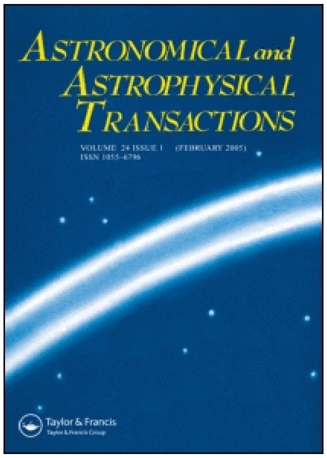

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BM Cas – a long-period eclipsing young supergiant binary system in common envelope stage

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We report main results of the analysis of *UBVR* light curves of the long-period eclipsing binary BM Cas obtained between 1967 and 1996 in Tallinn observatory. The orbital period variations, evolutionary stage, peculiarities of the light curves and colour variations are discussed.

Keywords: Stars; Binaries; Eclipsing-stars; Individual (BM Cas)

1. Introduction

A long-period eclipsing binary BM Cas with a primary A5–A7Ia,b supergiant and invisible secondary component was an observational target for photometric study at Tallinn Observatory, where a number of seasonal light curves of this peculiar system in *UBVR* colours were obtained between 1967 and 1996. A complete light curve (see figure 1) was calculated according to

$$C = 2449051.17 + 197.275 \times E - 2.847 \cdot 10^{-5} \times E^2$$

Analysis of the O–C diagram based on these observations and a brief discussion of the observed properties of BM Cas as well as of its probable evolutionary history were published two years ago in our earlier paper [1]. Results of a detailed spectroscopic investigation and of some photometric data of BM Cas by Fernie and Evans [2] generally agree with our earlier conclusions about the probable range of physical parameters of the binary.

Here, we summarize the main results of a semi-quantitative analysis of our seasonal light curves (some examples are demonstrated in figures 1–6). Because of a pronounced intrinsic variability and asymmetry of the light curves as well as of anomalous radial velocity curves available only for the primary component up to now, nobody proposed a self-consistent quantitative model of BM Cas nor determined any reliable physical parameters of the components

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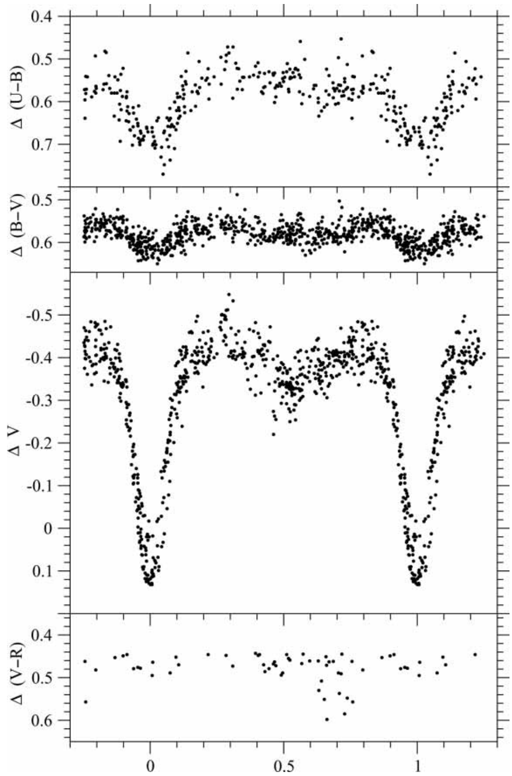

Figure 1. Light and colour curves of eclipsing binary system BM Cas. The mean-square-root error of a single measurement has been determined from the measurements of comparison, and check stars are $\sigma V = \pm 0.009$ mag and $\sigma(B-V) = \pm 0.01$ mag.

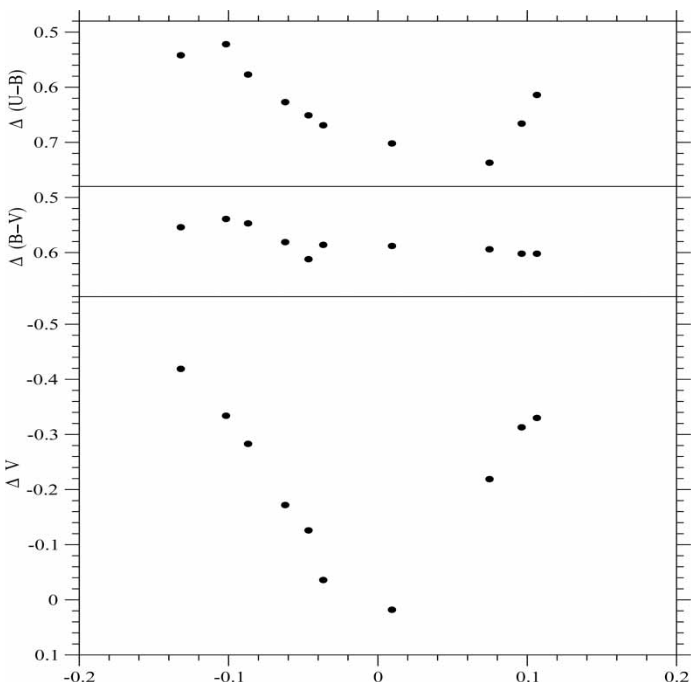

Figure 2. Light and colour curves of eclipsing binary BM Cas. E $= -19$(JD $= 2445303 \pm 40d$).

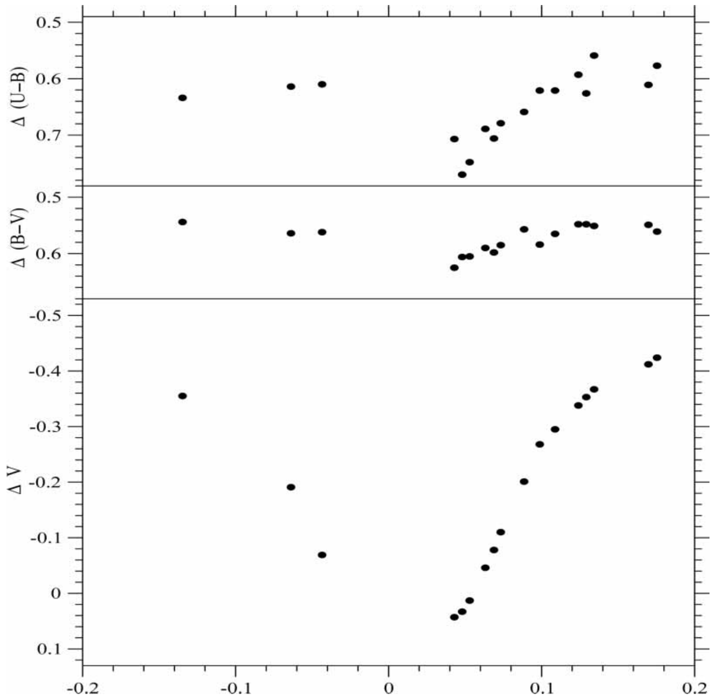

Figure 3. Light and colour curves of eclipsing binary BM Cas. $\mathrm{E} = -11(\mathrm{JD} = 2446884 \pm 40d)$.

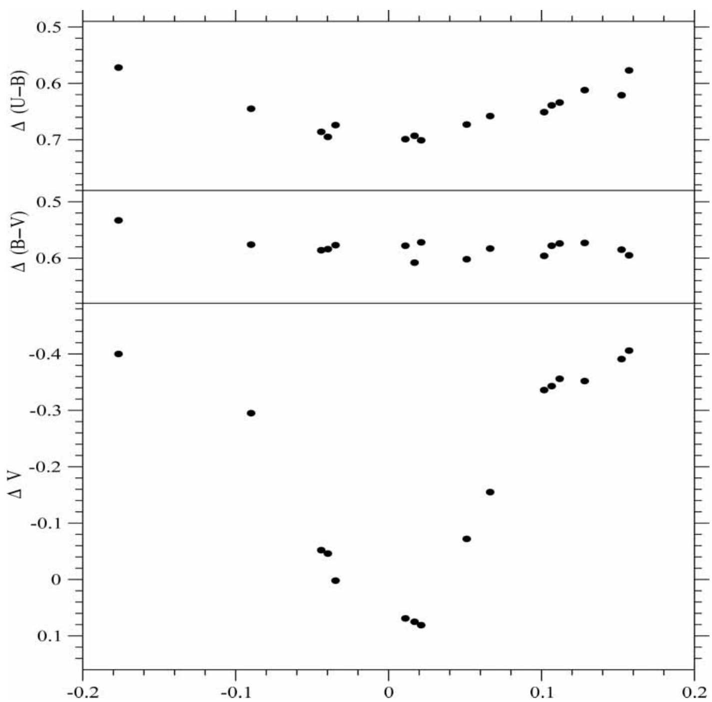

Figure 4. Light and colour curves of eclipsing binary BM Cas. $\mathrm{E} = -10(\mathrm{JD} = 2447079 \pm 40d)$.

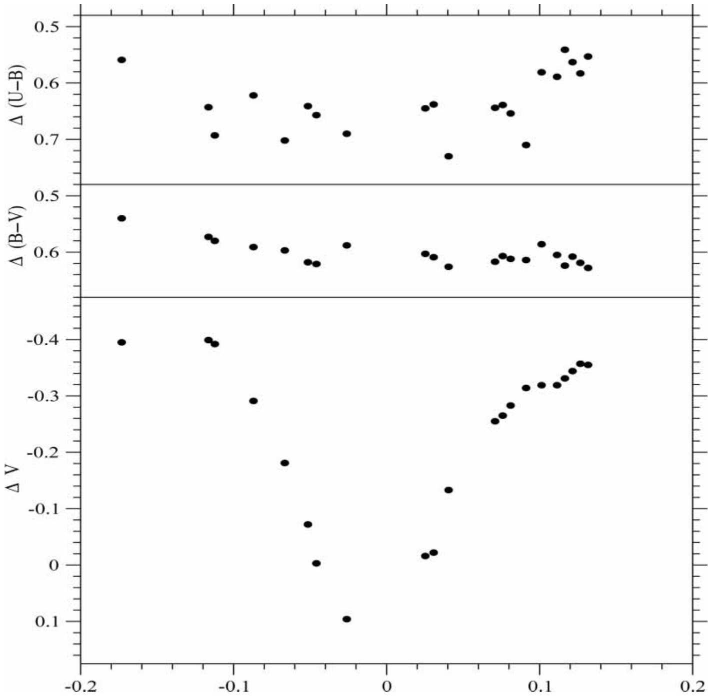

Figure 5. Light and colour curves of eclipsing binary BM Cas. E $= -9$(JD $= 2447274 \pm 40d$).

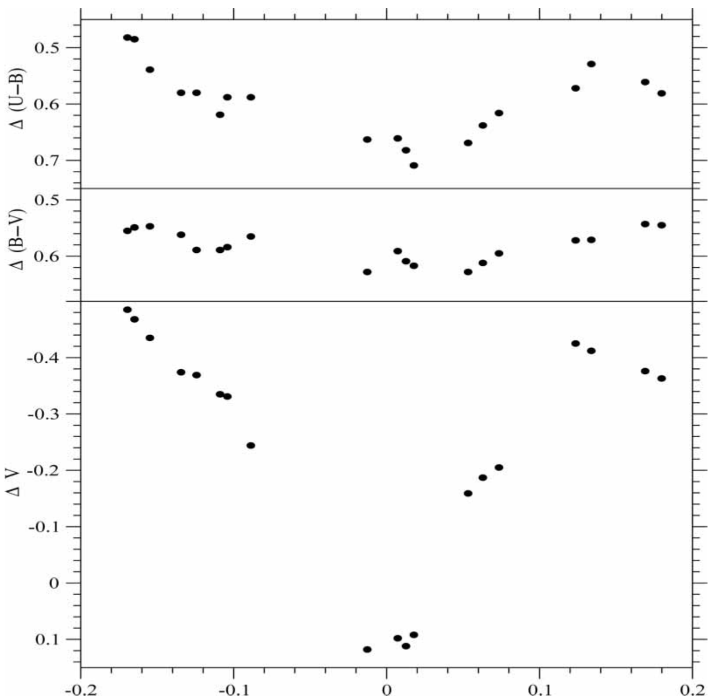

Figure 6. Light and colour curves of eclipsing binary BM Cas. E $= -8$(JD $= 2447472 \pm 40d$).

and the binary orbit. An earlier detailed model assuming the extended scattering envelope elaborated by Barwig [3] contradicts the recent IUE data in UV, which do not confirm the presence of an extended circumbinary envelope claimed by Barwig (figure 7).

2. Peculiarities of the observed *UBVR* light curves

Individual *UBVR* light curves manifest the following peculiarities:

2.1 *Temporal variations of the depths of both minima*

There are significant differences between individual light curves in the depths of both minima and to a smaller extent in their duration. The average values of light in units of the total luminosity normalized to the local maximum at the bottom of the primary minimum range between 0.56 and 0.61 for the primary and between 0.86 and 0.89 for the secondary minimum in all four colours, the average semi–widths of the primary minimum range between 0.14 P and 0.17 P. In some cases the primary minimum is even more shallow–the brightness at the bottom of the primary minimum 0.667 in B colour and 0.70 in V was obtained from one partial light curve obtained in 1974.

2.2 *Sporadic displacements of the moment of the primary minimum*

Sporadic displacements of the moment of the primary minimum from the predicted ephemeris amounting up to 0.02 P have been detected. At the same time no significant systematic period variations have been detected up to now. As for the secondary minimum, it is virtually impossible to give even the approximate numerical estimates because of a conspicuous asymmetry and scattering of observed points.

2.3 *The absence of contribution to the total light from the secondary component*

Spectroscopic data do not show the evidence for the presence of the spectrum of a companion, both in the visible and UV (see ref. [2] for a more detailed discussion). Our multi-colour photometric data supports this conclusion.

As will be shown below one can with a satisfactory accuracy reproduce the observed light variations assuming that the primary A5 supergiant is very close to its critical Roche lobe. We indicate that they are caused by a combined effect of the transient eclipse by a dark smaller body of an invisible secondary component and the ellipticity (tidal distortion) of the primary. The secondary minimum is caused solely by the ellipticity of the primary. Within the uncertainties imposed by intrinsic variability the depths of both minima and their widths are roughly the same in all four colours.

3. Description of the model

Because of the pronounced asymmetry of the light curves and the aperiodic intrinsic variability observed in BM Cas, up to now attempts to solve the light curves of this binary amount at best to semi–quantitative estimates of the physical and orbital parameters of this binary (see details in refs. [2, 4, 5]). In view of these complications we restrained from interpreting the average light curve and used instead, as much as possible, light curves obtained during one observational season covering satisfactorily at least one minimum of BM Cas. We applied commercially available Binary Maker program to model light curves and assumed the presence of a relatively small sized hot region (hot spot) upon the surface of the A5Iab supergiant companion located very close to the inner Lagrangian point L_1. The optical centre of the hot region is slightly displaced in respect to the line connecting gravity centres of the components. In this way, we attempted to estimate the influence of the hot source whose presence between the components was claimed by other investigators – first of all, Barwig [3] (emission region in Balmer lines), as well as Fernie and Evans [2]. In figure 8, we reproduce an example of such model light curve as superimposed upon the observed V light curve of BM Cas, obtained in 1968 during our series of multi-colour observations of BM Cas. This particular model light curve was obtained for the following set of physical and orbital parameters:

$$r_1 = 0.465, \quad r_2 = 0.33, \quad T_1 = 8200°\mathrm{K}, \quad T_2 = 3500°\mathrm{K}, \quad i = 72°, \quad L_3 = 0.04$$

Here r_1, r_2 are stellar radii in units of semi-major axis of relative orbit, both are for the direction opposite to the first Lagrangian point L_1 (thus, we assume that both components fill in their respective critical Roche lobes for mass ratio $q = 0.5$), parameters T_1, T_2 are effective temperatures of the components, i is inclination angle of orbit. $L_3 = L_{\mathrm{hotsp}}$ is the phase dependent luminosity of third light in BM Cas (hot region) in units of total luminosity of a binary normalized to its value at elongation (more details concerning an influence of L_3 upon the light curve are given below) . Normal limb darkening for both components was presumed, effect of gravitational darkening was ignored. Remaining parameters are characteristic parameters of

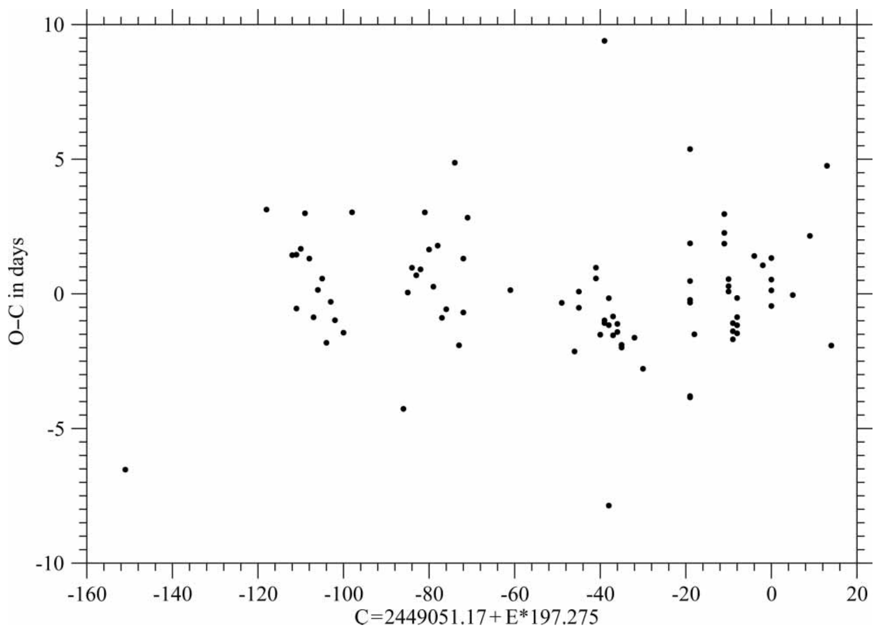

Figure 7. The *O–C* diagram for BM Cas. Despite the numerous new determinations of minimum epochs (see details in table I from paper Kalv *et al.*, 2005) no reliable traces of systematic changes of the orbital period $P_{\mathrm{orb}} = 197.275$ from *O–C* diagram were discovered up to now in view of pronounced intrinsic variability and light curve asymmetry.

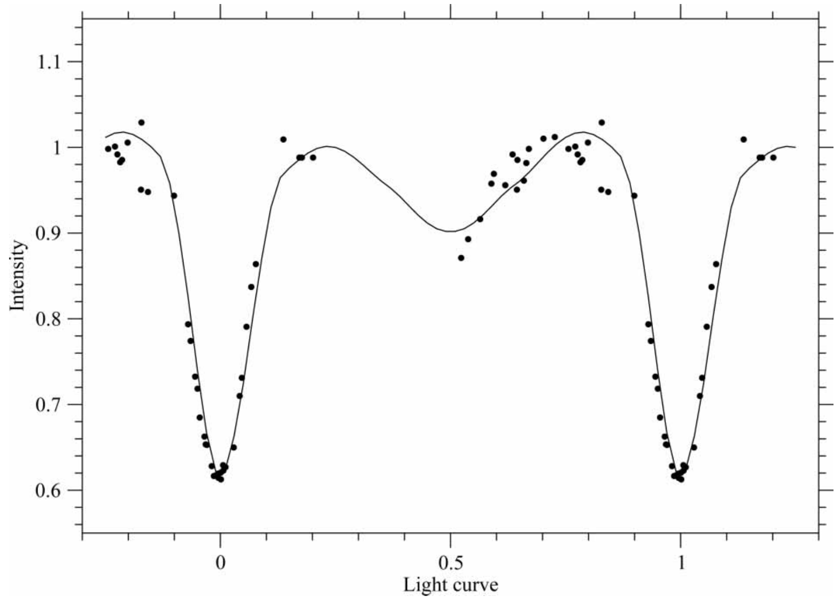

Figure 8. Seasonal V light curve in 1968 ($E = -46$, O–$C = 2^d.139$) with model light curve superimposed, $r_1 = 0.465$, $r_2 = 0.33$, $T_1 = 8200\,°K$, $T_2 = 3500\,°K$, $i = 72°$, $f(m) = 0.92$, $M_1 = 13.5M_\odot$, $M_2 = 6.5–7M_\odot$, $R1 = 65–70R_\odot$ and $R2 = 45–48R_\odot$. $\Delta T/T_{1sg} \sim 0.2–0.25$ ($T_{1sg} = 8200\,°K$), the angular radius of the hot region $R_{sp} = 12°–15°$, the central co-latitude $l = 88°$, the central longitude 350°.

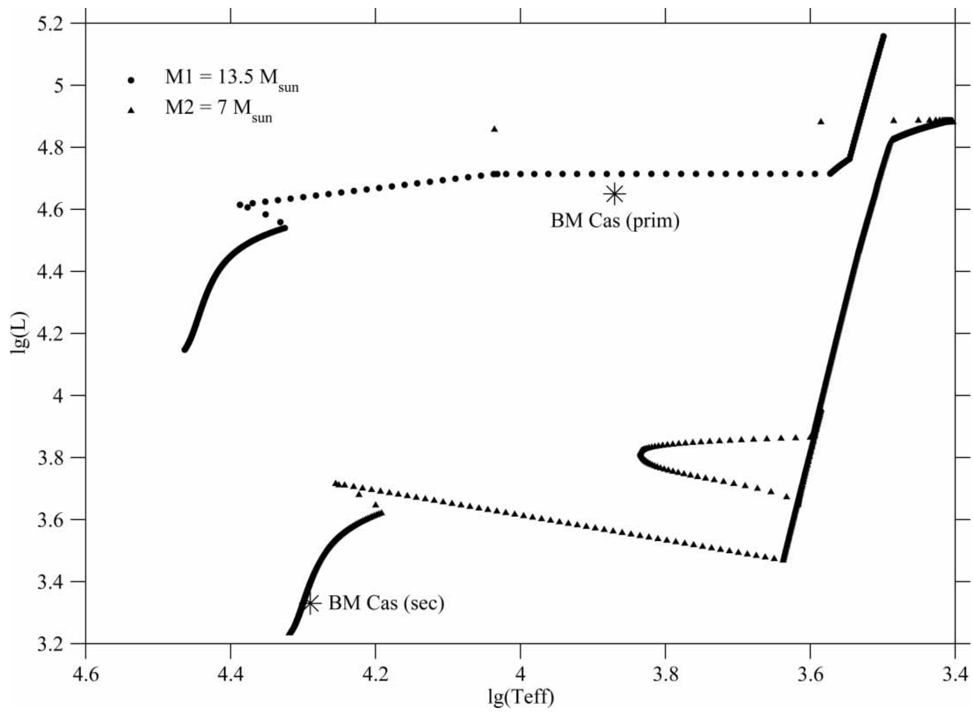

Figure 9. Evolutionary tracks for initial masses $M_1 = 13.5M_\odot$, $M_2 = 7.0M_\odot$ and solar metallicity $z = 0.02$, current positions of both BM Cas primary and secondary components are indicated, the age of BM Cas (counted from ZAMS) is 14.93 million years, the primary is in the core helium burning stage and the secondary is in MS stage.

the hot spot: its angular radius R_{sp}, the temperature contrast in respect to the ambient stellar photosphere temperature of a primary component $\Delta T_{\mathrm{sp}}/T_1$. Angular coordinates of the centre of the hot spot are: co–latitude l and longitude χ. Although the number of model parameters is large, the resulting light curves are insensitive to some of them. In particular, angular coordinates of the hot spot influence only displaced position of the maximum of the light curve (from the moment of elongation). Inclination angle is easily fixed because it defines the depths of the minima. The temperature of the secondary component is certainly below $T = 4000\,^{\circ}\mathrm{K}$ because no traces of it can be found in spectra and the colours of the binary. Mass ratio cannot be very different from $q = 0.5$–0.6. Otherwise it is difficult to achieve an accord with the observed duration of both minima and also for evolutionary considerations (see a brief discussion below). The parameters of the hot spot for the same model light curve shown in figure 8 are as follows:

the temperature contrast ($T_{1sg} = 8200\,^{\circ}\mathrm{K}$) .... $\Delta T/T_{1sg} \sim 0.2 - 0.25$,

the angular radius of the hot region .... $R_{\mathrm{sp}} = 12^{\circ}$–$15^{\circ}$,

the central co–latitude .... $l = 88^{\circ}$,

the central longitude .... 350°,

4. Discussion of probable physical and orbital parameters of BM Cas

The main conclusions from the comparison between the observed light curves and the model curves are:

(a) The primary component A5–A7Iab supergiant dictates the shape of the light curve. Light changes in the secondary minimum are definitely caused only by the gravitational distortion of the primary component. In the primary minimum, light changes are caused by transit eclipse of supergiant by an invisible companion and tidal distortion of the supergiant. Some additional input is from the hot region, whose best visibility should be at phase angle $\phi = 0.78$–$0.79\,\mathrm{P}$ (according to Barwig [3], this is the phase of maximum H_{α}, H_{β} and other Balmer line series emission lines visibility). This region most probably is responsible for the observed asymmetry of the light curves as well. The best fit of the observed and model light curves both in the amplitude and the overall trend of the asymmetry was found for the central co-latitude $l = 88^{\circ}$ and the central longitude of the circular hot spot 350°. Light curves are normalized as usually to the total light $L = L_1(\phi = 0.25\,\mathrm{P}) + L_2(\phi = 0.25\,\mathrm{P}) + L_{\mathrm{hotsp}}(\phi = 0.25\,\mathrm{P})$ at the elongation. Since the optical centre of the hot spot is slightly displaced in respect to the line of centres BM Cas is slightly brighter at phase $\phi = 0.78$-$0.79\,\mathrm{P}$ both in comparison with elongation ($\phi = 0.75\,\mathrm{P}$) and neighbouring maximum (orbital phases $\phi = 0.25$–$0.30\,\mathrm{P}$) as can be seen from figure 8. Due to the same effect, the ascending branch of the light curve in primary minimum is slightly steeper than the descending branch. In the lack of the mutual eclipses the best visibility of the hot spot region would have been close to the orbital phase angle $\phi = 0.0$.

(b) Both components practically fill in their Roche lobes. The same result was obtained earlier [2]. In all colours, *UBVR*, we find the contribution from the secondary to be negligible, less than 1% of the total luminosity.

5. Colour variations with phase

As we see from the figures 1–6, BM Cas looks considerably more blue in maxima in comparison with primary minimum. For maxima (spectral type A5–A7Iab) normal colour indices $(B–V)$, $(U–B)$ should be respectively 0.13, 0.02 (Straizys [6]). Colour excess $\Delta(B–V) = 0.93 - 1.0$ for distance $d = 2.5$ kpc according to Fernie and Evans [2] is neglected below, when making crude estimates of colour variations with orbital phase because we are not interested in absolute values of colour indice, here. For a late type supergiant K5–K7I ($T_2 = 3500\,°$K) the values of expected normal colour index should be $(B–V) = 1.7$ and the same for $(U–B)$ (see ref. [6]).

In primary minimum, the central part of the visible disc of supergiant and the hot spot region are eclipsed by the cool companion with the relative radius r_2 and temperature $T_2 = 3500$–$4000\,°$K. In addition at the bottom of the primary minimum due to the limb darkening the uncovered portion of A5–A7 supergiant is visible by the observer with the temperature being lower than that close to the optical centre of the primary component. Due to combination of both factors, the colour of BM Cas at the bottom of the primary minimum should be more red than in maximum. We can make a crude estimate of the respective colour change by comparing colour indices for light maximum (elongation phase $\phi = \pi/2$) and at the bottom of the primary minimum. Thus, neglecting gravitational darkening and reflection effect, the following simple self-explanatory relations for normal colour indices $(B–V)$ and $(U–B)$ should be valid for elongation phase (A5–A7Iab supergiant in full light, $\phi = 90°$) and at the bottom of the primary minimum during the maximum phase of transient eclipse $\phi = 0°$.

$$B–V = 2.5\ \log\left[\frac{F_{\rm v}T_{\rm ef1}}{F_{\rm b}T_{\rm ef1}}\right], \tag{1}$$

where $T_{\rm ef1} = 8200\,°$K, for elongation phase $\phi = \pi/2$, and

$$B–V = 2.5\log\frac{(F_{\rm v}(T_{\rm ef1d})[1 - r_2^2/r_1^2] + F_{\rm v}(T_{\rm ef2})[r_2^2/r_1^2])}{(F_{\rm b}(T_{\rm ef1d})[1 - r_2^2/r_1^2] + F_{\rm b}(T_{\rm ef2})[r_2^2/r_1^2])}, \tag{2}$$

where $T_{\rm ef2} = 4000\,°$K for the bottom of primary minimum $\phi = 0$. Here, $F_{\rm i}(T_{\rm efi})$, $i = u, b, v$ are the black body fluxes in U, B, V colors for $T_{\rm ef1} = 8200\,°$K primary and $T_{\rm ef} = 4000\,°$K secondary, respectively.

We assume $q = 0.5$, for Roche lobe filling components – $r_1 = 0.465$, $r_2 = 0.333$, the half-widths of UBV bands $\Delta(\lambda)$ =200Å, black-body energy distribution, respectively, for $T_1 = 8200\,°$K, $T_2 = 4000\,°$K and the temperature of the limb darkened portion of the disc either $T_{\rm ef1d} = 7400\,°$K or $T_{\rm ef1d} = 7755°$ visible at the bottom of primary minimum. The lower value of $T_{\rm ef1d}$ presumes the standard linear limb darkening law with a completely dark limb, whereas $T_{\rm ef1d} = 7755°$ corresponds to the limb darkening coefficient $x = 0.6$. With these parameters we find from the above-given expressions that both values $\Delta[(B–V)(\phi = 0°) - (B–V)(\phi = 90°)]$ and $\Delta[(U–B)(\phi = 0°) - (U–B)(\phi = 90°)]$ are $0^{\rm m}.09 - 0.^{\rm m}10$ for completely dark limb of the primary component and $0^{\rm m}.05$ for $x = 0.6$, which is in a reasonable accord with the observed value for BM Cas amplitudes of variations of color indices with orbital phase.

Of course, such crude estimates are sensitive to the ratio of the sizes of the components. Nonetheless, assuming $q \ll 0.5$ we obtain considerably lower amplitudes of variations of colour indexes with phase, as long as the size of both components remain close to their critical Roche lobes.

The traces of the secondary were not found spectroscopically by Barwig [3], Popper [7], also by Fernie, Evans [2]. Mass function value ranges between $f(m) = 0.92$–$5.7M_\odot$ by Popper and $f(m) = 4.8M_\odot$ by Barwig. Higher values of $f(m)$ are based solely on MgII 4481 line but Popper is doubtful about the photosphere origin of this line(see ref. [7] for more details): due to broadening the line is not separated into individual components even during elongation. Lower value is obtained for lines belonging to 17 metals. If we assume $f(m) = 0.92$, $i = 72°$, $M_1 = 13.5\,M_\odot$, we find, for the secondary, $M_2 = 6.5$–$7M_\odot$. For these values of the masses and relative radii of the components given above we find $R1 = 65$–$70R_\odot$ and $R2 = 45$–$48R_\odot$. If we assume that the temperature at the location of the secondary is dictated solely by A supergiant primary, we may roughly estimate T_2 value following from the diluted radiation of the supergiant primary and just given values of the radii of the component stars. We find from these figures $T_2 \simeq 3500\,°K$, which is in an excellent agreement with an independent estimate by Barwig [2] based on different arguments. We note also that our estimate of the mass of the primary component is pretty close to the value adopted in ref. [2] ($M_1 = 12.0M_\odot$)

We offered here a plausible constraint on physical and orbital parameters of BM Cas. It follows from the combination of the most reliable data on

(a) the primary component A5–A7Iab supergiant star,
(b) distance to the object – corrected for interstellar reddening,
(c) estimate of the age following both from evolutionary considerations and a good accord with the distance estimates to BM Cas and III Cassiopeia stellar association [4],
(d) mass function, size of orbit, duration of minima and their depths.

In case of BM Cas limitations of such an approach in the first hand are caused by

(a) unknown mechanism of intrinsic variability in binary and as a consequence a low accuracy of proposed solutions of photometric orbit,
(b) uncertainty in masses because of discrepancy in amplitudes of radial velocities for various chemical elements suggestive of stratification and influence of considerable line broadening most probably due to large scale convection motions over photosphere of supergiant.

6. On the probable nature of the observed intrinsic variability

Over more than 25 years of our time series asymmetry of the seasonal light curves preserved in all colours the same pattern: the ascending branch during primary minimum was systematically slightly more steep than the descending branch (a similar trend is in evidence in the published light curve of BM Cas in ref. [2]) and statistically the maximum preceding the primary minimum is slightly (by 0.01 mag) higher than the following maximum (with the phase corresponding to the light maximum shifted from elongation – 0.75 P to the orbital phase of $0.78\,P - 0.80\,P$). Also sporadic colour variations (like the one claimed in ref. [8]) were observed from time to time. How these transient phenomena can be interpreted in terms of the physical parameters of circumbinary gas in the frame of the proposed model?

In relative measure (again in the units of semi-major axis of orbit) our value of R_{sp} is close to the radius of the cross-section Q at the inner Lagrangian point determined by the isothermal density drop-off of the gas stream (see Meyer and Meyer–Hofmeister [9]):

$$Q = \frac{2\pi R_g T_{sp} a^3}{G(M_1 + M_2)k}. \tag{3}$$

Here a is the semi-major axis of orbit, M_1, M_2 masses of the components, R_g, G ideal gas universal constant and gravitation constant, respectively. The factor k is obtained from the Roche geometry (see formula (18) in ref. [9]). Approximating emission structure by a cylinder with the effective cross-section Q and characteristic height over the photosphere $r_2 a$, we have the following simple expression for lower limit of the total emission measure of plasma with the characteristic plasma particle density N_e per unit volume and its temperature T_{sp} (see [10], formula 1.240):

$$L_{min} \approx 10^{-21} N_e N_i T^{-1/2} V Z^4 (\text{erg/s}), \tag{4}$$

where V is the volume of emitting plasma, Z the effective ion charge number and N_i the number of ions.

For the sake of simplicity and the lack of anything better we assume hydrogen plasma and $N_e = N_i \sim 10^{10}\,\text{cm}^{-3}$ following from Barwig's estimate [3] for the region of formation of Balmer lines. In order to produce displacement of the phase of maximum by $\phi \simeq 0.01$–$0.03\,\text{P}_{\text{orb}}$ or at the bottom of minimum of the same order of magnitude from ephemeris (for instance, the seasonal light curves of BM Cas for U from 1987, B from 1974, 1982, 1987 and V 1987), an additional input of energy *comparable* to the total luminosity of the binary at specific phases is needed. As indicated above, tidal distortion harmonics $C\cos(2\Phi)$ is fully responsible for the light variations of BM Cas between the bottom of the secondary minimum and maximum. Thus, conservative estimates based on formula (4) for T_{sp}, R_2, N_e values given above result in contribution from the hot region L_{sp} in *UBV* colours, roughly $L_{sp} \approx 10^{36}$ erg/s or no less than 5%–10% of the total contribution from the tidal distortion effect. Fernie and Evans [2] found intrinsic light variations with the amplitude about 0.1^{m} and a quasi-periods around 20 days and 90 days(see the figures 2 and 3 in their article). If we assume that the velocity of escaping gas is close to a sound velocity (roughly 10 km/sec for $T_1 = 8200\,^\circ$K) and combine it with the value of the semi-major axis of orbit $a = 120$–$140\text{R}_\odot$ we find a good accord between the above-given values of quasi-periods and the time scale for intrinsic variability of circumbinary gas. Thus, turning to formula (4), we see that to produce light variations of the amplitude 0.01^{m} one needs variations in the density of plasma N_e by a factor of 2 in 20–90 days. The resulting variations in luminosity of circumbinary plasma by a factor of 4–5 can easily explain variations in the depths of a primary minimum referred in subsection 2.1 of this article.

7. On the evolutionary state of BM Cas

We used the package of computer programs sse.f (swift evolutionary code [11]) to specify in more detail the evolutionary history of BM Cas. For BM Cas, we can fix its current position on H–R diagram. Using the value of $T_1 = 8200\,^\circ$K for A5–A7Iab from ref. [2] which is confirmed also by more updated calibration for A type supergiants (more details are in ref. [12]) and the above-given radii, we can fix the position of the primary in H–R diagram quite accurately. Also Hipparcos value of trigonometric parallax of BM Cas is available: $p = 5.''8 \times 10^{-4} \pm 1.''07 \times 10^{-3}$ (see data in ref. [13]). The distance following from this estimate 1724 pc seems to be too low. A much more accurate value of absolute luminosity of BM Cas can be found from BM Cas visible magnitude $V = 8.95$ mag [14] and the data on colour excess $\text{E}(B\text{–}V) = 1.00$ [2]. Using canonical value $R = 3.0 \pm 0.2\text{E}(B\text{–}V)$ for the ratio of the total interstellar absorption to the colour excess and assuming the distance to BM Cas $r = 2.5$ kpc [2, 4, 7] we obtain $\text{M} = -5.86$ mag (bolometric correction for A5Iab is only -0.09 mag). On the other hand, from the above-given values of $T_1 = 8200\,^\circ$K, $R_1 = 70\text{R}_\odot$, we find $M \simeq -6.0$ mag. Thus, both estimates of absolute luminosity of A5Iab supergiant are in an excellent agreement.

In figure 9, we show the evolutionary tracks calculated for a star with solar abundance and mass $M_1 = 13.5\text{M}_\odot$ with the aid of swift evolutionary code [11] and observed current position of BM Cas. The age of the primary A5Iab supergiant according to this evolutionary scenario is nearly 15 mln. years (counted from ZAMS) and the primary lost roughly $0.25\text{M}_\odot$ while the star was on MS. At present, the A5Iab supergiant passes through CHeB evolutionary stage. Some portion of the lost matter was transferred to the MS companion of $M2 = 7M_\odot$. According to the same evolutionary computations, after 15 million years from zero MS, the luminosity of the companion constitutes only $1-2\%$ of the luminosity of the primary more massive companion (see figure 9 where also the evolutionary track for $M2 = 7M_\odot$ star has been plotted and the current position for BM Cas secondary component is inserted). Thus, invisible secondary looks like a giant star but in fact it is the MS star. How the large value of photometric radius of the invisible secondary component can be reconciled with the position of BM Cas secondary on H-R diagram ? Simple estimates indicate that the mass of the envelope surrounding the invisible secondary of only $10^{-6}M_\odot$ should be sufficient to make it opaque and thus to produce an impression of a giant star with the radius estimate given above. For a star of $M2 = 7M_\odot$ the accretion time scale of the gainer is comparable to the age of the system and this circumstance can explain why the accreted material does not contribute appreciably to the luminosity of the star dictated by the core burning. The energy of accreted material can be deposited in the turbulent motions rather than transformed directly into a thermal energy [15, 16]. Here, follow some characteristic figures to quantify the above-given arguments. According to spectroscopic investigation [3] we have for electronic density in the region surrounding the secondary where Balmer lines originate $Ne \sim 10^{10}$ cm^{-3}. Combining this with our estimate of the Roche lobe size for the secondary component we arrive at optical depth of circumstellar gas by Thompson scattering $\tau \sim 0.1$. This is certainly only a lower limit because the opacity due to genuine absorption is at least an order of magnitude higher. Thus the optical depth should be at least of order $\tau \sim 1$–5 explaining the large radius of the eclipsing body of the secondary following from the analysis of our *UBVR* light curves. We proposed here a crude empirical model of BM Cas. To verify its validity, light curves in infrared are badly needed, also a dedicated study of the nature of intrinsic variability should be made, using rapid photometry. From the above-given spectroscopic and photomoteric data, we conclude that in high probability BM Cas is a young supergiant binary system caught during quite recent stage of formation of the common envelope.

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