Panoramatic Photometry for the 1999 Solar Eclipse

Yu. A. Kupryakov[1,2] **and P. Kotrč**[2]

[1] *Sternberg Astronomical Institute, Moscow State University, 119899 Moscow, Russia*

[2] *Astronomical Institute of the Czech Academy of Sciences 251 65 Ondřejov, The Czech Republic*

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Abstract. Simultaneous observations of the solar corona and the photometric standard stars make possible to calibrate the corona radiation in the BVR system. A possibility for such observations during the 1999 solar eclipse is proposed. For the observations we suppose to use a system consisting of a simple camera obscura and a CCD video camera ICD-42 B (699 x 576 pixels) with an enhanced sensitivity. It enables to detect 0.06 Lux as a minimal registrated light flux. We plan to observe a 10 arc degrees field of view that provides us a sufficient amount of etalon stars for the calibration. Images of the solar corona and etalon stars obtained with use of B, V, R filters will be recorded on the VCR. The CCD photometer and the suggested method of data reduction and analysis are described.

Key words: solar eclipse – solar corona – photometric standard

Due to the large dynamical interval between the coronal radiation and the other usable (stellar/planetary) objects is the calibration of the solar corona radiation a rather complicated task.

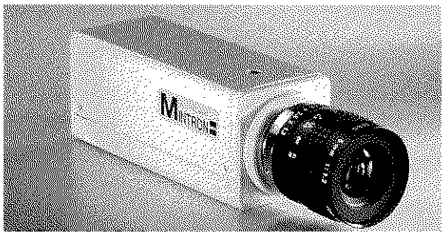

Figure 1. View of the video-camera ICD-42B

For the calibration during the full phase of the solar eclipse, we may use planets and stars in the vicinity of the solar disk. It is rather difficult to record during the eclipse (about 2 min time) simultaneously two objects with such a great brightness difference that exists between the solar corona and stars in the spectral region 400 - 900 nm. To solve this problem, we plan to use two CCD video cameras with working sensitive surface 8 x 6.5 mm which represents 795 x 596 pixels. These video cameras are very sensitive in the mentioned spectral region 400 - 1000 nm (see Fig. 2) and they can detect 0.03 - 0.06 Lux as a minimal registered light flux.

For observations (see Figure 8) we shall use a pinehole camera (1) and a short-focal lens (2).

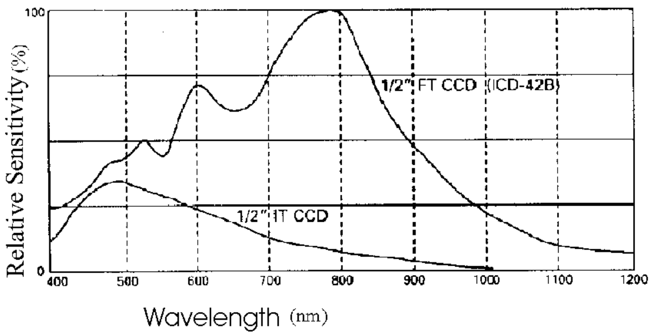

Figure 2. The spectral sensitivity of the video-cameras.

Pinhole cameras have, however, some inconvenient properties: low light gathering power, the images are not well defined, conspicuous interference pattern. Nevertheless, it helps to eliminate the optical elements of the observation scheme. Maximum exposure time for videocameras of such

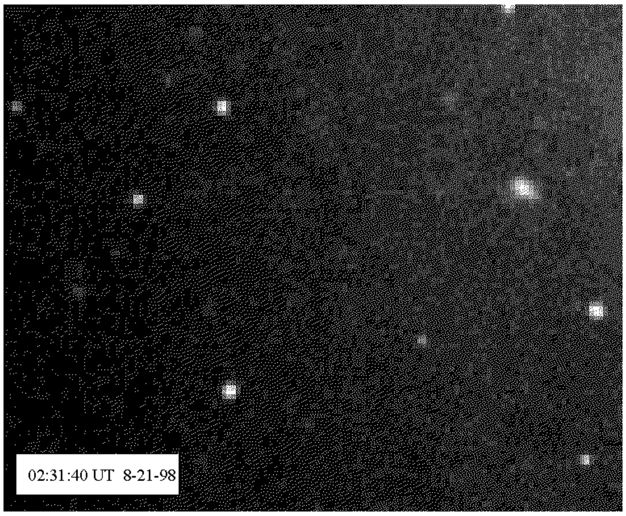

Figure 3. A night sky image of a region 3 x 3 arc degrees taken with the videocamera. Exposition time is 1/25 s.

Table 1.

Cns	Name	ρ	HD	R.A.	Dec	Sp	V	W-B	B-V	V-R
Leo	22	11:18′	85376	09 51.9	+24 24	A5IV	5.285	0.032	0.242	0.185
	17 ϵ	9:59′	84441	09 45.9	+23 46	G1II	2.966	0.317	0.822	0.600*
	4 λ	7:54′	82308	09 31.7	+22 58	K5III	4.304	1.819	1.582	1.194*
	8	3:31′	83189	09 37.0	+16 26	gK1	5.736	1.155	1.276	0.894
	20	8:37′	85040	09 49.8	+21 11	A7+A8 IV	6.079	0.167	0.249	0.191
	7	3:12′	83023	09 35.9	+14 23	A1V	6.313	-0.029	0.032	0.031
	16 ψ	5:08′	84194	09 43.7	+14 01	M2IIIab	5.390	1.895	1.658	1.365
	23	7:07′	85268	09 51.0	+13 04	M0III	6.462	1.902	1.629	1.284
	27 ν	8:58′	86360	09 58.2	+12 27	B9IV	5.267	-0.114	-0.051	-0.028
	18	6:38′	84561	09 46.4	+11 49	K4III	5.665	1.640	1.527	1.114
	19	6:59′	84722	09 47.4	+11 34	A7Vn	6.447	0.020	0.263	0.217
	5 ξ	4:33′	82395	09 31.9	+11 18	K0III	4.984	0.721	1.077	0.752*
	6	6:00′	82381	09 32.0	+09 43	K3III	5.064	1.381	1.393	0.988
	2 ω	6:24′	81858	09 28.5	+09 03	F9V	5.416	-0.033	0.622	0.491
	3	7:15′	81873	09 28.5	+08 11	K0III	5.732	0.712	1.060	0.748
	10	9:09′	83240	09 37.2	+06 50	K1IIIv	5.015	0.720	1.070	0.767*
	14 ø	6:58′	83808	09 41.1	+09 54	A5V+F6II	3.519	0.145	0.503	0.374
	29 π	11:37′	86663	10 00.2	+08 03	M2IIIab	4.688	1.909	1.654	1.372
Cnc	69 ν	10:19′	77350	09 02.7	+24 27	A0pSi	5.456	-0.103	-0.047	-0.019
	77 ξ	7:29′	78515	09 09.4	+22 03	K0III	5.161	0.653	0.983	0.707*
	79	7:20′	78715	09 10.3	+22 00	G5III	6.042	0.392	0.895	0.669*
	43 γ	11:17′	74198	08 43.3	+21 28	A1IV	4.658	0.053	0.013	-0.001
	47δ	9:39′	74442	08 44.7	+18 09	K0III-b	3.948	0.813	1.102	0.780*
	54	7:46′	75528	08 51.0	+15 21	G1V	6.371	0.032	0.654	0.522*
	62 $ø^1$	6:16′	76543	08 57.2	+15 19	A5III	5.222	0.122	0.155	0.100
	63 $ø^2$	6:11′	76582	08 57.6	+15 35	F0IV	5.690	0.060	0.211	0.165
	81 π^1	2:39′	79096	09 12.3	+15 00	G9V	6.499	0.066	0.743	0.606
	82 π^2	1:58′	79554	09 15.2	+14 56	K1III	5.360	1.256	1.346	0.959*
	45	7:46′	74228	08 43.2	+12 41	A3V+G0III	5.628	0.300	0.408	0.402
	49	10:44′	74521	08 44.7	+10 05	A1pEuCr	5.651	-0.309	-0.090	-0.027
	60	7:36′	76351	08 55.9	+11 38	gK5	5.453	1.587	1.500	1.014
	65 α	6:56′	76756	08 58.5	+11 51	A5m	4.253	0.187	0.146	0.096
	76 κ	5:59′	78316	09 07.7	+10 40	B8IIIpMn	5.240	-0.549	-0.089	-0.056
Hya	16 ζ	11:35′	76294	08 55.4	+05 57	G9II-III	3.117	0.616	1.023	0.713
	11 ϵ	12:37′	74874	08 46.8	+06 25	G5III+A8	3.377	0.230	0.696	0.566
	13 ρ	12:46′	75137	08 48.4	+05 50	A0Vn	4.348	-0.019	-0.031	-0.023
	10	13:27′	74591	08 45.0	+05 41	A6V	6.144	0.054	0.197	0.152

a type is 1/25 s, which is evidently not sufficient for observations of the 5-7 magnitude stars, see Fig. 3. Therefore, we use superposition of several video images with the best quality to get images of faint stars. For calibration of the solar corona we have selected 37 stars in a region 14 arc deg^2 in right ascension and declination, see Table 1. In the moment of the total eclipse the equatorial coordinates of the Sun are R.A. = $9^h 23^m 09^s$, Dec.= $15^o 19^{'} 33^{''}$. In the Table 1 (ρ) devotes a distance from the Sun center at 11:00 UT. The calibration stars

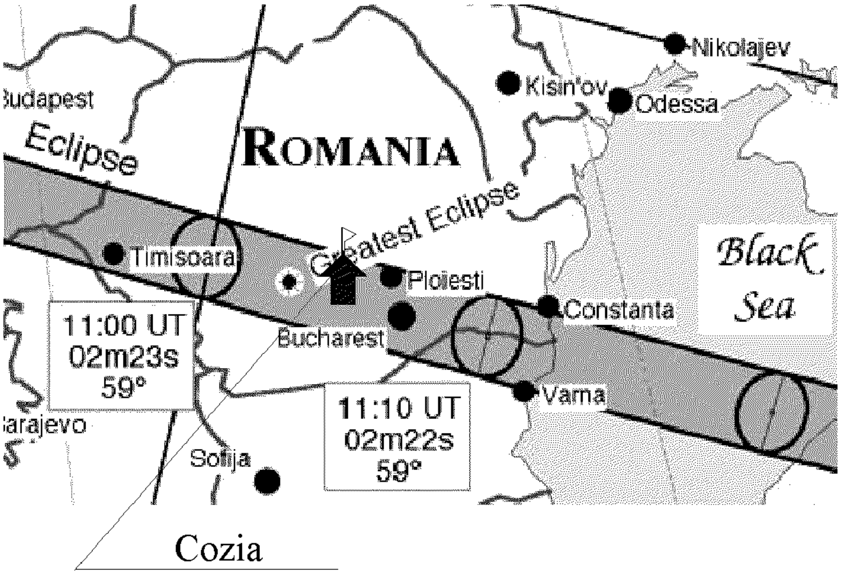

Figure 4. The supposed place of observation (Cozia, Romania).

are marked. For selection of calibration stars the Photometric Catalogue by Kornilov (1991) has been used and in the Catalogue the zero point for the star HD5015 as V = 4.497 has been taken. For the zero point of the colour index altogether 14 stars of the spectral class A0V have been used. To the star HD5015 the colour index values W-B = - 0.082, B-V = 0.553 , V-R = 0.456 have been taken.

Cozia (Romania) is the supposed place of observation of the total solar eclipse 11 Aug, 1999, see Fig. 4. The positions of the stars up to the magnitude 7^m for different scales at the moment of total eclipse can be seen in Figures 5 and 6. The region marked in the Fig. 6 corresponds to the square 10×10 arc degrees.

BVR filters may be used for observation, preferably the same type as used for the mentioned Catalogue. The curves for transmission of the filters (Kornilov, 1990) and for the spectral sensitivity of the video camera can be seen in Fig. 7.

Block diagram of the photometer is shown in Fig. 8. The revolver filter set (1) is synchronized with the VCR by the device 2.

The UT data and also the frame number will be automatically recorded by a PC. Our arrangement makes it feasible to receive an extensive amount of data.

Due to the fact that the observed stars are at different altitudes, we can deduce the reduction correction and eliminate the atmospheric extinction.

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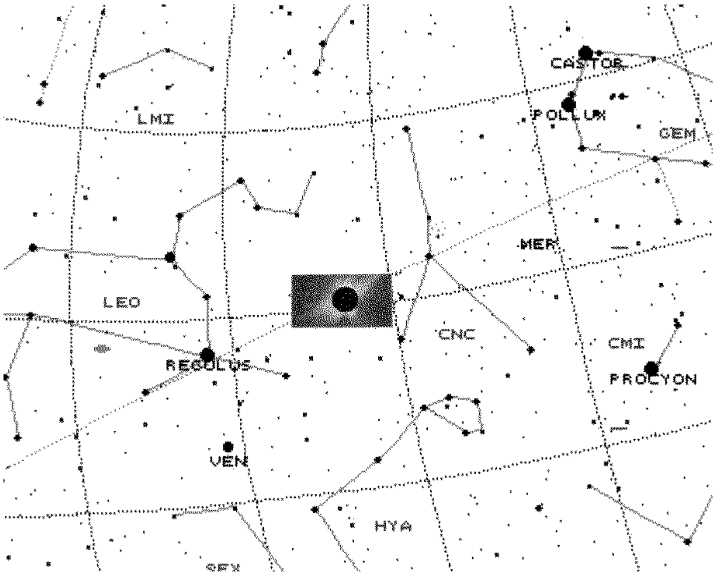

Figure 5. The sky region in the moment 11:05 UT, 11 Aug, 1999.

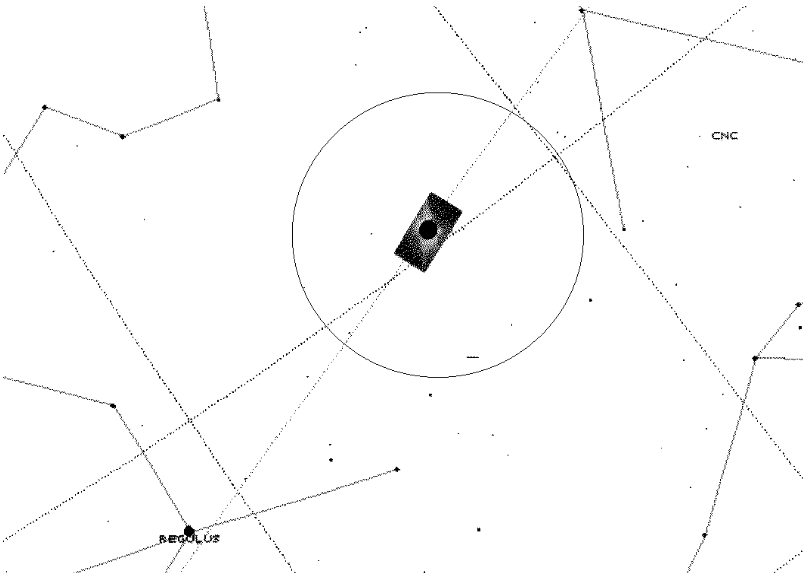

Figure 6. The circular area 10^o.

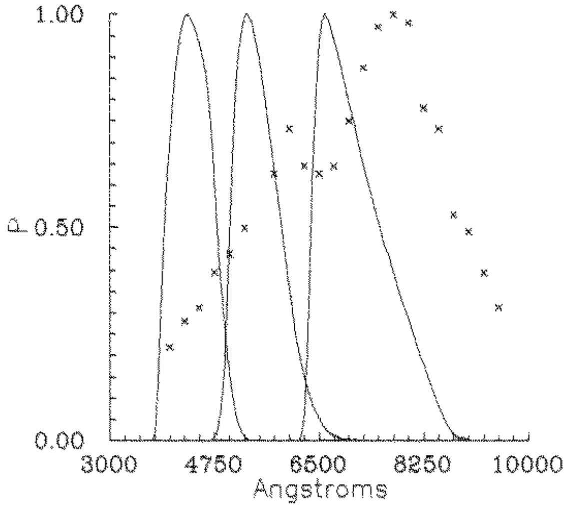

Figure 7. The curves of the transmission of the BVR filters and that of the spectral sensitivity of the video camera.

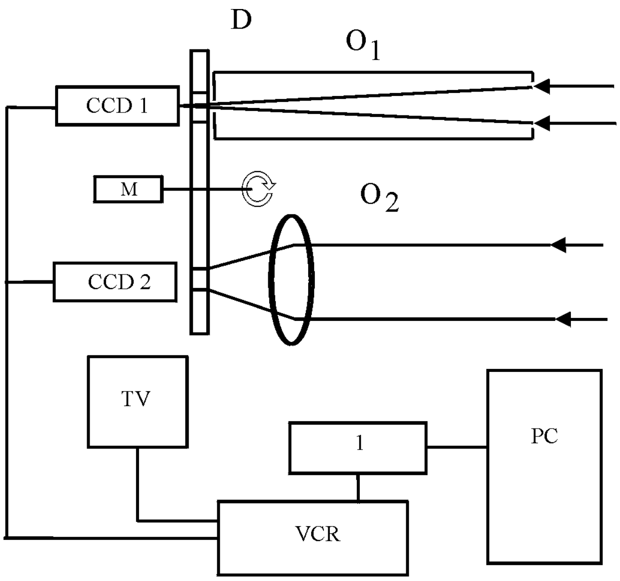

Figure 8. Block diagram of the photometer.

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Cns - constellation, Name - the name of the star as given in the catalog, ρ - distance from the Sun center, HD - the number (Henry Draper Catalog) of the object, R.A. - the Right Ascension of the star, Dec. - the Declination of the star, Sp - the spectral type as given in the HD catalog, V, W-B, B-V, V-R - colour index values.

Discussion

Question (M. Sobotka): *Why do you use the setup consisting of the pinhole camera and short-focal lens camera? What is the difference between these two light collectors?*
Answer (Yu. Kupryakov): We want use a pinehole camera to eliminate the optical elements of the observation scheme.
Question (S. Koutchmy): *How will you avoid the over exposure of the inner corona?*
Answer (Yu. Kupryakov): It is a good question, we have to discuss this matter thoroughly.