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MULTIBAND CALIBRATION OF AN ALL-SKY SAMPLE OF AGN FIELDS—EXTENDING LANDOLT'S STANDARDS TO V = 19

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We describe the first results of a program to extend the Landolt calibration standards to at least $V = 19$ mag and to calibrate fields separated from the celestial equator. This program is one of several coordinated efforts to find faint type AV and KIII stars suitable for the mid-IR calibration of the 10 m Gran Telescopio CANARIAS. We have obtained 34 712 measurements of 373 stars in 26 quasar fields between declinations $-30°$ and $+70°$, calculating magnitudes with high precision in the visible and near infrared ($UBVRIJHK$). The next stages will be to: 1) increase the number of fields covered, 2) take additional observations of poorly covered fields, 3) use our existing database to extend photometry of Selected Areas to include many stars not previously measured by Landolt, and 4) spectral type all candidate KIII and AV stars in the sample. We conclude that both samples (ours and that of Landolt) are increasingly dominated by local dwarfs at faint magnitudes.

1. INTRODUCTION

The absolute calibration of astronomical photometry has traditionally been one of the major problems faced when treating observational data. With the leap in sensitivity of astronomical instrumentation over the last 20 years it has become necessary to obtain precise calibration of images down to unprecedentedly faint magnitudes. The problem is common to almost all observational astronomers. As increasing numbers of 8 to 10 meter class telescopes become available to the astronomers, the problem of obtaining a reliable photometric calibration to faint limits, on a well-understood absolute photometric scale, will become increasingly important. This is particularly true in the IR where the faintest standards generally available are some 10 magnitudes or more brighter than the limiting magnitude of the detectors, but even in the visible the faintest stars calibrated by Landolt will saturate in 0.1 s or less.

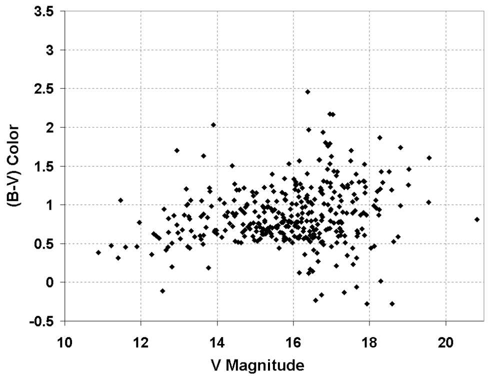

Fig. 1. The color–magnitude diagram for AGN fields.

2. THE LANDOLT STARS

Between 1983 and 1992, Landolt produced a series of papers calibrating over 700 stars mainly in equatorial Selected Areas (Landolt 1983a,b; 1992a,b). High precision photometry was presented in $UBVRI$ on a rigorously defined system based on photometry in UBV of Selected Areas 92−115 (Landolt 1973) and of calibrations in RI of mainly southern hemisphere stars taken from the Cousins VRI standard star lists (Cousins 1976). The former, in itself, is based on the pioneering work that defined the Johnson system (Johnson & Morgan 1953), which lists photometry for 290 mainly northern hemisphere stars and the latter on the system defined by Kron et al. (1953). These papers have formed the basis of photometric calibration in the visible for many years. The stars are, however, rather bright for large telescopes. The median magnitude is $V = 12.08$ mag, and less than 10% of the stars are fainter than $V = 15$ mag. This distribution makes the stars unsuitable for calibration with high sensitivity CCDs on large telescopes.

3. OUR AIM

Since 1994 we have been calibrating systematically quasar and blazar fields in the visible and infrared using the 82 cm IAC-80 Telescope at Teide Observatory, the 1 m Jacobus Kapteyn Telescope at Roque de los Muchachos Observatory, the 1.5 m

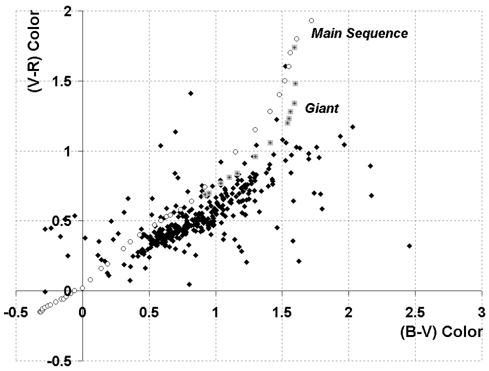

Fig. 2. The color–magnitude diagram for AGN fields.

Telescope at Calar Alto and, in the infrared, the 1.5 m Carlos Sánchez Telescope at Teide Observatory. We aim to obtain high precision photometry in $UBVRIJHK$ of a sample of > 1000 stars down to $V \gtrsim 20$ mag, $K \gtrsim 17$ mag on the scale defined by Landolt.

4. RESULTS

We have obtained a total of 34 712 measurements of 373 stars in 26 quasar fields between declination $-30°$ and $+70°$ with high precision in the visible and near infrared ($UBVRIJHK$) and with a median magnitude in V, which is 4.0 magnitudes fainter than Landolt, although still rather bright compared to the needs of the GTC. We have found a strong trend to redder colors of the stars at fainter magnitudes, which indicates that we increasingly detect local KV and MV stars at fainter magnitudes (see Figs. 1 and 2). This conclusion is supported by the color–color diagram, in which each star is dereddened by the line of sight extinction to the quasar—local dwarf stars are over-corrected by this dereddening and shift away from the main sequence. It appears that few of the fainter K and M stars in our sample are giants.

5. FUTURE WORK

We have only included data from photometric nights on which several Landolt fields were observed. Our data will be supplemented by the addition of large quantities of relative photometry of stars in the fields taken on non-photometric nights, or on photometric nights when no calibrations were attempted.

We will add substantial additional stars from each field that has been observed, but that have not been included in the reduction template.

We will take additional observations of fields with inadequate photometry, or in which we are missing data in one or more filters.

Additional quasar fields will be calibrated.

Reduction is in course of hundreds of observations of Landolt fields in which there are significant numbers of uncalibrated stars. These stars can be calibrated by relative photometry alone and will provide a substantial number of additional stars.

A program of spectral typing of stars is in course with the 2.5 m Issac Newton Telescope (see Martín-Luis et al., this volume, p. 303).

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