

Equivalent width of O I λ 7774 and absolute magnitude relation for F and G supergiants

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Summary. Luminosity calibration is established for F5–G2 supergiants using the equivalent width measures of O I λ 7774 and Fe I λ 7748.

1 Introduction

The strength of the neutral oxygen triplet at λ 7774 is known to be an excellent luminosity indicator for the range of spectral types B3–G3 (Keenan & Hynek 1950; Parsons 1964; Mendoza 1971). Osmer (1972) and Baker (1974) measured the equivalent width of λ 7774 ($W(7774)$) with a photoelectric spectrum scanner using 20 Å passband and obtained a calibration between $W(7774)$ and the absolute visual magnitude M_v , for F supergiants. Their calibration includes stars of F0–8 with six cluster members. In the spectral range F5–G3 the $W(7774)$ is not only sensitive to luminosity but to the temperature as well (Keenan & Hynek 1950). In extending the calibration to later spectral types this temperature sensitivity should also be taken into account. Moreover, the photoelectric $W(7774)$ determined using 20 Å passband includes another absorption feature λ 7780 of Fe I, which starts to appear at spectral type F5 and becomes stronger in later spectral types. The present work was undertaken to extend the M_v – $W(7774)$ calibration to G2 stars and also to investigate whether this relation could be applied to the peculiar F and G supergiants R CrB and XX Cam.

2 Observations and discussion

Fifteen F and G supergiants whose M_v 's are known whether because of their membership in a cluster or association or the M_v 's have been established from other spectroscopic criteria (Wilson & Bappu 1957; Kraft, Preston & Wolff 1964) have been observed along with R CrB and XX Cam. Coudé spectrograms were obtained with Varo-tube equipment at the 24-in coudé auxiliary telescope of Lick Observatory, with a dispersion of 33 Å/mm and/or 16 Å/mm. The stars observed and $W(7774)$ are given in Table 1, along with $W(7774)$ observed by Keenan & Hynek (1950). The error in the equivalent widths is estimated to be ± 0.04 Å from two or more plates of the same star. Table 1 also gives the equivalent width of an absorption feature λ 7748 ($W(7748)$) due to Fe I, which seems to be sensitive mainly to temperature, i.e. the $W(7748)$ increases with decreasing temperature, whereas $W(7774)$

Table 1.

Star	Sp type	M_V	$W(77774)$ (A)	$W(7748)$ (A)	E	$W(7774)$ KH (A)	Cluster or association	Reference
δ CMa	F8 Ia	-7.3	1.86	0.25	0.47	1.88	Cr 121	Feinstein (1967)
ρ Cas	F8 Ia	-8.4	2.42	0.27	0.65		IV Cas	Sargent (1961)
HD 217476	G0 Ia	-9.6	2.10	0.34	0.71		Cep II	Schmidt-Kaler (1961)
HD 195593	F5 Iab	-5.8	1.61	0.26	0.42		Cep OB5	
α Per	F5 Ib	-4.6	1.16	0.16	0.19	1.15	Cyg OB1	Guetter (1964)
BD + 60° 2532	F7 Ib	-4.8	1.24	0.28	0.34		α Per	Mitchell (1960)
HD 14662	F7 Ib	-7.2	1.18	0.34	0.40		NGC 7654	Pesch (1959)
U Sgr	F5 Ib-	-3.9	0.98	0.24	0.23		M25	Schmidt (1972)
β Cam	G1.5 Ib	-5.2*	0.78	0.33	0.25		(Cepheid)	Sandage & Tammann (1969)
HD 4362	G0 Ib	-5.9*	0.78	0.31	0.25			
ζ Mon	G2 Ib	-5.0*	0.59	0.40	0.24			
β Dra	G2 Ib	-5.7*	0.54	0.53	0.29	0.50		
HD 192713	G2 Ib	-5.7*	0.75	0.55	0.41			
ϵ Leo	G0 II	-2.2*	0.42	0.25	0.11			
α Sge	G0 II	-2.5*	0.52	0.34	0.18			
R CrB	F8 Ibp		1.91	0.22				
XX Cam	Gp		2.40	0.28				

* Mean of the absolute magnitudes obtained from Wilson & Bappu (1957) and Kraft *et al.* (1964).

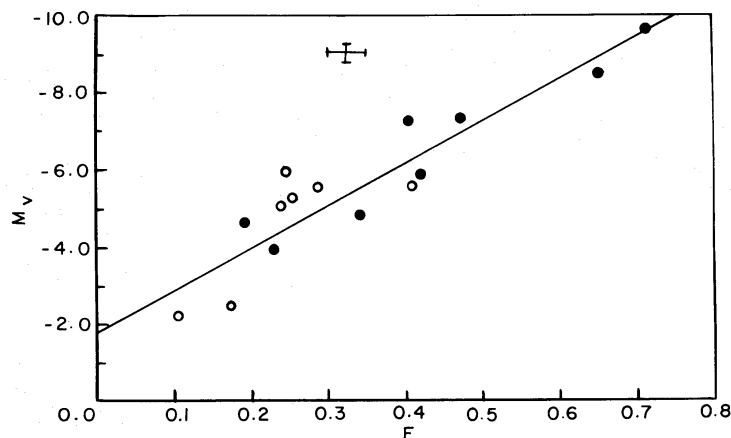


Figure 1. Absolute visual magnitude (M_V) plotted against the product of $W(7774)$ and $W(7748)$. The filled circles denote cluster or association members.

decreases with decreasing temperature. Thus the product of $W(7748)$ and $W(7774)$ is expected to be mostly sensitive to luminosity. A plot of this product with respect to $B-V$ or spectral type does not show any systematic effect for the 15 supergiants observed thus showing the temperature effect is not significant for this calibration. Fig. 1 shows the plot between M_V and the product of $W(7774)$ and $W(7748)$. The straight line drawn is a least-squares fit to the data which is given by $M_V = -10.98, E - 1.79$, where $E = W(7774) \times W(7748)$. In the above fit double weight was given to cluster members. The error in the determination of M_V is estimated to be ± 0.5 mag. It is of interest that the absolute magnitudes obtained from the Wilson–Bappu effect fit into the above calibration down to $M_V - 2$. Thus this calibration not only extends the range in spectral types and luminosity but also ties into the Wilson–Bappu effect.

A direct application of the above calibration to the hydrogen deficient and carbon, helium rich supergiants R CrB and XX Cam gives M_V as -6.4 and -9.2 respectively. These values are too high when compared with the derived absolute visual magnitudes (M_V of -4 to -5) of R CrB stars observed in the Large Magellanic Cloud (Feast 1972). There could be various effects which make M_V obtained from the above calibration different for R CrB stars relative to normal supergiants, like the lower surface gravities and the obvious difference in abundances, etc.

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