LETTERS TO THE EDITOR

ON THE ULTRAVIOLET EXCESS IN G DWARFS*

That the subdwarfs show a considerable excess in ultraviolet light as compared with normal main-sequence stars was first pointed out by Roman (1955*a*). Detailed spectroscopic analyses of subdwarfs have shown that such stars exhibit large deficiencies of the metals as compared with the sun (Chamberlain and Aller 1951; Burbidge and Burbidge 1956; Baschek 1959; Aller and Greenstein 1960). A large number of early G and late F dwarfs have now been analyzed from spectra at 15-A/mm dispersion in the yellow region by the methods described by Wallerstein and Helfer (1959). The results are summarized in Table 1, where we list each star in order of increasing ultraviolet excess, the colors as

TABLE 1

Star	$B-V$	$U-B$	$U-B$ Excess	[M/H]	Notes
Hyades No. 63	0.63	+0.17	−0.01	+0.06	1
Hyades No. 64	.66	+ .20	− .00	+0.14	1
Hyades No. 73	.61	+ .13	− .00	+0.09	1
λ Aur	.61	+ .13	− .00	+0.15	2,4
ι Per	.60	+ .10	+ .02	+0.10	
β Com	.56	+ .05	+ .02	+0.07	3
HR 483	.63	+ .12	+ .04	+0.20	3
HD 30455	.61	+ .09	+ .04	+0.03	4
10 CVn	.54	− .01	+ .05	−0.32	
HD 115043	.60	+ .07	+ .05	−0.06	4
ρ CrB	.60	+ .07	+ .05	+0.14	
HD 55575	.58	+ .03	+ .07	−0.15	
HD 90508	.60	+ .05	+ .07	−0.16	
72 Her	.62	+ .07	+ .08	−0.21	
HD 152792	.65	+ .08	+ .10	−0.36	
δ Tri	.61	+ .02	+ .11	−0.41	3
HD 106516	.45	− .14	+ .14	−0.64	
HD 114762	.54	− .08	+ .14	−0.66	
HD 157089	.60	− .02	+ .14	−0.46	
85 Peg	.66	+ .04	+ .16	−0.49	5
HD 219617	.47	− .20	+ .19	−1.30	6
HD 19445	.46	− .24	+ .25	−1.60	6
HD 140283	0.51	−0.28	+0.31	−2.15	7,8

NOTES TO TABLE 1

1. Analysis by Parker, Greenstein, Helfer, and Wallerstein, *Ap. J.*, in preparation.
2. Colors by Wallerstein.
3. Colors by Johnson and Morgan, *Ap. J.*, **117**, 313, 1953.
4. Analysis by Wallerstein and Helfer, *Ap. J.*, in preparation.
5. Analysis by Wallerstein and Helfer, *Ap. J.*, **129**, 720, 1959.
6. Analysis by Aller and Greenstein, *Ap. J. Suppl.*, in press.
7. Mean of analyses by Aller and Greenstein (*ibid.*) and Baschek, *Zs. f. Ap.*, **48**, 95, 1959.
8. Colors by Melbourne, *Ap. J.*, in press.

observed by Roman (1955*b*) or others as noted, the ultraviolet excess as compared to the mean of the main-sequence stars in the Hyades (Johnson and Knuckles 1955), and, finally, [M/H], which is the logarithm of the metals-to-hydrogen ratio minus the same quantity in the sun. For the abundances of the metals we have taken the mean of the

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abundances of the following elements: Na, Mg, Si, Ca, Sc, Ti, Cr, Fe, and Ni. Manganese and barium have been omitted from the mean because manganese often shows an appreciable deficiency as compared with the other elements and barium is represented by only two lines and may show significant deviations from the mean. Some stars that have been analyzed by others are included in Table 1.

In Figure 1 we plot [M/H] against the ultraviolet excess. It can be seen that the correlation is good enough that the metal abundance of a main-sequence star whose color lies between $B - V = 0.45$ and 0.65 can be inferred from three-color photometry about as

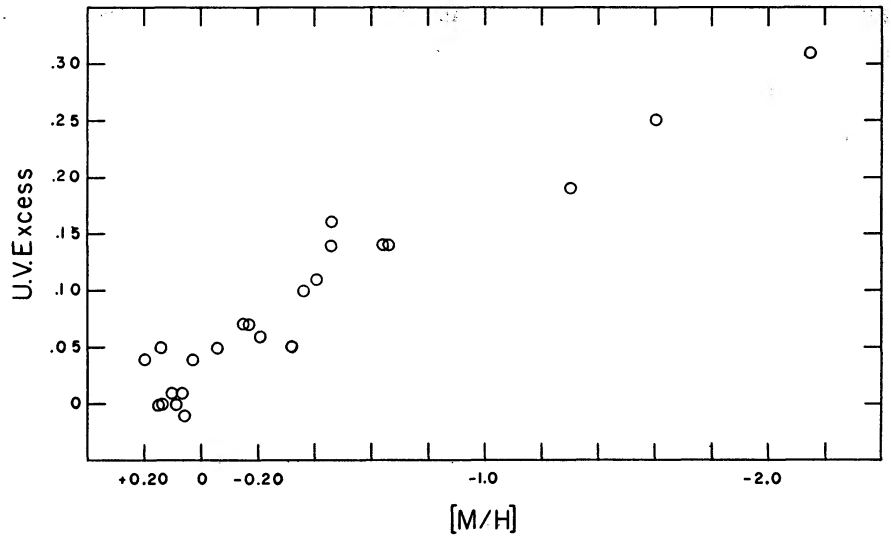

FIG. 1.—The metal deficiency plotted against ultraviolet excess for late F and early G dwarfs

well as by spectrophotometric analysis. For example, Arp (1959) has reported the ultraviolet excess of main-sequence stars ($B - V = +0.6$) in three globular clusters. For the clusters M5, M13, and M2 he quotes ultraviolet excesses of 0.21, 0.22, and 0.33 mag., respectively. Reference to Figure 1 shows that M5 and M13 are deficient in metals by a factor of about 20, while M2 must be deficient by about 200.

This material will be fully presented and more completely discussed at a later time.

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REFERENCES

Aller, L. H., and Greenstein, J. L. 1960, *Ap. J. Suppl.*, in press.
Arp, H. C. 1959, *A.J.*, **64**, 441.
Baschek, B. 1959, *Zs. f. Ap.*, **48**, 95.
Burbidge, E. M., and Burbidge, G. R. 1956, *Ap. J.*, **124**, 116.
Chamberlain, J. W., and Aller, L. H. 1951, *Ap. J.*, **114**, 52.
Johnson, H. L., and Knuckles, C. F. 1955, *Ap. J.*, **122**, 209.
Roman, N. G. 1955*a*, *A.J.*, **59**, 307.
———. 1955*b*, *Ap. J. Suppl.*, **2**, 195.
Wallerstein, G., and Helfer, H. L. 1959, *Ap. J.*, **129**, 347.