ULTRAVIOLET ENERGY DISTRIBUTION OF He-WEAK STARS

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Abstract. Ultraviolet observations of Helium-weak stars carried out on OAO-2 indicate that temperature estimates from the ground based region of the spectrum may be unreliable.

A paper dealing with ultraviolet observations of Helium-weak stars has been recently prepared by Bernacca and Molnar (1972) (BM) so that I will here summarize only the results. The purpose is to show how the flux in the ultraviolet may in some cases be different than expected from the *UBV* photometry, placing an uncertainty on temperatures derived from the ground based region of the spectra.

The helium-weak stars can be roughly described by saying that their photometric spectral type S_Q is earlier by 2 subclasses or more than that given by the MK classification system, that is B3–5 compared to B7–9. The metal spectrum in these stars may also be stronger than normal but not as greatly as in the hot Ap stars which also show the color-spectrum anomaly and in which helium is also found to be weak for their colors. A fairly complete description of the spectral characteristics of helium-weak stars can be found in Molnar (1972). Contributors to the discovery of these peculiar objects have been more recently Garrison (1967), Bernacca (1968), Jaschek *et al.* (1969), Ciatti and Bernacca (1971), Schild and Chaffee (1971), Molnar (1972), and Bernacca and Ciatti (1972). Atmospheric analysis by Norris (1971) and by Molnar (1972) has given $0.25 \leqslant \theta_e \leqslant 0.35$, $3.3 \leqslant \log g \leqslant 4.5$ and helium underabundant by a factor of 2 to 15. Metal abundances exist only for one star (Hack 1969). I like to call the attention on the color-color plot of $m_\lambda(4250\,\text{Å}) - m_\lambda(3320\,\text{Å})$ vs $m_\lambda(1910\,\text{Å}) - m_\lambda(3320\,\text{Å})$ shown in Figure 1 where the helium-weak stars are compared with standard stars between B3 and B8. The wavelengths in parenthesis are the constant energy effective wavelengths of three filter photometers of the Wisconsin Experiment Package on board OAO-2 (Code *et al.* 1970). Figure 1 shows the results schematically. The detailed diagram can be found in the BM paper. The broken line represents what we may consider a temperature sequence. The scatter of the observations is shown by the shaded area. The spread observed for the standard stars has to be attributed to a combination of the uncertainty in the reddening correction and to a different degree of line blocking in the 1910 Å filter for each star produced by the second and third spectrum of the metals. The correspondence between the spectral types of the standards and their location in the temperature band is shown schematically on the figure. Four of the helium-weak stars lie within the band (open circles) in good agreement with the spectral type predicted by the *UBV* photometry. They are: 3 Cen A (B3–5), HD 144334 (B3–5), α Scl (B5), and HD 144844 (B7). The stars 3 Sco (B3) and HD 21699 (B4) (open circles in the order) are apparently fainter by $0^m\!.2$ at 1910 Å with respect to the mean relation (broken line). However the effect can be qualitatively

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explained in terms of additional line blocking in the 1910Å filter due to Si II and Si III lines which are known to be stronger than normal in the visual spectrum. The possibility of having underestimated the reddening correction at 1910 should also be considered. It cannot be excluded that these two stars have ultraviolet fluxes which are normal for their *UBV* colours.

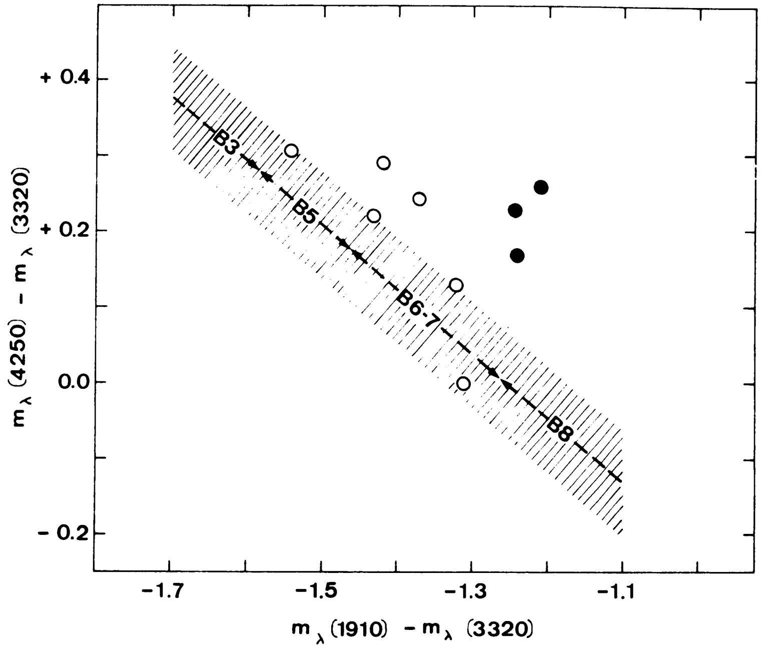

Fig. 1.

The filled circles on the figure represent the stars HR 8535 (B5, B8 IIIp), HR 8770 (B4, B8 III?) and HD 144661 (B5, B7 IIIp). The types given in parenthesis are S_Q and the MK spectral type respectively. The above three stars are fainter at 1910Å by about $0^m.3$ than their ground based colors would predict. It does not seem possible to explain the anomaly in terms of line blocking or a wrong reddening correction (see BM). The flux at 1910 Å seems to be more appropriate for their MK type so that a possible conclusion is that the region covered by the *U* filter is anomalous showing an excess of radiation. If so, these stars can't longer be considered to have atmospheres deficient of helium since they should be given a lower temperature which would be more appropriate for their faint helium lines. It is interesting to note that according to Garrison (1972), HD 144661 is a Mn-star and that HR 8535 and HR 8770 are likely to be hot Ap stars of the Si-λ4200 type. The conclusion that these hot Ap stars are not helium-weak is suggestive but certainly not proved as of yet. Leckrone (1971) has analyzed a fairly large number of Si-λ4200 stars and He has found systematically that these objects have the far ultraviolet flux more in agreement with their MK types than with their S_Q.

Despite the implications that these ultraviolet observations might have concerning the helium abundance and the nature of the peculiar B type stars I restrict here the conclusion to emphasize how temperature determinations based on a limited portion of the continuous spectrum appear to be unreliable at least for these peculiar objects.

In particular it should be said that the fitting of the data to a model atmosphere in the near Balmer continuum does not give an unambiguous value of the effective temperature.

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DISCUSSION

Schild: Where is the reddening trajectory in your graph, and how have you corrected for reddening?

Bernacca: We have used $(B - V)_0$ given by the colour type and the mean reddening curve by Bless and Sovage (OAO Symposium, Amherst, Mass., August 1971). I have not here the slope of the reddening path on the colour-colour plot that I have shown. However, the correction at 1910Å is larger than that at 4250 Å so that the reddening trajectory is nearly parallel to the m_λ (1910) $-$ m_λ (3320) axis. I like to mention that HR 8535, HR 8770 and HD 144661 are still fainter than normal at 1910 Å when Stecher's reddening curve is used, a curve which overestimates the reddening in the UV.