47. PHOTOMETRIC AND SPECTROSCOPIC DATA FOR SOME DISTANT O AND B STARS

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Abstract. The open cluster Stock 16 and some distant OB stars in Crux have been studied. Lack of absorption between spiral arms −I and −II is apparent. Negative residual radial velocities are found at distances of about 6 kpc at $l^{II} = 298°$.

The first group of stars that I am about to describe is situated in Crux at $l^{II} = 298\overset{\circ}{.}5$; $b^{II} = +2\overset{\circ}{.}1$ and the second group is essentially the cluster St. 16 at $l^{II} = 306\overset{\circ}{.}1$, $b^{II} = 0\overset{\circ}{.}2$ (Stock in Alter *et al.*, 1959). Data for these stars are given in Table Ia and Ib respectively. The numbers refer to my catalogue (Lyngå, 1968) of faint OB stars between Carina and Centaurus; identifications with CPD numbers are also given. The photoelectric UBV data were obtained at various telescopes at Mount Stromlo Observatory and the spectral plates were taken with the 100 cm reflector at Siding Spring Observatory equipped with a Meinel spectrograph (dispersion 119 Å/mm). The spectral classification (column 3 of Table I) was made using a number of standard spectra taken with the same instrument, and radial velocities were measured using the Abbe comparator with automatic setting device (Gollnow, 1962) at Mount Stromlo Observatory. The radial velocities with their mean errors are entered in column 4. Where variable radial velocity is suspected individual plate results are listed. The estimates of interstellar K line strength (column 5) were made on an arbitrary scale from 0 to 4. Column 6 gives absolute magnitude, colour excess and distance, spectroscopically determined. Colour excesses in brackets are photometrically determined on the assumption of luminosity class V. Residual radial velocities, using the same parameters of circular galactic motion as assumed by Feast (1967), are given in column 7 of Table I. In Table Ib, column 7 also contains remarks on membership of St. 16.

Using the unreddened colours given by Johnson (1963) I derive a reddening in $B–V$ for the stars in Crux, the mean value of which is $0\overset{m}{.}66$ with an rms scatter of $0\overset{m}{.}07$, all stars having nearly the same reddening. The reddening ratio E_{U-B}/E_{B-V} varies with spectral class in much the same way as the data treated by Lindholm (1957). The distances given in column 7 depend largely on the estimated luminosity classes and the calibration given by Blaauw (1963). From these it is concluded that the stars do not form a physical group.

To discuss the absorption conditions in more detail, I shall divide the stars into two groups. The three closest stars Nos. 111, 112 and 115 have a mean distance of 3.1 kpc and a mean colour excess of $0\overset{m}{.}66$. The mean distance of the four remaining stars is 5.8 kpc with the same mean colour excess $0\overset{m}{.}66$. If the reddening is proportional to a density of interstellar matter

$$\mathrm{d}(z) = \mathrm{d}(0)\, e^{-z/125}$$

Becker and Contopoulos (eds.), The Spiral Structure of Our Galaxy, 270–275. All Rights Reserved.

TABLE Ia

Data for seven OB stars in Crux

Star No. CPD No.	V $B–V$ $U–B$ n	MK class N_{sp}	Stellar r.v. (km s^{-1})	K-line int. r.v. (km s^{-1})	M_{sp} E_{B-V} r_{sp}(kpc)	Remarks
110 $-59°4119$	$10^{m}.22$ $+^{m}.26$ $-^{m}.60$ 5	B0 III 3	-33(var.) -39 $+16$	2.0 $+30$	$-5^{m}.0$ $^{m}.56$ 5.0	
111 $-59°4127$	$10^{m}.73$ $+^{m}.39$ $-^{m}.57$ 5	B1 IV 3	$-\ \ 3$(var.) -84 $+21$	3.0 -18	$-4^{m}.1$ $^{m}.65$ 3.6	
112 $-59°4128$	$11^{m}.00$ $+^{m}.39$ $-^{m}.59$ 4	B2 III 3	$+12$(var.) -19 $+35$	2.3 -12	$-3^{m}.6$ $^{m}.63$ 3.5	
113 $-59°4130$	$10^{m}.42$ $+^{m}.36$ $-^{m}.67$ 5	O7 3	-34 ± 7	2.0 $+39$	$-5^{m}.4$ $^{m}.68$ 5.8	res. vel. -12 km s^{-1}
114 –	$11^{m}.48$ $+^{m}.48$ $-^{m}.51$ 5	B0 III 3	-43 ± 6	1.7 $+\ 8$	$-5^{m}.0$ $^{m}.78$ 6.9	res. vel. -25 km s^{-1}
115 $-59°4147$	$9^{m}.40$ $+^{m}.43$ $-^{m}.59$ 6	B1 III 4	-34 ± 4	3.0 -17	$-4^{m}.4$ $^{m}.69$ 2.2	res. vel. -19 km s^{-1}
116 $-59°4152$	$10^{m}.71$ $+^{m}.31$ $-^{m}.73$ 5	O9 V 2	$+34$: -36	2.0 –	$-4^{m}.8$ $^{m}.60$ 5.5	

where z is height above the galactic plane in parsec, then the further group is expected to be more reddened than the nearer one by $0^{m}.26$. I suggest that there is a lack of absorbing matter at distances 3–6 kpc in this direction, $l^{II} = 298°.5$, which also agrees with the expected gap between spiral arms $-$I and $-$II.

The strength of the interstellar K-line varies from star to star, but is not correlated with distance for the stars studied, which indicates that the K-line absorption takes place close to the sun. This agrees with the fact that the K-line velocities are not systematically negative, which would have been required by a large distance for this galactic longitude.

TABLE Ib

Data for stars in the field of St. 16

Star No. CPD No.	V B–V U–B n	MK class N_{sp}	Stellar r.v. (km s^{-1})	K-line int. r.v. (km s^{-1})	M_{sp} E_{B-V} r_{sp}(kpc)	Remarks
233 $-61°3549$	$10^{m}.06$ $1^{m}.08$ $-^{m}.11$ 2	O9 III 2	-61 (var.) $+\ \ 1$	1.0 -18	$-5^{m}.7$ $1^{m}.39$ 2.2	non-member
235 $-61°3558$	$10^{m}.24$ $+^{m}.30$ $-^{m}.52$ 2	B1 Vn 1	-63	–	$3^{m}.6$ $^{m}.56$ 2.7	possible member
236 $-61°3566$	$9^{m}.29$ $+^{m}.23$ $-^{m}.75$ 2	B0 IIIn 4	-36 (var.) -147 -52 -47	1.0 $+24$	$-5^{m}.0$ $^{m}.53$ 3.5	possible member
238 $-62°3544$	$10^{m}.65$ $+^{m}.49$ $-^{m}.46$ 2	–	–	–	– ($^{m}.78$) –	non-member; multiple star; in nebulosity
239 $-61°3575$	$7^{m}.95$ $+^{m}.19$ $-^{m}.82$ 4	O9 V 5	-53 ± 4	1.4 -37	$-4^{m}.8$ $^{m}.50$ 1.8	member res. vel. -31 km s^{-1}
240 $-61°3576$	$9^{m}.48$ $+^{m}.23$ $-^{m}.71$ 4	B1 Vn 4	$+51$ (var.) -111 $+98$ -18	2.0 $+22$	$-3^{m}.6$ $^{m}.49$ 2.2	member
241 $-61°3579$	$10^{m}.44$ $+^{m}.25$ $-^{m}.71$ 3	B2 V 3	-92 (var.) $+14$ -33	2.0 $-\ \ 3$	$-2^{m}.5$ $^{m}.49$ 2.1	member
241 A	$11^{m}.62$ $+^{m}.26$ $-^{m}.51$ 1	–	–	–	– ($^{m}.49$) –	member
241 B	$11^{m}.43$ $+^{m}.34$ $-^{m}.30$ 1	–	–	–	– ($^{m}.52$) –	member
241 C	$12^{m}.50$ $+^{m}.33$ $-^{m}.16$ 1	–	–	–	– ($^{m}.46$) –	member

Table Ib (continued)

Star No. CPD No.	B $B-V$ $U-B$ n	MK class N_{sp}	Stellar r.v. (km s^{-1})	K-line int. r.v. (km s^{-1})	M_{sp} E_{B-V} r_{sp}(kpc)	Remarks
242 $-61°3581$	$10^m.09$ $+^m.27$ $-^m.66$ 3	B0: V 2	-78 (var.) $+1$	1.0 0	$-4^m.4$ $^m.57$ 3.6	member
246 $-61°3587$	$10^m.73$ $+^m.28$ $-^m.58$ 3	B1 V 3	-21 (var.) -50 $+3$	0.7 $+39$	$-3^m.6$ $^m.54$ 3.5	possible member; in nebulosity
247 $-61°3598$	$10^m.28$ $+^m.83$ $-^m.17$ 3	B2 Ib 4	-22 ± 3	4.0 $+6$	$-5^m.7$ $1^m.00$ 4.0	non-member res. vel. $+13$ km s^{-1}
HD 115071 $-61°3544$	$6^m.64$ $+^m.22$ $-^m.74$ 1	O9 Vn 3	-147 (var.) -124 -49	1.0 –	$-4^m.8$ $^m.53$ 0.9	non-member

Stars Nos. 113, 114 and 115 have constant radial velocities. Of the other stars, No. 111 has probably variable radial velocity and the remaining may or may not have variable radial velocities. If one or several of these stars were undisclosed binaries their distances would have been somewhat underestimated but the above discussion would not be significantly altered.

The area of the open cluster Stock 16 is shown in Figure 1. Numbers marked refer to Table Ib. It is clear from this table that the cluster stars have common colour excesses $E_{B-V} = 0\overset{m}{.}53$ and $E_{U-B} = 0\overset{m}{.}32$. The slope of the reddening trajectory is then 0.60. Figure 2 shows the colour-magnitude diagram $V/(U-B)_0$ and gives an apparent distance modulus of $13\overset{m}{.}4$. Assuming $R = 3.0$ we derive a true distance modulus of $11\overset{m}{.}8$, which agrees with the mean of the spectroscopic distance moduli of Table Ib, thus confirming our choice of absorption to reddening ratio. We also conclude that duplicity of cluster stars has not greatly affected our photometric distance determination, as such an effect would tend to increase the observed distance modulus.

The cepheid V 378 Cen is situated 8 min of arc from the cluster centre. If this star is a member of the cluster, then it is $0\overset{m}{.}7$ more luminous than was estimated from its period by Kraft and Schmidt (1963).

Four stars in Table Ib have been considered as non-members because of deviating colour excesses and because of deviating positions in the colour-magnitude diagram. None of these is situated close to the cluster (compare Figure 1). Star No. 238 is a multiple star involved in nebulosity and may be considered as a very compact cluster.

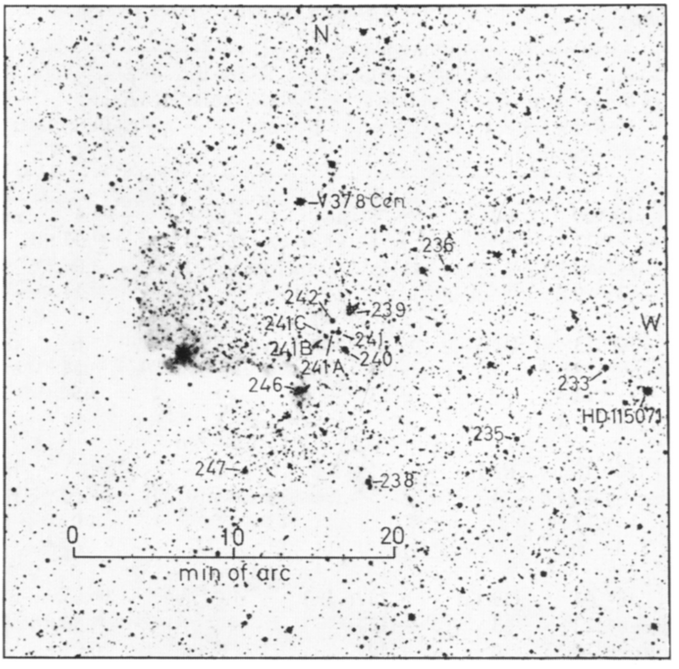

Fig. 1. Finding chart for St. 16. Nos. 233, 238, 247 and HD 115071 are considered as non-members.

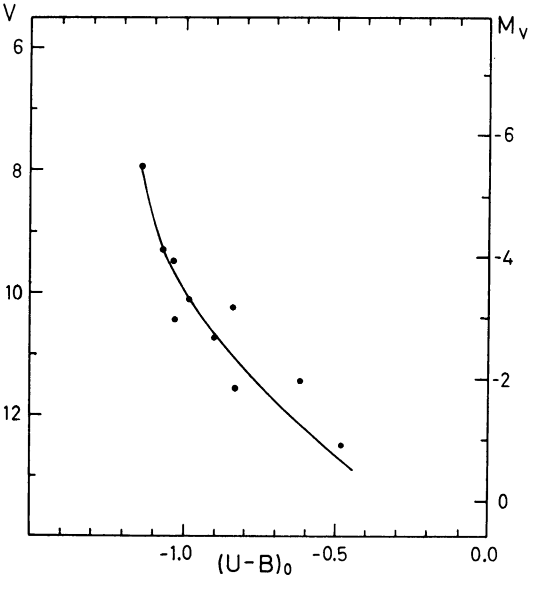

Fig. 2. Colour-magnitude diagram for members and possible members of St. 16 assuming $E_{U-B} = 0^m.32$. The right-hand scale and the curve assume an apparent distance modulus of $13^m.4$.

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On St. 16 we can further remark that it is a very young cluster since the O9V star No. 239 is on the main sequence.

It is of interest to compare the residual velocities listed in Table I with the compilation of residual velocites for OB stars and cepheids made by Feast (1967). Stars Nos. 113 and 114 are situated beyond the region in which residuals are predominantly negative thus extending this region. Nos. 115, 239 and 247 are situated in or slightly east of Feast's regions and confirm the sign of the residual in all cases. The mean value of the radial velocity for all members and possible members of St. 16 is -38 km s^{-1} from 22 plates. This gives a residual of -16 km s^{-1} as compared to -31 km s^{-1} measured from No. 239 alone.

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