NOVA-LIKE VARIBLE V603 AQUILAE IN 1999

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ABSTRACT. We perform the CCD (R) photometry of the nova-like variable V603 Aquilae (Nova Aquilae 1918) during 7 nights in 1999. The star showed quasi-periodic oscillations (QPO) with cycles ranging from $0^{\rm d}.035$ to about $0^{\rm d}.055$, and "positive" superhumps with a photometric period of 0.144437 days. The "$\Lambda-$ scalegram" analysis shows evidence for QPOs with an effective period $P = 17.6$ minutes and an amplitude of 23 mmag.

Key words: Stars: binary: cataclysmic; nova-like: superhumps: stars: individual: V603 Aql.

1. Introduction

Nova Aquilae 1918, named now V603 Aql, was one of the brightness nova with a peak visual magnitude of about -1$^{\rm m}$. Now this is a close binary with an accretion disk around white dwarf. The orbital period of the system ($P_{orb} = 0^{\rm d}.138$) was found by Kraft (1964) and then was determined with better accuracy ($P_{orb} = 0^{\rm d}.1385$) by Arenas et al. (2000). Haefner and Metz (1985) had found that this system has photometric brightness variations with an amplitude $0^{\rm m}.2 - 0^{\rm m}.3$ and with period longer ($0^{\rm d}.1449$) than orbital one (superhumps period).

2. Observations

Our observations of V603 Aquilae have been carried out at the 380-mm Cassegrain telescope (K-380) of the Crimean Astrophysical Observatory in the spectral band close to the standard Johnson R were obtained in August 1999. The exposure time was $120^{\rm s}$. The start and the end of observations, maximal and minimal brightness in respect to the comparison star and the number of measurements are listed in Table 1. The mean accuracy of a single measurement was $0^{\rm m}.03$. The complete light curve of V603 Aquilae is shown in Fig.1. The light curves of V603 Aquilae for separate nights are shown in Fig.2. In Fig.1, it is possible to see changes of the average level of light of the system. These changes of an average level of light are owed to change of average accretion rate. On Fig.2 it is possible to see QPO's and superhumps. During one of nights, the eclipse-like minimum was detected (Fig.3).

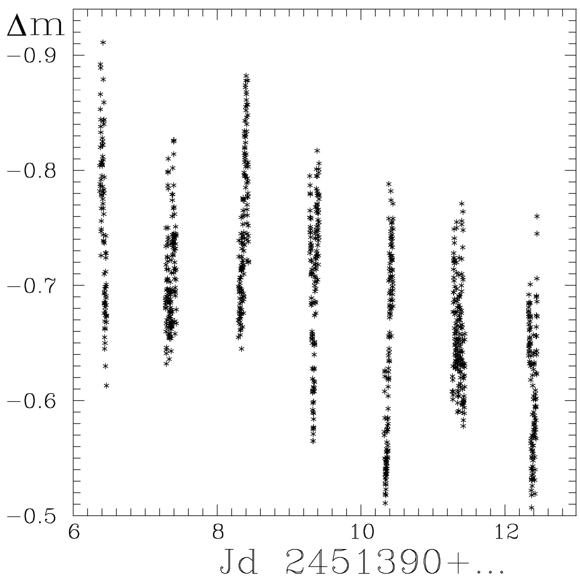

Figure 1: Light curve of V603 Aql in 1999.

Table 1. Journal of observations.

JD	m_{min}	m_{max}	Δm	N
2451396.3692-.4643	-0.817	-0.565	0.252	90
2451397.2840-.4318	-0.806	-0.589	0.217	150
2451398.2947-.4357	-0.764	-0.507	0.257	137
2451399.2880-.4171	-0.788	-0.511	0.277	133
2451400.3227-.4452	-0.826	-0.632	0.194	123
2451401.2685-.4414	-0.911	-0.613	0.298	167
2451402.3270-.4457	-0.882	-0.650	0.232	123

2. Results

We carried out the periodogram analysis for separate nights (Fig. 4, Table 2). The test function $S(f)$ had been used, which is the square of the coefficient of correlation between the data and the sine fit for a given trial frequency (Andronov 1994).

The apparent values of the periods of superhumps range from $0^{\rm d}.11$ to $0^{\rm d}.15$, and characteristic times of QPO range from $0^{\rm d}.035$ to about $0^{\rm d}.055$ days were obtained. In HJD 2451397 and HJD 2451401, the maxima are very weak. In HJD 2451402, the photometric

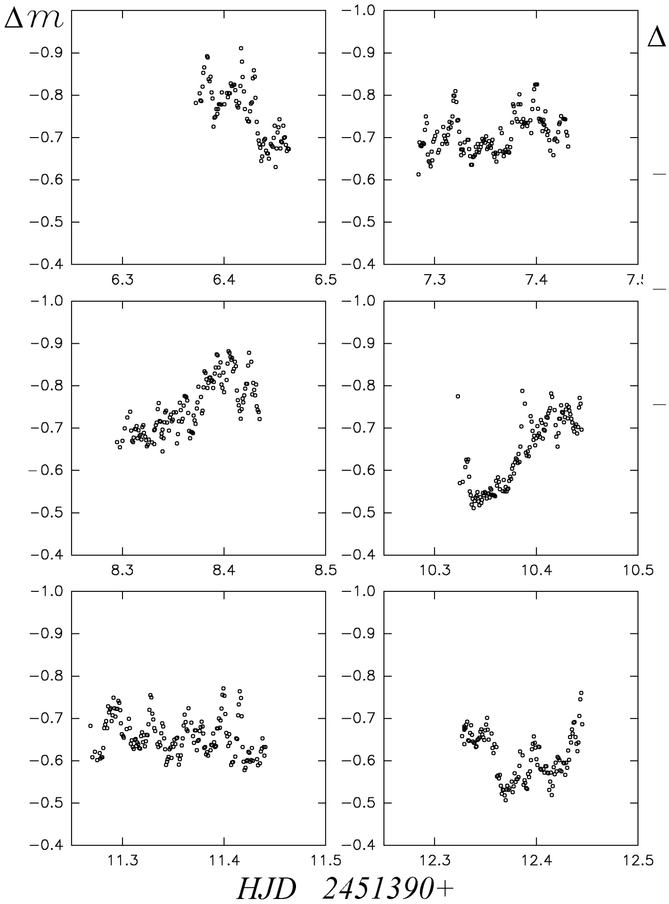

Figure 2: Light curves for days of V603 Aql for separate nights in 1999.

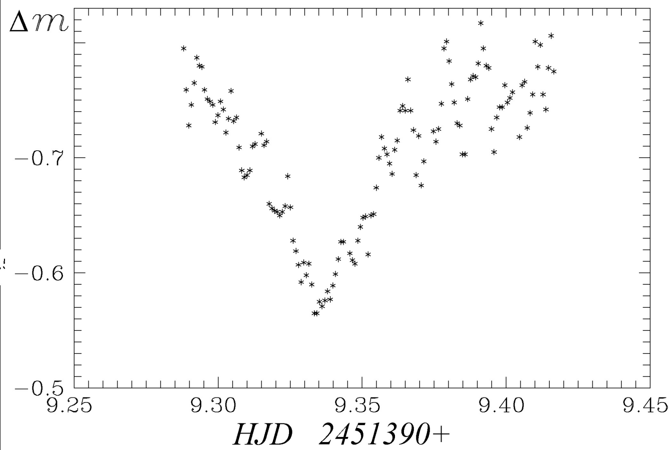

Figure 3: Eclipse-like minimum of V603 Aql.

Table2. Characteristics of the highest peaks at the periodogram

JD	frequency	Period	S(f)
2451396	6.7	0.14925	0.585
2451397	12.4	0.08065	0.266
2451398	6.4	0.15625	0.683
2451399	8.8	0.11364	0.772
2451400	6.7	0.14925	0.862
2451401	26.0	0.03846	0.273
2451402	3.2	0.31250	0.557

period is apparently twice the basic period, thus the brightness maximum is not expressed. It can be caused with a rather short number of observations this night (123 points), and possibly by smaller size of stellar image.

We had carried out the periodogram analysis for all nights with removal of trend using the program "Four" (Andronov 1994). The results are shown in Fig 5. On it the maximum peak corresponds to the period i$P_{ph} = 0.^{\rm d}34429$, very far from the period of superhumps ($P_{sh} = 0.^{\rm d}144437$) discovered by Haefner and Metz (1985).

However, there is a peak in the neigbourhood of this superhump period. To study the profile of the corresponding phase curve, we have applied the multi-harmonic fit (the program FOUR-N by Andronov (1994)). The statistically significant value of the degree of trigonometric polynomial is $s = 2$ with a "false alarm probability" FAP=$10^{-3.5}$. The maximum and minimum brightness of the smoothing curve are $m_{max} = -0.^{\rm m}753 \pm 0.^{\rm m}005$ and $m_{min} = 0.^{\rm m}634 \pm 0.^{\rm m}005$, respectively. The amplitude is $0.^{\rm m}119 \pm 0.^{\rm m}005$, asymmetry is 0.614 ± 0.019. The ephemeris for the maximum is

$$HJD_{max} = 2451399.5707 + 0.144481 \cdot E \quad (1)$$
$$\pm 0.0017 \pm 0.000086$$

with an initial epoch for the minimum $HJD_{min} = 2451399.4821 \pm 0.0022$.

In our data, we see no strict evidence for the possible $\sim 3^{\rm d}$ period suggested by Patterson et al. (1993, 1997). Maybe it is superimposed onto brightness variations with another characteristic times, and thus is hidden in the periodogram.

We also have used another method of time series analysis, i.e. the "$\Lambda-$ scalegram" analysis (Andronov 2003) which is based on the dependence of the unbiased estimate of the r.m.s. deviation of the observations from the "running parabola" fit (Andronov 1997) on the filter half-width Δt. For the continuous infinite functions and sinusoidal signal of amplitude R and period P, the function $\Lambda(\Delta t)$ has maximum of height $2.52R^2$ at $\Delta t = 1.106P$.

This scalegram for our observations of V603 Aql (Fig.7) has 3 maxima, the characteristics of which are listed. Two peaks "2" and "3" correspond to hour-scale variability, whereas the highest first peak corresponds to the "effective period" $P = 17.6$ minutes, which probably correspond to quasi-periodic oscillations.

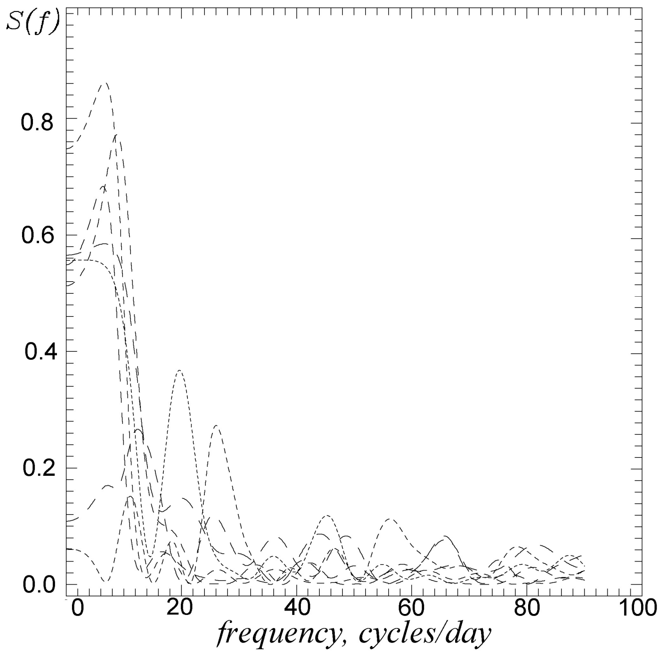

Figure 4. Periodogram $S(f)$ for separate nights of V603 Aql.

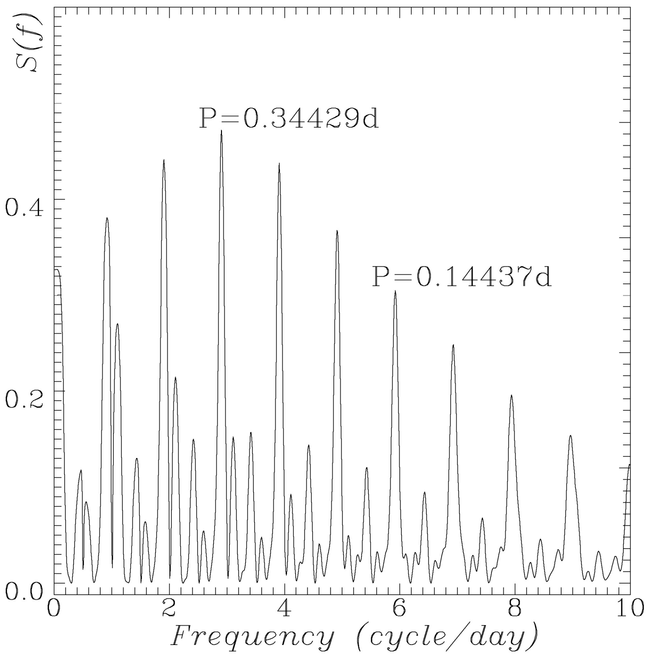

Figure 5. Periodogram $S(f)$ for all observations of V603 Aql in 1999.

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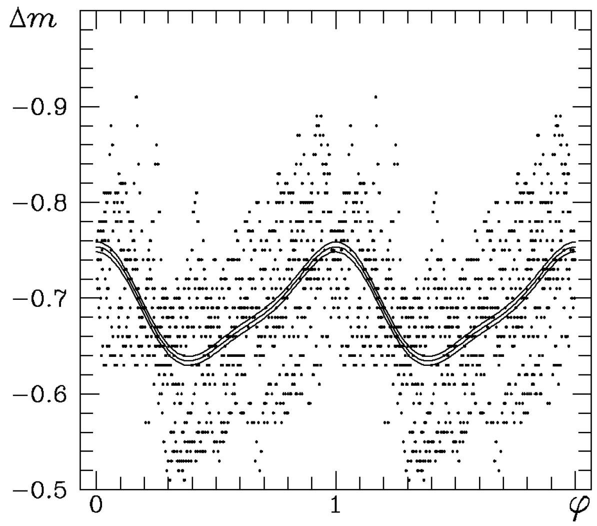

Figure 6. The phase light curve of V603 Aql according to ephemeris (1). Solid lines correspond to the second–order trigonometric polynomial fit and it's "1σ corridor".

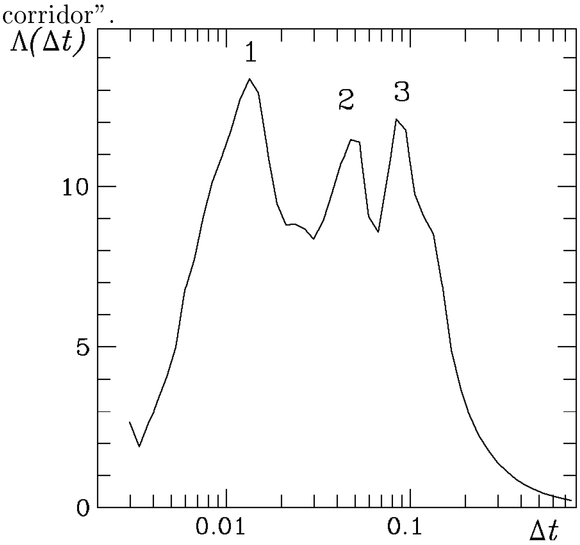

Figure 7. $\Lambda(\Delta t)$ scalegram for V603 Aql. The peaks correspond to the following characteristic times P and amplitudes R:

peak	Δt	P	R
1	$0^{d}.0135$	$0^{d}.0122$	$0^{m}.023$
2	$0^{d}.0495$	$0^{d}.0448$	$0^{m}.021$
3	$0^{d}.0875$	$0^{d}.0791$	$0^{m}.022$

References

Andronov I.L.: 1994, *Odessa Astron.Publ.,* **7**, 49.

Andronov, I.L. 1997, *As.Ap.Suppl.,* **125**, 207.

Andronov I.L.: 2003, *As.Soc.Pac. C.Ser.,* **292**, 391.

Arenas J., Catalan M., Augusteijn T., Retter A.: 2000, *MNRAS*, **311**, 135.

Haefner R., Metz, K.: 1985, *As.Ap.*, **145**, 311.

Kraft R.: 1964, *Ap.J.*, **139**, 457.

Patterson J., Kemp J., Saad J. et al.: 1997, *PASP*, **109**, 468.

Patterson J., Thomas G., Skillman D., Diaz. M.: 1993, *Ap.J. Suppl. Ser.*, **86**, 235.