



# Light Curve Measurements of Stellar Objects Using a Small Telescope

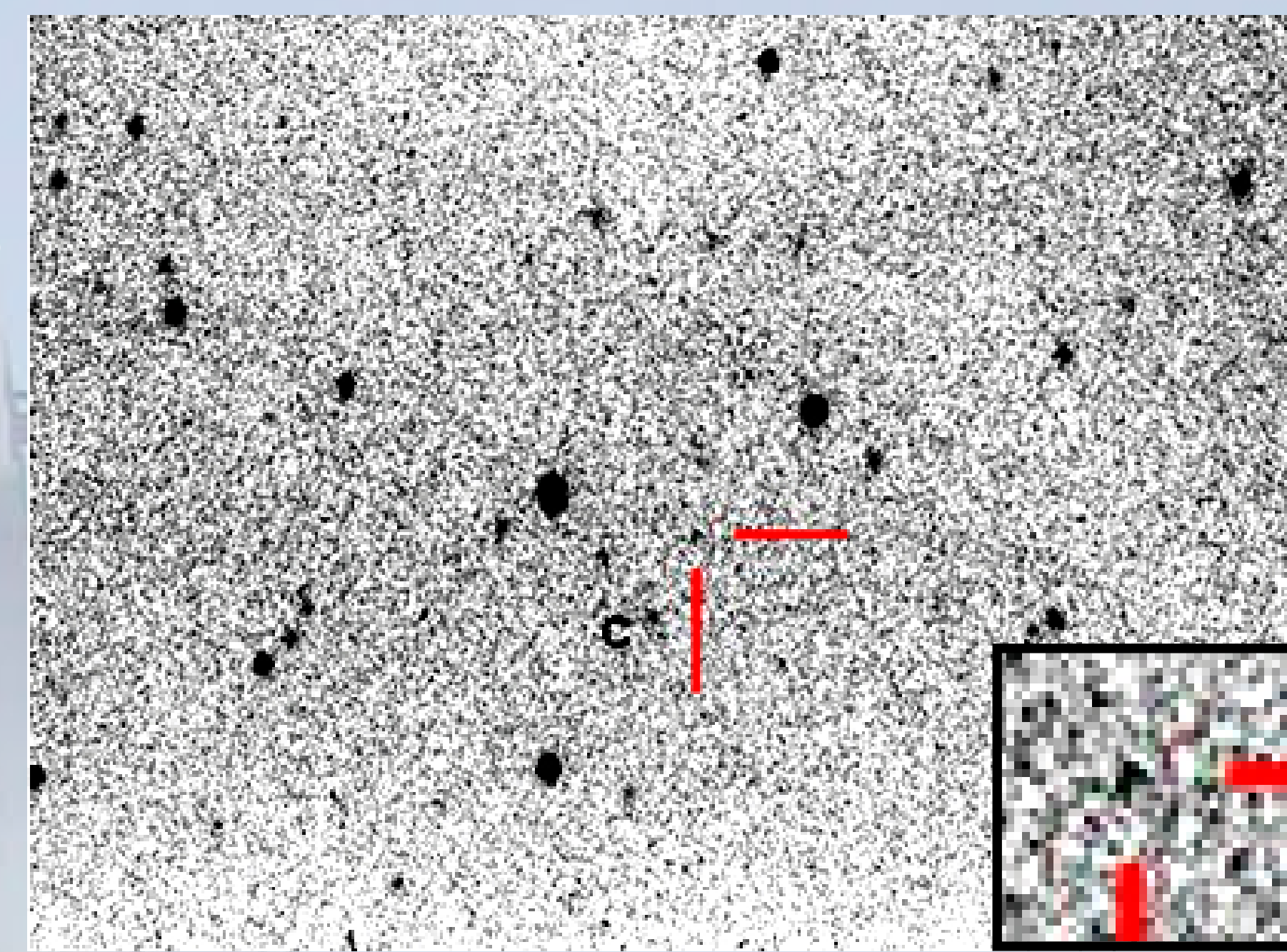
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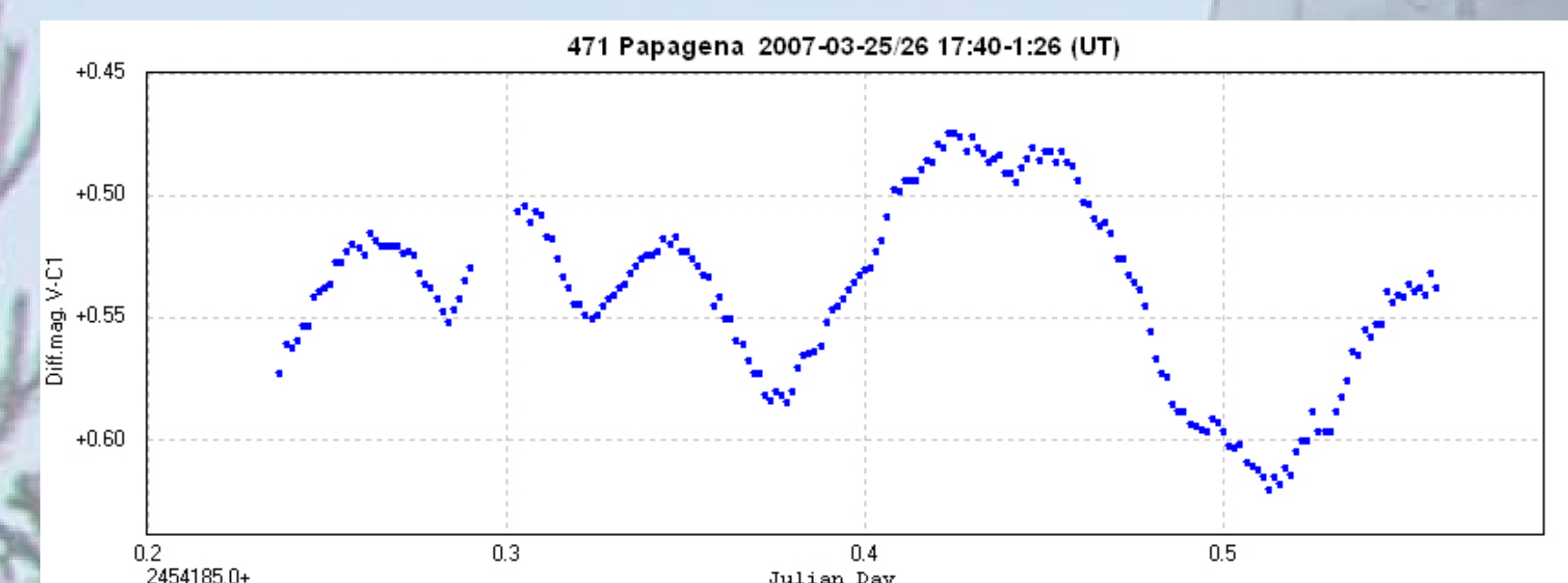
Taurus Hill Observatory (THO) is owned by Warkauden Kassiopeia, an amateur astronomical association. The observatory itself is located on top of the Härkämäki hill, Varkaus, Finland. The observatory's main instrument is a 14" Celestron C-14 Schmidt-Cassegrain telescope. Further, we use a SBIG ST8-XME CCD camera with UVBRI photometric filters for photographing and measurements. The main interests of the THO research team are supernovae (discoveries and brightness measurements), solar system bodies (asteroids, etc.) and exoplanets.

## Gamma ray bursts

The Swift satellite can observe very short gamma ray bursts (GRB) from distant galactic objects. From these detections also amateurs can get quick messages via GCN circulars by e-mail. While observing at THO we have a possibility to change our target to a GRB position in few minutes after getting a new GCN message. Optical afterglows of these phenomena are seen only for some hours after the initial GRB detection. But the afterglows are often so bright that many amateur telescopes can detect them. THO's first GRB afterglow was imaged in October 2007. The object got a code name GRB071020. This was also one of the most distant objects ever observed in Finland. Its red shift was  $z \sim 2.145$ . The second GRB afterglow was GRB080319B which we were able to image at 19th of March 2008. The source was possibly the most distant object which could be seen by naked eye. Its visual brightness was as high as 5.7 magnitudes even though the distance was even 7.5 billion lys. Some GRBs can counterpart with peculiar supernovae. This kind of afterglow from GRB060218 was observed at THO many weeks after the detection of the initial gamma ray burst. The object was classified as type I b/c supernova.



GRB080319B photographed 19.3.2008 at THO. Unfiltered 1x300 sec. and 2x600 sec. exposures. Photo: Veli-Pekka Hentunen and Markku Nissinen.



The lightcurve of the asteroid 471 Papagena was measured by Veli-Pekka Hentunen and Markku Nissinen 25./26.2.2007 in Taurus Hill Observatory. They used 120 sec. exposures and photometric filter R for the measurements. The comparison stars were GSC 2488-0284 and GSC 2495-0287.

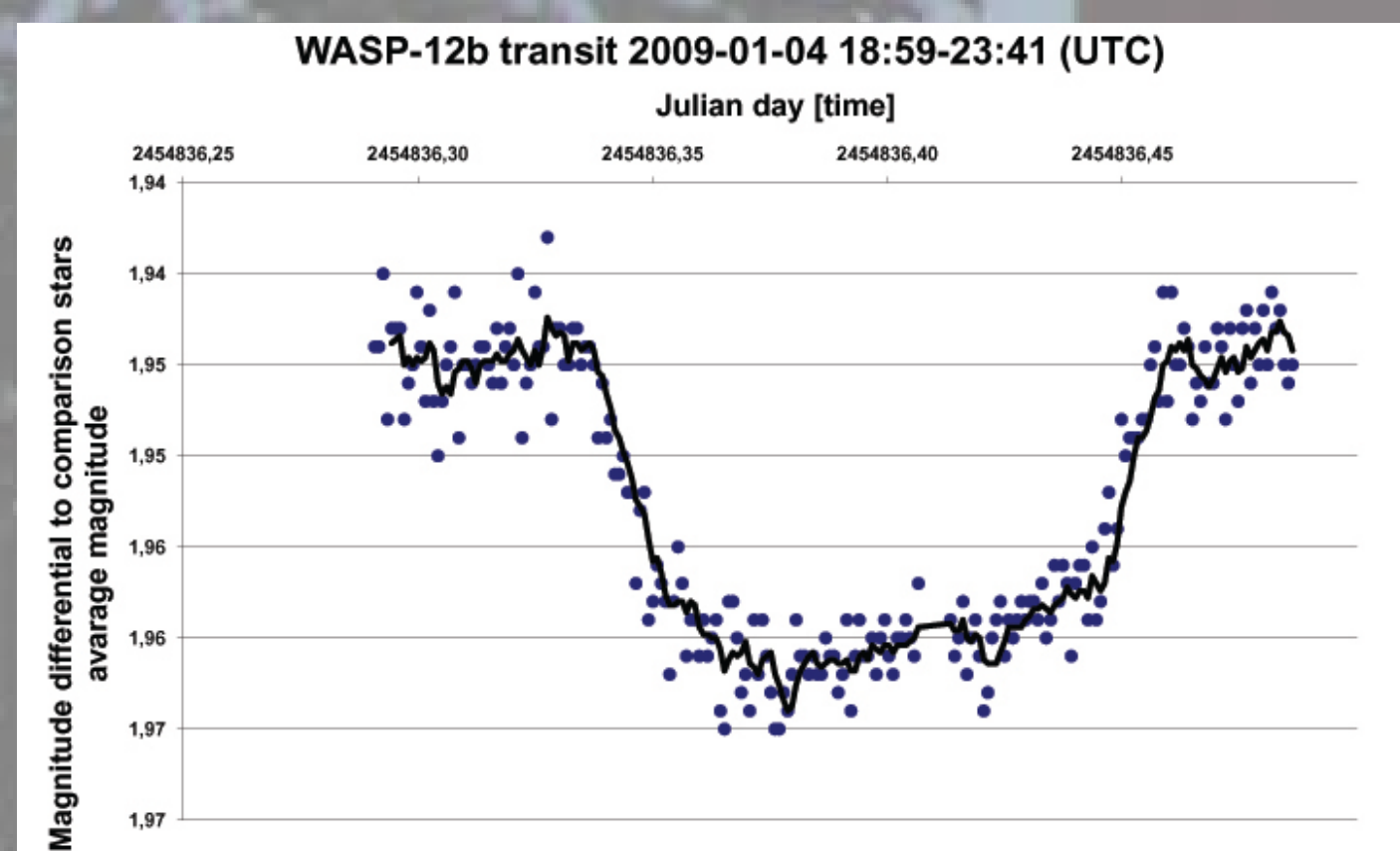
## Asteroid light curves

The THO research team has measured 15 light curves of different asteroids at THO during the last couple of years. Because the rotation period of an asteroid is often 5 - 10 hours this usually means that the measurements take all night. Because of the quite fast relative motion of asteroids the exposure time must be short, about one minute. However, this is usually enough when using photometric R-filter since the brightness of the objects are between 11 and 13 magnitudes.

Our measurements have been submitted to Johanna Torppa, researcher of the University of Helsinki, who analyzed them. Her doctoral thesis "*Light curve inversion for asteroid spins and shapes*" [1], was accepted in December 2007.

## Observations of OJ287

OJ287 has been observed at THO from December 2006 to October 2008 about 50 times. The measurements have been normally made once a week according to the prevailing weather conditions. The target has usually been imaged with the exposures of 300 or 600 seconds through the photometric R-filter and on each observation night 3 - 6 times. In photometric measurements we have used the finding chart and the brightness list of the check stars which are listed on the project pages of OJ287: [www.astro.utu.fi/OJ287MMVI/](http://www.astro.utu.fi/OJ287MMVI/). The observation results have been submitted to Dr. Kari Nilsson from Tuorla Observatory. We usually have achieved brightness precision of 0.01 magnitudes. Our results have been in harmony with the measurements done by others around the world. Also, THO's measurements of OJ287 measurements were used in the article that was published in Nature, April 2008 [2].



WASP-12b exoplanet transit measured 4.2.2009 18:59-23:41 at THO.



OJ287 is an Active Galactic Nuclei (AGN) that is located about 4,3 billion light years from Earth. There has been a variation in the brightness of the OJ287 in 12 years cycle. Photo: Veli-Pekka Hentunen and Markku Nissinen.

## Exoplanet light curves

Exoplanets have been one of the specialties of the THO research team. To this date the team has measured more than 20 different exoplanet light curves and some of them many times. The measurements have been added to the AXA-database which is maintained by Bruce L. Gary. Our highlights in the exoplanet research are the measurements of the planet GJ436b and the HAT-P-13 system. The THO research team presented results from its exoplanet research at EPSC 2009, Potsdam, Germany [4].

## References

- [1] Lightcurve inversion for asteroid spins and shapes; J. Torppa; University of Helsinki, Faculty of Science, Department of Astronomy; Doctoral dissertation; 2007
- [2] 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. Drozd, 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.
- [3] 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.
- [4] Small Telescope Exoplanet Observations in Taurus Hill Observatory; V.-P. Hentunen, M. Nissinen, H. Haukka and H. Aartolahti; Vol. 4, EPSC2009-119, 2009; European Planetary Science Congress 2009

## Supernova discoveries and observations

THO has been the most active supernovae observer in Finland. The observatory research team has discovered eighth new supernovae from the northern part of the sky. Observatory has also monitored few interesting supernovae. For example, the measurements of the supernova SN 2008ha were used in the Nature article [3] published in June 2009.

## More information about the Taurus Hill Observatory research

If You would like to get more information about the research work made at THO, please visit our website in the address <http://english.taurushill.net>. We recommend that You also visit the Transitsearch (<http://www.transitsearch.org/>) and AXA (<http://brucegary.net/AXA/x.htm>) websites.

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Poster design: Harri Haukka