PHOTOMETRIC OBSERVATIONS OF THE X-RAY DWARF NOVA HL CANIS MAJORIS

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ABSTRACT

High speed optical photometric observations of the X-ray dwarf nova HL Canis Majoris (1E 0643-1648), discovered with the Einstein observatory, are presented in this paper. The observations were carried out with 1 m reflector of the Kavalur observatory. Results of long term monitoring and attempts to detect photometric eclipses at the reported orbital periods of 0.22 d or 0.18 d of the binary system are presented.

Key words: X-ray dwarf nova, photometry.

1 INTRODUCTION

As a part of the ongoing program of optical observations of X-ray sources we have carried out high speed optical photometric measurements of the recently discovered X-ray cataclysmic variable HL CMa (1E 0643-1648) during 1982 and 1983. The source was discovered during imaging observations of the Sirius neighbourhood with the Einstein X-ray observatory by Chlebowski et al., (1982). Observations of optical outbursts approximately every 15 days (Morgan, 1981) and simultaneous IR and optical light flickerings on time scales of several minutes (Bailey et al., 1981) have revealed the dwarf nova signature of the source. Detailed optical or X-ray light curves of the source during different phases of its state of activity are not available. The present observations in the optical band, therefore, constitute an attempt to fill this gap. Spectroscopy of HL CMa (Hutchings et al., 1981) has revealed the binary nature of the source, with a period of either 0.22 day or 0.18 day. We have searched for possible photometric eclipses in the light curves of the source, the results of which are also presented in this paper.

2 OBSERVATIONS

The observations were carried out on 8 nights during Jan. 14 - March 14, 1982 and Feb. 23-24, 1983 using the 1 m reflector at the Kavalur observatory. A single channel photometer (Sharma et al., 1981) was used for the observations. The star was observed for a total duration of 5 h with integration times of 1 s or 2 s. The measured apparent magnitudes and colours of the star are given in Table-1.

3 RESULTS AND DISCUSSION

Figures 1, 2 and 3 show a part of the light curves of HL CMa as measured on three nights, viz., Jan. 15/16, 1982; March 2/3, 1982 and Feb. 24/25, 1983. We note that the light curves presented in the three figures represent the longest duration observations so far on the object. Irregular light variation on time scales of minutes, which is typical of dwarf novae is quite clearly noticeable in these results. Flicker amplitudes are usually <0.2 mag. and flicker is not always present. We must, however, draw attention to the unique flarelike flicker shown in Fig. 2. Although such large amplitude flickers (about 0.4 mag. in the present case) are not uncommon in the light curves of other dwarf novae like EX Hya, H2252-035, etc., this one is unique in its smooth wavelike pattern, which may perhaps be indicative of a coherent build-up of instabilities in the accretion disc around the white dwarf in the binary system. We also note that the unusual flare repeats itself with reduced intensity after $\sim$12 min. This may be the first indication of a possible rotation of the underlying object.

The observation of a minimum in the stellar flux at $17^h\ 36^m$ on Jan. 15, 1982 and a dip in V band flux on March 2, 1982, as seen in Fig. 1, made us first suspect that these minima resulted from short duration ($\sim$6-8 min) eclipses in the binary system. The phase of the second minimum with respect to the first for the 0.22 day binary period is 0.99 and for the 0.18 day period, it is 0.43. This result made us initially think that the true binary period of the system might be 0.22 day. Searches for similar eclipses during the observations in 1983, however, did not reveal any such minima. One could argue that, due to constant flickerings in the light curves of dwarf novae, one may not detect the short duration eclipse in every orbital cycle. This is certainly true in the case of EX Hya. We hasten to add, however, that in the case of observations with single star photometers, as is the case with the present work, one cannot distinguish between the true decreases in stellar flux and obscuration caused by the passage of thin clouds over the telescope FOV. Although our records were taken in clear sky conditions, because of the above reasons, the observation of possible short duration eclipses in HL CMa should be treated as preliminary.

Long term variations of the stellar flux depicting the dwarf nova behaviour of HL CMa are shown in Fig. 4. The last 13 points in the fig. are the present measurements. The faintest level of the stellar flux recorded by us corresponds to about $m_V \lesssim 14.1$, about 1.1 mag. fainter than any of the previous observations. The star appears at about $m_V = 10$ in its highest state (Chlebowski et al., 1982) and hence represents a maximum magnitude variation of $\Delta m_V \gtrsim 4.1$. Further examination of Fig. 4 reveals that our recent

observations appear to indicate a very sharp rise ($\sim$2 mag. per day) towards the maximum of the outburst state, a result that has so far not been reported.

4 CONCLUSIONS

The observations reported here represent the longest duration high speed photometric measurements of HL CMa. The dwarf nova behaviour of the star is confirmed by the observation of flickers in the light curves. We also report the faintest level of visible light emission from the star (m_v = 14.1) in its quiescent state and the fastest rise ($\sim$2 mag. per day) towards the outburst state.

TABLE - 1

APPARENT V MAGNITUDE OF HL CMa

Date	Julian Date 244	V		B-V
Jan. 15, 1982	4985.215	13.82		0.45
	4985.302	14.04		
Feb. 10, 1982	5011.099	11.42		0.15
	5011.235	11.43		
	5011.238	11.41	± 0.05	
	5011.239	11.39		
Mar. 1, 1982	5030.125	14.10		0.30
Mar. 2, 1982	5031.206	13.78		0.61
Mar. 14, 1982	5043.115	12.39		
Feb. 23, 1983	5389.159	12.8		
Feb. 24, 1983	5390.094	11.7		
	5390.149	11.6	± 0.1	
	5390.285	10.9		

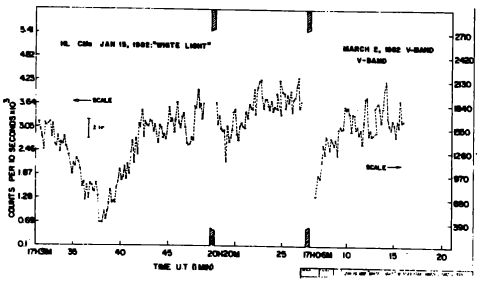

Figure-1

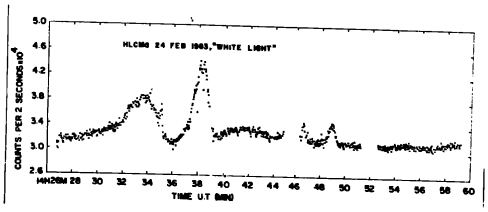

Figure-2

Fig. 1-2: Light curves indicating flickers, dips and miniflares.

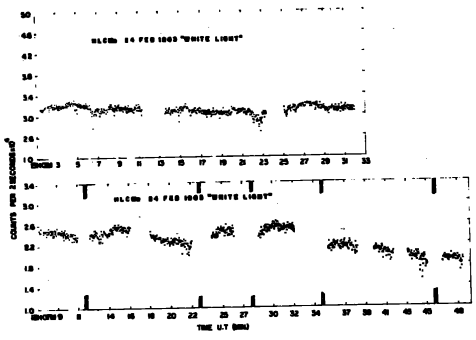

Fig_3: Long duration light curves.

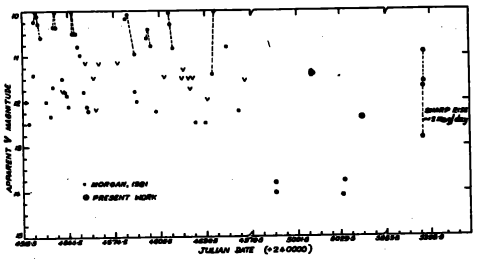

Fig-4: Long term variation of m_v of HL CMa.

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