

Investigations on the nature of 6 suspected or hardly known variables in Equuleus

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Abstract: Six alleged variables in the constellation of Equuleus are examined using Catalina Sky Survey, NSVS and ASAS data. NSV 25461, NSV 13665 and NSV 13696 are of constant brightness, these objects should be removed from the list of suspected variable stars. ASAS J205848+0841.5 turned out to be a semi-regular variable star (SRA) with a pseudo-period of 80.12 days. GSC 00525-00380 is a W UMA eclipsing binary ($P=0.315385$ days), and NSVS 14398712 a Beta Lyrae variable star ($P=20.4372$ days).

ASAS J205848+0841.5

This object was first identified as a variable star of unknown type (residual category “MISC” = miscellaneous) by Pojmanski et al. (2005), based on the All Sky Automated Survey (ASAS) data (Pojmanski 2002). Reanalysing the ASAS data (JD 2452216-55092) with the Peranso 2.50 (Paunzen & Vanmunster, 2016) ANOVA procedure yields a period of 80.2(7) days. An analysis of the Catalina Sky Survey (Christensen et al. 2012) data (JD 2453466-56227) gives a period of 79.3 days (± 0.9). The time interval of the Northern Sky Variability Survey (NSVS) observations (Wozniak 2004) is too short to determine an accurate period of that order. The ASAS and Catalina data agree on the amplitude in V-band: up to 0.40 mag, but varying from cycle to cycle. Therefore both datasets were merged, taken the average brightness as point of reference. The result is the light curve in figure 1. The combined dataset enables us to determine the period more precisely: 80.12(11) days. Obviously, it is a semi-regular variable of subtype A (SRA), varying between $V=12.9$ mag at the brightest maxima and $V=13.3$ mag at the faintest minima (according to the ASAS reference system). This is in good agreement with the mean brightness ($V=13.041$ mag) from the AAVSO Photometric All-Sky Survey (APASS) (Henden et al. 2012). HJD 2455400.886(48) is a suitable epoch E0.

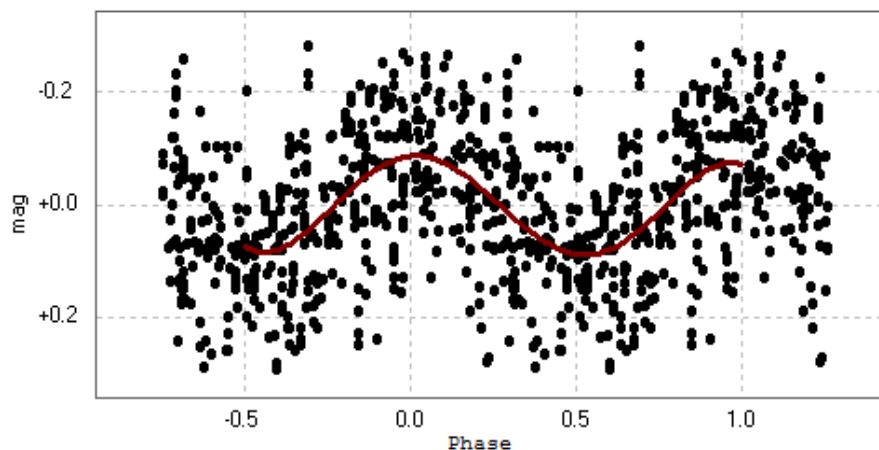


Figure 1: Phase diagram and mean light curve of ASAS J205848+0841.5, with reference to the average brightness of the ASAS and Catalina data respectively (V passband).

Aliases: GSC 01103-02460, USNO-B1.0 0986-0587027, CSS_J205847.6+084133, 2MASS 20584758+0841336

Classification: SRA Period: 80.12 days Epoch: HJD 2455400.886

Magnitude range: 12.9 – 13.3 V Position (UCAC4): RA 20 58 47.59 DEC +08 41 33.6 (J2000.0)

GSC 00525-00380

Discovered by Warner (2009), this variable star was supposed to be an eclipsing binary with a period of approximately 0.318 days. It was added to the VSX database of AAVSO based on observations from one single night. At this juncture a typing error occurred: The true position in right ascension (2000.0) is not 20h 59m 47.7s but 20h 59m 49.7s. Therefore, the correct identification of this variable should be **VSX J205949.7+071204**, not VSX J205947.7+071205.

The Catalina data were analyzed for the time span JD 2453466-55154 (later measurements were omitted because the zero-point magnitude calibration seems to be erroneous). It proves that this variable is of the W UMa type (see figure 2), ranging between $V=13.52$ mag in maximum and $V=14.03$ mag in primary minimum (secondary minimum: $V=13.99$ mag), in good agreement with the mean magnitudes given in the NOMAD catalog ($V=13.740$ mag), the GSC 2.3.2 ($V=13.92$ mag) and APASS ($V=13.737$ mag). Finally, an ANOVA period search yields 0.315385(9) days for the period and HJD 2454997.9295(17) as epoch E0 for the elements.

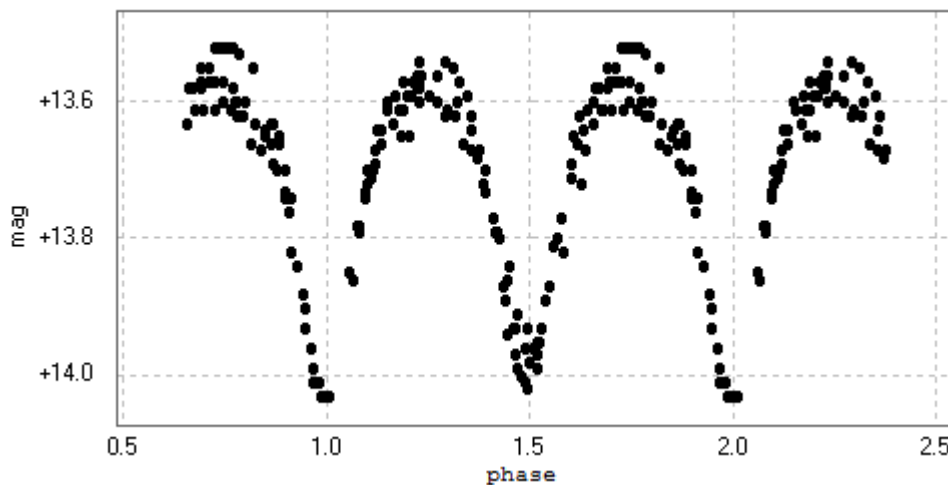


Figure 2: Light curve (phase diagram) of GSC 00525-00380, based on Catalina data (V passband).

Aliases: USNO-B1.0 0972-0685254, 3UC 195-287215, CSS_J205949.7+071204, 2MASS 20594972+0712047
 Classification: EW Period: 0.315385 days Epoch: HJD 2454997.9295
 Magnitude range: 13.52–14.03 CV (Min. II: 13.99) Position (UCAC4): RA 20 59 49.73 DEC +07 12 04.8 (J2000.0)

NSVS 14398712

Shokhan (2012) discovered this new variable, based on NSVS data, and classified it as a long-period Beta Lyrae eclipsing binary ($P=20.44$ days). The Catalina data covers a much longer time span (JD 2453480-56277) and are suitable to check these specifications and to refine the period. The findings of Shokhan (2012) are confirmed. NSVS 14398712 is a Beta Lyrae variable star varying between $V=13.03$ mag in maximum and $V=13.48$ mag in primary minimum (secondary minimum: $V=13.46$ mag). The elements of the semidetached binary system are:

$$\text{HJD (Min. I)} = 24\,55092.73 + 20.4372 * E \\ \pm 0.05 \quad \pm .0007$$

They were derived by the Peranso 2.50 method of least squares applied to all observations fainter than $V=13.40$ mag. The outcome is the light curve displayed in figure 3.

Aliases: VSX J210358.6+041711, GSC 00534-00978, USNO-B1.0 0942-0551758, 2MASS J21035868+0417115, CSS_J210358.7+041711
 Classification: EB Period: 20.4372 days Epoch: HJD 2455092.73
 Magnitude range: 13.03–13.48 CV (Min. II: 13.46) Position (UCAC4): RA 21 03 58.69 DEC +04 17 11.7 (J2000.0)

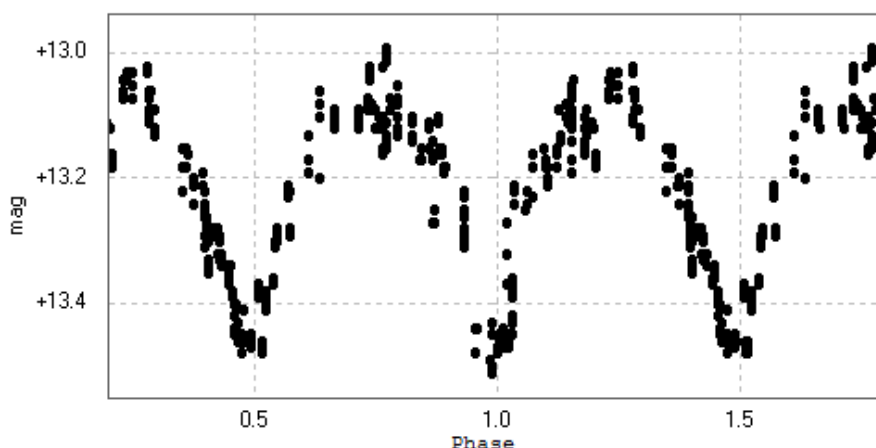


Figure 3: Light curve (phase diagram) of NSVS 14398712, based on Catalina data (V passband).

NSV 25461

This is the red dwarf Gliese 4180, a high proper motion star at a distance of only 22.9 pc, spectral type M2 (Lepine & Shara, 2005; Koen et al., 2010). While obtaining parallax measurements, Weis (1984, 1986) determined brightness of $V=12.13$ mag. Some years later, again as a byproduct of parallax measurements, Harrington et al. (1993) established $V=12.25$ mag, based on only 4 observations. This difference in brightness of 0.12 mag between two independent data sets prompted the editors of the NSV catalogue to suspect if Gliese 4180 might be a variable star. They ascribed the new identification NSV 25461. Of course, this conjecture is by no means safe. Such a relatively small difference can be a result of all kinds of calibration problems (different comparison stars, different instrumentation et cetera). On the other hand, the probability of a red dwarf to be a variable star is high. According to Gershberg (2005, p. VIII) 40 to 90 % of red dwarfs are flare stars (UV Cet type), and many others of them show BY Dra type variability due to starspot activity (Aleksiev 2000). Nevertheless, to classify a specific object as a “suspected” variable star should have some empirical basis beyond pure stellar statistics.

In the case of Gliese 4180 = NSV 25461 this evidence is missing. In all three datasets put to analysis (ASAS, NSVS, Catalina) the star was constant within the limits of measurement errors. The ASAS and also the Catalina data are not accurate enough to detect a possible 0.12 mag variability for sure (in case of Catalina because of saturation effects; the star is too bright). But the NSVS data are good enough to exclude the possibility of (semi-)periodic variations in an amplitude order of 0.1 mag. An ANOVA search for possible periods was unsuccessful. In conclusion, the available empirical evidence suggests that this red dwarf is not a BY Dra type variable (at least not in the supposed amplitude range), and it is also not a UV Cet type variable, because no flares could be verified. NSV 25461 seems to be constant at $V=12.163$ mag (according to APASS). The visually estimated error is approximately 0.06 mag.

Aliases: Gliese 4180, USNO-B1.0 0944-00550589, 2MASS J21055638+0425407, LP 576-34, GSC 00534-02183
CSS_210556.4+042539

Classification: CST ($V=12.163$) Position (UCAC4): RA 21 05 56.38 DEC +04 25 40.8 (J2000.0)

NSV 13665

The object of spectral type K1 (Pickles & Depagne, 2010) was reported to be a variable star in the range 12.4-12.9 p mag by Zinner (1936). ASAS, NSVS and Catalina data disprove this supposition. NSV 13665 is constant at $V=11.277$ mag (according to APASS). The visually estimated error in the NSVS data is approximately 0.05 mag. NSV 13665 should be removed from the list of suspected variables.

Aliases: AN 1011.1935, USNO-B1.0 0955-0554818, 2MASS J21204738+0532516, GSC 00536-00780
CSS_J212047.3+053251
Classification: CST ($V=11.277$) Position (UCAC4): RA 21 20 47.38 DEC +05 32 51.6 (J2000.0)

NSV 13696

Kurochkin (1964) reported an alleged variability of this object without identifying a type. To the contrary, the Catalina data ($N=369$, JD 2453466-2456227) demonstrates that NSV 13696 is not a variable star but constant (at $V=15.048$ mag according to APASS). The visually estimated error is approximately 0.04 mag. NSV 13696 should be removed from the list of suspected variables.

Aliases: SVS 1430, USNO-B1.0 1002-0591292, 2MASS J21254564+1013572, GSC 01110-01001,
CSS_J212545.6+101357
Classification: CST ($V=15.048$) Position (UCAC4): RA 21 25 45.64 DEC +10 13 57.3 (J2000.0)

References

- Alekseev, I.Y., 2000, Statistics of BY Draconis variables. *Astronomy Reports* **44**, 696-700, ([2000ARep...44..696A](#))
- Belyavskii S.I., 1934, 22 neue Veränderliche Sterne. *Peremennye Zvezdy* **4**, 254-256.
- Drake, A.J. et al., 2009, First Results from the Catalina Real-time Transient Survey. *Astrophysical Journal* **696**, 870, ([2009ApJ...696..870D](#))
- Gershberg R.E., 2005, *Solar-Type Activity in Main-Sequence Stars*. Springer, Berlin / Heidelberg / New York. ([2005stam.book.....G](#))
- Harrington R.S. et al., 1993, U.S. Naval Observatory photographic parallaxes - List IX. *Astronomical Journal* **106**, 1571-1580, ([1993AJ....105.1571H](#))
- Henden A., Smith, T., Levine, E., Terrell, D., 2012, The AAVSO Photometric All-Sky Survey Completes the Sky. ([2012AAS...22013306H](#))
- Koen C., Kilkeny D., Van Wyk F., Marang F., 2010, UBV(RI)_cJHK observations of Hipparcos-selected nearby stars. *Monthly Notices of the Royal Astronomical Society* **403**, 1949-1968, ([2010MNRAS.403.1949K](#))
- Kraus A. et al., 2007, The First MOTESS-GNAT Variable-Star Survey, *Astronomical Journal* **134**, 1488-1502, ([2007AJ....134.1488K](#))
- Kurochkin N.E., 1964, New Variable Stars. *Peremennye Zvezdy* **15**, 77-83, ([1964PZ.....15...77K](#))
- Lepine S., Shara M.M., 2005, A catalog of northern stars with annual proper motions larger than $0''.15$ (LSPM-NORTH catalog). *Astronomical Journal* **129**, 1483-1522, ([2005AJ....129.1483L](#))

Paunzen, E., Vanmunster, T., 2016, Peranso – Light Curve and Period Analysis Software. *Astronomische Nachrichten* 337, 239-245, ([2016AN....337..239P](#))

Pickles A., Depagne E., 2010, All-sky spectrally matched UBVRI - ZY and u'g'r'i'z' magnitudes for stars in the Tycho2 catalog. *Publications of the Astronomical Society of the Pacific* **122**, 1437-1464, ([2010PASP..122.1437P](#))

Pojmanski, G., 2002, The All Sky Automated Survey. *Catalog of Variable Stars, Acta Astronomica* 52, 397-427, ([2002AcA....52..397P](#))

Pojmanski, G. et al., 2005, The All Sky Automated Survey. *Catalog of Variable Stars. V. Declinations 0° - +28° of the Northern Hemisphere. Acta Astronomica* **55**, 275-301, ([2005AcA....55..275P](#))

Shokhan A., 2012, Phase plot of NSVS 14398712. Supporting document for [VSX database](#).

Warner, B.D., 2009, Data and Plot for 3UC 195-287215. Supporting document for [VSX database](#).

Weis E.W., 1984, Photometric parallaxes for selected stars of color class m from the NLTT catalog. *Astrophysical Journal, Suppl. Ser.* **55**, 289-299, ([1984ApJS..55..289W](#))

Weis E.W., 1986, Photometric parallaxes for selected stars of color class M from the NLTT catalog. II - The declination zone 0 deg to +20 deg. *Astronomical Journal* **91**, 626-639, ([1986AJ.....91..626W](#))

Wozniak P.R. et al., 2004, Northern Sky Variability Survey (NSVS): Public data release. *Astronomical Journal* **127**, 2436-2449, ([2004AJ....127.2436W](#))

Zinner E. (1936), Mitteilungen über veränderliche und verdächtige Sterne. *Astronomische Nachrichten* **258**, 315-319, ([1936AN....258..315Z](#))