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A MULTICOLOR PHOTOMETRIC STUDY OF CN ORIONIS

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CN Ori is one of the brightest and most active dwarf novae (DNe), with a very short recurrence time between two consecutive outbursts ($\simeq$ 18 days), and one of the few DNe with an orbital period above the 3-hour upper boundary of the period gap ($P = 0\overset{d}{.}163199$). The maximum reported brightness is $V = 11.9$. The minimum is extremely variable and ranges between $V = 14.2$ and $V = 16.3$, with a quasi–sinusoidal component of variability due to a partial eclipse (Mumford 1967), and other components superimposed that probably are the signature of an accretion disk out of the steady state (Mantel et al. 1988). Many photometric observations of CN Ori are reported in the literature, with time scales ranging from a few seconds to many days (see e.g., Petit 1960, Shoembs 1982). However, these data have been generally obtained in a single photometric band, and only sporadic multi–band observations are available (for example, Echevarria 1984).

We have observed this dwarf nova at the Perugia Astronomical Observatory since 2002. The instruments used and the photometric techniques applied was already described in Spogli et al. (1998). Other observations have been collected at the Porziano Astronomical Observatory, Mt. Subasio, Assisi (Italy), with a 0.35 m Schmidt–Cassegrain telescope equipped with an HiSIS 23 CCD Camera (Kodak Kaf 401E of 762×512 pixel) and standard BVR_CI_C Johnson–Cousins broad band filters. There is no evaluable difference between the reduced data obtained with the two telescopes.

The photometric data have been obtained in differential photometry using the calibration stars reported by Bailey & Howarth (1979) and Misselt (1996). With the principal aim to give the I_C magnitudes, we selected and re–calibrated a new sequence by observing, on three photometric nights, several standard stars (Landolt 1992) having $B-V$ from -0.2 to 1.5 mag. Table 1 reports the weighted averages and the standard deviations for the selected comparison stars. Fig. 1 shows the finding chart. The BVR_C magnitudes are in general agreement with the results of Misselt (1996), while they are in average fainter by 0.07 mag compared with the B and V photoelectric estimates of Bailey & Howarth (1979), with an r.m.s. scatter of 0.08 mag around the offset. The I_C values are original results.

Table 2 gives the BVR_CI_C magnitudes of CN Ori. An important sample of our data has been obtained during the partial eclipse of the binary system, considering the orbital ephemeris reported by Barrera & Vogt (1989). Neglecting eclipse points, our data confirm

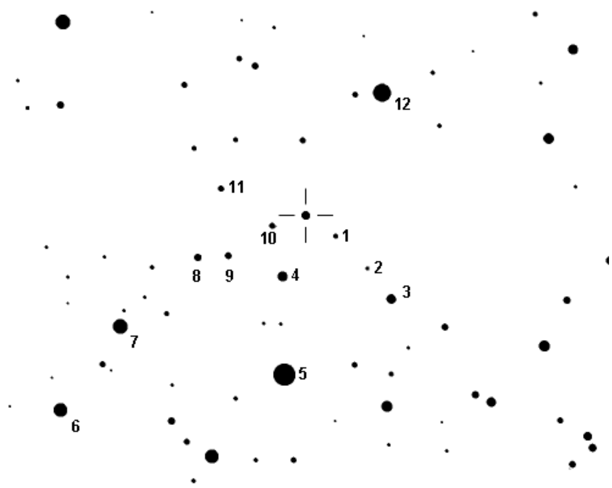

Figure 1. Finding chart of CN Ori, with the selected sequence.

the very short recurrence time between two consecutive outbursts (Fourier periodogram gives $P \simeq 18.76$ days), with a symmetric shape of the outburst profile characterized by a relatively fast rise and decline. Many variability patterns are superimposed on the outburst cycle, but our data–sampling is not applicable for an accurate investigation. Fig. 2 shows that the outburst amplitude changes at different filters. Fig. 3 shows the color-index versus magnitude diagram for CN Ori.

Table 1: BVR_CI_C magnitudes for the selected comparison stars

name(s)	RA	DEC	B	V	R_C	I_C
C1, M1$^{(1)}$, L$^{(2)}$	5:52:04.0	-5:25:40	15.95±0.06	14.65±0.05	13.88±0.03	13.15±0.03
C2, M$^{(2)}$	5:52:00.0	-5:26:42	16.08±0.07	15.10±0.04	14.52±0.04	14.01±0.05
C3	5:51:57.0	-5:27:40	14.19±0.08	12.94±0.04	12.26±0.02	11.58±0.03
C4, M3$^{(1)}$	5:52:10.7	-5:26:56	12.93±0.03	12.48±0.03	12.19±0.03	11.97±0.03
C5	5:52:10.5	-5:30:03	10.32±0.05	9.81±0.03	9.50±0.05	9.24±0.03
C6, C$^{(2)}$	5:52:38.8	-5:31:09	13.15±0.10	11.93±0.03	11.12±0.04	10.34±0.03
C7, B$^{(2)}$	5:52:31.3	-5:28:32	11.78±0.07	11.34±0.04	10.98±0.03	10.76±0.04
C8, G$^{(2)}$	5:52:21.4	-5:26:20	14.90±0.05	13.68±0.04	12.92±0.02	12.19±0.03
C9, M5$^{(1)}$, H$^{(2)}$	5:52:17.6	-5:26:18	15.36±0.05	13.93±0.03	13.14±0.03	12.38±0.03
C10, M4$^{(1)}$, K$^{(2)}$	5:52:12.1	-5:25:21	15.45±0.05	14.21±0.04	13.48±0.03	12.74±0.03
C11	5:52:18.5	-5:24:10	14.88±0.09	13.92±0.04	13.33±0.04	12.85±0.04
C12, A$^{(2)}$	5:51:58.1	-5:21:08	11.76±0.03	10.61±0.02	9.94±0.03	9.29±0.03

(1) Misselt (1986)
(2) Bailey & Howarth (1979)

During the rise to the outburst, and the subsequent decline, the emission is progressively dominated by the accretion disk and the color index follows the typical path well represented by a line. During quiescence the emission is generally dominated by the secondary, but our data show a large variation in the color–magnitude diagram, with a change in slope and curvature, and the color index is far from the expected color of an M4-5 star (Ritter & Kolb 1998). So we can conclude that the accretion disk remains relatively bright during the quiescence of CN Ori, and the large color variations are increased by the partial eclipse of the binary system.

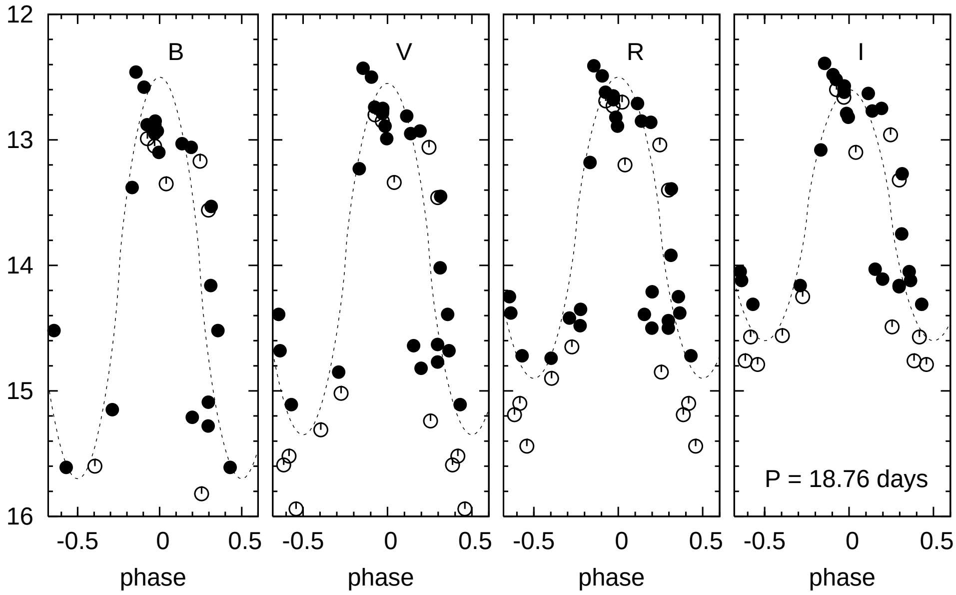

Figure 2. The phase diagram of CN Ori shows a relatively stable outburst-cycle, with a quasi-sinusoidal trend (dashed line), and the outburst amplitude that changes at different wavelengths. Empty circles represent the data obtained during the partial eclipse of the binary system.

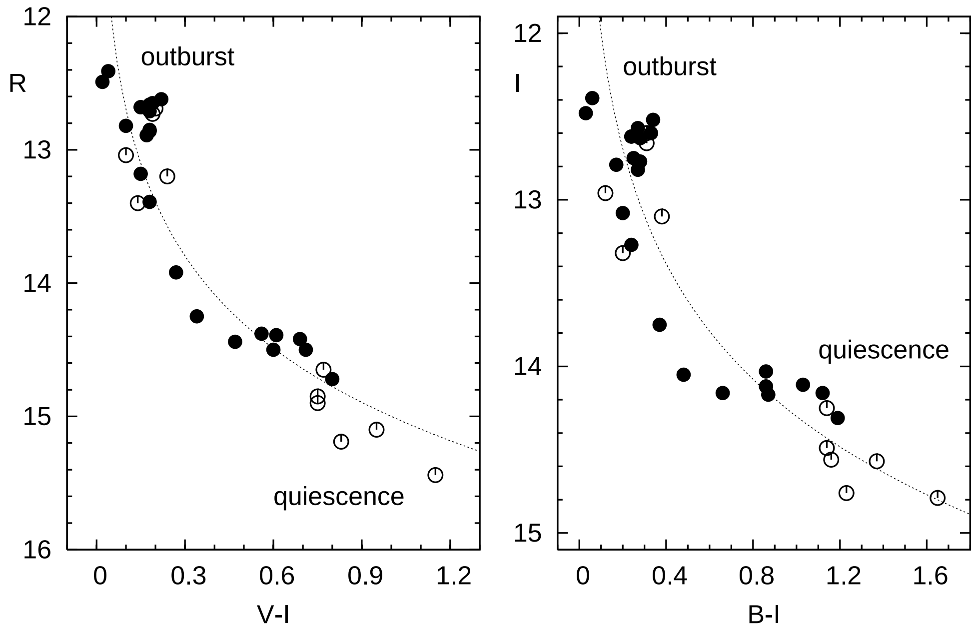

Figure 3. During the outburst the emission is dominated by the accretion disk and the color index is bluer; the emission of the secondary is progressively more important during quiescence and the color index is redder, with a complex behaviour like a curvature (dotted line).

Table 2: BVR_CI_C data of CN Ori

UT DATE	JD (245+)	B	V	R_C	I_C
11/02/2002	2317.327	12.78±0.06	12.77±0.05	12.68±0.04	12.62±0.04
22/02/2002	2328.339	15.60±0.07	15.31±0.05	14.90±0.05	14.56±0.05
24/02/2002	2330.332	15.15±0.07	14.85±0.05	14.42±0.05	14.16±0.04
04/03/2002	2338.326	13.03±0.07	12.95±0.05	12.85±0.04	12.77±0.04
10/03/2002	2344.361		15.94±0.08	15.44±0.05	14.79±0.05
19/12/2002	2628.458			14.74±0.04	
10/01/2003	2650.443			14.48±0.05	
10/01/2003	2650.485			14.35±0.04	
18/01/2003	2658.434			14.21±0.05	
12/03/2003	2711.385			12.70±0.03	
05/12/2003	2979.499	13.53±0.06	13.45±0.04	13.39±0.04	13.27±0.04
20/12/2003	2994.488		12.81±0.05	12.71±0.05	12.63±0.05
26/12/2003	3000.428	15.61±0.08	15.11±0.03	14.72±0.04	14.31±0.03
23/01/2004	3028.444	12.88±0.07	12.74±0.04	12.62±0.04	12.52±0.03
23/01/2004	3028.478	12.99±0.07	12.80±0.05	12.69±0.04	12.60±0.04
24/01/2004	3029.298	13.05±0.06	12.85±0.04	12.73±0.04	12.66±0.04
24/01/2004	3029.317	12.95±0.06	12.79±0.04	12.65±0.04	12.60±0.04
24/01/2004	3029.335	12.88±0.06	12.77±0.04	12.68±0.04	12.62±0.04
24/01/2004	3029.358	12.85±0.06	12.75±0.04	12.66±0.04	12.57±0.04
30/01/2004	3035.431	15.28±0.08	14.77±0.05	14.50±0.04	14.17±0.04
30/01/2004	3035.442	15.09±0.06	14.63±0.04	14.44±0.04	14.16±0.03
12/02/2004	3048.362	12.93±0.06	12.89±0.04	12.82±0.04	12.79±0.03
13/02/2004	3049.384	13.35±0.04	13.34±0.03	13.20±0.04	13.10±0.03
16/02/2004	3052.365	15.21±0.07	14.82±0.05	14.50±0.05	14.11±0.04
17/02/2004	3053.426	15.82±0.08	15.24±0.05	14.85±0.05	14.49±0.05
02/03/2004	3067.313	13.10±0.06	12.99±0.04	12.89±0.03	12.82±0.03
05/03/2004	3070.298		14.64±0.05	14.39±0.04	14.03±0.05
27/11/2005	3702.525	12.46±0.06	12.43±0.04	12.41±0.04	12.39±0.04
28/11/2005	3703.457	12.58±0.05	12.50±0.05	12.49±0.05	12.48±0.04
07/12/2005	3712.458		15.59±0.07	15.19±0.05	14.76±0.05
10/01/2006	3746.375	13.06±0.06	12.93±0.05	12.86±0.05	12.75±0.05
11/01/2006	3747.376	13.17±0.06	13.06±0.05	13.04±0.05	12.96±0.05
12/01/2006	3748.332	13.56±0.06	13.46±0.05	13.40±0.05	13.32±0.05
13/01/2006	3749.429	14.52±0.06	14.39±0.06	14.25±0.05	14.05±0.05
20/01/2006	3756.357		15.02±0.05	14.65±0.05	14.25±0.05
22/01/2006	3758.374	13.38±0.07	13.23±0.05	13.18±0.05	13.08±0.05
31/01/2006	3767.361	14.16±0.07	14.02±0.05	13.92±0.05	13.75±0.05
01/02/2006	3768.343		14.68±0.06	14.38±0.05	14.12±0.05
02/02/2006	3769.388		15.52±0.06	15.10±0.06	14.57±0.05

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