

PHOTOMETRIC OBSERVATIONS OF 6000 STARS IN THE CYGNUS FIELD

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A small photometer to detect transits by extrasolar planets has been assembled and is being tested at Lick Observatory on Mt. Hamilton, California. The Vulcan photometer is constructed from a 30 cm focal length, F/2.5 AeroEktar reconnaissance lens and Photometrics PXL16800 CCD camera. (See Figure 1.) A spectral filter is used to confine the pass band from 480 to 763 nm. It simultaneously monitors 6000 stars brighter than 12th magnitude within a single star field in the galactic plane. When the data are folded and phased to discover low amplitude transits, the relative precision of one-hour samples is about 1 part per thousand (1×10^{-3}) for many of the brighter stars. This precision is sufficient to find jovian-size planets orbiting solar-like stars, which have signal amplitudes from 5 to 30×10^{-3} depending on the inflation of the planet and the size of the star. Based on the frequency of giant inner-planets discovered by Doppler-velocity method, one or two planets should be detectable in a rich star field.

The goal of the observations is to obtain the sizes of giant extrasolar planets in short-period orbits and to combine these with masses determined from Doppler velocity measurements to determine the densities of these planets. A further goal is to compare the measured planetary diameters with those predicted from theoretical models.

From August 10 through September 30 of 1998, a forty nine square degree field in the Cygnus constellation centered at RA and DEC of 19hr 47min, +36° 55' was observed. Useful data were obtained on twenty-nine nights. Nearly fifty stars showed some evidence of transits with periods between 0.3 and 8 days. Most had amplitudes too large to be associated with planetary transits. However, several stars showed low amplitude transits as for example, those shown in **Figures 2 and 3**. The data for several transits of each of these two stars have been folded and binned into 30 minute periods. Only Cyg1433 (Tycho Catalog # 2663 607 1) shows any evidence of a flattened bottom that is expected when a small object transits a much larger primary. However when high-resolution spectra were obtained for both stars, the stars were found to be double-lined binaries so similar in size as to have indistinguishable transit depths. (Note that this fact implies that the photometric periods shown in the figures must be doubled). The low amplitude of the transits is explained if the stellar orbital planes are tipped approximately 5 degrees from the line of sight causing both binaries to show grazing transits. **Figure 4** shows measurements by G. Marcy, M. Butler, and J. Lissauer (personal communication, 1999) obtained for the spectral region near 490 nm for Star Cyg0937 (Tycho Catalog # 2681 1091 1). The two absorption lines, due to the H β feature in each star, are apparent and indicate the presence of a binary system with similar components.

CONCLUSIONS: Although the early results from the Vulcan photometer have not yet produced any planetary detections they have shown that the photometer has the necessary relative precision to routinely find low amplitude transits. These results indicate that the Vulcan photometer can find companions with the expected area ratio for jovian-size planets orbiting solar-like stars.

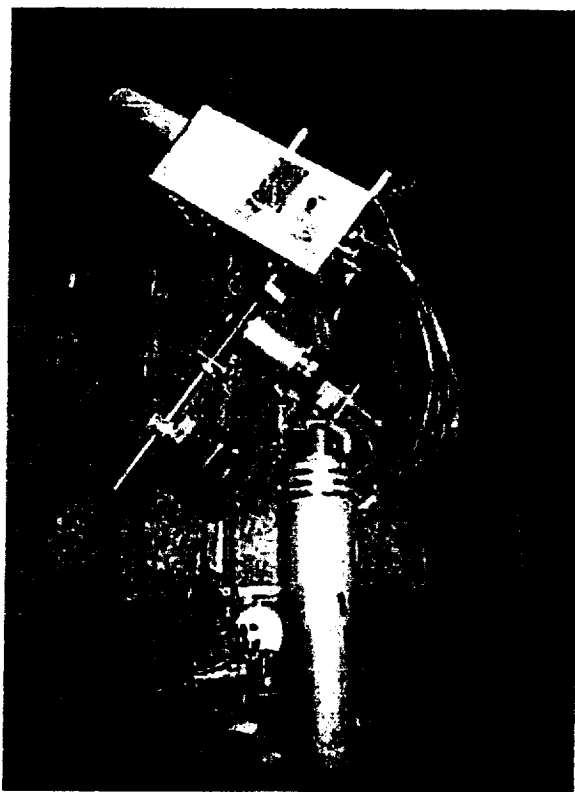


Figure 1. Photo of the Vulcan Photometer in the Crocker Dome. At the top right are two finder scopes and the auto guider. The main camera is in the large aluminum box. A light baffle extends off of the end.

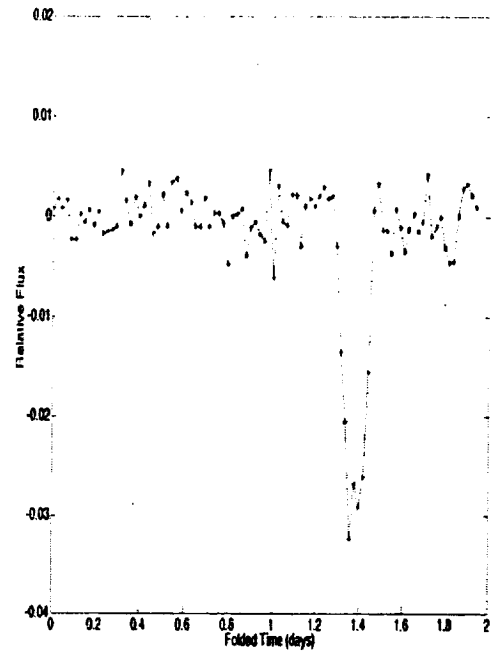


Figure 2. Folded and Phased Light Curve for Cygnus Star #1433. The amplitude of the transit is about 3%.

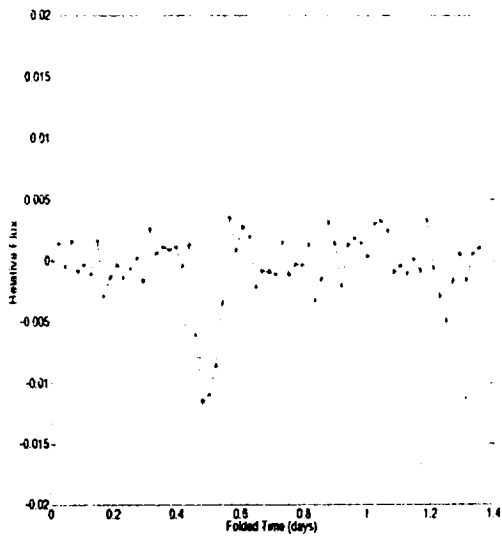


Figure 3. Folded and Phased Light Curve for Cygnus Star #937. The amplitude of the transit is 1.2%.

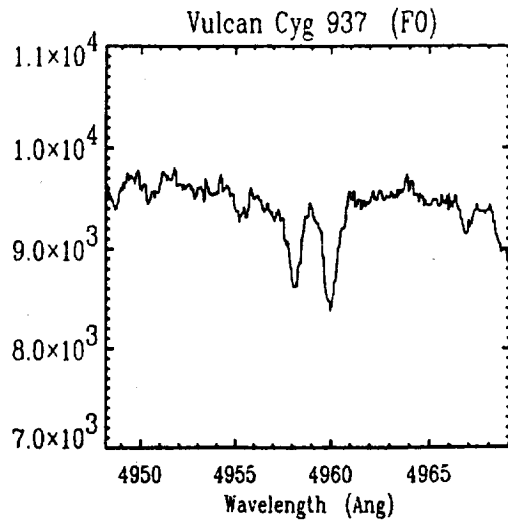


Figure 4. Spectra near H β line of Cyg937. (G. Marcy, P. Butler, & J. Lissauer, personal communication, 1999)

