ULTRAVIOLET PHOTOMETRY FROM THE S2/68 OBSERVATIONS IN THE TD1 SATELLITE

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SUMMARY

An ultraviolet photometric system based on observations obtained from the ultraviolet Sky Survey Telescope in the TD1 satellite is described. The system considered here consists of ultraviolet magnitudes at λ_1 = 2740A, λ_2 = 2190A and λ_3 = 1490A. The extinction free parameters derived from the observed ultraviolet colours enable determination of interstellar reddening, spectral type and luminosity. This photometric system has been evaluated by comparing these parameters with other classification parameters.

The observations from the S2/68 Ultraviolet Sky Survey Telescope in the ESRO satellite TD1 have provided homogenous data on stellar spectra in absolute fluxes in the wavelength range from 2500A to 1350A over an area covering approximately 80% of the sky; the spectral resolution is $\sim$ 30A (Boksenberg et al., 1973). In addition the experiment gives a broad band measurement centred at 2740A of width 310A at half maximum. The number of observations per star is usually 3, this number being greater for stars near the ecliptic pole. The stars brighter than V=9^m at B0 to 8^m at A0 have been detected and identified. The estimated number of stars observed is over 40000. Since the number of observations does not depend on the brightness of the star, the photometric accuracy of the spectral data points becomes low for stars fainter than V=6^m. For brighter stars with small amount of reddening the accuracy of the mean spectrum is better than 3%. These spectra are individually useful and an ultraviolet catalogue of bright stars is going

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to be published. A number of distinct features appear in these spectra, the strength of which vary with spectral type and luminosity (Cucchiaro et al., 1976). For the fainter stars, however, the spectral data points have to be combined into wider wavelength bands to give statistically useful results. The narrow band ($\Delta\lambda \sim 100$A) magnitudes have been constructed at several wavelengths from the spectral data, and the intrinsic ultraviolet colours, their dependence on spectral type and luminosity and the effect of interstellar reddening have been studied from the extensive data available from the S2/68 experiment (Nandy et al., 1976a). On the basis of these results an ultraviolet photometric system has been considered, which determines spectral type, luminosity and reddening (Nandy et al., 1976b). In this paper this photometric system will be evaluated.

Because of the complexity of the spectra in the ultraviolet wavelength region due to the presence of many absorption lines, the colour indices need to be selected with considerable care for an ultraviolet photometric system. The wavelengths have been chosen (1) to avoid the strong spectral features, (2) to avoid the extremities of the spectrophotometer channels and (3) to include the wavelength at which maximum interstellar extinction occurs. The wavelengths chosen are $\lambda_1 = 2740$A, $\lambda_2 = 2190$A and $\lambda_3 = 1490$A, λ_2 being close to the wavelength of the ultraviolet extinction peak. λ_2 and λ_3 are chosen in view of the observations that the luminous stars have flux deficiency increasing with $1/\lambda$ as compared to the main sequence stars of similar spectral types (Humphries et al., 1975).

The fluxes obtained at these wavelengths are converted to magnitudes m_λ, where $m_\lambda = -2.5 \log I_\lambda - 21.1$ (Oke and Schild, 1970). The photometric accuracy of m_λ has been discussed by Nandy et al. (1976a). The ultraviolet colour (m_{2740} - V) primarily determines the spectral type (colour temperature) while the colour (m_{1490} - V) is sensitive to both spectral type and luminosity (Nandy et al., 1976b). The two extinction free parameters have been derived from the observed colours, using (m_{2190} - V) as a reddening indicator. These parameters are defined as follows:-

$$\mathrm{PHI} = (m_{2740} - V) - \frac{E_{2740\,-\,V}}{E_{2190\,-\,2740}} (m_{2190} - m_{2740});$$

and

$$\mathrm{PSI} = (m_{1490} - V) - \frac{E_{1490\,-\,V}}{E_{2190\,-\,V}} (m_{2190} - V).$$

The mean values of the colour-excess ratios (see Nandy et al., 1976a) are:

$$\frac{E_{2740\,-\,V}}{E_{2190\,-\,2740}} = 1.1; \quad \frac{E_{1490\,-\,V}}{E_{2190\,-\,V}} = 0.8$$

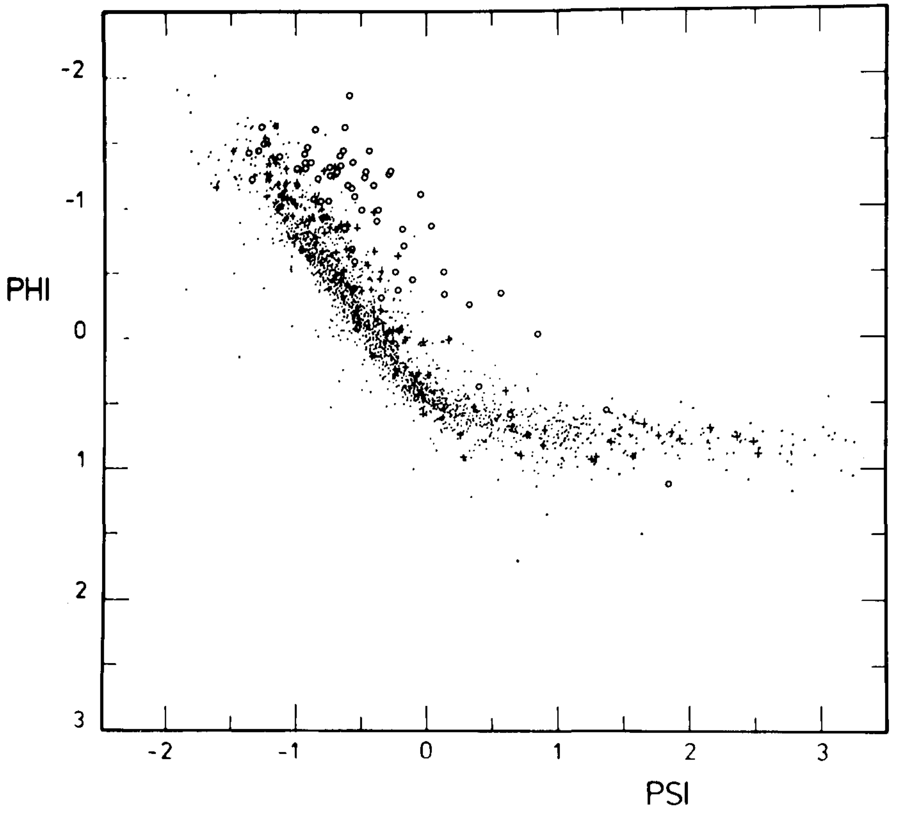

FIGURE 1. The relation between PHI and PSI. Circles denote class I and II stars, crosses class III and dots main sequence stars.

The analysis of the extensive stellar data obtained from the S2/68 experiment shows that the extinction laws derived for different galactic regions are not significantly different. All the observations have been used to give a single mean extinction curve. However, there are a number of individual cases which exhibit significant deviations from the mean extinction law; these deviations may arise due to the presence of circumstellar or local clouds close to the stars (see, for example, Willis and Wilson, 1976).

Fig. 1 shows the relation between PHI and PSI for several thousands stars. Except for a few stars, the points fall naturally into two groups. The points denoted by dots lie in a fairly narrow region in the lower part of the diagram and all of these are class V. Also many points lie significantly above (open circles) and these belong to class I and II. The class III stars denoted by crosses tend to lie between these two sequences. The importance of the PHI - PSI diagram is that the stars can be classified according to their positions in this diagram. Also, any star which shows an anomalous extinction law due to circumstellar or localised cloud can be identified.

The correlation between PHI and Q, and PSI and Q are shown in Fig. 2, where

$$Q = (U-B) - 0.72\ (B-V).$$

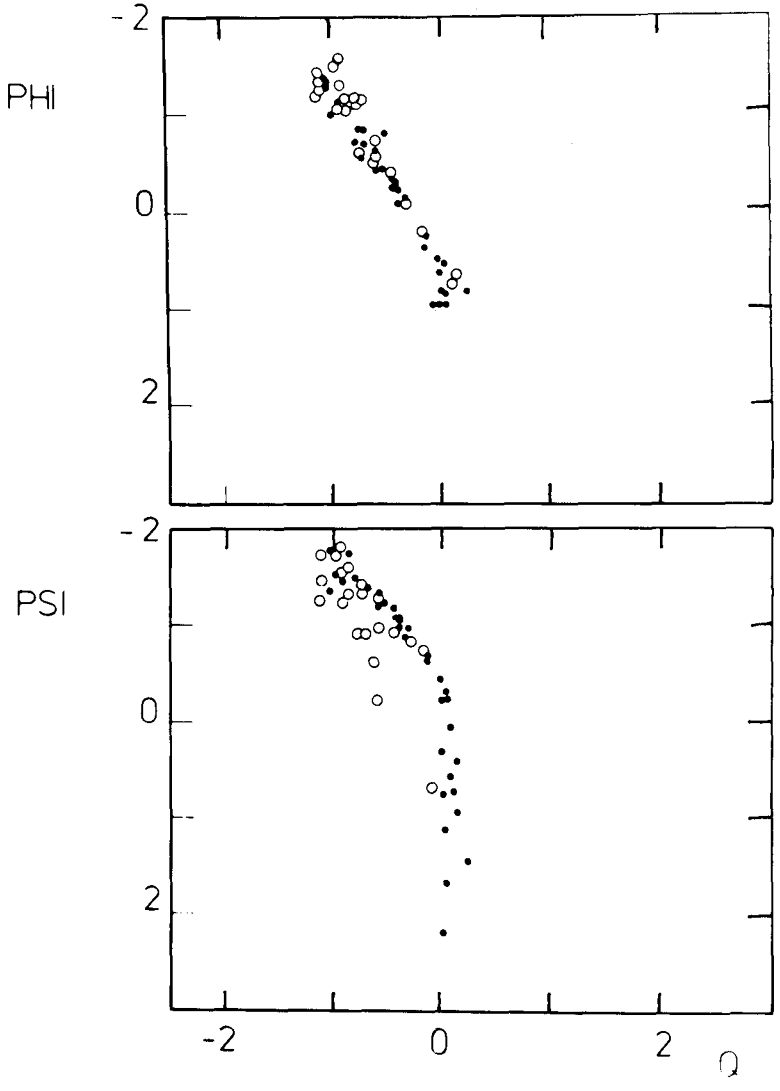

FIGURE 2. Relation between PHI and Q (top) and between PSI and Q (bottom). Symbols as in Fig. 1.

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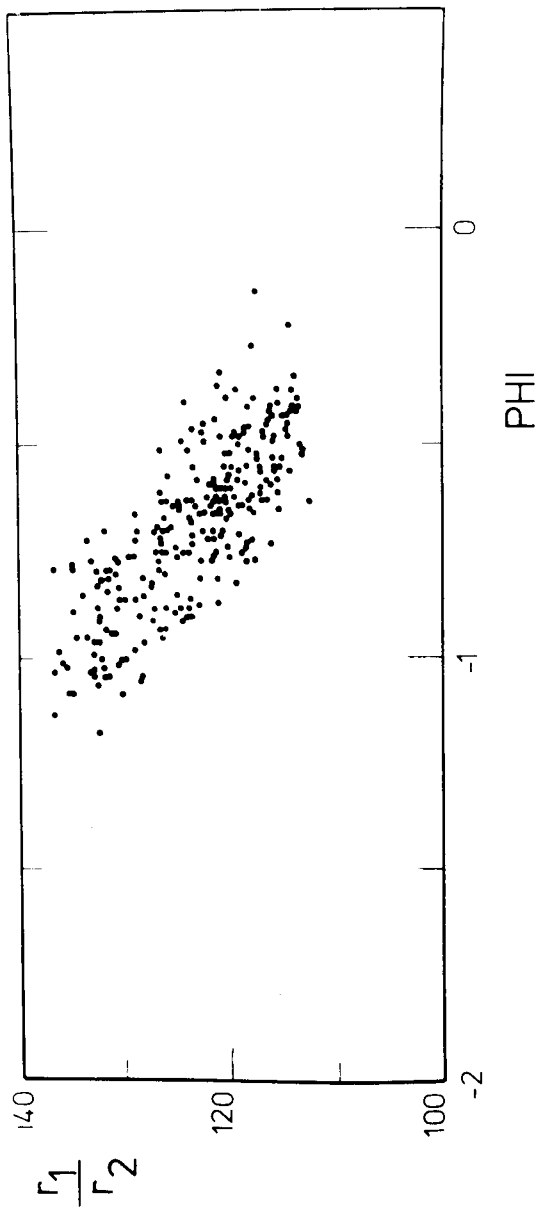

FIGURE 3. Relation between r_1/r_2 and PHI (see text).

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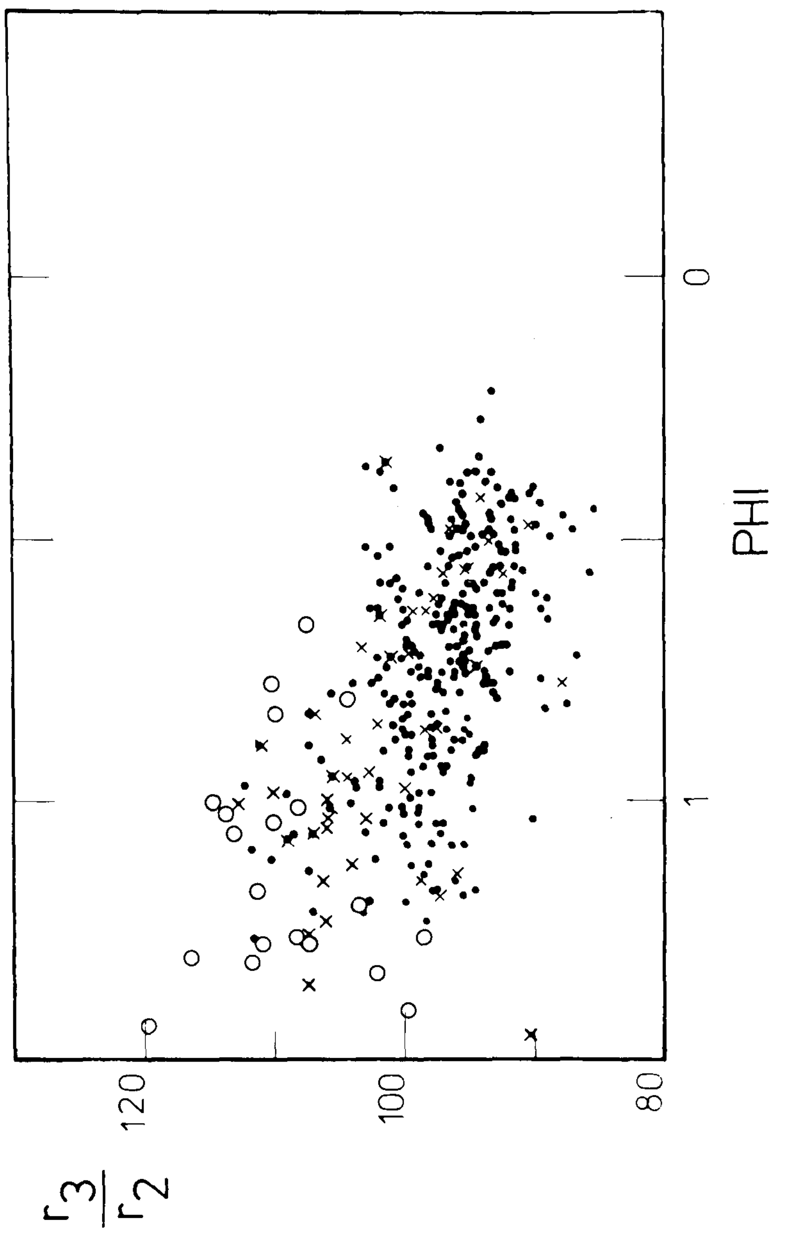

FIGURE 4. Relation between r_3/r_2 and PSI (see text). Symbols as in Fig. 1.

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The mean relation between PHI and Q is linear, and there is no separation between dwarfs and luminous stars, whereas in the PSI vs Q diagram the supergiants are clearly separated from the main sequence stars.

Cucchiaro et al. (1976) have used the intensity ratio of the features occurring at 1410A and 1550A (denoted by r_1/r_2) and of the 1620A and 1550A features (denoted by r_3/r_2) for a two dimensional classification. The intensity ratios are independent of interstellar reddening. The relation between PHI and these intensity ratios are shown in Figs. 3 and 4.

It is shown that the classification parameters derived from the observed ultraviolet colours are well correlated with the parameters derived from the intensity ratios of the spectral features. Therefore for the fainter stars the ultraviolet colours $(m_{2740} - V)$, $(m_{2190} - V)$ and $(m_{1490} - V)$ allow separation of dwarfs from luminous stars and determination of interstellar reddening and spectral type. This photometric system will provide homogenous classification of a large number of stars distributed all over the sky. This work is in progress.

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