The Photometric Period of Nova V2891 Cygni

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Abstract A photometric study of the recently discovered classical nova V2891 Cyg has been undertaken at the urban Burleith Observatory in Washington, DC. A total of 887 CCD observations were obtained over a time span of 70.92 days. Analysis indicates an orbital period of 3.8755 h ± 0.0042 h, epoch (HJD) of minimal light 2458752.3860, with amplitude 0.014 magnitude (Cousins I). The long-term light curve resembles that of the F class nova DO Aql (1925).

1. Introduction

The classical nova V2891 Cyg, R.A. $21^h 09^m 25.53^s$, Dec. +48° 10' 52.2" (2000), was discovered by the Palomar Gattini-IR wide-field NIR survey on UT 2019 September 17.25 (De *et al.* 2019). Other catalogue names are: PGIR19brv, AT 2019qwf, ZTF 19abyukuy, 000-BNG-814, and PSO J210925.535+481052.332. A finding chart is given as Figure 1.

The present author began an observing program that detected a possible photometric period on 15 Oct. 2019. By 2019 Nov. 6, the observed period had stabilized sufficiently to report it to D. Green at the *Central Bureau for Astronomical Telegrams* (CBAT), who then requested "quick naming" by N. Samus of the *General Catalogue of Variable Stars* (GCVS). The GCVS assigned the name "V2891 Cyg" (Green 2019; Kazarovets 2019). (Note that the GCVS requires reporting of novae to the CBAT prior to assigning a GCVS designation.)

V2891 Cyg is highly reddened, at galactic latitude 0.22°. Its color index ($V–R_c$) was observed as +2.26 on 2019 September 26.1185 UT (De Young 2019). Such red objects are of special interest in light-polluted urban observatory sites, as at the Burleith Observatory in Washington, DC, where CCD imaging in the near infrared (700–900nm) remains feasible, unlike in U, B, and V bands where sky brightness dominates (Schmidt 2016).

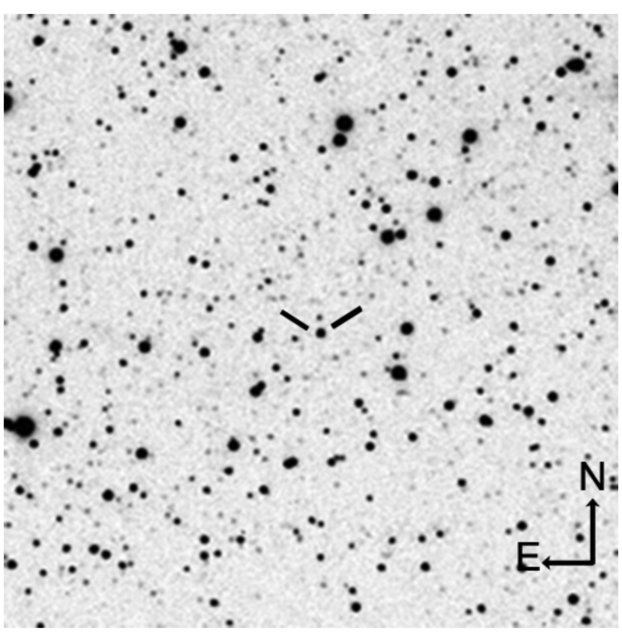

Figure 1. 10 arc-min field of V2891 Cyg.

This nova has been remarkable for its slow rise time, which had continued for 80 days by 2019 Dec. 5. In this regard its light curve resembles the F class nova DO Aql (1925) during its 70-day slow rise along the shoulder to its flat top (Vorontsov-Velyaminov 1940; Strope *et al.* 2010). Long periods of observability allow for searches for low-amplitude periodicities indicative of the nova's orbital period. At discovery the brightness of V2891 Cyg was 11.531 ABMag in J-Bessel band (De and Hankins 2019), within reach of smaller observatory instruments; continued monitoring of V2891 Cyg over the next year should aid in its classification.

2. Observations

At Burleith Observatory, CCD observations were obtained with a 0.32-m PlaneWave CDK and SBIG STL-1001E CCD camera with an Astrodon Cousins I-band filter. The KAF-1001E sensor features 24µ pixels, providing 85 dB dynamic range and scaling on the PlaneWave at 1.95 arc-sec/pixel, optimal for the typical 4 arc-sec seeing of my rooftop observatory (~2 pixels FWHM). Peak absolute quantum efficiency is ~50% in I-band.

Prior to each night's run, the acquisition computer was synchronized to the USNO NTP time service. Images (240-sec, autoguided) were sky flat-fielded, dark corrected, and aligned using SBIG CCDSOFT 5.00.12.

3. Reductions

Synthetic aperture photometry was performed using MIRA AP 7.974 (Mirametrics 2015). Cousins I-band differential ensemble photometry was performed using comparison stars from AAVSO chart sequence X24800DL (Table 1).

The resulting magnitudes of V2891 Cyg were detrended by subtracting the nightly means in order to remove the long-term light curve (De Young and Schmidt 1994). The observing log is presented in Table 2.

An example night's observing run is shown in Figure 2. Each night the individual standardized observations were uploaded to the AAVSO International Database (AID; Kafka 2019); nightly mean magnitudes are shown in Figure 3. The rising shoulder of the first 80 days of the DO Aql light curve (1925) can be seen in Figure 4.

Table 1. Comparison stars used for photometry.

AUID	R.A. (2000) h m s	Dec. (2000) ° ′ ″	C/K	Label	Ic
000-BNG-822	21 09 02.52	+48 09 51.8	1	133	12.472 (0.059)
000-BNG-823	21 09 30.71	+48 13 14.7	2	139	13.210 (0.084)
000-BNG-833	21 09 36.82	+48 07 26.6	3	143	13.193 (0.090)
000-BNG-834	21 09 46.30	+48 09 14.6	4	148	13.902 (0.117)
000-BNG-826	21 09 29.93	+48 10 17.4	K	151	14.011 (0.082)

Table 2. Observing Log.

UT	HJD 2458000+	Nr. Obs.	Mean Mag.	Mean Error (mag.)
Sep. 26.1658	752.66582	41	13.106	0.011
Sep. 27.0835	753.58348	09	13.093	0.014
Oct. 2.2099	758.70990	07	13.016	0.010
Oct. 11.0486	767.54860	32	12.924	0.011
Oct. 12.0979	768.59794	41	12.876	0.011
Oct. 15.0667	771.56667	50	12.827	0.010
Oct. 17.0619	773.56187	55	12.696	0.010
Oct. 18.0777	774.57765	44	12.652	0.009
Oct. 19.0789	775.57886	62	12.659	0.001
Oct. 24.0538	780.55384	56	12.718	0.008
Oct. 25.0513	781.55132	48	12.552	0.008
Oct. 28.0513	784.55128	57	12.529	0.008
Nov. 2.0709	789.57086	32	11.894	0.005
Nov. 3.0432	790.54322	37	11.782	0.006
Nov. 4.0576	791.55759	36	11.794	0.007
Nov. 7.0393	794.53925	33	11.922	0.008
Nov. 12.0027	799.50445	24	11.866	0.017
Nov. 13.0316	800.53156	30	11.468	0.009
Nov. 15.0509	802.55091	16	11.233	0.008
Nov. 16.9962	804.49626	18	11.447	0.008
Nov. 23.0646	810.56463	26	11.622	0.008
Nov. 24.9481	812.44807	39	11.546	0.003
Nov. 25.9566	813.51663	38	11.469	0.004
Dec. 04.9971	822.49708	15	11.527	0.005
Dec. 06.0005	823.50048	50	11.601	0.004

4. Analysis

Period analysis of reduced-by-mean observations was performed using PERANSO 2.60 software (Vanmunster 2006). Using its Date-Compensated Discrete Fourier Transform (DC-DFT) (Ferraz-Mello 1981) we derive the period 3.8755 h ± 0.0042. The resulting phased plot with spline-interpolated fit is shown in Figure 5.

The period was tested for significance using PERANSO's Fisher Monte Carlo randomization method which, while keeping observation times fixed, randomized the order of the magnitude observations over 200 permutations, searching for spectral responses due solely to observational biases (Moir 1998). The results were zero probability that no period was present in the data, and zero probability that any other significant periods were present in the data. The spectral window for all observations is shown in Figure 6. At period 6.19 cycles/day no spurious power appears, showing that the period found is not due to the sampling frequency. The resulting period information is summarized in Table 3.

Table 3. Period analysis results.

Parameter	Value
Period(h)	3.8755 (0.0042)
Period(d)	0.16148 (0.0001)
Frequency(c/h)	0.25803 (0.00028)
Mean amplitude (fit)	0.014 mag.
Number of observations	887
Time span	70.9212 days
Epoch (HJD) of light minimum	2458752.3860

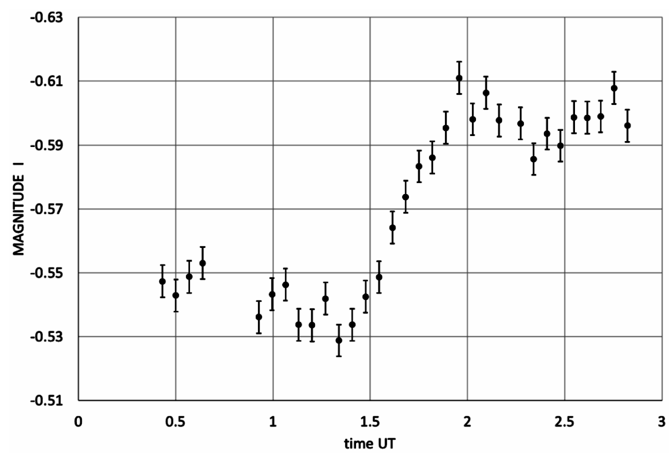

Figure 2. Observations 2019 Nov. 2.

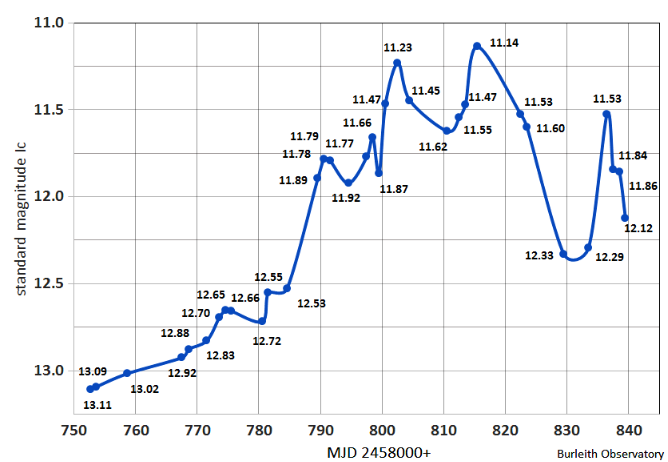

Figure 3. Nightly mean I_c magnitudes.

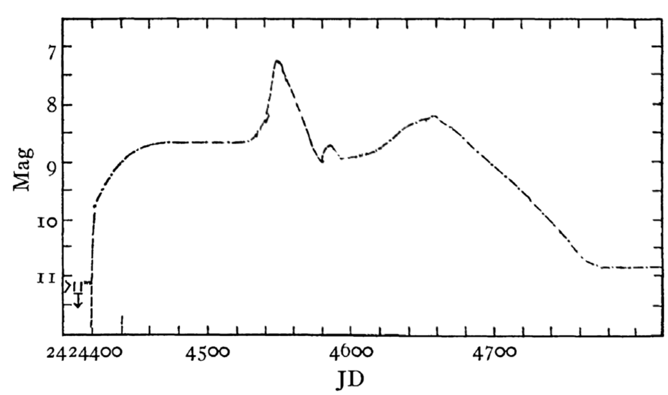

Figure 4. Light curve of DO Aql (1925; adapted from Vorontsov-Velyaminov 1940).

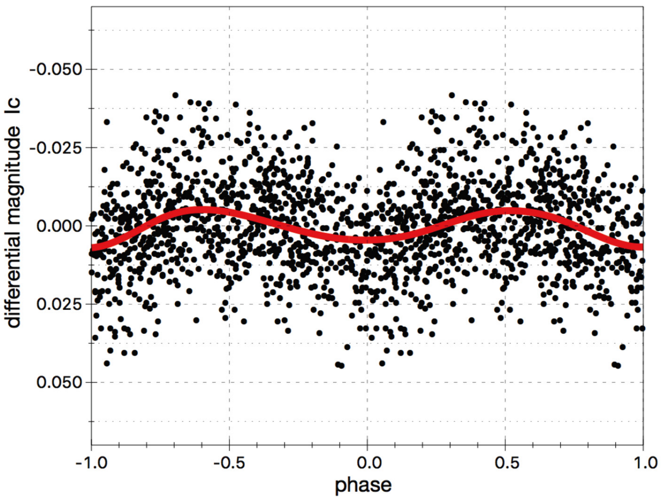

Figure 5. V2891 Cyg double phased plot with spline-interpolated fit.

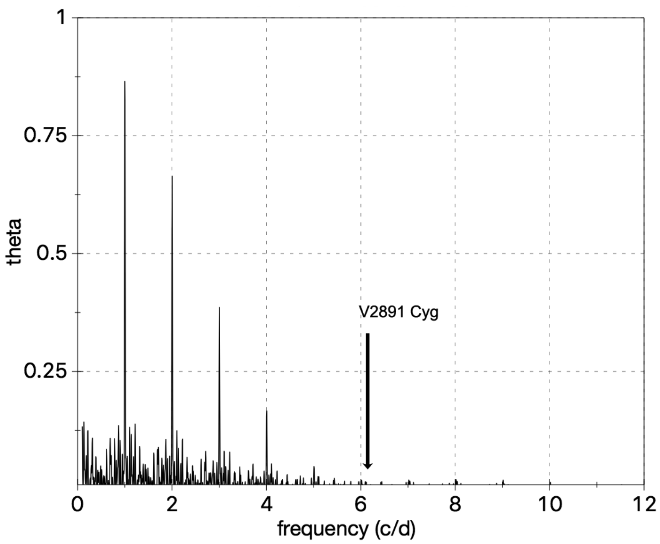

Figure 6. Spectral analysis of observational data.

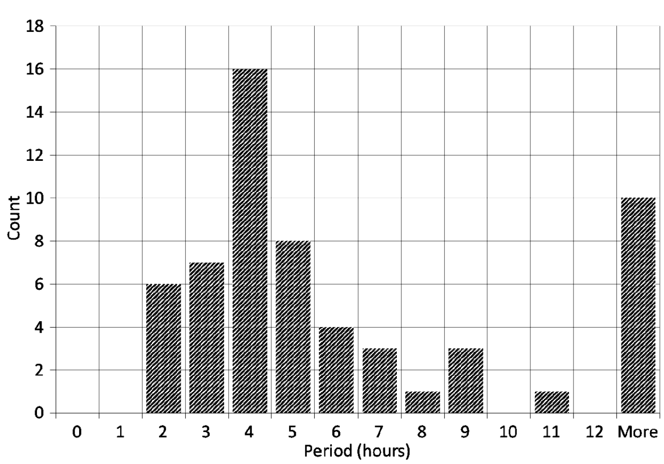

Figure 7. Histogram of novae orbital periods (Bode and Evans 2008).

5. Conclusion

The observed orbital period compares well with the median orbital period of 62 novae discussed by Bode and Evans (2008). A histogram of the orbital periods of novae from their table 2.5 in Classical Novae is shown in Figure 7. The observed period of V2891 Cyg places it in the range of most common period.

Despite its location in one of the most light-polluted urban American locations, the modest 12.5-inch telescope of the Burleith Observatory, with its ideally-matched pixel size CCD camera, is capable of quite satisfactory CCD photometry of a 13th magnitude variable observed in the near IR. The use of powerful period analysis software enables the detection of periodicity with an amplitude of only 10 milli-magnitude.

6. Acknowledgements

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References

Bode, M., and Evans, A. 2008, *Classical Novae*, 2nd ed., Cambridge University Press, Cambridge, 26.

De, K., and Hankins, M. 2019, *Transient Name Server Astron. Transient Report*, No. 47666.

De, K., *et al.* 2019, *Astron. Telegram*, No. 13130 (http://www.astronomerstelegram.org/?read=13130).

De Young, J. A. 2019, CCD photometry with the Norfolk State University/University of Virginia 0.6-meter Rapid Response Robotic Telescope, private communication.

De Young, J. A., and Schmidt, R. E. 1994, *Astrophys. J., Lett.*, 431, L47.

Ferraz-Mello, S. 1981, *Astron. J.*, **86**, 619.

Green, D.W.E. 2019, *Cent. Bur. Electron. Telegrams*, No. 4694, 1.

Kafka, S. 2019, AAVSO International Database (https://www.aavso.org/aavso-international-database).

Kazarovets, E., Samus, N. N., Durlevich, O. V., Khruslov, A. V., Kireeva, N., and Pastukhova, E. N. 2019, *Perem. Zvezdy*, **39**, No. 3, 1.

Mirametrics. 2015, MIRA AP 7 software (http://mirametrics.com).

Moir, R. 1998, *Exp. Economics*, **1**, 87.

Schmidt, R. E. 2016, *Minor Planet Bull.*, **43**, 129.

Strope, R. J., Schaefer, B. E., and Henden, A. A. 2010, *Astron. J.*, **140**, 34.

Vanmunster, T. 2006, PERANSO period analysis software, version 2.60, CBA Belgium Observatory.

Vorontsov-Velyaminov, B. 1940, *Astrophys. J.*, **92**, 283.