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SPECTRAL AND PHOTOMETRIC OBSERVATIONS OF MWC 340.

In the paper the results of simultaneous spectrophotometric and photometric observations, received for MWC 340 star, as well as the photometric data for three stars in its vicinity, during 2001-2006 years at highmounting Assy-Turgen observatory are given. In spectra the intensity Hб and Hв, numerous FeII and forbidden [OI] lines are presented. The variety of Hб lines intensity relatively to continuum (from 13 to 21) is observed. For this time the Hб line equivalent width EW was changed in the limits 110÷160 Å, the brightness in range V= $10.^{m}70$÷ $10.^{m}85$; (B-V)= $0.^{m}84$÷$0.^{m}94$; (V-R)= $0.^{m}95$÷$1.^{m}02$. Any distinct correlation's of Hб line equal width EW with brightness V and color indexes of star on our observations were not observed.

1. Introduction

Investigated by us MWC 340 (BD+40°4124 = V1685 Cyg) star is embedded into diffuse gas nebula of inhomogeneous structure as seen on fig.1, taken from Palomar Survey. At distance of 2 arc minutes from star in south-east direction is extended the thin rim (length near 7 arc minutes), passed in south-west direction into diffuse envelope, separated from star by dark most likely absorbed envelope. The molecular coma-like cloud [1], extended from south to north, is overlapped on all that.

Firstly about small aggregate of stars with emission lines, connected with MWC 340, was reported by Herbig G.H. [2]. The MWC 340 region consist of few tens very young stars attributed to HAEBE stars. The data about 33 stars of isolated association of stars up to main consequence, related with two HAEBE stars MWC 340 and V1686 Cyg, are given Hillenbrand at al [1]. Only eleven of them are seen in visual, for which the spectral and photometric data are cited in works [3,4,5]. Our observations includes the spectral and photometric data for MWC 340 and photometric ones in V band for N2, N3 and N6 (V1686 Cyg = LkHa 224) stars from Table 1 of Hillenbrand et al [1].

Fig.1

Observations

The spectroscopic and photometric observations were carried out at the Assy-Turgen highmountain observatory 1-m telescope of the Fesenkov Astrophysical Institute of National Academy of sciences of Kazakhstan Republic during 2001 September - 2006 September.

2.1 Spectrophotometry The spectral observations were made with the spectrograph UAGS and CCD camera ST-8 with 1530 x 1020 pixels. The inverse dispersion was 0.5 Å on pixel. The spectral investigations of MWC 340 were mainly carried out in the regions of Hα and Hβ lines. The flat field for spectrophotometry was received from dome, illuminated by usual tungsten lamp. The reductions for instrumental contour were not made. The equivalent width of Hα line was defined without taking into account the blending them by absorption lines. All spectra have the resolution R=6000. The S/N ratio reaches about 25 and 12 in region of Hα and Hβ lines, respectively.

2.2 Photometry The photometric BVRI data were received with CCD camera ST-7 and filters of SBIG firm. In spite of that the R and I filters most likely gives the magnitudes in Johnson-Cousiens system, we reduced the our observations to the standard Johnson system. All photometric observations were corrected for flat field, received from twilight sky.

3. Results

The spectral and photometric observations received for MWC 340 during 2001-2006 are collected in tables 1-4.

Table 1.

Date	UT	JD 2450000+	EW(Hα) Å	FW(0.1) km/s	EW([OI]6300) A
16.09.2001	18h50m	2169.2847	131.1	731.4	-
20.09.2001	18h22m	2173.2653	129.2	745.1	-
21.09.2001	16h21m	2174.1812	137.7	731.4	-
16.10.2001	16h17m	2199.1368	130.0	731.4	-
18.10.2001	15h53m	2201.1201	125.7	681.1	-
16.11.2001	13h35m	2230.0660	127.9	749.7	-
18.11.2001	14h17m	2232.0951	121.0	708.5	-
21.11.2001	13h11m	2235.0493	115.6	713.1	-
05.08.2002	18h56m	2492.2889	138.0	713.1	1.39
06.08.2002	18h11m	2493.2576	122.5	740.5	1.20
08.08.2002	16h50m	2495.2014	119.8	704.0	1.01
09.08.2002	15h45m	2496.1562	127.5	749.7	1.16
05.09.2002	17h13m	2523.2174	111.4	708.5	0.86
07.09.2002	15h22m	2525.1403	116.3	713.1	1.02
08.09.2002	15h15m	2526.1354	130.0	758.8	1.25
09.09.2002	15h18m	2527.1979	121.6	745.1	1.50
09.10.2002	16h39m	2557.1938	127.4	704.0	0.97
06.11.2002	14h29m	2585.1035	124.7	768.0	1.52
28.08.2003	16h47m	2880.1993	138.1	745.1	1.03
29.08.2003	16h57m	2881.2062	113.9	749.7	0.97
31.08.2003	17h31m	2883.2299	141.5	749.7	1.37
24.09.2003	16h00m	2907.1667	127.9	777.1	1.24
25.09.2003	15h35m	2908.1493	145.5	758.8	1.69
28.09.2003	15h43m	2911.1549	130.0	763.4	0.81
29.09.2003	15h17m	2912.1368	125.3	768.0	0.95
30.09.2003	15h16m	2913.1361	128.4	758.8	0.87
13.08.2004	17h18m	3231.2208	131.7	745.1	1.01
13.09.2004	16h45m	3262.1979	138.4	669.4	1.58
08.10.2004	16h32m	3287.1472	130.7	704.0	1.15
14.10.2004	16h43m	3293.1549	143.6	736.0	0.91
09.11.2004	12h45m	3319.0312	153.8	740.5	0.89
31.07.2005	15h54m	3583.1625	121.5	713.1	1.62
03.09.2005	17h03m	3617.2104	158.4	726.8	-
04.09.2005	17h31m	3618.2299	152.1	681.1	1.26
05.09.2005	16h21m	3619.1812	130.6	722.2	1.51
01.10.2005	13h47m	3645.0743	113.8	694.8	0.76
22.09.2006	13h59m	4001.0826	128.4	726.8	1.35

In columns of Table 1 are given: the observational date, the universal time,

Julian Date, the equivalent width EW(Hα) of Hα line emission at 1/40 line maximum intensity in Å, the full width FW(0.1) at 0.1 maximum intensity in km/s, the equivalent width EW([OI]6300) of forbidden oxygen line [OI] in Å, respectively.

The columns of Table 2 contains: the observational date, the maximum intensities of red Imax (red) and blue Imax (blue) components of Hα line, as well as the intensity of absorption Iabs relatively to the continuum, the ratio of maximum intensities of red and blue components R/V, the distance between red and blue peaks in km/s, the distance between red peak and absorption in km/s, respectively.

Table 2.

Date	Imax (red)	Imax (blue)	Iabs	R/V	Distance between peaks km/s	Distance between red peak and absorption km/s
16.09.2001	17.36	11.12	7.92	1.56	137.1	91.4
20.09.2001	16.79	11.15	8.18	1.51	136.2	68.1
21.09.2001	17.98	12.23	8.65	1.47	135.8	90.5
16.10.2001	17.27	12.09	7.30	1.43	136.2	68.1
18.10.2001	17.06	11.56	7.60	1.48	147.2	79.1
16.11.2001	16.42	11.58	8.32	1.42	136.2	90.5
18.11.2001	16.04	11.04	7.89	1.45	136.2	90.5
21.11.2001	15.06	10.63	7.91	1.42	147.2	90.5
05.08.2002	18.11	12.84	7.77	1.41	174.6	84.1
06.08.2002	15.80	10.82	7.52	1.46	170.5	91.0
08.08.2002	16.12	10.40	7.15	1.55	159.1	79.5
09.08.2002	15.58	11.46	7.37	1.36	170.5	91.0
05.09.2002	13.56	10.84	6.71	1.25	159.1	68.1
07.09.2002	15.13	11.36	6.87	1.33	159.1	68.1
08.09.2002	16.53	12.27	7,35	1.35	159.1	68.1
09.09.2002	15.02	11.26	7.63	1.33	159.1	68.1
09.10.2002	16.30	12.34	7.63	1.32	159.1	68.1
06.11.2002	14.24	12.98	8.00	1.10	147.6	79.5
28.08.2003	16.65	12.90	8.62	1.29	124.8	68.1
29.08.2003	13.04	9.96	7.26	1.31	136.2	68.1
31.08.2003	16.59	12.67	8.32	1.31	136.2	79.5
24.09.2003	14.94	11.54	7.75	1.29	136.2	79.5
25.09.2003	17.07	13.36	8.93	1.28	148.6	69.0
28.09.2003	15.28	12.31	7.85	1.24	147.6	68.1
28.09.2003	14.05	11.81	7.48	1.19	159.1	68.1
29.09.2003	14.83	11.52	7.71	1.29	147.6	68.1
30.09.2003	15.06	11.78	7.94	1.28	136.2	68.1
13.08.2004	16.98	10.23	9.19	1.66	135.8	68.1
13.09.2004	19.87	10.31	6.90	1.93	124.8	68.1
08.10.2004	18.73	9.50	6.77	1.97	204.3	68.1
14.10.2004	18.08	10.91	8.01	1.66	204.3	79.5
09.11.2004	20.06	11.68	8.95	2.24	170.5	79.5
31.07.2005	16.82	9.87	7.38	1.70	181.5	91.4
03.09.2005	21.20	13.42	10.86	1.58	201.1	132.6
04.09.2005	20.96	14.97	9.22	1.40	204.3	91.4
05.09.2005	17.23	10.48	7.03	1.64	181.5	68.1
01.10.2005	16.37	7.98	6.99	2.05	113.4	68.1
22.09.2006	17.09	11.72	8.51	1.46	135.8	90.5

In columns of Table 3 are given: the date of observations, the V magnitude, the color indexes (B-V) and (V-R) for MWC 340, the V band photometry of N2, N3 and N6 stars from Table 1 of Hillenbrand et al [1], respectively.

Table 3.

Date	V	B-V	V-R	N2	N3	N6
05.09.2002	10.74	0.88	-	-	-	-
07.09.2002	10.83	0.89	1.00	13.96	-	-
08.09.2002	10.85	0.90	0.96	13.94	-	-
09.09.2002	10.77	0.91	0.99	13.86	-	-
09.10.2002	10.81	0.89	1.00	13.92	-	-
06.11.2002	10.81	0.86	1.01	-	-	-
28.08.2003	10.72	0.94	0.98	13.83	12.08	14.72
29.08.2003	10.70	0.94	0.98	13.89	12.08	14.66
31.08.2003	10.78	0.90	0.97	13.88	12.08	14.74
24.09.2003	10.73	0.94	0.99	13.64	12.08	14.82
25.09.2003	10.76	0.92	0.99	13.78	12.08	14.94
28.09.2003	10.72	0.91	0.98	13.78	12.08	14.88
29.09.2003	10.74	0.91	0.98	13.76	12.07	14.94
30.09.2003	10.76	0.90	0.97	13.91	12.10	15.02
13.08.2004	10.82	0.88	1.00	13.82	12.07	-
13.09.2004	10.77	0.90	1.00	13.81	12.09	15.24
08.10.2004	10.74	0.93	1.01	13.90	12.08	15.31
14.10.2004	10.71	0.93	0.95	13.88	12.09	14.49
09.11.2004	10.80	0.89	1.02	13.95	12.07	14.82
31.07.2005	10.80	0.86	1.02	13.97	12.07	14.96
03.09.2005	10.80	0.88	1.01	13.92	12.08	15.10
04.09.2005	10.77	0.86	0.99	13.99	12.06	14.98
05.09.2005	10.79	0.88	1.00	13.88	12.08	14.91
06.09.2005	10.80	0.88	1.02	13.98	12.08	14.93
01.10.2005	10.76	0.90	0.96	14.01	12.08	14.21
22.09.2006	10.76	0.84	0.98	13.84	12.08	15.13

In columns of Table 4 are given: the observational date, Julian Date, the equivalent width EW(Hβ) of Hβ line emission at 1/40 line maximum intensity in Å, the full width FW(0.1) at 0.1 maximum intensity in km/s, the maximum intensities of red Imax (red) and blue Imax (blue) components of Hβ line, as well as the intensity of absorption Iabs relatively to the continuum, the ratio of maximum intensities of red and blue components R/V, the distance between red and blue peaks in km/s, respectively.

Table 4.

Date	JD 2450000+	EW(Hβ) Å	FW(0.1) km/s	Imax (red)	Imax (blue)	Iabs	R/V	Distance between peaks km/s
17.11.2001	2231.0444	7.52	654.1	1.80	0.86	-0.29	2.09	230.2
19.11.2001	2233.0451	7.77	635.6	2.02	0.81	-0.13	2.49	245.6
06.08.2002	2493.1438	10.24	558.5	2.27	2.15	-0.49	1.06	230.2
08.08.2002	2495.2472	9.33	586.2	2.04	2.04	-4.70	1.00	245.6
09.08.2002	2496.2264	11.80	706.6	2.12	2.19	-0.26	0.97	227.1
07.09.2002	2525.2153	10.03	617.1	1.96	2.23	-0.18	0.88	214.8
08.09.2002	2526.1965	9.16	552.3	2.40	1.99	-0.24	1.21	214.8
09.09.2002	2527.1979	9.94	617.1	1.52	1.33	0.20	1.14	230.2
10.09.2002	2528.2014	11.20	614.0	2.49	2.12	0.11	1.17	199.3
14.11.2004	3324.0507	11.84	685.0	2.36	1.76	0.19	1.34	230.2
06.09.2005	3620.1972	4.21	561.6	1.34	1.12	0.03	1.20	245.6
22.09.2006	4001.1069	5.73	462.8	2.06	0.72	-0.12	2.86	276.5

As seen from tables, the variety of Hα lines intensity relatively to continuum (from 13 to 21) is observed. For this time the Hб line equivalent width EW is changed in the limits 110÷ 160A, the brightness in range V= 10.^{m}70÷ 10.^{m}85; (B-V)= 0.^{m}84÷0.^{m}94; (V-R)= 0.^{m}95 ÷ 1.^{m}02. Herewith it should be noted that the measuring error of equivalent width determining at different taking into account of continuum is near 2%. The photometric measuring error of magnitude determining is less than 0.^{m}01.

The optical spectrum of MWC 340 shows the strong emission of Hα and Hβ lines, the forbidden oxygen [OI] λλ 6300; 6363 and numerous FeII emission lines. Hα and Hβ lines have the clear cut double-peaked profiles with practically non-shifted central absorption, and the ratio of red and blue intensities is changed with time. Hα profiles received in different observational dates are shown as example on Fig.2. Hα profile with minimum value for blue component (received 2005 October 1) is given off by thick solid line.

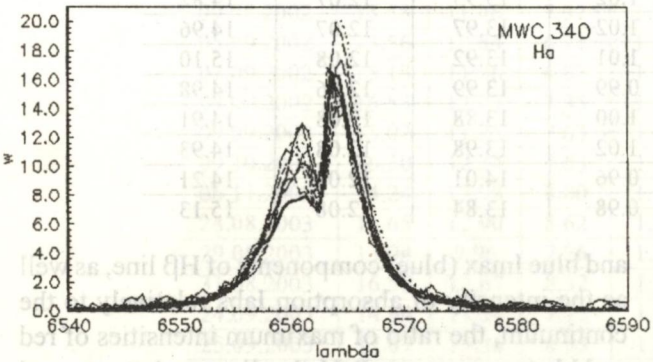

Fig.2

The nonsymmetrical profile of Hα line may be explained by three models:

-a model, in which the shape of gas envelope is deviate from spherical one;

-a model of rotating and extending envelope;

-a model with relatively small inclination of circumstellar discs to the observer, so that a disc material is closed the line of sight.

However, the third model will always provide for $I_{blue}>I_{red}$, what is inconsistent with our observations.

The first and second models best satisfy to our observations. But in case of third model we must have the some displacement of emission line in spectrum violent region. And if the displacement is little, this is difficult to observe on our spectrograms, taking into account the low resolution (R=6000). The problem may be only solved after theoretical calculations with provision for value I_{blue}/I_{red}.

On our observations the MWC 340 star has the practically symmetric and non-shifted [OI] λ 6300.31 emission relatively the laboratory wavelength. Herewith there are observed the variations both the equivalent width (from 0.8 to 1.7 A - on our observations; 1.10 – the work [6]; 1.5 – the work [7]) and the maximum intensity of line relatively to the continuum. In generally, as it assumes, the stars having such profile structure of forbidden lines may be regarded as more evolved than stars, in which the emission are shifted in blue region of spectrum [6].

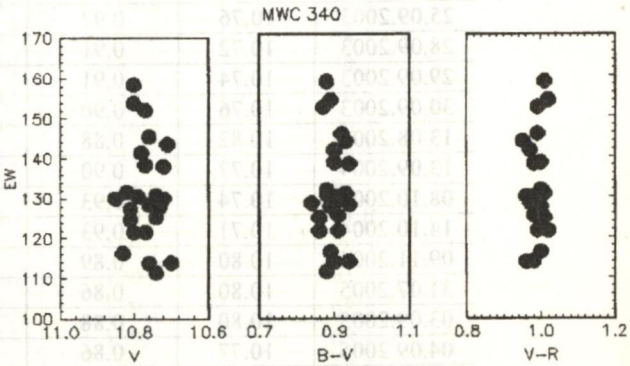

Fig.3

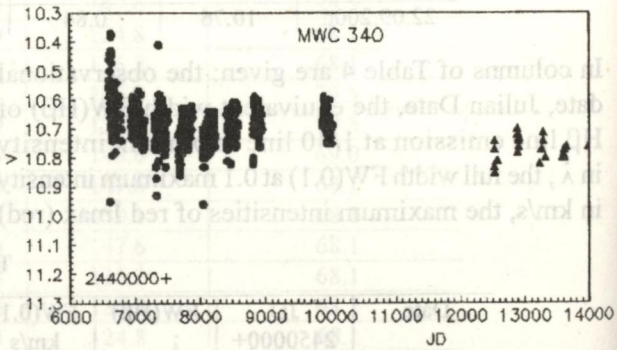

Fig.4

Any distinct correlation's of Hα line equal width EW with brightness V and color indexes of star were not observed (Fig.3) on our observations. Herewith it should be marked that in observed period the amplitude of changing both the brightness V and color indexes of MWC 340 was lower (Fig.4, where filled circles – the Maidanak's data in V band [8], filled triangles – our measurements), than on data of Maidanak observatory (V=10^m.37÷10^m.96, (B-V)=0^m.68÷0^m.93, (V-R)=0^m.91÷ 1^m.27).

Our photometric measurements in V band for N2, N3 and N6 stars from Table 1 of Hillenbrand et al [1] showed the variability of N2 ($V=13^m.64 \div 14^m.01$) and N6 ($V=14^m.21 \div 15^m.31$) stars and practically brightness constancy of N3 ($\sim 12^m.08$) star, what most likely give evidence about no belonging of this star to the association, but about its projection on given region.

4. Conclusion

This work presents the results of spectral and photometric observations for Be star MWC 340 and photometric ones in V band for N2, N3 and N6 stars from Table 1 of Hillenbrand et al [1].

The photometric measurements of these stars in V band showed the variability of N2 and N6 stars and practically brightness constancy of N3 star.

The brightness and color indexes of MWC 340 in process of observations were changed in limits $V=10^m.70 \div 10^m.85$, $(B-V)=0^m.84 \div 0^m.94$, $(V-R)=0^m.95 \div 1^m.02$.

The optical spectrum of MWC 340 shows the strong emission of Hα and Hβ lines, the forbidden oxygen [OI] λλ 6300; 6363 and numerous FeII emission lines.

Hα and Hβ lines have the clear cut double-peaked profiles with practically non-shifted central absorption, and the equivalent widths and the ratio of red and blue intensities are changed with time.

The change character of Hα line profile shows that the star has whether the rotating non-spherical envelope, perhaps produced by nonsymmetrical gas outflows, or the rotating and extending envelope.

The stars in MWC 340 region are significantly younger than those in the surrounded OB associations with the low- and the high-mass stars having formed nearly simultaneously [4], what lead some authors to the assumption that star formation in this association might have been induced by the propagation of external shock wave into the cloud core.

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Резюме

Ассы-Түрген жоғары биік таулы обсерваториясында 2001–2006 жылдар аралығында MWC 340 жұлдызы үшін алынған спектрфотометрлік және фотометрлік сонымен қатар оның төңірегіндегі үш жұлдызы үшін фотометрлік мағлұматтар келтірілді. Спектрде Hα, Hβ, [OI], әрі көпсандық FeII қарқынды сызықтары қатысады. Үзіліссіз спектрге қатысты Hα сызығының қарқындылық вариациялары (13-ден 21-ге дейін) байқалады. Бұл уақытта Hα сызығының баламалы ені 110÷160Аманында, жарықтылығы $V=10.^m70 \div 10.^m85$, түс көрсеткіші $(B-V)=0.^m84 \div 0.^m94$; $(V-R)=0.^m95 \div 1.^m02$ болып жұлдыздың шамасы өзгерді. Біздің өлшемдеріміз бойынша Hα сызығы баламалы енін жұлдыздың жалтырау мен түс көрсеткіштерімен салыстырғанда қандай да болсын айқын корреляциялар байқалмады.

Резюме

В статье представлены спектрофотометрические и фотометрические данные для звезды MWC 340, а также фотометрические данные для трех звезд, расположенных в ее окрестности, полученные за период 2001-2006 гг. на высокогорной обсерватории Ассы-Тургень. В спектре MWC 340 присутствуют интенсивные линии Hα, Hβ, многочисленные линии FeII, а также запрещенные линии [OI]. Наблюдаются вариации максимума интенсивности линии Нб по отношению к непрерывному спектру (от13 до 21). За это время эквивалентная ширина EW линии Hα изменялась в пределах 110÷160А, яркость в $V=10^m.70 \div 10^m.85$ звездной величины, $(B-V)=0^m.84 \div 0^m.94$, $(V-R)=0^m.95 \div 1^m.02$. Каких-либо отчетливых корреляций эквивалентной ширины EW линии Нб с блеском и показателями цвета звезды по нашим наблюдениям не наблюдалось.

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