

## A BROAD-BAND INDEX FOR THE EFFECTIVE TEMPERATURES OF NORMAL LATE TYPE STARS

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An index for temperatures of stars, based on  $B$ ,  $V$  and  $R$  magnitudes, has been obtained. It was found that  $\{\Theta_e, [(B - V)^2 + (V + R)^2]^{1/2}\}$  relations are well defined linear equations for stars of spectral type later than G0 and belonging to different luminosity classes.

*Широкополосный показатель для эффективной температуры „нормальных“ звезд поздних спектральных типов. Определен показатель температуры звезд на основании звездных величин полученных в цветах  $B$ ,  $V$  и  $R$ . Найдено, что соотношения  $\{\Theta_e, [(B - V)^2 + (V + R)^2]^{1/2}\}$  хорошо выражаются линейными уравнениями для звезд более поздних чем G0 и принадлежащих к различным классам светимости.*

### 1. Introduction

Apart from the determination of effective temperatures of late-type stars based on a determination of the diameter and the luminosity of individual stars, which method has only been applied to a few stars (Mendoza, 1969), the other methods of temperature determination depend on either a spectrophotometric determination of energy distribution, or the measurement of some kind of a broad-band photometric colour. Examples of the latter kind are the use of the  $B-V$  colour (Johnson and Morgan, 1953; Harris, 1963), the  $I-L$  colour (Johnson, 1966), the  $V-R$  colour (Mendoza, 1969), etc.

The methods of temperature determination described above, based on individual colour indices, have their limitations. Thus the  $B-V$  colour fails to bring out the dependence of temperature on the luminosity class, the  $V-R$  colour is not a uniformly good indicator of temperature for stars of all spectral types and the  $I-L$  colour is not easy to obtain. We have tried if an index based on a simple suitable function of the colours could be a better indicator of temperature. We found, that the index,  $X$ , defined as

$$X = [(B - V)^2 + (V - R)^2]^{1/2}$$

is a suitable index for all stars later than G0.

### 2. Data

We take as our starting point the grouped data given by Johnson (1966) on effective temperatures  $T_e$  ( $= 5040/\Theta_e$ ) and colours,  $B - V$  and  $V - R$ , of stars of spectral types between G0 and M8 and belonging to luminosity classes I, III and V (Tab. 1). In addition, data for 8 individual stars, for which direct determination of temperature has been made, have also been taken (Tab. 2). The latter serve as check points for our analysis. The effective tempera-

ture  $\Theta_e$  and the index  $X$  have been calculated for each of the above cases and a plot of  $\Theta_e$  against  $X$  has been made (Fig. 1).

### 3. Discussion

It is apparent from Fig. 1, that the range of  $X$  can be broken up into four parts, viz., from 0.75 to 1.20, 1.20 to 2.10, 2.10 to 2.60 and 2.60 to 3.20, in each of which the run of  $\Theta_e$  with  $X$  appears very nearly linear. Least-square straight-line solutions have been obtained for each of these ranges, with the following results:

$$\begin{aligned} \Theta_e &= 0.435(X) + 0.508, & \text{for } 0.75 \leq X < 1.20; & \\ & & (s = 0.014); & \\ \Theta_e &= 0.480(X) + 0.410, & \text{for } 1.20 \leq X < 2.10; & \\ & & (s = 0.025); & \\ \Theta_e &= 0.508(X) + 0.403, & \text{for } 2.10 \leq X < 2.60; & \\ & & (s = 0.018); & \\ \Theta_e &= 0.233(X) + 1.080, & \text{for } 2.60 \leq X < 3.20; & \\ & & (s = 0.012). & \end{aligned}$$

The quantity  $s$ , mentioned against each of these solutions, is the standard deviation of the residuals from the respective least-square fit.

However, we find that a few individual stars ( $\alpha$  Her,  $\alpha$  Ori,  $\alpha$  Sco) fall away from the general trend. This could be so perhaps because  $\alpha$  Ori and  $\alpha$  Sco are affected by reddening while  $\alpha$  Her and  $\alpha$  Sco have close companions.

The efficacy of the present index is apparent when we compare Fig. 1 with Figs. 2 and 3 which give the plots of  $\Theta_e$  against  $V - B$  and  $V - R$  colours, respectively. In the latter two cases, the scatter of the points does not permit a reasonably concise determination of  $\Theta_e$ . It is realized, however, that like the colour indices  $B - V$  and  $V - R$ , the index  $X$ , also cannot be used for faint stars without applying suitable corrections for interstellar reddening. We have verified that for stars of spectral types earlier