Orbital Elements of Meteors

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The meteors whose orbits we study here were chosen from the Baker Super-Schmidt photographs taken from stations at Doña Ana and Soledad, New Mexico, from February 1952 to July 1954. The photographs form a homogeneous and fairly continuous record of the night sky, the major interruptions being caused by periods of moonlight. The principle of the classical decimation process was used to ensure a random sample, every tenth meteor being chosen for analysis. Heights, velocities, and radiants for these meteors were given previously (Hawkins and Southworth, 1958). The orbital data were computed by the method of Whipple and Jacchia (1957).

The fundamental data for each meteor tabulated in our earlier paper included date, height of appearance, height of maximum light, height of disappearance, radiant, zenith distance of radiant, extrapolated extra-atmospheric velocity V_∞, photographic magnitude at maximum light, and rise in magnitude above the plate limit.

The orbital elements of 359 meteors, computed by Whipple and Jacchia's (1957) method, appear in table 1, which has been arranged to facilitate comparison with other papers in this volume of meteor papers. We omitted one meteor (1954 April 29.13439) because its velocity could not be determined. We assigned the orbit of the earth to two meteors (1953 April 11.14238 and 15.24742) whose velocities V_∞ fall short of the velocity of escape. Each double-station meteor has two trails and two trail numbers; in the first column of the table we tabulate the trail number used by other investigators at Harvard. Forty-six of the meteors selected for our random sample had already been accurately reduced by Jacchia (Jacchia and Whipple, 1961) and are designated in the table by an asterisk; the tabulated values are his. The date (Universal Time) will permit identification of the meteor in our 1958 paper.

Members of meteor showers included in the Whipple and Hawkins (1959, p. 545) list have been identified in the usual way. To conform with other papers in this volume, they are designated here in the following code:

Blank—Sporadic
1 —α Capricornid
2a—Southern Taurid-Arietid
3 —Southern ι Aquarid
4 —Geminid
5 —Southern δ Aquarid
7 —Perseid
8 —Orionid
9 —Draconid (Giacobinid)
10 —Quadrantid
17 —Northern Taurid
19 —Monocerotid
26 —Northern δ Aquarid
28 —Andromedid (Bielid)
33 —Northern ι Aquarid.

The successive columns in table 1 contain the orbital elements referred to the mean ecliptic and equinox of 1950.0: major semi-axis a, eccentricity e, perihelion distance q, aphelion distance q', argument of perihelion ω, longitude of ascending node Ω, inclination i, longitude of perihelion defined here as $\pi = \omega + \Omega$, and elongation of the true geocentric radiant from the earth's apex λ. The values of a, q, and q' are expressed in astronomical units; the values of ω, Ω, i, and π are expressed in degrees.

The standard deviation ΔV_∞ of the extrapolated extra-atmospheric velocity V_∞, as estimated from all the uncertainties in the reduction, is listed next as a guide to the accuracy of the result. We give no standard deviation for meteors analyzed by Jacchia; these were long trails of superior quality whose standard errors in V_∞ would be less than 0.1 km/sec. The radiant was determined with

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comparatively small error, averaging seven minutes of arc. Representative values of the errors in the orbital elements that can arise from an error of 0.1 km/sec in V_∞ are as follows:

a:	$\pm 0.008a$	Ω:	no error
e:	± 0.003	i:	$\pm 0^\circ.2$
q:	± 0.003	π:	$\pm 0^\circ.2/e$
ω:	$\pm 0^\circ.2/e$	λ:	$\pm 0^\circ.2$

These values may be multiplied appropriately for larger errors in V_∞. In unfavorable cases the errors in the elements may be larger.

Whipple's (1954) cosmic weight C.W. and comet-asteroid criterion K are tabulated in the next columns of table 1. The final column contains an approximate value of the mass m_∞ of the meteor above the atmosphere, computed on the conventional model of the single-body meteor (Hawkins, 1957, equation (48)).

Acknowledgments

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References

HAWKINS, G. S.
1957. The method of reduction of short-trail meteors. Smithsonian Contr. Astrophys., vol. 1, pp. 207–214.

HAWKINS, G. S., AND SOUTHWORTH, R. B.
1958. The statistics of meteors in the earth's atmosphere. Smithsonian Contr. Astrophys., vol. 2, pp. 349–364.

JACCHIA, L. G., AND WHIPPLE, F. L.
1961. Precision orbits of 413 photographic meteors. Smithsonian Contr. Astrophys., vol. 4, pp. 97–129.

WHIPPLE, F. L.
1954. Photographic meteor orbits and their distribution in space. Astron. Journ., vol. 59, pp. 201–217.

WHIPPLE, F. L., AND HAWKINS, G. S.
1959. Meteors. Handbuch der Physik, vol. 52, pp. 519–564.

WHIPPLE, F. L., AND JACCHIA, L. G.
1957. Reduction methods for photographic meteor trails. Smithsonian Contr. Astrophys., vol. 1, pp. 183–206.

Table 1. — Orbital Elements of a Random Sample of Meteors

Trail No.	Day	Mo.	Yr.	Sh. No.	a	e	q	q'	ω	Ω	i	π	λ	ΔV_∞	C.W.	K	m_∞
*9888	1.44056	Jan	54		3.49	0.727	0.952	6.03	202.3	280.4	18.8	122.7	114.8		10.1	0.34	0.46
9907	2.37141	Jan	54	10	2.88	0.659	0.983	4.78	177.2	281.4	72.1	98.5	63.5	0.2	1.75	0.15	0.0142
9928	3.36061	Jan	54	10	3.05	0.679	0.979	5.11	171.5	282.4	70.0	93.9	65.0	0.3	2.04	0.20	0.0052
9930	3.36219	Jan	54	10	2.89	0.662	0.977	4.80	170.1	282.4	71.7	92.5	63.7	0.2	2.02	0.15	0.0043
9948	3.44375	Jan	54		11.9	0.952	0.578	23.2	261.1	282.5	135.7	183.6	33.0	0.5	2.26	1.68	0.00077
9968	3.47494	Jan	54	10	2.72	0.640	0.981	4.47	174.1	282.5	71.0	96.7	63.9	0.3	1.87	0.09	0.0086
9992	3.50625	Jan	54	10	2.96	0.670	0.977	4.94	169.6	282.5	73.1	92.1	62.8	0.5	1.99	0.18	0.0031
8753	4.49735	Jan	54		39.5	0.976	0.965	78.0	164.1	283.6	152.8	87.6	16.5	0.6	0.32	2.50	0.00158
10022	5.39088	Jan	54		4.46	0.803	0.879	8.04	319.6	104.5	153.2	64.0	18.2	0.6	0.59	0.61	0.00114
10041	6.26510	Jan	54		10.5	0.934	0.692	20.2	67.3	105.4	36.2	172.7	86.1	0.2	12.2	1.49	0.0066
6069	13.29493	Jan	53		2.01	0.739	0.525	3.50	275.5	292.8	1.0	208.3	86.5	1.2	0.69	0.13	0.00115
6098	13.45089	Jan	53		2.58	0.779	0.570	4.59	267.7	292.9	17.2	200.6	87.2	0.1	10.7	0.32	0.021
6102	13.45411	Jan	53		2.52	0.798	0.507	4.53	275.2	292.9	11.3	208.1	85.5	0.9	7.10	0.35	0.151
10085	13.51791	Jan	54		0.751	0.330	0.503	0.998	345.9	292.7	24.5	278.6	54.1	0.3		-0.83	0.063
6119	14.22500	Jan	53		1.37	0.555	0.609	2.13	273.9	293.7	11.5	207.6	85.3	0.2	9.78	-0.32	0.00194
6139	14.34632	Jan	53		44.1	0.998	0.076	88.2	147.8	113.8	39.4	261.7	62.7	0.2	7.64	3.71	0.0026
6160	15.21244	Jan	53		3.98	0.763	0.941	7.01	26.0	114.7	0.7	140.7	137.7	0.6	0.60	0.47	0.052
6179	15.40959	Jan	53		2.41	0.716	0.686	4.14	254.1	294.9	7.4	189.0	96.5	0.2	6.54	0.16	0.00068
6204	16.40208	Jan	53		-38.1	1.014	0.546		83.4	115.9	101.8	199.3	48.9	1.1	4.96		0.00117
6206	16.40235	Jan	53		3.29	0.934	0.216	6.37	308.0	295.9	47.1	243.9	65.1	0.5	10.7	0.99	0.0022
6227	17.20082	Jan	53		2.80	0.655	0.966	4.64	197.4	296.8	27.8	134.1	100.9	0.2	8.14	0.13	0.054
6245	19.19278	Jan	53		2.55	0.694	0.778	4.31	240.7	298.8	4.4	179.5	105.0	0.2	4.15	0.15	0.0112
6264	19.42292	Jan	53		-34.5	1.016	0.557		262.0	299.0	137.9	201.0	33.2	0.6	2.20		0.00084
6266	19.42292	Jan	53		1.75	0.789	0.370	3.14	294.5	299.0	39.1	233.5	69.8	0.4	12.9	0.17	0.0043
6286	21.37852	Jan	53		2.81	0.723	0.780	4.85	239.6	301.0	1.1	180.6	106.3	0.2	1.09	0.24	0.0157
6312	21.47209	Jan	53		1.20	0.203	0.959	1.45	211.8	301.1	12.0	152.9	101.5	0.3	6.00	-0.74	0.034
6310	21.47354	Jan	53		2.24	0.961	0.088	4.40	149.1	121.1	18.8	270.2	62.5	0.4	5.17	1.05	0.0027
*6329	23.38956	Jan	53		2.41	0.725	0.664	4.16	77.0	123.1	4.2	200.0	95.5		3.70	0.18	0.030
6350	24.44375	Jan	53		1.15	0.338	0.762	1.54	83.8	124.1	15.9	207.9	86.0	0.1	14.7	-0.63	0.035
12193	28.17159	Jan	54		3.34	0.762	0.794	5.88	236.4	307.7	7.9	184.1	106.7	0.6	6.76	0.39	0.0168
12221	2.48125	Feb	54		1.00	0.144	0.858	1.15	271.4	313.0	8.6	224.4	84.2	0.3	5.29	-0.87	0.030
12235	3.35977	Feb	54		9.24	0.964	0.333	18.2	290.5	313.9	58.8	244.4	65.6	0.3	10.3	1.70	0.0060
12643	4.51289	Feb	54		62.9	0.984	0.986	125.	181.4	315.1	84.8	136.5	57.9	0.7	1.22	2.90	0.0021
*6376	5.14883	Feb	53		2.71	0.858	0.384	5.03	108.8	136.0	0.8	244.8	80.2		0.39	0.55	0.058
12690	6.38914	Feb	54		2.63	0.810	0.499	4.76	276.0	317.0	16.6	233.0	83.7	0.1	9.17	0.40	0.174
12752	6.42292	Feb	54		2.45	0.807	0.474	4.44	279.4	317.0	2.6	236.4	84.4	0.8	1.65	0.36	0.0033
12667	8.42292	Feb	54		2.83	0.652	0.985	4.68	185.3	319.1	49.9	144.4	79.6	0.7	3.01	0.13	0.026
*6398	10.27808	Feb	53		16.9	0.959	0.697	33.0	246.4	321.2	15.8	207.6	97.9		9.29	1.90	1.47
13301	10.40343	Feb	54		3.69	0.871	0.477	6.90	276.3	321.1	36.3	237.4	77.0	0.3	12.1	0.73	0.0084
13324	11.42659	Feb	54		1.80	0.479	0.939	2.66	211.8	322.1	3.4	173.9	126.7	0.2	3.31	-0.29	0.090

Table 1. — Orbital Elements of a Random Sample of Meteors (continued)

Trail No.	Day	Mo.	Yr.	a	e	q	q'	ω	Ω	i	π	λ	ΔV_∞	C.W.	K	m_∞
6416	12.38367	Feb	53	1.59	0.760	0.381	2.79	295.0	323.3	20.1	258.3	74.8	0.4	10.1	0.07	0.0061
6438	12.50846	Feb	53	13.2	0.943	0.752	25.5	239.4	323.5	115.5	202.9	39.8	0.3	2.66	1.65	0.0027
6458	17.20441	Feb	53	2.49	0.758	0.604	4.39	84.3	148.2	2.4	232.5	91.6	0.5	1.75	0.26	0.021
6460	17.20626	Feb	53	1.89	0.720	0.529	3.25	276.4	328.2	14.5	244.6	83.8	0.2	8.92	0.06	0.030
6484	18.35000	Feb	53	1.95	0.701	0.582	3.31	269.9	329.4	4.8	239.3	88.6	0.3	3.75	0.04	0.0180
6512	20.37820	Feb	53	1.02	0.280	0.731	1.30	101.1	151.4	2.5	252.5	82.8	0.3	2.72	-0.74	0.020
6523	20.41300	Feb	53	1.05	0.903	0.101	1.99	333.1	331.4	14.3	304.5	57.9	0.3	5.09	0.31	0.0031
*6546	21.46448	Feb	53	11.1	0.916	0.933	21.2	151.7	332.5	125.0	124.2	33.0		1.06	1.40	0.0043
10168	26.30579	Feb	54	1.91	0.660	0.649	3.17	82.4	157.1	4.6	239.5	92.3	0.5	3.94	-0.03	0.0065
4012	26.40208	Feb	52	1.65	0.621	0.625	2.67	267.9	336.7	8.9	244.6	88.7	0.7	7.72	-0.15	0.0047
10193	1.36968	Mar	54	2.01	0.639	0.726	3.30	251.7	340.2	7.3	231.9	97.2	0.2	6.84	-0.04	0.111
10215	5.29565	Mar	54	1.84	0.472	0.970	2.71	21.4	164.1	1.9	185.6	139.2	0.1	1.37	-0.29	0.021
10237	5.44662	Mar	54	3.52	0.794	0.723	6.31	247.2	344.3	24.3	231.5	92.0	0.2	13.2	0.49	0.022
6784	12.17613	Mar	53	1.53	0.456	0.833	2.23	61.0	171.3	9.6	232.3	100.8	0.7	9.17	-0.39	0.045
6803	12.27841	Mar	53	2.53	0.671	0.830	4.22	233.8	351.4	0.5	225.2	109.7	0.2	0.45	0.11	0.023
6826	13.29792	Mar	53	1.55	0.414	0.907	2.19	45.5	172.4	5.6	217.9	112.3	0.3	5.61	-0.43	0.0182
6824	13.29824	Mar	53	2.83	0.657	0.970	4.68	200.3	352.4	7.8	192.7	133.8	0.3	5.23	0.13	0.080
6843	13.37773	Mar	53	2.15	0.793	0.445	3.85	284.4	352.5	62.2	276.8	62.9	0.3	10.6	0.27	0.00190
6865	14.16204	Mar	53	1.94	0.488	0.994	2.89	355.9	173.2	4.2	169.1	157.0	0.3	1.48	-0.25	0.087
6885	14.34102	Mar	53	1.68	0.596	0.677	2.67	81.7	173.4	4.4	255.1	92.6	0.2	4.17	-0.18	0.0103
6907	14.44147	Mar	53	0.917	0.142	0.786	1.05	312.9	353.5	3.5	306.4	67.6	0.2	1.42	-0.91	0.073
6901	14.44426	Mar	53	3.14	0.687	0.981	5.30	165.4	353.5	86.1	158.9	54.8	0.4	1.33	0.23	0.0025
6905	14.44737	Mar	53	3.67	0.880	0.440	6.90	281.1	353.5	159.1	274.6	27.9	0.7	1.26	0.76	0.00053
6927	18.33889	Mar	53	1.80	0.497	0.905	2.69	223.5	357.4	6.9	220.9	113.7	0.2	6.83	-0.27	0.072
6929	18.33892	Mar	53	1.35	0.492	0.685	2.01	86.9	177.4	2.3	264.3	90.2	0.4	2.48	-0.40	0.0155
6952	18.44619	Mar	53	35.3	0.980	0.701	69.9	113.7	357.5	136.5	111.2	31.3	0.5	1.81	2.55	0.00054
*6971	19.31853	Mar	53	2.91	0.731	0.783	5.03	240.4	358.4	11.5	238.8	102.2		9.40	0.27	0.0170
*6992	19.39518	Mar	53	8.49	0.913	0.736	16.2	243.1	358.4	9.5	241.5	102.3		6.90	1.27	0.0184
7033	20.42303	Mar	53	2.14	0.625	0.802	3.48	60.4	179.5	7.5	239.8	103.6	0.3	7.63	-0.03	0.0146
3067	21.36111	Mar	52	3.23	0.713	0.927	5.53	213.6	0.6	29.4	214.2	97.5	0.2	10.2	0.28	0.0082
7054	21.40029	Mar	53	3.07	0.802	0.609	5.54	262.7	0.4	10.1	263.2	91.4	0.2	6.92	0.45	0.0116
7056	21.40331	Mar	53	2.71	0.710	0.788	4.64	240.3	0.4	4.3	240.8	105.0	0.2	4.17	0.20	0.048
3079	28.22500	Mar	52	2.66	0.625	0.998	4.32	178.5	7.4	34.1	186.0	94.3	0.4	1.64	0.06	0.0151
3038	28.45222	Mar	52	2.26	0.558	0.998	3.52	184.0	7.7	98.8	191.7	46.0	0.3	0.35	-0.10	0.0024
3011	2.38125	Apr	52	2.80	0.644	0.995	4.60	189.3	12.5	46.2	201.9	82.9	0.7	2.02	0.11	0.0102
*7075	4.17230	Apr	53	3.14	0.690	0.975	5.31	200.4	14.1	16.2	214.4	118.9		6.90	0.23	0.042
*7097	7.28372	Apr	53	1.98	0.809	0.378	3.58	293.0	17.1	27.4	310.1	74.1		11.1	0.27	0.027
7114	7.35030	Apr	53	2.41	0.832	0.403	4.41	108.4	197.2	1.1	305.5	80.5	0.3	0.59	0.42	0.0044
7135	9.29081	Apr	53	2.77	0.688	0.864	4.68	228.5	19.1	8.9	247.6	110.9	0.4	7.85	0.18	0.0121
7155	9.35927	Apr	53	1.90	0.599	0.760	3.03	249.1	19.2	21.0	268.3	91.8	0.2	14.0	-0.12	0.0087

Table 1. — Orbital Elements of a Random Sample of Meteors (continued)

Trail No.	Day	Mo.	Yr.	a	e	q	q'	ω	Ω	i	π	λ	ΔV_∞	C.W.	K	m_∞
7179	10.24583	Apr	53	1.63	0.398	0.980	2.28	202.5	20.0	12.0	222.5	116.6	0.7	5.34	-0.42	0.022
7199	11.14238	Apr	53	1.00	0.017	0.983	1.02			0.0	101.2		0.3	0.00	-0.99	0.050
7218	11.22535	Apr	53	2.58	0.682	0.821	4.34	236.4	21.0	4.9	257.4	107.5	0.8	4.50	0.14	0.027
*7240	11.34984	Apr	53	2.30	0.694	0.703	3.89	254.3	21.1	4.2	275.4	97.0		3.70	0.10	0.105
7261	13.25625	Apr	53	3.76	0.786	0.805	6.72	236.5	23.0	26.6	259.5	94.6	0.3	12.6	0.50	0.0136
7259	13.25916	Apr	53	1.71	0.914	0.147	3.28	321.9	23.0	2.8	344.9	65.6	0.9	0.96	0.58	0.0031
7283	13.46416	Apr	53	3.24	0.722	0.901	5.58	220.7	23.2	151.1	243.9	18.5	1.6	0.60	0.30	0.00108
7303	14.28612	Apr	53	2.01	0.605	0.795	3.23	243.3	24.0	2.6	267.3	103.5	0.3	2.58	-0.09	0.0086
7324	15.24583	Apr	53	2.92	0.708	0.853	4.99	50.4	204.9	2.4	255.3	112.6	0.9	2.28	0.23	0.020
7326	15.24742	Apr	53	1.00	0.017	0.983	1.02			0.0	101.2		0.3	0.00	-0.99	0.050
7344	15.35235	Apr	53	3.31	0.700	0.993	5.63	167.0	25.0	18.2	192.0	119.5	0.3	4.21	0.27	0.0177
7360	15.45282	Apr	53	1.45	0.340	0.955	1.94	144.1	25.1	71.8	169.2	59.4	0.3	2.55	-0.53	0.0034
7362	15.45366	Apr	53	110.	0.994	0.686	220.	111.4	25.1	147.9	136.5	27.3	0.3	1.35	3.55	0.0166
7364	15.45669	Apr	53	5.61	0.844	0.874	10.3	224.2	25.1	122.1	249.3	34.8	0.5	1.61	0.82	0.00084
7385	16.28881	Apr	53	2.13	0.674	0.695	3.57	256.4	25.9	16.0	282.3	92.1	0.3	11.4	0.04	0.0087
7410	16.42532	Apr	53	4.32	0.770	0.994	7.65	192.3	26.1	43.6	218.3	87.4	0.3	2.39	0.52	0.0043
7433	21.36042	Apr	53	15.7	0.936	1.001	30.4	187.0	30.9	47.1	217.9	87.0	0.3		1.68	0.0041
7431	21.36280	Apr	53	3.34	0.733	0.894	5.79	222.4	30.9	29.1	253.3	96.3	0.2	11.5	0.34	0.021
*7454	21.44645	Apr	53	28.2	0.989	0.305	56.2	66.4	31.0	68.4	97.4	63.1		9.90	2.72	0.0127
3210	22.29792	Apr	52	3.02	0.868	0.397	5.63	287.6	32.1	4.8	319.7	80.9	1.0	2.38	0.63	0.0070
*3228	23.32587	Apr	52	10.2	0.907	0.946	19.5	208.9	33.1	63.8	242.0	71.7		3.96	1.32	0.0052
11160	24.15182	Apr	54	2.51	0.860	0.351	4.66	114.1	213.4	5.3	327.5	78.0	0.2	2.46	0.52	0.185
3246	26.28750	Apr	52	1.98	0.592	0.806	3.15	62.3	216.0	4.6	278.2	103.9	0.3	4.62	-0.11	0.021
11180	28.30873	Apr	54	1.15	0.172	0.949	1.34	127.2	37.4	22.1	164.7	87.1	0.2	7.44	-0.79	0.0153
*7474	5.28417	May	53	2.95	0.925	0.220	5.68	128.8	224.4	3.2	353.3	72.0		1.20	0.88	0.0154
*7494	6.28495	May	53	2.15	0.671	0.707	3.60	75.3	225.4	0.5	300.6	97.2		0.50	0.04	0.042
7514	7.22324	May	53	2.37	0.674	0.772	3.96	245.4	46.3	1.0	291.7	102.9	0.2	0.89	0.08	0.0174
7535	7.33659	May	53	1.43	0.444	0.794	2.06	252.2	46.4	33.0	298.6	81.4	0.5	13.5	-0.43	0.0028
7541	7.33958	May	53	1.50	0.379	0.932	2.07	223.8	46.4	19.9	270.3	97.8	0.2	10.8	-0.48	0.060
7543	7.33977	May	53	3.99	0.933	0.269	7.71	301.4	46.4	41.3	347.8	68.7	0.3	10.8	1.06	0.0044
7557	8.26605	May	53	1.30	0.371	0.820	1.79	252.2	47.3	8.1	299.5	96.6	0.8	8.23	-0.55	0.030
7577	8.38998	May	53	1.39	0.321	0.944	1.84	222.7	47.4	17.9	270.1	98.5	1.2	9.71	-0.57	0.068
7600	9.35808	May	53	3.27	0.782	0.712	5.83	250.8	48.4	11.1	299.2	97.7	0.2	8.41	0.43	0.029
7620	9.42072	May	53	1.00	0.157	0.846	1.16	79.0	48.4	16.4	127.4	81.2	0.3	8.99	-0.86	0.074
7641	12.26313	May	53	1.24	0.651	0.432	2.04	296.8	51.2	14.8	348.0	75.3	0.3	9.77	-0.23	0.0166
7643	12.26667	May	53	2.52	0.669	0.836	4.21	235.3	51.2	17.7	286.5	101.1	0.6	12.2	0.10	0.023
7661	13.16348	May	53	2.04	0.512	0.997	3.09	196.2	52.0	2.8	248.3	146.8	0.3	0.63	-0.20	0.0165
7682	18.41332	May	53	1.06	0.273	0.768	1.35	277.1	57.1	22.9	334.2	79.1	0.3	14.4	-0.73	0.040
4084	19.21518	May	52	1.03	0.131	0.896	1.17	90.6	58.1	0.8	148.7	93.7	0.2	0.38	-0.87	0.045
*3327	21.36274	May	52	2.62	0.915	0.223	5.02	129.2	240.2	4.5	9.4	71.9		1.76	0.77	0.0062

Table 1. — Orbital Elements of a Random Sample of Meteors (continued)

Trail No.	Day	Mo.	Yr.	Sh. No.	a	e	q	q'	ω	Ω	i	π	λ	ΔV_∞	C.W.	K	m_∞
*3303	22.28093	May	52		2.04	0.581	0.855	3.23	234.8	61.1	2.2	295.9	110.1		2.27	-0.11	0.049
4088	24.35000	May	52		7.18	0.860	1.008	13.4	188.5	63.1	66.3	251.5	70.3	0.3		0.98	0.0045
4100	31.38916	May	52		2.88	0.732	0.770	4.98	244.5	69.8	108.5	314.4	42.1	0.3	3.06	0.27	0.00131
7702	2.22566	Jun	53		1.91	0.606	0.751	3.06	251.8	71.3	25.1	323.1	89.2	0.2	14.2	-0.11	0.037
12440	3.25929	Jun	54		1.08	0.148	0.923	1.25	107.8	72.1	6.2	179.9	98.2	0.5	3.28	-0.83	0.190
*7726	4.20432	Jun	53		2.34	0.838	0.379	4.31	112.0	253.2	3.0	5.2	79.6		1.60	0.43	0.020
12462	4.24583	Jun	54		1.70	0.417	0.993	2.41	202.0	73.0	22.7	275.0	101.0	0.3	3.92	-0.38	0.023
12484	4.35000	Jun	54		4.27	0.953	0.202	8.35	129.9	253.1	10.9	23.0	71.7	0.7	3.72	1.25	0.0084
7745	5.17987	Jun	53		2.48	0.596	1.004	3.96	166.3	74.2	9.4	240.5	137.2	0.3		-0.01	0.065
*12504	5.26538	Jun	54		3.01	0.703	0.894	5.12	135.3	74.0	14.9	209.3	111.0		11.3	0.24	0.84
7767	6.19792	Jun	53		3.55	0.725	0.976	6.12	155.4	75.1	13.3	230.6	125.3	0.5	6.47	0.35	0.035
7784	8.28370	Jun	53		5.73	0.891	0.625	10.8	259.4	77.1	78.6	336.5	59.5	0.3	7.18	1.00	0.00128
7790	8.28750	Jun	53		3.28	0.720	0.920	5.64	219.1	77.1	31.8	296.2	95.0	0.3	10.1	0.30	0.0114
7788	8.29039	Jun	53		3.19	0.751	0.795	5.58	240.3	77.1	5.6	317.5	106.3	0.3	4.97	0.35	0.0187
12528	8.32663	Jun	54		1.52	0.958	0.064	2.97	336.3	76.9	10.8	53.2	59.3	0.4	3.18	0.85	0.0123
7808	8.37832	Jun	53		3.42	0.893	0.365	6.47	111.0	257.2	3.1	8.2	80.2	0.2	1.50	0.78	0.0084
7827	9.33150	Jun	53		2.62	0.942	0.151	5.09	319.0	78.1	1.8	37.1	68.1	0.3	0.60	0.95	0.0046
7829	9.33275	Jun	53		1.84	0.455	1.005	2.68	194.9	78.1	1.5	273.0	151.8	0.2		-0.31	0.128
12548	9.37083	Jun	54		2.81	0.644	1.001	4.62	195.5	77.9	39.6	273.5	89.1	0.5		0.11	0.0081
12570	11.38442	Jun	54		3.27	0.697	0.990	5.55	200.3	79.9	33.6	280.1	96.0	0.3	4.10	0.26	0.0121
7854	13.26806	Jun	53		3.70	0.736	0.977	6.42	204.5	81.9	31.3	286.4	98.7	00.2	6.10	0.39	0.020
*7873	13.36281	Jun	53		9.28	0.925	0.695	17.9	249.9	82.0	131.0	331.9	33.2		2.20	1.38	0.0057
7895	16.30529	Jun	53		3.11	0.827	0.538	5.68	92.2	264.8	4.5	357.0	88.9	0.3	2.92	0.52	0.0103
7899	16.31098	Jun	53		2.86	0.837	0.465	5.25	100.9	264.8	4.9	5.7	84.8	0.2	2.88	0.51	0.0052
3346	17.36898	Jun	52		2.83	0.641	1.015	4.64	183.3	86.1	26.7	269.4	104.8	0.2		0.11	0.056
7920	20.35000	Jun	53		2.07	0.521	0.990	3.14	202.4	88.7	28.9	291.0	96.8	0.4	4.42	-0.18	0.0095
7936	20.43325	Jun	53		1.32	0.406	0.781	1.85	78.5	268.7	9.7	347.2	94.3	0.3	10.6	-0.51	0.037
*4138	21.42265	Jun	52		18.0	0.951	0.886	35.1	137.4	89.9	153.6	227.3	19.5		0.63	1.85	0.0035
12592	23.21042	Jun	54		2.74	0.629	1.016	4.46	178.9	91.9	38.2	270.1	90.8	0.3		0.08	0.0058
4167	24.20301	Jun	52		2.79	0.720	0.780	4.79	243.6	92.6	6.5	336.2	104.4	0.1	5.63	0.23	0.040
12615	24.23159	Jun	54		5.24	0.947	0.276	10.2	299.8	92.1	10.2	31.9	76.2	0.3	3.86	1.29	0.0023
*4181	25.22215	Jun	52		3.92	0.878	0.480	7.37	277.4	93.6	13.0	11.0	85.4		6.77	0.78	0.168
12711	25.24461	Jun	54		2.81	0.642	1.006	4.62	193.1	93.1	21.3	286.2	112.3	0.2		0.11	0.057
12732	29.33144	Jun	54		0.955	0.100	0.859	1.05	314.6	97.0	25.2	51.6	74.0	0.3	5.64	-0.93	0.083
*4199	29.43208	Jun	53		1.50	0.852	0.223	2.78	314.2	97.6	7.4	51.8	69.4		3.51	0.27	0.0106
12864	3.17241	Jul	54		2.62	0.747	0.664	4.58	259.2	100.6	17.0	359.8	92.2	0.2	11.0	0.26	0.0178
7959	10.31681	Jul	53		1.85	0.457	1.006	2.70	194.9	107.7	41.7	302.6	83.2	0.3		-0.30	0.0071
7974	10.40023	Jul	53		8.61	0.899	0.867	16.4	133.5	107.8	150.4	241.3	21.1	0.6	0.76	1.21	0.00115
8003	15.23777	Jul	53		0.757	0.386	0.465	1.05	18.5	112.4	25.3	130.9	53.9	0.2	11.0	-0.77	0.0182
8022	15.28729	Jul	53		1.40	0.286	1.002	1.80	200.8	112.4	19.8	313.3	99.8	0.3		-0.60	0.072

Table 1. — Orbital Elements of a Random Sample of Meteors (continued)

Trail No.	Day	Mo.	Yr.	Sh. No.	a	e	q	q'	ω	Ω	i	π	λ	ΔV_∞	C.W.	K	m_∞
8047	15.42229	Jul	53		2.89	0.864	0.393	5.39	288.9	112.6	113.9	41.5	42.9	0.4	5.22	0.60	0.00129
8072	16.40248	Jul	53		3.62	0.724	1.001	6.25	195.4	113.5	152.1	308.9	16.3	0.7		0.35	0.00025
8098	21.35918	Jul	53	3	1.37	0.921	0.108	2.63	149.7	298.2	2.9	87.9	62.4	0.5	1.08	0.52	0.0054
*3377	24.34757	Jul	52		34.1	0.971	0.994	67.1	197.1	121.3	129.8	318.4	30.0		0.30	2.36	0.0056
8120	24.43319	Jul	53		10.4	0.913	0.911	20.0	218.3	121.2	106.7	339.5	44.2	0.6	2.00	1.36	0.00118
*3399	25.44425	Jul	52	5	2.85	0.978	0.063	5.63	153.8	302.4	27.3	96.2	61.5		6.89	1.41	0.0075
3417	27.22387	Jul	52		2.89	0.769	0.666	5.11	258.0	124.1	12.4	22.1	95.0	0.2	8.99	0.35	0.0108
3419	27.22705	Jul	52	33	3.48	0.947	0.186	6.77	312.9	124.1	15.0	76.9	70.8	0.2	5.00	1.10	0.0043
*3450	28.31172	Jul	52	5	2.36	0.973	0.064	4.65	154.2	305.1	30.1	99.3	60.8		7.45	1.23	0.0136
3472	29.40913	Jul	52	5	2.40	0.970	0.071	4.72	152.6	306.2	29.4	98.8	61.4	0.3	7.59	1.20	0.00172
3474	29.41137	Jul	52		2.72	0.630	1.007	4.44	191.4	126.2	116.8	317.6	36.0	0.3		0.08	0.0061
8144	4.22721	Aug	53		-83.9	1.009	0.792		235.8	131.5	124.5	7.3	36.0	0.3	2.07		0.00190
*3497	4.46209	Aug	52		2.75	0.635	1.005	4.50	167.4	132.0	43.1	299.4	85.8			0.09	0.020
8165	5.24597	Aug	53	7	68.6	0.986	0.965	136.	154.3	132.5	114.1	286.8	39.6	0.2	1.04	2.99	0.0041
*8192	5.35035	Aug	53		0.947	0.723	0.263	1.63	140.1	312.6	10.2	92.6	64.7		6.70	-0.23	0.027
*8215	5.43212	Aug	53		19.5	0.954	0.908	38.1	141.7	132.6	69.8	274.4	67.8		4.60	1.91	0.0062
8233	6.16985	Aug	53		2.53	0.624	0.949	4.10	33.7	313.4	1.2	347.0	131.6	0.2	0.95	0.04	0.147
8235	6.17192	Aug	53		1.71	0.827	0.295	3.12	124.5	313.4	1.9	77.8	74.6	0.4	0.97	0.26	0.0102
8257	6.30833	Aug	53		4.08	0.813	0.761	7.40	243.7	133.5	81.6	17.1	58.1	2.2	5.61	0.60	0.00074
*8294	7.39845	Aug	53		2.06	0.515	1.000	3.13	196.2	134.5	7.7	330.7	138.3			-0.19	0.35
*8307	8.19278	Aug	53	3	3.32	0.927	0.243	6.39	125.5	315.3	7.5	80.8	74.4		2.91	0.94	0.022
8330	8.35862	Aug	53	7	38.4	0.975	0.948	75.9	150.2	135.4	113.5	285.7	40.1	0.4	1.28	2.49	0.00110
8334	8.36042	Aug	53	1	2.65	0.753	0.653	4.64	260.1	135.4	7.7	35.5	95.4	0.3	6.42	0.27	0.0157
8332	8.36458	Aug	53	7	74.5	0.987	0.956	148.	152.2	135.5	112.7	287.6	40.6	0.3	1.21	3.06	0.00170
8348	8.40951	Aug	53	7	577.	0.998	0.933	1153.	147.2	135.5	106.9	282.7	44.3	0.4	1.70	4.85	0.00123
8369	9.23255	Aug	53		2.59	0.611	1.006	4.17	191.2	136.3	18.6	327.5	116.5	0.2		0.03	0.038
*8394	10.22697	Aug	53		2.36	0.587	0.976	3.75	205.8	137.2	4.3	343.1	138.1		2.70	-0.04	0.26
8418	10.35729	Aug	53	7	51.6	0.981	0.970	102.	155.8	137.4	110.3	293.2	41.9	0.4	1.05	2.74	0.00186
8441	10.43442	Aug	53	26	2.41	0.960	0.097	4.73	327.8	137.4	22.5	105.3	63.9	0.3	6.59	1.07	0.0021
8466	13.19186	Aug	53	26	2.50	0.949	0.127	4.87	322.7	140.1	24.1	102.8	65.7	0.4	7.06	0.98	0.0024
8486	13.35836	Aug	53		1.37	0.348	0.895	1.85	56.8	320.2	0.9	17.1	111.3	0.3	0.96	-0.55	0.069
8488	13.36031	Aug	53		14.2	0.929	1.012	27.5	184.1	140.2	145.8	324.3	20.1	0.6		1.59	0.00054
8490	13.36156	Aug	53	7	12.7	0.925	0.948	24.4	150.1	140.2	111.3	290.3	41.1	0.4	1.34	1.51	0.00084
*8510	13.42525	Aug	53		2.50	0.617	0.955	4.03	211.8	140.3	17.3	352.1	112.9		10.0	0.02	0.66
8526	13.45457	Aug	53		-67.1	1.015	0.997		14.5	320.3	173.0	334.9	6.2	0.6	0.026		0.00036
8528	13.45561	Aug	53		144.	0.997	0.433	288.	277.3	140.3	75.4	57.6	61.8	0.3	9.14	3.97	0.0062
8530	13.45625	Aug	53		7.66	0.886	0.876	14.5	135.4	140.3	98.9	275.7	48.5	0.4	2.76	1.10	0.00047
8555	14.36275	Aug	53	7	16.9	0.944	0.956	32.9	152.1	141.2	117.0	293.3	37.7	0.3	1.08	1.77	0.0023
8736	14.44728	Aug	53		9.05	0.910	0.819	17.3	53.2	321.3	163.6	14.5	17.7	0.8	0.49	1.28	0.00088
8581	14.45417	Aug	53		31.3	0.976	0.749	61.9	241.8	141.3	105.1	23.1	46.5	0.7	3.61	2.41	0.0078

Table 1. — Orbital Elements of a Random Sample of Meteors (continued)

Trail No.	Day	Mo.	Yr.	Sh. No.	a	e	q	q'	ω	Ω	i	π	λ	ΔV_∞	C.W.	K	m_∞
8697	15.41947	Aug	53	7	15.3	0.938	0.946	29.7	149.8	142.2	123.6	292.0	33.9	0.5	1.03	1.68	0.00176
8699	15.42275	Aug	53		2.06	0.518	0.994	3.13	199.0	142.2	18.7	341.2	111.7	1.2	4.15	-0.19	0.0130
8599	15.44366	Aug	53	7	8.99	0.896	0.935	17.0	146.8	142.2	114.7	289.1	39.0	0.5	1.40	1.21	0.00081
3586	16.32917	Aug	52		0.951	0.837	0.155	1.75	149.2	323.3	26.6	112.6	58.6	4.8	11.1	0.03	0.0185
*3604	18.25543	Aug	52		20.9	0.952	1.011	40.8	183.4	145.2	44.7	328.6	89.9			1.93	0.043
3623	18.44646	Aug	52		10.7	0.909	0.971	20.4	203.8	145.4	106.0	349.2	44.3	0.3	1.14	1.35	0.0013
3646	21.23344	Aug	52		1.03	0.442	0.573	1.48	294.4	148.1	1.4	82.5	78.9	0.5	1.52	-0.58	0.029
3666	22.20000	Aug	52		0.83	0.361	0.533	1.13	321.7	149.0	4.6	110.7	60.6	0.3	4.38	-0.75	0.033
3664	22.20417	Aug	52	1	3.19	0.793	0.660	5.72	257.6	149.0	8.3	46.6	96.7	0.6	6.28	0.44	0.0099
8626	22.41119	Aug	53		1.40	0.777	0.312	2.49	305.5	149.0	21.1	94.5	71.7	0.2	11.1	0.05	0.0090
4219	25.35970	Aug	52	26	2.38	0.947	0.127	4.64	322.9	152.0	17.0	114.9	66.4	0.2	5.48	0.94	0.0051
4304	12.11222	Sep	52		3.24	0.701	0.970	5.51	204.0	169.2	20.4	13.2	112.8	0.5	7.96	0.26	0.0132
*4330	14.23858	Sep	52		59.0	0.985	0.903	117.	217.5	171.3	125.4	28.8	33.8		1.33	2.88	0.039
*4351	14.37389	Sep	52		1.93	0.720	0.541	3.32	96.0	351.4	12.0	87.4	86.6		8.96	0.07	0.053
4370	16.33723	Sep	52		3.22	0.937	0.203	6.24	310.5	173.4	2.7	123.9	72.5	0.8	1.03	1.00	0.0096
4372	16.33958	Sep	52		1.57	0.422	0.905	2.23	228.3	173.4	1.0	41.6	117.9	0.3	1.16	-0.41	0.041
*4394	17.31692	Sep	52	2a	2.47	0.894	0.263	4.68	124.4	354.3	4.5	118.7	74.9		2.00	0.64	0.0110
4414	17.47711	Sep	52		24.7	0.981	0.463	48.9	275.1	174.5	125.9	89.6	39.9	1.0	3.65	2.42	0.00106
4416	17.47750	Sep	52		4.61	0.785	0.993	8.24	346.5	354.5	113.2	341.0	38.9	2.1	0.47	0.58	0.00077
4432	19.23462	Sep	52		2.70	0.713	0.775	4.63	243.2	176.2	0.7	59.4	106.6	0.8	0.70	0.21	0.037
4455	19.37056	Sep	52	2a	1.17	0.736	0.309	2.03	129.4	356.3	6.1	125.7	71.4	0.3	4.06	-0.12	0.0036
4478	20.28367	Sep	52	2a	1.37	0.741	0.355	2.39	121.1	357.2	3.0	118.4	75.8	0.2	1.98	-0.03	0.0108
4482	20.28438	Sep	52		2.80	0.764	0.661	4.94	77.8	357.2	0.8	75.0	97.6	0.2	0.67	0.32	0.045
4480	20.29047	Sep	52		1.40	0.592	0.569	2.22	99.5	357.2	15.5	96.7	83.6	0.2	12.4	-0.26	0.0125
4501	20.37133	Sep	52		11.2	0.927	0.822	21.6	231.5	177.3	177.6	48.8	15.0	0.5	0.068	1.47	0.00049
4524	25.17361	Sep	52		1.79	0.510	0.876	2.70	231.3	182.0	21.2	53.3	98.3	0.3	13.9	-0.26	0.035
4522	25.17571	Sep	52		15.9	0.947	0.844	31.0	227.5	182.0	89.0	49.5	55.2	0.2	3.82	1.77	0.0024
4544	25.36001	Sep	52		2.80	0.775	0.630	4.98	261.4	182.2	4.7	83.6	95.3	0.2	3.91	0.35	0.0140
4546	25.36076	Sep	52	2a	1.52	0.846	0.234	2.80	132.3	2.2	7.9	134.5	70.6	0.2	3.85	0.26	0.0059
4548	25.36419	Sep	52		5.60	0.881	0.668	10.5	73.3	2.2	148.5	75.5	26.5	0.7	1.36	0.95	0.00051
4565	25.47579	Sep	52		3.30	0.817	0.603	6.00	276.5	2.3	131.5	278.8	32.7	0.3	2.45	0.52	0.00058
4586	26.33935	Sep	52		20.4	0.981	0.394	40.5	283.0	183.1	174.3	106.1	30.6	0.5	0.38	2.32	0.00030
4607	26.43333	Sep	52		13.5	0.965	0.470	26.6	274.6	183.2	41.6	97.9	77.4	0.7	12.3	1.88	0.0039
4627	27.30972	Sep	52		1.79	0.599	0.720	2.87	255.7	184.1	10.9	79.8	96.3	0.2	10.7	-0.15	0.0093
4648	27.43247	Sep	52		-17.5	1.057	0.999		253.9	4.2	137.1	358.1	25.5	2.0	0.090		0.00098
4670	28.33541	Sep	52		1.69	0.804	0.332	3.06	120.0	5.1	16.0	125.1	75.2	0.4	8.39	0.19	0.0041
4668	28.33834	Sep	52		3.68	0.764	0.868	6.49	226.2	185.1	152.6	51.3	19.4	0.3	0.67	0.44	0.00025
4690	28.48414	Sep	52		19.9	0.993	0.142	39.6	316.3	185.2	51.5	141.5	64.4	0.4	10.4	2.74	0.0024
8782	2.20670	Oct	53		3.15	0.824	0.555	5.75	89.2	8.7	19.5	97.8	87.5	0.3	10.8	0.51	0.0114
8800	2.31090	Oct	53		2.54	0.773	0.578	4.51	268.2	188.8	3.7	97.0	91.7	0.2	2.86	0.30	0.029

Table 1. — Orbital Elements of a Random Sample of Meteors (continued)

Trail No.	Day	Mo.	Yr.	Sh. No.	a	e	q	q'	ω	Ω	i	π	λ	ΔV_∞	C.W.	K	m_∞
8828	3.25367	Oct	53		1.46	0.432	0.827	2.09	244.8	189.7	11.5	74.5	100.1	0.3	11.9	-0.43	0.041
8844	3.29383	Oct	53		1.73	0.501	0.862	2.59	234.2	189.7	5.4	64.0	111.2	0.3	6.21	-0.28	0.043
8865	3.44375	Oct	53		71.2	0.990	0.747	142.	240.5	189.9	150.7	70.4	24.6	1.0	1.08	3.13	0.00052
8888	6.28447	Oct	53		1.81	0.703	0.537	3.08	96.9	12.7	3.6	109.6	87.3	0.3	2.91	0.02	0.0101
*8917	7.39307	Oct	53		1.92	0.649	0.673	3.17	80.2	13.8	1.9	93.9	96.0		2.00	-0.04	0.089
*8943	9.19222	Oct	53	9	3.37	0.704	0.998	5.74	177.0	195.5	24.6	12.5	108.7		2.20	0.29	0.29
4730	9.19742	Oct	52		1.46	0.314	0.999	1.91	181.8	195.8	8.9	17.6	126.6	0.2	1.21	-0.55	0.29
4728	9.19792	Oct	52		2.50	0.773	0.568	4.43	269.4	195.8	2.1	105.2	91.1	0.2	1.53	0.29	0.0110
8952	9.24410	Oct	53		1.73	0.791	0.363	3.10	296.3	195.6	5.4	131.9	78.1	0.3	3.19	0.17	0.0094
8954	9.24725	Oct	53	2a	1.45	0.813	0.272	2.64	128.5	15.6	7.5	144.1	72.2	0.2	3.89	0.15	0.0101
*8976	9.31647	Oct	53		19.4	0.949	0.998	37.9	177.0	195.7	104.0	12.7	45.3		0.30	1.87	0.0029
8998	10.21343	Oct	53		2.18	0.929	0.155	4.20	319.0	196.6	4.7	155.5	68.4	0.1	1.67	0.77	0.033
9020	10.31215	Oct	53		2.39	0.700	0.717	4.06	71.6	16.6	7.5	88.3	99.9	0.4	7.04	0.13	0.0105
4750	12.33141	Oct	52		5.49	0.818	0.998	9.98	179.5	198.9	72.1	18.4	65.4	0.2	0.68	0.74	0.00193
9046	12.33162	Oct	53		10.7	0.974	0.279	21.1	297.4	198.6	95.3	136.0	52.7	0.3	7.63	1.91	0.00148
4774	13.27778	Oct	52		2.38	0.787	0.507	4.26	276.7	199.8	8.1	116.6	86.8	0.3	5.48	0.30	0.0097
4772	13.28086	Oct	52	2a	1.85	0.840	0.296	3.40	122.7	19.8	5.9	142.6	75.2	0.4	2.97	0.33	0.0033
4795	14.26667	Oct	52		0.944	0.373	0.592	1.30	119.8	20.8	3.9	140.6	74.7	0.7	4.45	-0.68	0.0086
4817	14.34938	Oct	52		7.18	0.929	0.509	13.9	90.9	20.9	29.8	111.8	83.2	0.2	11.9	1.29	0.0119
4819	14.35000	Oct	52	2a	1.47	0.844	0.229	2.70	133.2	20.9	6.2	154.1	70.1	0.3	2.98	0.24	0.0063
4821	14.35291	Oct	52		1.85	0.625	0.694	3.01	257.9	200.9	25.9	98.8	87.2	0.3	15.9	-0.10	0.0102
4842	16.21458	Oct	52		2.61	0.670	0.862	4.36	48.5	22.7	2.6	71.3	117.0	0.4	2.72	0.12	0.033
4864	16.33880	Oct	52		47.6	0.981	0.910	94.2	34.5	22.9	172.6	57.4	11.4	0.2	0.14	2.69	0.00189
4866	16.33975	Oct	52	17	2.26	0.912	0.199	4.32	312.7	202.9	3.4	155.6	71.1	0.1	1.37	0.69	0.0170
9082	16.42579	Oct	53		22.9	0.965	0.797	45.0	233.6	202.7	173.3	76.3	16.4	0.5	0.20	2.11	0.00060
4889	17.40034	Oct	52		10.4	0.919	0.842	19.9	227.5	203.9	173.8	71.4	14.1	0.4	0.16	1.39	0.00042
4912	19.26487	Oct	52	2a	1.95	0.806	0.379	3.53	112.8	25.8	4.3	138.6	79.7	0.1	2.50	0.26	0.0095
4932	19.38057	Oct	52		33.8	0.971	0.988	66.7	169.6	205.9	59.8	15.5	76.1	0.1	2.16	2.36	0.0035
4934	19.38343	Oct	52	17	1.44	0.782	0.314	2.57	304.0	205.9	5.0	149.9	74.2	0.1	2.96	0.07	0.0134
9097	19.42117	Oct	53	8	3.53	0.843	0.553	6.50	88.4	25.7	163.6	114.1	24.6	0.8	0.83	0.62	0.00044
4952	19.44228	Oct	52		0.952	0.120	0.838	1.07	118.7	26.0	2.7	144.7	73.1	0.2	0.93	-0.92	0.134
4954	19.44444	Oct	52		1.04	0.840	0.167	1.92	145.5	26.0	31.9	171.4	60.1	0.3	12.2	0.08	0.0055
4950	19.44602	Oct	52		3.14	0.683	0.996	5.28	178.3	206.0	77.4	24.3	60.4	0.2	0.81	0.22	0.0073
*4974	21.27695	Oct	52		57.2	0.988	0.664	114.	70.7	27.8	145.1	98.5	28.6		1.52	2.99	0.0102
4994	21.32905	Oct	52		6.50	0.942	0.375	12.6	106.5	27.8	42.6	134.3	73.4	0.4	11.6	1.34	0.00190
4996	21.32940	Oct	52		1.75	0.558	0.775	2.73	67.6	27.8	8.0	95.4	101.3	0.2	8.83	-0.21	0.0152
5015	21.37795	Oct	52	8	13.9	0.958	0.589	27.2	80.5	27.9	165.1	108.3	24.8	0.4	0.71	1.81	0.00054
5039	21.43514	Oct	52	8	14.5	0.959	0.599	28.4	79.3	27.9	164.0	107.2	24.7	0.4	0.76	1.84	0.00163
*5063	22.26372	Oct	52		26.8	0.971	0.773	52.8	236.8	208.8	173.0	85.6	17.3		0.22	2.26	0.0030
5080	22.33227	Oct	52		8.26	0.907	0.766	15.8	238.9	208.8	154.9	87.7	21.8	0.3	0.84	1.23	0.00052

Table 1. — Orbital Elements of a Random Sample of Meteors (continued)

Trail No.	Day	Mo.	Yr.	Sh. No.	a	e	q	q'	ω	Ω	i	π	λ	ΔV_∞	C.W.	K	m_∞
5102	22.40394	Oct	52	8	30.3	0.981	0.567	60.1	82.5	28.9	164.8	111.4	25.8	2.6	0.76	2.51	0.00171
*5124	22.47095	Oct	52	2a	2.76	0.829	0.473	5.05	99.1	29.0	5.3	128.1	86.0		3.50	0.47	0.12
5145	23.32858	Oct	52	8	22.2	0.974	0.580	43.8	81.0	29.8	165.4	110.9	25.2	0.2	0.71	2.22	0.0117
5163	23.37987	Oct	52	8	-7.11	1.081	0.574		79.3	29.9	165.2	109.2	26.6	0.7	0.73		0.0027
5165	23.38440	Oct	52	8	22.8	0.975	0.578	45.0	81.2	29.9	166.9	111.1	25.0	0.4	0.64	2.25	0.00092
5183	23.45296	Oct	52	8	-110.	1.005	0.590		79.2	29.9	164.0	109.1	25.5	0.5	0.78		0.00086
5185	23.45794	Oct	52	8	10.2	0.950	0.511	19.8	89.8	29.9	165.7	119.8	27.0	0.3	0.79	1.60	0.0022
5204	23.49206	Oct	52		1.41	0.664	0.474	2.35	251.8	30.0	156.1	281.8	23.2	0.5	1.26	-0.16	0.00146
5206	23.49348	Oct	52		6.78	0.874	0.852	12.7	226.2	210.0	129.8	76.2	31.3	0.2	1.45	1.00	0.0060
5208	23.49375	Oct	52	8	16.8	0.967	0.557	33.1	83.9	30.0	163.7	113.9	26.1	0.5	0.84	2.00	0.00076
5210	23.49586	Oct	52	8	-112.	1.005	0.596		78.4	30.0	164.5	108.4	25.2	0.6	0.75		0.00060
*5231	24.27733	Oct	52		22.8	0.973	0.609	44.9	257.6	210.8	158.0	108.4	25.8		1.02	2.22	0.0075
5250	24.35000	Oct	52		2.48	0.707	0.726	4.23	69.6	30.8	4.1	100.4	101.7	0.2	4.15	0.16	0.0116
5270	24.42292	Oct	52		1.08	0.901	0.108	2.06	331.8	210.9	37.6	182.8	57.1	0.5	11.5	0.32	0.0039
5268	24.42326	Oct	52	8	18.2	0.972	0.508	35.8	89.5	30.9	165.7	120.4	27.4	0.9	0.79	2.11	0.00072
5298	27.35625	Oct	52	2a	1.79	0.869	0.235	3.35	129.9	33.8	9.9	163.8	71.6	0.5	4.42	0.41	0.0035
5296	27.35799	Oct	52	17	2.40	0.856	0.344	4.45	294.6	213.8	3.0	148.4	79.0	0.5	1.58	0.49	0.0054
5294	27.36228	Oct	52		10.4	0.918	0.854	19.9	225.1	213.8	85.5	78.9	57.0	0.2	3.93	1.38	0.0028
5315	27.48226	Oct	52		4.77	0.799	0.958	8.58	203.1	214.0	110.0	57.1	41.0	0.3	1.19	0.63	0.0024
9114	31.24399	Oct	53		1.18	0.347	0.773	1.59	261.9	217.5	2.0	119.4	94.3	0.4	2.40	-0.61	0.043
9162	2.35675	Nov	53		6.87	0.872	0.882	12.9	220.5	219.6	69.2	80.0	67.2	0.3	5.13	1.00	0.00109
9164	2.36021	Nov	53		2.13	0.900	0.213	4.06	131.1	39.6	7.0	170.7	71.4	0.3	2.85	0.61	0.0055
9182	3.29681	Nov	53	17	1.97	0.800	0.394	3.55	290.9	220.5	3.6	151.4	80.4	0.3	2.13	0.25	0.0054
9208	6.33041	Nov	53		3.06	0.704	0.906	5.22	37.7	43.6	7.0	81.2	123.5	0.1	7.07	0.25	0.168
5337	7.10870	Nov	52	28	2.59	0.708	0.758	4.43	244.3	224.6	8.4	108.9	103.3	0.2	7.57	0.18	0.062
*9252	7.46139	Nov	53	28	2.29	0.679	0.735	3.85	248.8	224.7	0.0	113.5	102.5		0.02	0.08	0.050
9272	9.27016	Nov	53		2.73	0.795	0.559	4.90	89.1	46.5	64.6	135.6	64.9	1.0	9.65	0.38	0.0059
9311	11.44044	Nov	53		8.87	0.968	0.284	17.5	296.7	228.7	57.1	165.4	66.0	0.3	11.0	1.74	0.0087
5373	12.19033	Nov	52		3.41	0.717	0.964	5.85	200.4	229.7	7.6	70.1	138.6	0.1	5.69	0.32	0.076
5375	12.19349	Nov	52		2.46	0.605	0.969	3.94	199.0	229.7	6.9	68.7	139.3	1.0	5.07	0.00	0.065
5371	12.19596	Nov	52	17	2.25	0.839	0.361	4.13	293.1	229.7	3.1	162.8	79.4	0.2	1.60	0.41	0.0178
5396	12.26391	Nov	52		3.42	0.719	0.963	5.89	200.8	229.8	7.4	70.6	138.5	0.4	5.84	0.32	0.061
5417	12.37045	Nov	52	17	2.35	0.836	0.386	4.32	289.9	229.9	2.3	159.7	80.8	0.1	1.28	0.42	0.023
5419	12.37333	Nov	52	17	1.98	0.855	0.288	3.68	302.6	229.9	5.3	172.5	75.0	0.5	2.60	0.40	0.0080
9323	13.24583	Nov	53		2.02	0.577	0.853	3.18	51.5	50.5	3.8	102.0	113.2	1.4	4.31	-0.12	0.072
9346	13.41988	Nov	53		26.9	0.989	0.292	53.5	114.6	50.7	138.1	165.3	39.5	0.6	3.30	2.69	0.0041
5439	15.41654	Nov	52		6.93	0.927	0.508	13.4	90.6	53.0	26.6	143.6	84.2	0.1	11.6	1.26	0.0115
9362	16.41339	Nov	53		1.81	0.941	0.107	3.51	327.2	223.7	20.5	200.9	63.3	0.3	6.29	0.77	0.0063
5463	18.50424	Nov	52		4.85	0.814	0.902	8.80	143.7	236.1	103.1	19.7	45.1	0.2	2.09	0.68	0.00088
5485	20.33769	Nov	52		3.52	0.981	0.068	6.98	331.7	237.9	113.4	209.6	48.9	0.3	7.48	1.56	0.00059

Table 1. — Orbital Elements of a Random Sample of Meteors (concluded)

Trail No.	Day	Mo.	Yr.	Sh. No.	a	e	q	q'	ω	Ω	i	π	λ	ΔV_∞	C.W.	K	m_∞
5505	21.37387	Nov	52		5.67	0.831	0.960	10.4	20.1	59.0	162.8	79.1	11.3	0.9	0.21	0.79	0.00041
9385	4.35998	Dec	53		2.74	0.836	0.449	5.04	101.3	71.9	4.0	173.1	84.4	0.4	2.38	0.49	0.026
9406	4.43333	Dec	53		5.31	0.872	0.679	9.94	70.6	71.9	19.6	142.6	94.8	0.3	12.2	0.89	0.047
9430	8.31711	Dec	53		2.32	0.744	0.592	4.04	86.3	75.9	5.2	162.2	91.3	0.6	4.14	0.20	0.0161
5552	9.26560	Dec	52		2.60	0.682	0.824	4.37	233.2	257.1	2.1	130.3	111.7	0.2	2.25	0.14	0.037
5554	9.26872	Dec	52		2.68	0.666	0.894	4.46	39.7	77.1	3.5	116.8	122.7	0.1	3.80	0.13	0.060
9452	9.40208	Dec	53		4.36	0.947	0.229	8.48	125.2	77.0	128.2	202.2	41.8	1.0	4.50	1.21	0.0062
5573	10.22380	Dec	52		1.81	0.528	0.853	2.76	232.3	258.1	1.6	130.4	112.0	0.2	1.88	-0.23	0.040
9475	10.51604	Dec	53	19	20.2	0.992	0.171	40.1	131.3	78.1	39.8	209.4	67.5	0.3	9.35	2.67	0.0045
5596	11.18502	Dec	52		1.96	0.813	0.367	3.55	293.5	259.0	35.4	192.6	71.9	0.2	12.3	0.28	0.0036
5614	11.25625	Dec	52	4	1.35	0.893	0.144	2.56	324.0	259.1	24.1	223.1	62.9	0.3	8.03	0.38	0.0039
9495	11.32126	Dec	53		1.08	0.310	0.744	1.41	91.8	78.9	2.7	170.8	87.8	0.3	3.17	-0.69	0.050
9519	12.29396	Dec	53		4.91	0.944	0.276	9.54	298.8	259.9	8.3	198.8	76.4	0.3	3.18	1.23	0.0071
9540	12.34620	Dec	53	4	1.28	0.889	0.142	2.43	324.9	260.0	23.7	224.8	62.4	0.3	8.18	0.34	0.0047
9561	12.40883	Dec	53		3.04	0.677	0.982	5.10	186.5	260.0	76.0	86.5	61.1	0.2	1.64	0.20	0.0053
9587	12.49241	Dec	53	4	1.34	0.896	0.139	2.54	324.8	260.1	23.1	224.9	62.7	0.3	8.09	0.39	0.0054
9608	13.31502	Dec	53	4	1.31	0.893	0.140	2.48	324.9	261.0	24.1	225.9	62.4	0.2	8.15	0.36	0.0044
*9631	13.36370	Dec	53	4	1.38	0.897	0.142	2.62	324.0	261.0	23.5	225.0	63.0		8.00	0.40	0.026
9657	13.43578	Dec	53	4	1.44	0.900	0.144	2.74	323.4	261.1	24.4	224.4	62.4	1.0	8.25	0.44	0.0131
9682	13.46534	Dec	53	4	1.32	0.891	0.144	2.49	324.3	261.1	23.0	225.5	62.8	0.3	8.17	0.36	0.0029
9702	13.50766	Dec	53		34.3	0.987	0.439	68.2	96.6	81.2	111.1	177.8	45.5	0.4	4.87	2.73	0.00126
5943	14.15038	Dec	52	4	1.37	0.898	0.140	2.60	324.3	261.1	23.3	226.4	62.9	0.1	7.63	0.41	0.0158
5958	14.25344	Dec	52	4	1.34	0.893	0.144	2.54	324.2	262.2	23.2	226.3	62.8	0.1	7.80	0.37	0.058
5962	14.25625	Dec	52		1.31	0.252	0.983	1.65	186.7	262.2	2.2	88.8	156.6	0.9	0.74	-0.66	0.054
5964	14.25988	Dec	52	4	1.47	0.903	0.143	2.80	323.3	262.2	23.3	225.5	63.6	0.2	7.59	0.46	0.0029
9726	14.37933	Dec	53	4	1.42	0.898	0.145	2.70	323.4	262.0	23.6	225.4	63.4	0.2	7.98	0.42	0.0066
*9749	14.40912	Dec	53	4	1.39	0.897	0.143	2.64	323.8	262.1	23.5	225.9	63.2		8.00	0.41	0.25
5991	14.44600	Dec	52	4	1.39	0.896	0.144	2.64	323.7	262.4	23.3	226.1	63.2	0.1	8.07	0.41	0.0065
9771	14.47656	Dec	53	4	1.49	0.905	0.142	2.84	323.3	262.1	20.5	225.4	64.0	0.4	7.13	0.48	0.0036
6007	14.51304	Dec	52		8.33	0.888	0.931	15.7	207.8	262.4	165.3	110.2	11.4	0.3	0.24	1.15	0.0055
6011	14.51538	Dec	52		14.6	0.973	0.397	28.7	282.1	262.4	134.9	184.6	37.3	0.5	3.07	2.02	0.00022
6013	14.51668	Dec	52	4	1.43	0.900	0.143	2.71	323.5	262.4	23.0	226.0	63.4	0.2	8.00	0.43	0.0054
6017	14.51848	Dec	52	4	1.30	0.897	0.133	2.46	325.9	262.4	23.4	228.4	62.0	1.3	8.16	0.38	0.0069
9794	15.49848	Dec	53		7.99	0.889	0.888	15.1	142.5	263.2	127.3	45.6	31.8	0.5	1.27	1.13	0.00073
6029	16.50693	Dec	52		2.72	0.833	0.453	4.98	100.8	84.5	126.1	185.3	37.0	0.4	3.49	0.47	0.00041
6052	20.44578	Dec	52		2.07	0.813	0.388	3.76	290.5	268.5	4.3	199.0	79.8	0.2	2.53	0.30	0.0096
9824	27.20060	Dec	53		2.21	0.772	0.503	3.91	97.0	95.1	12.0	192.0	84.8	0.2	7.30	0.23	0.034
9845	30.36336	Dec	53		2.01	0.827	0.346	3.67	295.5	278.3	4.2	213.8	77.1	0.6	2.22	0.33	0.0052
9866	31.33958	Dec	53		1.20	0.386	0.739	1.67	263.7	279.3	14.8	183.0	87.3	0.4	13.8	-0.57	0.061

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