The $\eta$ Carinæ 2009.0 “event”: a detailed optical photometric record


Abstract

During the last “event” occurred in 2009.0, $\eta$ Carinæ was the target of several observing programs. In our optical photometric monitoring campaign, we recorded with detail the behavior of the associated “eclipse-like” event, which happened fairly on schedule. In this work we present the resulting UBVRI and Hα light curves, and a new determination of the present period length.

Observations

The 2009.0 event was monitored from two observatories in Argentina: La Plata Observatory (OALP), Buenos Aires, and Complejo Astronómico El Leoncito (CASLEO), San Juan. Observations started in early November 2008, after the annual visibility gap. Our observing program involved the daily acquisition of CCD images. Typically, three or four series of 15 or 20 images each, spanned no longer than 30 minutes each, were obtained for each filter every night.

Image acquisition from OALP: Observations were performed from December 14 to 16 (JDN 2454762) up to late July 2009. (JDN 2455007). "Virgo Splendens" (VSN) telescope and a Photometrics-STAR I CCD camera. A standard Johnson-Cousins BVRI filter set was used all the time, and a narrow passband (peak at 656.3 nm, 4.5 nm wide) Hα filter was incorporated to the monitoring on December 26, 2008 (JDN 2454827).

Data reduction: The data reduction process was exactly the same as the previous events, except that every 0.5 days of observation, the program of B and V reference stars were observed to perform the photometric data of the OALP. Comparis-son and check stars are identified:

- 3- CPD-59 2627
- 4- CPD-59 2627
- J1-49 659
- J2-49 659
- J3-49 659
- J4-49 659
- J5-49 659

Results

The resulting UBVRI and Hα light curves of the 2009.0 “eclipse-like” event are depicted in Figure 1. The UBVRI epochs were extracted from the OALP observations provided by Feinstein (1982). No zeropoint was applied to the Hα data. All the light curves are folded using cubic splines. They are featured by an ascending branch starting at about JDN 2454816 and lasting almost 30 days, when a maximum is reached. This maximum peaks at different dates depending on the photometric band and is followed by a steep fading towards the minimum. In the R band the lack of the first ascending branch produces no maximum, with the exception of a sharp peak centered at JDN 2454834. Although the U light curve is not complete, the general behaviour is evident. Unfortunately, the Hα line photometry was not recorded during the event before JDN 2454827 when the maximum apparently occurred. After the minimum, a second ascending branch develops until almost the same brightness level at maximum is recovered. The Hα light curve shows a less pronounced rising tilt. Figure 2 depicts the complete light curves through “cycle 11”, including 2003.5 and 2009.0 events. The present status of the visual band in a historical context, is shown in Figure 3.

Period fitting

A new estimation of the period length was made using our BVRI photometric data of the 2003.5 and 2009.0 events, and the “phase dispersion minimization” method (Stellingwerf, 1978). We obtained that the most significant period values are close to all photometric bands, span between 2021.9 and 2023.5 days. From a final visual inspection, we adopt for the period length of “cycle 11”:

$$P = 2022.8 \pm 0.5 \text{ days}$$

If we consider the date of $\phi = 0$ given by Daminiel et al. (2008), the orbital phase can be calculated using the following ephemeris:

$$J D(\phi = 0) = 2452819.8 + 2022.8 \times E$$

Remarks

The 2009.0 event optical photometric behaviour happened very close to the dates announced by Fernández Lajús et al. 2009. In the optical range the event exhibited once again an “eclipse-like” light curve. It was evident in all the UBVRI bands and also in the narrow Hα band. In spite of the overall similar behavior, the time of occurrence of some features and other photometric details (for instance the depth of the dips) differ in each band, especially in R and Hα.

All these features resemble the behaviour registered during the 2003.5 event. The main difference is that the 2009.0 minimum is about 0.02-0.03 mag deeper than the previous one, and the recovering branch is also steeper.

The starting of the minimum registered in the V band takes place 15 days after the phase of minimum excitation (Daminiel et al., 2009) and 11 days after the starting of the minimum in X-rays (Corcoran, 2009). This is in good agreement with what happened in the 2003.5 event.

The new estimation of the current period length is in complete agreement with the average value derived by Daminiel et al. (2008) from different spectral features and photometric bands.

The periodic recurrence of the observed events is verified by the fact that this 2009.0 event occurred at the time predicted some time ago. This periodicity and the “eclipse-like” feature displayed in the optical light curves strongly support the proposal of the binarity of $\eta$ Carinæ.

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References

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- Feinstein, A., 1967, Observatory, 87, 287

Daily updated light curves are available at
http://etacar.fcaglp.unlp.edu.ar/