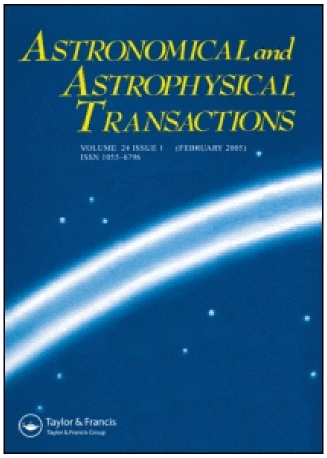

Astronomical & Astrophysical Transactions
The Journal of the Eurasian Astronomical Society
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713453505

Charge-coupled device-photometric observations of SS433 in 2003-2005

T. R. Irsmambetova [a]
[a] Sternberg Astronomical Institute, Moscow University, Moscow, Russia

Online Publication Date: 01 February 2007
To cite this Article: Irsmambetova, T. R. (2007) 'Charge-coupled device-photometric observations of SS433 in 2003-2005', Astronomical & Astrophysical Transactions, 26:1, 97 - 101
To link to this article: DOI: 10.1080/10556790701295217
URL: http://dx.doi.org/10.1080/10556790701295217

Astronomical and Astrophysical Transactions
Vol. 26, Nos. 1–3, February–June 2007, 97–101

Charge-coupled device–photometric observations of SS433 in 2003–2005

T. R. IRSMAMBETOVA*

Sternberg Astronomical Institute, Moscow University, 13 Universitetskij Prospekt, Moscow 119992, Russia

(Received 26 January 2007)

Charge-coupled device–photometric *BVRI* observations of SS433 perfomed in Crimea in 2004–2005 are presented. Analysis of the variations in the colour indices $B-V$ and $V-R$ was made on different timescales. The 'colour–magnitude' $V-(V-R)$ relations for both rapid and orbital variabilities possess typical features; the colour $V-R$ decreases when the brightness of V increases. It has been shown that the object's reddening with decreasing brightness is caused not only by eclipses but also by its own variability. The behaviour of colour indices during the night can be explained by the interaction of the relativistic jets with the photosphere around the accretion disc.

Keywords: Stars; Close binary; Individual (SS433) charge-coupled device observations; 'Colour–magnitude' relations

1. Observations

There is a supercritical accretion disc and relativistic jets in the close binary system SS433. This binary is of an eclipsing type with an orbital period of 13.08 days. Both the disc and the jets precess with precession periods of 162.38 days. The disc precession is displayed in the variability of the total brightness and colour indices of SS433 and in the changing eclipse light curve parameters with the precession phase.

The observations of SS433 cover the intervals August–September 2004 and September–October 2005. The detector was an Apogee model Ap-47 charge-coupled device (CCD) camera attached at the Cassegrain focus of the Zeiss-600 and 38 cm reflector (KGB) in Nauchnyi. Figures 1 and 2 show the *BVRI* data obtained from the observations. The 2004 observations (Julian date (JD) 2453225–2453270) were performed at time T_3 ($\psi = 0.85-0.15$), *i.e.* the moment of maximal opening of the accretion disc to the observer. The 2005 observations (JD 2453616–2453659) correspond to the moment T_1 ($\psi = 0.24$–0.45), when the position of the accretion disc is 'edge on'. *BVR* photometry of SS433 in May 2003 was performed simultaneously with INTEGRAL observations [1]. The observations SS433 in 2003–2005

*Email: tri@sai.crimea.ua

Astronomical and Astrophysical Transactions
ISSN 1055-6796 print/ISSN 1476-3540 online © 2007 Taylor & Francis
http://www.tandf.co.uk/journals
DOI: 10.1080/10556790701295217

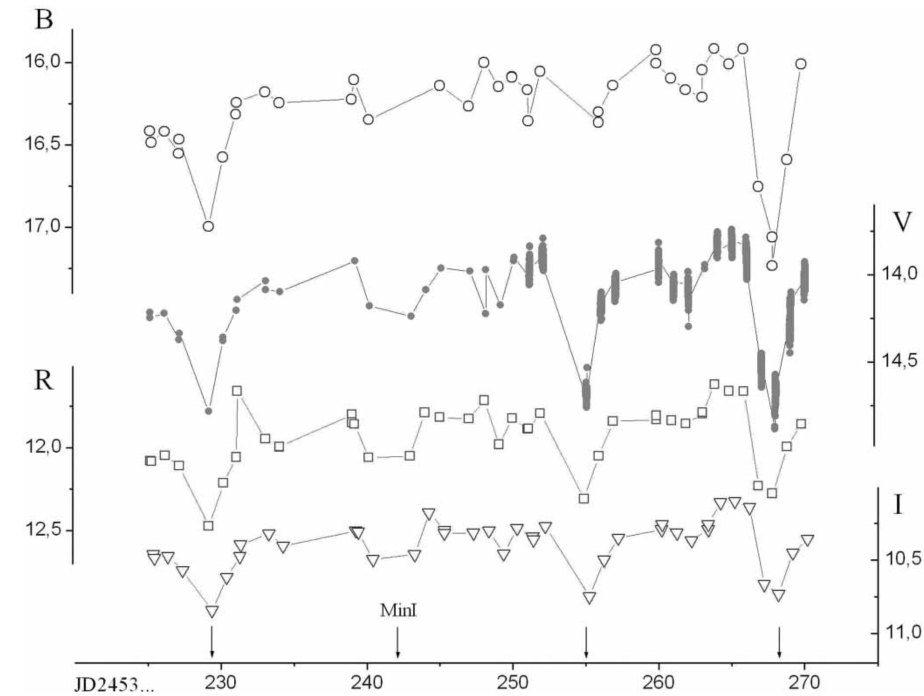

Figure 1. *BVRI* photometry of SS433 in 2004, $\psi = 0.85{-}0.15$ (T_3).

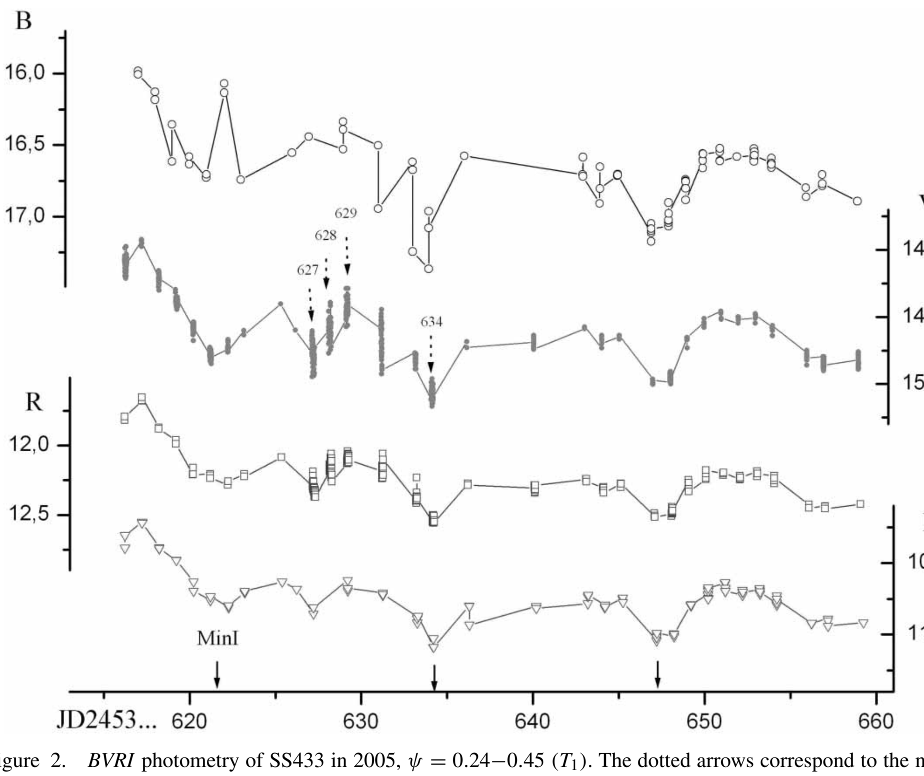

Figure 2. *BVRI* photometry of SS433 in 2005, $\psi = 0.24{-}0.45$ (T_1). The dotted arrows correspond to the nights JD 2453627, 2453628, 2453629 and 2453634 with rapid photometry observations in the V and R bands.

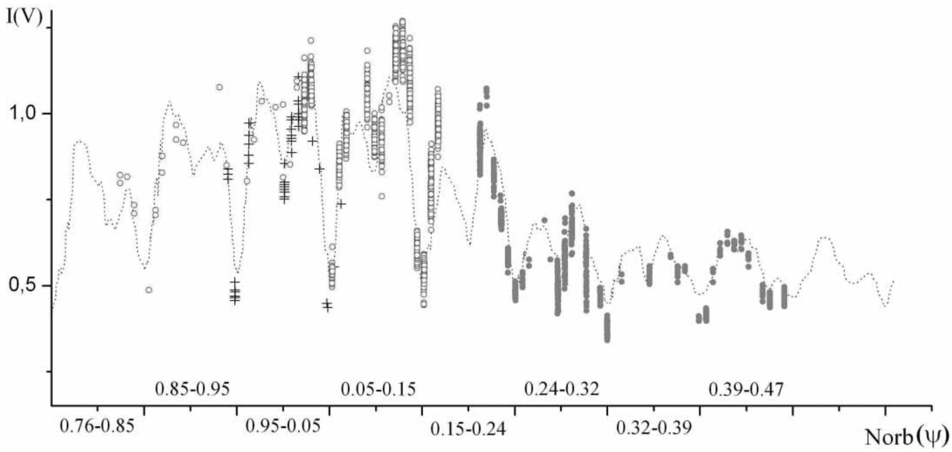

Figure 3. The precessional light curve of SS433 which is composed of mean orbital light curves in quiescent states in terms of fractions of the orbital period (dotted curve) and CCD data obtained in 2003 (crosses), 2004 (open circles) and 2005 (full circles) in the V band.

demonstrate the orbital (13.08 days) and precessional (162.38 days) effects in the quiescent state. Figure 3 shows V observations in 2003–2005 and the mean precessional light curve of SS433 in passive states. The precession phases were calculated from [2], and the orbital phases from [3].

The rapid photometric V observations of SS433 were performed on JD 2453265, 2453267, 2453268, 2453269, 2453270, 2453616, 2453619 and 2453621, and VR observations on JD 2453627, 2453628, 2453629 and 2453634, with a time resolution of about 1.5 min. The fast variability was detected in all nights including the deepest eclipses. The amplitude magnitudes of the brightness variations are 0.15–0.34 in the V band and 0.08–0.15 in the R band. Light variations during the night in MinI are different for the $\psi = 0$ (T_3) and $\psi = 0.34$ (T_1) precessional phases. There are waves of 0.25–0.34 amplitude magnitude in the V band with a period of approximately 1 h during observations on JD 2453267–2453269 (MinI, T_3). The amplitudes and period of light variations during observations on JD 2453619–2453621 (MinI, T_1) are less.

2. The ‘colour–magnitude’ relations

According to the well-known relation between $V - R$ and V, the colour of SS433 reddens with decreasing brightness of V. This applies to the orbital and precessional variabilities [4, 5]. Figure 4 shows the relations $B-(B - V)$ and $V-(V - R)$ for select precession phases $\psi = 0 \pm 0.15$ (2004) and $\psi = 0.34 \pm 0.10$ (2005) (table 1).

Table 1. Correlations for $B-(B - V)$ and $V-(V - R)$.

Diagram	ψ	Linear fit	Correlation
$B-(B - V)$	0.85–0.15	$B = 11.63(\pm 0.87) + 2.06(\pm 0.41)(B - V)$	0.66
$B-(B - V)$	0.24–0.45	$B = 14.60(\pm 0.25) + 1.03(\pm 0.12)(B - V)$	0.74
$V-(V - R)$	0.85–0.15	$V = 9.87(\pm 0.67) + 2.23(\pm 0.35)(V - R)$	0.74
$V-(V - R)$	0.24–0.45	$V = 10.25(\pm 0.31) + 2.13(\pm 0.14)(V - R)$	0.80

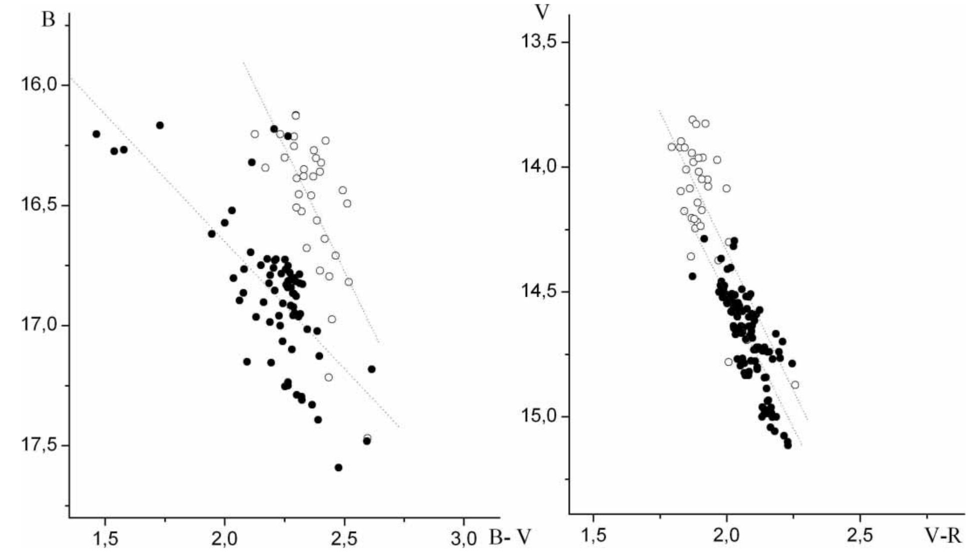

Figure 4. Correlation between $B - V$ and B, and between $V - R$ and V, for two observing seasons in 2004 and 2005 in different precessional phases.The open circles correspond to 2004 observations in the $\psi = 0.85$–0.15 (T_3) precessional phase. The full circles correspond to 2005 observations in the $\psi = 0.24$–0.45 (T_1). The dotted lines are linear fits.

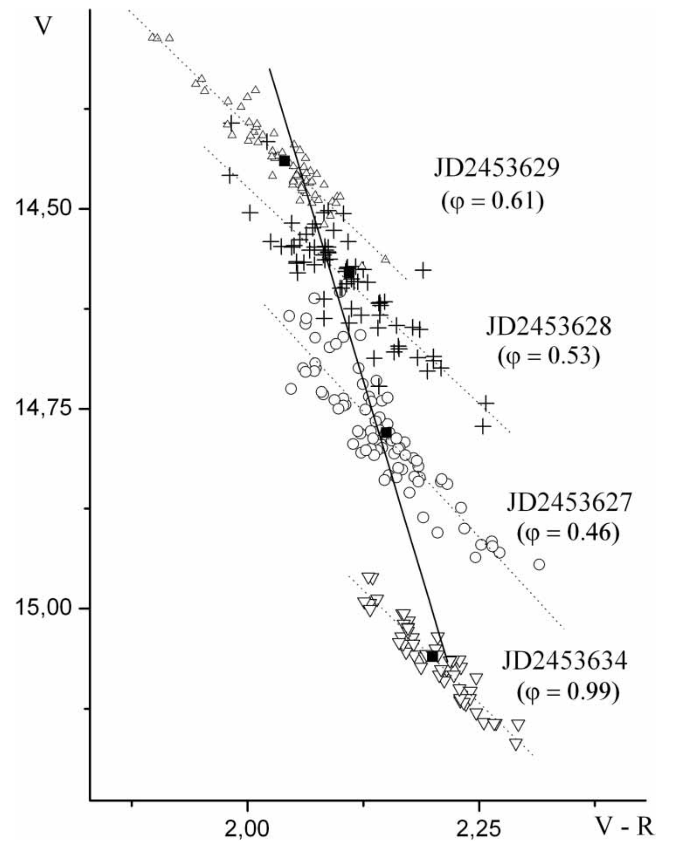

Figure 5. Correlation between $V - R$ and V for rapid photometry observations during four nights in different orbital phases ϕ in 2005 (see figure 2). The solid line represent the orbital linear relation. The full squares indicate the main points for these four nights.

Table 2. $V-(V-R)$ correlations.

	Linear fit	Correlation
JD 2453627	$V = 12.08(\pm 0.15) + 1.25(\pm 0.07)(V - R)$	0.89
JD 2453628	$V = 12.31(\pm 0.15) + 1.08(\pm 0.07)(V - R)$	0.87
JD 2453629	$V = 12.15(\pm 0.09) + 1.15(\pm 0.05)(V - R)$	0.95
JD 2453634	$V = 12.58(\pm 0.13) + 1.13(\pm 0.06)(V - R)$	0.94

It can be seen that the colour index $V - R$ depends on the precession phase, while $B - V$ does not. The $V-(V-R)$ diagrams for the moments T_3 and T_1 form a united relation, but the $B-(B-V)$ diagrams separate into two branches with different linear coefficients. So there are blue and red optical components in the system.

Figure 5 presents the $V-(V-R)$ relations according to rapid photometric *VR* observations of SS433 performed on JD 2453627, 2453628, 2453629 and 2453634 in different orbital phases. The $V-(V-R)$ correlations for every night are given in table 2.

As can be seen from figure 5, the relations constructed for each night form analogous relations for the orbital period. It is considered that at the primary minimum the accretion disc is eclipsed by the optical star, and the system becomes redder. However, in the case of rapid variability during the night, the behaviour of the colour indices can be explained by the interaction of the relativistic jets with the photosphere around the accretion disc.

References

[1] A.M. Cherepashchuk, R.A. Sunyaev, S.N. Fabrika *et al.*, Astron. Astrophys. **437** 561 (2005).
[2] S.S. Eikenberry, P.B. Cameron, B.W. Fierce *et al.*, Astrophys. J. **561** 1027 (2001).
[3] V.P. Goranskii, V.F. Esipov and A.M. Cherepashchuk, Astron. Rep. **42** 209 (1998).
[4] T.R. Irsmambetova, Astron. Lett. **23** 341 (1997).
[5] T.R. Irsmambetova, Astrophysics **44** 297 (2001).