CALIBRATION OF PHOTOMETRIC SYSTEMS FROM HOMOGENEOUS SPECTROPHOTOMETRIC DATA

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1. INTRODUCTION

The atlas of stellar spectrophotometric data published by Gunn and Stryker (GS, 1983) constitutes an extremely valuable tool for the evaluation and calibration of photometric systems. The resolution of the scanner fluxes (10 or 20 Å), given for a broad wavelength range (λλ 3160-10620 Å) and the systematic coverage of stellar types are (almost) ideal for calculating synthetic colors for Becker's (1946) photographic RGU system which has been extensively applied in galactic structure work (cf. Buser 1981). Since RGU photometry is tightly linked to UBV data (Steinlin 1968, Buser 1978b), the Gunn-Stryker atlas has been used in the present paper to evaluate these two systems and subsequently investigate the resulting calibration of the RGU colors in terms of MK spectral classification.

2. UBV COLORS

Our evaluation of UBV colors differ from that by Gunn and Stryker in three basic respects.

2.1 UV Fluxes

Unlike GS, who absorbed incomplete wavelength coverage in their UV fluxes into the transformation of synthetic to standard colors (cf. section 2.2 below), we have been interested in the most adequate representation of the U filter passband (cf. also Buser and Kurucz 1985). We have therefore used available OAO (Code and Meade 1979, Meade and Code 1980) and IUE (Heck et al. 1984) data of about ten early-type stars of the GS sample to extend their fluxes to the atmospheric cutoff of the U filter(s) at 3000 Å. For most stars the UV data could be joined smoothly with the GS data, and the U magnitudes computed from the Matthews and Sandage (MS, 1963) response functions (for one air mass) were found to be brighter by about 0.05 mag (for O-stars) than the corresponding magnitudes obtained from the

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incomplete scans, declining to 0.03 mag for an A star. Extrapolation of these corrections to later spectral types and different luminosity classes was checked using the library of mean stellar energy distributions given in the catalog by Straižys and Sviderskienė (1972), and the synthetic (U-B) colors for the whole GS sample were corrected accordingly. For the U passband as given by Buser (Paper I, 1978a), these corrections never exceeded 0.01 mag due to its slightly redder short-wavelength cutoff.

2.2. Transformations

In contrast to GS, who first corrected the synthetic scan colors and the observed colors for interstellar reddening (by adopting an interstellar extinction model of the Galaxy) in order to then establish the transformations, our interest focussed on the direct comparison of the scan colors (uncorrected for interstellar reddening) and the observations, because systematic errors introduced by inadequate response functions in the synthetic calculations are augmented by interstellar reddening effects (Paper I).

More than 110 GS stars for which homogeneous UBV colors exist in the catalog of Nicolet (1978) have been used in our study of the transformations (GS excluded stars with low-weight photometry as well as those marked for duplicity and/or variability to end up with about 70 objects used in their corresponding calculations). Linear regressions between synthetic and observed colors confirm that the UBV response functions adopted in Paper I are clearly superior to the MS functions. The former give tighter fits in the U-B and transformation coefficients closer to unity for both B-V and U-B. Most importantly, the systematic nonlinearities present in the residuals of the $(U-B)_{MS}$ colors are completely eliminated on the improved U-B system of Paper I.

2.3. Dereddening

While GS adopted an interstellar extinction model to deredden the fluxes and colors, we have decided to study extinction using the color excesses derived by comparing the program star colors with the mean intrinsic colors as given by FitzGerald (1970). Homogenization of the spectral type and luminosity class (using essentially the Bright Star Catalog) assigned to each star was important for estimating the intrinsic scatter of the resulting E_{B-V} vs. spectral type/luminosity class plot. A uniform scatter independent of spectral type and luminosity class of ± 0.05 mag was found, which is comparable to the standard deviations of the mean intrinsic colors associated with a given spectral type (FitzGerald 1970). We therefore chose to deredden only those stars with $E_{B-V} > 0.05$ mag and to exclude the few objects with $E_{B-V} < -0.05$ mag. Dereddening of the fluxes was then accomplished employing Whitford's (1958) law as adopted in Paper I.

3. RGU COLORS

The intrinsic colors on the photographic RGU system were computed applying the response functions given in Paper I. Plots of color vs. spectral class were then used to establish smooth relations from weighted averages for each stellar type. For (U-G), the resulting relations are in good accord with those obtained in Paper I from averaged spectral scans. As yet unexplained systematic discrepancies exist however for the (G-R) colors of intermediate-type dwarfs and late-type giants. Further work including the comparison of synthetic colors with photoelectrically determined RGU data will be necessary for an improved evaluation of the photographic system.

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