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Comet astrometry made at the Skalnaté Pleso Observatory in the year 1990

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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 1990. A total of 68 observations of 8 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; 1997) and contains positional comet observations made in the year 1990.

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 68 accurate positions of 8 comets, arranged according to the new system designation of the comets, are given. The list of collaborators is

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given, together with their share in photographing, measuring and reducing the positions.

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):

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

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 data have been arranged according to individual 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.

Note: N. 26 - time uncertain.

N	Date U.T.		$R.A._{2000}$	$Decl._{2000}$	T	A	B
			Comet 59P/Kearns-Kwee				
1	1990 Oct.	16.06111	6 48 37.17	+32 51 16.1	40	1.2	0.4
2	1990 Oct.	16.11389	6 48 41.62	+32 51 17.9	40	0.2	0.1
3	1990 Oct.	19.05319	6 52 36.25	+32 51 22.0	35	0.9	0.5
4	1990 Oct.	19.07587	6 52 37.80	+32 51 21.6	36	0.6	0.7
5	1990 Oct.	25.92500	7 00 54.19	+32 50 42.8	44	0.8	0.4

N	Date U.T.	$R.A._{2000}$	$Decl._{2000}$	T	A	B
		Comet 59P/Kearns-Kwee – cont.				
6	1990 Dec. 13.87720	7 16 27.40	+32 23 40.8	20	0.4	0.6
7	1990 Dec. 13.90521	7 16 26.60	+32 23 37.4	20	0.4	0.3
8	1990 Dec. 14.79688	7 15 57.93	+32 22 07.6	22	0.1	0.5
9	1990 Dec. 14.83750	7 15 56.89	+32 22 03.8	22	0.1	0.5
10	1990 Dec. 17.74421	7 14 15.33	+32 16 46.6	24	0.9	0.4
11	1990 Dec. 17.79201	7 14 13.28	+32 16 40.8	24	0.7	0.4
12	1990 Dec. 22.99514	7 10 41.27	+32 04 50.9	40	0.1	0.7
		Comet 93P/Lovas 1				
13	1990 Jan. 01.71325	6 55 02.77	+45 02 23.9	22	1.1	1.2
		Comet 116P/Wild 4				
14	1990 Feb. 19.94306	9 13 22.84	+22 02 53.5	60	0.1	0.1
15	1990 Feb. 20.03681	9 13 18.10	+22 03 06.1	60	0.2	0.7
16	1990 Mar. 18.87986	8 59 16.15	+21 55 44.6	50	0.5	0.1
17	1990 Mar. 18.98125	8 59 15.29	+21 55 28.1	50	0.8	0.5
18	1990 Mar. 19.84375	8 59 10.74	+21 53 13.3	50	0.5	0.9
19	1990 Mar. 21.78634	8 59 05.82	+21 47 45.0	50	0.2	0.1
20	1990 Mar. 21.82292	8 59 05.74	+21 47 39.5	50	0.1	0.1
21	1990 Mar. 24.77963	8 59 13.48	+21 38 12.0	45	0.1	0.2
22	1990 Mar. 24.81227	8 59 13.64	+21 38 04.9	45	0.3	0.6
23	1990 May 19.87013	9 50 18.93	+15 06 23.4	35	0.4	0.6
24	1990 May 19.90885	9 50 22.71	+15 06 00.1	18	0.5	1.0
		Comet C/1989 T1 (Helin-Roman-Alu)				
25	1990 Jan. 1.69086	18 40 16.28	+50 27 11.7	15	1.1	1.0
26	1990 Jan. 3.70959	18 35 15.66	+51 07 09.0	15	0.1	0.4
27	1990 Jan. 4.68947	18 32 47.46	+51 26 34.5	15	0.8	0.3
		Comet C/1989 Y2 (McKenzie-Russell)				
28	1990 Jan. 1.74838	3 59 54.94	+0 20 58.7	22	0.1	0.4
29	1990 Jan. 1.77315	3 59 48.80	+0 20 45.0	22	0.3	0.3
30	1990 Jan. 3.76528	3 50 46.67	+0 02 00.8	22	0.6	0.6
		Comet C/1989 X1 (Austin)				
31	1990 May 19.93507	21 17 24.68	+18 17 38.9	2	0.5	0.3
32	1990 May 19.94896	21 17 12.64	+18 15 42.2	2	0.4	0.3
33	1990 May 19.96285	21 17 00.75	+18 13 41.9	2	0.4	0.4
34	1990 May 23.91944	20 15 56.43	+6 59 20.7	2	0.9	0.2
35	1990 May 23.95278	20 15 20.90	+6 53 10.3	2	0.1	0.5
36	1990 May 26.93056	19 26 40.23	-2 52 16.9	4	0.2	0.6
37	1990 May 26.95694	19 26 14.57	-2 57 21.5	4	0.8	0.4
38	1990 May 27.96250	19 10 06.33	-6 09 35.5	4	0.4	1.2
39	1990 May 27.98681	19 09 43.25	-6 14 06.4	4	0.7	0.8

N	Date U.T.		$R.A._{2000}$	$Decl._{2000}$	T	A	B
			Comet C/1990 K1 (Levy)				
40	1990 May	23.99792	23 58 57.63	+27 59 13.7	20	1.1	0.1
41	1990 May	24.02014	23 58 58.38	+27 59 18.2	20	0.4	1.0
42	1990 May	26.97639	0 00 33.22	+28 08 33.7	20	0.5	0.3
43	1990 May	27.97569	0 01 04.00	+28 11 45.1	20	0.6	0.1
44	1990 July	1.00712	0 08 48.77	+29 48 08.8	5	0.2	0.6
45	1990 July	1.03831	0 08 48.46	+29 48 12.2	4	0.5	0.5
46	1990 July	22.89653	23 50 32.38	+29 29 50.3	6	0.7	1.0
47	1990 July	22.94028	23 50 27.75	+29 29 37.7	6	0.2	0.1
48	1990 July	23.93056	23 48 38.26	+29 23 42.5	4	0.6	0.2
49	1990 July	23.96806	23 48 33.98	+29 23 29.9	4	1.4	0.9
50	1990 July	24.92083	23 46 40.82	+29 17 01.2	6	0.9	1.0
51	1990 July	24.93889	23 46 38.40	+29 16 54.5	4	0.5	0.2
52	1990 July	31.84306	23 28 26.74	+27 59 24.3	4	0.4	0.8
53	1990 July	31.88508	23 28 18.40	+27 58 43.2	4	0.3	0.5
54	1990 Aug.	13.82188	22 18 19.63	+20 05 37.3	3	0.9	0.5
55	1990 Aug.	13.85868	22 18 01.18	+20 03 05.1	3	0.9	1.2
56	1990 Aug.	24.83322	20 15 52.69	-1 21 49.8	3	0.3	0.6
57	1990 Aug.	24.93530	20 14 29.62	-1 37 55.2	3	0.1	0.3
58	1990 Aug.	25.94062	20 00 51.88	-4 17 07.7	3	0.8	0.2
59	1990 Aug.	25.95104	20 00 43.39	-4 18 44.4	3	0.7	0.2
60	1990 Aug.	27.82361	19 35 15.23	-9 12 12.9	2	0.1	1.3
			Comet C/1990 N1 (Tsuchiya-Kiuchi)				
61	1990 Oct.	22.13299	10 47 48.77	-4 45 46.8	6	0.3	0.4
62	1990 Oct.	22.14375	10 47 47.93	-4 46 07.4	6	0.8	0.2
63	1990 Oct.	23.12083	10 46 27.25	-5 16 13.0	4	0.1	0.4
64	1990 Oct.	23.14028	10 46 25.58	-5 16 49.8	4	0.1	0.1
65	1990 Oct.	24.11505	10 45 02.58	-5 47 31.6	4	0.4	1.0
66	1990 Oct.	24.12500	10 45 01.65	-5 47 49.8	4	0.3	1.0
67	1990 Oct.	26.12292	10 42 02.04	-6 52 54.7	4	0.6	0.5
68	1990 Oct.	27.11875	10 40 27.68	-7 26 36.2	6	0.2	1.0

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

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N	Numbers of stars and dependences					
1	59423	.26114	59499	.29104	59548	.44782
	59456	.33551	59482	.30144	59568	.36305
2	59423	.24844	59499	.29751	59548	.45405
	59456	.32828	59482	.29654	59568	.37518
3	59504	.20649	59572	.35404	59597	.43947
	59527	.38237	59548	.32759	59637	.29004
4	59504	.20178	59572	.35477	59597	.44345
	59527	.37907	59548	.32728	59637	.29365
5	59637	.34425	59704	.28935	59721	.36640
	59652	.43383	59703	.30830	59739	.25787
6	59910	.29389	59916	.30097	59974	.40514
	59912	.35239	59937	.27343	59959	.37418
7	59910	.29440	59916	.30371	59974	.40189
	59912	.35514	59937	.27804	59959	.36682
8	59910	.32452	59916	.39418	59974	.28130
	59912	.47017	59921	.20276	59959	.32707
9	59910	.32546	59916	.39758	59974	.27696
	59912	.47382	59921	.20541	59959	.32077
10	59856	.33681	59910	.26867	59937	.39452
	59863	.19956	59912	.21769	59916	.58275
11	59856	.17226	59910	.31913	59916	.50861
	59863	.20970	59912	.20513	59916	.58517
12	59817	.39108	59846	.34455	59894	.26437
	59792	.22849	59863	.32800	59879	.44351
13	41375	.19205	41412	.61730	41527	.19065
	41375	.29836	41433	.56883	41524	.13281
14	80668	.45431	80697	.32318	80771	.22251
	80665	.47193	80721	.28443	80756	.24364
15	80668	.46209	80697	.32301	80771	.21490
	80665	.48232	80721	.27864	80756	.23904
16	80489	.22580	80537	.31049	80597	.46371
	80494	.33010	80563	.30889	80602	.36101
17	80489	.22566	80537	.31358	80597	.46076
	80494	.33075	80563	.31122	80602	.35803
18	80489	.22045	80537	.33786	80597	.44169
	80494	.33181	80563	.33086	80602	.33733
19	80494	.32606	80563	.31236	80597	.36158
	80534	.40610	80553	.37650	80589	.21740
20	80494	.32588	80563	.31336	80597	.36076
	80534	.40712	80553	.37543	80589	.21745
21	80494	.27870	80563	.41431	80597	.30699
	80534	.44630	80553	.27708	80589	.27662

N	Numbers of stars and dependences					
22	80494	.27796	80563	.41564	80597	.30640
	80534	.44656	80553	.27595	80589	.27749
23	98758	.32506	98800	.28152	98830	.39342
	98764	.43369	98805	.30401	98842	.26230
24	98758	.31406	98800	.28566	98830	.40028
	98764	.42312	98805	.30872	98842	.26816
25	31068	.39137	47715	.40010	31150	.20853
	31064	.13554	31087	.67645	31168	.18801
26	31020	.21482	31068	.56723	31070	.21795
	31025	.30658	31044	.36034	31098	.33308
27	31016	.45375	31044	.22939	31064	.31686
	30982	.27961	31044	.37130	31068	.34909
28	111520	.35018	111544	.19368	130887	.45614
	111520	.46040	111552	.14436	130896	.39524
29	111520	.37855	111544	.17940	130887	.44205
	111520	.48234	111552	.13495	130896	.38271
30	111433	.28192	111463	.23880	130777	.47928
	111425	.26587	111458	.25002	130784	.48411
31	106918	.21798	106996	.33487	107034	.44715
	106923	.17833	107005	.43441	107021	.38726
32	106918	.25731	106996	.30104	107034	.44165
	106923	.21212	107005	.44073	107021	.34715
33	106918	.29649	106996	.26655	107034	.43696
	106923	.24528	107005	.44806	107021	.30666
34	125508	.41780	125624	.28822	125726	.29398
	125537	.48655	125644	.26618	125759	.24727
35	125508	.41334	125624	.39369	125726	.19297
	125537	.57680	125644	.18903	125759	.23417
36	143357	.30505	143384	.28138	143458	.41357
	143333	.13996	143379	.53354	143479	.32650
37	143357	.31320	143384	.37847	143458	.30833
	143333	.14332	143379	.61070	143479	.24598
38	143034	.30158	143082	.31720	143139	.38122
	143027	.26581	143088	.30565	143132	.42854
39	143034	.33042	143082	.38029	143139	.28929
	143027	.32070	143088	.32663	143132	.35267
40	91598	.68097	91630	.14498	73742	.17405
	91569	.52939	91630	.08779	73733	.38282
41	91598	.67942	91630	.14539	73742	.17519
	91569	.52775	91630	.08841	73733	.38384
42	91598	.47964	91630	.18711	73742	.33325
	91569	.32991	91630	.17063	73733	.49946

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N	Numbers of stars and dependences					
43	91598	.41383	91630	.20206	73742	.38411
	91569	.26495	91630	.19881	73733	.53624
44	73726	.41473	53699	.26106	73813	.32421
	73736	.29314	53645	.42075	73844	.28611
45	73726	.41532	53699	.26149	73813	.32319
	73736	.29274	53645	.42180	73844	.28546
46	91435	.16966	73521	.48344	91602	.34690
	91433	.18359	73521	.48155	91613	.33486
47	91435	.17630	73521	.48087	91602	.34283
	91433	.19048	73521	.47837	91613	.33115
48	91435	.34005	73521	.41037	91602	.24958
	91433	.35718	73521	.39639	91613	.24643
49	91435	.34642	73521	.40776	91602	.24582
	91433	.36352	73521	.39344	91613	.24304
50	91435	.51725	73521	.33259	91602	.15016
	91433	.54645	73521	.25789	91592	.19566
51	91439	.37881	91472	.27905	91545	.34214
	91447	.33436	91473	.41395	91542	.25169
52	91251	.34052	91292	.46628	91338	.19320
	91252	.37425	91289	.28390	91321	.34185
53	91251	.35626	91292	.46867	91338	.17507
	91252	.39306	91289	.29001	91321	.31693
54	90341	.38196	107805	.30396	90466	.31408
	107748	.33577	107823	.27145	90444	.39278
55	90341	.39679	107805	.33233	90466	.27088
	107748	.37252	107823	.27706	90444	.35042
56	144135	.33708	144225	.20172	144306	.46120
	144116	.08569	144220	.32965	144248	.58466
57	144135	.44772	144225	.28481	144306	.26747
	144116	.25667	144220	.36760	144248	.37573
58	143948	.28251	144007	.40508	144010	.31241
	143958	.35994	143982	.18585	144023	.45421
59	143948	.31633	144007	.35836	144010	.32531
	143958	.41542	143982	.14402	144023	.44056
60	143510	.36103	143560	.25662	143632	.38235
	143483	.30483	143584	.23248	143609	.46269
61	137753	.38500	137822	.31735	137826	.29765
	137746	.34216	137811	.34393	137837	.31391
62	137753	.38688	137822	.31989	137826	.29323
	137746	.34283	137811	.34905	137837	.30812
63	137757	.40926	137775	.32894	137822	.26180
	137737	.29102	137775	.27401	137811	.43497

N	Numbers of stars and dependences					
64	137757	.42086	137775	.31771	137822	.26143
	137737	.29953	137775	.26266	137811	.43781
65	137737	.26884	137769	.50093	137775	.23023
	137721	.39734	137769	.28931	137811	.31335
66	137737	.27241	137769	.50188	137775	.22571
	137721	.39706	137769	.29455	137811	.30839
67	137694	.24757	137731	.48006	137769	.27237
	137697	.36714	137727	.33745	137787	.29541
68	137681	.37255	137706	.30320	137765	.32425
	137677	.38435	137718	.31770	137763	.29795

5. List of collaborators

Name	Exposures	Measurements	Reductions
G. Červák	30	32	–
L. Neslušan	2	–	–
P. Rychtarčík	36	36	–
J. Svoreň	–	–	68

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