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A new discussion on the $M_v - W$(O I 7774 Å) relationship for F–G stars in the light of high-resolution data*

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SUMMARY

High-resolution CCD spectra were obtained to measure the equivalent width, W(O I), of the O I feature at 7774 Å, in F–G type stars of known distance. It was found that these values are 20–30 per cent smaller than earlier measurements made using lower-resolution data. It is shown that one can overestimate W(O I) with the low-resolution data.

A new calibration of the $M_v - W$(O I) relationship is given, using selected F–G supergiants in open clusters and OB associations as calibrators. By including F–G giants and supergiants of known parallax the calibration was extended to the domains F0–G8, III–Ia and M_v from −10 to +2.

The stars in our sample show the non-linearity of the $M_v - W$(O I) relationship. The data points are satisfactorily fitted by a second-degree polynomial. The residuals about this fit show some dependence on stellar temperature, represented by the $(b-y)_0$ Strömgren colour index. Introduction of the additional $(b-y)_0$ in the relationship leads to the equation

$$M_v = \underset{\pm 0.82}{1.52} - \underset{\pm 1.57}{6.33}\, W(\mathrm{O\,I}) + \underset{\pm 0.68}{0.85}\, W(\mathrm{O\,I})^2 - \underset{\pm 0.95}{3.74}\,(b-y)_0,$$

which can be used to estimate M_v to within ±0.8 mag. The residuals from this equation do not show any dependence on turbulent velocities derived from NLTE calculations. We used the above calibration for the peculiar stars 89 Her (F2Ib), HD 161796 (F3Ib) and HR 4912 (F3Ib), and derive M_v − 5.1, −6.7 and −2.8, respectively.

1 INTRODUCTION

It is now fairly well established that the strength of the O I triplet at λ7774 Å is related to the stellar luminosity for B8–G2 stars. There have been a few attempts made in the past to calibrate this relation (e.g. Osmer 1972a; Baker 1974; Sorvari 1974; Kameswara Rao & Mallik 1978; Arellano Ferro *et al.* 1989). These earlier studies were, however, based on low-resolution data, such as medium-dispersion spectra, photoelectric spectrum scans or narrow-band photometry. Furthermore, all previous $M_v - W$(O I) calibrations have been done almost exclusively for F-type stars in the absolute magnitude range −9 to −4. For G-type stars the O I 7774 Å feature is weak (Faraggiana *et al.* 1988) and it is generally believed that the strength of the triplet does not give much information on the stellar luminosity for later spectral types. It appears, however, that G stars have been poorly represented and that very good resolution observations are needed to extend the M_vW(O I) relation to later spectral types.

In a recent paper we discussed the use of luminous F–G non-cepheid supergiants as distance indicators. A calibration of M_v in terms of $uvby\beta$ colour indices was calculated using as calibrators F–G supergiants in open clusters and OB associations (Arellano Ferro & Parrao 1990). We believe that these stars can be used to find a better calibration of the $M_v - W$(O I) relationship, provided that one can measure W(O I) accurately.

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With the aid of new CCD detectors it is possible to obtain high-resolution spectra for fainter stars, and one can therefore extend the sample to a larger number of stars, covering a larger range in spectral type. Most important of all, the strength of O I feature can now be measured with greater accuracy. Encouraged by this idea we observed the O I 7774 Å triplet in a group of F–G supergiants in open clusters and OB associations. The present investigation was made using high-resolution spectra (8 Å mm^{-1}) and a good signal-to-noise ratio (100–150), covering the absolute magnitude range -10 to $+2$, and the spectral type range F0 to G8. In Sections 2 and 3 we describe the observations and present the equivalent widths. In Section 4 our measurements are compared with earlier ones and the differences discussed. In Section 5 we calibrate M_v in terms of $W(\mathrm{O\,I})$ and the influence of stellar temperature and turbulent velocity is investigated. In Section 6 M_v is estimated for five field supergiants of spectral type F and the results are discussed. In Section 7 we summarize our conclusions.

2 OBSERVATIONS AND REDUCTIONS

The CCD spectra used in this investigation were obtained from 1990 January to April, with the Coudé Echelle spectrograph on the 1.0-m telescope of the Vainu Bappu Observatory (VBO), Kavalur, India. The spectrograph is equipped with a Thomson-CSF7H7882 CCD which is sensitive up to 1 μm. The CCD has 384×576 pixels; each pixel has an area of 23 $\mu\mathrm{m}^2$. The reciprocal dispersion is 8 Å mm^{-1} and the spectral resolution is 0.18 Å pixel^{-1}. The FWHM of the instrumental profile is 0.45 Å. A more detailed description of the instrumental set-up and tests of the spectrograph performance can be found in Goswami & Giridhar (1990).

All reductions were carried out with the VAX 11/780 computer at VBO, and the spectroscopic data reduction package RESPECT (Prabhu, Anupama & Giridhar 1987).

Typical exposure times were less than 30 min for stars brighter than $V = 4.5$ mag. For fainter stars we opted to take several 30 min frames to avoid cosmic ray impacts on the CCD chip. For stars fainter than $V = 6.0$ mag normally four frames were needed to attain a signal-to-noise ratio of 100. To compensate for pixel-to-pixel detector sensitivity variations, several Xe light flats were secured on each night.

3 THE SAMPLE OF F–G STARS OF KNOWN M_v

In order to study the O I triplet as the luminosity indicator in F–G supergiants, a large group of stars of known distances is required. We have selected our sample from the compilation of yellow supergiants in open clusters and OB associations of Arellano Ferro & Parrao (1990) (their table 1). These authors have used these stars to calibrate $E(b-y)$ and M_v in terms of $uvby\beta$ colour indices. We have measured $W(\mathrm{O\,I})$ for 19 stars from the above compilation and they are given in Table 1. These stars are in the ranges F0–G6 and II–Ia. Their absolute magnitudes, derived from their cluster or association membership are in the range -9.5 to -3.9. All previous M_v–$W(\mathrm{O\,I})$ calibrations have been calculated in this absolute magnitude range. It seems, however, from spectral type $W(\mathrm{O\,I})$ plots (e.g. Faraggiana *et al.* 1988) that even for dwarfs and giants the strength of the O I triplet is sensitive to luminosity. Our interpretation of fig. 2 of Faraggiana *et al.* (1988) is slightly different from that of the authors; we think that at a given temperature, not only Ia stars are separated from less luminous stars, but also that in the F0–G3 domain most V–IV stars have weaker O I than most III–II and Ib stars. It is possible that the lack of a clearer split is due to different values of turbulent velocity, as suggested by Faraggiana *et al.*, but it is also possible that high-resolution data allow us to measure the subtle differences. The effect of the spectral resolution on $W(\mathrm{O\,I})$ will be addressed in the following section.

Table 1. The F–G calibrators of the M_v–$W(\mathrm{O\,I})$ relationship.

HD	ST	V	b-y	m1	c1	β	notes	M_V	E(b-y)	W(OI)
7927	F0Ia	4.972	0.493	0.021	1.467	2.640	1	−8.7	0.382	2.021
9973	F5Iab	6.887	0.607	0.094	1.213		5	−6.9	0.382	1.164
10494	F5Ia							−7.6	0.694	1.594
18391	G0Ia	6.9						−6.6	0.437	1.270
20902	F5Ib	1.8	0.304	0.194	1.076	2.677	3	−4.7	0.03	1.001
20123	G6Ib	5.027	0.731	0.340	0.376	2.592	1	−4.7	0.086	0.432
31964	F0Ia	2.938	0.405	0.020	1.298	2.584	1	−8.7	0.370	2.020
36673	F0Ib	2.6	0.126	0.161	1.190		3	−3.6p	0.010	1.008
45348	F0II	−0.8	0.110	0.128	1.512	2.732	2	−3.9p	0.122	1.100
48329	G8Ib	3.023	0.852	0.678	0.167	2.598	1	−1.0p	0.04	0.149
54605	F8Ia	1.830	0.375	0.322	0.929	2.661	2	−7.9	0.020	1.528
62058	G0Ia	6.529	0.701	0.253	0.861	2.655	5	−7.8	0.28	1.590
62345	G8IIIa	3.57						+0.6p	0.03	0.141
63700	G3Ib	3.327	0.742	0.558	0.360	2.619	5	−4.1p	−0.042	0.266
65228	F7II	4.20	0.423	0.264	0.553		3	+1.0p	−0.037	0.131
74180	F0Ia	3.816	0.494	0.494	1.338	2.637	5	−9.0	0.40	2.273
75276	F2Iab	5.739	0.391	0.060	1.539	2.736	5	−7.0	0.38	1.114
84441	G1II	2.991	0.494	0.279	0.436	2.575	1	−2.5p	0.134	0.337
87283	F0II	5.944	0.173	0.134	1.414	2.76	4	−3.9	0.06	1.017
89025	F0III	3.44	0.201	0.158	0.997	2.722	6	−0.5p	0.005	0.854
90772	F0Ia	4.667	0.389	0.001	1.094	2.594	5	−8.3	0.335	2.051
96918	G0Ia	3.933	0.733	0.530	0.488	2.672	5	−9.2	0.01	1.680
97534	F0Ia	4.602	0.416	−0.017	1.146	2.602	5	−7.9	0.32	2.065
101947	G0Ia	4.970	0.449	0.277	0.670	2.663	5	−7.9	0.01	1.757
102070	G8IIIa	4.73						+2.0p	0.02	0.181
150421	F2Ib	6.264	0.569	0.118	1.037	2.693	5	−6.1	0.429	0.983
164136	F2II	4.41	0.254	0.141	0.901		3	−1.4p	0.001	0.760
194093	F8Ib	2.2	0.401	0.295	0.878	2.641	3	−5.6p	0.04	1.175
204867	G0Ib	2.91						−3.6p	0.11	0.448
206859	G0Ib	4.336	0.705	0.492	0.334	2.593	5	−1.0p	−0.04	0.163
217476	G0Ia	4.836	0.904	0.330	0.712	2.644	5	−9.1	0.33	1.985
224014	F8pIa	4.65	0.886	0.578	0.467	2.644	5	−9.5	0.55	1.792

Notes: 1 – Arellano Ferro *et al.* (1990); 2 – Crawford *et al.* (1970); 3 – Dazinger & Faber (1972); 4 – Gronbech & Olsen (1976); 5 – Olsen (1983); 6 – Strömgren & Perry (1965).

With the above ideas in mind and with the aim of studying the M_v–$W(\mathrm{O\,I})$ relationship for a larger M_v range, we included some F–G stars with $M_v > -4$ and of known parallax (Hoffleit 1982). These stars are also included in Table 1 and have a 'p' after the value of M_v. Table 1 also contains $uvby\beta$ photometry gathered from the literature, the sources are coded in column 8. Colour excesses for F0–G3 supergiants have been calculated from the $E(b-y)$–$uvby$ calibration of Arellano Ferro & Parrao (1990). For cooler and less luminous stars the typical extinction value within the galactic plane of $A_v = 0.002$ mag pc^{-1} was used (Kitchin 1984).

4 THE O I 7774 Å EQUIVALENT WIDTHS

The O I 7774 Å feature is composed of three lines at $\lambda\lambda$7771.954, 7774.177, and 7775.395 (Moore, Minnaert &

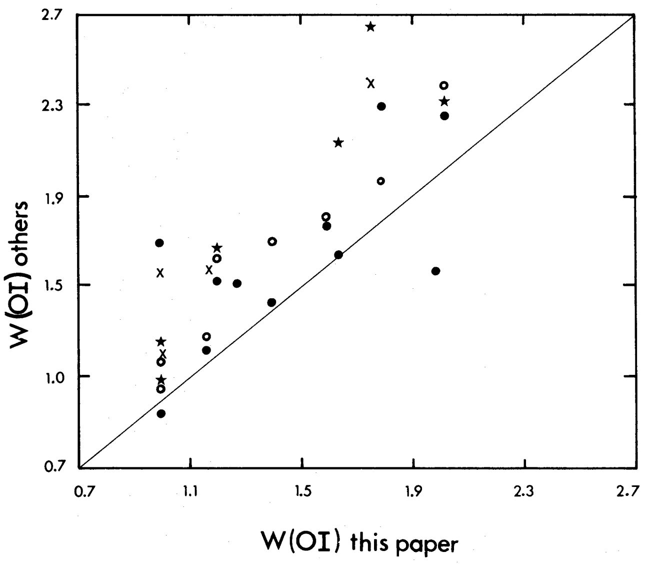

Figure 1. Comparison of our values of W(O I) with those from previous authors for stars in common: dots – Osmer (1972a); open circles – Baker (1974); crosses – Hopkinson & Humrich (1981); stars – Faraggiana *et al.* (1988).

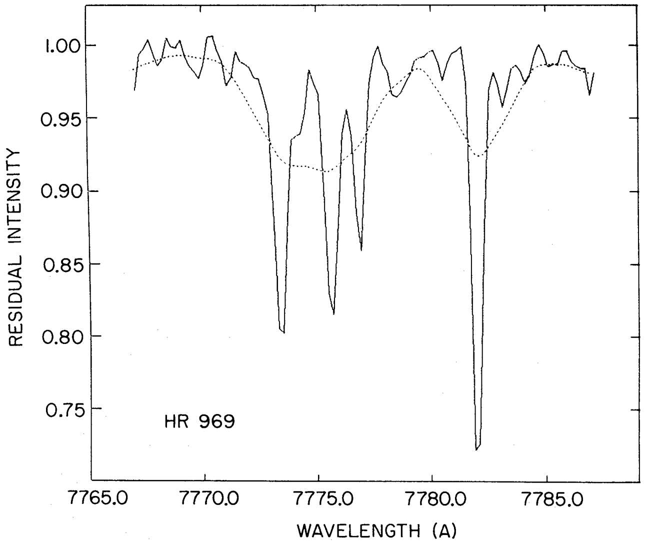

Figure 2. The O I triplet in the star HD 20123 (HR 969) at high resolution (solid line). The resolution was degraded by heavily smoothing the spectra (dashed line). The consequence of lowering the resolution is that W(O I) is overestimated by 20–30 per cent.

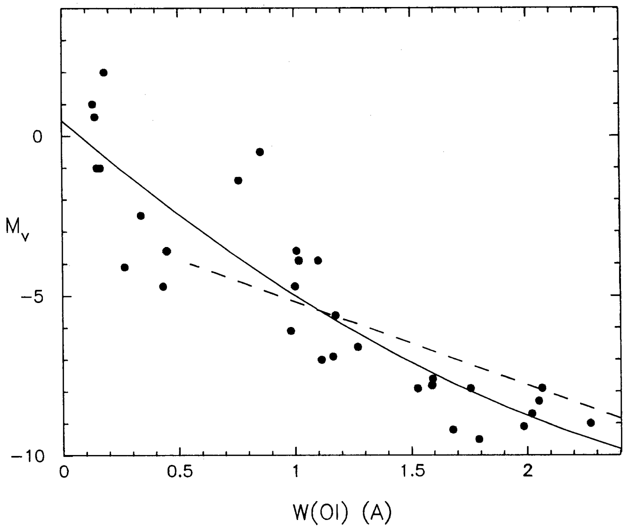

Figure 3. The variation of M_v with W(O I) for F–G stars of known distances, can be represented by a second-degree polynomial fit (solid line). The earlier calibration of Osmer (1972a) (broken line) is shown for comparison.

Houtgast 1966). With the present resolution the bluest component is clearly separated from the other two, which are generally mildly blended (see Fig. 2). Therefore individual measurements of the three components are possible in most cases. The values of W(O I), which are the added equivalent widths for the three components, are given in Table 1 for the sample stars. From repeated independent measurements for a given star, we estimate the uncertainty in W(O I) to be about 10 per cent.

We have compared in Fig. 1 our W(O I) values with those obtained by earlier authors for the stars in common. Our values appear to be systematically smaller than those from other authors. It should be noted, however, that earlier measurements were made at lower spectral resolution. Therefore the O I feature for all these authors appears as a blend. This effect alone is sufficient to overestimate W(O I). In Fig. 2 we give an example of such effect; the O I triplet is displayed as observed by us in the star HR 969 (HD 20123) (solid line). We have artificially degraded the resolution, by about a factor of 4, by heavily smoothing the spectrum (dashed lines). The equivalent width of the triplet before smoothing was 0.323 Å. After smoothing the value was 0.442 Å. Repeating this for the star ε Aur (not illustrated) we found 1.980 and 2.366 before and after smoothing, respectively. The later value agrees very well with the low-resolution values 2.51 Å (Osmer 1972a) and 2.4 Å (Hopkinson & Humrich 1981). The O I triplet in Canopus (HD 45348) was measured at very high resolution by Johnson, Milkey & Ramsey (1974), their value of W(O I) = 1.1 Å agreeing very well with ours of 1.09 Å.

5 CALIBRATION OF THE M_v–W(O I)–$(b-y)_0$ RELATIONSHIP

A simple plot of W(O I) versus M_v for all stars in Table 1 shows the non-linear dependence of these two parameters (Fig. 3). The variation can be represented by a second-degree polynomial of the form

$$\begin{array}{l} M_v = 0.49 - 6.33\, W(\mathrm{O\,I}) + 0.85\, W(\mathrm{O\,I})^2 \\ \quad \pm 0.75 \pm 1.57 \qquad\quad \pm 0.68 \end{array} \qquad (1)$$

(the standard error of fit is 1.5 mag).

All previous calibrations of the M_v–W(O I) relationship found it to be linear for F0–G2 supergiants (Osmer 1972a; Baker 1974; Sorvari 1974; Kameswara Rao & Mallik 1978; Arellano Ferro *et al.* 1989). For comparison, in Fig. 3 we have also shown the calibration of Osmer (1972a) which is rather representative of previous calibrations. This calibration was done exclusively for F supergiants and hence its M_v range is more limited. The inclusion of cooler (G-type) and less luminous ($M_v > -2$) stars requires high resolution to measure the feature that becomes weaker for later spectral types, but in turn reveals the non-linear nature of the relationship.

The scatter about the fitted curve could be caused by uncertainties in $W(\mathrm{O\,I})$ and M_v estimates, but it is also possible that it is caused by the dependence of O I lines strengths on atmospheric parameters, particularly the temperature, due to the high-excitation potential ($E_l = 9.15$ eV) of the metastable $3s^5S^2_0$ lower level. The effect of stellar temperature on the strength of the O I triplet for F0–G8 stars of luminosity classes V–Ib, is well known (Keenan & Hynek 1950; Faraggiana *et al.* 1988); i.e. it is noticed that the O I feature gets weaker for lower temperatures. However, for luminosity Ia according to Faraggiana *et al.*, the temperature dependence is not very significant, but their data for Ia stars do not extend beyond spectral type G0. From our observations we feel that even for Ia stars the strength of the O I feature shows a mild dependence on temperature. Thus the residuals about the polynomial-fitted curve must be a function of temperature.

Indeed, the residuals are correlated with stellar temperature, represented by $(b-y)_0$, as can be seen in Fig. 4. The photometric index $(b-y)_0$ was calculated from *uvby* data in Table 1 and $E(b-y)$ obtained as described in Section 3. Hence those stars in Table 1 without *uvby* data were not considered. The star HD 48329 was also discarded since being the reddest of the sample its photometric data are less accurate (Arellano Ferro *et al.* 1990). With the data on hand there is no obvious explanation for the rather discrepant position of HD 75276 and HD 89025 in Fig. 4. The least-squares fit for the rest of the 24 stars is given by

$$O-C = \underset{\pm 0.36}{1.04} - \underset{\pm 0.95}{3.74}(b-y)_0. \qquad (2)$$

Combining equations (1) and (2) we obtain

$$M_v = \underset{\pm 0.82}{1.53} - \underset{\pm 1.57}{6.33}\, W(\mathrm{O\,I}) + \underset{\pm 0.68}{0.85}\, W(\mathrm{O\,I})^2 - \underset{\pm 0.95}{3.74}(b-y)_0. \qquad (3)$$

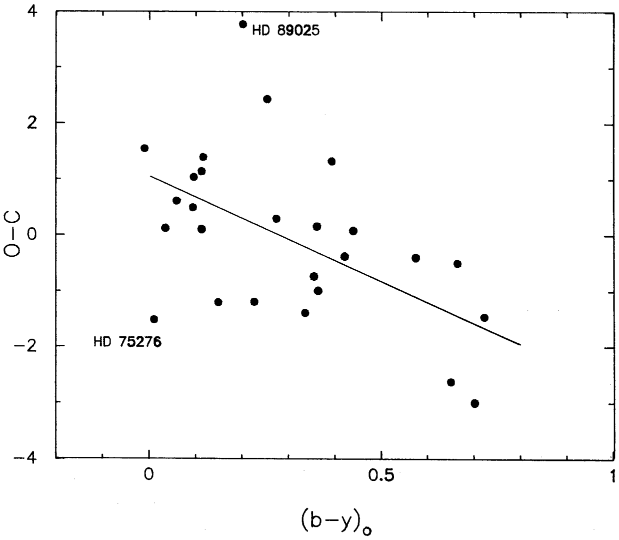

Figure 4. The residuals about the polynomnial fit in Fig. 3 show a strong dependence of stellar temperature, i.e. $(b-y)_0$. The straight line is a least-squares fit to the data (equation 2). The stars HD 75276 and HD 89025 were not considered in the fit.

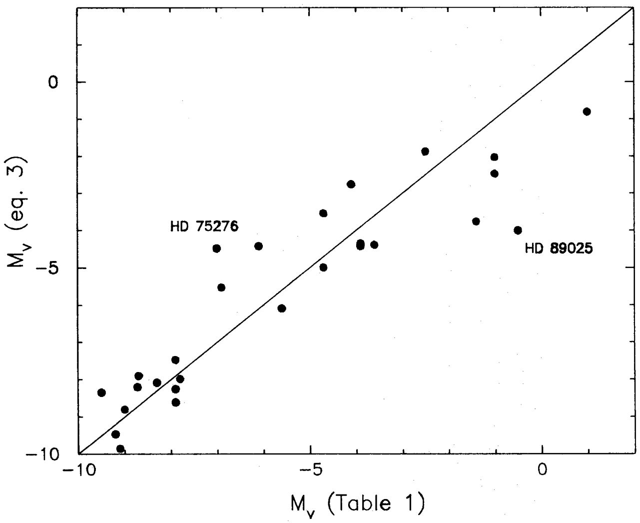

Figure 5. The absolute magnitudes of the calibrator stars calculated from equation (3), compared with their calibrating values in Table 1. The average deviation about the line is ±0.8 mag. These residuals are not correlated with turbulent velocities.

Fig. 5 shows M_v from Table 1 versus M_v calculated from equation (3) for the calibrator stars. The average scatter about the line is ±0.8 mag, which is an estimate of the uncertainty in M_v as predicted by equation (3).

It is possible that the residuals from equation (3) are still a function of some other atmospheric parameters. Inclusion of gravity sensitive term c1 or [Fe/H] did not reduce the scatter. Homogeneous oxygen abundances for sufficient stars in our sample are not available and so we did not try to include it as an extra term in equation (3).

The effect of microturbulent velocity on the strength of the O I 7774 feature has been studied in the past. Osmer (1972b) reported very large (larger than velocity of sound) turbulence velocity based on his LTE calculations of this triplet. Johnson *et al.* (1974) have done NLTE calculations for O I triplet using a 10-level atom for the F0I star α Car. They found that inclusion of detailed NLTE effects eliminates the need of ultrahigh turbulent velocity and brings the derived O abundance in good agreement with that derived using other lines of O I. Baschek, Schalz & Sedlmayr (1977) did similar NLTE calculations for early-type stars and reported turbulence velocities about 0.5–1.0 km s^{-1}. Erikson & Toff (1979) have done similar NLTE calculations for late spectral G-type giants and found moderate values for microturbulence.

Faraggiana *et al.* (1988) have prepared a grid of NLTE models on which the effect of turbulence on $W(\mathrm{O\,I})$ is described for various spectral types and luminosity classes. The $W(\mathrm{O\,I})$ shows very strong dependence on turbulent velocity for A0–F1 spectral types and luminosity type Ia, but for F–G spectral types and luminosities Ib–V, the dependence on turbulent velocity is not very conspicuous. Dependence of $W(\mathrm{O\,I})$ on turbulent velocity for early spectral types may possibly explain the scatter near $M_v \sim -9$ in Fig. 3.

We have used Faraggiana *et al.*'s grid to estimate the turbulent velocity for the stars in Table 1. We have found that the residuals about equation (3) are not correlated to such

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velocities. However, as already discussed by Faraggiana *et al.*, the above turbulent velocities are a good representation for the Fe I- and Fe II-forming levels in the stellar atmosphere and not of the higher levels where the O I triplet is formed.

6 DISCUSSION

In Table 2 there are five field supergiants for which W(O I) was measured in our programme. We have used the calibration of equation (3) to calculate M_v for each one. Here we discuss the results. The reddenings in Table 2 were calculated using the $E(b-y)$–*uvby* calibration of Arellano Ferro & Parrao (1990). The *uvbyβ* photometry was collected from the literature.

Table 2. M_v for five field yellow supergiants from equation (3).

Star	Name	Sp type	E(b-y)	W(OI)	M_V
HR4114		F2II	0.11	1.026	-4.4
HR4441	'Cen	G3 0-Ia	0.32	1.989	-9.0
HR4912				0.724	-2.8
HR6685	89 Her	F2Ibe	0.19	1.203	-5.1
HD161796		F3Ib	0.26	1.641	-6.7

89 Her and HD 161796. A long debate has been taking place on whether these high-galactic-latitude stars are normal massive luminous supergiants or less massive and less luminous stars in the pre-planetary nebula stages. From photometric studies Arellano Ferro & Parrao (1990) found high luminosities, $M_v = -8.8$ and -9.0, for 89 Her and HD 161796, respectively. Independent photometric studies have also found high luminosities (low gravities) for these stars (Fernie 1986; Mantegazza, Antonello & Poretti 1989). On the other hand, our present O I data and calibration indicate $M_v = -5.2$ and -6.8, respectively. Other estimates implied from previous O I calibrations also favour lower luminosities, e.g. -6.9 (89 Her) (Baker 1974) and -6.6 (89 Her) and -6.9 (HD 161796) (Osmer 1972a). Spectroscopic studies by Giridhar *et al.* (1988) and Luck, Bond & Lambert (1990) show abundances indicative of a thick-disc population. Other properties like emission in Hα and strong infrared excesses are also not typical of massive population I supergiants. For a recent discussion on the M_v values of these two stars see Arellano Ferro & Parrao (1990), and references therein.

HR 4114. This star is listed in the *Bright Star Catalogue* (Hoffleit 1982) as a suspected variable. In 1979 it was monitored for one month with a B filter and it did not show significant variations (Arellano Ferro 1981), although variations of longer period and small amplitude cannot be ruled out. Photometry in the *uvbyβ* system is available from Crawford, Barnes & Golson (1970). From the parallax of this star; $+0.010$ (Hoffleit 1982) and $+0.006 \pm 0.007$ (Jenkins 1950), one can derive $M_v \sim -2.2$. However, from the O I triplet data and the present calibration we find $M_v \sim -4.4$.

HR 4441 (o^1 Cen). The variability of this star was discovered independently by Cousins (1951) and O'Connell (1961). It exhibits cycles of about 200 d. The amplitude varies from less than 0.1 to 0.8 mag (Eggen 1983). *uvbyβ* data can also be found in Crawford, Barnes & Golson (1970). Although the star is in the Carina spiral feature, it is not in Car OB1 association (Humphreys 1972). The distance assigned to this star by Humphreys (2.31 Kpc) implies $M_v = -8.0$, while Eggen (1983) from photometric data derived $M_v = -8.2$. Our estimate from the O I triplet data and the calibration of equation (3) is $M_v = -9.1$, in reasonable agreement with earlier results and with its spectral type F3 0–Ia (Hoffleit 1982). Our value of $E(b-y) = 0.32$ is significantly larger than that from Eggen; $E(b-y) = 0.149$, which in our equation (3) would produce $M_v = -9.7$.

It is worth mentioning that while all the above absolute magnitude estimates place the star at further than 2.5 kpc, the parallax estimates $+0.024$ (Hoffleit 1982) and $+0.020 \pm 0.010$ (Jenkins 1950) imply too small a distance, less than 60 pc!

HR 4912. This star was found to be a variable with a period of about 44 d (Arellano Ferro 1981). Its high galactic latitude encouraged some authors to carry out abundance analyses. Luck *et al.* (1983) found it slightly metal deficient, [Fe/H] $= -1.2$ and hence they consider it to be an old low-mass ($\sim 1\ M_\odot$) star evolving off the AGB towards the planetary nebulae stage. An independent analysis by Sasselov & Kolev (1986) also found mild iron deficiency ([Fe/H] $= -0.7$). These authors found it similar to other UU Her-type stars and do not rule out the intermediate-mass case. From their gravity determination ($\log g = 0.6$) and assuming $M = 0.6\ M_\odot$, Luck *et al.* derive $M_v = -4$. From ultraviolet data Böhm-Vitense & Proffitt (1984) found slightly lower gravity ($\log g = -0.3 \pm 0.3$), and thus higher luminosity. Since *uvby* data is not available to us, $M_v = -3.7$ can be estimated directly from Fig. 3 (equation 1). By assuming the value of $(b-y)_0$ for 89 Her or HD 161796, we can apply the temperature correction (equation 2), then we obtain $M_v = -2.8$. All determinations seem to point to this star being less luminous than other UU Her-type variables (e.g. 89 Her and HD 161796).

7 CONCLUSIONS

With the aid of high-resolution CCD data we are able to investigate the intrinsic nature of the M_v–W(O I) relation and also to consider the effect of other atmospheric parameters on this relation.

A large group of F–G stars of fundamentally determined distances (i.e. members of open clusters, OB associations and of known parallax) were used as calibrators. The M_v–W(O I) relation is not linear in the absolute magnitude range -10 to $+2$. The effect of the stellar temperature, represented by $(b-y)_0$ colour index, on the strength of the O I triplet can be quantitatively studied. Introduction of this additional colour term leads to a calibration of the M_v–W(O I)–$(b-y)_0$ relationship in the above M_v range, which can serve as a valuable tool towards the determination of M_v for F–G field stars.

No systematic effect of the turbulent velocity on the above calibration was found. However, the turbulent velocities were estimated from the Fe I and Fe II lines which were formed at deeper atmospheric levels than the O I triplet. Measurements of the turbulent velocities in the O I 7774 Å formation region might prove to be important to the strength of this feature and their inclusion in the above calibration may contribute to improve the present accuracy.

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