COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS

Number 5553

Konkoly Observatory
Budapest
6 August 2004

HU ISSN 0374 – 0676

HD 52452: NEW BVRI PHOTOMETRY

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HD 52452 (V369 Gem, SAO 78998; $V = 8.05$, $B - V = 0.67$; G5 V) is one of the shortest period ($0\overset{d}{.}42304$) non-eclipsing chromospherically active binary star discovered so far. Its X-ray properties were discovered in the ROSAT all sky survey program and it is one among 383 relatively bright X-ray sources cataloged by Pounds et al. (1993). The star HD 52452 is an optical counterpart of the EUV bright source RE J70222+255054 (Mason et al. 1995) and its photometric and spectroscopic observations aimed at the classification of EUV stellar sources detected by EXOSAT and ROSAT were carried by Cutispoto et al. (1999, 2000). Furthermore, HD 52452 is also listed in the 2RE source catalogue published by Pye et al. (1995). Messina et al. (2001) reported that HD 52452 is a triple system consisting of a tidally coupled G4 V + late-G SB1 (responsible for the most of the observed optical variability) and a G5 V companion. Their photometric observations reveal that the observed photometric variability is due to the presence of cool spots on the photospheres of both component of the SB1 system. In this paper we report the multi-band BVRI photometry of HD 52452.

The BVRI photoelectric photometric observations of HD 52452 were carried out during two observing runs - one during February 17 - March 23, 2000 for 8 nights and another one during February 20 - February 26, 2001 for 6 nights. For the first observing run we have a total of 158 data points and have 93 data points for the next one. The 40-cm Schmidt-Cassegrain LX 200 Meade telescope equipped with SSP-3A photoelectric photometer and Johnson standard broad-band BVRI filters were used for the observation. The telescope is situated on the campus of the Inter University Centre for Astronomy and Astrophysics (IUCAA) in Pune, India. The detector used in the SSP-3A photometer is a silicon PN-photodiode which is not cooled. The response function of the B, V, R and I filters with the detector closely match those of the Johnson standard filters. In order to obtain accurate differential photometry, we used two nearby stars HD 52071 (K2 III, $V = 7.11$, $B - V = 1.27$) as comparison star and HD 50692 (G0 V, $V = 5.76$, $B - V = 0.56$) as check star. The mean of four to five independent differential magnitudes per observation in each band were corrected for atmospheric extinction and transformed into BVRI standard system. No significant light variation was detected for the differential magnitudes of the comparison and check star ΔV_c, which is a good measure of the quality of our observation. The uncertainties in ΔV, $\Delta(B - V)$, $\Delta(V - R)$ and $\Delta(V - I)$ are 0.015, 0.02, 0.017 and 0.02 magnitudes, respectively.

The combined data for both 2000 and 2001 were analyzed to obtain the photometric period using a Scargle-Press period search routine (Scargle 1982, Horne & Baliunas

Table 1: Photometric periods for HD 52452

Data set	Period	FAP (%)
2000+Messina et al. (2001)	0.42402±0.00021	2.00
2001+Messina et al. (2001)	0.45163±0.00146	4.40
Combined (2000+2001)	0.42261±0.00002	5.68

Table 2: Results form photometric analysis of HD 52452

Epoch	JD interval	Minimum I	phase II	Maximum amplitude
2000.132	51592.144 - 51593.347	0.2	0.7	0.13
2000.193	51605.125 - 51608.304	0.2	0.7	0.24
2001.140	51961.140 - 51962.301	0.1	0.6	0.14
2001.147	51963.141 - 51964.211	0.1	0.6	0.16

1986), and a photometric period P = $0^{\mathrm{d}}.42261\pm0.00002$, with a false- alarm-probability FAP = 5.68 % was found. Photometric periods with error and false-alarm- probability (FAP in %) are listed in Table 1. To cross check our period search routine we also derived photometric period from Messina et al. (2001) data and a photometric period $0^{\mathrm{d}}.42309\pm0.00017$ with FAP 8.61 % was found which agrees well with the period ($0^{\mathrm{d}}.42304$) reported by Messina et al. (2001). The slightly larger period for the epoch 2001 with Messina et al. (2001) data as compared to the other epoch may be due to the scatter in the data covering long period.

Observed data points have been folded in to a phase using the photometric ephemeris HJD = 2449672.0 + $0^{\mathrm{d}}.42261 \times E$. We divided our photometric data points into four subsets (two for each epoch) and phase diagram for these subsets and associated colors $(B-V)$, $(V-R)$ and $(V-I)$ are shown in Figure 1 and 2 for the V band. The differential magnitudes of the check star with respect to the comparison star V_c are shown in the same diagrams. We have also shown the complete light curve for epoch 2000 and 2001 in the panel (c) of Figure 1 and 2 respectively. Table 2 gives the epoch, JD interval, the minimum phase and maximum amplitude for observed data points.

A significant variation in the light curve within the first year and between the two seasons from the phase diagrams is seen (Fig. 1 & 2). Small variations are observed for the epoch 2000.132 but the data points are very scattered. Visual inspection of light curve for the star HD 52452 reveals the existence of two minima separated from each other by about half period in phase. This behavior is possibly due to the existence of two spots on the stellar surface. The amplitude of light variation is ~0.24 magnitude in V band for 2000.193, which is large compared to the ~0.16 magnitude in V band reported by Messina et al. (2001). He also observed peaked light curve separated by 0.4 in phase. For the next observing epochs 2001.140 and 2001.147 the amplitude of light variation decreases to ~0.14 and ~0.16 magnitude in V band respectively.

The $(V-I)$ color curve for the epoch 2000.193 reveal the variation of ~0.7 magnitude but except this, in general there are no significant variation for the $(B-V)$, $(V-R)$ and $(V-I)$ color indices. The observed variation in $(V-I)$ color index can be attributed to the lower spot temperature relative to the photosphere than in other cases. The present observations clearly suggests that the optical variability in the star HD 52452 is due to the presence of cool spots on the stellar surface.

The comparison of our data with previous observations reported by Messina et al. (2001) shows that there is a variation in amplitude, but the phases of the two minima, thus the positions of the spot, are quite stable during our observations. The very short photometric period makes this star very interesting for studying the evolution of spots on stellar surface in terms of spot parameters over a longer time period.

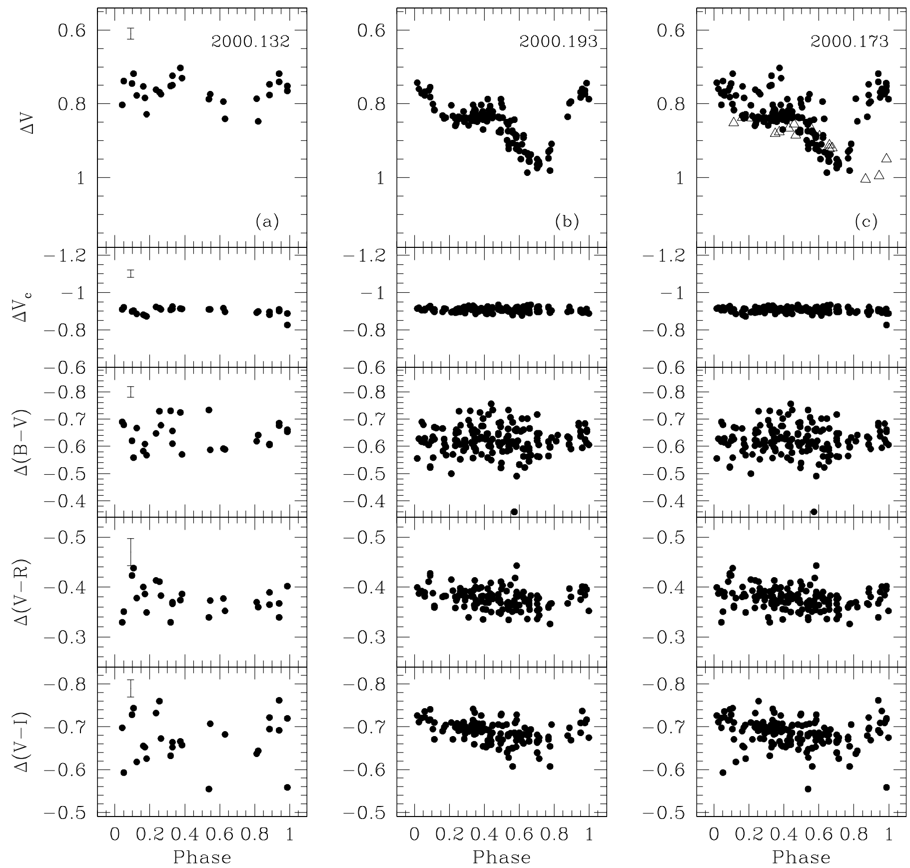

Figure 1. V band light curves and $(B-V), (V-R)$ and $(V-I)$ colors for HD 52452 for the observing run during February - March 2000. V_c for the check star observed on the same nights. Typical error bars are shown in the upper left corner of each light curve in panel (a). The open triangle denote the observations from Messina et al. (2001).

Acknowledgements:
We are thankful to IUCAA for providing their observing, library and computing facilities. We also express our sincere thanks to Professor A. K. Kembhavi and Padmakar Singh Parihar for there kind co-operation and suggestions during the course of the observations. We are grateful to Dr. Katalin Olah whose comments and suggestions have led to significant improvements in the presentation of the paper. SB and SKP would like to express their sincere thanks to CSIR, New Delhi, for financial support through a project grant No. 03(0985)/03/EMR-II.

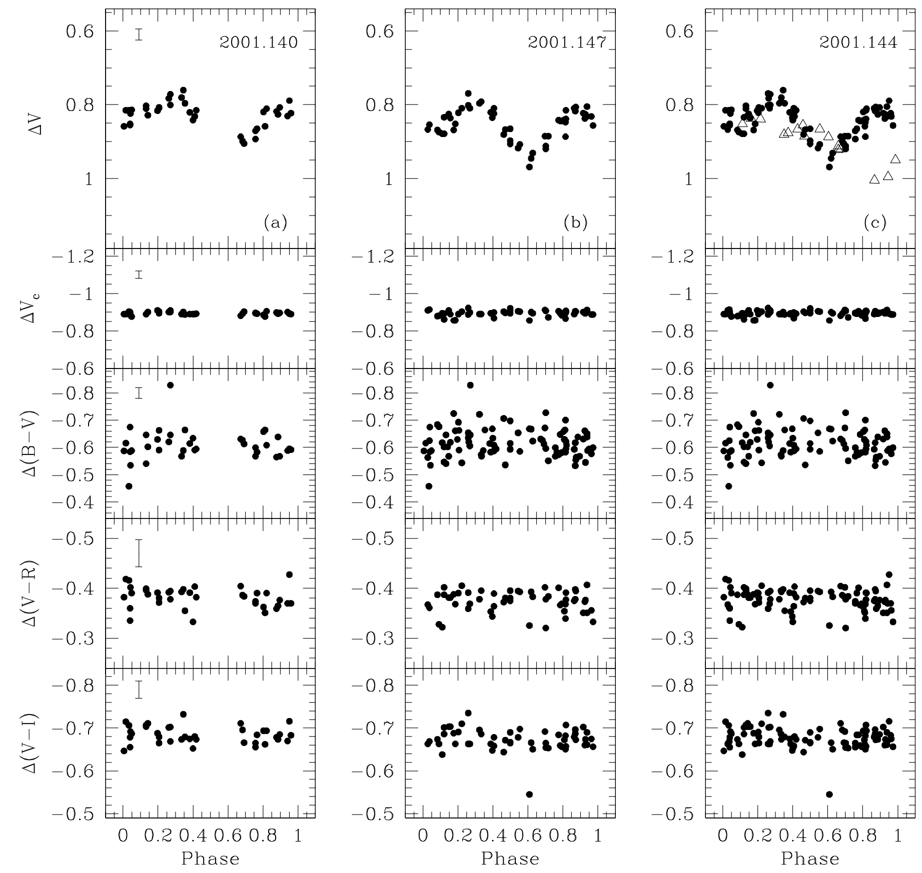

Figure 2. V band light curves and $(B-V),(V-R)$ and $(V-I)$ colors for HD 52452 for the observing run during February 2001. V_c for the check star observed on the same nights. Typical error bars are shown in the upper left corner of each light curve in panel (a). The open triangle denote the observations from Messina et al. (2001).

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