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The nature of Sk −67°18 in the Large Magellanic Cloud: A multiple system with an O3f* component

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Abstract. We present the results of photometric and spectroscopic observations obtained between 1980 and 1996, which show that the bright star Sk −67°18 in the Large Magellanic Cloud (LMC) is a multiple star which contains an eclipsing binary system. Our spectra show that this is an Of + O type binary, where the primary is probably of type O3f*. The orbital period of the eclipsing binary is almost exactly 2 days, which considerably compromises the obtaining of data with suitable phase coverage. Furthermore, from our radial velocity analysis of the spectral lines, Sk −67°18 appears to be a multiple system consisting of at least two pairs of short-period binaries.

Key words. galaxies: individual: LMC – stars: binaries: general – stars: early-type – stars: individual: Sk −67°18

1. Introduction

Sk −67°18 (Sanduleak 1970) is a bright, blue star in the LMC located within the stellar association NGC 1747, which is embedded in the ring-shaped HII region DEM 31 (Davies et al. 1976). This region was included by Oey (1996) in her studies of stellar content of HII rings in the LMC. Walborn (1977) classified the spectrum of Sk −67°18 as O6-7 + WN5-6; therefore, this star is included in the catalogue of Wolf-Rayet (WR) stars in the LMC as Brey 5 (Breysacher 1981), and as BAT99-6 (Breysacher et al. 1999). Walborn also stated that the spectrum of Sk −67°18 is variable, and that it most probably would be a spectroscopic binary.

The spectral type assigned by Walborn (1977) for Sk −67°18 seemed to indicate that it possibly might be a double-lined binary, and thus appeared as a good candidate for estimates of individual stellar masses. We therefore began collecting spectroscopic and photometric data of Sk −67°18 in 1980 in order to obtain an orbital solution of its binary motion.

In this paper we present our results of several years of observations showing that Sk −67°18 indeed contains an eclipsing binary, and that it is a multiple system, probably consisting of two pairs of short-period binaries.

2. Observations

2.1. Photographic spectrograms

During 1980 December, 1982 January, and 1985 March, we obtained a total of 23 blue spectrograms of Sk −67°18, with the Carnegie image tube spectrograph (CITS) attached to the 1-m Yale telescope at the Cerro Tololo Inter-American Observatory (CTIO), Chile. These spectra have a reciprocal linear dispersion of 45 Å mm^{-1} and cover the wavelength range 3700–5000 Å. A helium-argon (He-A) lamp was used as the comparison source.

The spectrograms obtained in 1980 and 1982 were secured on baked Kodak IIa-O emulsion, with 0.65 mm widening. They have a signal-to-noise (S/N) ratio ∼20–30. Radial velocities from these spectrograms were determined for the HeII λ4686 Å emission and hydrogen (H) absorption lines by fitting a parabola to the line cores on rectified photographic density mode scans, obtained with the PDS at the David Dunlap Observatory (DDO), Toronto.

The spectrograms secured in 1985 have a slightly better S/N (∼40), as they are on fine grain Kodak IIIa-J emulsion, baked in forming gas, and widened to 1 mm. These spectrograms were measured for the determination of radial velocities with the Grant oscilloscope comparator at the Instituto de Astronomía y Física del Espacio (IAFE), in Buenos Aires, Argentina.

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2.2. Digital spectrograms

At the end of 1985, the CITS of the 1-m telescope at CTIO was transformed to digital mode, called 2DF. In essence, this consists of the output from the spectrograph passing through three coupled image tubes, i.e. two VARO tubes and the Carnegie tube, to a CCD detector. A total of 28 blue digital spectrograms of Sk −67°18 was obtained with this instrumental configuration during 1985 December, 1986 January, 1988 November and 1990 December. The same grating and the same He-A comparison lamp as for the photographic spectrograms was also used for the digital 2DF spectrograms. The S/N of these spectra is ∼30–50. Radial velocities from the digital 2DF spectrograms were determined with the data processing facilities of CTIO at La Serena, Chile.

Five blue, flux-calibrated Image Dissector Scanner (IDS) spectrograms were secured for Sk −67°18 in 1982 December, with the 1.5 m telescope at the European Southern Observatory (ESO), Chile. These spectrograms cover the wavelength range 4000–5000 Å with about 3 Å (FWHM) resolution, and S/N of about 30. Radial velocities were determined only for HeII λ4686 Å emission, using the IHAP image processing package at ESO, Garching.

Twelve spectral CCD images were obtained in 1992, February, and in 1996, February and December, with the Cassegrain spectrograph attached to the 2.15 m telescope at the Complejo Astronómico El Leoncito (CASLEO)[1], San Juan, Argentina.

These spectra have a reciprocal dispersion of ∼2 Å per pixel, and they cover the wavelength range 3900–5200 Å, except the last one from 1992, which extends from 4500 to 5900 Å. The S/N of these digital CCD spectra is ∼150.

Radial velocities from these spectra were obtained fitting gaussian profiles to the spectral lines using IRAF routines at La Plata University, Argentina.

The journal of all our spectroscopic observations and the radial velocities derived for Sk −67°18, are listed in Table 1. In total, radial velocities have been secured for the emission lines of NIV λ4058 Å and HeIIλ 4686 Å, and for the λ4604 Å absorption of the NV doublet at λλ4604/20 Å. Mean values of radial velocities are given for the absorption lines of H Balmer, HeII and HeI. Because the visibility of the spectral lines is highly dependant on the S/N ratio of the spectrograms, only the most intense lines could be measured when the S/N was low. Furthermore, the variable shape of the HeII λ 4686 Å emission, particularly when double peaks appeared (see Fig. 1), sometimes hindered the determination of even a rough radial velocity value.

2.3. Photometry

The photometric data were obtained in 1982 January, with the WALRAVEN photometer attached to the 0.9 m Dutch telescope at ESO, Chile, as part of a general photometric variability study of WR stars in the Magellanic Clouds (Seggewiss et al. 1991). The photometric system comprises five intermediate-width passbands, $VBLUW$, with effective wavelengths extending from λ3235 Å to λ5441 Å which can be recorded simultaneously. The V passband is fairly close to V of the JOHNSON UBV system in peak wavelength as well as in bandwidth. The WALRAVEN B band has only half the width of JOHNSON B but similar peak wavelength. The system is described in detail by Lub & Pel (1977).

A diaphragm of diameter 11.″6 on the sky was used. The integration time was always 32 s per observation. The comparison star was HD 32034 (Sk −67°17). The differential photometric data in the sense star minus comparison in V and $(B - V)$ are listed in Table 2. As usual in the WALRAVEN system the magnitudes and colors are given in +log (intensity) reduced to air-mass 1.0. For the comparison star, see also Seggewiss et al. (1991).

In addition to the WALRAVEN photometry, a few JOHNSON V measurements were obtained in 1988 October, at the Bochum 61 cm telescope at ESO, Chile. These measurements are listed in Table 3.

[1] Operated under agreement between CONICET, SECYT, and the National Universities of La Plata, Córdoba and San Juan, Argentina.

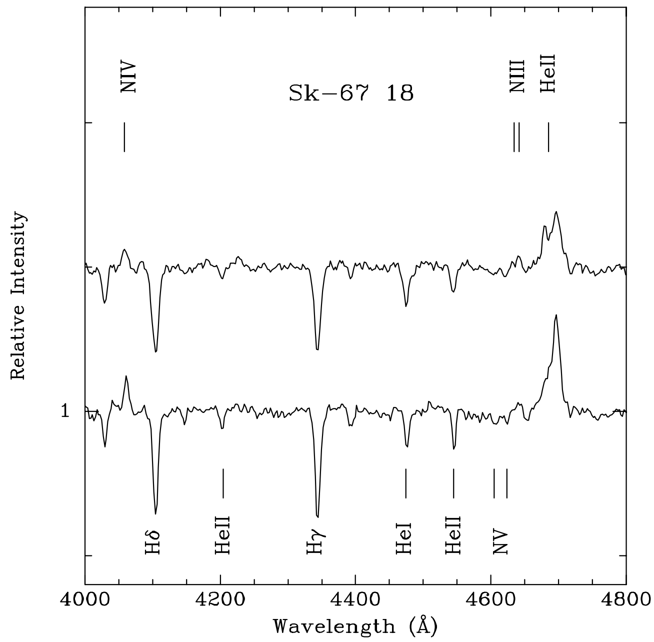

Fig. 1. Continuum-rectified CCD spectra of Sk −67°18 observed during consecutive nights at CASLEO in 1996, December. Lower spectrum was observed at HJD 2450433.7 and upper spectrum at HJD 2450434.8. Note the difference in relative strengths of HeI and HeII absorptions, and the variation in the shape of HeII 4686 Å emission

3. The spectrum

The spectrum of Sk −67°18 is illustrated in Fig. 1, which depicts two rectified CCD spectra obtained during consecutive nights at CASLEO in 1996, December. The spectrum seen in this figure confirms at first glance Walborn's (1977) spectral classification of O6-7 + WN5-6 for

Table 1. Journal of spectroscopic observations of Sk −67°18

	Heliocentric Radial Velocities (km s^{-1})					
HJD	He II 4686e	N IV 4058e	N V 4604a	H abs	He II abs	He I abs
4584.747	538			299		
4585.651	180			199		
4586.651	618			332		
4587.799	161			233		
4588.684	412			314		
4589.719	316			199		
4594.682	705			288		
4596.778	397			255		
4597.646	1			226		
4599.651	146			241		
4974.655	135:			262		
4975.771	245			278		
4976.577	572			271		
4977.647	394			201:		
4978.733	690			291		
4980.585	800			278		
4981.649	276			227		
4982.632	744			273		
5309.661	763					
5312.678	263					
5313.560	776:					
5314.678	584:					
5315.649	590					
6134.589	89			185		272
6137.576	739	583		297		275
6138.510	347			194		237
6139.575	769	654		319		312
6403.805	696	620	626	325	364	271
6404.854	453	−139	−112	239		288
6405.783	683	613	749	365	454	365
6407.794	850	721	632	374		348
6408.750	113	−198	−261	242		306
6409.721	727	598	634	337	436	327
6410.739	−12	−41	1	219		295
6411.702	788	717		376	448	307
6412.744	41	−70	13	219	59	304
6445.654	768	556	592	342		339
6446.687	27	39		218	197	325
6447.743	815	597		378		295
6448.697	57	−46	20	265		256
6449.714	688	570	491	364	541	254
6450.656	67	−32		250	166	213
6451.656	757	567		340	473	265
6452.669	72	−32		249		245

continued

Sk −67°18. Our spectrograms also confirm his statement of spectral variability (see Fig. 1) which we mainly observe as striking profile variations of the He II λ4686 Å emission line, large variations in the ionization of the absorption line spectrum seen as changes in the relative strengths of the He I and He II absorptions and more subtle variations of

Table 1. Continued

HJD	Heliocentric Radial Velocities ($km\,s^{-1}$)					
	HeII 4686e	NIV 4058e	NV 4604a	H abs	HeII abs	HeI abs
7473.803		278	531	255	287	213
7474.751		493		234	349	200
7475.761				238		174
7476.771		361		250	322	217
7477.740		47		247	276	185
7478.833		405		251	336	252
7479.723				236	303	195
7480.683		398		261	343	181
7481.831		264		245	308	197
8252.626	638:	387		244	264	250
8253.708	570:	51		288	218	313
8661.716		114		240	267	312
8662.578		243		268	292	301
8663.550		387	156	277	298	282
8664.588	657:			232	228	
10123.657	776	395	261	290	290	287
10125.576	741	421		288	285	324
10126.598	461:	96	58	242	205	297
10128.603	350	100	151	236	202	291
10129.537	740	349	394	285	322	294
10432.673		251	27	245	302	293
10433.709	678	255	137	233	225	260
10434.830		90	02	214	187	289

Note: HJD = Heliocentric Julian Date − 2 440 000 d
a: absorption, e: emission, H abs: mean value from hydrogen Balmer absorptions,
HeII abs: mean value from HeII λ 4200 and 4542 Å absorptions
HeI abs: mean value from HeI λ 4143, 4387, and 4471 Å absorptions.

absorption line widths. The spectral variations probably are correlated with the binary phase.

4. Analysis of the data

4.1. The period

The light variations of Sk −67°18 in the WALRAVEN and JOHNSON photometric data prove the star to be an eclipsing system and immediately indicate a period of almost exactly two days. Because our photo-electric data were obtained within short intervals of time (weeks), the period, which is so close to an integral number of days, produces a crowding of the data points at particular phases. Moreover, the measurements do not include observations at times of minima. Therefore, these data alone are insufficient for the determination of a reliable period.

An inspection of the radial velocity (RV) data (Table 1) shows large variations for the emission lines of NIV λ4058 Å and HeII λ4686 Å and for the central absorption of NV λ4604 Å. On the one hand, periodicities were searched for in these data, independently for each data set, applying a period search algorithm (Marraco & Muzzio 1980) to the radial velocities. (We have omitted all those inferior data points which are indicated by a colon in Table 1.) On the other hand, we have made a simultaneous analysis of the three data sets, adding also the photometric data, in order to find a period that would be compatible with all radial velocities and the photometry.

Unfortunately, the inevitable period of nearly exactly 2 days produces a large number of alias periods, all close to 2 days. Furthermore, tiny changes in period and epoch for one data set normally result in a phasing which is incompatible with the other data sets. For example, with the slightly shorter period previously found to be compatible with all the data obtained up to 1990 (Niemela et al. 1995), the radial velocities determined from spectral observations gathered later were clearly out of phase. However, a close alias period was found to be more suitable for all data sets (see below). Therefore, the derived period and the other orbital parameters are only preliminary, in anticipation of a better ephemeris from observations of times of minimum light for the binary system.

Table 2. Observations of Sk −67°18 in the Walraven photometric system

HJD	Phase	ΔV	$\Delta(B-V)$
4984.605	0.5840	−0.921	−0.126
4984.719	0.6409	−0.912	−0.122
4984.770	0.6664	−0.899	−0.123
4985.566	0.0642	−0.953	−0.110
4985.676	0.1191	−0.923	−0.115
4985.730	0.1461	−0.904	−0.130
4985.762	0.1621	−0.891	−0.130
4986.566	0.5639	−0.955	−0.108
4986.609	0.5854	−0.928	−0.120
4986.684	0.6228	−0.919	−0.121
4986.715	0.6383	−0.906	−0.131
4986.742	0.6518	−0.911	−0.126
4986.773	0.6673	−0.912	−0.129
4987.559	0.0601	−0.954	−0.114
4987.598	0.0796	−0.935	−0.118
4987.637	0.0991	−0.931	−0.122
4987.687	0.1240	−0.922	−0.123
4987.730	0.1455	−0.913	−0.115
4987.766	0.1635	−0.905	−0.124
4987.797	0.1790	−0.915	−0.124
4988.555	0.5578	−0.940	−0.120
4988.594	0.5773	−0.939	−0.127
4988.664	0.6123	−0.925	−0.119
4988.719	0.6397	−0.902	−0.125
4988.762	0.6612	−0.909	−0.120
4988.801	0.6807	−0.896	−0.125
4989.555	0.0575	−0.944	−0.117
4989.590	0.0750	−0.931	−0.114
4989.641	0.1005	−0.924	−0.121
4989.711	0.1354	−0.922	−0.121
4989.754	0.1569	−0.907	−0.129
4989.781	0.1704	−0.902	−0.117
4989.812	0.1859	−0.904	−0.126
4990.559	0.5592	−0.941	−0.123
4990.602	0.5807	−0.934	−0.115
4990.656	0.6077	−0.919	−0.120
4990.719	0.6391	−0.910	−0.134
4990.762	0.6606	−0.904	−0.118
4990.793	0.6761	−0.898	−0.118
4990.812	0.6856	−0.895	−0.122
4991.598	0.0784	−0.927	−0.117
4991.656	0.1074	−0.925	−0.125
4991.746	0.1523	−0.908	−0.118
4991.781	0.1698	−0.904	−0.124
4991.812	0.1853	−0.899	−0.119
4992.566	0.5621	−0.942	−0.121
4992.660	0.6091	−0.918	−0.124

continued

Table 2. Continued

HJD	Phase	ΔV	$\Delta(B-V)$
4992.719	0.6386	−0.910	−0.119
4992.758	0.6580	−0.913	−0.118
4992.793	0.6755	−0.900	−0.120
4993.566	0.0618	−0.945	−0.116
4993.613	0.0853	−0.931	−0.120
4993.656	0.1068	−0.919	−0.117
4993.723	0.1403	−0.910	−0.123
4993.781	0.1692	−0.901	−0.123
4993.805	0.1812	−0.881	−0.114
4994.559	0.5580	−0.941	−0.121
4994.664	0.6105	−0.919	−0.123
4994.723	0.6400	−0.908	−0.121
4994.773	0.6649	−0.898	−0.124
4994.801	0.6789	−0.893	−0.133
4995.543	0.0497	−0.955	−0.117
4995.666	0.1112	−0.924	−0.121
4995.715	0.1357	−0.905	−0.120
4995.750	0.1532	−0.905	−0.122
4995.801	0.1786	−0.910	−0.127
4996.559	0.5574	−0.939	−0.126
4996.660	0.6079	−0.918	−0.117
4996.730	0.6429	−0.907	−0.120
4996.766	0.6609	−0.896	−0.121
4996.797	0.6763	−0.891	−0.118
4997.562	0.0586	−0.946	−0.121
4997.617	0.0861	−0.930	−0.121
4997.676	0.1156	−0.915	−0.123
4997.730	0.1426	−0.914	−0.119
4997.734	0.1446	−0.906	−0.123
4997.777	0.1661	−0.895	−0.124
4997.793	0.1740	−0.904	−0.127
4998.559	0.5568	−0.948	−0.112
4998.613	0.5838	−0.921	−0.121
4998.660	0.6073	−0.913	−0.118
4998.707	0.6308	−0.906	−0.116
4998.762	0.6583	−0.894	−0.115
4998.793	0.6738	−0.892	−0.116

Note: HJD = Heliocentric Julian Date − 2 440 000 d.
The magnitudes and colors are given in +log (intensity) reduced to air-mass 1.0 in the sense Sk −67°18 minus comparison star. The phases are calculated from orbit listed in Table 4.

For simultaneous solution of all our data sets, we first considered those data which covered the longest time-interval, i.e. the radial velocities of He II λ4686 Å emission and hydrogen Balmer absorptions. These data indicated as the most probable periods 2.0011 and 2.0012 days, respectively. The best-defined radial velocities in our data are those of the N IV λ4058 Å emission, and the most probable period from these data alone also indicated a period of 2.0012 days. We then proceeded to find a period close to the values found above, with which the photometric data would reproduce a plausible light-curve. Because our photometric observations do not cover the phases of minimum light, we also imposed the condition that the observed rising and declining branches of the light-curve should not overlap when phased with the appropriate period. The simultaneous solution for all data sets gives the following result:

period $P = 2.001185 \pm 0.000005$ days

epoch $T_0 = JD2446506.338 \pm 0.01$

Table 3. Photometric observations of Sk −67°18 in Johnson V

HJD	Phase	ΔV	$\Delta V_{\rm w}$
7438.661	0.8854	2.225	−0.890
7438.811	0.9603	2.303	−0.921
7439.645	0.3771	2.220	−0.888
7441.645	0.3765	2.248	−0.899
7441.792	0.4499	2.302	−0.921
7441.861	0.4844	2.357	−0.943
7444.650	0.8781	2.238	−0.895
7444.766	0.9361	2.310	−0.924
7454.592	0.8462	2.229	−0.892
7454.606	0.8531	2.212	−0.885
7454.672	0.8861	2.249	−0.900
7454.756	0.9281	2.335	−0.934
7454.817	0.9586	2.362	−0.945
7454.870	0.9851	2.433	−0.973
7455.599	0.3494	2.226	−0.890
7455.667	0.3833	2.252	−0.901
7455.729	0.4143	2.308	−0.923
7455.790	0.4448	2.325	−0.930

Note: HJD = Heliocentric Julian Date − 2 440 000 d.
The magnitude difference ΔV is given in the sense Sk −67°18 minus comparison star. $\Delta V_{\rm w}$ is the difference transformed to Walraven system.
The phases are calculated from orbit listed in Table 4.

(We choose the time of passage T_0 through the systemic velocity V_0 from positive to negative values which, in the case of a circular orbit, corresponds to the time of the eclipse where the O3f star is behind).

The errors were estimated plotting all the data with different values of P and T_0 until the relative phasings had been noticeably altered.

4.2. The radial velocity orbit

Table 4 lists the calculated orbital parameters corresponding to each set of radial velocity data. The individual data with the circular orbits from Table 4 are plotted in Fig. 3. From this figure and Table 4 we note the following:

- The RVs of the NIV λ4058 Å and HeII λ4686 Å emission and NV λ4604 Å absorption lines show a variation of large amplitude, similar for all three lines;
- The HeII λ4686 Å emission varies with much scatter, and seems to be phase-shifted with respect to the NIV emission by 0.3 days;
- The RVs of the HeII absorptions vary in phase with the emission lines, but with smaller amplitude;
- The RVs of the hydrogen Balmer absorption lines also vary in phase with the emission lines, but with even smaller amplitude than the HeII absorptions;
- The neutral He absorption lines show almost no periodic variation when plotted in the same period as the emission and HeII and H absorption lines, (but see below);
- The systemic velocity V_0 is in good agreement for all lines, except for the HeII λ4686 Å emission, which has a considerably more positive V_0.

The different behaviour of HeII vs. HeI absorption lines is likely due to combined spectra from stars of different temperature, one with HeII strong and HeI weak, indicating an early O type, and the other with HeI stronger than HeII, indicating a late O or early B type spectrum. The radial velocities of the neutral helium absorption lines, despite the lack of periodic variations with the same period as the light curve and emission lines, show a considerable range of values. A period search routine applied to these values yields as a best period

$P = 19.265 \pm 0.005$ days

$T_0 = 2446509.15 \pm 0.1$ days.

In this period, the HeI absorptions show an approximately sinusoidal variation of $K = 58$ km s^{-1}, as shown in Fig. 4. This indicates that the HeI absorptions mainly come from the brighter component of another binary system, and thus Sk −67°18 probably harbours at least four stars.

4.3. The light curve

The photoelectric data are plotted in Fig. 5, with the same ephemeris as for the radial velocity data (Table 4). Each data set defines the branch in a light curve of an eclipsing binary apparently of W UMa type. It must be stressed again that small changes in period and epoch significantly modify the relative position of the two branches. In Fig. 5 two similar light minima are present, approximately 0.2 mag deep.

5. Discussion

Because we observe (1) that the mean radial velocities of the hydrogen Balmer and HeII absorption lines follow the same orbital motion as the emission lines (cf. Fig. 2), and (2) that the absorption lines are not blue-shifted, then the emission-line star cannot be of WN type, but rather of spectral type Of. The presence of NV absorptions, and NIV emission indicates a spectral type O3f* (cf. Walborn 1982) for the brighter component of Sk −67°18. This spectral type is supported by the NIV/NIII emission ratio. Thus, the primary in Sk −67°18 has the same "fate" as the secondary component of the once-WN binary system HDE 228766, which also had to be reclassified to an Of-type star (Walborn 1973; Massey & Conti 1977).

Neutral helium should not be visible in an O3f* star. The different pattern of periodic variability of the RVs of the HeI absorptions as seen in Fig. 4 is easily explained if they arise in a close visual companion, too close to be resolved at the distance of the LMC. This companion also appears to be a binary. The considerable strength of the HeI absorption lines in the spectrum of Sk −67°18 (cf. Fig. 1), together with its absolute magnitude $M_V = -6.9$

Table 4. Preliminary orbital elements of Sk $-67°18$

		$P = 2.001185$ days; $e = 0$					
		N IV 4058e	N V 4603a	H abs	He II 4686e	He II abs	He I abs
V_0	$\mathrm{km\,s^{-1}}$	278 ± 6	246 ± 20	266 ± 3	464 ± 15	287 ± 10	272 ± 7
K	$\mathrm{km\,s^{-1}}$	320 ± 7	336 ± 15	55 ± 3	308 ± 18	131 ± 8	13 ± 10
T_0		$6506.338 \pm .01$					
σ	$\mathrm{km\,s^{-1}}$	32	71	16	84	36	31

Note: T_0 is the time of passage through the systemic velocity V_0 from positive to negative radial velocity $+\,2\,440\,000$ adopted to be the same for all radial velocity curves.

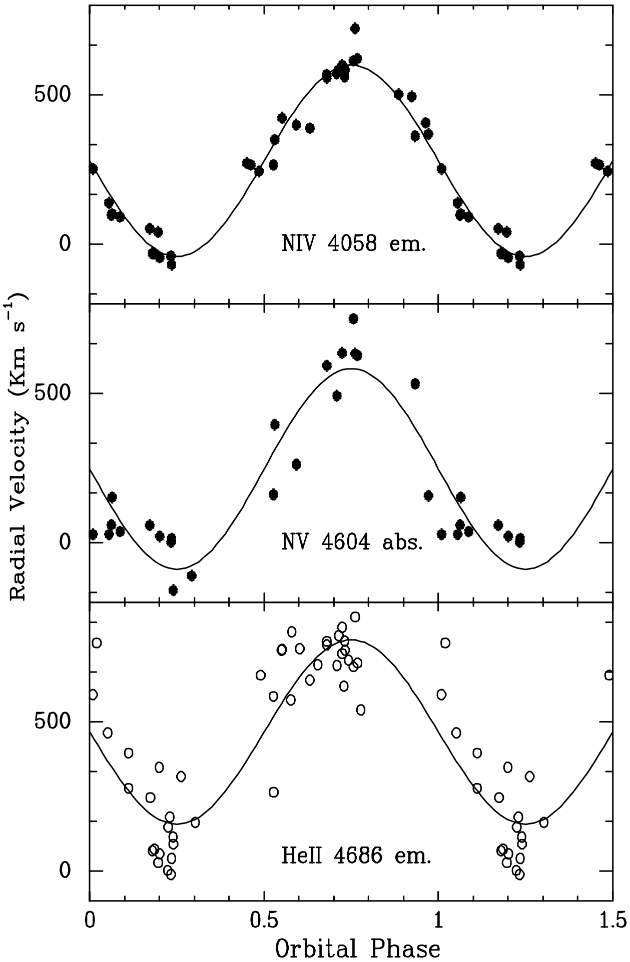

Fig. 2. Radial velocity variations of N IV and He II emissions and N V absorption in the spectrum of Sk $-67°18$ phased with the period of 2.001185 days. Continuous lines represent the orbital solution from Table 4

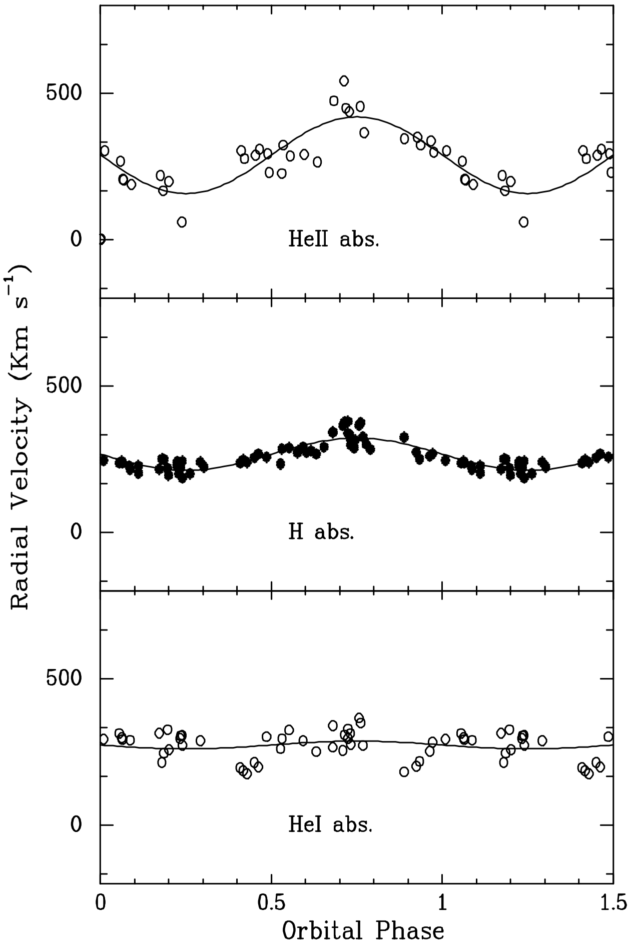

Fig. 3. Radial velocity variations of He II, H and He I absorption lines in the spectrum of Sk $-67°18$ phased with the period of 2.001185 days. Continuous lines represent the orbital solution from Table 4

(Walborn 1977), means that the companion to the close binary also must be very luminous, indicative of a supergiant of spectral type O8-B0. Of course, the brightest stars in the Magellanic Clouds may well include a great number of multiple systems, as has been emphasized e.g. by Heydari–Malayeri et al. (1988).

The large value of the systemic velocity V_0 of the He II λ4686 Å emission line, compared to the other lines, is a well-known effect of all Wolf-Rayet and Of-type stars. The small shift in epoch, compared to the N IV and N V lines, might be spurious due to the difficulties with the 2-day period, as mentioned above. On the other hand, these shifts might also be caused by a manifold superposition of antiphased emission and photospheric He II λ4686 Å absorption in the other stars (see Fig. 1).

The He II absorption lines appear to have variable shape in our spectrograms. The radial velocity variations

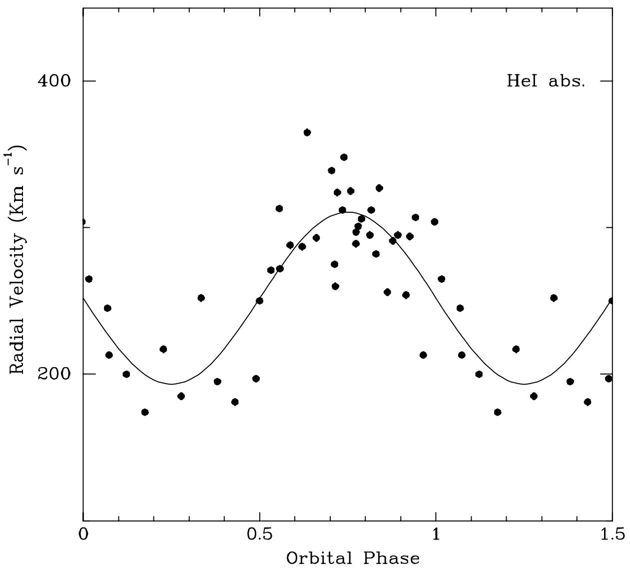

Fig. 4. Radial velocity variations of the HeI absorption lines in the spectrum of Sk −67°18 phased with the period of 19.265 days and T_0 2446509.15 days

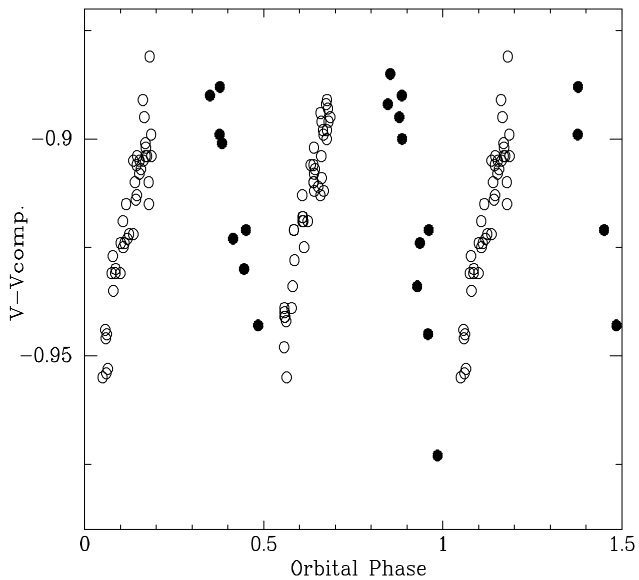

Fig. 5. Photoelectric data of Sk −67°18 plotted with the same ephemeris as the radial velocity data in Fig. 3, showing a continuous light variation of W UMa type. Open circles correspond to the data obtained with the Walraven V filter, and filled circles to the data obtained in the Johnson V filter, converted to the Walraven system

of the mean absorption follow the same orbital motion as the emission lines, but with lower amplitude. This means that these lines are blends, the main contribution for the HeII absoption arising in the atmosphere of the O3f* component. On a few of our spectra, the HeII absorption lines seem to have components that suggest an orbital motion opposite to that of the O3f* star. Therefore, the close binary companion to the O3f* star must be also an O-type star. This is consistent with the lack of phase-dependant color variations in the light curve.

The considerably lower amplitude of the radial velocity orbit of the hydrogen Balmer lines and their variable width indicate that these lines are also blends, consisting of 4 components. The strongest contribution to these lines comes from the O3f* star.

The orbital motion of the O3f* component of the binary is most clearly indicated by the NIV λ4058 Å emission and the NV λ4604 Å absorption lines, which do not show blending effects. However, in order to obtain the orbital elements for the secondary component of the binary, spectrograms with much higher resolution and signal-to-noise ratio are required to isolate the lines from their blending components. Although the secondary's orbit is beyond our reach now, we note that the mass function, calculated from the primary's NIV orbit, is quite high: $f(M) = 6.5 \pm 0.5\,M_\odot$. This, in turn, means that one gets equal masses for the two components at $M_{\rm O3f} = M_2 = 26\,M_\odot$ in the most "modest" case, i.e. orbital inclination $i = 90°$. If the orbital inclination would be ~60°, as suggested by the rather small depth of the eclipses, then the masses would be $40\,M_\odot$. Moreover, we speculate that the O3f* star is the more massive component of the multiple system, in which case the combined masses of the components turns out to be well over 80 $M_\odot$.

The very early spectral type and the eclipsing nature of Sk −67°18 suggest that further observations with better spectral resolution and CCD photometry would be a rewarding program.

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