Peculiarities in the spectrum of the early-type system MY Ser

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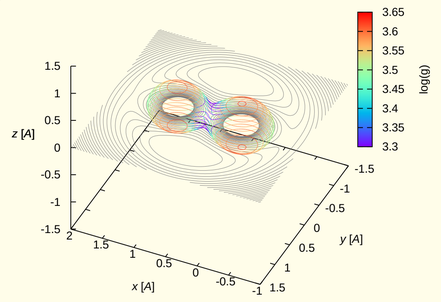

MY Serpentis System

The eclipsing binary MY Ser (HD 167791) belongs to a rare class of early-type contact systems. It has a period of 3.34 d, its magnitude in maximum is V = 7.3, and the depths of both minima is 0.3 mag. The integral spectrum was classified as O8 Ib(f)p by Walborn (1972). Leitherer et al. (1987) found that the spectrum is dominated by lines of a third component, probably of spectral type O8 Ib, and that the lines of the eclipsing components belong to stars of earlier type. Mayer et al. (2010) solved the UBV light curves and derived an overcontact solution with a large filling factor.

He I/II Line Spectra

The ESO archive contains 150 FEROS spectra of MY Ser, taken in the years 2006–2009. These spectra are available in a pipeline processed form. We chose He I 5876 and He II 5411 lines for this study, selected about half of the available spectra and averaged groups of them to represent 22 different phase points. We fitted Gaussian profiles to obtain the positions, widths and depths of all line components.

Emission Lines

The He II 4686 and Hα lines are in emission. Superpositions of the 4686 and Hα profiles as measured in all analyzed spectra suggest that the third body contribution to the 4686 line is small. A stronger emission is present in Hα and is similar to the emission in other early-type supergiants. In Fig. 1 eleven profiles of the Hα line from various phases are shown. Most of the emission between their low limit and continuum should originate from the third body.

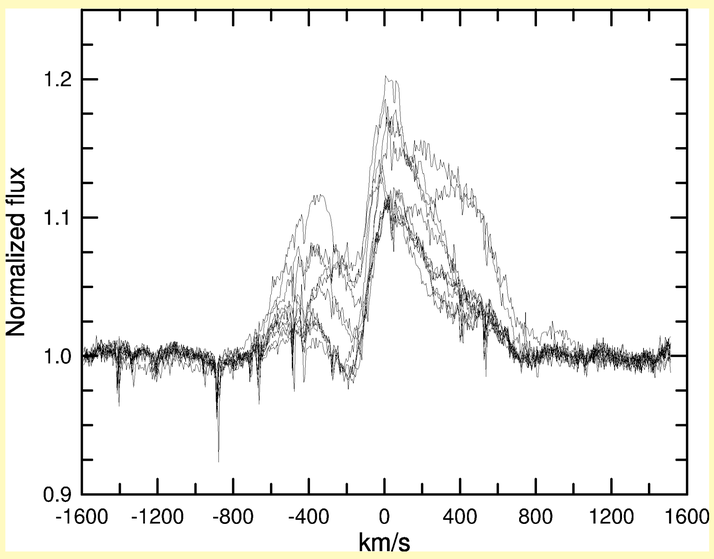

Figure 1: A set of Hα profiles suggests that the free space under them is the emission connected with the third body.

Bibliography

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Leitherer, C. et al. 1987, A&A 185, 121
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Mayer, P., Božić, H., Lorenz, R., & Drechsel, H. 2010, AN 331, 274
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* Based on observations made with the European Southern Observatory telescopes obtained from the ESO/ST-ECF Science Archive Facility.

Third Component Lines

Third body lines should behave independently of the eclipsing binary lines. The most pronounced spectral features of the third component are He I lines. Their FWHM should not be correlated with the binary orbital phase, but the measured depth of the third component line depends on phase. Fig. 2 shows the V-band continuum flux contributions of all three components according to our overcontact solution.

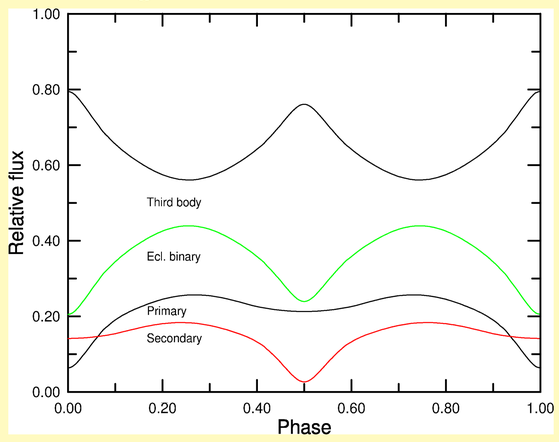

Figure 2: Contributions of various system components to the light curve.

The measured depths of the third lines as a function of L_3 are shown in Fig. 3. The values for $L_3 = 1$ are the depths which both lines would have if the contribution from the binary components was negligible. The regression lines suggest that the depths would be 0.151 and 0.287 for the 5411 and 5876 lines, respectively. Corresponding FWHMs are 3.1 and 3.3 A and EWs 0.47 and 0.95 A (ratio 0.50). Such values agree with spectral type O8 I (according to the OSTAR spectra by Lanz & Hubeny 2003, O-star parameters by Martins et al. 2005).

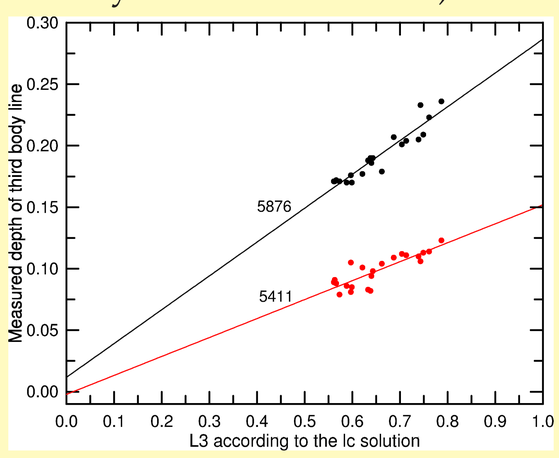

Figure 3: Measured depths of the third component lines He I 5876 and He II 5411.

Leitherer et al. measured the third line radial velocity of the He II 5411 line as +21 km/s in the year 1986. Our RVs for the years 2006 to 2009 exhibit a large scatter, nevertheless the velocity is smaller (close to zero) in the years 2008/9. The RVs of the third component derived for He I are systematically smaller by $\approx$ 15 km/s. The **decreasing velocity of the third body** is confirmed by the C III 5695 emission line shown in Fig. 4. In the year 2006 the velocity was $\approx$ 20 km/s more positive than in 2009. The correctness of the wavelength scale follows from the unchanged position of the 5905.1 A DIB.

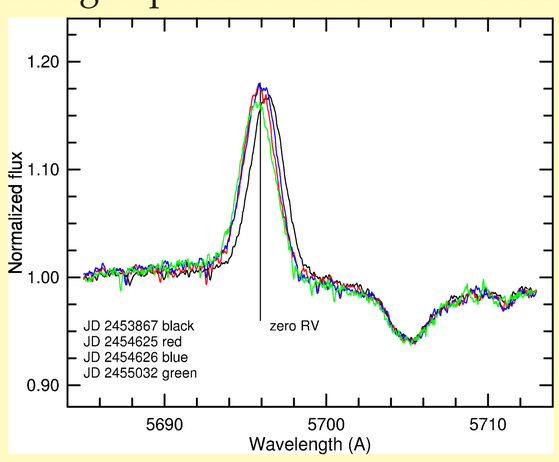

Figure 4: The emission line C III 5696 proves the secular change of the third body radial velocity.

The Eclipsing Binary

To show the eclipsing component line profiles the third line has been subtracted. The profiles are shown for 18 phases in Fig. 5. The 5411 profiles look as expected at phases 0 to 0.5, i.e., the primary line (blue shifted) is stronger than the secondary; however, at phases 0.5 to 1, **the primary line** (red shifted) **is weaker**. The line 5876 has an asymmetric shape with a stronger blue wing around both conjunctions; at other phases, these lines behave similarly as 5411, but at phases 0.5 to 1, the primary is yet weaker. It is necessary to assume that for the weakness of the primary lines, as well as for the blue component, **the circumbinary matter is responsible**.

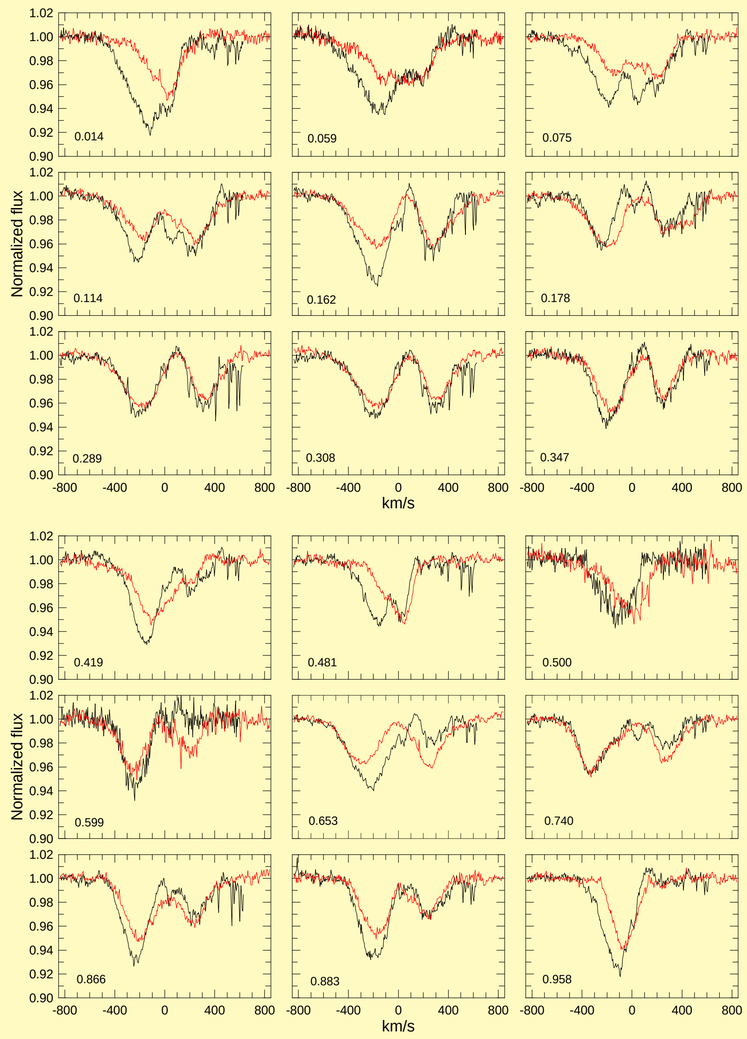

Figure 5: Profiles of the lines He I 5876 (black line) and He II 5411 (red line). Phases are written in figures.

Radial velocities are presented in Fig. 6. In spite of deviations from the expected RV curve around conjunctions, the velocities at quadratures should represent the orbital motion; however, the gamma velocities differ.

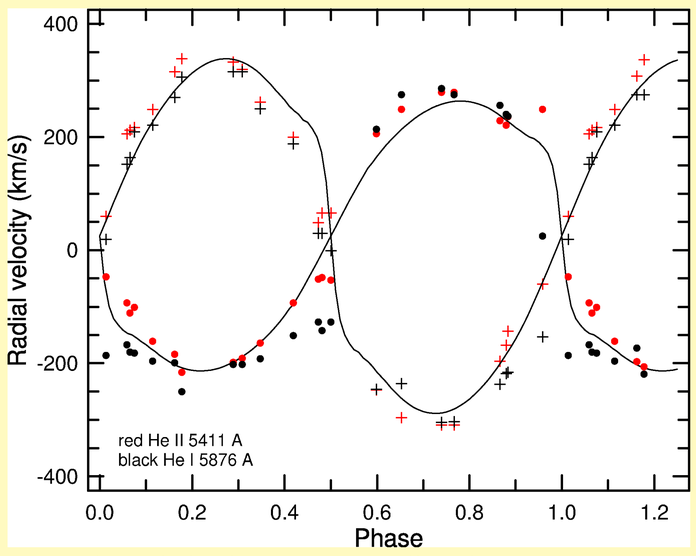

Figure 6: The radial velocity curve. Full circles – primary, crosses – secondary.

	Primary	Secondary
K (km/s)	284	305
Vγ (km/s)	28	10
a sin i ($R_\odot$)	18.8	20.1
M $\sin^3 i$ ($M_\odot$	36.7	34.2

With i = 83.6°, the masses are 37.4 and 34.8 $M_\odot$, a = 39.1 $R_\odot$; radii are 16.5 and 15.4 $R_\odot$. According to Martins et al. (2005), such parameters correspond to the spectral type O6 III.