Astronomical Research by Amateurs

at the Taurus Hill (Härkämäki) Observatory, THO (A95)

Position: 62° 18'.896 Northern Latitude 28° 23'.357 Eastern Longitude, Kangaslampi - Varkaus - Finland

Veli-Pekka Hentunen, Markku Nissinen and Harri Haukka

BL Lac object OJ287

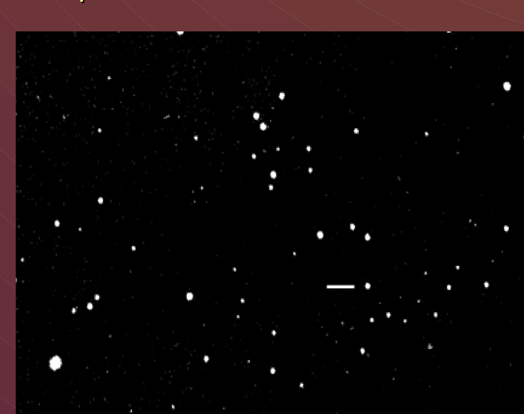
The BL Lac objects are one of the biggest mysteries of the modern astronomy. The explaining of simultaneous variations in all energy bands of different electromagnetic radiation is a big challenge for astronomers. OJ287 has been best studied BL Lac object and it has been observed for already more than a hundred years since 1891. The bursts appear at intervals of 11 - 12 years and are seen as a double peak in the optical light curve. The previous double burst was during the years 2005 - 2008 and it is just now in its end point. The magnitude varies between 12.0 - 17.5 so the brightness of the target can change even hundredfold. It has been thought that the BL Lac object OJ287 is a binary black hole (BH) system. The mass of the bigger component is 18 billions and the smaller one has the mass of a hundred million times the mass of the Sun. The smaller BH is orbiting the heavier one on a fairly eccentric orbit. It goes regularly through the accretion disc which is surrounding the more massive BH.

On the basis of wide international optical observations during the last few years it has been shown that the brightness of the BL Lac objects have continuous variations. A time period during which no brightness changes take place hasn't been perceived either in OJ287. This makes constructing models of the BL Lac objects more difficult because the functional model should explain the varying brightness lasting from some minutes to over one decade. According to the quite latest period observations Mauri Valtonen's group has succeeded in developing the best model in harmony with the measurements of OJ287. According to the model the first maximum of the double burst hit in November 2005 and the second one between the 9th - 16th of September 2007, just as the model by M. Valtonen predicted. These results by the researching group of M. Valtonen were announced in the *Nature* magazine on April 2008 (Valtonen, M.J. et al., Nature, Volume 452, Issue 7189, pp. 851-853, 2008). OJ287 is the fiercest known test laboratory of the Theory of General Relativity.

The observing measurements of OJ287 at THO

OJ287 has been observed at THO since December 2006 to October 2008 about 50 times. The measurements have been normally taken 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 3 - 6 times on each night of observation. In our photometric measurements we have used the finding chart and the brightness list of the check stars which can be read on the project pages of OJ287 *www.astro.utu.fi/OJ287MMVI/*. The observation results have been analysed by Kari Nilsson in Tuorla Observatory. We usually have achieved brightness precision of about 0.01 magnitudes. Our results have been in harmony with the measurements done by others around the world. At the moment OJ287 can be observed very low over the horizon on the eastern sky about four o'clock in the morning. Because of this the measurements have been difficult to do in the previous months.

OJ287 in February 2007



OJ287 in September 2007

Asteroid observations at THO

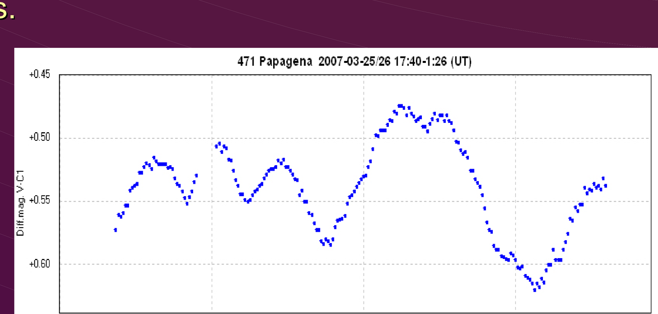
The small particles of the Solar System have been one of our main celestial targets at THO. Our chairman Markku Nissinen has specialised as observing meteors and he is also a volunteer coordinator of the meteor division of the Finnish Amateur Astronomical Association Ursa. He reports to the International Meteor Organisation all the visual and radio observations of meteors done by Finnish amateurs. At the 7th of October 2008 Markku succeeded in imaging the colliding meteoroid 2008 TC3.

Observation of the Near Earth Objects

More than five thousands Near Earth Objects (NEOs) are known nowadays. Potentially dangerous objects which pass the Earth under the distance of 0.07 AU are known about one thousand and about 130 of them are over a kilometre in diameter. The orbits of some asteroids change continuously in the consequence of the planets. That is why all the time new potential collision objects are found.

The present NEO observation at THO took place in January 2008 when, TU24 2007 passed the Earth at the distance of 530 000 km. This asteroid is the nearest known target before year 2027. On the series of CCD images taken by Veli-Pekka Hentunen the passing route of this asteroid on the sky was able to follow for about 40 minutes.

2007 TU24; 2008-01-30T1:33:47-1:38:47; unfiltered 300s; 12" LX200GPS UHTC OTA; Paramount ME; SBIG ST8XME; Taurus Hill Observatory (A95); Veli-Pekka Hentunen, Varkaus



Lightcurve measurements of asteroids

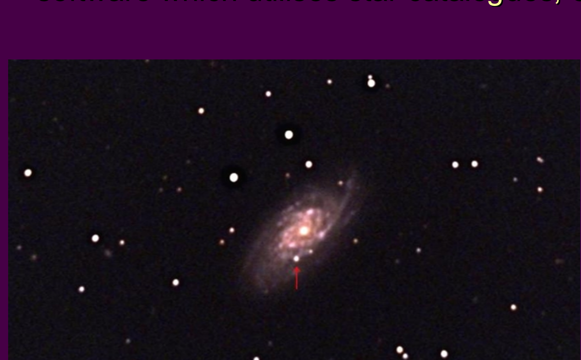
In every night there are visible many asteroids which can be easily detected with amateur devices. If a telescope has been equipped with a CCD camera, variations of brightness can be measured. The brightness variation of one rotation period can be presented as a lightcurve. When the variation of brightness is observed in a few different sections of an asteroid's orbit the shape of the asteroid can be calculated.

We have measured 15 lightcurves of the different asteroids at THO during the last a couple of years. Because the rotation period is usually 5 - 10 hours this means the doing of the measurements for all night long. Because of the quite fast relative move of asteroids exposure time must be short, e. g. about one minute. However this is generally enough when using photometric R filter because the brightness of asteroids have been between 11 - 13 magnitudes.

Our observations were submitted to the SAPC supported by the University of Helsinki. These results were analysed by researcher Johanna Torppa. Her doctoral thesis, "Lightcurve inversion for asteroid spins and shapes", was accepted in December 2007.

Position measurements of asteroids

THO has an observatory code A95. So we must send at times exact position measurements of some asteroids to the Minor Planet Center. In these measurements we have used Pin Point software included in MaXiM DL software which utilises star catalogues, e. g. GSC 1.1 and USNO-A2.0.



SN2008bo; NGC6643; 2008-04-04T20:06-21:55; C & photometric RVB; 12" LX200GPS UHTC OTA; Paramount ME; SBIG ST8XME; Taurus Hill Observatory (A95); Veli-Pekka Hentunen, Markku Nissinen, Varkaus

Discovery image of SN 2008fb in UGC 2813; Mag. 16.9R; 2008-08-24T21:27:59; unfilt. 7x150s; 12" LX200GPS UHTC OTA; Paramount ME; SBIG ST8XME; Taurus Hill Observatory (A95); Discoverers: Markku Nissinen, Veli-Pekka Hentunen; Varkaus

Introduction

In this poster a few examples of the successful cooperation between the amateurs of the Taurus Hill Observatory and both Finnish and foreign professional astronomers are presented.

The Taurus Hill Observatory (THO) is owned by an Amateur Astronomical Association Warkauden Kassiopeia. The observatory itself is located on the top of Hill Härkämäki 160 m above the sea level. The village of Kangaslampi is located 6 kilometers away from the observatory and the town of Varkaus is about 30 kilometers away. There is no near residence in the neighbourhood of the observatory. The area is almost totally free from the light pollution. The main telescope of the observatory is 12" Meade LX200GPS (UHTC) which is Schmidt-Cassegrain type telescope. THO has also a smaller 5" Meade LXD55 EMC achromatic refractor for planetary and Solar observations. LXD55 is also used for public "star shows" due its mobility. The 12" Meade LX200GPS -telescope was bought for the observatory in the end of the year 2002. The telescope is mounted on the Paramount ME robotic mount. We operate a SBIG ST8-XME CCD camera with UVBRI photometric filters. The telescope and the CCD are controlled via computers in the remote operating building.

Hunting for supernovae as the main researching case

As much as 570 new supernovae discoveries were made worldwide in the year 2007. The number of the discoveries has increased during the last couple of decades over tenfold. The majority of the supernovae are found by the professionals' automated robotic telescopes. However, the persistent efforts by amateurs are worth while because not all supernovae are discovered by the automation telescopes.

The observation strategy

At THO CCD imaging of galaxies has been made for three years. Several thousands images of separate galaxies have been accumulated to our archives. We have now about 600 target areas for our CCD's 14' x 9' image field. Each field has at least one galaxy brighter than 16th magnitudes. In every field there are usually many other visible galaxies too. From each target we will take normally two images with 150 sec exposures. We have concentrated especially on the environment of the Pole Star, accurately to the declination area between 70 - 90 degrees. The observations in this direction are quite easy because the telescope movements are relatively small and the position of the dome does not need to be turned at all. We do not have rolling automatic of the dome. When the targets are chosen from the certain RA band, we usually can do the observations whole night so that the targets will move conveniently to the gap of the dome during the observation block as a consequence of the rotation of the Earth. The advantage given by our northern location is also important. Because the targets of our selected area are located high above the horizon, the faint targets can be observed better than from elsewhere. The environment of the Pole Star is also less examined from other observing sites (including the robotic telescopes).

Checking the images is a laborious job

After taking of every galaxy image a checking is done at first with our own comparison images. When a possible supernova candidate is seen on the field, additional images are exposed. Then we will expose also with a photometric R filter and with longer exposures. In the comparison of our images we use the blinking function of MaXiM DL software and nowadays also the image subtraction functions of MaXiM DL and so called optical image subtraction also widely used by the professionals. We check the possible known minor planets on the Minor Planet Checker page on www and the known stars e.g. with DSS II images and USNO-A2.0 catalogue in Aladdin via internet. The limiting magnitude of these images is of the same order as in our own images, about 20 - 21 magnitudes. The CCD camera has different kinds of failures, e. g. ghost spots can cause wrong alarms or can cover interesting features of the images. For that sake the analysis of images must be done carefully otherwise the time used for taking observations is loosed. Every week several hundreds images are accumulated and it is really heavy work to analyse all of them.

The first supernova discoveries in Finland

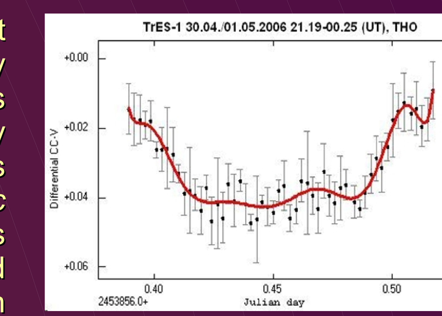
At THO at the 19th of February 2007 when only about 40 minutes time had elapsed a point source was extremely weakly seen in the raw image of the galaxy UGC 10704 which has a distance of about 270 Mpc. After that we obtained a few more images with longer exposure time. By this way we were ensured that this was not a question of a mistake. The object seemed to be a starlike target of 17.5 magnitudes. We also took images through the filter R so we could measure the brightness of the target. It had been imaged at THO previously only in one month ago at the 17th of January 2007. We reported our possible discovery to Harvard-Smithsonian Astrophysical Institute and got an answer after a couple of days from Dr D. Green in CBET 856. Our discovery was confirmed at Nayuta in Japan. The new designation was SN 2007ae and it was classified as a type Ia supernova by The Whipple Observatory.

The second supernova at THO was found at the 31st of March 2008. It was designated as SN 2008bo (CBET 1324). This supernova was fairly near object, its distance was only 24 Mpc. The nearby supernovae are of a great interest for the professionals because they can give much more accurate information than the more distance objects. This supernova was observed intensively also by the Swift satellite and by the VLA. This object was classified as a type Ib or IIb supernova. Therefore its progenitor had been a Wolf-Rayet star which had loosed its outer layers by companion partner or by extensive stellar winds by the time of the explosion.

The third and this time the most recent supernova at THO was found at the 24th of August 2008 in the galaxy UGC 2813. It got a designation SN 2008fb (CBET 1479) and was typed as an old type II supernova. The supernova's distance was only 19 Mpc but its host galaxy is fairly faint. This time the confirmation was obtained at the NOT telescope (La Palma) by the Danish Astrophysics Researh School (DARS) course in observational astrophysics.

Measuring transits of exoplanets

TrES-1b exoplanet transit observed at the 30th of April in 2006 was the very first one at THO. We reported this result to Gregory Laughlin in University of California (UC) (Santa Cruz). He has reported our results on his *Systemic* web blog (*www.oklo.org)* some days after our announcement. He suspected that on our light curve of the transit can be seen a tantalizing hint of the star-spot activity that is known to characterize TrES-1. Also the results by the images of HST have shown that starspot activity on TrES-1 can produce strange-looking features in the light curve.



After that very beginning of our exoplanet transit survey we have got at least a partial transit light curve of seventeen different exoplanets. We have used normally clear or photometric R-band and exposure times between 20 and 120 seconds. The photometric analysis has been done with AIP4Win2 software using several different reference stars seen on the CCD image field.

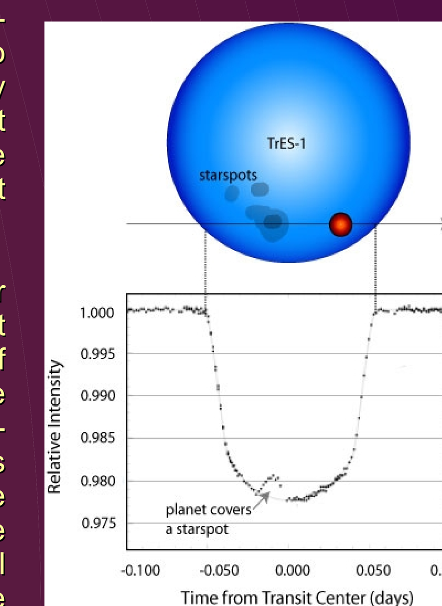
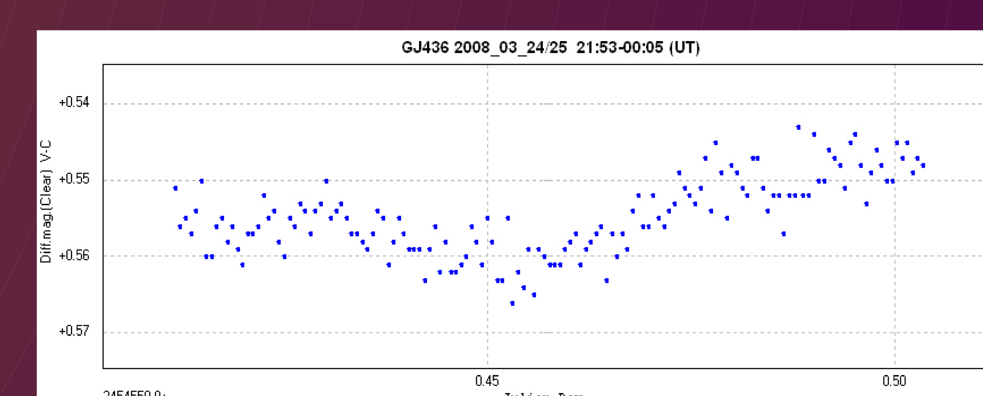
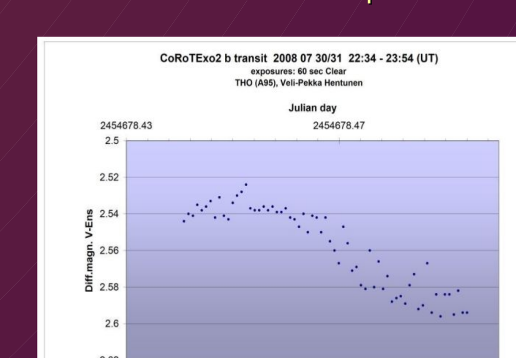


Figure © Gregory Laughlin

Star GJ436 (GSC 1984-1926) has a planet that has a size about the planet Neptune. It diminishes the light of the host star only seven milli-magnitudes. It has a orbital period of 2.64 days, so it is very close to its host star. The planet is very interesting due to its atmosphere which is supposed to contain water. Also there are estimates that there might be even more planets around the host star. Veli-Pekka Hentunen and Markku Nissinen measured the light curve of GJ436 at the 24th of March 2008 at THO. They used 25 sec. exposure time with clear filter. This time GJ436 was quite high on the southern sky, altitude was about 50 degrees. We used five comparison stars for the measurements.

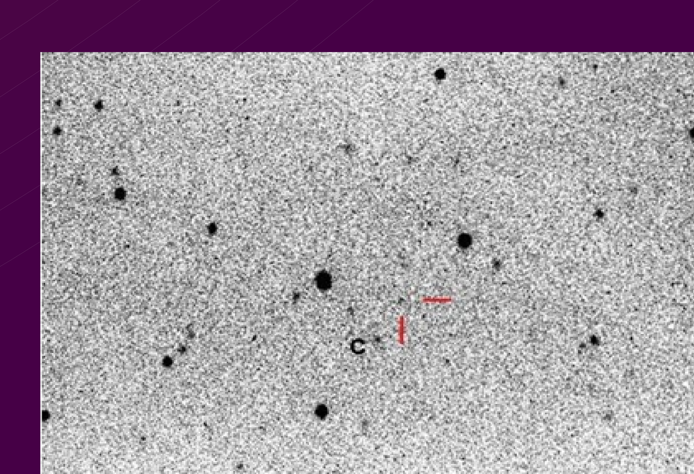


Despite the light sky of Finnish summer Veli-Pekka Hentunen managed to image and to measure the lightcurve of the exoplanet CoRoTExo2 b. This exoplanet dims the brightness of its host star (GSC 465-1282) almost 40 millimagnitudes. The period of the very eccentric orbit around the host star is only 42 hours. Veli-Pekka imaged about half of the transit at THO the 30th of July 2008. He used 60 seconds exposure time, clear filter and six different comparison stars.



The gamma ray bursts, GRBs

Swift satellite can observe gamma ray bursts (GRBs) from distant extragalactic objects. From these detections also amateurs can get quick messages via GCN circulars by e-mail. While working at THO we can easily change our observing target to a GRB position in few minutes after getting a new GCN message. Optical afterglows of these phenomena are seen only some hours after the GRB detection. But they are often so bright that many amateur telescopes can detect them. At THO a GRB afterglow was imaged for the first time in October 2007. The object received a designation GRB071020. This was in the same time one of the most distant objects ever observed from Finland. Its red shift was z ~ 2.145. The second GRB afterglow was GRB080319B which we were able to image at the 19th of March in 2008. That object was possibly the most distant object which could be seen by naked eye. Its visual brightness was as high as 5.7 magnitudes though the distance was even 2,300 Mpc. The latest GRB afterglow observed at THO was GRB080430. The so called long duration GRBs are connected with core-collapse supernovae. The afterglow of GRB060218 which was observed at THO many weeks after the detection of the GRB was connected to a type Ib/c supernova.



GRB080319B; 2008-03-19T21:22:38-21:48:58; unfiltered 1x300s&2x600s; 12" LX200GPS UHTC OTA; Paramount ME; SBIG ST8XME; Taurus Hill Observatory (A95); Veli-Pekka Hentunen, Markku Nissinen, Varkaus

Future plans

Our main plan in developing THO is to provide our observatory with two new telescopes and CCD cameras. From the point of view of the price-quality ratio the most efficient telescope is the 14-inches SC OTA which is fastened on to the robotic mount. Thinking of Finland's varying weather conditions many actively used small telescopes are more efficient in practise than one big more expensive telescope. By this way we can study different targets simultaneously and we can achieve nearly the best possible precision under our conditions. The purchase price of the equipment in our plan remains moderate and the maintenance costs are low. Two telescopes in simultaneous use also make our searching project of supernovae more competitive.

The amazing burster comet 17P/Holmes imaged by Markku Nissinen.

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