M_V AND T_{eff} OF B-TYPE STARS AS DERIVED FROM 13-COLOR PHOTOMETRY

P. Conconi and L. Mantegazza

Astronomical Observatory of Brera, Milano-Merate

1. INTRODUCTION

The 13 color medium-narrow band photometric system (Johnson and Mitchell 1975) potentially contains a great deal of information, but so far only a little work has been done in order to recover some physical parmeters from its color indices. Our aim is to obtain relations to be used in calibrating this system in terms of physical quantities, making use of the information given by this system alone.

We begin with B type stars as there is an excellent paper of Underhill et al. (1979) which evaluates many physical quantities for 160 O-B type stars which are among the stars observed in the 13 color system. The present paper describes the procedure we adopted to get preliminary relations for deriving T_{eff}'s and M_V's.

Our first attempt has been to calibrate all classes of B type stars, but as this fit was unsatisfactory, we have restricted ourselves to the stars of luminosity classes III-IV-V. Independent relations are probably needed for supergiants. Moreover, some Be stars, which were in extremely active stages when they were observed, fail to fit our relations; therefore they have been excluded from our sample. Finally a group of 108 stars has been adopted.

2. THE METHOD

The interstellar extinction is not generally negligible for these stars. As there is some uncertainty connected with the estimation of this coefficient, especially for the Be stars which may have circumstellar absorption, and in order to avoid the use of information not supplied by the 13 color photometry, we have defined the 'reddening free indices':

$$[\lambda_i-\lambda_{i+1}] = (\lambda_i-\lambda_{i+1}) - \alpha_i \cdot (45-52) \quad i=1,12 \qquad (1)$$

D. S. Hayes et al. (eds.), Calibration of Fundamental Stellar Quantities, 553–556.

TABLE I

Coefficients for the calculation of the reddening-free indices

color index	α_i
(33-35)	0.47
(35-37)	0.32
(37-40)	0.53
(40-45)	0.84
(45-52)	1.00
(52-58)	0.89
(58-63)	0.37
(63-72)	0.79
(72-80)	0.37
(80-86)	0.37
(86-99)	0.58
(99-110)	0.42

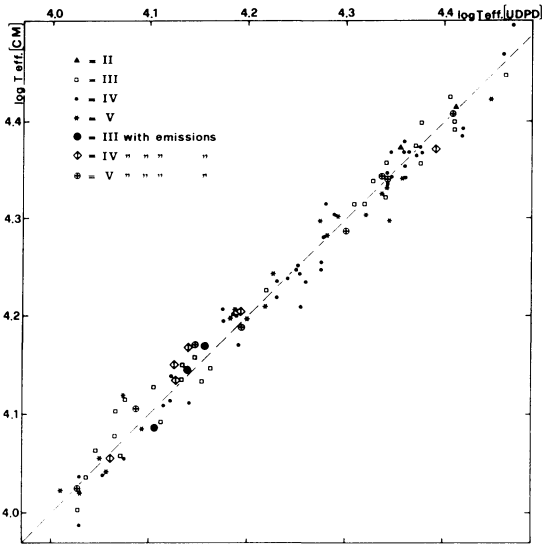

Fig. 1

where the α_i's have been calculated by means of the interstellar reddening law given by Scheffer (1982) and they are reported in Table I.

Then we have reduced the reddening-free indices into 'standardized variables' (zero mean and unit variance) and we have constructed 11 orthogonal indices by means of factor analysis (Whitney, 1983a,1983b). This procedure yields linear combinations of the indices that are themselves linearly independent. This is an important step, because the indices are strongly correlated, being in almost all cases strong functions of temperature, and this can result in an ill-conditioned coefficient matrix and meaningless coefficients when one performs a least-squares fit.

Multiple linear regressions have been performed between the orthogonal indices and their quadratic and bi-linear functions as independent variables.

The independent variables contained in each relation and their number have been selected with a FORWARD procedure; the number of independent variables has been increased starting from one, selecting at each stage that variable which gives the most important contribution to the residual variance of the dependent variable. The procedure ends when any further contribution is no longer statistically significant (Buzzi-Ferraris 1975). Finally a STEPWISE procedure has been applied to the results of the FORWARD procedure in order to get a further improvement (i.e., if some independent variables are no longer significant because of the introduction of

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successive terms in the relations, they are discarded, and, if in consequence of this, some excluded variables become significant, they are included in the relations). Figs. 1 and 2 show the correlations between the values of Underhill et al. (1979; UDPD) and ours (CM) for T_{eff} and M_V respectively. The rms residual is 0.017 for log T_{eff} and 0.287 for M_V.

3. THE CRITERION FOR SELECTING THE STARS

We have searched for a criterion which permits one to choose, by means of the 13 color photometry alone, the stars to which our relations apply. If a star falls inside the cloud constituted by the 108 stars of our sample in the 11-dimensional space of orthogonal indices, then our relations may be applied with confidence to it. As this cloud has not a simple geometrical structure, an empirical criterion must be adopted to verify if a star belongs to it. We have tried a few. One which works quite satisfactorily consists in verifying if the examined star falls inside a hyper-sphere with a radius of the order of the mean distance between adjacent stars of the sample and centered on the nearest star of the sample.

4. CONCLUSIONS

Our attempt at calibrating the 13-color photometric system seems promising. Now we are working to improve our relations, making a more accurate selection of the stars in our sample and defining better the selection criterion. Moreover, we intend to extend these relations to other types of stars and to study the correlations of the indices of 13 color photometry with other quantities such as log g, intrinsic brightness and rotational velocity.

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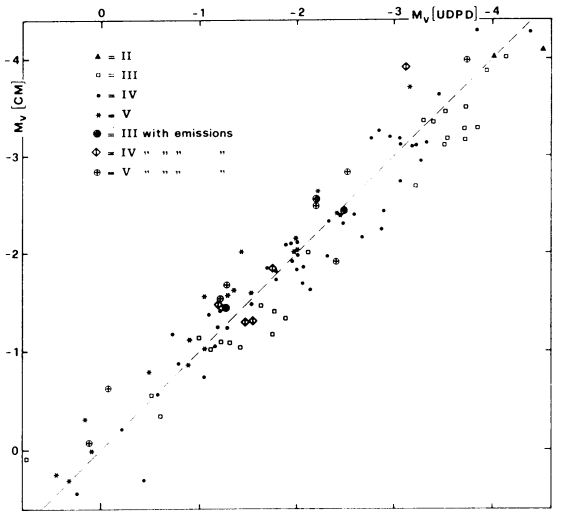

Fig. 2

DISCUSSION

HAUCK: We already have good calibrations to determine T_{eff} and M_v for B stars with the four-color system (Philip and Relyea, e.g.) and the Geneva system (Maeder and Cramer). What is the advantage of using the 13-color system for this kind of star? Do you obtain more precise values of T_{eff} and M_v?

MANTEGAZZA: The more color indices you have the more independent physical parameters you can get from them. Moreover, you may expect to be able to evaluate these parameters for peculiar objects too (i.e. Be, Ap, Am, Of, etc.) without referring to corrections for metal blanketing and so on.

ROUNTREE: In calibrating the 13-color photometry with the stars on the list of Underhill et al., did you make any use of the spectral types quoted in that paper? Many of these spectral types are incorrect, because the original MK type was changed to match the colors.

MANTEGAZZA: We did not make any use of the spectral types or luminosity classes quoted in that paper because our aim was to derive all we needed from the information contained in the photometric indices only.

TOBIN: Remie and Lamers (1982 Astron. Astrophys. 105, 85) have reanalyzed the Underhill et al. stars using almost the same data and method and they find temperatures 1000 - 1500 K cooler. People using the Underhill et al. results should be aware that they may suffer important systematic effects. (See also Tobin, 1983 Astron. Astrophys. 125, 168.)

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