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

Number 5866

Konkoly Observatory
Budapest
5 December 2008

HU ISSN 0374 – 0676

THE 2008/2009 ECLIPSE OF EE CEP WILL SOON BEGIN

GALAN, C.[1]; MIKOLAJEWSKI, M.[1]; TOMOV, T.[1]; CIKALA, M.[1,2]

[1] Uniwersytet Mikolaja Kopernika, Centrum Astronomii, ul. Gagarina 11, Pl-87-100 Toruń, Poland; e-mail: cgalan@astri.uni.torun.pl (CG); mamiko@astri.uni.torun.pl (MM); tomtom@astri.uni.torun.pl (TT)

[2] Obserwatorium Astronomiczne im. T. Banachiewicza, Węglówka, PL-32-412 Wiśniowa, Poland; e-mail: cikala@astri.uni.torun.pl (MC)

EE Cep is a very long period (5.6 yr) eclipsing binary star, as bright as about 11 magnitude in the B and V passbands. The nature of the system still remains unclear. During different eclipses very large changes of the duration and the depth of particular minima are observed (Fig. 1). This variability indicates that the secondary is probably a complex object. The most attractive explanation of these observational facts seems to be the hypothesis that the secondary consists of a dark, opaque, relatively thick disc around a low luminosity central object: a low-mass single star or a close binary (Mikolajewski & Graczyk 1999, Graczyk et al. 2003).

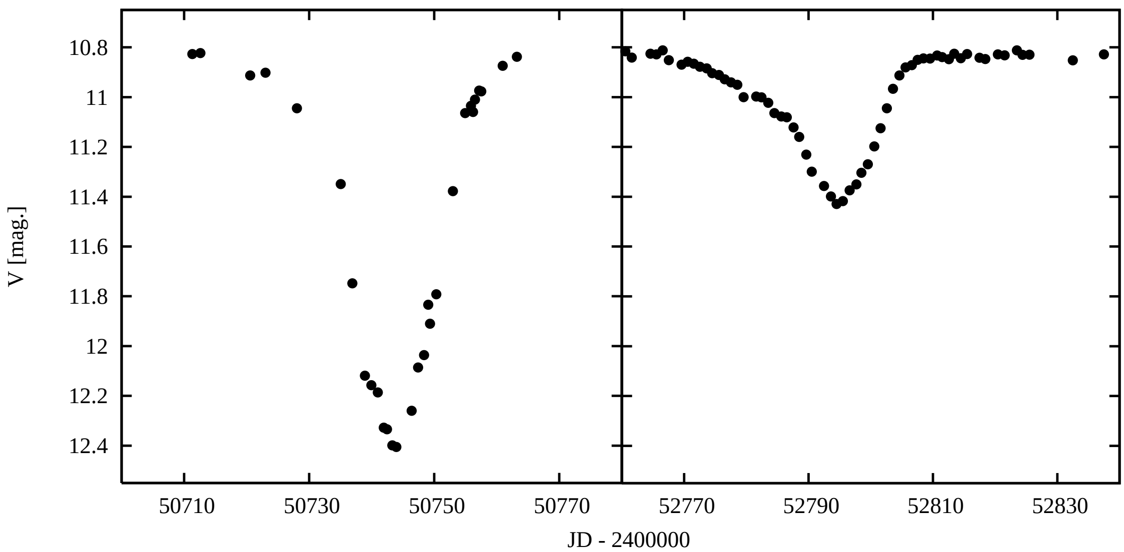

Figure 1. Light curves in V passband of two last minima: left - 1997 eclipse (Mikolajewski & Graczyk 1999, + Cook's CCD data (Halbach 1999)), right - 2003 eclipse (Mikolajewski et al., 2005a).

Differences in the shape of the particular eclipses could be explained by precession, which changes both the inclination of the disc to the line of sight, and the tilt of its cross-section to the direction of motion. The majority of the eclipses have an asymmetrical shape, in which it is possible to distinguish five repeatable phases: atmospheric and real ingress, sloped-bottom transit and real and atmospheric egress. The unique eclipse with flat bottom observed in 1969 can be explained by a nearly edge-on and non-tilted projection of the disc.

Over five years have passed, since the last eclipse in the EE Cep system took place. The observational campaign, which has been organized during the last eclipse (Mikolajewski et al. 2003), brought the best multicolour photometric and spectroscopic data so far, in respect of the time coverage as well as the quality. Ten instruments from four countries took part in photometric measurements and seven instruments from six countries in spectroscopic observations. Results of that campaign was described by Mikolajewski et al., (2005ab) in two papers signed by forty four coauthors representing fifteen institutions.

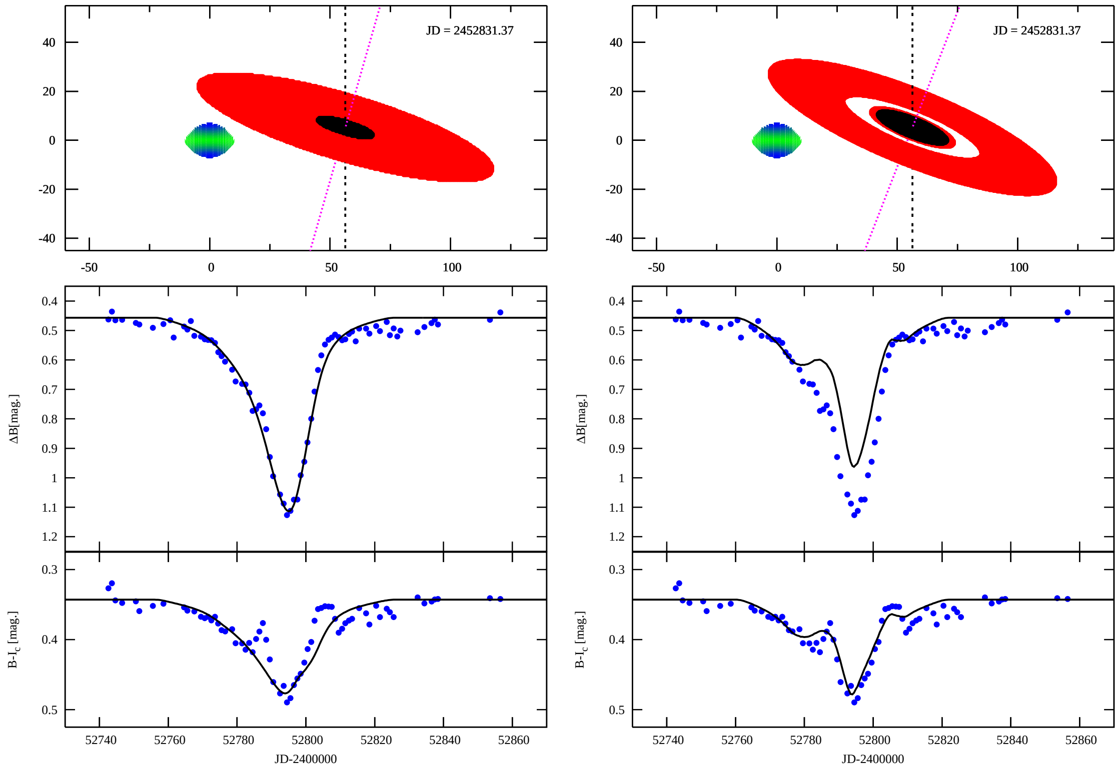

Figure 2. Two models of the eclipse of the fast rotating Be star in EE Cep by a solid disc (left) and by a disc with a gap (right). A flat and circular disc with r^{-2} density distribution has been assumed. *Top*: projection of the system in the sky plane. Polar (hot) and equatorial (cool) areas of the star are shown by dark (blue) and light (green) shades respectively. Inner (opaque) and exterior (semitransparent) areas of the disc are shown by dark and light shades (black and red colours) respectively. *Middle*: B light curve (points) from Mikolajewski et al. (2005a) with corresponding synthetic curves (lines). *Bottom*: $B - I_C$ colour index from the last 2003 eclipse (points) together with synthetic fits (lines).

The next eclipse is approaching and we hope to gather participants for the new observational campaign. The mid-eclipse moment should take place on about 14 January 2009 ($JD_{mid-eclipse} = 2454846$). The longest eclipse observed in 1969, lasted for about 60 days, so the photometric campaign should begin at least 5 weeks before (7 Dec 2008) and finish

5 weeks after (22 Feb 2009) the mid-eclipse. The most important should be the period between 2 and 27 Jan 2009 because of an interesting colour evolution noticed in 2003. The colour indices from the last eclipse show two blue maxima about 9 days before and after the mid-eclipse moment. These maxima can be understood if *(i)* the eclipsed B star is rotationally darkened at the equator and brightened at the poles and *(ii)* the eclipsing disc is divided into two parts by a transparent gap (Fig. 2). Indeed, the spectroscopic observations during the last campaign showed that the eclipsed component is a rapidly rotating Be star (Mikolajewski et al., 2005b). The best fit to its Balmer absorptions (Fig. 3) gives $v \sin i \approx 350$ km/s. This velocity leads to a difference about 5-6 $\cdot\ 10^3 K$ between the polar and equatorial temperatures. The motion of the gapped disc on the background of this star could explain both blue maxima (at $JD = 2452788, 2452805$), when the star's pole is visible in the gap. A solid disc can give quite a good fit to the light curve but does not explain the colour changes (Fig. 2 – left). A disc with a circular gap gives a quite good fit to the colours, but a poor fit to the light curve (Fig. 2 – right). Most probably it is caused by different opacities in different parts of the disc.

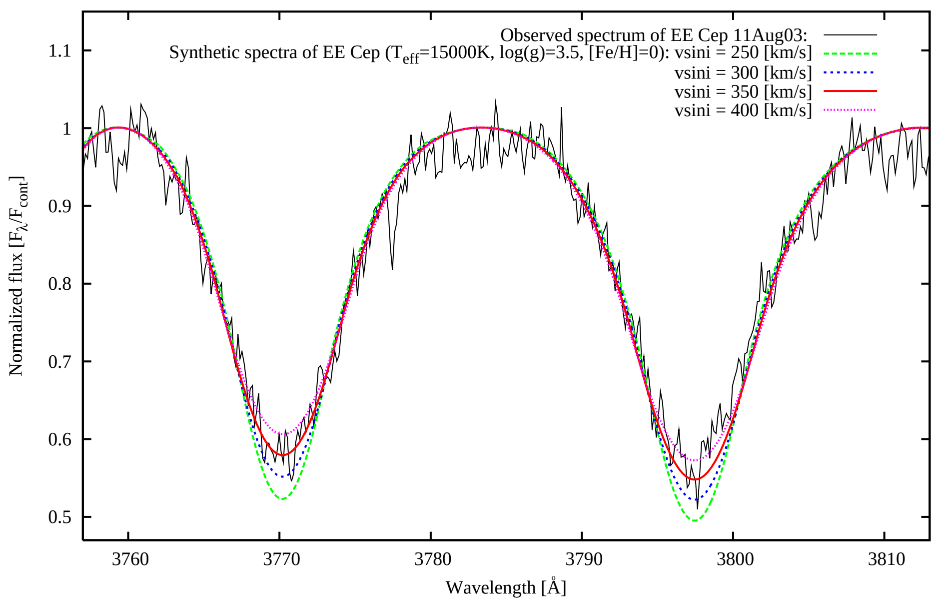

Figure 3. Synthetic and observed profiles of the H10, H11 lines.

During the 2008/2009 eclipse, we recommend photometric observations in the standard Johnson-Cousins $UBV(RI)_C$ systems. At least one measurement per night is needed, with accuracy near to about $0\overset{m}{.}01$. Some multicolour observations far from the eclipse should be made in order to calibrate systematic differences between observatories. We propose to use the same sequence of comparison stars as during the previous campaign, given by Mikolajewski et al. (2003), together with a finding chart.

Any infrared, photometric (at least JHK) and spectroscopic observations before, during and after the eclipse would be very useful. They could make it possible to detect the secondary companion of EE Cep (disc and/or central star/stars). During the last decade we observed variations in the I passband before and after the eclipses of about $0\overset{m}{.}2$ (Fig. 4), which indicate a significant contribution of a dark body in this band. The variations can be connected with changes of the spatial orientation of the disc. In the

JHK passbands, the cool component can dominate the observed fluxes.

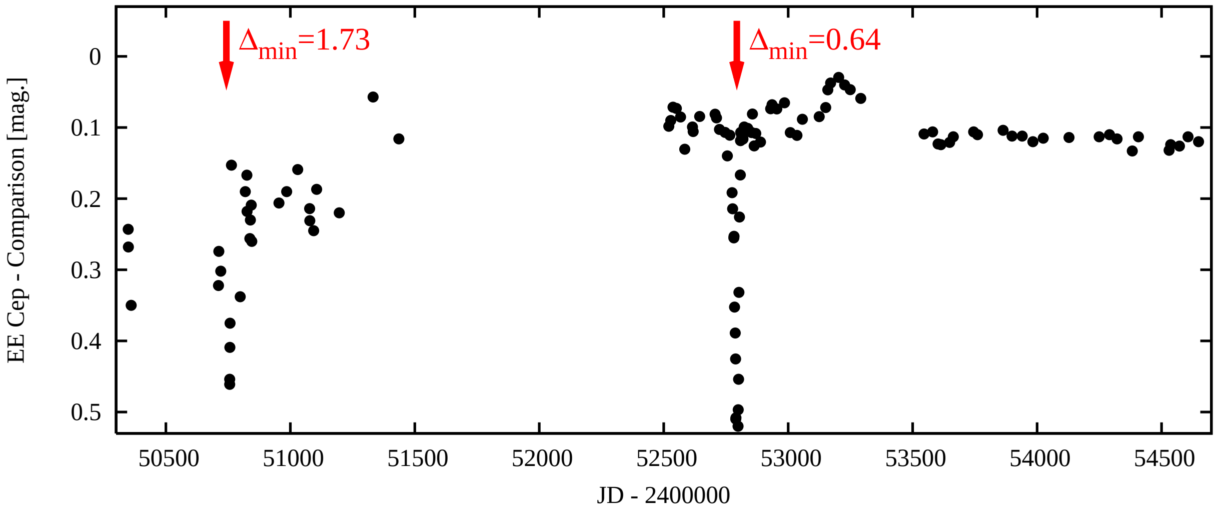

Figure 4. Differential I magnitudes of EE Cep observed in Toruń observatory during last eleven years. The depths of eclipses in 1997 and 2003 exceed the scale: both are denoted by arrows with numerical values of its amplitude. The three series of observations have been made with two photomultipliers and a CCD camera, respectively. Nevertheless, the evident non-eclipsing changes are clearly visible.

As was shown during the 2003 eclipse, the shell lines of circumstellar matter were visible about 3-2.5 months before and after the mid-eclipse, so it is advisable to begin spectroscopic observations immediately and to continue until April 2009. Of course, significant changes in the profiles of absorption and emission lines during the photometric eclipse (between 14 Dec 2008 and 14 Feb 2009) can be expected from night to night. Low and high resolution spectra and spectral distributions would be very useful.

We invite all interested observers to participate in the current campaign. Please contact us: *cgalan@astri.uni.torun.pl* or *mamiko@astri.uni.torun.pl*.

Acknowledgements: This work was supported by MNiSW grant No. N203 018 32/2338 and UMK grant No. 412-A. We are very grateful to Dr B. Roukema for his language corrections.

References:

Graczyk, D., Mikolajewski, M., Tomov, T., et al. 2003, *A&A*, **403**, 1089,
Halbach, E.A., 1999, *JAAVSO*, **27**, 35,
Mikolajewski, M. & Graczyk, D., 1999, *MNRAS*, **303**, 521,
Mikolajewski, M., Tomov, T., Graczyk, D., et al. 2003, *IBVS*, No. 5412,
Mikolajewski, M., Galan, C., Gazeas, K., et al., 2005a, *Ap&SS*, **296**, 445, (`http://www.springerlink.com/content/v6t4630310j26300/fulltext.pdf`)
Mikolajewski, M., Tomov, T., Hajduk, M., et al., 2005b, *Ap&SS*, **296**, 451, (`http://www.springerlink.com/content/w28t429p3446p615/fulltext.pdf`)