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THE ATMOSPHERIC EXTINCTION AT ESTACION ASTRONOMICA "DR.CARLOS ULRRICO CESCO"

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RESUMEN

Con el objeto de determinar los coeficientes de extinción de la Estación Astronómica "Dr.Carlos Ulrrico Cesco" se observaron estrellas estándar de las zonas de Landolt (1973, 1983) durante el período marzo 1991 – mayo 1992. En el segundo semestre de 1991 se ha detectado un incremento en la extinción primaria debido a la presencia de partículas en suspensión en la atmósfera, mientras que los coeficientes de segundo orden se han mantenido constantes durante todo el período estudiado.

ABSTRACT

In order to obtain the extinction coefficients for the Estación Astronómica "Dr.Carlos Ulrrico Cesco" stars of the Standard Areas of Landolt (1973, 1983) have been observed during the period March 1991 – May 1992. An increase in the primary extinction was detected during the second semester of 1991 due mainly to the presence of particles in the atmosphere, while the secondary coefficients have been constant during this period.

Key words: **ATMOSPHERIC EFFECTS — TECHNIQUES–PHOTOMETRIC**

1. INTRODUCTION

To reduce photoelectric observations it is essential to know the behavior of the atmosphere at the observing site and how the light of the stars is absorbed and scattered. This phenomenon known as "atmospheric extinction" is due to three processes: scattering by molecules, molecular absorption, and scattering due to dust and atmospheric aerosols (atmospheric obscuration).

The scattering by molecules obeys Rayleigh's Law, i.e., it is proportional to λ^{-4} and depends on the altitude of the observatory. This effect produces an apparent selective absorption, which is more noticeable in the ultraviolet than in the red.

The selective absorption that some molecules produce is a real absorption since the disappeared irradiated energy is used to disassociate molecules, to ionize them, or to produce other physical phenomena. For example, the water and molecular oxygen bands produce a weak absorption in the visible and near-infrared region, while the ozone absorbs most of the energy between 2200 and 3100 A, and near 6000 A.

The dispersion produced by the atmospheric obscuration is due to the presence of liquid droplets and solid particles of any size in suspension which scatter the radiation in a non-selective way. Normally, these particles are bigger than optical wavelengths, but in some cases this is not true, and the process follows more complicated laws which cannot be described by a simple theory.

In this work a study of the atmospheric absorption at Estación Astronómica "Dr. Carlos Ulrrico Cesco" of Félix Aguilar Observatory, San Juan, Argentina (longitude = $4^h\ 37^m\ 20^s$; latitude = $-31^\circ\ 48'\ 08''$; altitude over sea level = 2500 m) is presented for the first time, complementing a previous work of Minitti, Clariá, & Gómez (1989) for the nearby station of CASLEO. The spectral region chosen is that of the effective wavelengths of the *UBV* photometric system.

2. OBSERVATIONS

The measurements were carried out during 17 nights in the period March 1991 – May 1992 with the 0.76-m. reflector and a photon-counting photometer which uses a RCA 31034A phototube refrigerated by Peltier effect. The photometric data were recorded using a microcomputer which was interfaced with the photometer and the data were stored on a computer disk file. The diaphragm used was of 30 arcsec and the typical seeing was 2–3 arcsec.

Several procedures of determining the extinction

TABLE 1

SPECTRA, MAGNITUDES AND COLORS OF STANDARD STARS

Area	Star	Spec.	*V*	*B–V*	*U–B*	Area	Star	Spec.	*V*	*B–V*	*U–B*
95	15	G0	11.320	0.710	0.150	106	834	dG9	9.088	0.701	0.292
	74	G5	11.529	1.127	0.702		1146	dG2	9.100	0.620	0.100
	132	G0	12.062	0.449	0.302		1250	gK0	8.123	1.029	0.832
	149	K4	10.930	1.570	1.560	107	544	A5	9.037	0.401	0.156
96	36	A3	10.589	0.250	0.111	107	847	gG5	10.250	1.070	0.810
	51	G1	10.640	0.520	0.060		990	F7	9.560	0.490	0.000
	180	G8	8.930	1.049	0.841		1006	G3	11.715	0.764	0.285
102	58	B9	9.380	0.060	0.021	111	717	F0	8.529	0.425	0.224
	620	gK5	10.067	1.087	1.013		773	B9	8.963	0.206	−0.211
	743	G2	12.080	0.730	0.280		1342	gK2	9.220	1.690	1.780
	747	G2	11.760	0.580	0.030		2009	gG5	10.608	0.889	0.513
103	42	G5	11.520	0.760	0.360	113	259	K	11.743	1.196	1.213
	517	F5	11.100	0.410	−0.050		276	G0	9.074	0.647	0.181
	526	gG8	10.903	1.089	0.941		466	F0	10.007	0.452	−0.001
105	56	gG2	9.970	0.650	0.150	113	475	G5	10.306	1.057	0.841
	66	gG9	9.426	0.977	0.756		488	dG5	10.160	0.700	0.230
	257	G0	9.140	0.490	0.020	114	151	G3	10.660	0.750	0.290
	448	A1	9.176	0.249	0.037		670	K5	11.106	1.203	1.220
106	411	F0	9.270	0.410	0.080	114	750	A2	11.913	−0.038	−0.357
	700	dK2	9.787	1.361	1.574		755	G2	10.908	0.571	−0.064
	702	F7	10.600	0.490	−0.020		790	dG5	12.130	0.820	0.400

coefficients are available (Minitti et al. 1989 and references therein), but in this opportunity groups of three or more stars near the celestial equator were observed several times during the night to try to obtain a global solution by least-squares. The groups were selected from the list of Landolt (1973, 1983) and each one included at least one early, one intermediate, and one late-type star. The use of this method allows the use of most parts of the night in other programs, and it is justified when constant atmospheric transparency, absence of azimuthal effects, and constant instrumental sensitivity are assumed during the night. These conditions were monitored observing each night standard stars symmetrically on both sides of the meridian to measure any drift in the instrumental sensitivity.

The standard stars used are listed in Table 1. Each star was observed many times during the night at air masses X < 2 and the integration time was calibrated by means of the method proposed by Fitzgerald & Shelton (1982) to secure always an average uncertainty of 0.01 magnitude. I found variable atmospheric extinction during few nights, mainly for the period December 1991 – January 1992, which have not been included in the present study.

3. RESULTS

In Table 2 the extinction coefficients (in magnitudes/air mass) are shown for this observatory, where the values for different nights in one month were averaged using weights corresponding to the quality of the nights, and the average values and sigmas obtained from the least-squares were assigned to that month. Due to the difficulty of obtaining very good values for the second-order extinction, only nights with 5 of more stars observed were used.

The value for the sigma of the first-order coefficient for the *V* filter is due to a very clear process which can be noted in Figure 1, where the values for the first-order extinction coefficients for this filter and for each month listed in Table 2 are shown. It is quite clear that an increment in the extinction coefficient was present during the period August–December 1991 due to the presence in the atmosphere of volcano's ashes from Hudson Volcano (Argentina) and Mount Pinatubo (Philippines). This effect was detected by Piatti (1992) when he performed extinction measurements at CASLEO during December 1991. The increment for the extinction coefficient found at that time was approximately 0.1 mag for the *V* filter.

If the values obtained in August, September and

TABLE 2

OBSERVED FIRST ORDER AND SECOND ORDER EXTINCTION COEFFICIENTS

Month	No. Nights	mag/col	1st. Order	2nd. Order
March 1991	2	*U–B*	0.259 ± 0.021	....
		B–V	0.159 ± 0.011	....
		V	0.105 ± 0.012	....
May	3	*U–B*	0.259 ± 0.021	0.010 ± 0.012
		B–V	0.131 ± 0.012	−0.028 ± 0.011
		V	0.158 ± 0.010	−0.010 ± 0.010
June	2	*U–B*	0.194 ± 0.023	0.000 ± 0.010
		B–V	0.157 ± 0.012	−0.028 ± 0.010
		V	0.082 ± 0.010	0.011 ± 0.008
August	2	*U–B*	0.216 ± 0.020	....
		B–V	0.150 ± 0.015	....
		V	0.213 ± 0.018	....
September	2	*U–B*	0.226 ± 0.025	−0.011 ± 0.015
		B–V	0.108 ± 0.015	−0.041 ± 0.012
		V	0.241 ± 0.013	0.000 ± 0.012
December	2	*U–B*	0.258 ± 0.022	....
		B–V	0.101 ± 0.012	....
		V	0.219 ± 0.012	....
April 1992	2	*U–B*	0.175 ± 0.018	....
		B–V	0.172 ± 0.015	....
		V	0.107 ± 0.015	....
May	2	*U–B*	0.184 ± 0.015	....
		B–V	0.153 ± 0.013	....
		V	0.149 ± 0.011	....
Average	17	*U–B*	0.224 ± 0.034	0.000 ± 0.010
		B–V	0.141 ± 0.024	−0.032 ± 0.006
		V	0.160 ± 0.055	0.000 ± 0.009

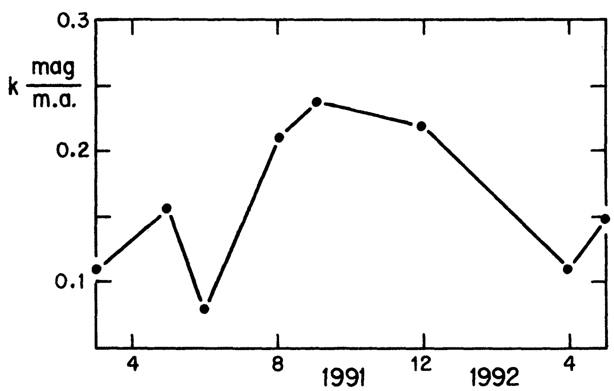

Fig. 1. Variation of the first-order extinction during the period March 1991 – May 1992.

December 1991 were not taken into account, the first-order coefficients are:

$$k_{(U-B)} = 0.218 \pm 0.039 \ ,$$
$$k_{(B-V)} = 0.152 \pm 0.015 \ ,$$

and

$$k_{(V)} = 0.124 \pm 0.031 \ ;$$

where the color indexes are maintained constant and the difference for the *V* filter agrees with the excess found at CASLEO. So, the adopted values for the first-order extinction coefficients are:

$$k_{(U-B)} = 0.22 \pm 0.04 \ ,$$
$$k_{(B-V)} = 0.15 \pm 0.02 \ ,$$

and

$$k_{(V)} = 0.12 \pm 0.03 \ ,$$

and for the second-order coefficients, the averaged values of Table 2.

4. DISCUSSION

The three points obtained for the *UBV* first-order extinction coefficients are not enough to define an extinction curve, but they are useful to compare the result obtained with extinction curves for other observatories. In Figure 2 are shown

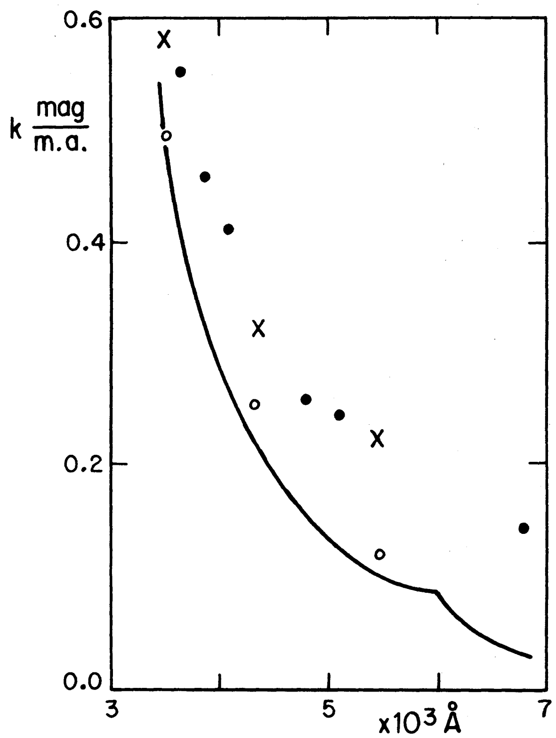

Fig. 2. Extinction for Estación Astronómica "Dr. Carlos Ulrrico Cesco". Open circles: adopted values; crosses: values for December 1991; filled circles: values obtained by Gil-Hutton & Licandro (1993) using IHW filters; continuous line: extinction curve for La Silla by Tüg (1977).

the values found for the extinction at each effective wavelength for this observatory and an extinction curve for La Silla Observatory obtained by Tüg (1977) using a photoelectric rapid spectrum scanner with steps of 50 A; this curve can be considered representative of the typical observing conditions at the observatories located in the north of Chile. Also, the first-order coefficients for December 1991 and the values obtained by Gil-Hutton & Licandro (1993) are shown for the same month (4/12/1991) and the same instrument using narrow-band filters of the International Halley Watch (IHW) for the spectral region between 3650 and 6840 A, giving more points to adjust an extinction curve.

It is clear that the atmospheric extinction at El Leoncito region is slightly higher than in the north of Chile, but the values adjust to extinction curves similar to the example shown for La Silla shifted vertically, which means that there is an excess of suspended particles in the atmosphere compared with the typical conditions of the chilean observatories.

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