SUPPLEMENT

Comet astrometry made at the Skalnaté Pleso Observatory in the year 1994

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Abstract. The paper presents the results of position photographing of comets carried out at the Skalnaté Pleso Observatory in the year 1994. A total of 58 observations of 7 comets are given.

Key words: comets – astrometry

1. Introduction

The presented paper is a continuation of the previous papers which gave the results of positional observations of comets made at the Skalnaté Pleso Observatory (the last paper of this series: Svoreň; 2000) and contains positional comet observations made in the year 1994.

The observations were made with a 0.3-m f/5 Zeiss astrograph. The reduction constants of the Skalnaté Pleso astrograph are as follows:

$\lambda = -\ 1^h\ 20^m\ 58.70^s$,
$\varphi = +49^\circ\ 11'\ 20.0''$,
h = 1783 m m.s.l.,
$\rho = 0.99836$ of the equatorial radius of the Earth.

The comets were photographed on ORWO plates with ZU 21 emulsion, dimensions 9x12 cm, which roughly correspondens to field of 3°x 4°. The reference stars required to compute positions using Schlesinger's method of dependences, from two independent triangles were selected from the Star Catalog of the Smithsonian Astrophysical Observatory (1966). The differences between independent determination of the equatorial coordinates, given for each poosition, provide some information about the accuracy of the measuring (but not about the accuracy of the object position). The rectangular coordinates of the reference stars and the comets were measured with the aid of instrument for measuring coordinates produced by Zeiss (Ascoremat E-60).

A total of 58 accurate positions of 7 comets, arranged according to the new system designation, are given. The list of collaborators is given, together with their share in photographing, measuring and reducing the positions.

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2. Conversion from eqn. B1950.0 to eqn. J2000.0

The reference stars were selected from the Smithsonian Astrophysical Observatory Star Catalog(1966). The positions were measured in B1950.0 system and then converted to J2000.0 following the formulas published by System Transition Committee of the IAU Commission 20 (Yeomans, 1990). Conversion from eqn. B1950.0 to eqn. J2000.0 is as follows:

Let α_0 and δ_0 are object's right ascension and declination referred to 1950.0 system. Then the calculated rectangular components of the object's position vector $\mathbf{r_0}$ referred to 1950.0 system are:

$$r_{0x} = cos\alpha_0 \;\; cos\delta_0 \tag{1}$$
$$r_{0y} = sin\alpha_0 \;\; cos\delta_0 \tag{2}$$
$$r_{0z} = sin\delta_0 \tag{3}$$

The astrographic position vector $\mathbf{r_1}$ is formed to remove the effects of elliptical aberration:

$$r_{1x} = r_{0x} - A_x + B\ r_{0x} \tag{4}$$
$$r_{1y} = r_{0y} - A_y + B\ r_{0y} \tag{5}$$
$$r_{1z} = r_{0z} - A_z + B\ r_{0z} \tag{6}$$

where B is a scalar product of the vector transpose to $\mathbf{r_0}$ and the vector $\mathbf{A}$, i.e.

$$B = r_{0x}\ A_x + r_{0y}\ A_y + r_{0z}\ A_z \tag{7}$$

and A_x, A_y, A_z are the rectangular components of the vector $\mathbf{A}$:

$$A_x = -1.62557 \times 10^{-6}$$
$$A_y = -0.31919 \times 10^{-6}$$
$$A_z = -0.13843 \times 10^{-6}$$

If the t is Julian time of the observation, then the Julian centuries from 1950 epoch to the observation time can be calculated as

$$T = (t - 2433282.423)\ /\ 36525 \tag{8}$$

The rectangular components of the object's position vector $\mathbf{r}$ referred to 2000.0 system are:

$$r_x = X_x\ r_{1x} + X_y\ r_{1y} + X_z\ r_{1z} \tag{9}$$
$$r_y = Y_x\ r_{1x} + Y_y\ r_{1y} + Y_z\ r_{1z} \tag{10}$$
$$r_z = Z_x\ r_{1x} + Z_y\ r_{1y} + Z_z\ r_{1z} \tag{11}$$

where $X_x, X_y, ..., Z_z$ are the elements of the rotation matrix (Murray, 1989):

$$X_x = +0.9999256794956877 - 0.0026455262 \times 10^{-6}\ T$$
$$X_y = -0.0111814832204662 - 1.1539918689 \times 10^{-6}\ T$$
$$X_z = -0.0048590038153592 + 2.1111346190 \times 10^{-6}\ T$$
$$Y_x = +0.0111814832391717 + 1.1540628161 \times 10^{-6}\ T$$
$$Y_y = +0.9999374848933135 - 0.0129042997 \times 10^{-6}\ T$$
$$Y_z = -0.0000271625947142 + 0.0236021478 \times 10^{-6}\ T$$
$$Z_x = +0.0048590037723143 - 2.1112979048 \times 10^{-6}\ T$$
$$Z_y = -0.0000271702937440 - 0.0056024448 \times 10^{-6}\ T$$
$$Z_z = +0.9999881946023742 + 0.0102587734 \times 10^{-6}\ T$$

The coordinates α, δ in J2000.0 system are calculated using the expressions:

$$\alpha = arctg\frac{r_y}{r_x} + 90.\ (1 - \frac{r_x}{|r_x|}) \tag{12}$$

$$\delta = arctg\ \frac{r_z}{\sqrt{r_x^2 + r_y^2}} \tag{13}$$

3. Positions of comets

The individual columns of the table contain the following:
N - ordinal number of observation,
Date U.T. - date and time of the middle of the exposure,
$R.A._{2000}$ - right ascension for equinox 2000.0 (in h,m,s),
$Decl._{2000}$ - declination for equinox 2000.0 (in °,′, ″),
T - the exposure time in minutes,
A - the difference between independent determinations of R.A. in arc seconds,
B - the difference between independent determinations of Decl. in arc seconds.
Notes: N. 12 - involved with star, N. 33 and 34 - bad seeing.

N	Date U.T.		$R.A._{2000}$	$Decl._{2000}$	T	A	B
			Comet C/1993 Y1 (McNaught-Russell)				
1	1994 May	04.86325	08 35 31.22	+74 47 16.4	40	0.7	0.9
2	1994 May	04.89294	08 35 56.64	+74 48 11.5	40	0.7	0.9
			Periodic comet P/1994 A1 (Kushida)				
3	1994 Feb.	15.81256	09 44 03.39	+01 43 54.5	30	0.1	0.4
4	1994 Feb.	15.83715	09 44 02.93	+01 44 00.0	30	0.4	0.5
5	1994 Mar.	08.93889	09 41 55.25	+03 29 50.4	42	0.8	0.3
6	1994 Mar.	09.87384	09 42 04.24	+03 34 16.3	40	0.1	0.1
7	1994 Mar.	09.90336	09 42 04.58	+03 34 27.1	40	0.2	0.3
8	1994 Mar.	11.76181	09 42 26.75	+03 43 06.8	45	0.1	0.4
9	1994 Mar.	11.79421	09 42 27.22	+03 43 14.2	45	0.4	0.9
10	1994 Mar.	12.76042	09 42 40.94	+03 47 38.0	42	0.3	0.1
11	1994 Mar.	12.79028	09 42 41.24	+03 47 46.3	42	0.1	0.5

N	Date U.T.		$R.A._{2000}$	$Decl._{2000}$	T	A	B
			Comet C/1994 G1-A (Takamizawa-Levy)				
12	1994 Apr.	22.04387	21 19 28.38	+10 32 42.1	22	0.9	0.1
13	1994 Apr.	22.08872	21 19 26.10	+10 35 08.2	22	0.2	0.1
14	1994 May	16.96944	20 24 56.56	+45 23 53.4	16	0.8	0.4
15	1994 May	17.00694	20 24 44.41	+45 28 04.8	16	0.6	0.6
16	1994 June	14.96806	13 01 28.97	+62 29 47.0	14	0.6	0.3
17	1994 June	14.99306	13 01 16.02	+62 28 19.2	14	0.4	0.4
18	1994 July	02.94931	11 51 06.40	+47 45 53.4	14	0.1	0.1
19	1994 July	03.88472	11 49 38.66	+47 10 20.3	12	0.5	0.5
20	1994 July	06.91181	11 45 36.56	+45 21 53.7	14	0.2	0.4
21	1994 July	06.93472	11 45 35.49	+45 21 03.1	10	0.4	0.7
			Comet C/1994 N1 (Nakamura-Nishimura/Machholz)				
22	1994 Aug.	09.93750	01 07 32.11	+63 55 38.9	12	0.1	0.9
23	1994 Aug.	09.95417	01 07 23.26	+63 54 55.2	12	0.2	0.1
24	1994 Aug.	10.99792	00 58 49.25	+63 08 19.5	12	0.6	0.4
25	1994 Aug.	14.91389	00 25 38.86	+59 18 56.6	12	0.3	0.5
26	1994 Aug.	14.94861	00 25 20.17	+59 16 20.0	12	0.1	0.4
			Comet C/1994 T1 (Machholz)				
27	1994 Oct.	16.10833	08 25 41.40	+54 49 19.6	24	0.7	0.1
28	1994 Oct.	16.14306	08 25 36.25	+54 49 11.3	24	0.5	0.5
29	1994 Oct.	29.91042	07 40 04.38	+53 09 29.9	20	0.6	0.6
30	1994 Oct.	29.93056	07 39 55.84	+53 09 33.1	20	0.2	0.1
31	1994 Nov.	23.72326	05 22 21.65	+40 50 48.7	22	0.3	0.2
32	1994 Nov.	23.75538	05 22 10.68	+40 48 59.0	22	0.4	0.1
33	1994 Dec.	07.74352	04 11 36.49	+26 13 18.4	25	0.7	1.0
34	1994 Dec.	07.76389	04 11 30.97	+26 11 54.8	20	0.1	0.1
			Periodic comet 9P/Tempel 1				
35	1994 Mar.	05.89306	13 33 33.35	+10 25 24.8	40	0.4	0.7
36	1994 Mar.	05.95833	13 33 33.79	+10 25 44.9	40	0.2	0.5
37	1994 Mar.	08.90556	13 33 55.46	+10 41 02.0	42	0.1	0.8
38	1994 Mar.	08.97153	13 33 55.62	+10 41 25.4	42	0.1	0.6
39	1994 May	02.89028	13 02 05.69	+10 46 57.3	40	0.1	0.3
40	1994 May	02.94861	13 02 03.29	+10 46 18.3	40	0.1	0.3
41	1994 May	13.89792	12 57 35.39	+08 19 21.1	30	0.6	0.2
42	1994 May	13.97639	12 57 34.24	+08 18 05.6	30	0.5	0.5
43	1994 May	16.94931	12 57 10.79	+07 29 16.3	26	0.8	0.4
44	1994 May	16.98889	12 57 10.55	+07 28 35.1	26	0.7	0.8
			Periodic comet 19P/Borrelly				
45	1994 Sep.	07.06806	05 18 11.45	-05 16 37.3	26	0.5	0.8
46	1994 Sep.	07.10278	05 18 16.66	-05 16 08.1	26	0.4	0.8

N	Date U.T.	$R.A._{2000}$	$Decl._{2000}$	T	A	B
	Periodic comet 19P/Borrelly - cont.					
47	1994 Sep. 08.07917	05 20 46.45	-05 03 37.0	22	0.8	0.9
48	1994 Sep. 08.10625	05 20 50.15	-05 03 18.1	22	0.7	0.6
49	1994 Oct. 12.97222	06 50 21.78	+05 16 18.3	18	0.4	0.4
50	1994 Oct. 13.01736	06 50 28.85	+05 17 25.3	18	0.8	0.3
51	1994 Nov. 03.95417	07 47 40.82	+16 29 34.6	14	0.1	0.1
52	1994 Nov. 03.97708	07 47 44.44	+16 30 28.9	14	0.4	0.3
53	1994 Nov. 05.93056	07 52 50.18	+17 44 43.4	14	0.5	0.1
54	1994 Nov. 05.96736	07 52 55.94	+17 46 11.2	14	0.7	0.4
55	1994 Nov. 06.94722	07 55 28.89	+18 24 19.9	14	0.2	0.4
56	1994 Nov. 06.97639	07 55 33.50	+18 25 31.6	14	0.3	0.1
57	1994 Dec. 03.89444	09 02 52.03	+38 59 49.6	18	0.6	0.2
58	1994 Dec. 03.94514	09 02 59.10	+39 02 21.4	18	0.1	0.6

4. Reference stars and dependences

The individual columns of the table contain the following:
N - ordinal number of the observation in agreement with the Section 2,
Numbers of reference stars and dependences

N	Numbers of stars and dependences					
1	6502	.13924	6525	.43079	6662	.42997
	6519	.13186	6555	.52206	6630	.34608
	6502	.44959	6604	.20607	6663	.34434
	6502	.50299	6629	.18663	6662	.31038
2	6502	.14852	6525	.40476	6662	.44672
	6519	.32459	6555	.31044	6662	.36497
3	117841	.32052	117882	.29458	117903	.38490
	117826	.28778	117873	.39121	117925	.32101
4	117841	.32253	117882	.29233	117903	.38514
	117826	.28904	117873	.39043	117925	.32053
5	117824	.39496	117852	.14468	117885	.46036
	117826	.32183	117839	.21753	117884	.46064
6	117832	.13439	117831	.36807	117884	.49754
	117824	.29468	117844	.25048	117887	.45484
7	117832	.13664	117831	.36464	117884	.49872
	117824	.29174	117844	.25315	117887	.45511
8	117832	.26626	117838	.33104	117889	.40270
	117824	.35927	117852	.22222	117896	.41851

N	Numbers of stars and dependences					
9	117832	.26675	117838	.32922	117889	.40403
	117824	.35731	117852	.22347	117896	.41922
10	117832	.33626	117838	.31905	117918	.34469
	117824	.29523	117852	.26832	117896	.43645
11	117832	.33745	117838	.31712	117918	.34543
	117824	.29357	117852	.26980	117896	.43663
12	106987	.40827	107010	.24595	107094	.34578
	106995	.33029	126703	.29632	107068	.37339
13	106987	.37569	107010	.29555	107094	.32876
	106995	.37577	126703	.24355	107068	.38068
14	49522	.33947	49593	.35077	49663	.30976
	49576	.26668	49582	.53749	49679	.19583
15	49522	.34220	49593	.40795	49663	.24985
	49576	.34292	49582	.49893	49679	.15815
16	15934	.09035	15952	.28673	15971	.62292
	15942	.55102	15989	.23912	15995	.20986
17	15934	.09038	15952	.31827	15971	.59135
	15942	.57040	15989	.21440	15995	.21520
18	43901	.42765	43922	.40527	43933	.16708
	43895	.37651	43913	.26795	43942	.35554
19	43870	.30222	43929	.63082	43933	.06696
	43856	.37398	43901	.02111	43946	.60491
20	43870	.20554	43874	.45829	43908	.33617
	43853	.36650	43900	.33573	43902	.29777
21	43870	.20043	43874	.46655	43908	.33302
	43853	.36938	43900	.32462	43902	.30600
22	11536	.30264	11596	.33961	11605	.35775
	11550	.45088	11593	.23197	11626	.31715
23	11536	.32352	11596	.32405	11605	.35243
	11550	.46253	11593	.24486	11626	.29261
24	11485	.55901	11487	.26087	11584	.18012
	11473	.39393	11505	.38343	11549	.22264
25	21352	.46925	21383	.26615	21443	.26460
	21348	.35940	21364	.40128	21479	.23932
26	21352	.53383	21383	.24283	21443	.22334
	21348	.38180	21364	.41998	21479	.19822
27	26797	.29737	26829	.37697	26865	.32566
	26801	.30884	26828	.39913	26867	.29203

N	Numbers of stars and dependences					
28	26797	.30782	26829	.37922	26865	.31296
	26801	.32390	26828	.39400	26867	.28210
29	26389	.21635	26456	.36718	26490	.41647
	26398	.36976	26456	.35398	26526	.27626
30	26389	.22712	26456	.36758	26490	.40530
	26398	.37763	26456	.35458	26526	.26779
31	40208	.39855	57970	.31029	40335	.29116
	40199	.34743	40300	.29432	40331	.35825
32	40208	.41646	57970	.31809	40335	.26545
	40199	.37844	40300	.25879	40331	.36277
33	76466	.25972	76484	.35210	76519	.38818
	76466	.14160	76472	.48290	76530	.37550
34	76466	.26023	76484	.37338	76519	.36639
	76466	.12638	76472	.51022	76530	.36340
35	100596	.31623	100612	.27940	120033	.40437
	100578	.31582	119996	.30965	100643	.37453
36	100596	.31346	100612	.28242	120033	.40412
	100578	.31659	119996	.30649	100643	.37692
37	100596	.18281	100612	.42121	120033	.39598
	100578	.34723	119996	.16431	100643	.48846
38	100596	.18047	100612	.42458	120033	.39495
	100578	.34885	119996	.16032	100643	.49083
39	100361	.34107	100386	.37975	100403	.27918
	100360	.39144	100395	.19492	100400	.41364
40	100361	.35276	100386	.37062	100403	.27662
	100360	.39919	100395	.19916	100400	.40165
41	119659	.26625	119678	.33348	119710	.40027
	119647	.23674	119667	.28227	119718	.48099
42	119659	.27650	119678	.32329	119710	.40021
	119647	.22992	119667	.29463	119718	.47545
43	119666	.42456	119682	.37530	119724	.20014
	119657	.23988	119664	.36356	119713	.39656
44	119666	.41800	119682	.38559	119724	.19641
	119657	.23452	119664	.37023	119713	.39525
45	131950	.54194	131971	.37468	131998	.08338
	131942	.45227	131964	.27886	132002	.26887
46	131950	.50995	131971	.37426	131998	.11579
	131942	.42452	131964	.28387	132002	.29161
47	131981	.32653	132002	.43881	132047	.23466
	131995	.30104	131998	.50842	132045	.19054

N	Numbers of stars and dependences					
48	131981	.32385	132002	.42035	132047	.25580
	131995	.28404	131998	.50414	132045	.21182
49	114464	.41732	114490	.36703	114560	.21565
	114452	.55269	114522	.15161	114555	.29570
50	114464	.39190	114490	.35902	114560	.24908
	114452	.51342	114522	.18752	114555	.29906
51	97222	.38007	97241	.22554	97277	.39439
	97207	.30781	97247	.36265	97301	.32954
52	97222	.34681	97241	.24873	97277	.40446
	97207	.30437	97247	.34944	97301	.34619
53	97301	.29567	97327	.38771	97363	.31662
	97290	.25560	97338	.42207	97350	.32233
54	97301	.26920	97327	.39715	97363	.33365
	97290	.23339	97338	.41166	97350	.35495
55	97350	.39318	97355	.27087	97416	.33595
	97339	.38560	97385	.45533	97419	.15907
56	97350	.38475	97355	.25452	97416	.36073
	97339	.36320	97385	.46997	97419	.16683
57	61183	.34434	61222	.29295	42681	.36271
	61195	.52631	42675	.20240	61248	.27129
58	61183	.32538	61222	.28140	42681	.39322
	61195	.49689	42675	.22516	61248	.27795

5. List of collaborators

Name	Exposures	Measurements	Reductions
G. Červák	40	40	–
P. Rychtarčík	18	18	–
J. Svoreň	–	–	58

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