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Observations

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Photometrical Observations Made from Iceland

A report summarizing photometrical observations, made at the Nes Observatory in Hornafjörður Southeast Iceland in 2020-2021, has been published. The report highlights observations of selected eclipsing binaries and exoplanet transits. The text is mainly written in Icelandic (the author's nationality) but abstract, summary and text of figures are added in English. The Nes Observatory is a private facility, owned by Snævarr Guðmundsson, a advanced amateur astronomer. Currently, it is the only astronomical observatory in Iceland devoted to photometrical observations of variable stars.

Figure 1. The Nes Observatory is located in the subarctic at latitude 64°N in Iceland. Siddy Bjorgvinsdottir, the author's wife poses in front of the facility.

The main intention of the eclipsing binary observations is to determine accurate timings of mid-eclipses and compare to predicted timings. The following stars were observed: NX Dra is a little known eclipsing binary located in the northern constellation Draco. The primary eclipse is of magnitude 0.2 with a shallower secondary by 0.03 mag. Four observations were made between January 26, 2019 and November 20, 2021. A 40 cm telescope, was used in the first and last observations, and yielded excellent results. The other observations were made with an 80 mm refractor, resulting in significantly high-noise data. Comparison of data obtained with the different instruments manifests limitations of using small optics on a faint object. Predicted timings and mid-eclipses did not match. The measurements indicate that the orbital time of NX Dra fluctuates significantly.

Two observations in 2020-2021 covered the entire period of V 885 Per. The primary eclipse is of 0.35 magnitude and the secondary is slightly shallower. O'Connell effect can be detected in its light curve. The primary eclipse occurred one hour earlier than predicted. Observations of the contact binary V 566 And were first made in 2017 with a 40 cm telescope, but repeated in 2020, then using 80 mm refractor, again with a V-filter. The measurements revealed shallower eclipses than were observed in the 2017 session. The variations of the eclipsing depth remain unexplained.

V 442 UMa is one of several unusual eclipsing binaries discovered by the SuperWASP sky survey. It consists of a short period EW star of ~0.227 day and EA binary with a period of 1.30550 days. The two pairs form a quadruple system, sharing a common centre of gravity. The V 442 UMa's tighter binary is on its way to merging. Fewer than 30 such system are known. Observations of V 442 UMa were made on several occasions in 2021, sometimes with very odd results. The measurements reflect the different periods of the two nonidentical eclipsing binaries. In all cases when eclipse extremum was determined it coincided very well with predicted timings.

11 observations of the EA type star SV Cam were made between September 22, 2021, and January 18, 2022. Several

observations were required to photometrically cover its >14 hours period. Altogether three primary and two secondary eclipses were recorded in the observations.

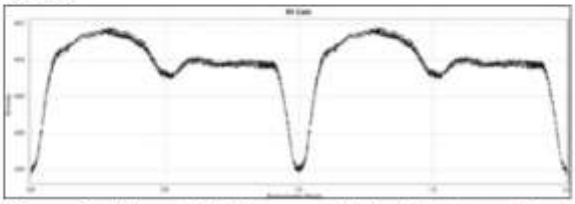

Figure 2. The odd light curve of the EA-type eclipsing binary SV Cam.

The results revealed an unusual light curve. Following the primary out-of-eclipse maximum the brightness seems unconstrained, but after the secondary the flux is restrained. These are strong indications of a large star spot on one or both stars. Determination of extremum revealed only a small time deviation from predicted timings, but certain orbital irregularity.

In November and December 2021, and early January 2022, nine observations were made of NR Cam. In total the measurements took more than 52 hours and revealed the period of the EW binary in BVR bandpasses. On December 3-4 four eclipses were recorded during a >10 hour observing session. On December 21, three eclipses were recorded. The results indicate about mag. 0.2 depth difference of primary and secondary eclipses.

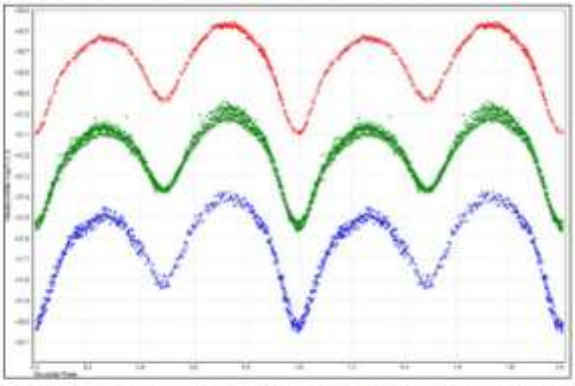

Figure 3. Phase diagram for NR Cam, based on observations. The color indicate the different bands in the measurements, i.e. red curve for R-band, green for V-band and blue for B-band.

The light curves show that the out-of-eclipse maximum after a secondary is mag. 0.1 brighter than the out-of-eclipse maximum after a primary. Such asymmetry is identified as the O'Connell effect. One explanation for the O'Connell effect is distribution of starspots on the surface of the stars.

2021 was devoted to exoplanet observations, after the author was invited to participate in an international collaborative project called EXPANSION. The aim is to search for anomalies in transit timings of selected objects. Precise measurements are needed to determine time deviations. A total of 32 transits on 21 exoplanets were measured in 2021. These measurements provide information on the depth of the eclipse, the length of the transits and the time deviation if these exist.

In January 2021, transits of HAT-P-32 b, XO-3 b, WASP 12 b, K2-29 b, HAT-P-20 b, HAT-P-36 b and Qatar 4 b were observed from Nes observatory. The transit of XO-3 b is the faintest the author has ever measured, as the magnitude drop is only 0.005 (0.5%). Weather conditions permitted only three transit observation windows in February. Firstly, a HAT-P-22 b transit on February 1, then additional observations were made on HAT-P-36 b on February 18 and 22. In early March, the transiting HAT-P-54 b was observed for the second time. Later same month a transit of WASP-92 b was observed for the first time by the author, and of TrES 5 b on March 31. On April 2, another TrES 5 b transit was observed, following a HAT-P-21 b transit a day earlier. The author did his third transit observation of XO-6 b on April 10, and finally of HAT-P-44 b on April 13, 2021. April observations are very unusual as the early spring season in Iceland is almost void of dark nights.

The winter season of 2021/22 began

unusually late, due to the weather. In September an observation of Qatar 1 b was made and of Qatar 4 b in late October 2021. In November observations were made of WASP-59 b, HAT-P-19 b, WASP-10 b and HAT-P-1 b and in December of HAT-P-22 b, HAT-P-16 b, WASP-12 b, HAT-P-19 b, TrES-1 b, TrES-5 b, HAT-P-19 b, HAT-P-9 b and WASP-12 b.

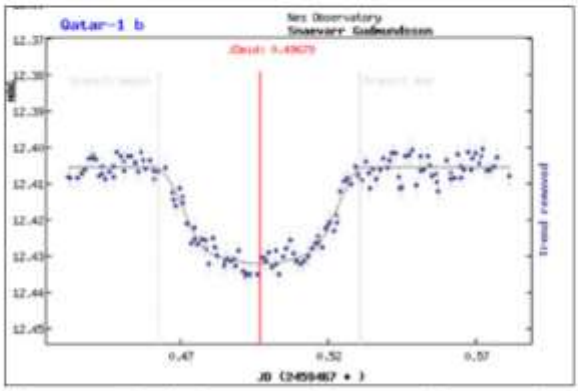

Figure 4. The light curve of the transiting exoplanet Qatar-1 b, results from the September 9, 2021 observation.

Transits of several exoplanets listed above have been observed before and noted in previous reports. Others were observed for the first time. In 2021, a total of 55 evenings/nights were used for astronomical observations, 22 from January to April and 33 from September until the end of 2021. That's all that the ever frustrated amateur astronomer gets in Iceland. Weather conditions in South-east-Iceland provide few opportunities for measurements of these kinds and the weather can turn extreme. Therefore, a firmly built observatory is vital. When an observation of the transiting WASP 10 b, was made on November 25, 2021, the wind changed from a gentle 2 m/s to furious >20 m/s average wind with gusts of 30 m/s in less than two hours! Nevertheless the observation was successful.

Two telescopes were used to increase data acquisition. A small (80 mm) refractor was mainly aimed at bright eclipsing binaries or used for astrophotography, while the 40 cm

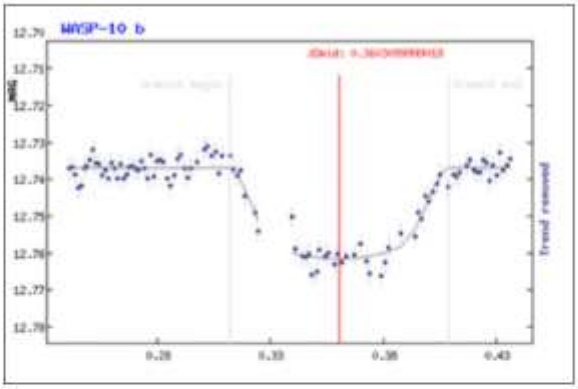

Figure 5. The light curve of the transiting WASP 10b, was obtained during an extreme wind conditions on November 25, 2021.

(16" SCT) reflector is used for the exoplanet transits. The results are usually submitted to the international databases of B.R.N.O. and TRESCA, the Variable Star and Exoplanet Section of the Czech Astronomical Society, where it is accessible to the astronomical community.

Similar reports were previously published in 2016, 2018, 2019, 2020 and 2021. The reports are accessible in the report section at the Nes Observatory website. As before, the report is an electronic publication, downloadable for printing.

Figure 6. The spiral galaxy Messier 101 (NGC 5457), nicknamed the Pinwheel, is located in the constellation Ursa Major. It is at distance of 21 million light years. Two smaller galaxies are identified in the image: Near the upper edge the dwarf galaxy NGC 5477 can be spotted and below M 101, the spiral PGC 49919. The image was captured with Skywatcher Evostar 80 mm apochromatic refractor, Zwo Asi 174MM-C camera og RVBHα filters.