# LETTERS

# Discovery of Four Peculiar Variable Stars\*

Xiao-Bin Zhang $^{1,2}$  and Rong-Xian Zhang $^1$ 

- <sup>1</sup> National Astronomical Observatories, Chinese Academy of Sciences, Beijing 100012; xzhang@bao.ac.cn
- $^2\,$  CAS-PKU Joint Beijing Astrophysics Center, Beijing 100871

Received 2003 June 16; accepted 2003 June 27

**Abstract** Four stars, GSC 1258–0143, GSC 1986–1665, GSC 3045–0892 and GSC 2983–1597 were found to be new variables during a campaign of CCD photometric monitoring of short-period eclipsing binary stars. The variabilities of these new variables are reported. The main characteristics and probable classifications of the variables are discussed through a preliminary analysis on their light curves. Among these stars, GSC 1258–0143 is classified as a RR Lyr star of sub-type a. Its pulsation period is determined to be about 0.5206 days. The other three stars, are definite variables, but their periods and types of light variations remain unknown.

**Key words:** techniques: photometric — stars: variables: RR Lyr — stars: individual: GSC 1258–0143, GSC 1986–1665, GSC 3045–0892, GSC 2983–1597

# **1 INTRODUCTION**

In the past years, we have made a long-term photometric survey on a set of short-period close binaries (Zhang et al. 2002). Parts of the observations were carried out with a CCD photometer. That enabled us to select more than two stars within the program field as reference stars for each main target. During the follow-up data reduction, some of the reference stars were found to be unsuspected variables. In a previous paper (Zhang & Zhang 2002), we have reported a new variable star discovered in this way in the field of a near-contact binary TW CrB (Zhang & Zhang 2003). After that, four more new variables were identified when we analyzed the CCD photometric data for the other close binaries. In the present work, we shall report the discovery and present the light curves obtained of these four new variables. Preliminary properties and probable classifications of the variables are discussed.

## 2 OBSERVATIONS AND DATA REDUCTION

All the observations were made in the observing seasons of 2000 with a CCD photometer (Wei, Chen & Jiang 1990; Zhou et al. 2001, 2002) mounted on the 85 cm reflector at Xinglong Station of NAOC. A single Johnson V filter was used and with a red-sensitive Thomson TH7882

<sup>\*</sup> Supported by the National Natural Science Foundation of China.

 $576 \times 384$  CCD camera the photometer provides a field of view of about  $12' \times 8'$ . Proper comparison and check stars were hard to find for the limited field of view. Thus we used 3 to 5 stars around each of the mission targets as the reference stars according to their brightness. The best comparisons were identified later during the data reduction. In Table 1, we give the main information about the observations including the comparisons finally taken for the data reduction.

Exposure time was always set at 30 s for each measurement. Data reduction was made as described by Zhang et al. (2002) and Zhang & Zhang (2003). Atmospheric extinction was not taken into account, in view of the close spacing of the stars in each program field. The magnitude differences between the comparison and check stars generally kept constant within 0.01 mag.

 Table 1
 Data on the CCD Photometric Observations

Mission target	New variable	Comparison	Check star	UT. Date
GR Tau	$GSC \ 1258-0143$	$GSC \ 1258-0171$	$GSC \ 1258-0209$	January 25–27, 29–30
CC Com	GSC 1986 - 1665	GSC 1986 - 1673	GSC 1986 $-0106$	January 31, April 23, 26
TZ Boo	$GSC \ 3045-0892$	$GSC \ 3045 - 1068$	GSC $3045 - 1108$	April 21–22, 27
UV Lyn	GSC 2983 $-1597$	GSC 2983 - 1629	GSC 2983–0736	January 28–29

#### 3 RESULTS AND DISCUSSION

As a result, a total number of four new variables are identified in the fields of GR Tau, CC Com, TZ Boo and UV Lyn, respectively. In this section, we present the variabilities of these new variables one by one. The main properties and probable classifications of the stars are given based on a preliminary analysis of their light curves. The basic parameters of the four variables are given in Table 2. Their coordinates and magnitudes were taken from the GSC catalogue.

Star	$\alpha$ (2000)	$\delta$ (2000)	V (mag.)	Amp.	Period (days)	Туре
GSC 1258–0143	04:00:44.64	20:24:07.6	13.36	$\simeq 2$	0.52056	RRa
GSC 1986 - 1665	12:11:42.24	22:35:12.9	13.51	> 1.5		unknown
$GSC \ 3045-0892$	15:07:47.26	39:55:58.8	9.10	1.7		unknown
GSC 2983 - 1597	09:03:01.73	38:08:51.8	11.79	> 1.5	>1	unknown

 Table 2
 The Basic Parameters of the Four New Variables

#### 3.1 GSC 1258\_143

This variable was discovered in the field of GR Tau. It was observed as one of 5 reference stars for the near-contact binary GR Tau. Useful data were obtained on five nights from January 25 to 30. Figure 1 displays the real-time light curve of GSC 1258\_143. It shows a fast ascending branch and a slowly descending branch, which suggests that the star could be a pulsating variable. The amplitude of the light variation is as large as about 2 mag. By using the method of PDM (phase dispersion minimization) (Stellingwerf 1978; Zhang et al. 2003), we derive a most probable period of 0.52056 days. With this value the phased light curve is formed and shown in Fig. 1. Considering the probable period and amplitude as well as the shape of the light curve, we suggest that GSC 1258–143 could be a RR Lyr star of sub-type a.



Fig. 1 Real-time (up) and phased (down) light curves of GSC 1258-143



Fig. 2  $\,$  Real-time light curve of the new variable GSC 1986–1665  $\,$ 

#### 3.2 GSC 1986-1665

This star was observed as a reference star for the very short-period W UMa system, CC Com. The light curves obtained on three nights (Fig. 2) show definite light variability with an amplitude greater than 1 mag. We failed to determine its period and classification.

#### 3.3 GSC 3045-0892 (= HD 134303 = BD+40 2856)

GSC 3045–0892 is a visual double star in the field of TZ Boo. No variability of the star has been reported before. As a reference star for TZ Boo, we observed it on three nights. Light variability is clearly shown (Fig. 3); however, the light curve seems quite strange to understand. On the first night, we recorded an eclipse-like, symmetric minimum and a flat maximum, the amplitude of the light variation was about 1.7 mag. On the next night, the minimum light became asymmetric and the maximum light was about 0.4 mag. fainter than on the first night. Compared to the first two nights, the light curve obtained on the third night changed quite a lot. We recorded only part of a minimum but it lasted much longer. Meanwhile, the shape of this minimum was more rounded. It seems that GSC 3045–0892 is a peculiar variable star with complex variations. To understand its complicated light variations, more observations are needed.



Fig. 3 Real-time light curve of the new variable GSC 3045-0892

#### 3.4 GSC 2983-1597

It was observed as a reference star for the W UMa system, UV Lyn. Light variability is obvious in the measurements carried out on two nights (Fig. 4). The amplitude of the light variation could be larger than 1.5 mag and the period could be longer than one day considering the general trends in the data. No further information about the variable could be drawn from our two-night CCD observations.



Fig. 4 Real-time light curve of the new variable GSC 2983–1597

#### 4 CONCLUSIONS

We report the discovery of four new variable stars during a CCD photometric survey of eclipsing binaries. These stars are all peculiar variables with large amplitudes (> 1.5 mag.). Among them, GSC 1258–0143 is preliminarily identified to be a RR Lyr star with a period of about 0.5206 days and an amplitude larger than 2 mag. The classification of the other three new variables is uncertain. To understand more of these four variables, further observations are being planned for the future.

**Acknowledgements** This work is partly supported by the National Natural Science Foundation of China through grant 10173013.

### References

Stellingwerf R. F., 1978, ApJ, 224, 953
Wei M.-Z., Chen J.-S., Jiang Z.-J., 1990, PASP, 102, 698
Zhang X.-B., Zhang R.-X., Fang M. J., 2002, A&A, 395, 587
Zhang X.-B., Zhang R.-X., 2002, IBVS, No. 5292
Zhang X.-B., Deng L.-C., Xin Y., Zhou X., 2003, ChJAA, 3, 151
Zhang X.-B., Zhang R.-X., 2003, AJ, 125, 1431
Zhou A.-Y., 2002, Chin. J. Astron. Astrophys., 2, 43
Zhou A.-Y., Du B.-T., Zhang X.-B., Zhang R.-X., 2001, IBVS, No. 5061