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B[e] stars

VI. MWC 297 = IRAS 18250−0351[⋆,⋆⋆]

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Abstract. On the basis of spectroscopic CCD material obtained at the Haute Provence Observatory, we provide line identifications and equivalent width measurements in the wavelength region 4100 − 8900 Å of the spectrum of MWC 297. About two hundred features are identified, almost exclusively emission lines. Only one interstellar feature could be identified (λ 6613) a fact which contrasts with the eigth magnitudes of extinction found by photometrists. The spectrum of the underlying star corresponds probably to a late O or early B-type object. The cooler emission lines correspond to a spectrum of a middle A-type star. Analogies with other stars observed in this series of papers are examined.

Key words: stars: MWC 297=IRAS 18250 − 0351 — stars: Be — stars: peculiar — stars: variable

1. Introduction

MWC 297 is a little known B[e] star. It was discovered, because of its H_α emission as Be star by Merrill et al. (1932), but carries no special note. Herbig (1960) adds that H_β and H_γ were strongly in emission in 1931, but that on his plates H_γ was weak and H_β very weak, if in emission at all. He found Ca II to be in very strong absorption and saw no other absorptions. He found in red light a moderately bright nebulosity extends up to about 5′ from the star and states that it is a heavily reddened reflection nebula.

A large infrared excess was found by Allen & Swings (1972) ($V-K>8^{\rm m}$).

Sanduleak & Stephenson (1973) call attention to the strong emission in H_β, calling the star a Be! object and Loren et al. (1973) discovered CO emission, confirmed later on by Canto et al. (1984).

Bergner et al. (1988) made a photometric study of the object in the Johnson $UBVRIJHK$ system and found,

a) variations of up to $0\overset{\rm m}{.}48$ in V, of up to $3\overset{\rm m}{.}26$ in U and of less than $1\overset{\rm m}{.}00$ in I, J, H, K,
b) an anticorrelation between U and K variations, implying a dust component in the variations,
c) the color curve $(U, B, ... K)$ can be decomposed into that of a heavily extinguished B0 type star plus a body with $T = 1300$ K.

The distance of the object is given as about 450 pc by Hennings et al. (1994), which for a normal dwarf B0 would imply an extinction of about zero, wheras the observed color $B-V$ (=2.37) conduces to an extinction of 8m.

Of later authors, Thé et al. (1994) classify it as Herbig Ae/Be candidate and de Winter & Pérez (1998) as B[e] candidate with [O I] in emission.

2. Material

The star was observed at the Haute Provence Observatory (OHP) of the CNRS in 1997. The wavelength regions and dates of observation are given in Table 1.

The observations were made with the 152 cm telescope, in July 1997. The spectrograph used was Aurelie (see Gillet et al. 1994) with a Thomson 7832 double bar detector, with 2048 photodiodes ($750\times13\,\mu$). The grating used had 300 grooves/mm, blazed at 6000 Å. The original dispersion is 33 Å/mm, with a resolution of 1.3 Å, equivalent to 65 km s^{-1} at 6000 Å.

Calibrations were made with a tungsten lamp for flat field and in wavelength by means of a hollow cathod of

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⋆ Based on observations obtained at the Haute Provence Observatory (CNRS).
⋆⋆ Table 2 is only available in electronic form at the CDS via anonymous ftp 130.79.128.5 at the CDS http://cdweb.u-strasbg.fr/Abstract.html

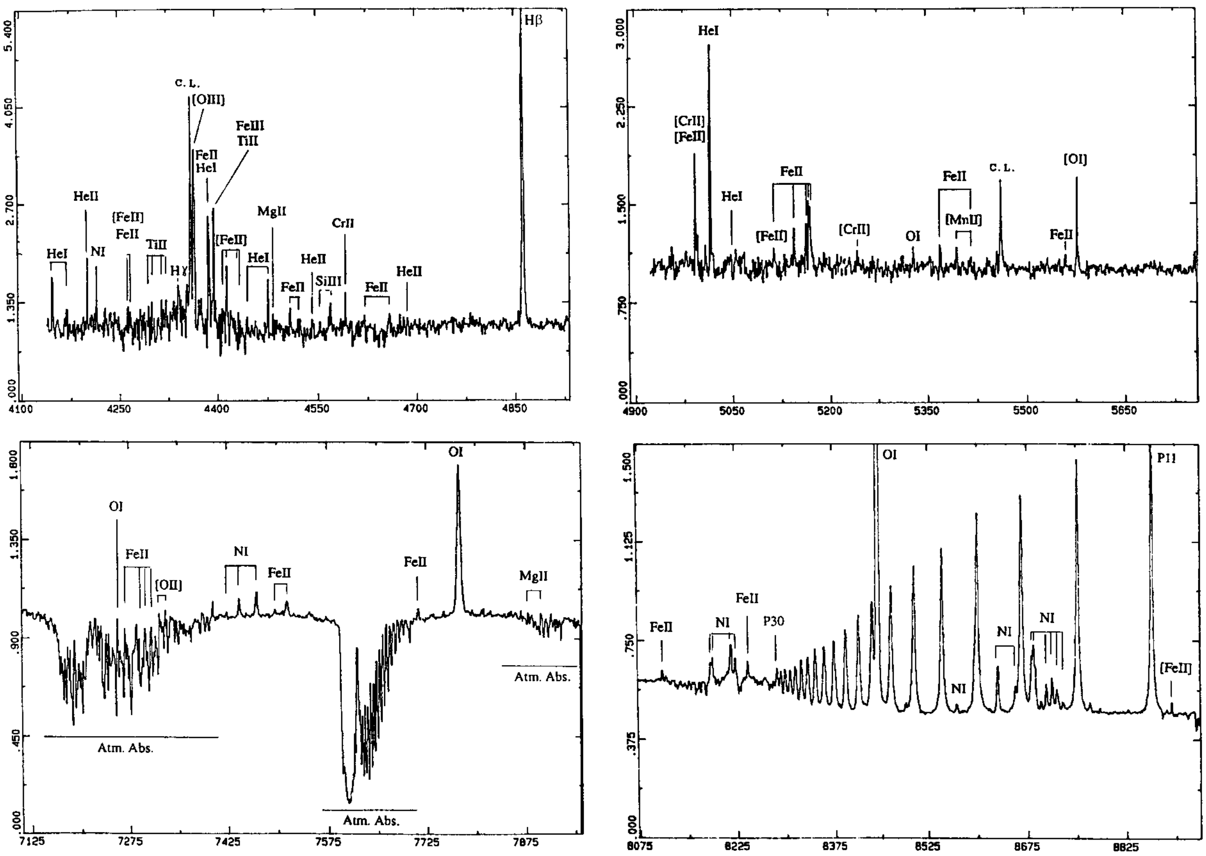

Fig. 1. The different parts are given from top to bottom and from left to right. The first wavelength range is 4133 − 4930 Å. The spectrum is under exposed, specially for $\lambda < 4470$ Å. CL = city lights. The second range is 4923 − 5755 Å, the third is 7124 − 7942 Å and the fourth, 8073 − 8909 Å. The atmospheric absorption of the Z band of H_2O has been corrected, but the star used was observed several hours after MWC 297. There result absorption residuals in the region $\lambda < 8180$ Å

Table 1. Observational material of MWC 297

4119 − 4939 A	21 07 1997
4914 − 5734	23 07 1997
6297 − 7118	24 07 1997
7123 − 7944	25 07 1997
8091 − 8911	20 07 1997

thorium and argon for the blue and the red and thorium-neon for the near infrared.

3. Line identification

Based upon this material we have made line identifications in the traditional way, paying attention to both wavelengths and intensities within the multiplets. The identifications were made with the help of the tables of Moore (1959); for Fe II we also used Johansson's (1978) compilation and for [Ni II] Nussbaumer & Storey (1982). In addition we have used the Meinel et al. (1969) catalogue for lines which we could not identify. (See notes to Table 2). Some contamination with Hg I from city lights was unavoidable and is signaled in Fig. 1, which reproduces part of the spectrum.

Part of the material is reproduced in Fig. 1, where also some line identifications are provided. The region λ 7123 to 7400 has been corrected by atmospheric absorption, which permitted to see a number of lines given in Table 2, but being hardly visible in Fig. 1. The correction by atmospheric extinction was done in the conventional way by dividing the spectrum of the star by that of comparison stars observed at similar airmasses.

In our spectra are present 197 emission lines and 4 absorption lines. We have not included in the latter count lines in which both emission and absorption features figure, like the He I lines. 18 emission lines could not be identified. The iron lines represent 40% of all identified emission lines.

Of the pure absorption lines we could identify only one, namely λ 6613, with an interstellar feature (Herbig 1975). The weakness of the interstellar features contrasts strongly with the extinction of $8\overset{\mathrm{m}}{.}0$ derived from photometry.

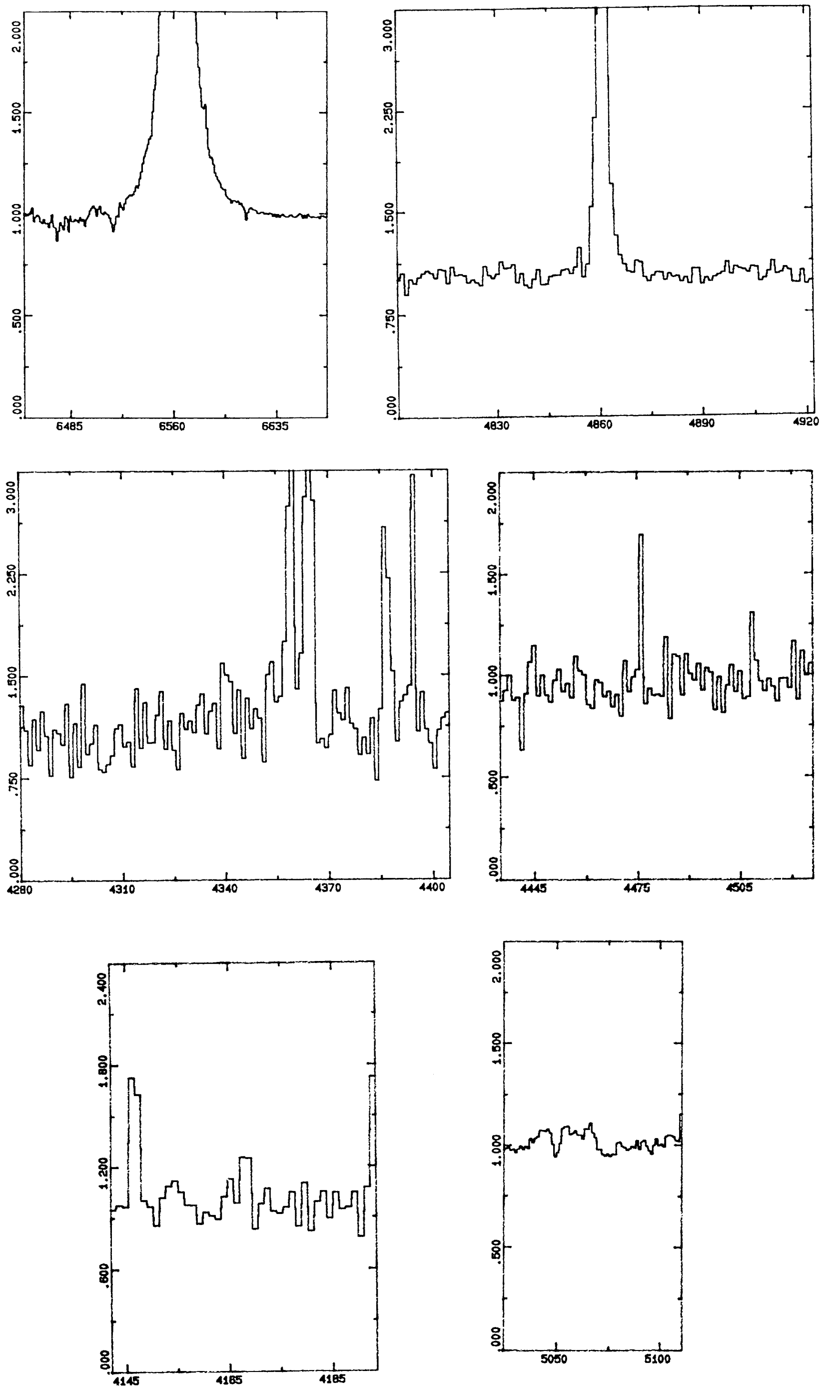

Fig. 2. From top to bottom and from left to right. Profile of the H_α line. Profile of the H_β line. Profiles of the lines H_γ and He I 4447 Å. Profiles of the He I lines 4447 and 4471 Å. Profiles of the He I lines 4146 and 4168 Å. Profile of the He I line 5047 Å

In the remainder of the paper, when we speak of lines,we refer always to emission lines, except if stated otherwise.

4. Behaviour of the elements

Hydrogen. The Balmer series is present on our spectra from H_α to H_γ and the Paschen series from P 11 to P 31.

Of the Balmer emission lines, H_α is broad; at the local mean continuum level it has a width of about 4000 km s^{-1}. A weak absorption line appears on the left side of H_α, converting the profile into a P Cyg type structure. H_β has a width of about 600 km s^{-1}, no underlying absorption being visible. H_γ is a relatively weak emission line, with a suggestion of two peaks, $V > R$. The decrement is therefore extremely strong. The profiles are illustrated in Fig. 2.

From P 11 to P 31, the Paschen lines appear in a very regular progression, with no enhancement due to Ca II, nor signs of an underlying absorption line. The Paschen discontinuity at λ 8203 can be evaluated as being of 0.004 in absolute units.

Helium. Neutral helium is represented by lines from the series ^{1}S, ^{1}D, ^{3}S and ^{3}D. The different lines merit some comments. λ 4471 is composed by a faint broad absorption line, upon which two emission components are seen with $V < R$ and separated by 340 km s^{-1}. In the ^{3}S series, λ 4713 is absent but λ 4121, shifted by 210 km s^{-1}, is observed. In the ^{1}S series, λ 5047 is an absorption line flanked by two emission components with $V = R$ and $\Delta = 320$ km s^{-1}. In λ 4437 only the red emission is visible, whereas for λ 4168 again two peaks are visible, separated by 230 km s^{-1}. In the ^{1}D series $\lambda\lambda$ 6678 and 4921 are absent and both $\lambda\lambda$ 4387 and 4143 are seen as an absorption accompanied by a red emission. Some of the line profiles are illustrated in Fig. 2. Ionized helium is represented by three lines ($\lambda\lambda$ 4200, 4541 and 4685).

Carbon. Ionized carbon is represented by two lines from M.3, although the strong line λ 4267 is missing. (M. stands for multiplet in what follows).

Nitrogen. Neutral nitrogen is well represented by lines from M.1, 2, 3, 5 and 8. Forbidden singly ionized nitrogen is represented by λ 6582 from M.1, but λ 6545 is missing.

Oxygen. Neutral oxygen is present with lines from M.1, 4, 12 and 20; forbidden neutral oxygen with lines from M.1 and 3 (There might however exist a substantial contribution from the night sky). Singly ionized oxygen by lines from M.2 and doubly ionized oxygen is represented by two lines from M.1 and two from M.2. There exists however an anomaly in the sense that λ 4363 is strong and λ 4959 doubtful, whereas the inverse is true in most of the stars.

Magnesium. Several lines from M.4 and 8 of ionized magnesium are present.

Aluminium. The ionized species is represented by a few lines from M.36, 46 and 94.

Silicium. One line from each M.2 and 5 from ionized silicium and two lines from M.2 of doubly ionized silicium are present.

Sulphur. One line from the neutral element, M.6, a possible line from M.18 of ionized sulphur and lines from S III, M.2 and 7 are present.

Titanium. Ionized titanium is represented by lines from M.20, 41, 50, 93 and 94 and by several lines of [Ti II] from M.15, 20, 21 and 39.

Chromium. Ionized chromium is represented by several lines from M.2 and 44, whereas [Cr II] shows lines from M.11, 13 and 25.

Manganese. Ionized forbidden manganese is present with two lines from M.9.

Iron. Ionized iron is represented by a large number of lines (51) from M.27, 33, 35, 37, 38, 42, 43, 73 and 197. Forbidden ionized iron is represented by 19 lines from M.1, 6, 7, 13, 14, 16, 19,21, 22, 30, 31, 32, 33, 36 and 37. Doubly ionized iron is represented by one line from M.4.

Nickel. Forbidden ionized nickel is represented by two lines from M.2.

Of the elements listed we consider the identifications of Mn and Ni as marginal.

5. The emission line spectrum discussed

This paper is part of a series of papers studying B[e] stars as defined by Allen & Swings (1976).

Judging from the elements present in the star, we conclude that the underlying star has the characteristics of a late O or early B type as far as He II, O III, Si III and S III are concerned. The other elements present correspond to the shell a nd judging from the elements present in the shell spectrum, correspond to a spectral type of at most an A type object. The combination of a hot underlying photosphere and a much cooler extended atmosphere is in fact characteristic of the stars investigated so far in this series of papers.

If we compare to other stars of the group, the star is similar to OY Gem(=HD 51585), MWC 349 and MWC 645 as far as no absorption lines are seen. With respect to elements found, the best analog is OY Gem, although the two other stars are also similar. We find the following elements in common: H, He, C, N, O, Mg, Si, S, Ti, Cr, Fe and Ni.

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References

Allen D., Swings J.P., 1972, ApJ 10, L83
Allen D., Swings J.P., 1976, A&A 47, 293
Bergner Yu.K., Kozlov V.P., Krivtsov A.A., Miroshnichenko A.S., Yudin R.V., et al., 1988, Astrophys. 28, 529
Canto J., Rodríguez L., Calvet N., Levreault R., 1984, ApJ 282, 631
de Winter D., Pérez M.R., 1998, Proc. Workshop on B[e] stars, Delplace A.M., Jaschek C. (ed.) (in press)
Gillet D., Burnage R., Kohler D., et al., 1994, A&AS 108, 181
Henning Th., Launhardt R., Steinacker J., Thamm E., 1994, A&A 281, 546
Herbig G.H., 1960, ApJS 4, 337
Herbig G.H., 1975, ApJ 196, 129
Johansson S., 1978, Phys. Scr. 18, 217
Loren R.B., van den Bout P.A., Davis J., 1973, ApJ 185, L 67
Meinel A.B., Aveni A.F., Stockton M.W., 1969 "Catalog of emission lines in astrophysical objects", Tucson
Merrill P.W., Humason M.L., Burwell C.G., 1932, ApJ 76, 156
Moore Ch., 1959 "A multiplet table of astrophysical interest" NBS Tech. Note 36
Nussbaumer H., Storey P.J., 1982, A&A 115, 205
Sanduleak N., Stephenson C.B., 1973, ApJ 185, 899
Thé P.S., de Winter D., Pérez M.R., 1994, A&AS 104, 31