Asteroseismic Investigation of two Algol-type systems V1241 Tau and GQ Dra

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Abstract

We present new photometric observations of eclipsing binary systems V1241 Tau and GQ Dra. These systems are claimed to possess pulsating components and therefore we investigated them for a potential pulsating signal on their light curves. We use the following methodology: Initially, WD code is applied to the light curves, in order to determine the photometric elements of the systems. Then the residuals are analyzed using Fourier Transformation techniques. The results show that one frequency can be barely attributed to the residual light variation of V1241 Tau, while there is no evidence of pulsation on the light curve of GQ Dra.

1. Introduction

V1241 Tau was first observed by Henrietta Leavitt (Pickering 1908, Yang et al. 2012). The spectral type of the components were determined as A5V and F3V by Arentoft et al. (2004). The configuration of the system was found to be semi-detached by Russo and Milano (1983) and it was classified as near-contact by Shaw (1990). Although Rodríguez et al. (2000) defended a δ Sct type variation on the light curve of the system, Arentoft et al. (2004) mentioned that no trace of pulsation can be seen. Lately, Yang et al. (2012) analysed the light curve and studied the period change of the system.

GQ Dra is a neglected system and very few studies have been published on this target. Its orbital period is about 0.7^d. The light variation was first determined by Hipparcos (ESA 1997). First photoelectric observations were made by Atay et al. (2000). The star is also listed in a catalogue by Dubath et al. (2011) as a periodic variable.

2. Observations and Solution of the Light Curves

BVRI light curves of V1241 Tau were obtained from the University of Athens Observatory in November 2012. The observations were carried out with the SBIG ST-10XMEI CCD camera attached on the 40-cm Cassegrain telescope. During the reduction process GSC 4709-1022 was used as comparison star.

GQ Dra was observed with the 1.22-m telescope of the Onsekiz Mart University Observatory equipped with Apogee Alta U42 CCD camera in 7 nights between March-April 2013. B, V and R filters. GSC 3520-917 was chosen as comparison star.

Light curves of both systems were analyzed using PHOEBE (Prša and Zwitter 2005) software, which utilizes Wilson-Devinney code (Wilson and Devinney 1971). The solutions were extracted by assuming that the systems are semi-detached and appropriate limb darkening and albedo values were selected from van Hamme (1993) and Rucinski (1969).

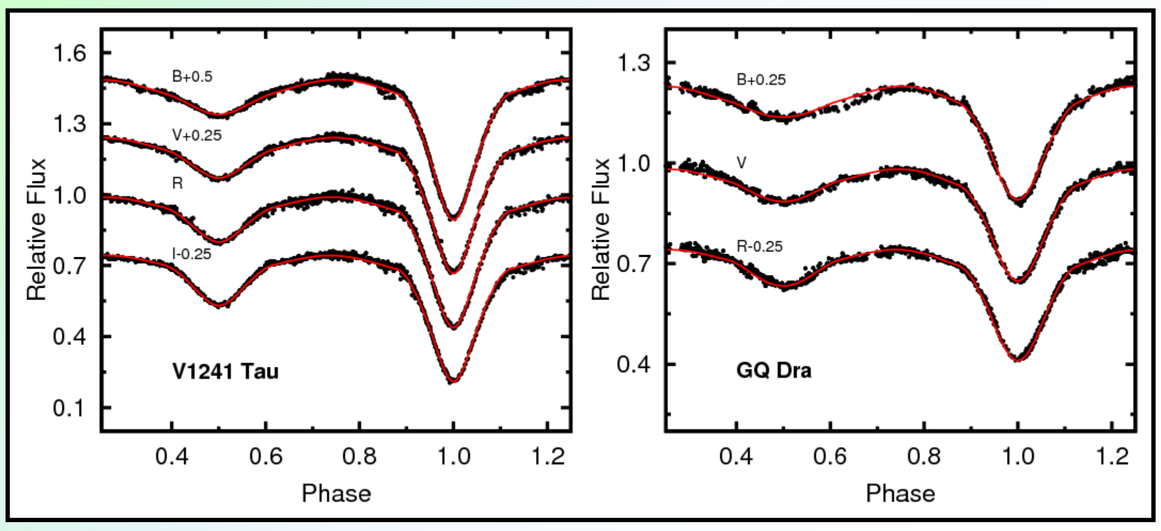

Fig. 1. Observed (points) and theoretical (lines) light curves of the systems.

Parameter	V1241 Tau	GQ Dra
Geometric parameters:		
i (°)	81.53(6)	75.31(6)
Ω_1	3.239(12)	2.639(21)
$\Omega_2 = \Omega_{RL}$	2.762	2.357
q	0.442(9)	0.253(6)
Fractional radius of primary	0.3654(21)	0.4345(45)
Fractional radius of secondary	0.3087(6)	0.2657(15)
Radiative parameters:		
T_1 (K)	7500	8750
T_2 (K)	4906(27)	5050(25)
Luminosity ratio: $\frac{L_1}{L_1+L_2}$		
B	0.949(6)	0.983(6)
V	0.910(6)	0.966(6)
R	0.871(9)	0.945(9)
I	0.834(6)	–

Table 1. Results of light curve analyses. The standard errors 3σ in the last digit are given in parentheses.

Results show that the system V1241 Tau has a semi-detached configuration with inclination of 81.5 degrees and mass ratio equal to 0.44. The primary and secondary components have effective temperature values as 7500K and 4906K, respectively. Additionally the light contribution of the primary is found to be about 95 percent of the total system luminosity. The agreement between solution and observation is shown in Fig. 1. Our solution of GQ Dra is the first light curve solution in the literature. During the solution a semi-detached configuration is used. The detailed results of the solutions are given in Table 1.

3. Search for Pulsations

Both systems were listed as having a potential pulsating component in literature (Rodríguez et al. 2000, Soydugan et al. 2006). Therefore, it was found useful to search for pulsational behaviour that can be found in the systems.

The residual data obtained after the binary's model removal was used to investigate for possible pulsational frequencies. Fourier Transformation tecqniques were used on the residual data. Namely, we tried to represent the residuals with a periodic variation. In the case of V1241 Tau, our research has resulted in one frequency (f=2.13 c/d) which can be attributed to a change in the light curve (Fig. 2). However, it is worth to emphasize that this kind of variation may be assigned to other reasons as well, such as observational effects and atmospheric conditions. The same method was applied to the residuals yielded from the binary solution of GQ Dra which showed no remarkable oscillation-like variation.

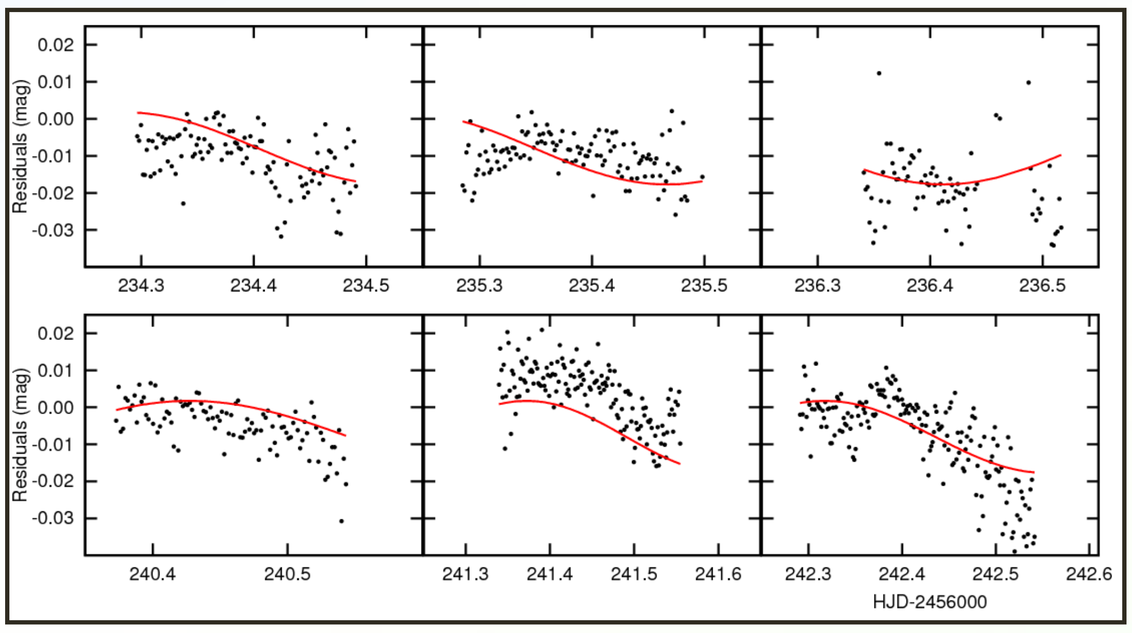

Fig. 2. Fourier fit on the residual data of V1241 Tau.

4. Conclusions

We analysed the photometric light curves of two systems and checked their residual light curves for pulsations. We concluded our study with two main results regarding the pulsational behaviour of the system were found: (i) the residual light curve of the system V1241 Tau can be represented by a periodic variation, however, it is not satisfactorily enough to mention any physical oscillation for this change and (ii) there is no trace of pulsations in the light of the binary star GQ Dra.

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