

STUDIES ON THE COMETARY SYSTEM OF COMET PONS—WINNECKE

PART I

THE SECULAR PERTURBATIONS OF THE ORBIT OF COMET PONS—WINNECKE

For the investigation of the motion of Comet Pons—Winnecke and the meteor stream associated with it I considered it necessary to compute the secular perturbations produced by eight major planets. For this purpose Hill's modification of the Gaussian method of treating the secular inequalities was applied (The Collected Mathematical Works of G. W. Hill, Volume II, 1906). The computation of the perturbations by Mercury, Venus, the earth, Mars, and Saturn was carried out in the points separated by 15 degrees of eccentric anomaly from each other; the perturbations due to Uranus and Neptune were determined in the points separated by 30 and 45 degrees, respectively. In the case of Jupiter, however, an interval of 10 degrees was chosen which would have to be made even narrower in the region of the maximum perturbing action. Nevertheless, as far as chiefly tentative calculations were intended, the results have not been further improved. In general it appears that the derivation of secular perturbations of the short-periodic orbits which, moreover, are nearly commensurable with the perturbing planet, has not the same significance as in the case of the orbits of a longer and incommensurable period of revolution. The reason is that the orbits of the former type may become considerably altered by repeated close approaches to the planet in a similar configuration. A detailed discussion of this problem will appear in the sections of the present study to follow.

The notation used in the present study corresponds to that introduced by Hill in his description of the method quoted above.

Elements of the comet Pons—Winnecke:
The elements used in this computations according v. Haerdtel are:

$$\begin{aligned} T &= 1898 \text{ III. } 20, 497 \\ \omega &= 173^\circ 21' 27'' \\ \Omega &= 100^\circ 53' 11'' \\ i &= 16^\circ 59' 34'' \end{aligned} \left. \vphantom{\begin{aligned} T \\ \omega \\ \Omega \\ i \end{aligned}} \right\} 1900,0$$

$$\begin{aligned} \log q &= 9.965738 \\ U &= 5.83060 \\ \log e &= 9.85413 \\ \log a &= 0.51047 \\ n &= 222 \ 275.079'' \text{ per annum.} \end{aligned}$$

Therefore the numerical coefficients in the final integrals are:

$$\left[\frac{de}{dt} \right]_{00} = 155 \ 464.302'' \cdot m' \cdot M_E [R_0 \sin v + S_0 (\cos v + \cos E)]$$

$$\left[\frac{d\chi}{dt} \right]_{00} = 217 \ 517.773'' \cdot m' \cdot M_E \left[-R \cos v + S_0 \left(\frac{1}{a \cos^2 \varphi} + 1 \right) \sin v \right]$$

$$\left[\frac{dj}{dj} \right]_{00} = 317 \ 797.794'' \cdot m' \cdot M_E [W_0 \cos u]$$

$$\left[\frac{d\Omega}{dt} \right]_{00} = 1 \ 087 \ 413.880'' \cdot m' \cdot M_E [W_0 \sin u]$$

$$\left[\frac{d\pi}{dt} \right]_{00} = \left[\frac{dx}{dt} \right]_{00} + 0.043658 \left[\frac{d\Omega}{dt} \right]_{00}$$

$$\left[\frac{dL}{dt} \right]_{00} = 222 \ 275.079'' M_E \left[-2 \frac{r}{a} R_0 \right]$$

$$+ 0.300579 \left[\frac{d\chi}{dt} \right]_{00} + 0.043658 \left[\frac{d\Omega}{dt} \right]_{00}$$

Secular perturbations by the planet Mercury:
Elements of Mercury's orbit:

$n' = 14732''4197$
 $e' = 0.205615$
 $\pi' = 75^\circ 53' 50''$
 $i' = 7^\circ 00' 11''$
 $\Omega' = 47^\circ 08' 41''$
 $\log a' = 9.587821$
 $T = 87^1.969256$
 $m' = 1/8\ 000\ 000$

Constants for the determination of secular perturbations:

$I = 14^\circ 00' 13''$
 $\Pi = 329^\circ 23' 10''$ $K = 196^\circ 38' 45''$
 $\Pi' = 131^\circ 52' 48''$ $K' = 198^\circ 21' 49''$
 $\log k = 9.99284$ $\log \pi = 7.64607$
 $\log k' = 9.99436$ $\log \eta = 8.46621$
 $\log C = 7.80174$ $\log \lambda = 7.35262$
 $\log \alpha = 9.15688$ $\log \varrho = 9.19474$
 $\log \beta = 8.76757$ $\log \sigma = 9.17564$
 $\log \gamma = 8.89371$ $\log \tau = 9.58066$
 $\log \delta = 7.62342$ $\log \nu = 8.48869$
 $\log \mu = 8.01709$ $\log \psi = 9.57270$

The following tables contain the principal values of the computation.

In fine the following values of perturbations due to Mercury result:

A) as function of m'

$$\left[\frac{de}{dt} \right]_{00} = -3\ 148''735\ m'$$

$$\left[\frac{d\chi}{dt} \right]_{00} = +8\ 306''188\ m'$$

$$\left[\frac{di}{dt} \right]_{00} = +2\ 263''912\ m'$$

$$\left[\frac{d\Omega}{dt} \right]_{00} = -9\ 367''162\ m'$$

$$\left[\frac{d\pi}{dt} \right]_{00} = +8\ 306''188\ m' - 408''951\ m'$$

$$\left[\frac{dL}{dt} \right]_{00} = -456\ 077''066\ m' - 408''951\ m' + 2\ 496''666\ m'$$

B) with the value $m' = 1/8\ 000\ 000$

$$\left[\frac{de}{dt} \right]_{00} = -0''000394$$

$$\left[\frac{d\chi}{dt} \right]_{00} = +0''001038$$

$$\left[\frac{di}{dt} \right]_{00} = +0''000283$$

$$\left[\frac{d\Omega}{dt} \right]_{00} = -0''001171$$

$$\left[\frac{d\pi}{dt} \right]_{00} = +0''001038 - 0''000051 = +0''000987$$

$$\left[\frac{dL}{dt} \right]_{00} = -0''057010 - 0''000051 + 0''000312 = -0''056749$$

Secular perturbations by the planet Mercury

<i>E</i>	<i>A</i>	<i>B</i> ²	<i>g</i>	<i>h</i>	<i>l</i>	<i>G</i>	<i>G'</i>	<i>G''</i>	Θ	log <i>K</i>	log <i>L</i>
0	0.865	0.1057	0.00007	0.7196	0.1392	0.719	0.140	0.001	26.238	0.07180	0.36761
15	1.060	0.1332	0.00058	0.9157	0.1381	0.915	0.143	0.004	23.635	0.05770	0.34920
30	1.651	0.2119	0.00133	1.5111	0.1333	1.510	0.140	0.006	18.107	0.03329	0.31715
45	2.793	0.3659	0.00202	2.6553	0.1311	2.655	0.137	0.005	13.382	0.01799	0.29692
60	4.676	0.6259	0.00238	4.5385	0.1314	4.538	0.135	0.004	10.087	0.01017	0.28653
75	7.440	1.0164	0.00230	7.3011	0.1329	7.301	0.135	0.002	7.890	0.00620	0.28126
90	11.093	1.5424	0.00178	10.9520	0.1344	10.952	0.136	0.001	6.416	0.00409	0.27846
105	15.457	2.1806	0.00104	15.3145	0.1360	15.314	0.136	0.000	5.426	0.00292	0.27690
120	20.163	2.8779	0.00034	20.0190	0.1374	20.019	0.137	0.000	4.756	0.00225	0.27600
135	24.694	3.5571	0.00000	24.5488	0.1385	24.549	0.138	0.000	4.309	0.00184	0.27546
150	28.473	4.1308	0.00025	28.3273	0.1394	28.327	0.139	0.000	4.025	0.00161	0.27513
165	30.978	4.5179	0.00118	30.8311	0.1401	30.831	0.140	0.000	3.874	0.00149	0.27499
180	31.837	4.6602	0.00271	31.6904	0.1407	31.690	0.141	0.000	3.837	0.00146	0.27495
195	30.925	4.5355	0.00456	30.7776	0.1410	30.778	0.142	0.001	3.909	0.00152	0.27502
210	28.372	4.1620	0.00640	28.2242	0.1410	28.224	0.143	0.002	4.098	0.00156	0.27521
225	24.550	3.5946	0.00782	24.4027	0.1409	24.403	0.143	0.002	4.426	0.00194	0.27559
240	19.987	2.9129	0.00852	19.8399	0.1404	19.840	0.143	0.003	4.927	0.00241	0.27621
255	15.260	2.2064	0.00834	15.1145	0.1396	15.114	0.144	0.004	5.667	0.00319	0.27725
270	10.889	1.5539	0.00732	10.7450	0.1387	10.745	0.143	0.005	6.731	0.00451	0.27901
285	7.244	1.0129	0.00570	7.1015	0.1361	7.101	0.142	0.006	8.284	0.00684	0.28211
300	4.500	0.6105	0.00383	4.3604	0.1334	4.360	0.140	0.006	10.543	0.01111	0.28779
315	2.649	0.3447	0.00206	2.5123	0.1305	2.512	0.137	0.006	13.780	0.01909	0.29838
330	1.549	0.1922	0.00070	1.4137	0.1290	1.413	0.133	0.004	18.105	0.03329	0.31714
345	1.008	0.1215	0.00008	0.8687	0.1325	0.869	0.133	0.001	23.122	0.05512	0.34583

Secular perturbations by the planet Mercury

E	$\log M$	$\log N$	$\log P$	$\log Q$	$\log V$	$\log J_1$	$\log J_2$	$\log J_3$	$\log F_2$	$\log F_3$
0	0.28216	0.72762	1.37839	1.15236	1.15185	9.15229	8.20534 _n	7.93832 _n	7.50297 _n	6.29000 _n
15	0.26158	0.62564	1.04793	0.92377	0.92122	9.16982	8.79930 _n	7.54593 _n	7.94897 _n	6.83495 _n
30	0.22568	0.45529	0.41063	0.50007	0.49784	9.16702	8.95407 _n	6.90363	8.12867 _n	7.01454 _n
45	0.20298	0.30060	9.74758	0.07861	0.06150	9.15442	9.09078 _n	7.49248	8.21869 _n	7.00529 _n
60	0.19131	0.17161	9.14358	9.70564	9.70518	9.14395	9.12437 _n	7.31471	8.25458 _n	6.74373 _n
75	0.18538	0.06467	8.61890	9.38654	9.38635	9.13815	9.11576 _n	7.53694 _n	8.24622 _n	6.32713
90	0.18223	9.97619	8.17557	9.11888	9.11879	9.13624	9.06419 _n	8.14333 _n	8.19148 _n	7.00152
105	0.18048	9.90408	7.81075	8.89945	8.89940	9.13672	8.99542 _n	8.46141 _n	8.07374	7.16417
120	0.17946	9.84880	7.52234	8.72703	8.72700	9.13893	8.74115 _n	8.67374 _n	7.83328	7.09760
135	0.17885	9.80350	7.29890	8.59232	8.59229	9.14176	8.10534 _n	8.82303 _n	6.88068	6.26513
150	0.17850	9.77316	7.14388	8.49946	8.49941	9.14489	8.53224	8.92678 _n	7.76974 _n	7.23935
165	0.17832	9.75536	7.05236	8.44469	8.44467	9.14860	8.96445	8.99407 _n	8.10286 _n	7.63143
180	0.17828	9.74884	7.02192	8.42619	8.42619	9.15214	9.10807	9.02875 _n	8.28194 _n	7.84783
195	0.17836	9.75651	7.05504	8.44663	8.44669	9.15550	9.22881	9.03800 _n	8.39528 _n	7.97928
210	0.17859	9.77547	7.14939	8.50341	8.50338	9.15927	9.30599	9.02023 _n	8.46840 _n	8.05238
225	0.17901	9.80742	7.30806	8.59895	8.59884	9.16256	9.35238	8.97870 _n	8.51191 _n	8.07773
240	0.17971	9.85281	7.53381	8.73491	8.73488	9.16570	9.37296	8.91543 _n	8.53050 _n	8.05896
255	0.18088	9.91278	7.83103	8.91416	8.91399	9.17820	9.36974	8.83323 _n	8.52614 _n	7.99560
270	0.18285	9.98883	8.20506	9.14029	9.14005	9.17056	9.34228	8.73617 _n	8.49826 _n	7.88248
285	0.18634	0.08305	8.66179	9.41770	9.41727	9.16895	9.28787	8.62966 _n	8.44415 _n	7.70814
300	0.19272	0.19826	9.20579	9.75085	9.75006	9.16524	9.20043	8.51938 _n	8.35727 _n	7.55616
315	0.20462	0.33746	9.83372	0.14102	0.13973	9.15655	9.06064	8.40784 _n	8.22312 _n	7.03232
330	0.22567	0.49958	0.51398	0.57389	0.57148	9.14285	8.86888	8.28959 _n	8.00306 _n	7.08001
345	0.25781	0.65949	1.12698	0.97814	0.87771	9.13719	8.45969	8.14657 _n	7.51630 _n	6.00664

Secular perturbations by the planet Mercury

E	$\log R_0$	$\log S_0$	$\log W_0$	I + II	III + IV	$W_0 \cos u$	$W_0 \sin u$	$-2 \cdot r \cdot R_0/a$
0	0.72555 _n	9.18041 _n	9.07342 _n	-0.3030	+5.3156	+0.11762	-0.01370	+3.03287
15	0.62249 _n	9.62956 _n	8.34576 _n	-3.2085	+2.9947	+0.01936	+0.01079	+2.59645
30	0.45242 _n	9.39525 _n	7.71433	-2.9150	+0.7198	-0.00259	-0.00448	+2.15986
45	0.28319 _n	9.12414 _n	7.61542	-2.0869	-0.3083	-0.00042	-0.00429	+1.97018
60	0.17105 _n	8.81318 _n	7.05115	-1.4083	-0.6372	+0.00025	-0.00111	+1.90574
75	0.06448 _n	8.49206 _n	6.93450 _n	-0.9523	-0.7175	-0.00038	+0.00077	+1.89097
90	9.97612 _n	8.17638 _n	7.29667 _n	-0.6513	-0.7084	-0.00124	+0.00154	+1.89300
105	9.90406 _n	7.85095 _n	7.36361 _n	-0.4494	-0.6726	-0.00173	+0.00153	+1.90022
120	9.84879 _n	7.46464 _n	7.40226 _n	-0.3110	-0.6367	-0.00211	+0.00138	+1.91655
135	9.80349 _n	6.69897 _n	7.41497 _n	-0.2082	-0.6014	-0.00234	+0.00113	+1.91500
150	9.77317 _n	7.02530	7.42488 _n	-0.1801	-0.5782	-0.00251	+0.00087	+1.92058
165	9.75536 _n	7.40654	7.43854 _n	-0.0660	-0.5648	-0.00267	+0.00060	+1.92473
180	9.74882 _n	7.53148	7.45408 _n	-0.0068	-0.5608	-0.00282	+0.00033	+1.92328
195	9.75649 _n	7.67256	7.48287 _n	+0.0519	-0.5698	-0.00304	+0.00002	+1.92976
210	9.77543 _n	7.80686	7.52179 _n	+0.1170	-0.5882	-0.00331	-0.00034	+1.93061
225	9.80737 _n	7.94817	7.57345 _n	+0.1962	-0.6180	-0.00368	-0.00081	+1.93218
240	9.85272 _n	8.10397	7.64640 _n	+0.3002	-0.6589	-0.00416	-0.00150	+1.93394
255	9.91247 _n	8.27852	7.74155 _n	+0.4455	-0.7086	-0.00487	-0.00260	+1.93739
270	9.98852 _n	8.47516	7.86864 _n	+0.6598	-0.7596	-0.00584	-0.00452	+1.94780
285	0.08257 _n	8.69416	8.03782 _n	+0.9876	-0.7858	-0.00711	-0.00827	+1.97138
300	0.19732 _n	8.93288	8.25888 _n	+1.4988	-0.7131	-0.00800	-0.01629	+2.02456
315	0.33577 _n	9.16799	9.53845 _n	+2.2682	-0.3294	-0.00452	-0.03425	+2.14328
330	0.49582 _n	9.38532	8.83708 _n	+3.1947	+0.8516	+0.01985	-0.06593	+2.39744
345	0.65617 _n	9.26152	9.01984 _n	+3.0561	+3.4564	+0.09828	-0.08980	+2.80578
				+0.0452	+1.0458	+0.10514	-0.10376	+24.98624
				+0.0343	+0.5748	+0.08688	-0.12517	+24.91733
				+0.0795	+1.6206	+0.19202	-0.22893	+49.90357

Secular perturbations by the planet Venus:
Elements of the Venus orbit:

$$\begin{aligned} n' &= 5767''6698 \\ e' &= 0.00681636 \\ \pi' &= 130^\circ 08' 26'' \\ i' &= 3^\circ 23' 37'' \\ \Omega' &= 75^\circ 47' 17'' \\ \log a' &= 9.85933657 \\ T' &= 224.^\text{d}700805 \\ m' &= 1/410.000 \end{aligned}$$

Constants for the determination of secular perturbations:

$$\begin{aligned} I &= 13^\circ 59' 30'' \\ II &= 347^\circ 23' 48'' & K &= 144^\circ 30' 52'' \\ II' &= 203^\circ 30' 26'' & K' &= 143^\circ 15' 08'' \\ \log k &= 9.99797 & \log \pi &= 6.16666 \text{ n} \\ \log k' &= 9.98906 & \log \eta &= 7.53913 \\ \log C &= 5.38577 & \log \lambda &= 6.42516 \\ \log \alpha &= 9.71865 & \log \varrho &= 7.99188 \\ \log \beta &= 8.76684 & \log \sigma &= 9.71867 \\ \log \gamma &= 7.69085 & \log \tau &= 9.85730 \\ \log \delta &= 8.18446 & \log \nu &= 7.55222 \\ \log \mu &= 8.57852 & \log \psi &= 9.84838 \end{aligned}$$

The following tables contain the principal values of the computation.

In fine the following values of perturbations due to Venus result:

A) as function of m'
B) with the value $m' = 1/410\ 000$

$$\left[\frac{de}{dt} \right]_{00} = +599''0 \text{ m}' = +0.00146''$$

$$\left[\frac{d\chi}{dt} \right]_{00} = +59\ 333''6 \text{ m}' = +0.14472''$$

$$\left[\frac{di}{dt} \right]_{00} = +4538''7 \text{ m}' = +0.01107''$$

$$\left[\frac{d\Omega}{dt} \right]_{00} = -53\ 575''2 \text{ m}' = -0.13067''$$

$$\left[\frac{d\pi}{dt} \right]_{00} = +56\ 994''6 \text{ m}' = +0.13901''$$

$$\left[\frac{dL}{dt} \right]_{00} = +526\ 773''2 \text{ m}' = +1.28480''$$

Secular perturbations by the planet Venus

E	A	B^2	g	$h = G$	$l = G'$	G''	Θ	$\log K$	$\log L$	$\log M$
0	1.370	0.4417	0.00000	0.8503	0.5195	0.0	51.411	0.32530	0.68583	0.63281
15	1.520	0.5165	0.00000	1.0062	0.5133	0.0	45.570	0.24256	0.58442	0.52216
30	2.036	0.7612	0.00000	1.5431	0.4933	0.0	34.430	0.12848	0.44078	0.36367
45	3.082	1.2633	0.00002	2.5948	0.4868	0.0	25.668	0.06856	0.36339	0.27745
60	4.852	2.1339	0.00005	4.3625	0.4891	0.0	19.565	0.03903	0.32470	0.23415
75	7.492	3.4618	0.00008	6.9970	0.4947	0.0	15.421	0.02399	0.30486	0.21200
90	11.023	5.2675	0.00012	10.5222	0.5001	0.0	12.593	0.01591	0.29416	0.19988
105	15.272	7.4722	0.00016	14.7656	0.5060	0.0	10.670	0.01139	0.28815	0.19313
120	19.878	9.8908	0.00018	19.2672	0.5107	0.0	9.370	0.00876	0.28467	0.18921
135	24.332	12.2546	0.00019	23.8174	0.5145	0.0	8.451	0.00712	0.28248	0.18676
150	28.062	14.2569	0.00019	27.5444	0.5176	0.0	7.879	0.00618	0.28124	0.18536
165	30.548	15.6141	0.00017	30.0280	0.5199	0.0	7.560	0.00569	0.28058	0.18462
180	31.422	16.1212	0.00013	30.9002	0.5217	0.0	7.475	0.00556	0.28041	0.18443
195	30.555	15.7008	0.00009	30.0319	0.5228	0.0	7.575	0.00571	0.28061	0.18465
210	28.075	14.4150	0.00006	27.5516	0.5232	0.0	7.920	0.00625	0.28132	0.18545
225	24.350	12.4568	0.00003	23.8273	0.5228	0.0	8.519	0.00723	0.28264	0.18693
240	19.900	10.1040	0.00001	19.3789	0.5214	0.0	9.440	0.00890	0.28485	0.18941
255	15.296	7.6653	0.00000	14.7778	0.5187	0.0	10.799	0.01166	0.28852	0.19354
270	11.049	5.4178	0.00000	10.5343	0.5143	0.0	12.765	0.01635	0.29475	0.20054
285	7.517	3.5592	0.00001	7.0089	0.5078	0.0	15.614	0.02461	0.30568	0.21281
300	4.874	2.1812	0.00002	4.3755	0.4984	0.0	19.725	0.03969	0.32558	0.23512
315	3.100	1.2738	0.00002	2.6123	0.4877	0.0	25.600	0.06818	0.36289	0.27689
330	2.049	0.7535	0.00002	1.5692	0.4802	0.0	33.589	0.12172	0.43213	0.35405
345	1.526	0.5076	0.00001	1.0365	0.4897	0.0	43.424	0.21659	0.55213	0.48671

Secular perturbations by the planet Venus

E	$\log N$	$\log P$	$\log V = \log Q$	$\log J_1$	$\log J_2$	$\log J_3$	$\log F_2$	$\log F_3$
0	9.87290	1.69959	1.57614	9.71744	7.96118	7.87593 _n	7.13016 _n	6.72119 _n
15	0.75167	1.33072	1.27115	9.71825	8.04489 _n	8.17906	5.61758 _n	3.69603 _n
30	0.53922	0.60320	0.71449	9.70156	8.24596 _n	8.58228	7.17601	5.91920
45	0.36737	9.90255	0.23972	9.69360	8.12008 _n	8.77686	7.50094	5.89956
60	0.22678	9.27201	9.82120	9.69288	7.79007 _n	8.79822	7.68601	5.97113
75	0.11038	8.72542	9.47747	9.69606	7.40807 _n	8.97386	7.80865	6.67863 _n
90	0.01417	8.26412	9.19195	9.70042	7.22453 _n	9.01880	7.89275	7.02555 _n
105	9.93636	7.88601	8.96024	9.70469	7.39602 _n	9.03806	7.94866	7.24970 _n
120	9.87833	7.59336	8.78273	9.70843	7.61077 _n	9.03312	7.98152	7.40051 _n
135	9.82747	7.35616	8.63733	9.71155	7.76567 _n	9.00349	7.99383	7.49742 _n
150	9.79599	7.19716	8.54132	9.71406	7.86764 _n	8.94577	7.98645	7.54918 _n
165	9.77678	7.10232	8.48388	9.71602	7.93166 _n	8.85184	7.95889	7.55969 _n
180	9.76941	7.06391	8.46388	9.71744	7.96900 _n	8.70279	7.90909	7.52918 _n
195	9.77671	7.10216	8.48378	9.71833	7.98900 _n	8.44295	7.83271	7.45442 _n
210	9.79591	7.19694	8.54122	9.71865	7.99965 _n	7.65147	7.72114	7.32687 _n
225	9.82831	7.35680	8.63817	9.71832	8.00852 _n	8.24726 _n	7.55540	7.12667 _n
240	9.87771	7.58790	8.77979	9.71718	8.02123 _n	8.57036 _n	7.28074	6.79703 _n
255	9.93609	7.88539	8.96002	9.71502	8.03826 _n	8.72171 _n	6.51216	5.94906 _n
270	0.01386	8.26341	9.19181	9.71155	8.05054 _n	8.80025 _n	7.02124 _n	6.34721
285	0.10987	8.72424	9.47703	9.70650	8.03060 _n	8.83053 _n	7.32704 _n	6.49610
300	0.22551	9.22902	9.81960	9.70005	7.83967 _n	8.82065 _n	7.45050 _n	6.38067
315	0.36261	9.89146	0.22248	9.69395	6.78032 _n	8.76835 _n	7.49096 _n	5.94944
330	0.52155	0.56232	0.67992	9.69343	8.06137	8.66009 _n	7.46705 _n	5.71693
345	0.70636	1.22735	1.17750	9.70422	8.29770	8.45123 _n	7.37063 _n	6.08028

Secular perturbations by the planet Venus

E	$\log R_0$	$\log S_0$	$\log W_0$	I + II	III + IV	$W_0 \cos u$	$W_0 \sin u$	$-2 \cdot r \cdot R_0/a$
0	0 _n 86800	9.44253	0 _n 49070	+0.5541	+7.3790	+0.30745	-0.03580	+4.21015
15	0 _n 73795	9 _n 31789	9.42044	-3.5656	+4.2389	-0.22998	-0.12819	+3.38715
30	0 _n 52646	8 _n 93085	9.29750	-3.1923	+1.1954	-0.09931	-0.17174	+2.56132
45	0 _n 36514	8 _n 29878	9.00784	-2.3319	-0.0756	-0.01022	-0.10131	+2.29353
60	0 _n 22611	7 _n 50215	8.61923	-1.5869	-0.5693	+0.00927	-0.04098	+2.16331
75	0 _n 11015	6 _n 62992	8.45093	-1.0681	-0.7218	+0.01254	-0.02530	+2.10063
90	0 _n 01407	6 _n 07188	8.21024	-0.7224	-0.7385	+0.01021	-0.01261	+2.06586
105	9 _n 93633	6 _n 20140	7.99771	-0.4922	-0.7098	+0.00746	-0.00066	+2.04679
120	9 _n 87832	6 _n 32222	7.81514	-0.3369	-0.6766	+0.00547	-0.00357	+2.05138
135	9 _n 82747	6 _n 36361	7.64008	-0.2204	-0.6352	+0.00393	-0.00190	+2.02368
150	9 _n 79599	6 _n 38202	7.48636	-0.1346	-0.6106	+0.00289	-0.00100	+2.02420
165	9 _n 77678	6 _n 39620	7.33475	-0.0636	-0.5948	+0.00211	-0.00048	+2.02205
180	9 _n 76941	6 _n 41664	7.16554	+0.0005	-0.5880	+0.00145	-0.00017	+2.01667
195	9 _n 77671	6 _n 45939	6.92480	+0.0646	-0.5944	+0.00084	-0.00001	+2.02171
210	9 _n 79591	6 _n 53020	6.18327	+0.1356	-0.6100	+0.00015	+0.00002	+2.02380
225	9 _n 82832	6 _n 63899	6 _n 88705	+0.2220	-0.6355	-0.00075	-0.00017	+2.02764
240	9 _n 87770	6 _n 79553	7 _n 35064	+0.3375	-0.6742	-0.00211	-0.00076	+2.04847
255	9 _n 93609	6 _n 99717	7 _n 68173	+0.4932	-0.7072	-0.00425	-0.00226	+2.04565
270	0 _n 01384	7 _n 24699	7 _n 99189	+0.7233	-0.7341	-0.00776	-0.00601	+2.05478
285	0 _n 10977	7 _n 52257	8 _n 30720	+1.0674	-0.7129	-0.01322	-0.01539	+2.09883
300	0.22502	7 _n 70252	8 _n 63985	+1.5816	-0.5499	-0.01924	-0.03917	+2.15792
315	0 _n 36054	7 _n 53383	8 _n 99053	+2.2911	-0.0284	-0.01281	-0.09700	+2.26909
330	0 _n 51304	8.64757	9 _n 34038	+3.0469	+1.2215	+0.06312	-0.20967	+2.48339
345	0 _n 68478	9.41339	9 _n 63081	+3.2896	+3.6788	+0.31550	-0.28828	+2.99686
				+0.4064	+4.0446	+0.27160	-0.52148	+27.87126
				-0.3139	+2.5020	+0.07116	-0.66096	+27.33360
				+0.0925	+6.5466	+0.34276	-1.18244	+55.20486

Secular perturbations by the planet Earth:
Elements of the Earth orbit:

$$\begin{aligned} n' &= 3548''19283 \\ e' &= 0,0167498 \\ \pi' &= 101^\circ 13' 07'' \\ i' &= 0^\circ 00' 00'' \\ \Omega' &= - \\ \log a' &= 0:00000056 \\ T' &= 365,256361 \\ m' &= 1/331\ 950 \end{aligned}$$

Constants for the determination of secular perturbations are:

$$\begin{aligned} I &= 16^\circ 59' 34'' \\ \Pi &= 353^\circ 21' 27'' & K &= 173^\circ 02' 23'' \\ \Pi' &= 180^\circ 19' 56'' & K' &= 173^\circ 00' 36'' \\ \log k &= 0.00000 & \log \pi &= 4.94261 \\ \log k' &= 9.98062 & \log \eta &= 8.20456 \\ \log C &= 6.44802 & \log \lambda &= 7.17924 \\ \log \alpha &= 9.99988 & \log \varrho &= 8.52504 \\ \log \beta &= 8.93152 & \log \sigma &= 0.00000 \\ \log \gamma &= 8.22401 & \log \tau &= 0.00000 \\ \log \delta &= 8.63037 & \log \nu &= 8.22401 \\ \log \mu &= 8.93578 & \log \psi &= 9.98056 \end{aligned}$$

The following tables contain the principal values of the computation.

In fine the following values of perturbations due to Earth result:

A) as function of m'
B) with the value $m' = 1/331950$

$$\left[\frac{de}{dt} \right]_{00} = +9446''4 \cdot m' = +0.02846''$$

$$\left[\frac{d\lambda}{dt} \right]_{00} = -164\ 143''7 \cdot m' = -0.49448''$$

$$\left[\frac{di}{dt} \right]_{00} = -216''9 \cdot m' = -0.00065''$$

$$\left[\frac{d\Omega}{dt} \right]_{00} = -208\ 100''0 \cdot m' = -0.62690''$$

$$\left[\frac{d\pi}{dt} \right]_{00} = -173\ 228''9 \cdot m' = -0.52185''$$

$$\left[\frac{dL}{dt} \right]_{00} = +337\ 835''0 \cdot m' = +1.01773''$$

Secular perturbations by the planet Earth

E	A	B^2	g	$h = G$	$l = G'$	G''	Θ	$\log K$	$\log L$	$\log M$
0	1.823	0.8226	0.00000	1.0045	0.8184	0.0	64.503	0.60364	1.01302	0.98289
15	1.977	0.9566	0.00006	1.1314	0.8449	0.0	59.812	0.48481	0.87570	0.83719
30	2.503	1.4052	0.00029	1.6524	0.8500	0.0	45.846	0.24488	0.58729	0.52530
45	3.562	2.3443	0.00065	2.6904	0.8710	0.0	34.696	0.13066	0.44358	0.36677
60	5.349	3.9966	0.00106	4.4514	0.8975	0.0	26.692	0.07444	0.37105	0.28600
75	8.011	6.5403	0.00142	7.0884	0.9224	0.0	21.150	0.04582	0.33364	0.24416
90	11.562	10.0188	0.00164	10.6182	0.9432	0.0	17.389	0.03065	0.31366	0.22177
105	15.832	14.2800	0.00168	14.8715	0.9599	0.0	14.760	0.02159	0.30168	0.20832
120	20.457	18.9626	0.00151	19.4841	0.9729	0.0	12.914	0.01674	0.29526	0.20111
135	24.928	23.5414	0.00118	23.9445	0.9829	0.0	11.690	0.01369	0.29121	0.19656
150	28.670	27.4180	0.00078	27.6794	0.9903	0.0	10.904	0.01189	0.28883	0.19389
165	31.163	30.0383	0.00040	30.1676	0.9954	0.0	10.465	0.01095	0.28758	0.19249
180	32.039	31.0047	0.00011	31.0401	0.9986	0.0	10.333	0.01082	0.28740	0.19206
195	31.168	30.1687	0.00000	30.1681	0.9997	0.0	10.490	0.01100	0.28764	0.19256
210	28.679	27.6556	0.00006	27.6800	0.9988	0.0	10.950	0.01200	0.28896	0.19404
225	24.941	23.8450	0.00027	23.9448	0.9956	0.0	11.765	0.01387	0.29145	0.19683
240	20.473	19.2826	0.00055	19.4836	0.9894	0.0	13.025	0.01704	0.29565	0.20155
255	15.849	14.5695	0.00082	14.8696	0.9795	0.0	14.882	0.02232	0.30265	0.20942
270	11.580	10.2437	0.00099	10.6152	0.9647	0.0	17.546	0.03122	0.31441	0.22262
285	8.029	6.6854	0.00102	7.0852	0.9432	0.0	21.436	0.04712	0.33534	0.24606
300	5.365	4.0663	0.00089	4.4617	0.9131	0.0	26.937	0.07588	0.37293	0.28811
315	3.575	2.3588	0.00065	2.7016	0.8728	0.0	34.650	0.13028	0.44309	0.36624
330	2.512	1.3926	0.00036	1.6860	0.8256	0.0	44.433	0.22854	0.56701	0.50306
345	1.981	0.9425	0.00011	1.1887	0.7924	0.0	54.763	0.38227	0.75444	0.70708

Secular perturbations by the planet Earth

E	$\log N$	$\log P$	$\log Q = \log V$	$\log J_1$	$\log J_2$	$\log J_3$	$\log F_2$	$\log F_3$
0	1.04264	2.05172	2.02356	9.99938	8.06781	7.96440	7.23613 _n	6.17362 _n
15	0.91756	1.68610	1.70117	9.99102	8.64748 _n	8.62460 _n	7.86909	6.78635
30	0.61105	0.76211	0.91820	9.97125	8.73881 _n	8.96464 _n	8.21238	6.97798
45	0.40587	9.98977	0.34280	9.96166	8.54679 _n	9.13839 _n	8.38739	6.56847
60	0.24903	9.32304	9.88650	9.96313	8.18991 _n	9.24326 _n	8.49309	7.13423 _n
75	0.12374	8.75625	9.51734	9.96912	7.73239 _n	9.30983 _n	8.55655	7.60040 _n
90	0.02298	8.28453	9.21870	9.97693	6.78888 _n	9.33708 _n	8.58834	7.87214 _n
105	9.94189	7.89885	8.97785	9.98339	6.63347 _n	9.34064 _n	8.59268	8.02667 _n
120	9.87903	7.59492	8.79046	9.98865	7.18327 _n	9.31710 _n	8.57009	8.11080 _n
135	9.83160	7.36440	8.64896	9.99280	7.39967 _n	9.26345 _n	8.51770	8.13481 _n
150	9.79854	7.20306	8.55027	9.99590	7.44871 _n	9.17140 _n	8.42756	8.09730 _n
165	9.77903	7.10752	8.49198	9.99806	7.37383 _n	9.02043 _n	8.28014	7.98236 _n
180	9.77172	7.07527	8.47186	9.99938	7.16732 _n	8.74578 _n	8.01505	7.73147 _n
195	9.77908	7.10764	8.49210	9.99988	6.74819 _n	7.63799 _n	7.09088	6.80399 _n
210	9.79864	7.20338	8.55052	9.99950	6.27875 _n	8.66017	7.88519 _n	7.57732
225	9.83177	7.36480	8.64939	9.99813	6.90309 _n	8.95951	8.19782 _n	7.85013
240	9.87934	7.59565	8.79122	9.99570	7.40569 _n	9.10951	8.35205 _n	7.94327
255	9.94271	7.90076	8.97982	9.99158	7.74036 _n	9.19287	8.43759 _n	7.94192
270	0.02375	8.28630	9.22043	9.98580	7.92221 _n	9.23280	8.47894 _n	7.86217
285	0.12531	8.75990	9.52100	9.97808	7.94473 _n	9.23730	8.48452 _n	7.69474
300	0.25044	9.32630	9.89001	9.96901	7.41162 _n	9.20691	8.45532 _n	7.39278
315	0.40279	9.98260	0.33738	9.96192	8.19057	9.13666	8.38574 _n	6.68226
330	0.58158	0.69485	0.85775	9.96458	8.62839	9.00832	8.25850 _n	6.78441 _n
345	0.78286	1.38726	1.41490	9.98271	8.73175	8.76606	8.01833 _n	6.86253 _n

Secular perturbations by the planet Earth

E	$\log R_0$	$\log S_0$	$\log W_0$	I + II	III + IV	$W_0 \cos u$	$W_0 \sin u$	$-2 \cdot r \cdot R_0/a$
0	0.90251	0.01709	9.99540 _n	+2.0803	-7.9894	+0.98282	-0.11445	-4.55844
15	0.18240 _n	0.27244 _n	0.33188	-4.2178	-0.5530	-1.87554	-1.04540	+0.94251
30	0.52841 _n	9.55587 _n	9.88594	-3.5527	+0.7535	-0.38496	-0.66573	+2.57282
45	0.38902 _n	8.73006 _n	9.48167	-2.4860	-0.1457	-0.03043	-0.30163	+2.42286
60	0.24512 _n	7.72997 _n	9.12882	-1.6583	-0.5992	+0.02998	-0.13249	+2.26017
75	0.12279 _n	6.43136	8.82569	-1.0999	-0.7415	+0.02973	-0.05997	+2.16270
90	0.02265 _n	6.80889	8.55404	-0.7373	-0.7528	+0.02253	-0.02784	+2.10709
105	9.94178 _n	6.42975	8.31672	-0.4989	-0.7180	+0.01555	-0.01371	+2.07264
120	9.87899 _n	5.71600	8.10582	-0.3378	-0.6772	+0.01068	-0.00698	+2.05455
135	9.83158 _n	5.55630 _n	7.91073	-0.2229	-0.6409	+0.00733	-0.00355	+2.04295
150	9.79853 _n	5.74819 _n	7.71999	-0.1357	-0.6140	+0.00496	-0.00122	+2.03604
165	9.77902 _n	5.69020 _n	7.51081	-0.0643	-0.5978	+0.00316	-0.00072	+2.03251
180	9.77173 _n	5.48430 _n	7.21617	+0.0001	-0.5912	+0.00163	-0.00019	+2.02744
195	9.77908 _n	5.20412 _n	6.13033	+0.0644	-0.5978	+0.00014	-0.00000	+2.03278
210	9.79864 _n	5.30103 _n	7.20898 _n	+0.1359	-0.6141	-0.00161	-0.00016	+2.03660
225	9.83177 _n	5.85733 _n	7.60724 _n	+0.2231	-0.6411	-0.00395	-0.00088	+2.04385
240	9.87931 _n	5.33917 _n	7.89889 _n	+0.3383	-0.6777	-0.00745	-0.00269	+2.05607
255	9.94265 _n	6.87099 _n	8.17064 _n	+0.5004	-0.7185	-0.01310	-0.00698	+2.07681
270	0.02354 _n	7.29491 _n	8.45106 _n	+0.7398	-0.7503	-0.02234	-0.01729	+2.11042
285	0.12452 _n	7.67071 _n	8.75475 _n	+1.1056	-0.7348	-0.03704	-0.04312	+2.17131
300	0.24709 _n	7.90607 _n	9.09510 _n	+1.6635	-0.5726	-0.05488	-0.11173	+2.27036
315	0.38650 _n	8.01557	9.47334 _n	+2.4419	-0.0583	-0.03894	-0.29484	+2.40886
330	0.49527 _n	9.33532	9.86837 _n	+3.1442	+0.8888	+0.21260	-0.70624	+2.38379
345	0.21399 _n	0.05960	0.18597 _n	+4.6324	+0.2328	+1.13283	-1.03511	+1.01364
				+1.6802	-12.1964	+0.79396	-1.78701	+19.36230
				-0.2219	-5.9145	-0.81026	-2.80591	+23.42343
				+1.4583	-18.1109	-0.01630	-4.59292	+42.78573

Secular perturbations by the planet Mars
Elements of the Mars orbit:

$$\begin{aligned} n' &= 1886''5183 \\ e' &= 0,09330880 \\ \pi' &= 334^\circ13'6'' \\ i' &= 1^\circ51'1'' \\ \Omega' &= 48^\circ47'12'' \\ \log a' &= 0.18289323 \\ T' &= 868'.97982 \\ m' &= 1/3\ 085\ 000 \end{aligned}$$

Constants for the determination of secular perturbations:

$$\begin{aligned} I &= 15^\circ55'17'' \\ \Pi &= 348^\circ01'42'' & K &= 300^\circ55'26'' \\ \Pi' &= 48^\circ13'13'' & K' &= 298^\circ41'50'' \\ \log k &= 9.99072 & \log \pi &= 7.94683 \\ \log k' &= 9.99262 & \log \eta &= 9.31682 \\ \log C &= 8.30563 & \log \lambda &= 8.25525 \\ \log \alpha &= 0.36199 & \log \varrho &= 9.44456 \\ \log \beta &= 8.87651 & \log \sigma &= 0.36579 \\ \log \gamma &= 9.99072 & \log \tau &= 0.17362 \\ \log \delta &= 8.93747 & \log \nu &= 9.33571 \\ \log \mu &= 9.26644 & \log \psi &= 0.17361 \end{aligned}$$

The following tables contain the principal values of the computation.

In fine the following values of perturbations due to Mars result:

A) as function of m'
B) with the value $m' = 1/3\ 085\ 000$

$$\left[\frac{de}{dt} \right]_{00} = -69\ 999''4 \cdot m' = -0.02268''$$

$$\left[\frac{d\chi}{dt} \right]_{00} = +69\ 114''3 \cdot m' = +0.02240''$$

$$\left[\frac{di}{dt} \right]_{00} = -11\ 554''0 \cdot m' = -0.00374''$$

$$\left[\frac{d\Omega}{dt} \right]_{00} = -225\ 044''4 \cdot m' = -0.07294''$$

$$\left[\frac{d\pi}{dt} \right]_{00} = +60\ 289''3 \cdot m' = +0.01922''$$

$$\left[\frac{dL}{dt} \right]_{00} = +398\ 009''3 \cdot m' = +0.12899''$$

Secular perturbations by the planet Mars

E	A	B^2	g	h	l	G	G'	G''	Θ	$\log K$	$\log L$
0	3.308	2.3081	0.02955	2.3226	0.9649	2.313	0.987	0.013	40.977	0.18949	0.51818
15	3.584	2.9458	0.00840	2.3316	1.2324	2.328	1.239	0.003	46.863	0.25928	0.60509
30	4.186	4.1977	0.00898	2.5570	1.6085	2.553	1.614	0.002	52.695	0.34614	0.71104
45	5.268	6.4431	0.02813	3.3643	1.8835	3.359	1.894	0.004	48.700	0.28453	0.63613
60	7.025	10.1741	0.10835	4.9967	2.0078	4.989	2.026	0.011	39.659	0.17592	0.50109
75	9.604	15.7990	0.24754	7.5039	2.0796	7.498	2.101	0.016	32.058	0.11000	0.41708
90	13.057	23.4360	0.43737	10.9169	2.1202	10.912	2.144	0.019	26.409	0.07278	0.36889
105	17.129	32.7721	0.65518	14.9378	2.1707	14.934	2.194	0.020	22.630	0.05271	0.34267
120	21.562	43.0144	0.86776	19.3399	2.2016	19.337	2.224	0.020	19.909	0.04045	0.32658
135	25.826	53.0520	1.04006	23.5782	2.2279	23.576	2.250	0.020	18.067	0.03314	0.31695
150	29.364	61.5559	1.14019	27.0940	2.2498	27.093	2.270	0.019	16.894	0.02889	0.31134
165	31.668	67.1704	1.14996	29.3831	2.2642	29.382	2.283	0.017	16.241	0.02666	0.30839
180	32.381	69.1391	1.06746	30.0848	2.2764	30.084	2.293	0.015	16.078	0.02612	0.30768
195	31.388	67.0785	0.90810	29.0827	2.2847	29.081	2.299	0.012	16.374	0.02711	0.30898
210	28.823	61.2684	0.70073	26.5139	2.2888	26.513	2.301	0.011	17.176	0.02989	0.31265
225	25.061	52.5660	0.48104	22.7530	2.2880	22.752	2.298	0.009	18.565	0.03504	0.31945
240	20.625	42.1952	0.28172	18.3246	2.2799	18.324	2.288	0.007	20.719	0.04392	0.33113
255	16.084	31.5648	0.13232	13.7996	2.2638	13.799	2.269	0.004	23.936	0.05924	0.35122
270	11.952	21.8413	0.03998	9.7090	2.2225	9.708	2.225	0.002	28.609	0.08620	0.38633
285	8.559	13.9377	0.00269	6.3814	2.1570	6.381	2.157	0.000	35.554	0.13786	0.45278
300	6.088	8.2372	0.00496	4.0774	1.9900	4.077	1.991	0.001	44.342	0.22744	0.56564
315	4.503	4.6739	0.02514	2.9053	1.5774	2.899	1.589	0.005	47.800	0.27193	0.62067
330	3.645	2.8447	0.04265	2.5288	1.0958	2.517	1.123	0.015	42.100	0.20161	0.53340
345	3.304	2.2123	0.04455	2.3839	0.8999	2.371	0.933	0.040	39.436	0.17369	0.49828

Secular perturbations by the planet Mars

E	$\log M$	$\log N$	$\log P$	$\log Q$	$\log V$	$\log J_1$	$\log J_2$	$\log J_3$	$\log F_2$	$\log F_3$
0	0.44933	0.08143	9.86628	0.16409	0.16124	0.36305	9.86975 _n	8.63306 _n	9.30937	8.29399
15	0.54479	0.22100	0.09089	0.39819	0.39755	0.35721	9.65543 _n	8.81872	9.12616	8.02731
30	0.66014	0.42827	0.32435	0.68093	0.68051	0.34013	8.88389	9.23659	8.54747 _n	7.33990 _n
45	0.57871	0.41441	0.99710	0.46640	0.46575	0.33021	9.89979	9.42762	9.38857 _n	7.81585 _n
60	0.43046	0.27481	9.37792	0.00628	0.00517	0.33082	6.20239	9.53505	9.68142 _n	8.05670
75	0.33732	0.14999	8.81539	9.61147	9.61037	0.33612	0.38044	9.59141	9.86083 _n	8.79523
90	0.28360	0.04621	8.33778	9.29115	9.29023	0.34246	0.50021	9.60768	9.98442 _n	9.17690
105	0.25428	9.96941	7.96256	9.04893	9.04824	0.34821	0.58383	9.58642	0.07218 _n	9.43077
120	0.23625	9.90700	7.65990	8.85642	8.85588	0.35299	0.64104	9.52401	0.23320 _n	9.60850
135	0.22546	9.86060	7.43188	8.71322	8.71278	0.35692	0.67672	9.40739	0.17253 _n	9.73146
150	0.21917	9.82903	7.27406	8.61504	8.61464	0.36001	0.69342	9.19728	0.19249 _n	9.80983
165	0.21587	9.81156	7.18329	8.55910	8.55877	0.36207	0.68249	8.69205	0.19434 _n	9.84913
180	0.21505	9.80709	7.15767	8.54359	8.54332	0.36348	0.67205	8.77499 _n	0.17818 _n	9.85172
195	0.21652	9.81881	7.20022	8.57155	8.57136	0.36402	0.62222	9.21131 _n	0.14307 _n	9.81770
210	0.22064	9.84431	7.30967	8.64130	8.64102	0.36416	0.57153	9.40116 _n	0.08678 _n	9.74490
225	0.22826	9.88595	7.49102	8.75702	8.75679	0.36320	0.48289	9.50977 _n	0.00509 _n	9.62820
240	0.24136	9.94597	7.75077	8.92416	8.92397	0.36129	0.35700	9.57384 _n	9.88988 _n	9.45736
255	0.26384	0.02812	8.09940	9.15199	9.15184	0.35786	0.17187	9.60743 _n	9.72482 _n	9.21214
270	0.30306	0.13677	8.54863	9.45260	9.45250	0.35286	9.86096	9.61649 _n	9.46491 _n	8.84028
285	0.37699	0.28421	9.12713	9.85627	9.85624	0.34598	8.72173	9.60260 _i	8.87885 _n	8.09573
300	0.50156	0.45923	9.80411	0.35041	0.35033	0.33766	9.68135 _n	9.56373 _n	9.01167	7.98651 _n
315	0.56183	0.49736	0.19197	0.59616	0.59522	0.33086	9.91529 _n	9.49308 _n	9.36415	7.85458 _n
330	0.46609	0.28968	0.01605	0.35226	0.34919	0.33250	9.97674 _n	9.37464 _n	9.47796	7.80469
345	0.42735	0.11336	9.84703	0.15841	0.14979	0.35347	9.95043 _n	9.16444 _n	9.48895	8.25633

Secular perturbations by the planet Mars

E	$\log R_0$	$\log S_0$	$\log W_0$	I + II	III + IV	$W_0 \cos u$	$W_0 \sin u$	$-2 \cdot r \cdot R_0/a$
0	9.84339	9.94920 _n	8.67952 _n	-1.7792	-0.6973	+0.04749	-0.00553	-0.39783
15	9.96552	9.98448 _n	9.24959	-1.1748	-1.6706	-0.15518	-0.08649	-0.57202
30	8.79274	9.46589	9.91467	+0.4262	+0.4526	-0.41129	-0.71126	-0.04728
45	0.27595 _n	0.31749	9.88974	-0.4507	+4.1480	-0.07787	-0.77188	+1.86750
60	0.24808 _n	0.17555	9.54362	-0.4201	+2.6755	+0.07791	-0.34434	+2.27559
75	0.14220 _n	9.96924	9.21277	-1.4300	+1.2828	+0.07249	-0.14623	+2.26153
90	0.04222 _n	9.77541	8.91550	-1.1970	+0.4818	+0.05178	-0.06400	+2.20420
105	9.96775 _n	9.62096	8.65892	-0.9807	+0.0524	+0.03420	-0.03015	+2.20038
120	9.90596 _n	9.48598	8.41221	-0.7864	-0.2049	+0.02163	-0.01412	+2.18619
135	9.85991 _n	9.38227	8.16569	-0.6362	-0.3611	+0.01318	-0.00638	+2.18063
150	9.82854 _n	9.30168	7.88621	-0.5146	-0.4715	+0.00726	-0.00252	+2.18420
165	9.81115 _n	9.23522	7.45637	-0.4062	-0.5616	+0.00279	-0.00063	+2.18858
180	9.80674 _n	9.20959	7.02530 _n	-0.3241	-0.6408	-0.00105	+0.00012	+2.19764
195	9.81854 _n	9.18741	7.70070 _n	-0.2313	-0.7281	-0.00502	+0.00004	+2.22611
210	9.84404 _n	9.20583	7.99519 _n	-0.1451	-0.8313	-0.00984	-0.00100	+2.26100
225	9.88569 _n	9.23176	8.23464 _n	-0.0291	-0.9543	-0.01675	-0.00372	+2.31401
240	9.94560 _n	9.27092	8.47487 _n	+0.1334	-1.1039	-0.02807	-0.01014	+2.39718
255	0.02756 _n	9.30972	8.74351 _n	+0.3878	-1.2735	-0.04897	-0.02610	+2.52523
270	0.13424 _n	9.29110	9.05983 _n	+0.8130	-1.3898	-0.09076	-0.07224	+2.72440
285	0.27425 _n	8.44248	9.45632 _n	+1.5504	-1.1130	-0.18630	-0.21695	+3.06511
300	0.39194 _n	0.00443 _n	9.83956 _n	+2.1564	+1.3793	-0.30472	-0.62032	+3.16919
315	9.99120 _n	0.45938 _n	0.08434 _n	-1.0123	+5.7761	-0.15901	-1.20390	+0.96930
330	9.51788	0.25675 _n	9.71836 _n	-2.5838	+2.8179	+0.15071	-0.50064	-0.25112
345	9.73600	0.01820 _n	9.28664 _n	-2.1716	+0.5538	+0.14283	-0.13051	-0.33720
				-4.2214	+2.4677	-0.48893	-2.34399	+20.90336
				-6.5849	+5.1508	-0.38363	-2.62290	+20.88918
				-10.8063	+7.6185	-0.87256	-4.96689	+41.79254

Secular perturbations by the planet Jupiter
Elements of the Jupiter orbit:

$$\begin{aligned} n' &= 299''1283 \\ e' &= 0.04833475 \\ \pi' &= 12^\circ 43' 16'' \\ i' &= 1^\circ 18' 32'' \\ \Omega' &= 99^\circ 26' 36'' \\ \log a' &= 0.7162172 \\ T' &= 4332.4589 \\ m' &= 1/1047.4 \end{aligned}$$

Constants for the determination of secular perturbations are:

$$\begin{aligned} I &= 15^\circ 41' 05'' \\ \Pi &= 353^\circ 14' 05'' & K &= 262^\circ 29' 26'' \\ \Pi' &= 90^\circ 43' 03'' & K' &= 262^\circ 32' 42'' \\ \log k &= 9.98352 & \log \pi &= 8.32188 \\ \log k' &= 9.99999 & \log \eta &= 0.09969 \\ \log C &= 8.80093 & \log \lambda &= 9.03762 \\ \log c &= 1.43142 & \log \rho &= 9.68502 \\ \log \beta &= 8.86383 & \log \sigma &= 1.43244 \\ \log \gamma &= 9.38399 & \log \tau &= 0.69974 \\ \log \delta &= 9.99422 & \log \nu &= 0.11668 \\ \log \mu &= 0.33638 & \log \psi &= 0.71570 \end{aligned}$$

The following tables contain the principal values of the computations.

In fine the following values of perturbations due to Jupiter result:

- A) as function of m'
B) with the value $m' = 1/1047.4$

$$\left[\frac{de}{dt} \right]_{00} = -17\ 280''0 \cdot m' = -16.49803''$$

$$\left[\frac{d\chi}{dt} \right]_{00} = +31\ 213''0 \cdot m' = +29.80045''$$

$$\left[\frac{di}{dt} \right]_{00} = -20\ 705''5 \cdot m' = -19.76852''$$

$$\left[\frac{d\Omega}{dt} \right]_{00} = -247\ 432''0 \cdot m' = -236.23455''$$

$$\left[\frac{d\pi}{dt} \right]_{00} = +20\ 410''6 \cdot m' = +19.48692''$$

$$\left[\frac{dL}{dt} \right]_{00} = +24\ 675''4 \cdot m' = +23.55874''$$

Secular perturbations by the planet Jupiter

<i>E</i>	<i>A</i>	<i>B</i> ²	<i>p</i>	<i>q</i>	<i>r</i>	<i>G</i>	<i>G'</i>	<i>G''</i>	Θ	log <i>K</i>	log <i>L</i>	log <i>M</i>
0	27.862	23.167	9.266	8.873	-695.72	27.004	0.857	0.061	10.629	0.01130	0.28804	0.19300
10	28.120	30.017	9.352	8.835	-685.26	27.010	1.096	0.049	11.874	0.01413	0.29179	0.19722
20	28.524	40.192	9.487	8.787	-671.18	27.039	1.450	0.029	13.520	0.01837	0.29742	0.20354
30	29.103	54.551	9.680	8.725	-651.47	27.093	1.963	0.016	15.672	0.02480	0.30593	0.21309
40	29.904	74.474	9.947	8.646	-623.04	27.169	2.675	0.003	18.296	0.03400	0.31810	0.22674
50	30.981	101.605	10.306	8.544	-581.17	27.263	3.655	0.000	21.479	0.04731	0.33559	0.24635
60	32.383	137.496	10.773	8.421	-520.56	27.370	4.952	0.003	25.180	0.06585	0.35986	0.27350
70	34.156	183.597	11.364	8.287	-436.01	27.391	6.610	0.008	29.436	0.09160	0.39332	0.31086
80	36.300	239.879	12.079	8.167	-325.61	27.634	8.617	0.015	33.963	0.12470	0.43594	0.35830
90	38.795	306.306	12.911	8.087	-187.07	27.788	10.966	0.022	38.946	0.16886	0.49218	0.42061
100	41.581	381.215	13.839	8.082	-25.23	27.965	13.582	0.030	44.209	0.22584	0.56366	0.49938
110	44.557	461.956	14.831	8.180	+150.73	28.179	16.350	0.036	49.649	0.29830	0.65297	0.59721
120	47.592	544.906	15.843	8.388	+327.41	28.460	19.110	0.042	55.057	0.38766	0.76096	0.71406
130	50.529	625.728	16.822	8.687	+490.44	28.861	21.652	0.047	60.041	0.49005	0.88184	0.84373
140	53.200	699.723	17.712	9.034	+628.04	29.453	23.735	0.051	63.883	0.58632	0.99320	0.96197
150	55.439	767.186	18.458	9.371	+733.69	30.249	25.281	0.054	66.117	0.65125	1.06717	1.03990
160	57.102	809.037	19.013	9.644	+807.04	31.053	26.042	0.057	66.338	0.65809	1.07491	1.04803
170	58.069	836.836	19.335	9.805	+851.06	31.539	26.526	0.060	66.528	0.66404	1.08164	1.05510
180	58.272	843.552	19.403	9.825	+869.06	31.463	26.807	0.062	67.399	0.69207	1.11324	1.08822
190	57.692	828.561	19.210	9.697	+860.60	30.728	26.963	0.063	69.534	0.76678	1.19677	1.17543
200	56.357	792.615	18.765	9.439	+820.84	29.374	26.983	0.063	73.441	0.93031	1.37721	1.36226
210	54.351	737.919	18.096	9.090	+743.12	27.946	26.405	0.063	76.436	1.09086	1.54954	1.53898
220	51.802	668.113	17.246	8.708	+624.25	27.564	24.237	0.062	69.693	0.77274	1.20337	1.18230
230	48.863	587.437	16.266	8.356	+466.47	27.514	21.347	0.061	61.776	0.53205	0.92976	0.89480
240	45.708	500.708	15.215	8.097	+279.68	27.519	18.193	0.059	54.456	0.37668	0.71472	0.69992
250	42.513	413.140	14.150	7.963	+82.34	27.486	15.019	0.056	47.716	0.27081	0.61925	0.56028
260	39.438	328.976	13.125	7.965	-110.03	27.466	11.960	0.052	41.353	0.19350	0.52321	0.45487
270	36.620	252.113	12.185	8.076	-281.67	27.436	9.165	0.045	35.374	0.13633	0.45083	0.37481
280	34.157	185.386	11.365	8.251	-423.17	27.397	6.735	0.038	29.793	0.09398	0.39640	0.31430
290	32.112	130.432	10.683	8.445	-531.45	27.348	4.728	0.028	24.635	0.06291	0.35601	0.26920
300	30.503	87.768	10.146	8.622	-608.34	27.292	3.165	0.018	19.961	0.04067	0.32686	0.23657
310	29.315	56.864	9.751	8.760	-658.66	27.231	2.027	0.006	15.857	0.02539	0.30672	0.21398
320	28.506	36.412	9.481	8.852	-688.12	27.169	1.274	0.000	12.504	0.01569	0.29386	0.19954
330	28.015	24.618	9.317	8.899	-702.35	27.109	0.852	0.009	10.260	0.01052	0.28700	0.19184
340	27.783	19.653	9.240	8.911	-705.83	27.057	0.698	0.035	9.466	0.00895	0.28491	0.18948
350	27.743	19.486	9.226	8.900	-703.06	27.022	0.718	0.060	9.753	0.00950	0.28565	0.19031

Secular perturbations by the planet Jupiter

E	$\log N$	$\log P$	$\log Q$	$\log V$	$\log J_1$	$\log J_2$	$\log J_3$	$\log F_2$	$\log F_3$
0	8.30443	5.72765	7.06502	7.06371	1.43196	7.95569	9.40599 _n	0.77744	9.67808
10	8.34008	5.76725	7.10498	7.10380	1.42935	9.89596 _n	9.78160	0.77852	9.67796
20	8.43385	5.86635	7.20493	7.20439	1.41858	0.06862 _n	0.16423	0.73088	9.57995
30	8.56847	6.00817	7.34845	7.34821	1.40729	0.00468 _n	0.35861	0.61680	9.34724
40	8.72547	6.17534	7.51810	7.51812	1.40031	9.72190 _n	0.48434	0.36416	8.82925
50	8.89110	6.35554	7.70187	7.70183	1.39847	8.49666	0.57226	8.58190 _n	5.95040
60	9.05723	6.54244	7.89342	7.89343	1.40017	9.73110	0.63492	0.48800 _n	9.08832
70	9.22293	6.74078	8.09605	8.09587	1.40370	9.96719	0.67852	0.77959 _n	9.69440
80	9.37850	6.93107	8.29510	8.29482	1.40791	0.08904	0.70641	0.97629 _n	0.08382
90	9.53398	7.13774	8.51038	8.50997	1.41211	0.16082	0.72041	1.11679 _n	0.36270
100	9.68826	7.35775	8.74055	8.74002	1.41601	0.20596	0.72136	1.22431 _i	0.57637
110	9.84394	7.59596	8.99054	8.98991	1.41945	0.23474	0.70936	1.30927 _n	0.74533
120	0.00214	7.85334	9.26133	9.26062	1.42331	0.25226	0.68361	1.37734 _n	0.88071
130	0.15831	8.11812	9.54103	9.54026	1.42498	0.26113	0.64290	1.43188 _n	0.98917
140	0.29218	8.34564	9.78428	9.78347	1.42711	0.26258	0.58392	1.47506 _n	1.07498
150	0.37890	8.48310	9.93732	9.93649	1.42883	0.25701	0.50137	1.50827 _n	1.14094
160	0.39642	8.48551	9.95154	9.95069	1.43022	0.24429	0.38460	1.53252 _n	1.18901
170	0.40880	8.49110	9.96423	9.96336	1.43126	0.22362	0.20826	1.54842 _n	1.21988
180	0.44287	8.55880	0.03244	0.03153	1.43196	0.19426	9.88850	1.55636 _n	1.23592
190	0.52845	8.74839	0.21547	0.21366	1.43236	0.15411	8.90292 _n	1.55654 _n	1.23590
200	0.70465	9.14407	0.59802	0.59705	1.43241	0.10052	9.96180 _n	1.54896 _n	1.22026
210	0.86978	9.52473	0.96147	0.96048	1.43212	0.02918	0.23282 _n	1.53342 _n	1.18889
220	0.52142	8.84213	0.26238	0.26136	1.43144	9.93242	0.38726 _n	1.50958 _n	1.14080
230	0.23104	8.27976	9.68532	9.68428	1.43034	9.79504	0.48921 _i	1.47678 _n	1.07476
240	0.01284	7.84670	9.27233	9.27137	1.42874	9.57888	0.55954 _n	1.43405 _n	0.98885
250	9.83219	7.57147	8.95248	8.95148	1.42657	9.11581	0.60782 _i	1.38012 _n	0.88037
260	9.66712	7.31111	8.68238	8.68142	1.42375	9.04261 _n	0.63851 _n	1.31274 _n	0.74492
270	9.50915	7.08186	8.44490	8.44404	1.42018	9.51426 _n	0.65418 _n	1.22864 _n	0.57582
280	9.35285	6.87266	8.22885	8.22814	1.41583	9.69501 _n	0.64625 _n	1.12234 _n	0.36204
290	9.19479	6.67603	8.02661	8.02538	1.41079	9.76692 _n	0.64388 _i	0.98370 _n	0.08292
300	9.03355	6.48778	7.83380	7.83343	1.40543	9.74392 _n	0.61708 _n	0.79050 _n	9.69309
310	8.86981	6.29620	7.64863	7.64850	1.40068	9.56223 _n	0.57338 _i	0.47459 _i	9.05192
320	8.70725	6.13300	7.47273	7.47276	1.39846	7.40054 _n	0.50858 _n	9.19788 _n	5.94603
330	8.55398	5.97448	7.31256	7.31260	1.40140	9.66224	0.41464 _n	0.34562	8.83170
340	8.42384	5.84306	7.18048	7.17970	1.41128	9.90104	0.27118 _n	0.61461	9.35880
350	8.33490	5.75521	7.09255	7.09115	1.42391	9.82824	0.03766 _n	0.72734	9.58041

Secular perturbations by the planet Jupiter

E	$\log R_0$	$\log S_0$	$\log W_0$	I + II	III + IV	$W_0 \cos u$	$W_0 \sin u$	$-2 \cdot r \cdot R_0/a$
0	8.00676	6.51917	6.43136 _n	+0.00066	-0.01016	+0.00027	-0.00003	-0.00580
10	8.03559	6.81191 _n	6.90091	+0.00387	-0.01033	-0.00076	-0.00024	-0.00643
20	8.09666	7.16997 _n	7.37383	+0.00670	-0.01036	-0.00181	-0.00152	-0.00820
30	8.19134	7.26316 _n	7.70876	+0.01194	-0.00916	-0.00256	-0.00443	-0.01184
40	8.32037	7.14364 _n	8.00290	+0.01955	-0.00503	-0.00229	-0.00980	-0.01892
50	8.47360	6.19590	8.27409	+0.02957	+0.00429	+0.00018	-0.01007	-0.03217
60	8.64125	7.49693	8.52889	+0.04178	+0.02147	+0.00753	-0.03329	-0.05627
70	8.82199	7.91640	8.77637	+0.05649	+0.05100	+0.02326	-0.05504	-0.10030
80	8.97900	8.20745	9.00569	+0.03777	+0.09424	+0.05295	-0.08638	-0.17478
90	9.14441	8.46075	9.23839	+0.07688	+0.16118	+0.10890	-0.13460	-0.27889
100	9.29474	8.69987	9.47409	+0.07249	+0.25703	+0.21274	-0.20807	-0.44318
110	9.42929	8.94126	9.71791	+0.03787	+0.39167	+0.40862	-0.32529	-0.66881
120	9.52722	9.19216	9.97020	-0.06688	+0.56349	+0.78176	-0.51052	-0.91399
130	9.42469	9.44431	0.21818	-0.33994	+0.65410	+1.46121	-0.78048	-0.77608
140	9.21301 _n	9.65332	0.41390	-0.82296	+0.38817	+2.37787	-1.03549	+0.50545
150	0.03564	9.76420	0.49989	-1.30482	-0.51914	+2.98707	-1.03542	+3.51484
160	0.24197 _n	9.71957	0.42167	-1.26138	-1.39636	+2.55194	-0.66686	+5.83636
170	0.32085 _n	9.64622	0.30074	-1.02698	-1.94654	+1.96373	-0.37211	+7.13367
180	0.41229 _n	9.57772	0.16291	-0.75649	-2.58399	+1.44538	-0.16832	+8.86159
190	0.53149 _n	9.49717	9.92100	-0.38041	-3.49184	+0.83286	-0.03720	+11.58666
200	0.69704 _n	8.71324	0.11641 _n	+0.61264	-4.95937	-1.30690	-0.03622	+16.64235
210	1.03090	0.22216 _n	1.01849 _n	+0.75353	+12.03674	-10.38098	-1.06041	-34.76679
220	0.21100	9.83582 _n	0.54298 _n	+0.70829	+2.38424	-3.43549	-0.62105	-5.03110
230	9.98884	9.43033 _n	0.10202 _n	+0.06589	+1.30048	-1.22231	-0.32513	-2.84479
240	9.76126	9.07940 _n	9.78463 _n	-0.08990	+0.71870	-0.55089	-0.20690	-1.56670
250	9.55912	8.89085 _n	9.52399 _n	-0.09872	+0.45325	-0.30229	-0.14248	-0.90184
260	9.36876	8.67536 _n	9.29561 _n	-0.09758	+0.28043	-0.16905	-0.10216	-0.52553
270	9.18544	8.47020 _n	9.08219 _n	-0.08609	+0.17240	-0.09556	-0.07396	-0.30653
280	9.00477	8.26157 _n	8.86432 _n	-0.06823	+0.10253	-0.05155	-0.05192	-0.18546
290	8.82314	8.03205 _n	8.66389 _n	-0.05626	+0.06666	-0.02724	-0.03722	-0.10056
300	8.64041	7.75412 _n	8.44801 _n	-0.04212	+0.02698	-0.01237	-0.02518	-0.05616
310	8.46022	7.34528 _n	8.22129 _n	-0.02973	+0.00846	-0.00411	-0.01613	-0.03120
320	8.29210	5.46240 _n	7.98136 _n	-0.01949	-0.00217	-0.00002	-0.00958	-0.01773
330	8.15241	7.06183	7.72673 _n	-0.01158	-0.00752	+0.00154	-0.00510	-0.01082
340	8.05637	7.17348	7.44840 _n	-0.00587	-0.00962	+0.00169	-0.00224	-0.00748
350	8.00920	7.05461	7.12172 _n	-0.00204	-0.01006	+0.00114	-0.00068	-0.00605
				-1.70094	-4.13977	+1.90177	-3.77553	+22.83445
				-2.30050	+9.30564	-4.24729	-4.41598	-18.60792
				-4.00144	+5.16587	-2.34552	-8.19151	+4.22653

Secular perturbations by the planet Saturn
Elements of the Saturn orbit:

$n' = 120.4547''$
 $e' = 0.05589231$
 $\pi' = 91^\circ 05' 54''$
 $i' = 2^\circ 29' 33''$
 $\Omega' = 112^\circ 47' 25''$
 $\log a' = 0.9802192$
 $T' = 10759.223$
 $m' = 1/3499$

Constants for the determination of secular perturbations are:

$I = 14^\circ 33' 47''$
 $\Pi = 355^\circ 24' 09''$ $K = 182^\circ 58' 19''$
 $\Pi' = 172^\circ 10' 57''$ $K' = 183^\circ 28' 34''$
 $\log k = 9.99974$ $\log \pi = 7.75113$
 $\log k' = 9.98609$ $\log \eta = 0.69293$
 $\log C = 9.45514$ $\log \lambda = 9.59708$
 $\log \alpha = 1.95908$ $\log \rho = 0.02835$
 $\log \beta = 8.80088$ $\log \sigma = 1.96044$
 $\log \gamma = 9.72731$ $\log \tau = 0.97996$
 $\log \delta = 0.45893$ $\log \nu = 0.70779$
 $\log \mu = 0.83487$ $\log \psi = 0.96563$

The following tables contain the principal value of the computation.

In fine the following values of perturbations due to Saturn result:

A) as function of m'
 B) with the value $m' = 1/3499$

$$\left[\frac{de}{dt} \right]_{00} = -176.4'' \cdot m' = -0.05040''$$

$$\left[\frac{d\chi}{dt} \right]_{00} = +7505.5'' \cdot m' = +2.14506''$$

$$\left[\frac{di}{dt} \right]_{00} = -981.4'' \cdot m' = +0.28050''$$

$$\left[\frac{d\Omega}{dt} \right]_{00} = -6141.5'' \cdot m' = -1.75522''$$

$$\left[\frac{d\pi}{dt} \right]_{00} = +7237.4'' \cdot m' = +2.06842''$$

$$\left[\frac{dL}{dt} \right]_{00} = -307.9'' \cdot m' = -0.08801''$$

Secular perturbations by the planet Saturn

<i>E</i>	<i>A</i>	<i>B</i> ²	<i>p</i>	<i>q</i>	<i>r</i>	<i>G</i>	<i>G'</i>	<i>G''</i>	Θ	log <i>K</i>	log <i>L</i>	log <i>M</i>
0	91.162	14.03	30.292	30.358	-27.978	91.008	0.011	0.142	2.348	0.00055	0.27373	0.17691
15	91.453	40.49	30.389	30.310	-27.840	91.007	0.419	0.259	4.944	0.00233	0.27624	0.17973
30	92.357	115.94	30.691	30.201	-27.517	91.085	1.282	0.296	7.553	0.00568	0.28057	0.18460
45	93.976	255.48	31.230	29.985	-26.857	91.174	2.764	0.248	10.457	0.01093	0.28755	0.19245
60	96.477	474.98	32.064	29.647	-25.746	91.279	5.106	0.192	13.925	0.01950	0.29892	0.20523
75	99.959	785.49	33.225	29.181	-24.047	91.376	8.435	0.138	17.823	0.03224	0.31575	0.22412
90	104.381	1185.18	34.698	28.616	-21.676	91.447	12.743	0.096	21.993	0.04971	0.33874	0.24988
105	109.512	1654.01	36.409	28.012	-18.673	91.474	17.810	0.060	26.221	0.07170	0.36748	0.28202
120	114.931	2153.40	38.215	27.451	-15.254	91.448	23.232	0.033	30.285	0.09733	0.40074	0.31912
135	120.073	2630.65	39.929	26.998	-11.804	91.366	28.439	0.017	33.920	0.12435	0.43550	0.35780
150	124.319	3027.20	41.345	26.686	-8.819	91.243	32.796	0.006	36.839	0.14912	0.46713	0.39289
165	127.116	3290.23	42.277	26.579	-6.778	91.119	35.713	0.000	38.759	0.16705	0.48987	0.41806
180	128.069	3382.16	42.594	26.440	-6.025	91.030	36.754	0.000	39.452	0.17385	0.49849	0.42757
195	127.051	3290.06	42.255	26.474	-6.691	91.010	35.761	0.006	38.819	0.16763	0.49062	0.41888
210	124.194	3026.10	41.303	26.628	-8.673	91.060	32.867	0.017	36.933	0.14997	0.46821	0.39409
225	119.896	2627.58	39.870	26.929	-11.637	91.148	28.496	0.033	34.013	0.12510	0.43646	0.35887
240	114.714	2147.34	38.143	27.386	-15.106	91.237	23.247	0.056	30.346	0.09775	0.40128	0.31973
255	109.270	1643.46	36.328	27.970	-18.588	91.310	17.758	0.084	26.221	0.07170	0.36748	0.28202
270	104.130	1171.53	34.615	28.593	-21.642	91.324	12.642	0.121	21.938	0.04942	0.33837	0.24946
285	99.717	769.13	33.144	29.183	-24.072	91.304	8.293	0.165	17.703	0.03179	0.31517	0.22346
300	96.260	457.58	31.992	29.666	-25.813	91.249	4.941	0.217	13.737	0.01897	0.29822	0.20444
315	93.798	239.36	31.171	30.013	-26.942	91.173	2.608	0.268	10.215	0.01043	0.28688	0.19170
330	92.232	103.50	30.649	30.226	-27.592	91.094	1.161	0.310	7.289	0.00529	0.28005	0.18402
345	91.399	33.21	30.371	30.332	-27.903	91.035	0.328	0.248	4.562	0.00207	0.27576	0.17919

Secular perturbations by the planet Saturn

E	$\log N$	$\log P$	$\log Q$	$\log V$	$\log J_1$	$\log J_2$	$\log J_3$	$\log F_2$	$\log F_3$
0	7.50276	3.85697	5.71991	5.71908	1.95958	9.63764	9 _n 70868	0.40700	9.27549
15	7.57498	3.93060	5.29441	5.79288	1.95290	0 _n 45884	0.54960	1.46111	0.29883
30	7.75774	4.11659	5.98149	5.97973	1.93861	0 _n 48539	0.87177	1.72320	0.39031
45	7.98931	4.35476	6.22071	6.21924	1.93210	0 _n 08827	1.03813	1.86205	9.78261
60	8.22495	4.60130	6.46890	6.46777	1.93363	9.60746	1.13764	1.94105	0 _n 57442
75	8.44375	4.83653	6.70638	6.70559	1.93842	0.12580	1.19548	1.97973	0 _n 99672
90	8.63868	5.05417	6.92693	6.92638	1.94364	0.23189	1.22144	1.98514	1 _n 21690
105	8.80817	5.25250	7.12862	7.12827	1.94819	0.24106	1.21906	1.95812	1 _n 33476
120	8.95213	5.43020	7.30992	7.30973	1.95186	0.20627	1.18808	1.89408	1 _n 37401
135	9.06977	5.58354	7.46671	7.46661	1.95468	0.14502	1.12414	1.77911	1 _n 33286
150	9.15866	5.70533	7.59132	7.59129	1.95673	0.06170	1.01585	1.57253	1 _n 17681
165	9.21503	5.78658	7.67348	7.67349	1.95813	9.94963	0.83254	1.06552	0 _n 70047
180	9.23386	5.81397	7.70224	7.70224	1.95891	9.78776	0.45797	1.18592	0.83333
195	9.21634	5.78872	7.67611	7.67608	1.95909	9.48801	0 _n 07258	1.62020	1.26265
210	9.16073	5.71012	7.59541	7.59532	1.95864	8 _n 55169	0 _n 70495	1.81730	1.43703
225	9.07194	5.58859	7.47090	7.47072	1.95749	0 _n 62388	0 _n 93088	1.93236	1.51041
240	8.95390	5.43431	7.31319	7.31288	1.95551	9 _n 92268	1 _n 05403	2.00042	1.51519
255	8.80916	5.25481	7.13027	7.12978	1.95250	0 _n 09545	1 _n 12285	2.03435	1.45951
270	8.63910	5.05515	6.92740	6.92660	1.94828	0 _n 19247	1 _n 15325	2.03912	1.33938
285	8.44362	4.83624	6.70581	6.70484	1.94280	0 _n 22108	1 _n 15060	2.01536	1.13634
300	8.22445	4.60015	6.46763	6.46636	1.93667	0 _n 03371	1 _n 11447	1.95976	0.79365
315	7.98871	4.35331	6.21927	6.21769	1.93235	9.48834	1 _n 03821	1.86286	9.95167
330	7.75720	4.11532	5.98025	5.97836	1.93532	0.37024	0 _n 90296	1.70037	9 _n 20416
345	7.57462	3.92960	5.79342	5.79197	1.94862	0.49543	0 _n 64817	1.38772	0 _n 17505

Secular perturbations by the planet Saturn

E	$\log R_0$	$\log S_0$	$\log W_0$	I + II	III + IV	$W_0 \cos u$	$W_0 \sin u$	$-2 \cdot r \cdot R_0/a$
0	7.20112	5.35669	5 _n 42553	+0.00005	-0.00159	+0.000026	-0.000003	-0.00091
15	7.25164	6 _n 18721	6.34581	+0.00077	-0.00160	-0.000194	-0.000108	-0.00111
30	7.38712	6 _n 46512	6.85346	+0.00196	-0.00133	-0.000357	-0.000618	-0.00186
45	7.59688	5 _n 58274	7.25763	+0.00393	-0.00002	-0.000182	-0.001801	-0.00391
60	7.83954	6.66982	7.60380	+0.00659	+0.00333	+0.000895	-0.003955	-0.00888
75	8.07864	7.12492	7.89734	+0.00953	+0.00965	+0.003507	-0.007073	-0.01954
90	8.29761	7.40388	8.14201	+0.01207	+0.01958	+0.008723	-0.010781	-0.03969
105	8.49145	7.59822	8.33972	+0.01339	+0.03321	+0.016400	-0.014459	-0.07348
120	8.64454	7.73167	8.48892	+0.01216	+0.04855	+0.025810	-0.016855	-0.11972
135	8.79993	7.80578	8.58146	+0.01017	+0.06815	+0.034338	-0.016616	-0.18993
150	8.91073	7.80576	8.59888	+0.00581	+0.08545	+0.037518	-0.013005	-0.26363
165	8.98096	7.69096	8.50186	+0.00063	+0.09750	+0.030971	-0.007030	-0.32357
180	9.00772	7.32234	8.17334	-0.00420	+0.10179	+0.014905	-0.001724	-0.34909
195	8.98896	7 _n 04334	7 _n 65135	-0.00827	+0.09746	-0.004480	+0.000039	-0.32958
210	8.92327	7 _n 54514	8 _n 26861	-0.01164	+0.08509	-0.018465	-0.001886	-0.27135
225	8.81793	7 _n 65915	8 _n 37940	-0.01407	+0.06822	-0.023384	-0.005200	-0.19797
240	8.67814	7 _n 64749	8 _n 34997	-0.01507	+0.05013	-0.021054	-0.007605	-0.12938
255	8.51121	7 _n 55940	8 _n 23987	-0.01458	+0.03373	-0.015358	-0.008187	-0.07691
270	8.32482	7 _n 40788	8 _n 07079	-0.01295	+0.02054	-0.009308	-0.007204	-0.04225
285	8.09487	7 _n 19137	7 _n 84972	-0.00985	+0.01039	-0.004609	-0.005367	-0.02028
300	7.84991	6 _n 83206	7 _n 57800	-0.00678	+0.00251	-0.001669	-0.003340	-0.00910
315	7.59682	6 _n 05568	7 _n 25541	-0.00418	+0.00014	-0.000236	-0.001785	-0.00391
330	7.37456	6.19791	6 _n 88145	-0.00198	-0.00120	+0.000219	-0.000729	-0.00181
345	7.23742	6.23820	6 _n 44213	-0.00070	-0.00157	+0.000204	-0.000187	-0.00107
				-0.01399	+0.41286	+0.037144	-0.067762	-0.12377
				-0.01324	+0.41527	+0.036977	-0.067775	-0.12413
				-0.02722	+0.82813	+0.074121	-0.135537	-0.24789
				-0.00113	+0.03451			-0.01033

Secular perturbations by the planet Uranus
Elements of the Uranus orbit:

$$\begin{aligned} n' &= 42.2309'' \\ e' &= 0.0463444 \\ \pi' &= 171^\circ 32' 55'' \\ i' &= 0^\circ 46' 21'' \\ \Omega' &= 73^\circ 28' 38'' \\ \log a' &= 1.2837114 \\ T' &= 30688^d.45 \\ m' &= 1/22650 \end{aligned}$$

Constants for the determination of secular perturbations are:

$$\begin{aligned} I &= 16^\circ 18' 42'' \\ II &= 352^\circ 05' 29'' & K &= 103^\circ 25' 41'' \\ III &= 249^\circ 23' 57'' & K' &= 101^\circ 52' 50'' \\ \log k &= 9.98443 & \log \pi &= 8.85916n \\ \log k' &= 9.99788 & \log \eta &= 1.21511 \\ \log C &= 9.89942 & \log \lambda &= 0.17097 \\ \log \alpha &= 2.56648 & \log \rho &= 0.23517 \\ \log \beta &= 8.89697 & \log \sigma &= 2.56742 \\ \log \gamma &= 9.93414 & \log \tau &= 1.26814 \\ \log \delta &= 1.16242 & \log \nu &= 1.23342 \\ \log \mu &= 1.48665 & \log \psi &= 1.28112 \end{aligned}$$

The following tables contain the principal values of the computation.

In fine the following values of perturbations due to Uranus result:

- A) as function of m'
B) with the value $m' = 1/22650$

$$\left[\frac{de}{dt} \right]_{00} = -39.1'' \cdot m' = -0.00173''$$

$$\left[\frac{d\chi}{dt} \right]_{00} = +623.7'' \cdot m' = +0.02754''$$

$$\left[\frac{di}{dt} \right]_{00} = +122.0'' \cdot m' = +0.00539''$$

$$\left[\frac{d\Omega}{dt} \right]_{00} = -603.1'' \cdot m' = -0.02663''$$

$$\left[\frac{d\pi}{dt} \right]_{00} = +597.4'' \cdot m' = +0.02638''$$

$$\left[\frac{dL}{dt} \right]_{00} = -1705.1'' \cdot m' = -0.07528''$$

Secular perturbations by the planet Uranus

<i>E</i>	<i>A</i>	<i>B</i> ²	<i>g</i>	<i>h</i>	<i>l</i>	<i>G</i>	<i>G'</i>	<i>G''</i>	Θ	log <i>K</i>	log <i>L</i>	log <i>M</i>
0	369.820	471	236.8	368.54	0.48	368.542	1.112	0.625	3.935	0.00154	0.27505	0.17840
30	368.769	52	17.6	368.63	-0.66	368.628	0.076	0.730	2.676	0.00071	0.27395	0.17716
60	370.667	663	340.6	368.87	1.00	368.871	1.582	0.590	4.397	0.00192	0.27556	0.17897
90	376.966	2914	2161.1	369.09	7.08	369.072	7.848	0.748	8.769	0.00767	0.28321	0.18758
120	386.960	6608	5240.8	369.09	17.07	369.054	17.905	0.792	12.994	0.01696	0.29555	0.20144
150	396.989	10388	7962.0	368.89	27.31	368.827	28.136	0.767	16.239	0.02666	0.30839	0.21585
180	402.406	12467	8554.2	368.66	32.95	368.592	33.710	0.688	17.770	0.03204	0.31549	0.22383
210	400.777	11882	6608.6	368.61	31.37	368.556	31.988	0.560	17.279	0.03025	0.31314	0.22118
240	393.520	9159	3439.5	368.73	23.99	368.708	24.402	0.382	15.018	0.02274	0.30320	0.21003
270	384.540	5798	937.2	368.85	14.89	368.848	15.068	0.169	11.725	0.01376	0.29132	0.19669
300	377.226	3108	21.2	368.82	7.62	368.817	7.624	0.037	8.270	0.00682	0.28208	0.18630
330	372.556	1441	147.1	368.65	3.11	368.654	3.134	0.026	5.312	0.00280	0.27674	0.18029

Secular perturbations by the planet Uranus

<i>E</i>	log <i>N</i>	log <i>P</i>	log <i>Q</i>	log <i>V</i>	log <i>J</i> ₁	log <i>J</i> ₂	log <i>J</i> ₃	log <i>F</i> ₂	log <i>F</i> ₃
0	6.59266	1.73327	4.20384	4.20412	2.56657	0.67526	0.58416 _n	2.45257 _n	1.37002 _n
30	6.84288	1.98193	4.45260	4.44716	2.54164	1.10456 _n	1.51123	1.88792 _n	0.65089 _n
60	7.29794	2.43837	4.90934	4.90849	2.53365	0.67742	1.79829	2.53152	1.10957 _n
90	7.68708	2.83432	5.30667	5.30428	2.54542	1.06744	1.89963	2.93273	2.18558 _n
120	7.96173	3.12124	5.59514	5.59329	2.55636	0.99448	1.88987	3.12510	2.64058 _n
150	8.12495	3.29789	5.77308	5.77195	2.55118	0.69770	1.76346	3.21591	2.86338 _n
180	8.17979	3.36058	5.83626	5.83474	2.56665	9.83296 _n	1.40931	3.23149	2.92786 _n
210	8.12938	3.30819	5.78340	5.78176	2.56693	0.80351 _n	1.03405 _n	3.17545	2.84964 _n
240	7.96894	3.13789	5.61185	5.61225	2.56344	1.06382 _n	1.61907 _n	3.03364	2.60938 _n
270	7.69461	2.85185	5.32426	5.33445	2.55441	1.18693 _n	1.76561 _n	2.75132	2.12298 _n
300	7.30395	2.45239	4.92343	4.92428	2.53863	1.13938 _n	1.75082 _n	1.93827 _n	0.87593 _n
330	6.84618	1.98962	4.45982	4.46240	2.53348	0.90938	1.56072 _n	2.34925 _n	0.82312 _n

Secular perturbations by the planet Uranus

E	$\log R_0$	$\log S_0$	$\log W_0$	I + II	III + IV	$W_0 \cos u$	$W_0 \sin u$	$-2 \cdot r \cdot R_0/a$
0	6.29447	4.77452	4.79588 _n	+0.000012	-0.000197	+0.000006	-0.000001	-0.000061
30	6.44404	5.55991 _n	5.95808	+0.000209	-0.000169	-0.000045	-0.000079	-0.000212
60	6.88366	5.67988	6.70650	+0.000729	+0.000359	+0.000113	-0.000501	-0.000983
90	7.31186	6.46901	7.20214	+0.001224	+0.002092	+0.001002	-0.001238	-0.004101
120	7.62869	6.75078	7.47485	+0.001112	+0.004755	+0.002499	-0.001632	-0.011545
150	7.78383	6.79320	7.51628	+0.000169	+0.006514	+0.003102	-0.001075	-0.019683
180	7.88980	6.53706	7.19271	-0.000689	+0.007759	+0.00548	-0.000180	-0.026609
210	7.84123	5.90472 _n	6.90211 _n	-0.001351	+0.006849	-0.000794	-0.000081	-0.022464
240	7.67001	6.51388 _n	7.24586 _n	-0.001632	+0.004736	-0.001657	-0.000598	-0.012697
270	7.39357	6.46538 _n	7.10329 _n	-0.001522	+0.002391	-0.001003	-0.000776	-0.004950
300	6.91777	6.05423 _n	6.64093 _n	-0.000799	+0.000523	-0.000193	-0.000393	-0.001063
330	6.44560	5.32940	6.02325 _n	-0.000230	-0.000146	+0.000030	-0.000101	-0.000212
				-0.001267	+0.018026	+0.002317	-0.003305	-0.052958
				-0.001501	+0.017530	+0.002292	-0.003350	-0.051624
				-0.002768	+0.035556	+0.004608	-0.006655	-0.104582

Secular perturbations by the planet Neptune
Elements of the Neptune orbit:

$$\begin{aligned} n' &= 21.5349'' \\ e' &= 0.0089970 \\ \pi' &= 46^\circ 43' 38'' \\ i' &= 1^\circ 46' 45'' \\ \Omega' &= 130^\circ 40' 53'' \\ \log a' &= 1.4787046 \\ T' &= 60181.23 \\ m' &= 1/19350 \end{aligned}$$

Constants for the determination of secular perturbations are:

$$\begin{aligned} I &= 15^\circ 28' 25'' \\ II &= 356^\circ 40' 29'' & K &= 226^\circ 36' 36'' \\ II' &= 129^\circ 01' 28'' & K' &= 228^\circ 40' 42'' \\ \log k &= 9.99047 & \log \pi &= 8.23884 \\ \log k' &= 9.99378 & \log \eta &= 0.89546 \\ \log C &= 8.86561 & \log \lambda &= 9.82718 \\ \log \alpha &= 2.95737 & \log \varrho &= 9.72430 \\ \log \beta &= 8.85236 & \log \sigma &= 2.95741 \\ \log \gamma &= 9.42328 & \log \tau &= 1.46918 \\ \log \delta &= 1.50870 & \log \nu &= 8.15650 \\ \log \mu &= 2.85703 & \log \psi &= 1.47247 \end{aligned}$$

The following tables contain the principal values of the computations.

In fine the following values of perturbations due to Neptune result:

A) as function of m'

B) with the value $m' = 1/19350$

$$\left[\frac{de}{dt} \right]_{00} = -0.7'' \cdot m' = -0.00003''$$

$$\left[\frac{d\chi}{dt} \right]_{00} = -131.2'' \cdot m' = -0.00547''$$

$$\left[\frac{di}{dt} \right]_{00} = +10.9'' \cdot m' = +0.00045''$$

$$\left[\frac{d\Omega}{dt} \right]_{00} = -130.6'' \cdot m' = -0.00544''$$

$$\left[\frac{d\pi}{dt} \right]_{00} = -136.9'' \cdot m' = -0.00571''$$

$$\left[\frac{dL}{dt} \right]_{00} = -534.7'' \cdot m' = -0.02228''$$

Secular perturbations by the planet Neptune

E	A	B^2	g	h	l	G	G'	G''	Θ	$\log K$	$\log L$	$\log M$
0	907.10	535.5	311.4	907.01	0.02	907.009	0.185	0.176	1.141	0.00013	0.27317	0.17628
45	901.77	2796.3	69.8	906.69	3.01	906.686	3.036	0.025	3.331	0.00110	0.27447	0.17774
90	918.79	10765.2	3.8	906.92	11.80	906.921	11.796	0.000	6.549	0.00427	0.27869	0.18249
135	932.65	22700.7	372.8	907.59	25.00	907.586	25.012	0.016	9.559	0.00912	0.28515	0.18975
180	939.45	29862.1	1125.0	906.51	32.87	906.510	32.905	0.038	10.989	0.01208	0.28908	0.19417
225	931.42	22470.8	1319.0	906.64	24.71	906.636	24.770	0.059	9.526	0.00906	0.28506	0.18966
270	917.04	9260.4	676.5	906.83	10.14	906.832	10.212	0.073	6.113	0.00372	0.2775	0.18166
315	908.54	1678.0	74.9	906.68	1.78	906.684	1.822	0.045	2.601	0.00067	0.27390	0.17710

Secular perturbations by the planet Neptune

E	$\log N$	$\log P$	$\log Q = \log V$	$\log J_1$	$\log J_2$	$\log J_3$	$\log F_2$	$\log F_3$
0	6.00554	0.36332	3.22412	2.95735	0.55155	0.58642 _n	2.20931	8.65916
45	6.48487	0.84441	3.70515	2.92537	0.48259 _n	2.06144	2.58169	7.70446
90	7.09932	1.46287	4.32424	2.94011	1.50720	2.23663	1.75311 _n	8.57637
135	7.45900	1.82847	4.69086	2.95282	1.36948	2.12825	2.74837 _n	9.88692
180	7.57578	1.95007	4.81255	2.95728	0.68201	1.36621	2.98823 _n	0.21699
225	7.45958	1.82974	4.69178	2.95519	1.19802	1.98146 _n	3.02278 _n	0.17891
270	7.09879	1.46062	4.32290	2.94910	1.44179 _n	2.07998 _n	2.87778 _n	9.80592
315	6.48443	0.84338	3.70405	2.92550	0.64605 _n	2.06058 _n	2.39989 _n	7.95513

Secular perturbations by the planet Neptune

E	$\log R_0$	$\log S_0$	$\log W_0$	I + II	III + IV	$W_0 \cos u$	$W_0 \sin u$	$-2 \cdot R_0 \cdot r/a$
0	5.70330	3.80195 _n	3.81043 _n	+0.0000013	+0.0000505	+0.0000006	-0.0000000	-0.0000288
45	6.07984	4.13694 _n	5.76645	+0.0001192	-0.0000046	-0.0000058	-0.0000581	-0.0001189
90	6.74524	5.82994	6.56087	+0.0003498	-0.0002536	+0.0002288	-0.0002828	-0.0011124
135	7.14666	6.03422	6.81907	+0.0002818	-0.0011790	+0.0005935	-0.0002872	-0.0042202
180	7.28029	5.19324	6.17875	-0.0000312	-0.0019068	+0.0001499	-0.0000175	-0.0065391
225	7.15315	5.92705 _n	6.67226 _n	-0.0006071	-0.0012306	-0.0004590	-0.0001021	-0.0042838
270	6.77783	5.78196 _n	6.40422 _n	-0.0003858	-0.0002996	-0.0002242	-0.0001552	-0.0011991
315	6.08364	4.38367 _n	5.76562 _n	-0.0001229	+0.0000030	-0.0000076	-0.0000578	-0.0001199
				-0.0000660	-0.0024095	+0.0001552	-0.0004555	-0.0088795
				-0.0003289	-0.0024172	+0.0001210	-0.0005051	-0.0087429
				-0.0003949	-0.0048267	+0.0002762	-0.0009606	-0.0176224

The sums of all perturbed values are:

$$\left[\frac{de}{dt} \right]_{00} = -16.543''$$

$$\left[\frac{dX}{dt} \right]_{00} = +31.642''$$

$$\left[\frac{di}{dt} \right]_{00} = -19.486''$$

$$\left[\frac{dQ}{dt} \right]_{00} = -238.854''$$

$$\left[\frac{d\pi}{dt} \right]_{00} = +19.088''$$

$$\left[\frac{dL}{dt} \right]_{00} = +24.748''$$

ИССЛЕДОВАНИЕ СИСТЕМЫ КОМЕТЫ ПОНСА—ВИННЕКЕ

I ЧАСТЬ

ВЕКОВЫЕ ВОЗМУЩЕНИЯ ОРБИТЫ КОМЕТЫ ПОНСА—ВИННЕКЕ

Для изучения движения кометы Понса—Виннеке, или-же ее метеорного потока я полагал нужным вычислить вековые возмущения от 8 главных планет. Для определения вековых возмущений применялся способ Гаусса по Гиллу (*The Collected Mathematicae Works of G. W. Hill, Volume II, 1906*). При этом для вычисления возмущений от Меркурия, Венеры, Земли, Марса и Сатурна мы пользовались разделением в эксцентрической аномалии через 5° , для Урана через 30° и для Нептуна через 45° . Для Юпитера был однако взят интервал через 10° , который однако для максимального возмущающего действия должен

был бы быть еще более сужен. Ввиду того однако что вычисления были только ориентировочными, результат не был уточнен. Вообще выходит, что вычисления вековых возмущений для короткопериодических орбит, которые выше того приближаются к соизмеримости, не имеют того значения, как для орбит с периодом более длинным, который несоизмеримый с периодом возмущающей планеты. В первом случае орбита может существенно измениться повторяемым тесным приближением к возмущающей планете. Подробная дискуссия об этой проблеме будет произведена в следующих частях работы.

ŠTÚDIE O SYSTÉME PERIODICKEJ KOMÉTY PONS–WINNECKOVEJ

ČASŤ I

SEKULÁRNE PORUCHY DRÁHY PONS – WINNECKOVEJ KOMÉTY

Pre výskum pohybu Pons–Winneckovej kométy a s ňou súvisiaceho meteorického roja som pokladal za potrebné určiť sekulárne poruchy dráhy, vyvolané ôsmimi veľkými planétami. Pre výpočet bola použitá Gaussova metóda v Hillovej úprave. Poruchy Merkura, Venuše, Zeme, Marsa a Saturna boli určované v bodoch vzdialených od seba o 15° v excentrickej anomálii, Uranove a Neptúnove poruchy v intervaloch 30° , resp. 45° . Iba pre Jupitera bol zvolený interval 10° , ktorý by bolo treba v oblasti najsilnejších porúch ešte viac zúžiť.

Keďže išlo predovšetkým o kvalitatívne výsledky, výpočet nebol ďalej spresňovaný.

Všeobecne sa ukazuje, že výpočet sekulárnych porúch krátkoperiodických dráh, ktoré sú ešte k tomu v rezonancii s rušiacou planétou, nemá taký význam ako v prípade dráh o dlhšej a nekomenzurabilnej dobe obehu. Príčina spočíva v tom, že takéto dráhy sa môžu podstatne meniť opakovanými tesnými priblíženiami k rušiackej planéte. Podrobnejší rozbor tohto problému bude podaný v ďalších častiach práce.