Active OB stars: structure, evolution, mass loss, and critical limits
Proceedings IAU Symposium No. 272, 2010
C. Neiner, G. Wade, G. Meynet & G. Peters, eds.

doi:10.1017/S1743921311011549

H_α19 in the galaxy M 33, a high-luminosity massive merging eclipsing binary

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Abstract. CCD photometry reveals a hot spot on the surface of the hot accretion gainer in this supergiant O type binary with a big accretion rate. This spot is as bright as 25000 Suns. The orbital period of this system is 33.108 days. The absorption-line spectrum contains multiple lines of He I, Si III and N II. The star is associated with H II region formed by bipolar gas outflow from the system.

Keywords. binaries: eclipsing, circumstellar matter

We report the results of CCD $BVRc$ photometry and medium resolution spectroscopy of OB star No.0712 in the galaxy M 33 (Ivanov et al. 1993) identified with the emission line star H_α19 (Fabrika & Sholukhova 1995). The astrometric position of the star is $1^h33^m39^s.468 + 30°45'40''.25$, Eq. 2000.0. The first photometric and spectroscopic investigations of this star were described in the paper of Sharov, Goranskij & Fabrika (1997). It is an eclipsing binary with the orbital period of 33.108 day. H_α19 is associated with an H II region having two-lobe structure which is seen in two H_α images taken by Courtes *et al.* (1993) using the Russian 6-m telescope BTA. The blue central star and two red lobes of this H II region are seen in the high-resolution color image of M 33 central part taken by King *et al.* (2001) with KPNO 4 m Mayall Telescope. The overall size of H II region is 30 pc. The star is not associated with any X-ray or radio source.

In 2001 – 2009, we performed CCD BVR_C photometry with SAO 1 m reflector and CCD photometer based on the chip EEV 42-40, and SAI Crimean station 60 cm telescope with CCD VersArray manufactured by Princeton Instruments. Light curves, $B-V$ and $V-R_C$ color curves are shown in Fig. 1a and 1b. The range of variability was $16^m.90$ – $17^m.55$ in the V band, with the magnitude of Min II at 17.35. We determined light elements $Min\ I = 2453593.53 + 33^d.108(\pm 0^d.003) \times E$. This formula confirms the results of photographic observations by Sharov, Goranskij & Fabrika (1997). Color indices are the following: $B-V = +0^m.08, V-R_C = +0^m.16$. With these indices, H_α19 is located near the red edge of OB stars' main sequence, and $1^m.5$ lower than the brightest O supergiant in the CM diagram by Massey *et al.* (2006) of M33 galaxy.

The dominating feature of light curves is a hump just before the primary eclipse due to bright extended spot on the surface of a hot luminous companion. This spot is as bright as 25000 Suns. We assume that H_α19 is a merging binary which has a large rate of mass exchange, and therefore the radiative heat transfer has been changed partly by circulation in the volume of the hot gainer. This circulation transports very hot matter from the deep layers of the star envelope to the surface.

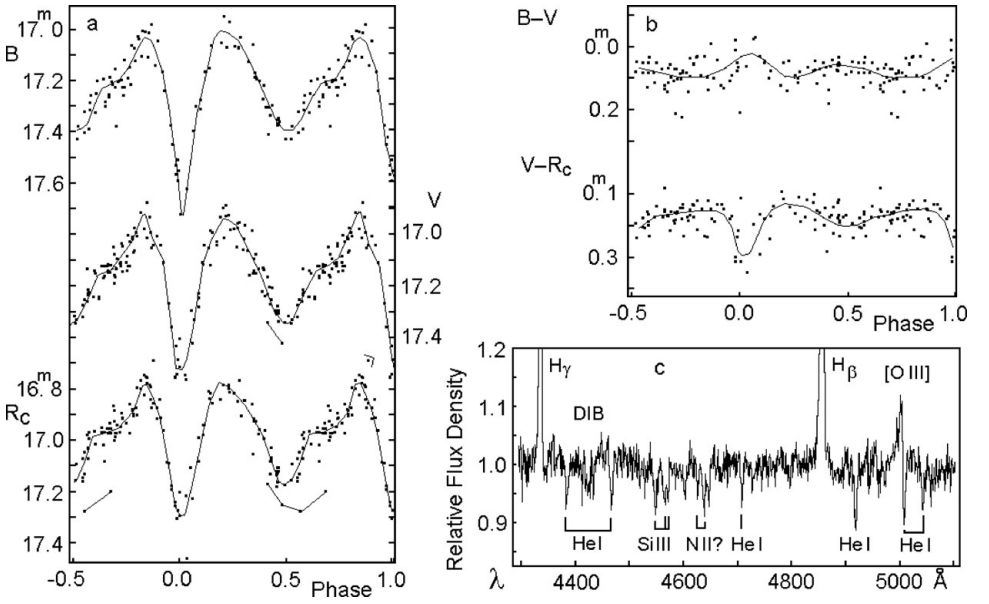

Figure 1. CCD BVR_C light (a) and color (b) curves of $H_\alpha 19$ plotted with the orbital period 33.108 day. The fragment of stellar spectrum is shown in the box (c).

We analyzed a long-slit spectrum taken with BTA/SCORPIO on 2005 September 8.04 UT with the exposure of 900 s. The slit was located along the lobes. The spectral range λ3960 – 5731 Å, and the spectrum resolution was FWHM = 5.0 Å. A fragment of the spectrum is shown in Fig. 1c. The star has weak absorption lines in the spectrum. He I is represented with lines at λ4009, 4024, 4026, 4143, 4388, 4471, 4713, 4921, 5015 and 5047 Å. We identified also N II absorptions at λ4630, 4643, 5666, 5679 and 5710 Å, and Si III absorptions at λ4552, 4567 and 4574 Å. These features are typical of O type stars. In the spectrum of bipolar nebula, we identified Balmer emissions down to H_ϵ. H_β line width FWHM = 220 km/s corrected for instrumental profile width. This is a low velocity bipolar outflow. EW(H_β) is 128 Å. It is about 10 times larger than previous estimate by S.I. Neizvestnyi with BTA TV scanner on 1991 September 10 (Sharov, Goranskij & Fabrika (1997)). Evidently, the nebula spectrum was not extracted from common light that time. Our nebular spectrum contains also [O III] 5007 Å line with the EW = 11 Å. B. Margon and P. Green didn't found any traces of [O III] λ4959 and 5007 Å lines in their spectra taken on 1991 December 7 and 22.

With M 33 distance module of $24^m.7$, the absolute magnitude M_V of $H_\alpha 19$ is -8.0, and the bolometric magnitude is -10.5. So, each of merging components of $H_\alpha 19$ is as massive as 40 - 50 $M_\odot$. $H_\alpha 19$ represents a rare event of merging massive supergiants.

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https://doi.org/10.1017/S1743921311011549 Published online by Cambridge University Press