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BALDONE SCHMIDT (LATVIA) TELESCOPE ASTROPHOTOS ARCHIVE

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ABSTRACT. From 1967 to 2005, many astrophotos have been taken with the Baldone Schmidt telescope (80cmx120cmx240cm). These photos have being archived in the Institute of Astronomy of the University of Latvia (IAU code 069, longitude 24.4041 E, latitude 56.7734 N, altitude 103 m). There are over 22000 direct and 2300 spectral photos of different regions of the sky in this archive. There are also information on the photo materials type as well as the types of color filters used for photographing the sky fields and objects. The home page of the Institute of Astronomy's Baldone observatory (www.baldoneobservatory.lu.lv) has the archive's description. Part of the description has also being published (Alksnis, et al., 1998).

Keywords: Schmidt telescope, wide field plate archive

1. Introduction

One of the main tasks of astronomers is to obtain observational data on various objects of the Universe and preserve these data for future use. The observational material subsequently forms the base for further studies and investigations. For over 100 years astronomers have gathered and stored photo collections on photographic glass and film photos. This has resulted to over 2 million wide field photos in Wide Field Imaging all over the world. From this quantity, more than 380000 of the wide field photos were taken with Schmidt telescopes (Tsvetkov et al., 1995). For more than 38 years, such an astronomical photo archive of photographic negatives, have been obtained with the Baldone Schmidt telescope. This is collected at the Astrophysical Observatory (IAU code 069) of the Institute of Astronomy, University of Latvia. The Baldone Schmidt telescope (80/120/240 cm) was first used in December 1996 on the hill Riekstkalns (longitude 24.4041 E, latitude 56.7734 N, altitude 103m) near Baldone city. The telescope ranges among the 12 biggest wide field Schmidt telescopes in the world (Table 1). By 2005, over 24300 photos have been taken with the Baldone Schmidt telescope.

2. Description of archive

The first astronomical photos were obtained in January 1967. The photos cover the field of 19 square degree, but the linear size of photoplates is 24x24 cm. Classically the scientific interests of the Latvian astronomers in the field of stellar astronomy were directed mainly to carbon stars. The implication was that most of the photos, both direct and spectral, obtained with the Baldone Schmidt telescope, covered the zone along the galactic equator, where the carbon stars are concentrated. The distribution of obtained direct and spectral photos, on the sky sphere, is presented in Figs. 1 and 2.

Table 1. The twelfth largest Schmidt-type telescopes in the world

Observatory	Aperture	From year	Country
Palomar	122	1947	U.S.A.
Bloemfontein	81	1950	South Africa
Hamburg-Calar Alto	80	1955	Germany-Spain
Tautenburg	134	1960	Germany
Byurakan	100	1961	Armenia
Kvistaberg	100	1964	Sweden
Baldone	80	1967	Latvia
La Silla	100	1969	ESO, Chile
Siding Spring	124	1973	Australia
Kiso	105	1974	Japan
Merida	100	1976	Venezuela
Calern	90	1976	France

Every photo taken with the Baldone Schmidt telescope has been taken in order to study a definite object and none stationary stars, especially carbon stars. Therefore, brightness and coordinates are only measured for these objects on the photos. On the average, about 95% to 99% of the information recorded on the photo remained unused. The glass and film photos are stored vertically in the rooms of the Schmidt telescope dome, which are no specially conditioned rooms, with temperature stabilization and less humidity. The photos are placed in original ORWO 24x24cm size plate standard packaging boxes.

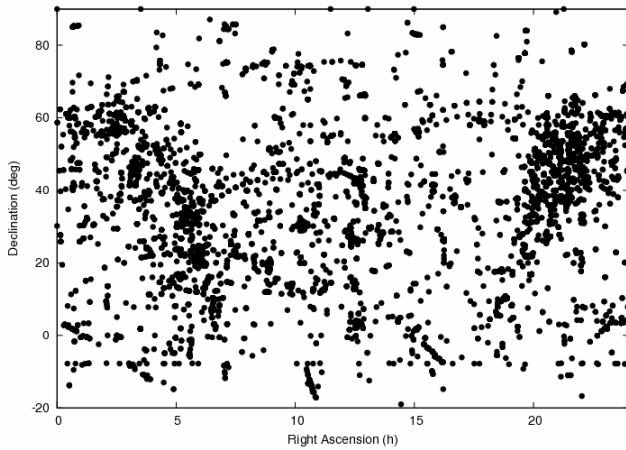


Figure 1: The distribution of the 22000 direct observations of the sky, made with the Baldone Schmidt telescope, in equatorial coordinates.

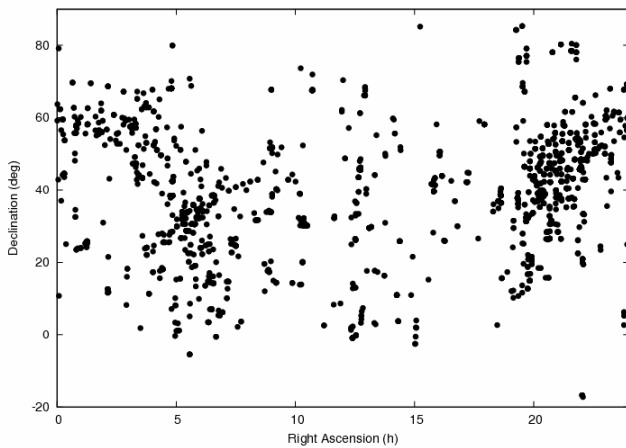


Figure 2: The distribution of the 2300 spectral observations of the sky, made with the Baldone Schmidt telescope, in equatorial coordinates.

The astroplates of the Baldone Schmidt telescope archive have been obtained mainly on the ORWO (East Germany) astronomical plates (Astro Platten ZU1, ZU2, ZU21, ZP1, ZP3). The plates have a size of 24x24cm. On the films (different versions of A500, A600, A700) of the Photographic Research Institute KAZNIIFOTOPROJEKT (Russia), most of the plates also have a size of 24x24 cm, while 1% have a size 13x18cm size. A small quantity is obtained on the Eastman Kodak mostly using IN plates in the USA.

For the stellar photometry the plates and light filters, were used. This provided a spectral sensitivity, close to the standard U, B, V system or the Becker's R- and Kron's I-magnitudes. In Table 2, the number (n) of direct photos taken with the emulsion type and filter combinations that is used most of the time, are listed.

The spectral photos have been obtained using 2 degree and 4 degree 80cm diameter objective prisms, which provide the resolution of about 200 and 450 at the hydrogen line H alpha respectively. For the searching of carbon stars, mostly the orthochromatic Kazan A600 astro films and the Kodak IN, infrared plates were used as detailed in Table 3.

Table 2. The combinations of the photo emulsions and filters used for the direct photos

Emulsion	Filter	n	Emulsion	Filter	n
	-			U	
ZU21	-	262	ZU21	UG1	337
ZU1	-	119	ZU2	UG1	229
ZP3	-	21	ZU21	UFS3	86
A500N	-	20	ZU1	UG1	62
	B			V	
ZU21	GG13	2783	A600N	ZS17	2102
ZU2	GG13	1692	A600	ZS17	1797
NT-1AS	GG13	337	A600U	ZS17	409
A500N	GG13	206	A600rP	ZS17	235
	R			I	
ZP1	RG1	7075	IN	KS19	877
ZP1	KS13	1692	IN	RG1+BG3	441
ZP3	RG1	764	I840	RG1	26
A700N	KS13	241	IVN	KS19	10

Table 3. The combinations of the photo emulsions and filters used for spectral photos

Emulsion	Filter	n	Emulsion	Filter	n
Blue spectrum			Yellow spectrum		
A600	GG13	98	A600	-	402
ZU2	-	68	A600N	GG5	167
ZU21	-	33	A600N	-	139
A600N	GG13	31	A600	GG5	134
Red spectrum			Near infrared spectrum		
103aF	-	123	IN	RG1	185
103aF	RG1	45	IVN	-	43
A700F	RG1	41	IN	-	37
A700N	-	37	I840	-	32

Many of the sky regions have been photographed tens and hundreds of times, in order to investigate variability of stars. The mostly photographed objects or regions are listed in Tables 4 for direct photos as well as the total number of photos (n) of the object obtained in 1967-2005.

Presently, the observational data and treated results are obtained in computer readable form, mainly online and stored in databases on the server of the Institute of Mathematics and Computer Science in University of Latvia ftp.e-spiets.lv. Nevertheless, the value of astronomical photo archives does not decrease. They contain information of the former changes in the optical range of cosmic objects at long time range. This information is very useful in current investigations and are therefore very relevant. This is more so, as the astronomers are gaining information in the whole range of the electromagnetic spectrum from gamma rays to radio waves.

3. Digitizing of archive

In the last 20 years, digitalization of astronomical information is taking place at a fast pace. From 2013, the regular digitization and processing of photographic astroplates started in Baldone observatory. The photos were digitized using Epson Expression 10000XL and 11000XL commercial scanners. The scanners had a resolution of 1200 dpi (or 2400 dpi). For processing, all images were transformed from TIFF format to the FITS format. This is achieved with an original program created at the Institute of Astronomy. Till this moment, more than 7000 photos

are digitized. Previously scans were tested, and the optimum mode of scanning was found (Protsyuk et al., 2014). Images were processed using advanced complex LINUX / MIDAS / ROMAPHOT programs (Andruk et al., 2015).

Scans are displayed on the server (ftp.e-spiets.lv) of the Institute of Mathematics and Computer Science in University of Latvia.

The digitizing of the UV-part of Baldone collection has started in June 2016 with two EPSON EXPRESSION 10000XL and three 11000XL flatbed scanners. Its photometric and astrometric characteristics were previously

The software was developed and implemented in Main Astronomical Observatory of the National Academy Science of Ukraine. The software is used to process the digitized astronomic photos as well as to obtain astrometric coordinates and photometric magnitudes of stars and compact galaxies.

Without these main tasks, the digitized photos of star fields allow to carry out a massive search for images of small bodies in the solar system. Furthermore, it allows for the determination of their coordinates. From the observations of earlier epoch, it is possible to extract information about the locations of these bodies (Eglitis et al., 2016).

Table 4. List of more observed objects in Baldone observatory from 1966 to 2005.

Object	n	Object	n	Object	n
CIT6	3164	IRC+20370	173	NGC 1817	91
Tr 2	831	Com.Halley	171	174,-3.5	91
M31	767	NGC 7419	169	CIT5	90
DY Per	440	V CrB	165	94,-10.5	89
BC 56	344	T Dra	144	NGC 2251	88
NGC 1245	300	IC 5146	142	CIT5+1245	87
90,-3.5	292	174,+7	139	NP Her	84
NGC 1664	287	94,+3.5	135	T Cnc+X Cnc	84
IRC+10216	262	94,0	134	Nova Cyg	79
NGC 7063	261	94,+7	131	Gal. II	77
86,+7	259	90,+3.5	129	NGC 7031	74
AFGL 2881	256	NGC 7092	125	U Cyg	74
Stock 4	254	NGC 1893	124	U Lyr	72
NGC 6871	243	CT Lac	124	NGC 659	72
94,-3.5	240	90,0	124	OW Aql	71
86,-7	234	94,+10.5	122	82,+7	69
NGC 7128	231	90,-7	122	82,+0	69
86,0	222	92,+6.5	121	RU Vir	68
86,-3.5	217	86,+10.5	120	CRL 3116	68
178,-7	210	94,-7	114	82,+3.5	66
86,+3.5	205	90,+1.3	114	Dol 2	64
178,+3.5	204	MQ Cyg	110	IC 1848	62
178,0	203	174,-7	107	Pluto	62
CIT6+SA54	199	174,0	107	82,-3.5	58
178,-3.5	183	174,+3.5	106	NML Tau	56
KL Cyg	180	NGC 457	103	82,-7	56
90,+7	180	SS Vir	98	NGC 7654	55
178,+7	175	BM Gem	96	V Cyg	55
NGC 7789	174	NGC 1528	94	EU And	54

4. The electronic format of the plate archive

In Table 5, the description of the electronic format of the computer-readable catalogue at the link www.baldoneobservatory.lu.lv is given. For more information on the Baldone Schmidt telescope plate archive contact e-mail: astra@latnet.lv or ilgmars@latnet.lv.

Table 5. The format of the plate archive.

Column heading	Bytes	Format	Units	Explanations
Plate No.	1-6	A6	---	Plate No.
Date	7-8	I2	y	Year
	9-10	I2	m	Month
	11-13	I2,1X	d	Day
	14-24	A11	---	Object
Object R.A.	25-27	I2,1X	h	Hours RA
	28-30	I2,1X	min	Minutes RA
	31-33	I2,1X	sec	Seconds RA
Object Dec.	34-37	I3,1X	o	Degrees Dec
	38-42	F4.1,1X	'	Minutes Dec
T exp. begin.	43-44	I2	h	Hours
	45-46	I2	min	Minutes
	47-49	I2,1X	sec	Seconds
T(exp)	50-53	I3,1X	min	Duration exp
Emulsion	54-60	A6	---	Emulsion type
Filter	61-67	A6,1X	---	Filter
System	68-69	A1,1X	---	System (Sp.Region)
Notes	70-71	A1,1X	---	Exposure
Notes	72-77	A6	---	Notes
Marker	78	A1	----	End of row

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