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

Number **5596**

Konkoly Observatory
Budapest
17 January 2005
HU ISSN 0374 - 0676 (print)
HU ISSN 1587 - 2440 (on-line)

BVRI observations of EM Cygni in the Years 2003-2004

Spogli, Corrado[1]; Fiorucci, Massimo[1]; Capezzali, Daniele[1]; Mancinelli, Vannio[2]; Nucciarelli, Giuliano[1]; Brunozzi, Paolo[2]; Fagotti, Paolo[2]; Rocchi, Gianni[2]

(1) Osservatorio Astronomico, Università di Perugia, Via A. Pascoli I-06100 Perugia, Italy
(2) Gruppo Astrofili Monte Subasio, Piazza Santa Maria 2, Assisi, Italy

SIMBAD object(s): EM Cyg

Type(s): UG

Keyword(s): photometry

Abstract: In this paper we report BVRI observations of the dwarf nova EM Cyg obtained in the years 2003 and 2004. A preliminary statistical analysis is reported.

The dwarf nova EM Cyg is an eclipsing and spectroscopic binary that belongs to the Z Cam class (Downes & Shara 1993). From the catalogue of Ritter and Kolb (2003), we know that EM Cyg has V =~ $13^m.3$ mag during the regular minimum, V =~ $14^m.4$ at minimum during the eclipse, V =~ $12^m.5$ during the maximum, and V =~ $12^m.9$ in standstill. We observed EM Cyg since 1997 with the aim to study its variability using broad band photometry (Spogli et al. 2003). Here we improve our previous analysis using new BVR_cI_c data obtained during the Summer-Autumn 2003 and 2004, for a total of 57 new nights. All photometric new data are reported in Tables 1 and 2.

The observations of EM Cyg were made at the Perugia Astronomical Observatory with 0.40 m Automatic Imaging Telescope (Tosti et al. 1996), and at Porziano Astronomical Observatory (Assisi) with the 0.35 m Schmidt-Cassegrain telescope equipped with an HiSIS 23 CCD camera (Kodak Kaf 401E of 762×512 pixel). The instruments used and the photometric techniques have been already described in Spogli et al. (1998). Both telescopes are endowed with standard BVR_cI_c Johnson-Cousins broad-band filters. An inter-comparison between results obtained during the same nights shows no relevant systematic difference, within the typical standard deviation of each

instrument. All data are obtained in differential photometry using the calibration stars reported by Misselt (1996) and Spogli et al. (2003).

Figure 1 shows the V light curve during 2003, and the visual estimates available from AFOEV (http://cdsweb.u-strasbg.fr/afoev/). A similar comparison can be done with all our database (including Spogli et al. 2003), with the conclusion that our multi-band photometry samples very well the outburst, the decline and the minimum phases, while there are few data about the rising phase. The typical time interval between two outbursts is 23 days, with a range of 15-40 days. The general trend is well characterized, with the emission dominated by the secondary star during the minimum (V-I =~ $1^m.1$, see Figure 2) and by the accretion disk during the outburst (V-I =~ $0^m.6$). The main photometric informations are summarized in Table 3, taking into account the new data and the 1997-2000 data (Spogli et al. 2003).

Table 1 2003 BVR_cI_c data of EM Cyg

UT Date	JD (2450000+)	B	V	R_c	I_c
02/06/2003	2792.528	13.02±0.05	12.82±0.04	12.49±0.04	12.01±0.04
05/06/2003	2795.549	13.29±0.13	12.97±0.05	12.65±0.04	12.14±0.03
06/06/2003	2796.556	13.61±0.12	13.21±0.05	12.79±0.04	12.21±0.03
11/06/2003	2801.581	14.08±0.05	13.38±0.05	12.93±0.04	12.33±0.03
12/06/2003	2802.574	13.96±0.05	13.43±0.05	13.02±0.04	12.37±0.03
20/06/2003	2810.554	13.11±0.05	12.86±0.05	12.58±0.04	12.14±0.03
21/06/2003	2811.546	13.38±0.07	13.01±0.05	12.65±0.04	12.12±0.03
22/06/2003	2812.558	13.57±0.08	13.15±0.04	12.74±0.04	
25/06/2003	2815.542	14.31±0.07	13.64±0.04	13.08±0.04	12.46±0.04
26/06/2003	2816.592	14.43±0.08	13.57±0.05	13.04±0.03	
08/07/2003	2828.501	12.78±0.09	12.43±0.04	12.13±0.04	11.66±0.04
12/07/2003	2832.521	13.35±0.07	13.12±0.05	12.77±0.04	12.22±0.04
15/07/2003	2836.496	14.51±0.05	13.61±0.04	13.09±0.04	12.47±0.04
18/07/2003	2839.475	14.49±0.10	13.62±0.05	13.13±0.04	12.46±0.04
19/07/2003	2840.495	13.99±0.11	13.53±0.04	13.04±0.04	12.41±0.04
22/07/2003	2842.536	14.01±0.09	13.42±0.06	13.12±0.03	12.48±0.04
23/07/2003	2843.526	14.47±0.11	13.53±0.03	13.04±0.04	
03/08/2003	2854.509	13.44±0.06	12.88±0.05	12.54±0.04	12.07±0.04
05/08/2003	2857.334			12.86±0.05	
06/08/2003	2858.428	14.33±0.05			
10/08/2003	2862.461	14.12±0.11			
12/08/2003	2864.487	14.23±0.07	13.49±0.04	13.15±0.04	12.47±0.04
13/08/2003	2865.404		13.68±0.05	13.18±0.04	12.54±0.04
18/08/2003	2870.321		13.57±0.05	13.08±0.05	
19/08/2003	2871.441	14.03±0.05	13.51±0.04	13.01±0.04	
20/08/2003	2872.392	14.32±0.12	13.83±0.04	13.21±0.05	
22/08/2003	2874.394	14.09±0.08	13.51±0.04	13.02±0.05	12.43±0.04
10/09/2003	2893.389	12.25±0.12			

15/09/2003	2898.346	12.51±0.09	12.32±0.05		
17/09/2003	2900.405	12.85±0.05	12.53±0.03	12.25±0.04	11.81±0.04
18/09/2003	2901.368	12.94±0.07	12.68±0.05	12.35±0.05	11.92±0.04
19/09/2003	2902.377	13.23±0.09	12.84±0.05	12.54±0.05	12.12±0.04
21/09/2003	2904.317	13.71±0.06	13.20±0.08	12.86±0.05	12.35±0.04
22/09/2003	2905.341	14.01±0.05	13.31±0.04		
25/09/2003	2908.355	13.98±0.05	13.28±0.07	12.85±0.07	12.37±0.05
26/09/2003	2909.363	13.96±0.07	13.41±0.06	12.92±0.06	12.34±0.05
03/10/2003	2916.336	13.26±0.08	12.76±0.05	12.44±0.05	12.03±0.04
06/10/2003	2919.321	13.67±0.08	13.21±0.05	12.72±0.05	
10/10/2003	2923.331	14.04±0.08	13.44±0.05	12.98±0.05	12.43±0.04
12/10/2003	2925.307	13.91±0.04	13.39±0.05		
16/10/2003	2929.396	13.23±0.12	12.86±0.05	12.51±0.05	12.09±0.04
27/10/2003	2940.271	13.56±0.13	13.07±0.05	12.76±0.03	12.21±0.04

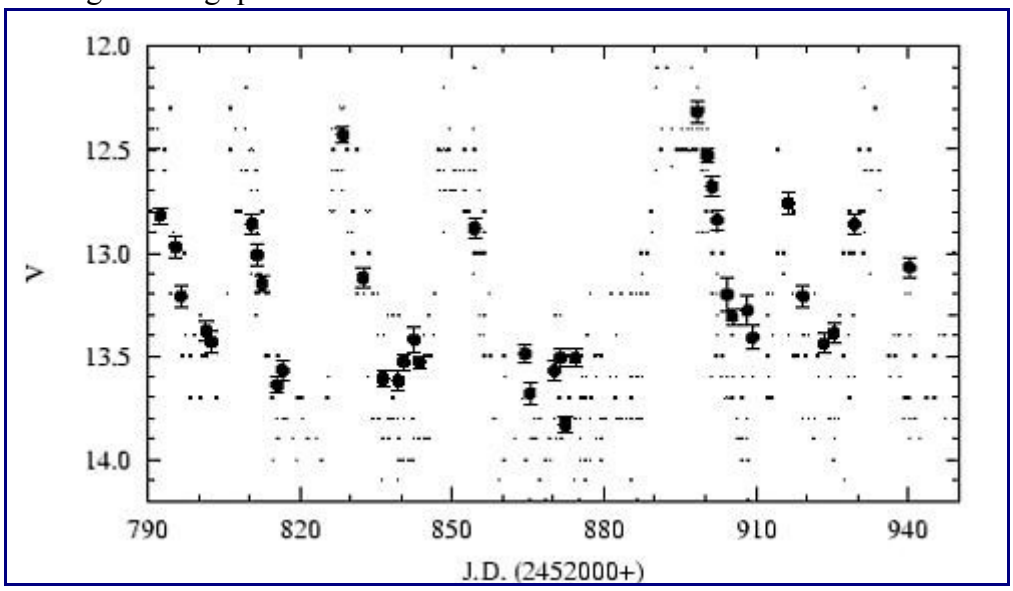
Table 2 2004 BVR_cI_c data of EM Cyg

UT Date	JD (2450000+)	B	V	R_c	I_c
25/05/2004	3150.599	13.08±0.09	12.74±0.05	12.45±0.04	12.01±0.03
31/05/2004	3156.609	13.69±0.08	13.31±0.05	12.91±0.05	12.37±0.04
12/06/2004	3168.612	13.82±0.08			
19/06/2004	3175.557	13.75±0.08	13.24±0.04	12.84±0.04	
06/07/2004	3193.394		12.67±0.07		11.94±0.06
15/07/2004	3202.384		13.40±0.05		12.33±0.04
16/07/2004	3203.379		13.31±0.05		12.37±0.05
17/07/2004	3204.379		13.49±0.05		12.36±0.05
22/07/2004	3209.487	14.04±0.09			
23/07/2004	3210.395		13.45±0.05		12.34±0.04
30/07/2004	3217.413		13.45±0.05		12.31±0.04
01/08/2004	3219.498	14.09±0.07			
17/08/2004	3235.441	14.45±0.11	13.58±0.05	13.05±0.05	12.42±0.04
18/08/2004	3235.514	14.38±0.09	13.62±0.05	13.10±0.04	12.50±0.04
21/08/2004	3239.444	13.89±0.12	13.19±0.07	12.74±0.04	12.22±0.05
22/08/2004	3239.571	13.93±0.09	13.26±0.04	12.78±0.04	12.24±0.05
08/10/2004	3287.418		12.91±0.05		12.16±0.05
23/10/2004	3302.404		13.57±0.05		12.35±0.04

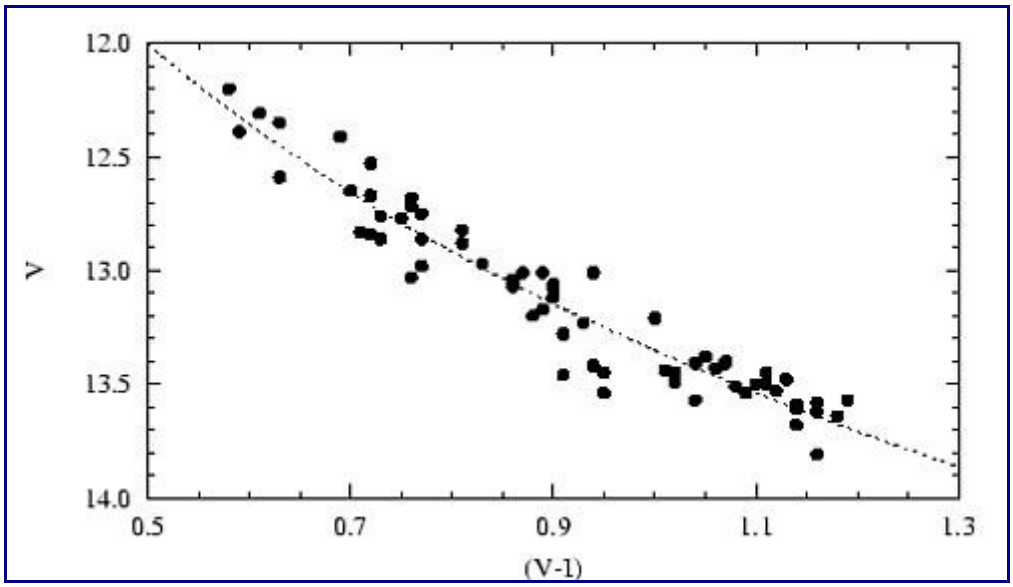
Table 3 Photometric characteristics of EM Cyg from our 1997-2004 observations.

	B	V	R_c	I_c
Maximum Outburst	12.25	12.20	11.98	11.62
Minimum of Light	14.51	13.83	13.24	12.65

Outburst Amplitude	2.2	1.5	1.1	0.9
Decay Rates(mag/day)	0.18±0.06	0.14±0.04	0.12±0.04	0.09±0.04
	(B-V)	($V-R_c$)	($V-I_c$)	
Averages during the outburst	0.2	0.3	0.7	
Averages during quiescence	0.7	0.5	1.1	



V light curve of EM Cyg from June 1st to October 27th 2003. Circles represent the data here reported, while small crosses are visual estimates available from AFOEV (http://cdsweb.u-strasbg.fr/afoev/).



Color-Magnitude diagram for the dwarf nova EM Cygni. The diagram contains the data here reported and the previous results (Spogli et al. 2003).

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