Search for Young transiting planets in the YETI network – The cluster Trumpler 37

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Abstract

The transit technique is the only method to determine the radius of a planet. Together with the mass from radial velocities measurements, information about density and the inner structure can be obtained. So far, only old transiting exoplanets are known. For testing planetary formation models, observational parameters for young exoplanets need to be gathered and should be compared with theoretical predictions.
We started to monitor the few Myr young cluster Trumpler 37 to search for transiting planets with our 90 cm telescope near Jena in 2009. For 5000 out of the 17000 stars in the field, we achieve the precision (few milli mag) to detect transiting planets. In 2010 the cluster was observed with telescopes collaborating in the YETI network to gather continuous light curves. Three runs with length of one to two weeks were performed. In the 2009 data we found so far one transit candidate, several eclipsing young binaries and stars with rotation periods.

Trumpler 37

Trumpler 37 is located in the star forming region Cepheus OB2 association. The distance is 870 pc (Contreras et al. 2002). Ages of the probable member stars are given with 3 to 10 Myrs (Contreras et al. 2002, Sicilia-Aguilar et al. 2004b, 2005). From the earlier investigations we know so far 500 probable member candidates. See Fig. 2 for a look on Trumpler 37 and part of the surrounding HII region IC 1396.

Instruments and Observations

With telescopes located in eastern Asia, central Asia, Europe and north America it is possible to observe nearly continuous lightcurves for targets on the northern hemisphere.
The YETI network telescopes have mirror diameters of 60 cm to 2.3 m (see Fig. 1).
Three campaign runs were performed in 2010 on Trumpler 37: 3 Aug. - 12 Aug. 2010
26 Aug. - 12 Sept. 2010
24 Sept. - 30 Sept. 2010
In total 27500 images were collected with 12 telescopes. But due to bad weather, the longest continuous observation lasted only 18 hours. Data analysis is still in progress.
In 2009 Trumpler 37 was observed in 40 nights with our 90/60 cm Schmidt-telescope near Jena. This data is fully analyzed and more than 300 variable stars were found.

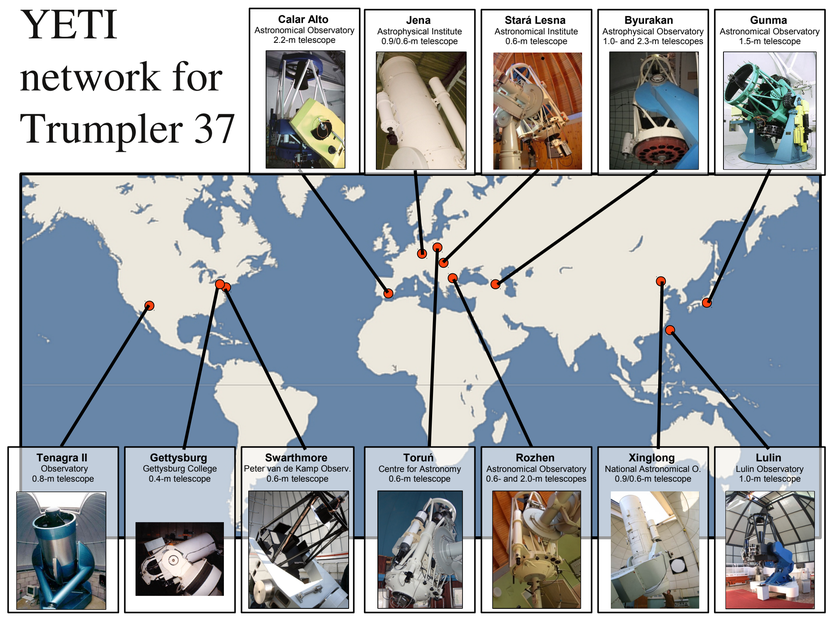


Fig. 1: The YETI network telescopes for Trumpler 37.

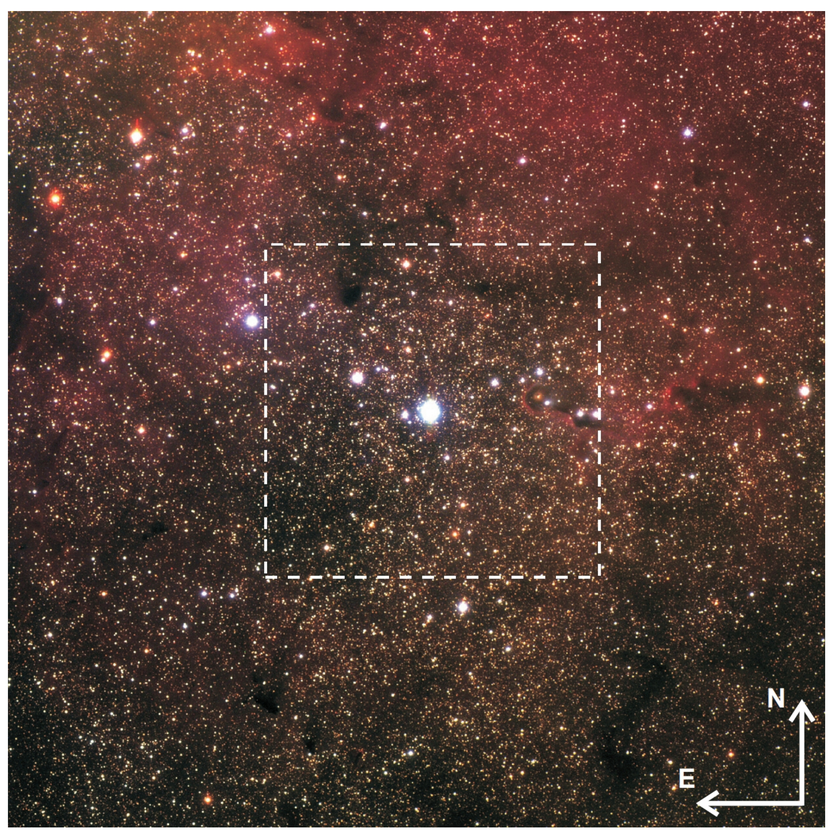
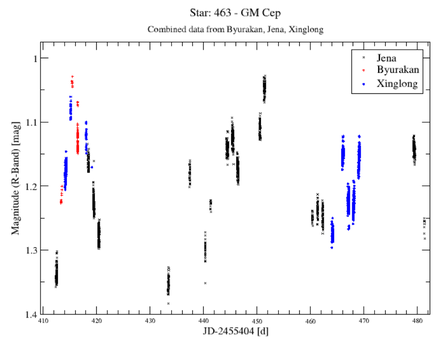


Fig. 2: VRI color composite mosaic of Trumpler 37, observed with our Jena STK CCD. The total image spans 2.1° x 2.1°, the central box indicates the FoV of our STK (53' x 53').

Results YETI campaign

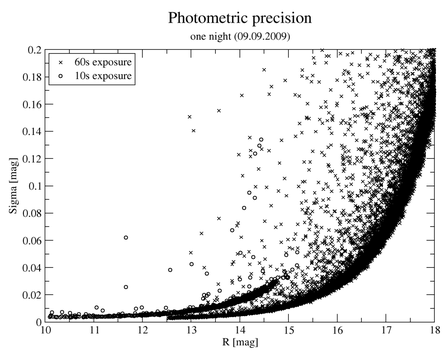
Here you can see one example lightcurve for GM Cep, a flare star (our internal number is 463). The data from Byurakan, Jena and Xinglong were combined for the time from beginning August to end of September 2010. One can see how the gaps in observation from one telescope are filled by the data from the other telescopes. The data processing is still in progress. A complete analysis of GM Cep will be by Hu et al. (in prep.).



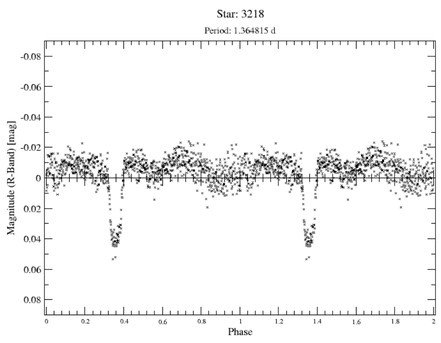
Results Jena telescope

Observations were done with alternating long and short exposure time. We achieve for the brightest stars in each exposure time precision below 5 mmag. 5000 of the field stars have a photometric precision less than 50 mmag and are therefore targets for transit detections. 6600 data points were collected in each exposure time.
More than 300 variable stars were found:

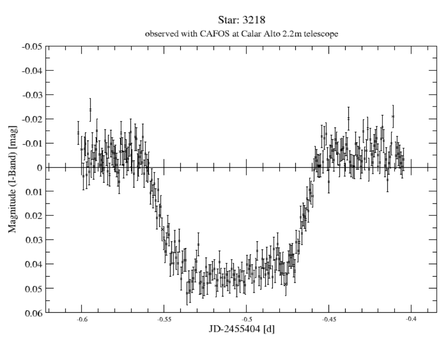
- many T Tauri stars (known from Sicilia-Aguilar et al. 2004-2006)
- rotating and pulsating stars (Periods 1h < P < ≈300d)
- irregular variabilities
- 50 eclipsing binaries
- 30 Flares
- 1 transit candidate



Transit candidate



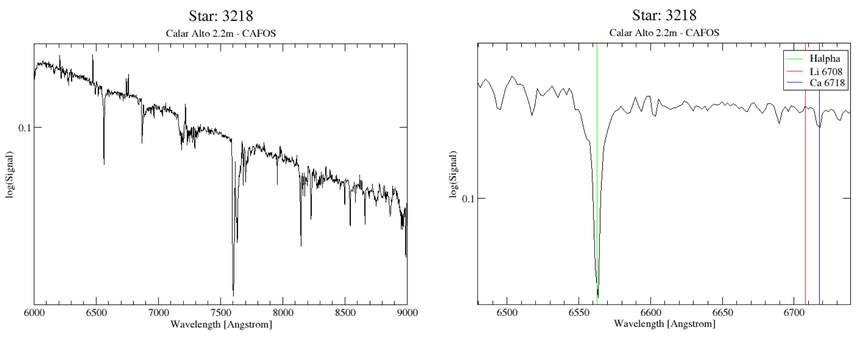
Transit like lightcurves were found for star 3218 in individual nights. The star have brightnesses of V=15.6 mag and R=15.1 mag. The dip has an depth of ΔR = 45 mmag. From BVRI photometry from Jena telescope we could determine a spectral type of G8 to K5. The spectral type from 2MASS JHK is consistent to this value.
We assumed cluster membership, because the star lies on the cluster main sequence and proper motion is comparable to cluster average, so the dip could be produced by an young planet with ongoing contraction. First follow up observation was the high precision photometry on the 2.2 m telescope on Calar Alto observatory (see right image).



Next follow up observation was the search for eclipsing background stars in the point spread function of the Jena image (FWHM = 2"). Therefore the 8 m Subaru telescope on Mauna Kea was used to do high resolution infrared imaging with adaptive optics. Faint objects to a distance of 0.3" away from the star could be resolved. Several objects lie in the Jena-PSF, but all are too faint to produce a 45 mmag deep dip if they are eclipsing binaries.

To determine the mass of the companion, high resolution spectra were taken using HIRES (High Resolution Echelle Spectrograph) at Keck-I telescope. The star was observed five times at different phases (including both quadratures) with 70 min integration time for each spectrum. The data analysis is still in progress.

Low resolution spectra were taken with CAFOS (Calar Alto Faint Object Spectrograph) shortly before the Keck observation. The spectral range was 6000 to 9000 Å with a resolution of 2 Å/px.
Lithium was detected marginally, so that the youth of the star is dubious. The Keck data is still being reduced. At the Keck telescope we also observed a few young eclipsing systems.



Discussion and Outlook

With our telescope near Jena we are able to detect transit like lightcurves. For our first transiting candidate we performed the necessary follow up observations to be able to reject false positives.
To not miss a transit it is necessary to observe continuous and therefore having telescopes at different longitudes, when observing with ground based telescopes. Over four weeks such continuous observations in Trumpler 37 were performed.
We found one and expect few more transit candidates from the international campaign, due to the great amount of data.
Follow up observations have to be done to determine membership and therewith youth of all variable stars (using Hectochelle at MMT). For the young eclipsing binaries and all transit candidates the orbits and masses should calculated by using radial velocity variations in high resolution spectra.

A similar monitoring like for Trumpler 37 is already done on the 8 Myr old cluster 25 Ori and planed for other young clusters. For summer 2011 three campaign runs are planed on Trumpler 37.

YETI: Young Exoplanet Transit Initiative

References

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