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Taurids – a list of photographic orbits

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Abstract. The paper presents a list of 227 autumn Taurids selected from the newest version of the IAU MDC database of photographic orbits. The selection was made by a method of indices described in detail in the paper on a structure of Perseids (Kaňuchová *et al.*, 2005). Because we wanted to study especially the fine structure of the inner part of the Taurid complex, we were focused on the interval of the higher activity of the stream – between the end of the Perseids activity and the beginning of the Geminids activity. We did not take into account outlying parts of the complex, which are active according to some authors until January. Therefore, the studied part of the database consisted of 1199 records. 84 orbits of the Northern Taurids and 143 orbits of the Southern Taurids were selected.

Key words: meteors – Taurids – photographic orbits

1. Introduction

In the period of autumn, many small showers are observed. Some of them belong to the complex system called the Taurids complex.

The aim of this paper was a selection of members of the Taurids complex from the International Astronomical Union Meteor Data Center database (hereafter IAU MDC database) of photographic orbits of meteors using the method of indices (Svoreň *et al.*, 2000). According to the photographic observations (Kornoš and Porubčan, 2002), the shower has two branches; more active Southern Taurids and Northern Taurids. The Earth is crossing the Southern Taurids approximately 32 days, the Northern part 48 days. As already found by Plavec (1956), the transit of the Earth across the Northern branch corresponds to its transverse dimension of about 95 million km. The Southern branch is concentrated; its diameter is 60 million km.

The first photographic observations made by Whipple (1940) confirmed the widespread of the Taurids radiants. Moreover, it was shown that the Taurids have short-period orbits and are associated with the comet 2P/Encke. Porubčan and Štohl (1987 a, b) analyzed photographic meteors considered by individual authors as the Taurids. Despite a dispersion of the Taurids orbits caused by the geometry of the collision of meteoroids with the Earth, the real observed dispersion found on the basis of the precise photographic orbits is extraordinary large (semi-majoraxis $1.2 < a < 3.0$ AU and eccentricity $0.72 < e < 0.94$; Porubčan, 1978).

2. Selection of Taurids

The IAU MDC database of photographic orbits (Lindblad *et al.*, 2003) was used to obtain the set of the Taurids orbits. To select the Taurids, we used the method of indices (Svoreň *et al.*, 2000). We assumed the same values of relative errors and ranges of individual parameters in Tab. 1 as in the previous work (Kaňuchová *et al.*, 2005). The errors of 8 individual parameters were determined as the mean weight values calculated from primary errors derived for the 5 most numerous streams – Perseids,Geminids, Orionids, Quadrantids and Leonids. The primary errors of the streams were calculated as the root-of-mean-squares deviations for the selected members of the streams. An independent (concerning the method of indices) procedure had to be used to obtain input data. The identification was made on the basis of Southworth-Hawkins D-criterion (Southworth and Hawkins, 1963), by using the break point method (Neslušan *et al.*, 1995). As the break points we considered the points from which the dependence of a cumulative number versus a D-discriminant change to quasi-linear and next changes (with the increasing D-discriminant and cumulative number) are only moderate (Neslušan *et al.*, 1995).

Because the study of only the inner part of the Taurids was in focus, we analyzed the meteor records within the interval of a higher activity of the stream, i.e. between the end of the activity of the Perseids (the begining of September) and the early activity of the Geminids (December). We did not take into account the border parts of the complex, although, according to some authors, the meteor shower is active until January (Porubčan *et al.*, 2006). We selected only meteors with a perihelion distance smaller than $0.5\,AU$, because in the catalog there is $q = 0.375\,AU$ for Northern and $q = 0.359\,AU$ for Southern Taurids (Cook, 1973).

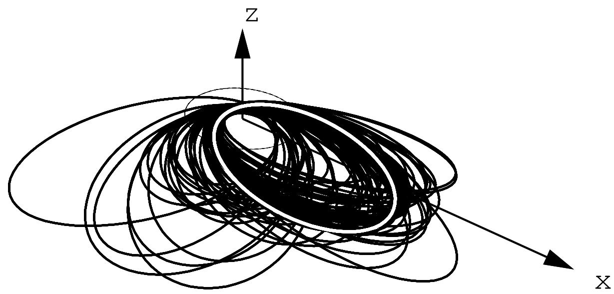

Figure 1. Orbits of 84 selected Northern Taurids. The orbit of the comet 2P/Encke is highlighted in white. The x axis points to the vernal equinox; z axis to the north ecliptic pole.

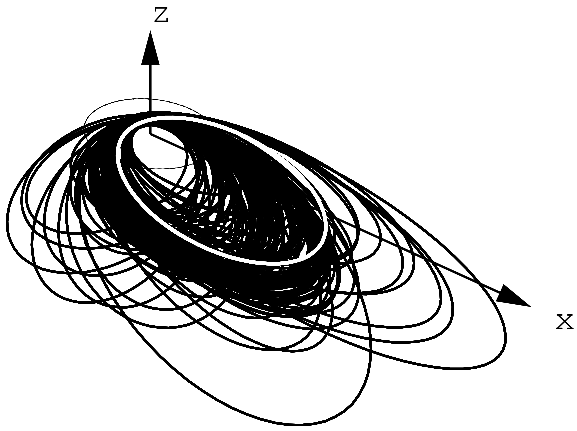

Figure 2. Orbits of 143 selected Southern Taurids. The orbit of the comet 2P/Encke is highlighted in white. The x axis points to the vernal equinox; z axis to the north ecliptic pole.

Table 1. The mean errors (MEs) and the numbers of intervals of basic division.

parameter	q	e	ω	Ω	i	α	δ	v_g
ME	0.016	0.072	3.5	2.6	2.3	3.6	1.3	1.3
Range	1.1	1.6	360.0	360.0	180.0	360.0	148.0	76.0
range/ME/11.39	6.04	1.95	9.03	12.16	6.87	8.78	10.00	5.13
intervals	6	2	9	12	7	9	10	5

Table 1 lists:
- the parameters considered in the method of indices;
- the errors of the parameters; the weighted mean values calculated from the 5 most numerous streams – Perseids, Geminids, Orionids, Quadrantids and Leonids;
- the ranges - differences between the uppermost and lowest values of parameters for the whole IAU MDC database;
- the ratios of given ranges to the mean errors, the result moreover divided by the empirical value (11.39 in our case) fulfilled a condition of minimal sum of squares of differences between real values and the closest integers.
- The corresponding nearest integers serving as a basic set of numbers for the division of the parameters into equidistant intervals, are in the last row.

Table 2. The ranges of parameters and the comparison of 2P/Encke orbit (in the same precision as mean orbits of the meteors, although the cometary orbit is known with higher precision) with the mean orbits of the Northern and Southern Taurids. Comet data were taken from http://ssd.jpl.nasa.gov/ for epoch 1995-10-10.

parameter	q	e	ω	Ω	i
lowest value NT	0.201	0.694	279.6	159.6	0.4
highest value NT	0.483	0.912	316.1	255.4	6.6
Northern Taurids	0.352	0.834	294.9	216.3	3.1
	±0.066	±0.040	±8.0	±25.0	±1.4
lowest value ST	0.208	0.666	97.2	2.9	0.5
highest value ST	0.482	0.911	135.2	358.0	10.2
Southern Taurids	0.347	0.826	116.4	32.9	5.4
	±0.064	±0.455	±8.2	±18.9	±1.5
Comet 2P/Encke	0.331	0.850	186.3	334.7	11.9

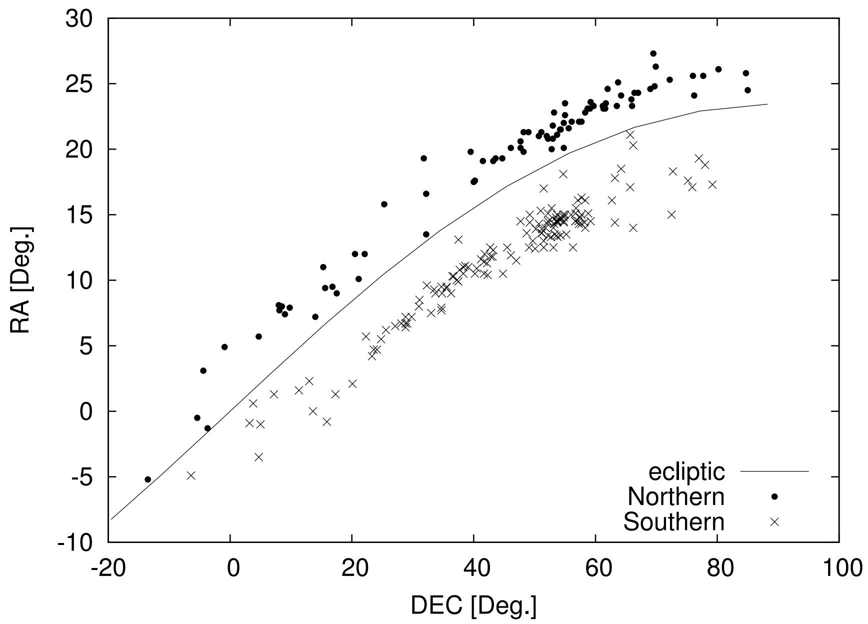

Figure 3. The motion of radiants of Northern (points) and Southern Taurids (crosslines) on the celestial sphere. The curve is the ecliptic.

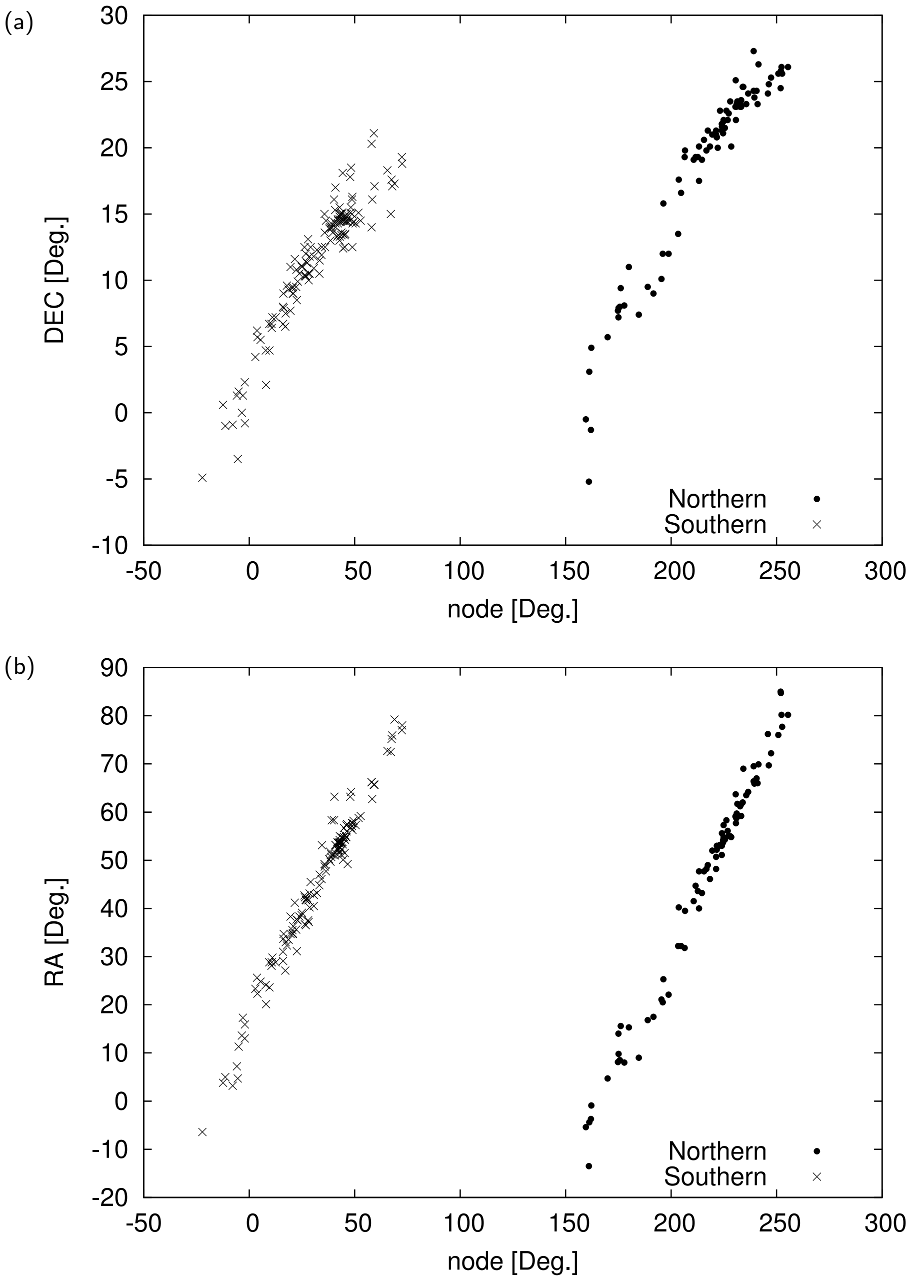

Figure 4. a) Declinations and b) right ascension of 84 Northern Taurids (points) and 143 Southern Taurids (crosslines).

A list of selected Taurids is given in Tab. 3 and Tab. 4. Only the identification number, date and time of observation and the above-mentioned 8 parameters are listed in the tables. The Universal Time was used for all data. The reader can obtain all the other data characterizing the selected meteors from the electronic version of the IAU MDC database (Lindblad *et al.*, 2003). The identification number is an easy way to find in the database the meteors here selected.

3. Selected Taurids

The selected Taurids cover an interval from August 30 to December 7. The ranges of parameters for 227 Taurids are listed in Tab. 2. The mean orbits of selected Northern and Southern Taurids are listed in the 3rd and 6th row, respectively. Figure 3 depicts the radiants of all the selected Taurids around the ecliptic.

Table 3. Selected Northern Taurids - IN - identification number, $d.t.$ - date (yymmdd.) and time (.ttttt) in UT, q - perihelion distance in AU, e - eccentricity, ω - argument of perihelion in degrees, Ω - longitude of ascending node and i - inclination of the plane of meteor orbit to the ecliptic in degrees, α - right ascension and δ - declination of the radiant in degrees, v_g - geocentric velocity in km per second.

IN	$d.t.\,[UT]$	q	e	ω	Ω	i	α	δ	v_g
286J1	520901.47897	0.318	0.805	302.4	159.6	2.1	354.6	-0.5	27.29
194P1	570903.35790	0.474	0.835	279.6	161.0	0.5	346.5	-5.2	25.95
196P1	570903.37433	0.284	0.856	304.0	161.2	6.4	355.6	3.1	29.97
164S1	560904.22577	0.270	0.813	309.3	162.2	6.6	359.1	4.9	27.98
200P1	570904.43257	0.294	0.893	300.4	162.0	0.4	356.3	-1.3	31.33
241F1	680912.17500	0.270	0.861	305.5	169.9	4.9	4.7	5.7	30.29
122D2	580917.90200	0.257	0.876	306.4	175.1	5.1	9.8	7.9	31.20
097E1	790918.02180	0.291	0.850	303.1	174.8	5.3	8.1	7.7	29.60
142I1	790918.27000	0.213	0.870	314.0	175.0	1.9	14.0	7.2	31.10
210P1	570918.34590	0.312	0.822	301.9	175.7	5.0	8.5	8.0	28.14
032D2	570918.71200	0.203	0.865	316.1	176.1	4.3	15.6	9.4	30.80
215P1	570920.40210	0.313	0.898	297.0	177.8	5.8	8.0	8.1	31.28
123D2	580922.91200	0.252	0.855	308.6	180.0	6.1	15.3	11.0	30.20
030S1	560927.21450	0.429	0.869	283.3	184.7	3.4	9.0	7.4	27.86
321J1	511002.22043	0.368	0.865	291.3	188.9	2.6	16.8	9.5	28.96
004P1	561004.24583	0.401	0.874	286.4	191.6	1.6	17.5	9.0	28.59
307F1	731008.43700	0.477	0.694	285.8	195.4	0.9	21.1	10.1	21.83
294P1	581009.23594	0.477	0.714	284.8	196.0	2.6	20.5	12.0	22.46
249H1	531009.24410	0.363	0.790	296.2	196.3	5.4	25.3	15.8	26.46
173F1	671012.27800	0.477	0.757	282.2	198.8	2.2	22.1	12.0	23.74
048W1	501016.23520	0.354	0.843	293.9	203.3	0.5	32.2	13.5	28.47
264H1	521016.33970	0.201	0.912	312.4	203.6	3.4	40.2	17.6	33.90

Table 3. Continued.

IN	$d.t.\,[UT]$	q	e	ω	Ω	i	α	δ	v_g
088I2	831018.41300	0.377	0.819	292.4	204.7	3.7	32.2	16.6	27.30
025I2	801019.32500	0.401	0.812	289.5	206.4	6.4	31.8	19.3	26.80
269H1	521019.38340	0.315	0.781	303.9	206.6	4.9	39.5	19.8	26.47
356J1	521023.44000	0.305	0.864	299.6	210.7	3.9	41.5	19.1	30.15
360J1	521024.38900	0.270	0.874	304.2	211.6	3.3	44.7	19.3	31.08
097F1	661026.09400	0.320	0.837	299.2	212.7	3.2	43.6	19.3	28.81
100S1	651026.30180	0.384	0.840	290.0	213.2	2.0	40.0	17.5	27.91
126W1	381026.34000	0.241	0.891	307.4	213.2	3.6	47.7	20.1	32.30
297H1	521027.35800	0.346	0.856	294.4	214.6	3.0	43.2	19.1	29.17
089I2	831029.30800	0.287	0.866	302.1	215.6	3.8	47.7	20.6	30.50
128W1	491030.38450	0.310	0.835	300.7	217.4	3.9	49.0	21.3	28.89
091I2	831030.45400	0.328	0.810	299.7	216.7	2.2	48.2	19.8	27.60
129W1	491031.33150	0.349	0.881	292.6	218.4	3.3	46.1	20.1	30.03
062K1	621101.79200	0.285	0.865	302.3	219.5	2.9	52.0	21.0	30.50
027I2	801103.27000	0.357	0.812	295.3	221.3	2.7	50.7	21.0	27.40
303H1	531103.29681	0.395	0.801	290.6	221.3	3.4	48.2	21.3	26.50
131W1	401103.31000	0.308	0.858	299.3	221.7	2.2	53.0	20.8	29.87
070D4	641103.87500	0.298	0.906	298.0	222.1	1.3	52.8	20.0	32.00
029E2	941104.12570	0.336	0.823	297.7	221.6	2.2	52.2	20.8	28.10
051I2	811105.38900	0.368	0.767	296.6	223.2	3.7	53.2	22.8	25.60
332P1	581106.28737	0.386	0.823	290.5	224.0	2.8	51.1	21.3	27.39
176S1	581106.29495	0.357	0.826	294.4	224.0	3.0	53.0	21.8	27.93
096S1	581106.30717	0.305	0.861	299.7	224.1	2.5	55.6	21.6	30.07
033P1	561106.30962	0.347	0.849	294.5	224.6	2.1	53.7	21.1	28.94
034P1	561106.31007	0.338	0.850	295.7	224.6	2.5	54.2	21.5	29.14
307S1	581107.16616	0.322	0.875	296.5	224.9	3.1	54.8	22.0	30.37
373J1	531107.48135	0.354	0.844	293.7	225.5	2.4	54.3	21.5	28.63
036I1	751107.55200	0.290	0.868	301.5	224.9	2.8	57.3	22.1	30.60
090O4	641108.01600	0.311	0.834	300.6	226.2	3.2	58.3	22.8	28.90
014I1	741109.23900	0.336	0.872	294.8	226.8	2.8	56.1	22.1	30.00
374J1	531109.25547	0.370	0.841	291.7	227.3	3.4	55.0	22.6	28.31
006D1	411109.88040	0.389	0.850	288.2	228.5	0.6	54.8	20.1	28.23
179S1	581110.25620	0.384	0.829	290.4	228.0	4.2	55.0	23.5	27.69
311H1	521112.19600	0.361	0.839	292.9	230.5	3.0	59.1	23.1	28.40
313H1	521112.37040	0.388	0.837	289.4	230.7	2.1	57.7	22.1	27.84
314H1	521112.37330	0.289	0.855	302.3	230.6	5.2	63.7	25.1	30.17
261S1	661113.23350	0.378	0.830	291.2	230.9	3.0	58.7	23.1	27.81
158W1	501113.31100	0.366	0.832	292.8	231.1	3.1	59.7	23.3	28.07
378J1	531113.35060	0.338	0.838	296.2	231.4	3.1	61.7	23.5	28.75
051P1	561114.42640	0.356	0.859	292.5	232.7	2.7	61.3	23.1	29.19
052P1	561114.43410	0.367	0.837	292.3	232.7	2.8	61.2	23.3	28.24
117I2	841115.16100	0.363	0.854	292.0	233.2	2.6	61.6	23.1	28.90
144W1	381115.27000	0.418	0.800	287.3	233.2	3.1	59.2	23.6	26.18
117S1	661116.22350	0.393	0.789	291.4	233.9	3.7	62.0	24.6	26.20
108E1	791116.79880	0.261	0.875	305.2	234.2	3.8	69.0	24.6	31.43

Table 3. Continued.

IN	$d.t.\,[UT]$	q	e	ω	Ω	i	α	δ	v_g
133D2	581117.80400	0.391	0.809	290.4	235.6	2.2	63.5	23.3	26.90
022E2	931118.76310	0.389	0.825	290.0	236.5	3.0	64.2	24.1	27.49
116B1	881121.03550	0.338	0.852	295.5	239.1	6.4	69.5	27.3	29.47
029F1	651121.47100	0.418	0.807	286.8	239.5	2.2	65.9	23.8	26.44
073I2	821121.47600	0.401	0.815	288.8	239.1	2.7	66.4	24.3	27.00
030F1	651122.46400	0.416	0.809	286.9	240.5	2.5	67.0	24.3	26.55
022O1	571122.80800	0.442	0.803	283.8	241.0	1.6	66.0	23.3	25.90
029I2	801123.25800	0.384	0.817	291.0	241.4	4.5	69.9	26.3	27.40
057P1	561127.32640	0.360	0.826	293.6	245.9	1.4	76.2	24.1	28.06
092O4	641127.89900	0.483	0.771	279.9	246.3	2.3	69.7	24.8	24.30
030I2	801129.11500	0.445	0.820	282.5	247.4	2.8	72.2	25.3	26.40
018E1	671203.16823	0.455	0.795	282.4	250.8	2.6	76.0	25.6	25.52
075P1	561203.49288	0.324	0.852	297.2	252.0	3.1	84.7	25.8	29.69
065D3	621203.82600	0.316	0.855	298.2	251.9	1.5	85.0	24.5	29.90
039E1	741204.74764	0.472	0.762	281.8	252.6	2.3	77.7	25.6	24.30
145E1	831204.77199	0.447	0.730	287.1	252.3	2.6	80.2	26.1	23.70
327F1	741207.44100	0.470	0.784	280.8	255.4	2.7	80.2	26.1	24.98

Table 4. Selected Southern Taurids - IN - identification number, $d.t.$ - date (yymmdd.) and time (.ttttt) in UT, q - perihelion distance in AU, e - eccentricity, ω - argument of perihelion in degrees, Ω - longitude of ascending node and i - inclination of the plane of meteor orbit to the ecliptic in degrees, α - right ascension and δ - declination of the radiant in degrees, v_g - geocentric velocity in km per second.

IN	$d.t.\,[UT]$	q	e	ω	Ω	i	α	δ	v_g
031D2	570830.85000	0.325	0.814	120.7	337.8	2.4	353.6	-4.9	27.60
284P1	580910.21380	0.253	0.903	125.2	347.6	1.5	3.8	0.6	32.49
149W1	500911.27610	0.283	0.867	123.2	348.7	4.1	5.0	-1.0	30.43
053E1	770914.79710	0.376	0.836	112.0	352.2	2.4	3.2	-0.9	27.79
063D1	530916.74080	0.424	0.666	116.5	354.2	1.4	7.2	1.3	21.19
207P1	570917.18030	0.443	0.764	107.0	354.6	4.8	4.7	-3.5	24.52
297J1	520917.31690	0.263	0.893	124.4	355.0	4.6	11.3	1.6	31.93
212P1	570919.15970	0.304	0.821	123.1	356.5	6.9	13.6	0.0	28.26
221H1	520919.37060	0.311	0.735	129.0	357.0	6.2	17.3	1.3	24.16
222H1	520920.28370	0.358	0.741	120.8	357.9	3.1	13.0	2.3	24.40
303J1	520920.38470	0.318	0.791	123.2	358.0	8.4	15.9	-0.8	26.00
229H1	520925.36080	0.236	0.846	132.0	2.9	7.9	23.3	4.2	29.83
308J1	520926.22640	0.253	0.781	134.9	3.7	5.4	25.6	6.2	26.09
013E1	620926.97100	0.249	0.848	129.6	3.9	5.0	22.3	5.7	29.85
223P1	570928.24360	0.247	0.840	130.7	5.4	6.6	24.8	5.5	29.46

Table 4. Continued.

IN	$d.t.\,[UT]$	q	e	ω	Ω	i	α	δ	v_g
320J1	520930.48300	0.302	0.820	123.3	7.9	6.4	24.1	4.7	28.21
047D2	570930.86400	0.399	0.764	112.9	8.0	5.9	20.1	2.1	25.10
230P1	571002.36428	0.224	0.878	131.4	9.5	7.9	28.8	6.7	31.77
234P1	571002.46458	0.308	0.870	119.2	9.6	6.4	23.6	4.7	30.33
034S1	561003.20630	0.256	0.860	127.5	10.6	6.7	28.1	6.7	30.49
039S1	561003.38117	0.262	0.842	128.0	10.7	7.3	28.8	6.4	29.59
292P1	581004.18176	0.287	0.778	129.1	11.0	5.8	29.8	7.2	26.24
102C1	591006.04078	0.261	0.881	125.3	12.6	6.5	28.8	7.2	31.48
329J1	531009.19547	0.271	0.826	127.8	16.2	5.9	33.7	9.0	28.69
250H1	531009.24725	0.273	0.813	128.3	16.3	7.6	34.7	7.9	28.10
297P1	581009.29860	0.304	0.830	122.3	16.0	5.6	31.0	8.0	28.65
298P1	581009.39421	0.360	0.786	117.0	16.1	5.4	29.1	6.7	26.31
334J1	531010.29030	0.300	0.829	122.9	17.3	7.1	33.0	7.5	28.71
306P1	581010.36220	0.369	0.862	111.2	17.1	5.1	27.1	6.5	28.95
069I2	821011.29000	0.361	0.723	121.4	17.9	3.3	32.3	9.6	23.70
019P1	561011.45130	0.295	0.843	122.7	18.7	5.2	33.5	9.3	29.33
021P1	561012.33930	0.303	0.841	121.6	19.6	7.7	34.7	7.7	29.29
022P1	561012.34860	0.208	0.899	132.3	19.6	6.8	38.3	11.0	33.11
257H1	521013.28090	0.297	0.839	122.7	20.5	5.9	35.5	9.4	29.19
126D2	581013.89500	0.309	0.836	121.1	20.6	5.3	34.7	9.5	28.90
175F1	671014.28300	0.313	0.835	120.6	20.7	5.9	34.8	9.0	28.82
260S1	661014.28320	0.364	0.711	121.9	20.9	5.1	36.3	9.0	23.29
260H1	521014.35000	0.230	0.844	132.9	21.6	6.4	41.2	11.6	29.77
026P1	561015.44620	0.444	0.729	108.5	22.6	3.5	31.1	8.5	23.37
127D2	581015.73000	0.257	0.898	124.7	22.4	6.0	37.7	10.8	32.40
005E2	901015.79140	0.318	0.844	119.2	22.3	5.6	35.6	9.5	29.15
021F1	651016.12300	0.300	0.846	121.7	23.0	6.2	37.5	9.9	29.46
056D3	611016.87800	0.288	0.864	122.3	23.8	6.0	38.3	10.5	30.40
317P1	581018.21290	0.314	0.830	120.7	24.9	4.8	38.6	11.1	28.58
321P1	581018.38290	0.295	0.861	121.5	25.0	5.6	39.1	11.0	30.15
267H1	521019.26490	0.379	0.806	112.9	26.4	4.4	36.7	10.3	26.83
045I2	811019.43100	0.231	0.907	127.9	26.2	6.2	42.7	12.5	33.30
063O4	621019.76500	0.289	0.836	124.0	26.4	7.5	42.3	10.4	29.20
015O1	571019.85700	0.276	0.865	123.9	26.8	5.6	41.8	12.0	30.60
339J1	531020.47560	0.305	0.825	122.4	27.4	6.0	42.2	11.3	28.51
035U1	791020.66950	0.384	0.818	111.5	26.9	4.3	36.5	10.3	27.20
036U1	791020.68480	0.261	0.911	123.3	27.0	7.0	41.7	11.4	33.00
092O2	601021.03600	0.401	0.805	109.9	28.2	4.6	37.2	10.0	26.50
123W1	361021.30000	0.297	0.845	122.2	28.6	6.0	43.1	11.8	29.50
209S1	661021.32400	0.369	0.817	113.6	27.9	1.8	37.5	13.1	27.33
210S1	661021.37590	0.373	0.728	118.9	28.0	5.3	41.7	10.5	24.02
345J1	521021.40050	0.350	0.830	115.4	28.6	5.8	40.2	10.5	28.20
344B1	921022.12040	0.241	0.898	127.0	29.1	7.3	45.5	12.5	32.72
355J1	521023.42690	0.335	0.836	117.2	30.6	5.4	42.8	11.8	28.62
357J1	521023.48190	0.384	0.813	111.7	30.6	5.0	40.5	10.9	27.05

Table 4. Continued.

IN	$d.t.\,[UT]$	q	e	ω	Ω	i	α	δ	v_g
242P1	571025.23790	0.358	0.817	115.0	32.1	4.6	43.2	12.3	27.57
173N2	811026.56000	0.336	0.882	114.4	33.3	8.0	44.8	10.5	30.50
060D3	621026.79200	0.330	0.819	119.0	33.4	7.1	47.0	11.5	28.10
296H1	521027.35620	0.237	0.868	129.6	34.5	10.2	53.1	12.5	31.41
002E1	511027.93940	0.350	0.826	115.6	34.3	6.1	46.1	11.9	28.08
064D4	641028.64800	0.289	0.873	121.5	35.7	4.3	49.2	15.0	30.80
065D4	641028.75600	0.330	0.821	118.8	35.8	5.2	48.7	13.6	28.10
181D2	591029.68900	0.348	0.791	118.1	36.0	6.2	49.1	12.5	26.80
090I2	831030.22200	0.321	0.879	116.5	36.4	4.1	47.7	14.5	30.50
046I2	811031.29600	0.324	0.855	117.5	38.0	5.6	50.2	13.9	29.60
130W1	371031.35000	0.294	0.882	120.2	38.3	6.5	51.8	14.0	31.20
031P1	561031.36530	0.360	0.819	114.6	38.5	5.9	49.7	13.0	27.71
066D4	641031.78100	0.322	0.868	117.0	38.8	5.3	50.7	14.3	30.10
067D4	641031.81300	0.322	0.859	117.6	38.9	5.9	51.2	13.9	29.80
047I2	811101.33400	0.242	0.843	130.9	39.1	9.2	58.3	14.0	30.00
063D3	621101.98900	0.354	0.816	115.6	39.6	5.7	51.2	13.6	27.70
302H1	531102.36021	0.215	0.900	130.8	40.2	7.1	58.3	16.1	33.28
070D1	541102.79040	0.275	0.733	135.2	40.4	7.7	63.2	14.4	24.00
002O4	611102.87100	0.348	0.854	114.2	40.7	3.9	51.0	15.3	29.10
106B1	881102.97130	0.343	0.815	117.2	40.9	5.5	53.2	14.3	27.76
107B1	881103.00350	0.341	0.844	115.7	40.9	2.0	51.5	17.0	28.80
048I2	811103.26000	0.333	0.845	116.8	41.0	6.2	53.1	14.0	29.10
177E1	881103.85573	0.329	0.868	116.0	41.8	7.4	53.8	13.3	30.10
071D4	641103.92000	0.345	0.867	113.9	42.0	5.3	52.5	14.6	29.70
049I2	811104.24100	0.376	0.812	112.7	42.0	4.9	52.1	14.3	27.20
050I2	811104.46700	0.353	0.866	112.8	42.2	5.2	52.2	14.5	29.50
130D2	581104.59800	0.417	0.700	114.0	42.2	5.1	53.6	13.4	22.80
040U1	781104.66367	0.342	0.846	115.4	42.2	5.6	53.5	14.5	29.00
110B1	881104.91620	0.391	0.774	112.9	42.9	3.5	52.8	15.5	25.65
111B1	881104.93870	0.349	0.853	114.1	42.9	5.2	53.5	14.8	29.13
112B1	881104.99770	0.356	0.838	114.0	42.9	5.5	53.7	14.4	28.47
113B1	881105.00260	0.337	0.861	115.3	42.9	5.8	54.2	14.6	29.64
114B1	881105.02690	0.375	0.841	111.2	43.0	6.3	52.7	13.3	28.31
115B1	881105.10420	0.328	0.855	116.9	43.0	5.6	55.0	15.0	29.55
326P1	581105.22096	0.434	0.744	108.6	42.8	5.2	51.5	13.0	24.18
132W1	371105.36000	0.350	0.864	113.3	43.3	5.6	53.7	14.5	29.53
327P1	581106.10909	0.437	0.773	106.4	43.7	4.6	51.1	13.6	25.03
330P1	581106.23139	0.408	0.812	108.2	43.8	5.5	52.2	13.4	26.77
115I1	781106.24600	0.352	0.835	114.6	43.7	5.1	54.7	15.0	28.40
159W1	501106.26654	0.396	0.824	109.3	43.9	4.0	52.2	15.1	27.29
116I1	781106.29600	0.360	0.852	112.6	43.8	4.9	53.7	15.0	28.90
035P1	561106.31926	0.409	0.794	109.1	44.4	5.6	53.3	13.5	26.15
036P1	561106.32613	0.349	0.836	115.1	44.3	1.6	54.7	18.1	28.43
038P1	561106.38473	0.468	0.778	101.9	44.5	5.2	50.1	12.4	24.70
052I2	811106.45000	0.377	0.829	111.5	44.2	5.2	53.8	14.5	27.80

Table 4. Continued.

IN	$d.t.\,[UT]$	q	e	ω	Ω	i	α	δ	v_g
053I2	811107.22100	0.354	0.874	112.2	45.0	5.6	54.8	14.8	29.80
138W1	501107.25450	0.339	0.847	115.8	44.9	6.5	56.7	14.5	29.13
369J1	531107.37403	0.408	0.795	109.3	45.3	6.0	54.3	13.4	26.23
370J1	531107.37850	0.470	0.751	103.1	45.3	5.3	51.5	12.5	23.90
371J1	531107.43475	0.389	0.824	110.2	45.3	4.9	54.3	14.8	27.43
023K1	581107.92800	0.399	0.793	110.5	45.5	6.1	55.2	13.5	26.30
089O4	641108.03300	0.369	0.807	114.0	46.1	6.0	57.2	14.5	27.20
141W1	371108.21000	0.369	0.844	111.9	46.2	5.4	56.0	15.0	28.49
199N2	851108.65000	0.356	0.829	114.4	46.4	6.0	57.5	14.8	28.20
043E2	951108.84930	0.388	0.836	109.6	46.0	5.4	54.8	14.5	27.90
044E2	951108.86040	0.393	0.827	109.5	46.0	5.4	54.8	14.4	27.50
118I1	781109.18100	0.467	0.886	97.2	46.7	3.6	49.2	14.4	27.60
072D4	641109.79200	0.400	0.814	109.2	47.9	5.6	56.7	14.5	27.00
142W1	371110.23000	0.396	0.823	109.4	48.2	4.6	56.8	15.5	27.30
178S1	581110.25830	0.319	0.774	123.6	47.9	3.8	63.2	17.8	26.27
336P1	581110.38860	0.393	0.827	109.4	48.0	5.1	56.7	15.1	27.51
091O1	581110.72800	0.301	0.794	125.1	48.3	3.4	64.2	18.5	27.20
054I2	811111.19500	0.402	0.793	110.0	48.9	3.8	57.7	16.3	26.20
376J1	521111.21210	0.409	0.796	108.9	49.4	5.8	58.2	14.4	26.28
325F1	741111.24800	0.396	0.816	109.6	48.8	5.3	57.7	15.0	27.13
072I2	821111.25100	0.382	0.858	109.4	48.7	4.3	57.1	16.1	28.70
092I1	771111.25900	0.406	0.810	108.6	49.0	5.9	57.7	14.3	26.80
334P1	581111.26900	0.431	0.818	104.9	48.9	7.2	56.3	12.5	26.69
047P1	561112.34960	0.439	0.800	104.7	50.5	5.4	57.3	14.3	25.92
012E1	611113.90960	0.428	0.814	105.4	51.8	5.1	58.8	15.1	26.50
097W1	471115.37000	0.460	0.766	103.5	52.8	5.3	59.2	14.5	24.56
248P1	571120.21420	0.370	0.887	109.5	58.0	1.6	66.2	20.3	29.90
338P1	581120.34310	0.427	0.801	106.1	58.0	7.5	66.2	14.0	26.33
251P1	571120.34640	0.477	0.794	99.8	58.3	4.4	62.7	16.1	25.05
382J1	521121.44140	0.401	0.887	105.9	59.1	0.5	65.7	21.1	29.23
114D8	821121.83000	0.478	0.716	103.8	59.4	3.7	65.7	17.1	22.80
056P1	561127.20510	0.395	0.896	105.6	65.5	4.7	72.7	18.3	29.78
152E1	841128.94100	0.482	0.771	100.1	67.1	6.5	72.5	15.0	24.50
031F1	651129.47600	0.411	0.844	106.0	67.5	5.4	75.2	17.6	27.89
159B1	891129.95590	0.423	0.805	106.3	67.8	5.7	75.9	17.1	26.47
107F1	661201.09900	0.378	0.832	111.0	68.9	6.5	79.2	17.3	28.17
322H1	531204.35998	0.450	0.836	101.3	72.5	4.1	78.0	18.8	26.86
146E1	831204.96705	0.481	0.785	99.5	72.4	3.2	77.0	19.3	24.80

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