POSSIBLE FIRST EXOPLANET CANDIDATE WITH ET - A NEW RADIAL VELOCITY TECHNIQUE.

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Introduction: The Exoplanet Tracker (ET) is a prototype of a new type of radial velocity (RV) instrument that has been developed at the University of Florida and Penn State University, based on the principle of externally dispersed fixed-delay interferometry [1, 2]. Essentially a fibre-fed Michelson interferometer in series with a medium resolution spectrograph, the instrument enables us to track differential radial velocity changes in a star by monitoring phase shifts in the interference fringes it produces, to a precision sufficient for the detection of extra-solar planets. The instrument's single-order mode of operation lends itself ideally to expansion to multi-object observing, an avenue currently being explored at the Sloan telescope at Apache Point Observatory [3]. The single-object instrument discussed here will serve both as a prototype and later as a higher precision follow-up instrument to the multi-object ET. Plans are also underway to increase the current instrument's wavelength coverage by as much as a factor of six and spectrograph resolution by three times, leading to a potential fourfold future improvement in Doppler precision [3].

Since 2003 when we reported our first confirmation of the well known companion to 51 Peg [4] we have been able to recover the expected RV signatures of known planets relatively routinely, and have obtained short term (two day) precision as high as 3.6ms^{-1} on the bright RV stable star, 36 UMa. In the winter of 2004 we began a several month small-scale survey for new extra-solar planets using the 0.9m Coudé and 2.1m telescopes at Kitt Peak National Observatory.

Here we show preliminary results for one of the more promising of our targets, which so far appear to be consistent with the discovery of a new planet.

Observations: Observations were conducted of around 90 previously unsearched stars during the period December 2004—May 2005 using the KPNO 0.9m Coudé from December to March and the 2.1m telescope in May (both telescopes are housed in the same building, so that the instrument itself does not have to be relocated). Most targets were chosen primarily from the N-star catalogue [5], selecting dwarf stars of type F—K with V magnitude 8—9, high metallicity, and where known, slow rotation and low activity indicators. Any known visual doubles or variable stars were rejected from the list. Weather permitting, stars were observed in blocks of typically around five nights. Where possible, candidates showing significant RV variation early in the survey were followed up using the 2.1m telescope in May 2005.

Results: In order to establish an independent estimate of our survey precision, we can define stars which appear RV stable at our precision level to be those showing a reduced $\chi^2 < 2$ over the period of observation (typically ~5—6 days). At the 0.9m Coudé during a typical observing block, 7 out of 15 search stars satisfied this criterion. For those, we found a mean RMS scatter of 18.9ms^{-1} compared to a mean photon limiting error of 21.2ms^{-1}, at a mean visual magnitude of 8.26 and typical exposure times of 20—30min. (The lower value of the RMS is comfortably within the range expected due to statistical variation). From the 2.1m observations using the same criterion, we found 12 stable stars out of 24 search stars, for which is found a mean SD of 17.6ms^{-1} compared to a mean photon limiting error of 17.4ms^{-1}. In this case the mean V magnitude was 8.48, and typical exposures were 10min. In both cases the errors are consistent with the expected photon limit.

55 Cnc: Figure 1 shows results obtained at the 2.1m for the known planet bearing star, 55 Cnc with the predicted RV curve due to its 14.7d companion 55 Cnc B over-plotted (the other known companions are neglected here). RMS deviation about the predicted curve is 7.8ms^{-1} compared to a mean photon limiting error of 4.2ms^{-1}.

Possible new candidate: Figures 2 and 3 show a preliminary best fit curve to one of our targets which exhibits a potential planetary companion RV signal. If the signal is due to a planet, then assuming zero eccentricity yields a most probable period of 4.85d and a semi-amplitude of 58.1ms^{-1}, with RMS residuals of

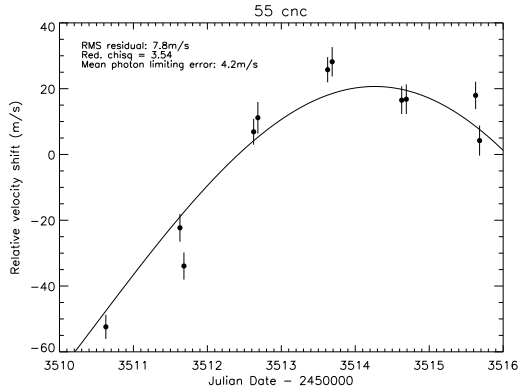

Fig. 1 - RV measurements of 55 Cnc at the 2.1m, with predicted RV curve over-plotted.

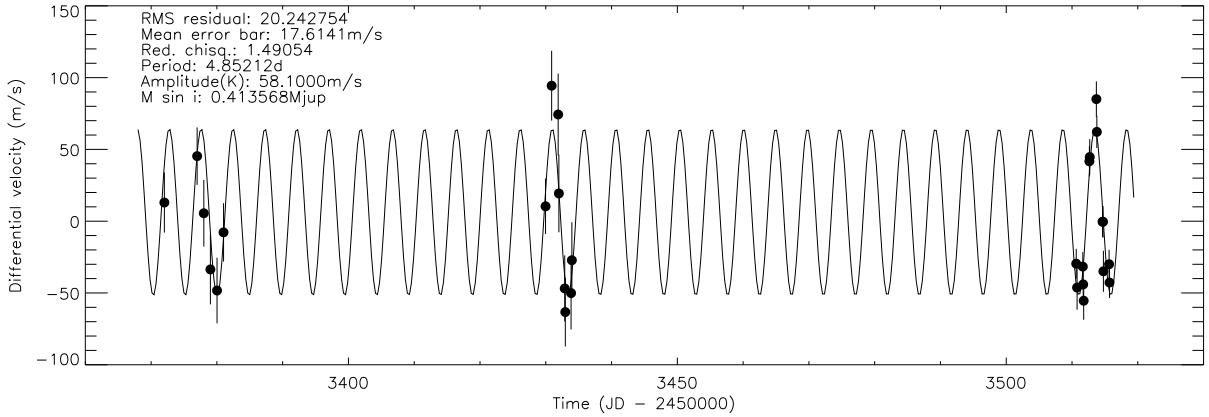

Fig. 2 - Best fit for follow-up star assuming a zero eccentricity planetary companion. Error bars represent calculated photon limiting error for each point.

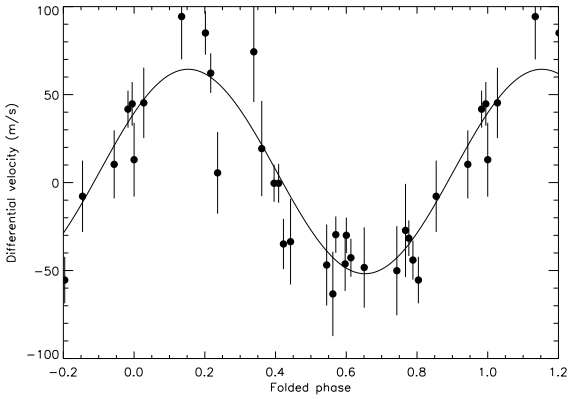

Fig. 3 - As fig. 2, but phase folded.

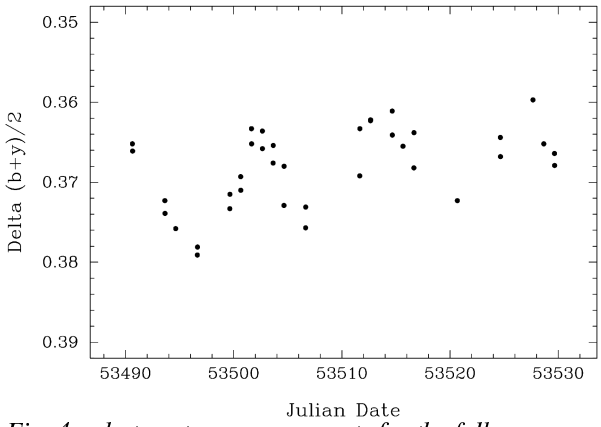

Fig. 4 - photometry measurements for the follow-up star. Time axis is modified Julian Date, JD – 2400000.5; error bars are around 0.001mag.

20.2ms^{-1} and (assuming photon limiting error bars) reduced $\chi^2 = 1.49$. This would give a mass limit of $M \sin i = 0.41 M_{Jup}$, consistent with other known hot-Jupiter exoplanets in the same range. Figure 4 shows photometric measurements of the same target taken a few weeks later. Some variation is seen at the 0.01 mag level, with somewhat of a periodicity around roughly 12 days, but this is far enough removed from the period of the RV curve not to rule out the possibility of a planetary companion. High resolution echelle spectra of the same target are currently being analysed for line bisector variation which should prove more conclusive.

Discussion: Although still subject to further investigation, these results demonstrate the ability of this technique to search effectively for extra solar planets even using only a small telescope. With the improvement in wavelength coverage mentioned previously, and continued streamlining of our observing strategy and data reduction software, we hope to further improve our operation efficiency, providing an important complement to the future multi-object project. Continued surveying planned later this year should also allow for follow-up of a number of other targets which had shown RV signals early in the survey but which were not observable later in the year to obtain more information.

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References: [1] J. Ge (2002) *ApJL, 571*, L165—L168 [2] J. Ge, D. J. Erskine, and M. Rushford, (2002) *PASP, 114,* 1016—1028 [3] J. Ge et al. (2005) *this conference*. [4] van Eyken et al. (2004), *ApJL, 600*, L79—L82 [5] R.O. Gray et al. (2003) *AJ, 126,* 2048—2059