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# Contribution to the search of binaries among Am stars. IV. HD 100054 B and HD 187258. \*

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## ABSTRACT

Radial velocity observations of HD 100054 B and HD 187258 with CORAVEL instruments at Haute-Provence and Cambridge Observatories are reported. Known as Am/Fm metallic-line stars, both objects were included in our spectroscopic survey of Am-type stars whose purpose was to determine the frequency and properties of binaries in this stellar family. HD 100054 B is found to be a single-lined spectroscopic binary with a variable value of  $V_0$ , the systemic velocity of the centre of gravity of the pair. The variation of this parameter is interpreted in terms of orbital motion of an unseen third body with a much longer period. The orbital elements are derived for both the short- and the long-period orbits. We find  $P = 12.79430$  days,  $T = 2449781.19$  HJD,  $\omega = 137^\circ$ ,  $e = 0.028$ ,  $K_1 = 18.69$  km s<sup>-1</sup>,  $a_1 \sin i = 3.29$  Gm,  $f(m) = 0.0087 M_\odot$ , for the short period orbit and  $P = 874.2$  days,  $T = 2449377$  HJD,  $\omega = 172^\circ$ ,  $e = 0.097$ ,  $K_1 = 5.30$  km s<sup>-1</sup>,  $V_0 = -13.52$  km s<sup>-1</sup>,  $a_1 \sin i = 63.4$  Gm,  $f(m) = 0.013 M_\odot$ , for the long period orbit.

HD187258 is found to be a single-lined spectroscopic binary whose orbital elements are:  $P = 25.8048$  days,  $T = 2449628.91$  HJD,  $\omega = 165.9^\circ$ ,  $e = 0.370$ ,  $K_1 = 17.36$  km s<sup>-1</sup>,  $V_0 = -34.76$  km s<sup>-1</sup>,  $a_1 \sin i = 5.72$  Gm,  $f(m) = 0.011 M_\odot$ .

Physical parameters of the primary components of these systems are derived.

**Key words:** Stars: individual: HD 100054 B, HD 187258 – Binaries: spectroscopic – Stars: fundamental parameters

## 1 INTRODUCTION

We present a study of the radial velocities ( $RV$ ) of the two spectroscopic binaries HD 100054 B (HIP 56205) and HD 187258 (HIP 97450) performed over the period 1994–1998 with the CORAVEL instrument (Baranne, Mayor & Poncet, 1979) at Observatoire de Haute-Provence (OHP) and more recently with a similar one at Cambridge Observatory (UK). This work is part of a systematic programme to study the frequency and properties of spectroscopic binaries ( $SB$ ) in a sample of metallic-lined (Am) hot stars (see Ginestet & Carquillat 1998, Paper I, and North et al. 1998). HD 100054 B is the faint component of the wide visual binary ADS 8191 AB. This pair is constituted by two A-type stars of visual magnitudes  $V = 7.31$  and  $V = 8.34$ , with a separation near  $12''$  (ESA 1997). HD 100054 A (HIP 56202) is classified as A5 in the SIMBAD data base; we did not find any correlation dip with CORAVEL for that object.

Olsen (1980) first suspected the chemically-peculiar nature of HD 100054 B: on the basis of its Strömgren photometric indices, he estimated its spectral classification as Ap. Some years later, Bidelman (1988) recognized the star as Am on the basis of spectroscopic observations performed with a slit-spectrograph at Lick Observatory. According to the  $B - V$  value of 0.095 quoted in the Hipparcos Catalogue (ESA 1997), HD 100054 B would be an early-type Am star.

Although that star was reported a long time ago as  $SB$  (Young 1942), no previous spectroscopic orbit has been determined, to our knowledge, for this object. Our observations (Sect. 2) show that HD 100054 B is a single-lined  $SB$  (i.e.  $SBI$ ), belonging to a triple spectroscopic system with a short-period orbit ( $P \approx 13$  days) and a long-period one ( $P \approx 2.4$  years).

Classified as F2 in the Henry Draper Catalogue, HD 187258 ( $V = 7.59$ ) was recognized by Bidelman (1951) as a metallic-line star of type Fm. More precisely, the types for the K-line and the metallic lines are F0 and F5 III, respectively. Those classifications agree with the values of the colour index  $B - V$  measured for this star: 0.32 from Mendoza,

\* Based on observations made at the Haute-Provence Observatory (France) and at Cambridge Observatory (U.K.).

Gómez & González (1978), and  $0.36 (\pm 0.01)$  from Hipparcos (ESA 1997). Apparently, no information about the *RV* of this star was known before the survey, related to the Hipparcos mission, carried out at OHP by S. Grenier and her team. For HD 187258, Grenier et al. (1999) quote an *RV* of  $-45.3 \pm 3.2 \text{ km s}^{-1}$ . That value was obtained from three independent observations, but there is no mention of any indication of *RV* variability. Our observations clearly establish that HD 187258 is a *SBI* with a period close to 26 days (Sect. 2).

## 2 OBSERVATIONS AND DERIVATION OF ORBITAL ELEMENTS

For HD 100054 B, 48 *RV* measurements were performed (39 at OHP and 9 at Cambridge), and for HD 187258, 40 *RV* were similarly obtained (26 at OHP and 14 at Cambridge). Those data are displayed in Tables 1 and 2. They were obtained with CORAVEL-type instruments, i.e., spectrophotometers that make *RV* measurements by performing a cross-correlation of the stellar spectrum with a physical mask placed in the focal plane of the spectrograph. In the case of the OHP observations, Gaussian functions are fitted to the cross-correlation dips to derive radial velocities (Baranne, Mayor & Poncet, 1979); Cambridge traces are cross-correlated with functions derived from one that was empirically established from observations of practically non-rotating stars by convolving it with a broadening function to mimic stellar rotation. The OHP CORAVEL is mounted at the Cassegrain focus of the 1-m Swiss telescope, while the Cambridge one is at the coudé focus of the 91-cm telescope. The observations later than JD 2451690 were obtained by RFG at Cambridge and adjusted by a velocity offset of  $-0.8 \text{ km s}^{-1}$  to make them consistent with the others, which were all performed at OHP by the Toulouse group. The r.m.s. uncertainties of the *RV*s were  $\sigma_O = 0.64 \text{ km s}^{-1}$  for HD 100054 B and  $0.55 \text{ km s}^{-1}$  for HD 187258; the two instruments give errors very similar to one another.

We also added the 6 *RV* obtained by Young (1942), with a weight of 0.07 to account for the larger errors of his measurements. In this case also, a velocity offset (of  $+4 \text{ km s}^{-1}$ ) was required to make these data consistent with our measurements.

A first determination of the orbital elements of HD 100054 B revealed its character of a triple system, as can be easily seen in the residuals presented in Fig. 1a. This system is constituted by a pair of stars in an orbit which has a period of about 13 days and a variable systemic velocity,  $V_0$ , that can be interpreted in terms of a perturbation from a third object. To carry out the orbital determination, we used a new program, BS4, developed by one of us (JLP), which fits simultaneously the orbital parameters of the inner orbit and the outer (third-body) one. The first step was to obtain an estimation of the elements of the long-period orbit by applying the least-squares program BS1 to the residuals from the fit of the short-period elliptical orbit to the observed radial velocities (Nadal et al., 1979, revised by JLP). The second step was to use the resulting values as the initial elements for the least-squares program BS4 which simultaneously fits the two orbits. The final residuals obtained by BS4 (Table 1 and Fig. 1b) have a standard deviation  $\sigma_{(O-C)} = 0.61 \text{ km s}^{-1}$ ,

which is very close to the mean error of the *RV* measurements. The two orbits are displayed in Fig. 2 and the corresponding elements with their errors are given in Table 3. Another calculation was independently performed by RFG with an analogous program and led to the same results.

The orbital elements of HD 187258 were derived with our routine BS1. For that object, no evidence for the presence of a third component could be seen in the residuals (cf. Fig. 3). The orbital elements are given in Table 3, and the corresponding radial velocity curve in Fig. 4.

## 3 DISCUSSION

### 3.1 Eccentricities of the inner and outer orbits of HD 100054 B

The eccentricities of both orbits of HD 100054 B are very small. That is not surprising for the inner system, given the period of 12.79 days: with such a short period, the orbits of binary systems are usually circular. Following Lucy & Sweeney (1971) and Bassett (1978), we performed an *F*-test to check whether these orbits could be considered as circular, taking the errors into account.

Let  $S_e$  and  $S_c$  be the weighted sum of squares of the residuals, corresponding to an elliptical or a circular orbit, respectively. Estimates of residual variance are given by  $S_e/(N - M)$  and  $S_c/(N - (M - 2))$  in the two cases, where  $N$  is the number of measurements, and  $M$  is the number of fitted parameters when two elliptical orbits are fitted simultaneously (here  $N = 54$  and  $M = 11$ ). The efficacy of the two additional elements ( $e \cos \omega$ ,  $e \sin \omega$ ) in reducing  $S_c$  may be then measured by the ratio *F* of the variances:

$$F = \frac{(S_c - S_e)/2}{S_e/(N - M)} \quad (1)$$

If the hypothesis of circularity is correct, *F* is distributed as  $F_{\nu_1, \nu_2}$ , with  $\nu_1 = 2$  and  $\nu_2 = N - M = 43$  degrees of freedom.

When both orbits are elliptical, the weighted sum of squares is  $S_e = 18.2 \text{ km}^2 \text{ s}^{-2}$ . When imposing a constraint of circularity on the inner and then the outer orbit, which we will call orbits 1 and 2 respectively, we obtain  $S_c(\text{orbit1}) = 23.6 \text{ km}^2 \text{ s}^{-2}$  and  $S_c(\text{orbit2}) = 22.0 \text{ km}^2 \text{ s}^{-2}$ . We then have  $F(\text{orbit1}) = 6.38$  and  $F(\text{orbit2}) = 4.49$ . Using the distribution of  $F_{2,43}$ , this corresponds to a level of significance of 0.4% and 1.7%, for orbits 1 and 2, respectively.

Hence this test indicates that the eccentricity of the short-period orbit of HD 100054 B is significant at the 0.4% level. The presence of a third body may well have contributed a small eccentricity to a system that is in principle already circularized (Mazeh 1990).

### 3.2 Physical parameters

For the two systems, we can use both Hipparcos data and Strömgren photometric indices for an estimation of the physical parameters, although those data are more accurate for HD 187258 than for HD 100054 B.

Indeed, for HD 100054 B, the Hipparcos Catalogue (ESA 1997) gives  $\pi = 8.52 \pm 5.27 \text{ mas}$  (relative error 62%), and the Strömgren indices  $V = 8.24$ ,  $b - y = 0.048$ ,  $m_1 = 0.232$ ,

$c_1 = 1.009$  (Olsen 1983) do not include  $\beta$  photometry. For HD 187258, the Hipparcos parallax,  $\pi = 7.68 \pm 0.90$  mas is more accurate (relative error 12%), and the Strömgen photometry (Jordi et al. 1996) includes  $\beta$  photometry:  $V = 7.59$ ,  $b - y = 0.218$ ,  $m_1 = 0.170$ ,  $c_1 = 0.717$ ,  $\beta = 2.721$ . Hence the quoted parallaxes would imply similar distances around 120–130 pc for the two systems.

To obtain a better estimate of the distance of HD 100054 B, we could also refer to HD 100054 A. The two stars almost certainly form a physical system for two reasons:

- on statistical grounds alone, one would not expect to find two stars so bright so close together very often.
- they have similar  $RV$ s. Young (1942) gives a value of  $-15.5 \text{ km s}^{-1}$  for HD 100054 A, which is very close to  $V_0 = -13.5 \text{ km s}^{-1}$  that we measured for HD 100054 B.

For HD 100054 A, Hipparcos found  $\pi = 3.87 \pm 1.95$  mas (relative error 50%), which corresponds to a distance of  $\sim 260$  pc. The mean value for the distance of that system is therefore  $d \approx 200$  pc, with still a large uncertainty. That estimate is in agreement with the visual absolute magnitude  $M_V = 1.7$  of HD 100054 B deduced from Strömgen photometry.

The physical parameters of the primary components that we obtained from these data are given in Table 4. For HD 187258, the value of  $M_V$  in Col. 2 corresponds to the mean of the values derived from Hipparcos and Strömgen photometry. For HD 100054 B, the value given by Hipparcos was too inaccurate;  $M_V$  was thus computed from Strömgen photometry only.

We derived the other parameters of the table from Crawford (1975, 1979)’s calibrations and the grids of Moon & Dworetzky (1985). For HD 100054 B, the value of  $\beta$  is indirectly deduced from the close correlation (Crawford 1979) between that parameter and the  $(b - y)$  index, i.e.,  $\beta = 2.90$  (value also obtained when using Moon’s (1985) UVBYBETA program). For these investigations, we neglect the contributions of the unseen components and the interstellar extinction. Indeed, using the ubvy photometry, Moon’s (1985) UVBYBETA program shows that there is no reddening for HD 100054 B, and only  $E(b - y) = 0.005$  for HD 187258.

Finally, we report in Fig. 5 the position of the single observed component of each of the systems in the theoretical HR diagram from Schaller et al. (1992), with the isochrones given by Meynet, Mermilliod & Maeder (1993). We shall adopt what follows:

- the primary of the spectroscopic triple system HD 100054 B is a little-evolved early Am star with a theoretical mass near  $2 M_\odot$  and some 500 million years old ( $\log(\text{age}) \approx 8.7$ ).
- the primary of the spectroscopic binary HD 187258 is an Am/Fm star that is already evolved above the MS. Its mass is about  $1.8 M_\odot$  and its age  $\sim 1300$  million years ( $\log(\text{age}) \approx 9.1$ ). Notice that its low metallicity,  $[Fe/H] = 0.13$  dex, could indicate it is a marginal Am star.

### 3.3 Rotation–revolution synchronism

Synchronization is a mechanism involved in the slowing of the rotation required to form Am stars under the diffusion

process. We therefore applied the synchronism test of Kitamura & Kondo (1978) to the primary components of the two systems.

This test consists of calculating the radius  $R$  of the star in the hypothesis of synchronism between axial rotation and orbital revolution, assuming that the equatorial plane of the star and the orbital plane are coplanar. That leads to  $R/R_\odot = V_e \times P/50.6$ , where  $V_e$  is the tangential, equatorial, rotation velocity in  $\text{km s}^{-1}$  and  $P$  is the orbital period in days. When the value of  $R$  is consistent with the value derived from theoretical predictions or other standard data, it is likely that there is indeed synchronism.

We have no direct knowledge of  $V_e$  but only of the projected rotation velocity,  $V_e \sin i$ , that can be derived from the analysis of the CORAVEL correlation dips, as shown by Benz & Mayor (1981, 1984). For the two systems concerned, the values of  $V_e \sin i$  are  $5.6 \pm 1.0 \text{ km s}^{-1}$  and  $11.4 \pm 1.0 \text{ km s}^{-1}$  for HD 100054 B and HD 187258, respectively.

#### 3.3.1 Case of HR 100054 B (inner orbit).

Let  $R_s$  be the radius of synchronism. The inequality  $V_e \geq V_e \sin i$  implies  $R_s \geq 1.4 R_\odot$ , and if we assume  $30^\circ < i < 90^\circ$  (the most probable range for SBs, taking into account that the probability that  $i < 30^\circ$  is only  $1 - \cos i = 0.13$ ) we have  $2.8 R_\odot > R_s > 1.4 R_\odot$  and we thus conclude that synchronism is plausible (see Table 4).

#### 3.3.2 Case of HD 187258.

HD 187258 has an elliptical orbit with a large eccentricity which rules out the possibility of a “true synchronism” (actually the inequality  $V_e \geq V_e \sin i$  would imply  $R_s \geq 5.8 R_\odot$  which is too large compared to the value found in Table 4). For elliptical orbits, Hut (1981) proposed instead a “pseudo-synchronism” near periastron, which may be marginally reached for HD 187258. Indeed Hut’s process implies a pseudo-synchronous rotation period of 13.7 days (formulae 44 and 45 in his paper) and consequently  $V_e \sin i \leq 10 \text{ km s}^{-1}$ , which is close to the value of  $11.4 \pm 1.0 \text{ km s}^{-1}$  estimated from the correlation dips (see above).

### 3.4 Nature and separation of the unseen companions

Let

$$f(m) = M_1 \sin^3 i \mu^3 / (1 + \mu)^2 \quad (2)$$

be the mass function of a spectroscopic binary, where  $\mu = M_2/M_1$  is the mass ratio, and let

$$a = a_1 + a_2 = a_1 \sin i (1 + 1/\mu) / \sin i \quad (3)$$

be the mean separation of components. In these two equations, the known (measured) quantities are  $f(m)$  and  $a_1 \sin i$ , deduced from the orbit. In the following, we shall attribute to  $M_1$  its theoretical value, in order to constraint the values of  $\mu$ ,  $M_2$ , and  $a$ . Let us also recall that we have shown (Carquillat et al. 1982) that a good estimation of  $a$  can be obtained even if the orbital inclination  $i$  is unknown. Let us now consider the equations (2) and (3) in the case of our two systems.

### 3.4.1 HD 100054 B (short-period system)

The orbital data lead to  $f(m) = 0.0087 M_{\odot}$  and  $a_1 \sin i = 3.29 \text{ Gm}$  (Table 3). Assuming a mass of the primary of  $M_1 = 2 M_{\odot}$  (Table 4), we obtain  $\mu \geq 0.18$  (cf. equation 2) and therefore  $M_2 \geq 0.4 M_{\odot}$ . The non-detection of the secondary component implies that it is at least 2 magnitudes fainter than the primary, and the same is true for the third body. Given the adopted value of  $M_{V_1} = 1.7$  (Table 4), we then have  $M_{V_2} > 3.7$ , and the secondary is likely to be a dwarf star in the spectral range F6–M2 (Schmidt-Kaler 1982).

The smallest separation of the components, obtained with the highest inclination,  $i = 90^{\circ}$ , and corresponding to a M2V secondary companion, is (equation 3):  $a = 21.6 \text{ Gm} \approx 31 R_{\odot}$ . For a F6V secondary companion, its mass would be  $\sim 1.5 M_{\odot}$ , and the mass ratio would be  $\mu = 0.75$ . In that case, equation (2) gives  $\sin i = 0.316$  ( $i \approx 18^{\circ}$ ), and consequently (equation 3)  $a = 24.3 \text{ Gm} \approx 35 R_{\odot}$  (i.e., 0.8 mas at a distance of 200 pc).

### 3.4.2 HD 100054 B (outer orbit)

The orbital data are  $f'(m) = 0.013 M_{\odot}$ ,  $a'_1 \sin i' = 63.4 \text{ Gm}$  (Table 3). Equation (2) becomes:

$$f'(m) = (M_1 + M_2) \sin^3 i' \mu'^3 / (1 + \mu')^2 \quad (4)$$

with  $\mu' = M_3 / (M_1 + M_2)$ , where  $M_3$  is the mass of the third body. We now consider the two following boundary cases, which takes into account the total mass of the short-period pair:

-  $M_1 + M_2 = 2.4 M_{\odot}$  (M2V secondary), that implies (equation 4)  $\mu' \geq 0.20$ , and thus  $M_3 \geq 0.48 M_{\odot}$ .

-  $M_1 + M_2 = 3.5 M_{\odot}$  (F6V secondary), that implies  $\mu' \geq 0.17$ , and thus  $M_3 \geq 0.60 M_{\odot}$ .

Our conclusion is that the third body could have a minimum mass of about 0.5 solar mass, i.e., the mass of a star of type M0V. The distance of this third component to the centre of gravity of the close pair can be estimated at  $380 \text{ Gm} = 2.5 \text{ AU}$  for a mass ratio of  $\mu = 0.20$ , and  $436 \text{ Gm} = 2.9 \text{ AU}$  for a mass ratio of  $\mu = 0.17$ , assuming  $i = 90^{\circ}$ , i.e., a value of about 2.7 AU that leads, at some 200 pc, to an angular separation of 0.014 arcsecond.

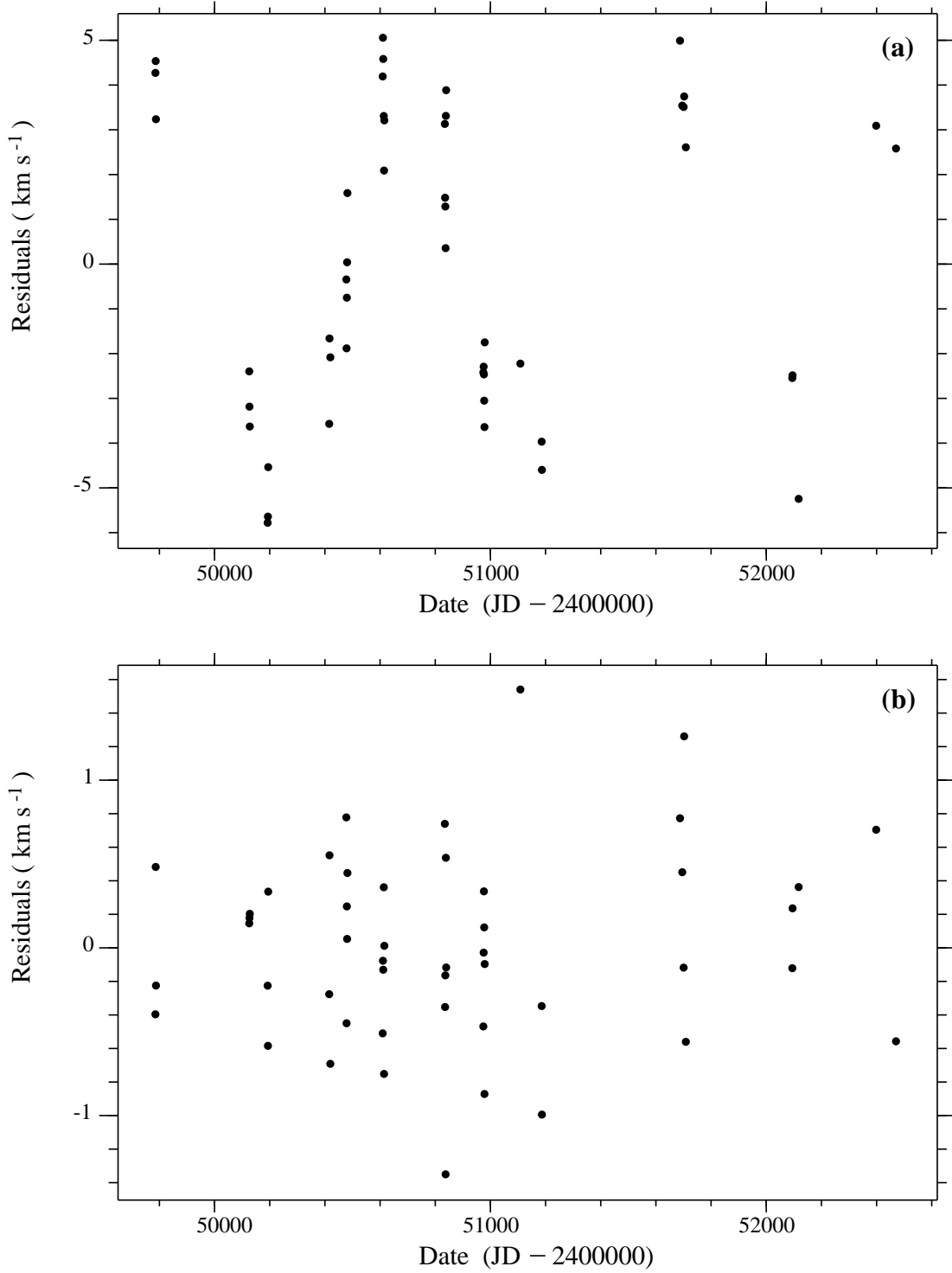
### 3.4.3 HD 187258

The orbital data are  $f(m) = 0.0112 M_{\odot}$ ,  $a_1 \sin i = 5.72 \text{ Gm}$  (Table 3), and the assumed mass of the primary is  $1.8 M_{\odot}$  (Table 4). Then, equation (2) implies:  $\mu \geq 0.21$ , and therefore  $M_2 \geq 0.4 M_{\odot}$ . Another constraint, as for HD 100054 B, is  $\Delta m > 2 \text{ mag.}$  because the secondary remains unseen. Given  $M_{V_1} = 1.95$  (Table 4), the absolute magnitude of the companion would be  $M_{V_2} \geq 4 \text{ mag.}$ , which corresponds to a main-sequence star of spectral type F8V, or later, with a mass  $M_2 \leq 1.2 M_{\odot}$  (Schmidt-Kaler, 1982). Therefore, the companion is most likely a dwarf star whose type can be G, K or early M. As stated above, we can obtain a valuable estimate of component separation, assuming an arbitrary value for  $i$ . Here, taking  $i = 90^{\circ}$  to simplify, we found (equation 3):  $a = 33.1 \text{ Gm} = 47 R_{\odot}$ . Thus, HD 187258 appears as a well detached system.

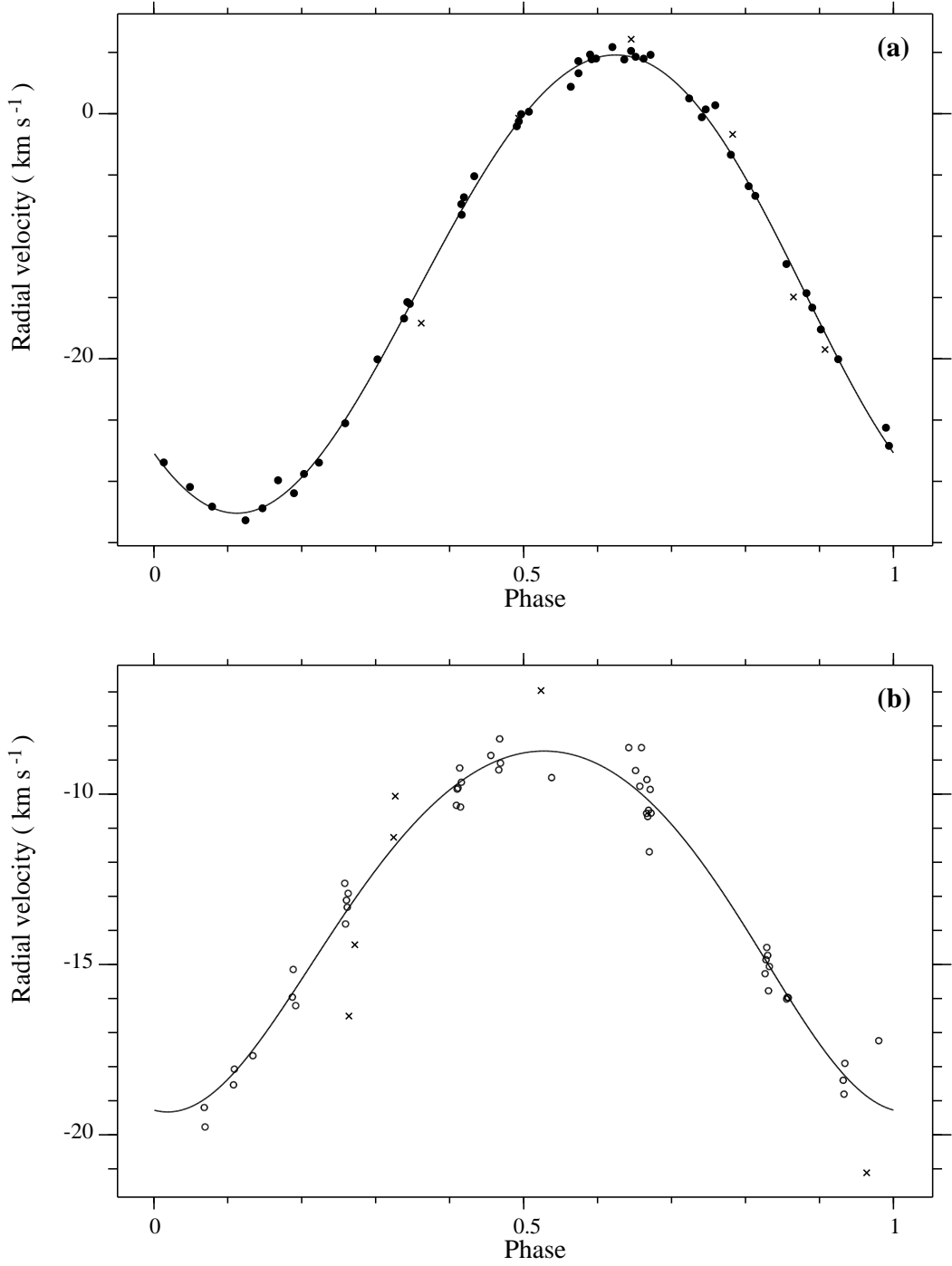
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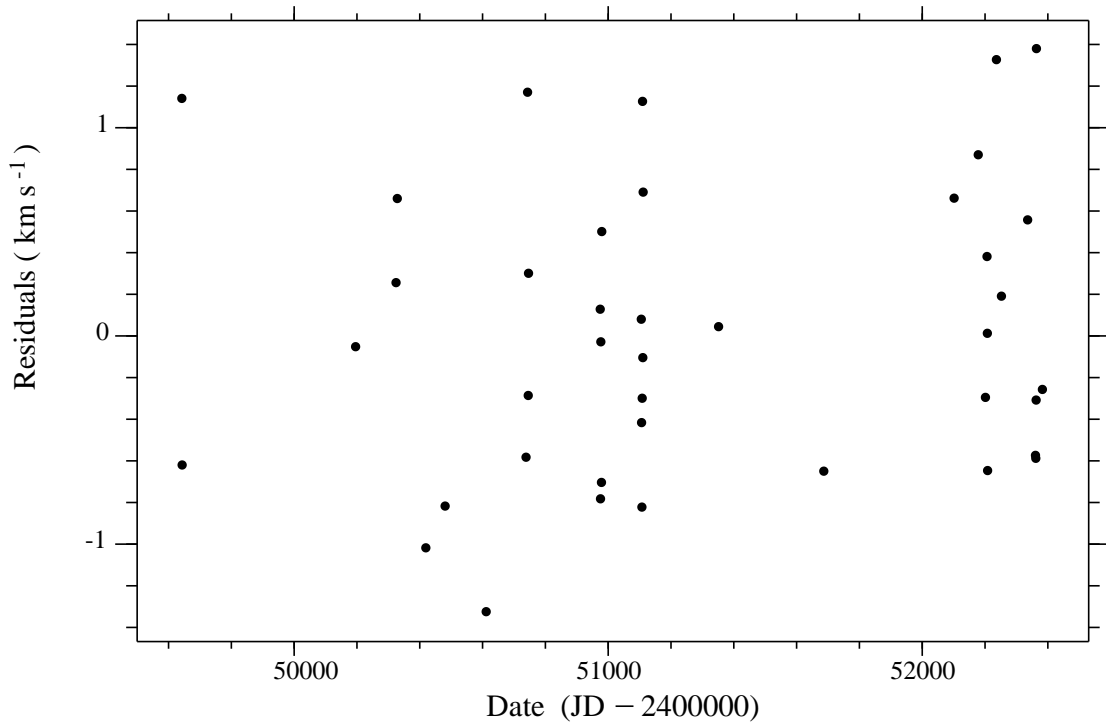
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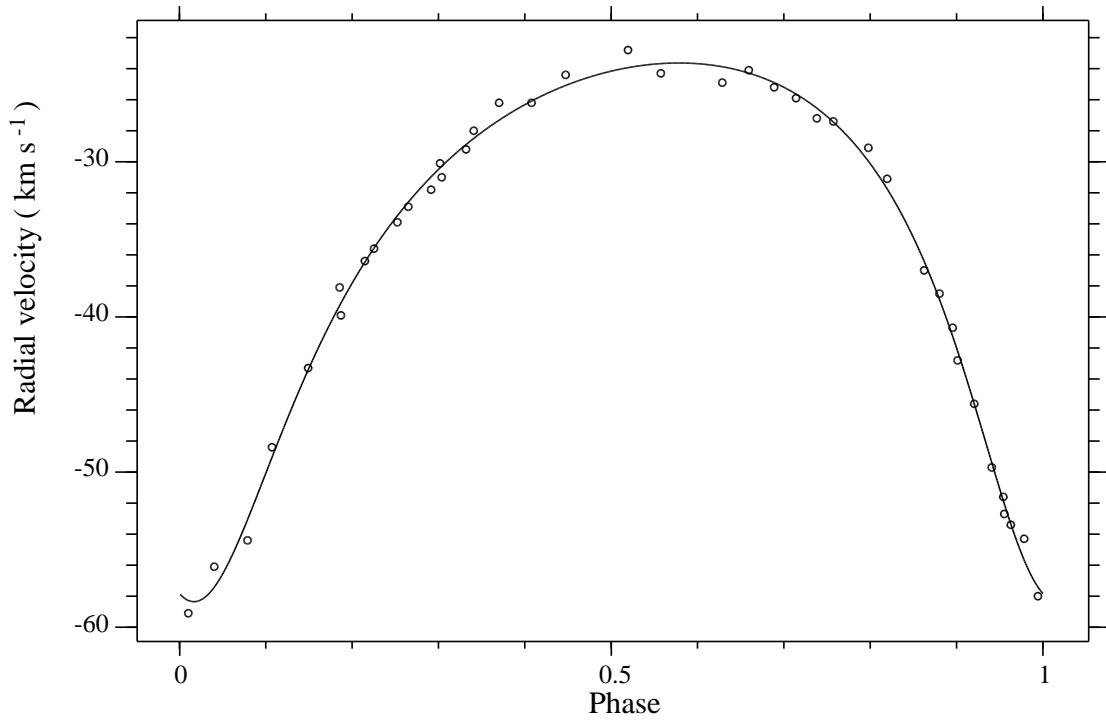
**Figure 1.** HD 100054 B:  $RV$  residuals ( $O - C$ ) obtained for our measurements when assuming two components only (a), and three components (b). Notice the difference in the vertical scales.



**Figure 2.** HD 100054 B: *RV* curves computed with the orbital elements of Table 3. (a): short period system (orbit 1); (b): motion of the centre of gravity of the inner system (orbit 2). Both orbits were fitted to the data simultaneously. The origin of the phases corresponds to the periastron passage. Circles correspond to our measurements and crosses to Young (1942)’s data.

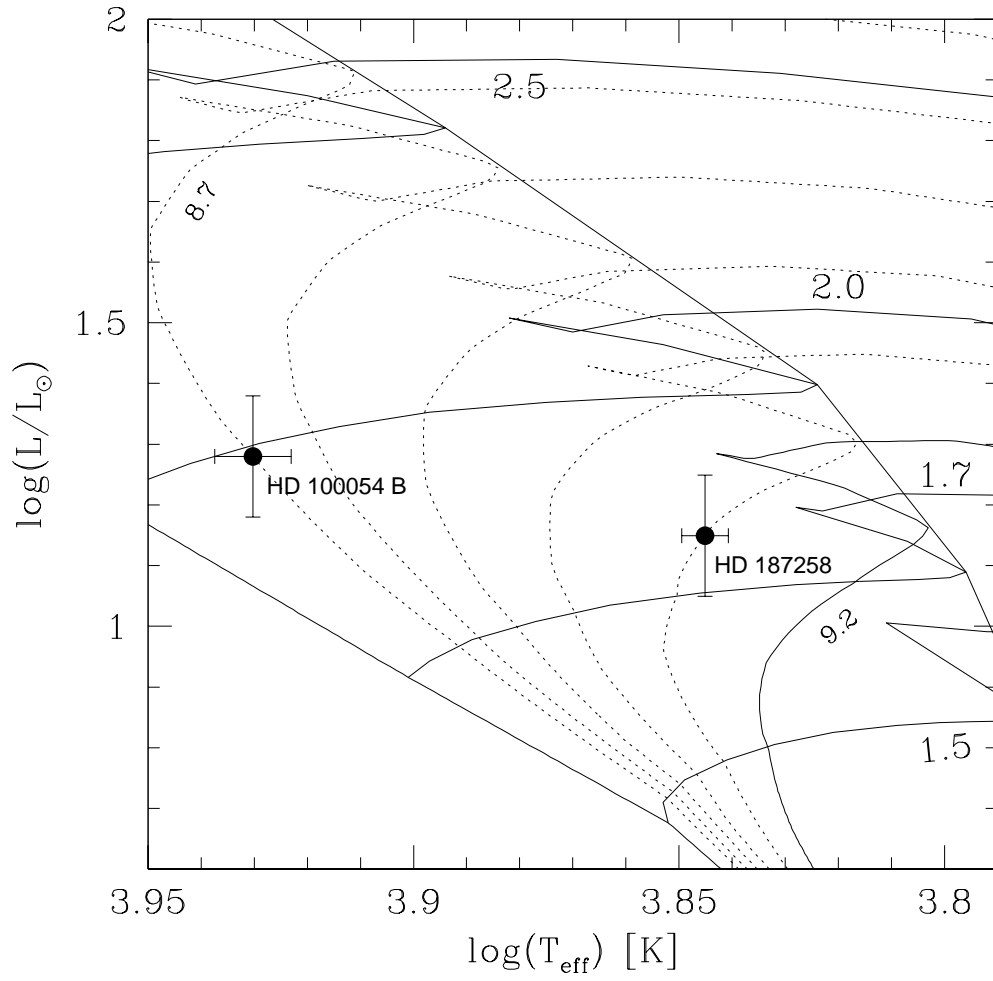


**Figure 3.** HD 187258: *RV* residuals ( $O - C$ ) versus time.



**Figure 4.** HD 187258: *RV* curve computed with the orbital elements of Table 3. The origin of the phases corresponds to the periastron passage.





**Figure 5.** Location of the primary components of HD 100054 B and HD 187258 in the theoretical evolutionary HR diagram computed by Schaller et al. (1992), with the isochrones given by Meynet et al. (1993).

**Table 1.** HD 100054 B: observed radial velocities  $RV$  (Col. 4) and residuals ( $O - C$ ) (Col. 5) relative to the orbits of Table 3. The epoch of observation (Col. 1) is given in Julian days. The first 6 values correspond to Young (1942)'s observations.

Date (JD) 2400000+	Cycle		$RV$ km s <sup>-1</sup>	$(O - C)$ km s <sup>-1</sup>
	orbit 1	orbit 2		
29729.736	-1567.22	-22.48	3.1	1.8
30114.617	-1537.14	-22.04	-20.3	-2.2
30376.859	-1516.64	-21.74	-16.9	-3.2
30383.844	-1516.09	-21.73	-18.8	-1.3
30429.721	-1512.51	-21.68	1.6	0.3
30431.668	-1512.35	-21.67	8.1	1.4
49785.516	0.34	0.47	-12.3	-0.3
49786.551	0.42	0.47	-2.4	0.6
49787.500	0.49	0.47	3.8	-0.1
50125.676	26.93	0.86	-22.5	-0.1
50126.555	26.99	0.86	-29.6	-0.1
50127.641	27.08	0.86	-34.6	0.0
50192.484	32.15	0.93	-37.0	-0.2
50193.461	32.22	0.93	-33.3	-0.6
50194.473	32.30	0.93	-24.9	0.4
50415.680	49.59	1.19	2.0	-0.1
50416.699	49.67	1.19	2.4	0.7
50419.645	49.90	1.19	-19.9	-0.5
50477.621	54.43	1.26	-5.2	0.9
50478.566	54.51	1.26	0.1	-0.3
50479.625	54.59	1.26	4.8	0.3
50480.551	54.66	1.26	4.5	0.1
50481.625	54.75	1.26	0.4	0.4
50609.500	64.74	1.41	3.4	-0.6
50610.426	64.81	1.41	-3.0	-0.1
50611.410	64.89	1.41	-12.1	-0.1
50613.441	65.05	1.41	-26.7	0.4
50614.402	65.12	1.41	-29.4	-0.7
50615.414	65.20	1.42	-25.6	0.0
50834.703	82.34	1.67	-12.1	0.6
50835.645	82.42	1.67	-5.0	-0.5
50836.598	82.49	1.67	2.2	-0.3
50837.531	82.56	1.67	5.4	-1.5
50838.574	82.65	1.67	8.3	0.4
50839.578	82.72	1.67	4.4	-0.3
50974.367	93.26	1.83	-26.7	-0.4
50975.484	93.35	1.83	-17.0	0.0
50976.375	93.42	1.83	-8.9	0.4
50977.410	93.50	1.83	-1.6	0.2
50978.402	93.57	1.83	1.7	-0.8
50979.391	93.65	1.83	3.0	0.0
51108.711	103.76	1.98	-5.0	1.9
51185.746	109.78	2.07	-8.9	-0.2
51186.707	109.86	2.07	-17.8	-0.8
51687.406	148.99	2.64	-21.9	1.1
51695.469	149.62	2.65	9.0	0.5
51700.504	150.01	2.66	-25.0	0.2
51702.480	150.17	2.66	-26.5	1.4
51708.469	150.64	2.67	7.7	-0.4
52094.449	180.80	3.11	-10.7	-0.3
52095.449	180.88	3.11	-19.4	0.1
52117.398	182.60	3.13	0.4	-0.2
52398.566	204.57	3.46	8.6	0.2
52470.414	210.19	3.54	-26.3	-0.8

**Table 2.** HD 187258: observed radial velocities  $RV$  (Col. 3) and residuals ( $O - C$ ) (Col. 4) relative to the orbit of Table 3. The epoch of observation (Col. 1) is given in Julian days.

Date (JD) 2400000+	Cycle	$RV$ km s <sup>-1</sup>	$(O - C)$ km s <sup>-1</sup>
49642.320	0.52	-22.8	1.1
49643.301	0.56	-24.3	-0.6
50195.660	21.96	-53.4	-0.1
50324.461	26.95	-51.6	0.2
50328.410	27.11	-48.4	0.7
50419.281	30.63	-24.9	-1.0
50480.738	33.01	-59.1	-0.8
50611.531	38.08	-54.4	-1.3
50738.371	42.99	-58.0	-0.6
50743.309	43.19	-38.1	1.2
50745.359	43.27	-32.9	-0.3
50746.309	43.30	-30.1	0.3
50974.609	52.15	-43.3	0.1
50975.590	52.19	-39.9	-0.8
50976.578	52.23	-35.6	0.0
50978.602	52.30	-31.0	-0.7
50979.559	52.34	-28.0	0.5
51105.328	57.21	-36.4	0.1
51106.301	57.25	-33.9	-0.4
51107.309	57.29	-31.8	-0.8
51108.352	57.33	-29.2	-0.3
51109.340	57.37	-26.2	1.1
51110.309	57.41	-26.2	-0.1
51111.328	57.45	-24.4	0.7
51351.570	66.76	-27.4	0.0
51686.539	79.74	-27.2	-0.7
52101.520	95.82	-31.1	0.7
52178.371	98.80	-29.1	0.9
52201.359	99.69	-25.2	-0.3
52206.301	99.88	-38.5	0.4
52207.340	99.92	-45.6	0.0
52208.238	99.96	-52.7	-0.7
52236.238	101.04	-56.1	1.3
52252.211	101.66	-24.1	0.2
52335.719	104.90	-40.7	0.5
52360.672	105.86	-37.0	-0.6
52361.672	105.90	-42.8	-0.6
52362.691	105.94	-49.7	-0.3
52363.660	105.98	-54.3	1.4
52382.648	106.71	-25.9	-0.3

**Table 3.** Orbital elements of HD 100054 B and HD 187258. For HD 100054 B, these elements were obtained with a simultaneous fit of two orbits. Orbit 1 refers to the short-period system, whereas orbit 2 refers to the orbital motion of the centre of gravity of the short-period system relative to the centre of gravity of the triple system. In Col. 3,  $T$  is the periastron passage.

Object	$P$ days	$T$ (JD) 2400000+	$\omega$ deg.	$e$	$K_1$ km s <sup>-1</sup>	$V_0$ km s <sup>-1</sup>	$a_1 \sin i$ Gm	$f(m)$ M <sub>⊙</sub>	$\sigma_{(O-C)}$ km s <sup>-1</sup>
HD 100054 B, orbit 1	12.79430 ±0.00008	49781.19 ±0.53	137. ±15.	0.028 ±0.008	18.69 ±0.15		3.29 ±0.03	0.0087 ±0.0002	
HD 100054 B, orbit 2	874.2 ±1.6	49377. ±36.	172. ±15.	0.097 ±0.033	5.30 ±0.17	-13.52 ±0.10	63.4 ±2.4	0.013 ±0.001	0.61
HD 187258	25.8048 ±0.0012	49628.91 ±0.12	165.9 ±1.6	0.370 ±0.011	17.36 ±0.20	-34.76 ±0.14	5.72 ±0.09	0.011 ±0.001	0.68

**Table 4.** Physical parameters of HD 100054 B and HD 187258 primary components according to their colours in the Strömgren photometry.

Object	$M_V$ (mag.)	$T_{eff}$ (K)	$\log g$ (cgs)	[Fe/H] (dex)	$\log(L/L_{\odot})$	$M$ (M <sub>⊙</sub> )	$R$ (R <sub>⊙</sub> )
HD 100054 B	1.7	8500	4.2	0.50	1.3	2.0	2.1
HD 187258	1.95	7000	3.75	0.13	1.15	1.8	2.7