RMS vs mag diagram for a single night of WASP0 data. The black curve indicates the theoretical noise limit with the 1σ errors being shown by the dashed lines either side. The diagram contains 3500 stars from 312, 50 second exposures. The known transiting extra-solar planet orbiting around HD 209458 (Charbonneau et al. 2000; Henry et al. 2000) was observed using WASP0 at the predicted transit time of 8th August, 2000. HD 209458 is shown as a 5-pointed star in the RMS vs mag diagram and the characteristic dip due to the planetary transit is clearly visible in the HD 209458 lightcurve, shown in Figure 1 (right).

Having demonstrated that the required high-precision photometry can be achieved with WASP0, we have built a robotic, multi-camera instrument housed inside an automated enclosure among the ING telescopes on La Palma, Canary Islands. The mount for SuperWASP is an OMI fork mount on which can be mounted up to 8 cameras. Each of the cameras consists of a 2048×2048 thinned CCD and a Canon 200mm f/1.8 lens which results in a field of view of 7.8×7.8 degrees. The SuperWASP project aims to monitor large numbers of stars in the magnitude range ~ 7 to 13 over a wide area of sky. The primary science goal of the project is to use the well-sampled lightcurves to detect planetary transits, but the data will also be used to detect Near-Earth Objects and optical transients. Funding has been secured to begin construction in 2004 of two additional SuperWASP installations. For more information on SuperWASP, visit `http://www.superwasp.org`.

References

Charbonneau, D., et al., 2000, ApJ, 529, L45

Henry, G.W., et al., 2000, ApJ, 529, L41