Bull. Astr. Soc. India (1998) **26**, 531-538

Neglected binaries of special interest

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Abstract. Some binaries of special interest, observed at Uttar Pradesh State Observatory, Naini Tal, have been presented in this communication. Some of these binaries, although sufficiently bright, have not yet been investigated properly. The results of these binaries have been discussed in a nutshell.

Key words : binaries - observations - elements

1. Introduction

This communication has the core of a research paper, the texture of a review article and a tinge of popularization of astronomy. In the early phase (1783-1912) of astronomical era, the variable and binary star research gathered momentum while in the later phase (1912 onwards) modern astrophysics played an important role in unveiling the mystries of the Universe.

Thanks to Goodricke (1783), who first discovered the variations in the brightness of Algol.

The introduction of photometers and the contribution of Russell (1912), giving a method of deriving the general solution of the light curves of eclipsing binaries, further revolutionised the variable and binary star researches.

2. Importance

The eclipsing binaries are important in deriving dimensional parameters of stars and in understanding the mutual interaction effects. The period is the fundamental parameter in binaries and acts as the starting point for the analysis of binaries. Recent researches on RS CVn binaries have revealed solar analogies in these stars.

3. Observations

Even with smaller aperture telescopes (38-cm and 52-cm reflectors), the Uttar Pradesh State Observatory, Naini Tal (UPSO) collected enormous observational data on binaries and variable stars. The details of stars and binaries, which have been discussed in this communication are given in Table 1. Out of these stars and star systems, given in Table 1, DX Aqr, CC Cas, δ Cap and HD 126200 are comparatively bright.

Table 1. Details of stars / binaries

Name of Star	BD Number	HD Number	Coordinates (1900)	V (mag.)	Depths (pr, sec) (mag.)	Spectral type (pr, sec)	Period (days)	Note
DX Aqr	−17°6422	209278	$21^h\ 57^m$ −17°	6.4	0.4	A2V KOIII	0.9450132	Changing lt.c.
CC Cas	+59°0609	19820	03 06 +59°	7.1	0.1 0.1	O9III O8	3.36897	Secondary missing
XX Cas	+60°246	–	01 23 +60°	10.0	0.7 0.2	B4n B6n	3.061773	No new lt.c.
δ Cap	-16°5943	207098	21 41 -16°	2.9	0.2	A7IIIm	1.022780	RSCVn binary
EI Cep	+75°0791	205234	21 28 +75°	8.0	0.5 0.4	Am F1	8.439334	No new lt.c.
GH Peg	+14°4684	207741	21 46 +14°	9.1	0.6	A3	2.556136	No new lt.c.
IZ Per	+53°0323	9234	01 25 +53°	7.8	1.4 0.3	B8 -	3.687663	No new lt.c.
HD126200	+8°2857	126200	14 24 +8 °	5.8		A0	P=?	Var.?

4. Details of stars and binaries

Some of the observational details of these stars and binaries with relevant references are given below to explain the points raised and problems involved in these stars/binaries.

DX Aquarii :

Strohmeier et al. (1965) first discovered the variability of this eclipsing binary system. Olsen (1976) attempted its photometry but failed to complete it. For the first time, Srivastava & Sinha (1985a) obtained its full light curves in U, B and V filters excluding any contamination to the extent possible. The period of the system is found to be nearly half of that given in Table 1. The primary eclipse appeared in total occultation and the presence of the eccentricity was suspected. Srivastava (1985b) presented a new set of U, B and V light curves of this system and found the shape and other light curve features and colour variable. Srivastava (1986a) also attempted its period study and found some period fluctuations in the system.

Photoelectrically neglected system DX Aqr has several potential problems:
(i) the changing light curves;
(ii) high scatter particularly in U;
(iii) the period behaviour; and
(iv) colour variations.

The literature (Srivastava, 1985a) reveals that a large uncertainty hangs over the spectral classes of the components, and they seem to appear of late F type, thus, it will be worthwhile to look into this system, the RS CVn type variability, which is expected. It is also desirable to look into the possibility of presence of a ring or a shell, eccentricity and intrinsic variability. It is suitable for observations (mag. 6.4, depth $0.^{m}4$). It is anticipated that, after the fixation of period, it will reveal many more problems associated with it.

CC Cassiopeiae:

Pearce (1927) discovered CC Cas - a double-lined spectroscopic binary system. Gaposchkin (1940,1953) from photographic observations confirmed the eclipsing binary nature of the system. Guthnick & Pragar's (1930) photometric observations showed it an eclipsing binary having ellipticity, and Hilditch & Hill's (1975) photoelectric observations and Binzel & Hartigan's (1979) and Srivastava's (1979) UBV photoelectric observations could not produce its full light curves. Polushina et al.'s (1985) V and Polushina's (1988) BV observations respectively remained unpublished. Szafraniec (1975) has pointed out that no light minimum of the system has been observed since 1930. Gibson & Hjellming (1974) detected occasional variable radio emissions at frequencies 2695 and 8085 MHz. Hill et al. (1994) negated the possibility of period change but indicated the presence of stellar-wind-mass loss.

The main problems attached to this system are the following:
(i) the appearance and disappearance of the secondary minimum;
(ii) out-side eclipse variation of light;
(iii) the eccentricity;
(iv) period behaviour; and
(v) intrinsic variability.

Although, it is a sufficiently bright star, which can be easily observable, yet remained observationally neglected. The changing patterns of light curves, night-to-night and time-to-time, with changing depths, do point to investigate the system thoroughly. The photoelectric observations obtained (after its discovery in 1927) are far from satisfactory, and concerted and coordinated programmes of observations will be useful in understanding the peculiarities of this system. The spectral type of the components (O9 III, O8) are potential indicators of interesting evolutionary history of this system.

XX Cassiopeiae:

Mackie (c.f. Bailey, 1921) first detected the variability of this system photographically. Gadomki's

(1935) wedge-photometric observations indicated that the primary eclipse was total. Neither Pierce (1938) nor Chau (1959) could fully cover the light curves of XX Cas photoelectrically. Srivastava (1983) first presented full UBV light curves of XX Cas, which showed outside eclipse (light) variation. These are still open for interpretation. Srivastava (1986b) presented its period study and Srivastava (1987a) derived its elements and found scatter in the fitting of its light curves.

Although, UBV light curves of Srivastava (1983) are well covered, yet they show some peculiarities:

(i) the large scatter in the preceding and following branches of primary minima.
(ii) outside eclipse scatter;
(iii) distortions and scatter around the tip of secondary minima and onwards;
(iv) displaced secondary; and
(v) intrinsic variability anticipated as both components appear to be of F-type.

δ Capricorni:

Slipher (1906) found the variable radial velocity in this system. Slettebak (1949) and Abt & Bidelman (1969) classified δ Cap as a metallic line A-type star, but Abt & Levy (1985), Batten & Fletcher (1992) did not classify it as a metallic line star. Cowley et al. (1969) classified δ Cap as a δ delphini star which was doubted by Kurtz (1976) and Gray & Garrison (1989), Wood & Lampert (1963). Dorren et al. (1980) and Ohmori (1981) attempted its photoelectric photometry, but none could secure its full light curve. Tinbergen (1979) and Luna (1981) found zero and marginal, and variable polarization respectively. Dorren (1980) selected the system for H_α photometry and Srivastava (1987e) first presented its full V light curve and suspected it to be a RS CVn binary. Srivastava (1988a) also detected the presence of the disc in this system based on U, B, and V observations. Later, Srivastava (1988b) presented spectrophotometric observations of δ cap and found irregularities and distortion around Hα line. Srivastava (1988c) also presented its detailed period study. Malasan et al. (1989) also published light curves of δ Cap, which differ from that of Ohmori (1981) and Wood & Lampert (1963). Cheng et al. (1992) could not detect circumstellar dust using IRAS data.

Recently, Lloyd & Wonnacott (1994) arrived at some conclusions which indicate that the secondary component of δ Cap may be chromospherically active, and the presence of spots in the system is an unconfirmed possibility. Wonnacott et al. (1992) suggested that the Hα-variability may be due to excess emission from material held in magnetic loops on the secondary. Another possibility is emission from plage regions which are distributed extensively on active star. Srivastava (1987e, 1988a) also suspected signatures of activity in this system.

The problems associated with this system are :

(i) the variability of the light curve in different filters;
(ii) the activity of the components to be confirmed by various methods;
(iii) the confirmation of the presence of gaseous stream;
(iv) the confirmation of period variability; and
(v) the confirmation of spots and gaseous streams.

There are sufficient reasons to believe that δ Cap may be a RS CVn binary.

EI Cephei:

Plaskett et al. (1921) recognised EI Cep as a spectroscopic binary. Harper et al. (1935) and Popper (1971) gave spectroscopic elements. Popper (1971) also declared it a metallic-line system. Strohmeier (1958c) found it to be an eclipsing variable and Strohmeier (1960) first assessed the variability in EI Cep. A photoelectric light curve, without filter, was obtained by Abrami (1966).

Padalia & Srivastava (1975) first obtained UBV light curves of EI Cep and presented elements of the system. Since then no UBV light curves appear to have been published in the literature. Kitamura (1976) analysed Padalia & Srivastava's (1975) observations and published geometrical elements and absolute dimensions, and indicated that both components of EI Cep have evolved well from the main sequence and declared their luminosity class as subgiant, with spectral types of the components as F2 IV and F3 IV-III, using Golay's (1974) tables. Isles (1986) published a report on eclipsing stars, which is not available to us. Srivastava (1987d) presented its period study.

The system needs:
(i) new light curves for defining maxima;
(ii) defining the tips of primary and secondary minima afresh; and
(iii) the period demands confirmation of jump around 1965 (Srivastava, 1987d).

GH Pegasi:

Strohmeier & Knigge (1960a,b) discovered the variability in GH Peg. Later, Filatov (1961) and Strohmeier (1962) gave its light curves. Srivastava & Padalia (1974) presented first UBV light curves and derived geometrical elements. Since then no photoelectric light curves of this system are traceable in the literature. Srivastava (1987c) attempted its period study.

The system needs proper attention to solve the following problems:
(i) huge scatter in the light curves;
(ii) huge scatter and distorted shape of the secondary minima; and
(iii) defining the tip of primary minimum afresh.

IZ Persei :

Strohmeier (1958a,b) discovered the light variations in IZ Per. Yavuz (1969) found only one component spectroscopically perceptible. Srivastava & Padalia (1970) presented UBV light curves for the first time. Since then no UBV light curves appears to have been published in the literature. Wolf & Baker (1977) analysed BV light curves, whose details are not available in the literature. Mardirossian et al. (1980) presented orbital elements of the system based on the observations of Srivastava & Padalia (1970). Srivastava (1987) attempted its period study and found period fluctuations. Srivastava (1987b) analysed variations present in the light curves and found primary component possessing a β-CMa type intrinsic-variability.

The knowledge of the system is still far from satisfactory and desires:

(i) fully covered new UBV light curves, as observations between phase 0.65 to 1.30 were lacking in the UBV light curves, given by Srivastava & Padalia (1970);
(ii) new spectroscopic study;
(iii) elements of the system and absolute dimensions; and
(iv) confirmation of shell in the system.

HD 126200:

Based on the findings of Sandig (1951), Kukarkin et al. (1982) indicated it to be a variable. Hoffleit & Jaschek (1982) listed the system as suspected eclipsing binary of E.A. type ($5^m.7$-$6^m.2$). Srivastava & Kandpal (1984) secured its UBV observations on 12 nights through 52-cm reflector during the years 1967, 1968 and 1970. Although they did not find it an eclipsing binary system, yet they did not negate such possibility.

Nothing much is known about this system but based on Sandig's (1951) observations, Kukarkin et al. (1982) found a variation of $0^m.5$, which is quite appreciable. It is a puzzling question why the eclipsing binary nature detected by Kukarkin et al. (1982) could not be established later.

The system is sufficiently bright $5^m.8$ and is suitable for photoelectric and spectroscopic observations, yet it remained observationally unattacked.

New light curves of these systems and stars are badly needed for their better understanding.

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