Exoplanet Observations in Taurus Hill Observatory – Scientific Support for Research Programs

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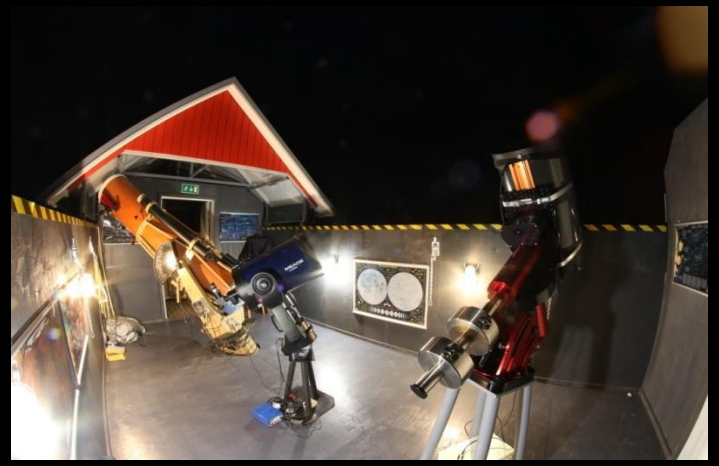


Abstract

Taurus Hill Observatory (THO) [1], observatory code A95, is an amateur observatory located in Varkaus, Finland. The observatory is maintained by the local astronomical association Warkauden Kassiopeia. THO research team has observed and measured various stellar objects and phenomena. Observatory has mainly focused on exoplanet light curve measurements (over 170 measurements so far) [4], observing the gamma rays burst, supernova discoveries and monitoring [2]. We also do long term monitoring projects [3].

The results and publications that pro-am based observatories, like THO, have contributed, clearly demonstrates that pro-amateurs are a significant resource for the professional astronomers now and even more in the future.

High Quality Measurements

The quality of the telescopes and CCD-cameras has significantly developed in 20 years. Today it is possible for pro-am's to make high quality measurements with the precision that is scientifically valid. In THO we can measure exoplanet transits < 10 millimagnitude precision when the limiting magnitude of the observed object is 15 magnitudes. At very good conditions it is possible to detect as low as 1 to 2 millimagnitude variations in the light curve.

Exoplanet Transit Observations in THO

To this date the team has measured over 70 different exoplanet light curves, some of them several times. Most of the transit measurements have been stored in the EDT (Exoplanet Transit Database) maintained by Variable Star and Exoplanet of Czech Astronomical Society.

Here are some examples of the exoplanet measurements from THO. In Figure 1 is the exoplanet measurement of the exoplanet WASP-10b. Here the the duration = 139.5 min ja depth 39.5 mmag.

Second example concerns measurement from HAT-P-12b observed on 1.9.2020 (Figure 2). Here the duration = 179.5 min and depth = 12.8 mmag.

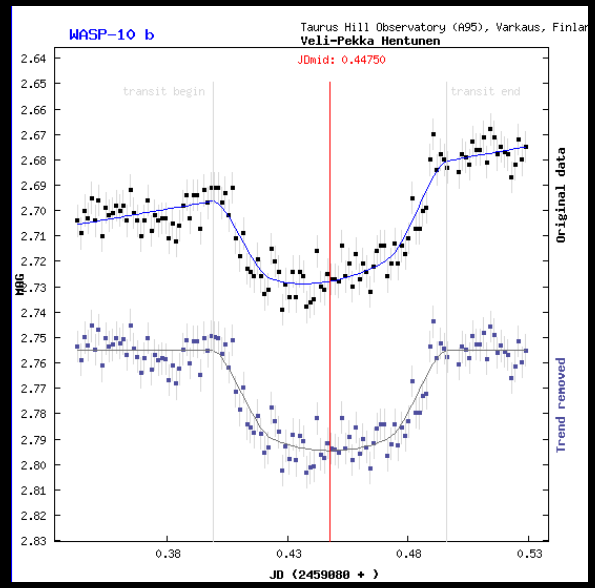


Figure 1: WASP-10b 18.8.2020 ; C-14, Paramount MEII, SBIG ST-8XME. Credit: TRESCA

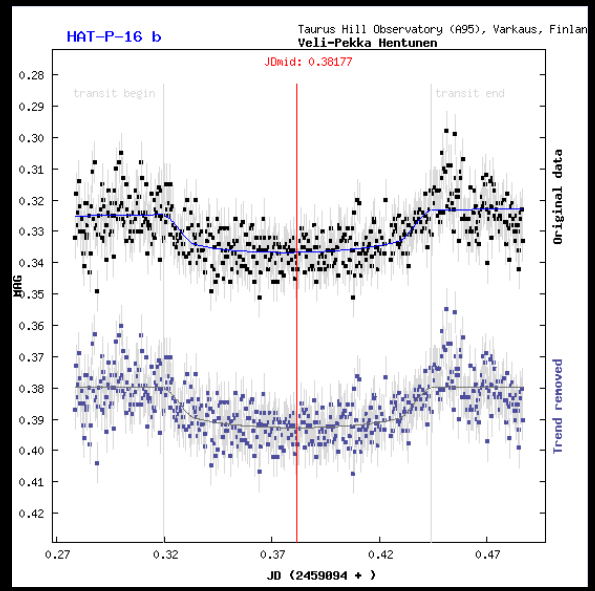


Figure 2: HAT-P-16b 1.9.2020; C-14, Paramount MEII, SBIG ST-8XME. Credit: TRESCA

High Quality Measurements

In Figure 3 (right) is observation regarding the TOI 1518.01b that is the first TESS candidate observed at THO. Observation was made 31.8.2020. Transit duration =107.9 min the dimmening depth = 7.2 mmag.

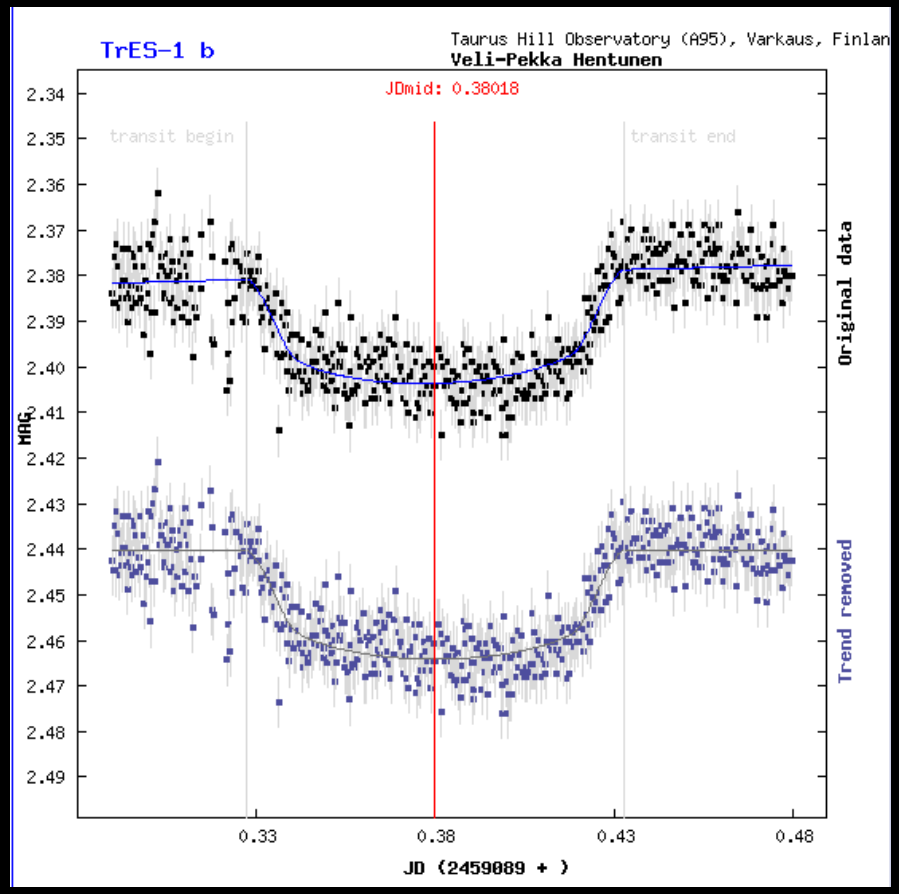


Figure 4: TOI 1518.01b 31.8.2020; C-14, Paramount MEII, SBIG ST-8XME. Credit: TRESCA

In Figure 4 (left) is measurement from the WASP-10b made in 18.8.2020. Here the duration = 139.5 min and depth 39.5 mmag. WASP-10b is three times more massive than Jupiter and its takes 3 days to orbit around the orbiting star.

Other Recent Observations Made in THO

Recently THO has also observed gamma ray burst optical afterglow of GRB 200829A OA (20/08/30 06:36:53 GMT). This observation has also reported in GCN circular 28318.

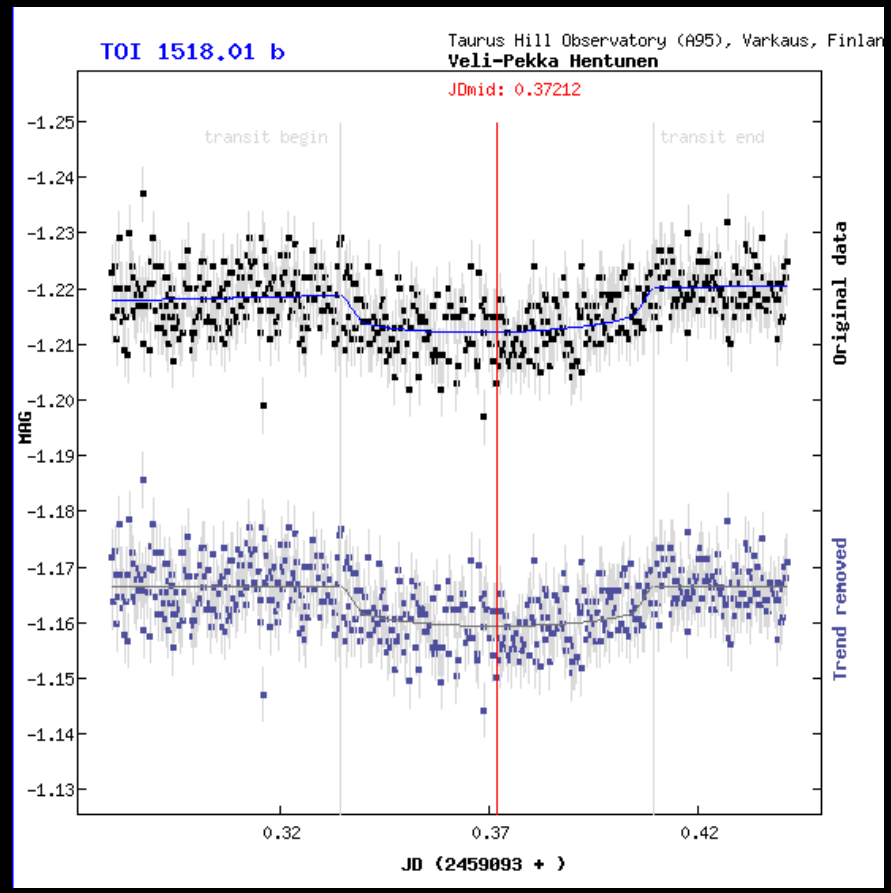
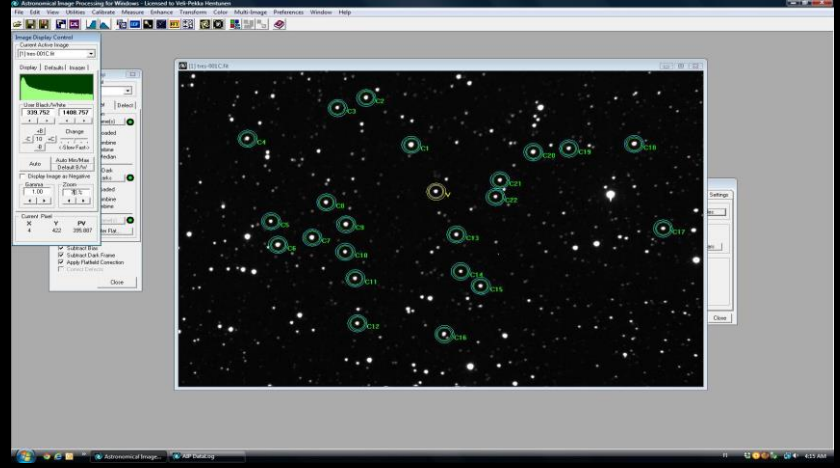
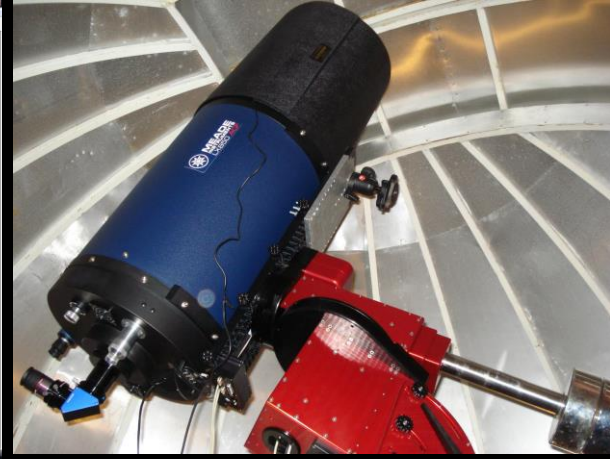


Figure 3: TOI 1518.01b 31.8.2020; C-14, Paramount MEII, SBIG ST-8XME. Credit: TRESCA

Scientific Level of Equipment





The main telescope of Taurus Hill Observatory is Meade 16”ACF on the Paramount ME with SBIG STT 8300M CCD camera. We use for imaging MaxIm DL 6 software. Images are also calibrated with this program. Photometric measurements are made using the AIP4WinV2 program.

Discussion: What must be considered with the amateur observations?

- The modest performance of the telescope. This limits the observation of the faint objects. The exoplanet objects must be brighter than 15 magnitudes . Usually only one telescope is in use though there are tens of interesting objects seen in the sky.
- Finnish weather conditions: only about 30 completely clear nights a year in the winter season!
- Lack of remote access to roof structures.
- Absence of a broadband connection with enough line speed. Internet is disconnected several times a day. One gigabyte image data will easily become overnight.
- The leisure time available for observations is very limited, “the daily work disturbs the hobby”.
- Other association activities take a lot of time. The main task of the association is to organize public events.
- Financial resources, the association does not get any financial support for basic activities and property management. For THO is needed about 8 000 euros a year. All the money is earned by members who work in the different volunteers.

Summary and Conclusions

Taurus Hill Observatory and other similar pro-amateur based observatories have a good record in field of astronomy and especially in the light curve measurements and photometric monitoring.

The research teams have the knowledge for making a good and high quality photometric light curve measurements. The publication records are one of the good examples from this knowledge. In the future the THO research team aims for more challenging astronomical research projects with professional astronomers and observatories, so please **contact us if you have a measuring campaign or project you would like to include us**.

As a conclusion it can be stated that it is possible to do high quality astronomical research with pro-amateur astronomy equipment if you just have the enthusiasm and knowledge to use your equipment in the right way.

Our Main Contacts and Cooperation Partners

- *Prof. Gregory Laughlin,* Santa Cruz, CA 2006 - 2007
- Amateur astronomer *Bruce Gary*, Hereford (G95), AZ 2007 - 2009
- TRESCA 2009 -
- *Prof. Sergio Messina*, Catania, Italy 2013 - 2014
- *Prof. Eugene Sokov*, Pulkovo (St. Petersburg), Russia 2013 -
- Amateur astronomer *Paul Benni*, Acton, MA, 2017 -

Acknowledgements

The Taurus Hill Observatory will acknowledge the cooperation partners, Pulkova Observatory, Finnish Meteorological Institute and all financial supporters of the observatory.

References and Links

[1] **Taurus Hill Observatory website** (http://www.taurushill.net)

[2] **A low-energy core-collapse supernova without a hydrogen envelope**; S. Valenti, A. Pastorello, E. Cappellaro, S. Benetti, P. A. Mazzali, J. Manteca, S. Taubenberger, N. Elias-Rosa, R. Ferrando, A. Harutyunyan, V.-P. Hentunen, M. Nissinen, E. Pian, M. Turatto, L. Zampieri and S. J. Smartt; Nature 459, 674-677 (4 June 2009); Nature Publishing Group; 2009.

[3] **A massive binary black-hole system in OJ 287 and a test of general relativity**; M. J. Valtonen, H. J. Lehto, K. Nilsson, J. Heidt, L. O. Takalo, A. Sillanpää, C. Villforth, M. Kidger, G. Poyner, T. Pursimo, S. Zola, J.-H. Wu, X. Zhou, K. Sadakane, M. Drozdz, D. Koziel, D. Marchev, W. Ogloza, C. Porowski, M. Siwak, G. Stachowski, M. Winiarski, V.-P. Hentunen, M. Nissinen, A. Liakos & S. Dogru; Nature - Volume 452 Number 7189 pp781-912; Nature Publishing Group; 2008

[4] **Transit timing analysis of the exoplanet TrES-5 b. Possible existence of the exoplanet TrES-5 c**; Eugene N Sokov, Iraida A Sokova, Vladimir V Dyachenko, Denis A Rastegaev, Artem Burdanov, Sergey A Rusov, Paul Benni, Stan Shadick, Veli-Pekka Hentunen, Mark Salisbury, Nicolas Esseiva, Joe Garlitz, Marc Bretton, Yenal Ogmen, Yuri Karavaev,Anthony Ayiomamitis, Oleg Mazurenko, David Alonso, Sergey F Velichko; Monthly Notices of the Royal Astronomical Society, Volume 480, Issue 1, October 2018, Pages 291–301, https://doi.org/10.1093/mnras/ sty1615

Links

[1] **https://www.kassiopeia.net**

[2] TRESCA: **http://var2.astro.cz/EN/tresca/transits.php?pozor=Veli-Pekka+Hentunen** (*Exoplanet lightcurves of this presentation*)

[3] **https://www.ursa.fi/proam/yleista-ryhmasta.html** (*general information about pro-amateur activitivites in Finland, pages in Finnish*)

[4] GRB 200829A OA. GCN circular 28318: https://gcn.gsfc.nasa.gov/gcn3/28318.gcn3