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QUANTITATIVE STELLAR SPECTRAL CLASSIFICATION

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RESUMEN

Para espectros de rendija digitalizados de 490 estrellas se compararon los anchos equivalentes de 19 líneas de absorción con sus respectivos índices de color $(B-V)$ y sus magnitudes absolutas derivadas de paralajes del catálogo *Hipparcos*. Se desarrollaron algoritmos que permiten obtener la magnitud absoluta para todos los tipos espectrales con un error promedio de 0.26 magnitudes. Los colores $(B-V)$ se pueden reproducir con un error promedio de 0.020 magnitudes.

ABSTRACT

Equivalent widths of 19 absorption lines in CCD slit spectra of 490 stars are compared with their respective $(B-V)$ colors and their absolute magnitudes derived from *Hipparcos* parallaxes. Algorithms are found which yield the absolute magnitudes for all spectral types with an average error of 0.26 magnitudes. The $(B-V)$ colors can be reproduced with an average error of 0.020 magnitues.

Key Words: **SPECTROSCOPY: ABSOLUTE MAGNITUDES — SPECTROSCOPY: INTRINSIC COLORS**

1. INTRODUCTION

For the determination of the spatial distribution of different stellar populations at least two steps are required: (1) the complete and unbiased identification of members of the respective population in the field of interest, and (2) a fairly accurate distance determination for each of the members. A combination of spectral classification with photometry can provide the required data, whenever the spectral classification yields intrinsic colors and absolute magnitudes of adequate accuracy. The MK classification has been applied in this sense many times, but it is well known that the precision of the predicted absolute magnitudes falls short of the desired goal. Also, so far the application of the MK system has been restricted to the visual inspection of photographic spectra. Objective prism spectra would be ideal for the mentioned type of galactic studies because they reach fainter magnitudes and provide data for many stars. Their low resolution permits only the use of strong spectral features, contrary to what the MK classification requires. Also it is now possible to combine objective prism techniques with the use of CCD detectors. Thus the purpose of our work is to test up to which point objective prism and CCD techniques can be used for stellar classification. It is not our purpose to reproduce or improve the MK system. Instead we shall try to recover stellar parameters directly from measured spectral features.

2. OBSERVATIONS

Our starting point is the *Hipparcos* Catalogue which provides accurate parallaxes for a large variety of stars. To this we add the library of CCD spectra of nearly 700 stars in the regions 3820 − 4500 Å and 4780 − 5450 Å made available to the public by L. Jones. The Jones library also provides B- and V-magnitudes. Practically all of his stars are contained in the *Hipparcos* Catalogue. The resolution of the Jones spectra is 0.6 Å, while typical objective prism spectra may have a resolution of about 5.0 Å. In order to make them comparable with the objective prism spectra, the Jones spectra were smoothed with the IRAF GAUSS routine. A total of 19 lines was selected in these spectra, all of which can be expected to be strong enough for certain spectral types to be measurable in objective prism spectra (Table 1). For each line an equivalent or pseudo-equivalent width, depending on whether a true continuum could be found or not, was determined. Combining the B-magnitude with the *Hipparcos* parallaxes absolute B-magnitudes could be calculated. Stars with a parallax error greater than 20 % were eliminated. Thus practically no supergiants are left in the sample. Since all stars in the sample are rather bright the effect of interstellar absorption will in most cases be small or even negligible. Inspection of the relations color versus equivalent width made it clear that early and late type stars had to be treated separately, and that it would be necessary to eliminate very early and very late type stars, hardly present in the sample anyway. The formation of these groups was performed on the basis of measured line criteria only.

TABLE 1

LIST OF ABSORPTION LINES

No	λ (Å)	No	λ (Å)	No	λ (Å)	No	λ (Å)	No	λ (Å)	No	λ (Å)	No	λ (Å)
1	3389	4	4045	7	4305	10	4383	13	4923	16	5171	19	5404
2	3933	5	4101	8	4325	11	4458	14	5016	17	5268		
3	3969	6	4226	9	4340	12	4861	15	5079	18	5327		

3. ANALYSIS AND CONCLUSIONS

Our principal purpose is to recover the physical parameters, i.e., the $(B-V)$ colors and the absolute magnitudes, directly from the measured line strengths. As algorithm we have chosen a second order polynomial with three line widths as independent variables. From the 19 lines 969 groups of three lines can be formed. We tried the above solutions, separately for early and late type stars, with all possible combinations. The results for the optimum combinations are given in Tables 2 and 3.

TABLE 2

ABSOLUTE MAGNITUDES

$A-F$					$G-K$				
L1	L2	L3	rms	N	L1	L2	L3	rms	N
2	4	16	0.263	142	1	11	16	0.237	259
2	7	16	0.265	143	2	4	5	0.237	260
6	11	16	0.267	144	11	16	19	0.238	243

TABLE 3

$(B-V)$COLOR

$A-F$					$G-K$				
L1	L2	L3	rms	N	L1	L2	L3	rms	N
2	5	7	0.016	140	3	5	8	0.019	266
3	9	10	0.019	243	5	6	9	0.020	252
5	7	17	0.015	137	9	17	19	0.016	140

REFERENCES

Jones, L. NOAO website, FTP Archives, Catalogs, Coudelib