Table 7. Lunar mantle and core initial Euler angles (radian) and angular velocities (radian/day)
(TDB) 2440400.5 (June 28, 1969). Note that the core angular velocity is expressed in the man

ϕ_m, θ_m, ψ_m	0.00512830031411853500	0.38239278420173690000	1.29416700274878300000
$\omega_{m,x}, \omega_{m,y}, \omega_{m,z}$	0.00004573724185991433	−0.00000218986174567293	0.22994486018992250000
ϕ_c, θ_c, ψ_c	−0.00241990927040684100	0.41101946488652730000	0.46309468558363680000
$\omega_{c,x}, \omega_{c,y}, \omega_{c,z}$	−0.00661836772247824400	−0.00107295445159005100	0.22964879652299730000

Table 8. Mass parameters of major bodies.

Body	GM, au^3/day^2	$GM_\odot / GM_{body}$	GM, km^3/s^2
Sun	0.295912208285591100E−03	1.000000	132712440041.939400
Mercury	0.491248045036476000E−10	6023682.155592	22031.780000
Venus	0.724345233264412000E−09	408523.718658	324858.592000
Earth	0.888769244512563400E−09	332946.048834	398600.435436
Mars	0.954954869555077000E−10	3098703.590291	42828.375214
Jupiter	0.282534584083387000E−06	1047.348625	126712764.800000
Saturn	0.845970607324503000E−07	3497.901768	37940585.200000
Uranus	0.129202482578296000E−07	22902.981613	5794548.600000
Neptune	0.152435734788511000E−07	19412.259776	6836527.100580
Pluto	0.217844105197418000E−11	135836683.768617	977.000000
Moon	0.109318945074237400E−10	27068703.241203	4902.800066

Table 9. Extended body parameters for the Sun.

R_9	696000.0	radius, km
$J_{2,9}$	2.1106088532726840E–07	Dynamical form–factor of the Sun
$a_{p,9}$	268.13	Right ascension of spin axis direction, deg
$d_{p,9}$	63.87	Declination of spin axis direction, deg

Table 10. Extended body parameters for the Earth.

R_E	6378.1363	Radius, km
J_{2E}	0.00108262545	Zonal harmonics of the Earth
J_{3E}	–0.00000253241	
J_{4E}	–0.000001616	
$d(J_{2E})/dt$	–2.60E–11	Rate of change of J_{2E} , yr^{-1}
$k_{20,E}$	0.335	Potential Love number for long–period deformation
$k_{21,E}$	0.32	Potential Love number for diurnal deformation
$k_{22,E}$	0.32	Potential Love number for semi–diurnal deformation
x_0^l	0.0640	Orbital time–lag for long–period deformation, days
x_1^l	–0.0044	Orbital time–lag for diurnal deformation, days
x_2^l	–0.1000	Orbital time–lag for semi–diurnal deformation, days
x_0	0.0	Rotational time–lag for long–period deformation, days
x_1	7.3632190228041890E–03	Rotational time–lag for dirunal deformation, days
x_2	2.5352978633388720E–03	Rotational time–lag for semi–diurnal deformation, days
U_{x_0}	5.6754203322893470E–03	X–axis rotation at J2000.0, ʺ
U_{y_0}	–1.7022656914989530E–02	Y–axis rotation at J2000.0, ʺ
dU_x/dt	2.7689915574483550E–04	Negative obliquity rate correction, ʺ/yr
dU_y/dt	–1.2118591216559240E–03	Precession rate correction times sine of obliquity, ʺ/yr

Table 11. Extended body parameters for the Moon.

R_M	1738.0	Radius, km
b_L	6.3102131934887270E–04	Lunar moment parameters
c_L	2.2773171480091860E–04	
$k_{2,M}$	0.024059	Potential love number
x_M	9.5830547273306690E–02	Time–lag for the solid–body tide, days
a_c	0.0007	Ratio of polar moment of inertia of core to mean total polar moment of inertia
f_c	2.4623904789198150E–04	Oblateness of core
k_v/C_T	1.6365616533709530E–08	Friction coefficient between core and mantle, radian/day
$J_{2,M}$	2.0321568464952570E–04	Undistorted 2nd zonal harmonic coefficient
$J_{3,M}$	8.4597026974594570E–06	Zonal harmonic coefficients
$J_{4,M}$	–9.7044138365700000E–06	
$J_{5,M}$	7.4221608384052890E–07	
$J_{6,M}$	–1.3767531350969900E–05	
$S_{3,1,M}$	5.8915551555318640E–06	Tesseral harmonic coefficients
$S_{3,2,M}$	1.6844743962783900E–06	
$S_{3,3,M}$	–2.4742714379805760E–07	
$S_{4,1,M}$	1.5789202789245720E–06	
$S_{4,2,M}$	–1.5153915796731720E–06	
$S_{4,3,M}$	–8.0349266627431070E–07	
$S_{4,4,M}$	8.2964257754075220E–08	
$S_{5,1,M}$	–3.5272289393243820E–06	
$S_{5,2,M}$	1.7107886673430380E–07	
$S_{5,3,M}$	2.8736257616334340E–07	
$S_{5,4,M}$	5.2652110720146800E–10	
$S_{5,5,M}$	–6.7824035473995330E–09	
$S_{6,1,M}$	–2.0453507141252220E–06	
$S_{6,2,M}$	–2.6966834353574270E–07	
$S_{6,3,M}$	–7.1063745295915780E–08	
$S_{6,4,M}$	–1.5361616966632300E–08	
$S_{6,5,M}$	–8.3465073195142520E–09	
$S_{6,6,M}$	1.6844213702632920E–09	
$C_{3,1,M}$	2.8480741195592860E–05	
$C_{3,2,M}$	4.8449420619770600E–06	
$C_{3,3,M}$	1.6756178134114570E–06	
$C_{4,1,M}$	–5.7048697319733210E–06	
$C_{4,2,M}$	–1.5912271792977430E–06	
$C_{4,3,M}$	–8.0678881596778210E–08	
$C_{4,4,M}$	–1.2692158612216040E–07	
$C_{5,1,M}$	–8.6629769308983560E–07	
$C_{5,2,M}$	7.1199537967353330E–07	
$C_{5,3,M}$	1.5399750424904520E–08	
$C_{5,4,M}$	2.1444704319218450E–08	
$C_{5,5,M}$	7.6596153884006140E–09	
$C_{6,1,M}$	1.2024363601545920E–06	
$C_{6,2,M}$	–5.4703897324156850E–07	
$C_{6,3,M}$	–6.8785612757292010E–08	
$C_{6,4,M}$	1.2915580402925160E–09	
$C_{6,5,M}$	1.1737698784460500E–09	
$C_{6,6,M}$	–1.0913395178881540E–09	

provided by the WISE and SIMPS surveys [9,10]. In a similar previous analysis [7], information on individual asteroid mass parameters was excluded, to allow independent estimates based on the range data to Martian spacecraft. For DE430 and DE431, asteroid mass parameter estimates from other techniques were included as a priori constraints. Estimates were included based on close encounters between asteroids [90,91], masses of binary asteroids [92–95], and masses determined from radio tracking of spacecraft directly affected by the gravity of individual asteroids [96–99]. The mass parameters used for DE430/DE431 are given in Table 12. The initial positions and velocities of the asteroids were taken from the Horizons online solar system data service [13] and are given in Table 13.

Acknowledgments

Table 12. Mass parameters of asteroids (1 of 7).

Number	Name	GM, au³/day²	$GM_{ast}/GM_\odot$	GM, km³/s²
1	Ceres	0.140047655617234400E–12	4.73E–10	62.809393
2	Pallas	0.310444819893871300E–13	1.05E–10	13.923011
3	Juno	0.361753831714793700E–14	1.22E–11	1.622415
4	Vesta	0.385475018780881000E–13	1.30E–10	17.288009
5	Astraea	0.374873628455203200E–15	1.27E–12	0.168126
6	Hebe	0.831241921267337200E–15	2.81E–12	0.3728
7	Iris	0.213643444257140700E–14	7.22E–12	0.958161
8	Flora	0.589425652970690800E–15	1.99E–12	0.264349
9	Metis	0.107784100424073000E–14	3.64E–12	0.483396
10	Hygiea	0.123580078729412500E–13	4.18E–11	5.542392
11	Parthenope	0.133153625545997500E–14	4.50E–12	0.597175
12	Victoria	0.193177578518292000E–15	6.53E–13	0.086637
13	Egeria	0.179700489450744600E–14	6.07E–12	0.805931
14	Irene	0.110064567957506800E–14	3.72E–12	0.493624
15	Eunomia	0.467830741835090500E–14	1.58E–11	2.098155
16	Psyche	0.341158682619381200E–14	1.15E–11	1.530048
17	Thetis	0.208150639646973800E–15	7.03E–13	0.093353
18	Melpomene	0.200892773665113200E–15	6.79E–13	0.090098
19	Fortuna	0.103564484013119400E–14	3.50E–12	0.464472
20	Massalia	0.919980747763091100E–16	3.11E–13	0.04126
21	Lutetia	0.252944287204099900E–15	8.55E–13	0.113442
22	Kalliope	0.120262444348346000E–14	4.06E–12	0.53936
23	Thalia	0.189533176041978300E–15	6.41E–13	0.085003
24	Themis	0.189390166752538200E–14	6.40E–12	0.849388
25	Phocaea	0.723984152236621100E–16	2.45E–13	0.03247
26	Proserpina	0.163734395226108400E–15	5.53E–13	0.073433
27	Euterpe	0.388800389854578800E–15	1.31E–12	0.174371
28	Bellona	0.292627274429452800E–15	9.89E–13	0.131239
29	Amphitrite	0.197584236512452000E–14	6.68E–12	0.886137
30	Urania	0.148201901643752900E–15	5.01E–13	0.066466
31	Euphrosyne	0.634328047364860200E–14	2.14E–11	2.844872
32	Pomona	0.119958501623344000E–15	4.05E–13	0.0538
34	Circe	0.294454129152128600E–15	9.95E–13	0.132059
35	Leukothea	0.235225617324184100E–15	7.95E–13	0.105495
36	Atalante	0.169706001840970900E–15	5.74E–13	0.076111
37	Fides	0.218562057711305600E–15	7.39E–13	0.098022
38	Leda	0.132328596474676800E–15	4.47E–13	0.059348
39	Laetitia	0.149751968255670100E–14	5.06E–12	0.671616
40	Harmonia	0.295241408030842200E–15	9.98E–13	0.132412
41	Daphne	0.932422376219886900E–15	3.15E–12	0.418178
42	Isis	0.276531664347438100E–15	9.35E–13	0.124021
43	Ariadne	0.727539385334071200E–16	2.46E–13	0.032629
44	Nysa	0.468864072012922000E–16	1.58E–13	0.021028
45	Eugenia	0.842567801856793400E–15	2.85E–12	0.37788
46	Hestia	0.327280000000000000E–15	1.11E–12	0.14678
47	Aglaja	0.554352356159888900E–15	1.87E–12	0.248619
48	Doris	0.253109172601506800E–14	8.55E–12	1.135159
49	Pales	0.754948162931440200E–16	2.55E–13	0.033858
50	Virginia	0.163332639111751800E–15	5.52E–13	0.073252

Table 12. Mass parameters of asteroids. (Continued: 2 of 7)

Number	Name	GM, au³/day²	GM_{ast}/GM_9	GM, km³/s²
51	Nemausa	0.257054911335314500E–15	8.69E–13	0.115285
52	Europa	0.247678810125586700E–14	8.37E–12	1.110804
53	Kalypso	0.623924331077516500E–16	2.11E–13	0.027982
54	Alexandra	0.562417365019245900E–15	1.90E–12	0.252236
56	Melete	0.369928831270212600E–15	1.25E–12	0.165908
57	Mnemosyne	0.368060192063965100E–15	1.24E–12	0.16507
58	Concordia	0.848117391146600300E–16	2.87E–13	0.038037
59	Elpis	0.633944272758765100E–15	2.14E–12	0.284315
60	Echo	0.509113678301446400E–16	1.72E–13	0.022833
62	Erato	0.108904819196005700E–15	3.68E–13	0.048842
63	Ausonia	0.564040174397624300E–16	1.91E–13	0.025296
65	Cybele	0.318065928265254100E–14	1.07E–11	1.426481
68	Leto	0.343102659123796900E–15	1.16E–12	0.153877
69	Hesperia	0.514461002087673500E–15	1.74E–12	0.230728
70	Panopaea	0.276888884015784600E–15	9.36E–13	0.124181
71	Niobe	0.142449274635095600E–15	4.81E–13	0.063886
72	Feronia	0.799505104491654100E–16	2.70E–13	0.035857
74	Galatea	0.350737445129561400E–15	1.19E–12	0.157301
75	Eurydike	0.435737462507712700E–16	1.47E–13	0.019542
76	Freia	0.831220000000000100E–15	2.81E–12	0.37279
77	Frigga	0.493129550950072900E–16	1.67E–13	0.022116
78	Diana	0.840190625346388700E–16	2.84E–13	0.037681
79	Eurynome	0.835182433140794000E–16	2.82E–13	0.037457
80	Sappho	0.116144395411310800E–15	3.92E–13	0.052089
81	Terpsichore	0.102236755455613400E–15	3.45E–13	0.045852
82	Alkmene	0.660126076693077000E–16	2.23E–13	0.029606
83	Beatrix	0.109683489062603500E–15	3.71E–13	0.049191
84	Klio	0.125731265563188600E–15	4.25E–13	0.056389
85	Io	0.925408545301853800E–15	3.13E–12	0.415033
86	Semele	0.215239955702289100E–15	7.27E–13	0.096532
87	Sylvia	0.219929517357407300E–14	7.43E–12	0.986353
88	Thisbe	0.257711412731104700E–14	8.71E–12	1.155799
89	Julia	0.340203115743942900E–15	1.15E–12	0.152576
90	Antiope	0.123519636282849100E–15	4.17E–13	0.055397
91	Aegina	0.244046167770100600E–15	8.25E–13	0.109451
92	Undina	0.403694351768607300E–15	1.36E–12	0.181051
93	Minerva	0.564773071797647600E–15	1.91E–12	0.253293
94	Aurora	0.127923000000000000E–14	4.32E–12	0.573717
95	Arethusa	0.271661970839325900E–15	9.18E–13	0.121837
96	Aegle	0.154656769562432500E–14	5.23E–12	0.693614
97	Klotho	0.103149563583763100E–15	3.49E–13	0.046261
98	Ianthe	0.244283174173206900E–15	8.26E–13	0.109558
99	Dike	0.735266201384159100E–16	2.48E–13	0.032976
100	Hekate	0.136597719646869700E–15	4.62E–13	0.061262
102	Miriam	0.128126622566059800E–15	4.33E–13	0.057463
103	Hera	0.100111801685864600E–15	3.38E–13	0.044899
104	Klymene	0.481223966780187300E–15	1.63Ev12	0.215822
105	Artemis	0.371546679753414500E–15	1.26E–12	0.166633
106	Dione	0.539739999999999800E–15	1.82E–12	0.242066

Table 12. Mass parameters of asteroids. (Continued: 3 of 7)

Number	Name	GM, au³/day²	$GM_{ast}/GM_\odot$	GM, km³/s²
107	Camilla	0.167172099170064400E−14	5.65E−12	0.749743
109	Felicitas	0.108261858615819300E−15	3.66E−13	0.048554
110	Lydia	0.140769857221050400E−15	4.76E−13	0.063133
111	Ate	0.335191928112805600E−16	1.13E−13	0.015033
112	Iphigenia	0.579603970155323500E−16	1.96E−13	0.025994
113	Amalthea	0.255802139245781900E−16	8.64E−14	0.011472
114	Kassandra	0.170500000000000000E−15	5.76E−13	0.076467
115	Thyra	0.552582419038552700E−16	1.87E−13	0.024783
117	Lomia	0.447136801784178900E−15	1.51E−12	0.200535
118	Peitho	0.270007596259813500E−16	9.12E−14	0.012109
120	Lachesis	0.118898494995200800E−14	4.02E−12	0.533243
121	Hermione	0.700790692204134300E−15	2.37E−12	0.314295
124	Alkeste	0.887727082656233800E−16	3.00E−13	0.039813
127	Johanna	0.366116824306172300E−15	1.24E−12	0.164198
128	Nemesis	0.965012951054875100E−15	3.26E−12	0.432795
129	Antigone	0.465424524739797500E−15	1.57E−12	0.208736
130	Elektra	0.993662954590924800E−15	3.36E−12	0.445644
132	Aethra	0.131961412217015600E−16	4.46E−14	0.005918
134	Sophrosyne	0.336204654208871600E−15	1.14E−12	0.150783
135	Hertha	0.951560504184620700E−16	3.22E−13	0.042676
137	Meliboea	0.856126059955389200E−15	2.89E−12	0.38396
139	Juewa	0.422428821437744500E−15	1.43E−12	0.189453
140	Siwa	0.313167325322240600E−15	1.06E−12	0.140451
141	Lumen	0.376614060167083300E−15	1.27E−12	0.168906
143	Adria	0.112608611474888300E−15	3.81E−13	0.050503
144	Vibilia	0.699516335498308700E−15	2.36E−12	0.313723
145	Adeona	0.755823292622889200E−15	2.55E−12	0.338976
146	Lucina	0.394160000000000000E−15	1.33E−12	0.176775
147	Protogeneia	0.406817291771643100E−15	1.37E−12	0.182452
148	Gallia	0.165952595163453000E−15	5.61E−13	0.074427
150	Nuwa	0.453364684879681200E−15	1.53E−12	0.203328
154	Bertha	0.829838876716369400E−15	2.80E−12	0.372171
156	Xanthippe	0.263360000000000000E−15	8.90E−13	0.118113
159	Aemilia	0.288240661838050000E−15	9.74E−13	0.129272
160	Una	0.102484870587440500E−15	3.46E−13	0.045963
162	Laurentia	0.237290753793420100E−15	8.02E−13	0.106422
163	Erigone	0.865800000000000100E−16	2.93E−13	0.03883
164	Eva	0.418326020317249000E−15	1.41E−12	0.187613
165	Loreley	0.106845990270469300E−14	3.61E−12	0.479189
168	Sibylla	0.534709999999999800E−15	1.81E−12	0.23981
171	Ophelia	0.151098849092935500E−15	5.11E−13	0.067766
172	Baucis	0.431771576449205300E−16	1.46E−13	0.019364
173	Ino	0.391242854708310100E−15	1.32E−12	0.175467
175	Andromache	0.289909719621158200E−15	9.80E−13	0.13002
176	Iduna	0.167134755200936100E−15	5.65E−13	0.074958
177	Irma	0.453728862942509900E−16	1.53E−13	0.020349
181	Eucharis	0.167967668335482500E−15	5.68E−13	0.075331
185	Eunike	0.113558589448392200E−14	3.84E−12	0.509294
187	Lamberta	0.941936446359531100E−15	3.18E−12	0.422445

Table 12. Mass parameters of asteroids. (Continued: 4 of 7)

Number	Name	GM, au^3/day^2	GM_{ast}/GM_9	GM, km^3/s^2
191	Kolga	0.172525552363828900E−15	5.83E−13	0.077375
192	Nausikaa	0.251194126565783300E−15	8.49E−13	0.112657
194	Prokne	0.272305872890598200E−15	9.20E−13	0.122125
195	Eurykleia	0.835481985073780800E−16	2.82E−13	0.03747
196	Philomela	0.450141365611792800E−15	1.52E−12	0.201882
198	Ampella	0.205385768290833100E−16	6.94E−14	0.009211
200	Dynamene	0.175546167825261400E−15	5.93E−13	0.07873
201	Penelope	0.101472968957165600E−15	3.43E−13	0.045509
203	Pompeja	0.184924720803005400E−15	6.25E−13	0.082936
205	Martha	0.915149992259589400E−16	3.09E−13	0.041043
206	Hersilia	0.117896698493573100E−15	3.98E−13	0.052875
209	Dido	0.259310730988729300E−15	8.76E−13	0.116297
210	Isabella	0.131453781488021000E−15	4.44E−13	0.058955
211	Isolda	0.304651155649041000E−15	1.03E−12	0.136632
212	Medea	0.386749965775167900E−15	1.31E−12	0.173452
213	Lilaea	0.952238918721723900E−16	3.22E−13	0.042707
216	Kleopatra	0.690797124746742500E−15	2.33E−12	0.309813
221	Eos	0.181684062017330300E−15	6.14E−13	0.081483
223	Rosa	0.139060396851984600E−15	4.70E−13	0.062367
224	Oceana	0.395205903434527200E−16	1.34E−13	0.017724
225	Henrietta	0.414565717253527800E−15	1.40E−12	0.185927
227	Philosophia	0.120484595454650200E−15	4.07E−13	0.054036
230	Athamantis	0.176089871551513500E−15	5.95E−13	0.078974
233	Asterope	0.197159196662545500E−15	6.66E−13	0.088423
236	Honoria	0.113632939011338100E−15	3.84E−13	0.050963
238	Hypatia	0.529666935807391100E−15	1.79E−12	0.237548
240	Vanadis	0.110486225287326500E−15	3.73E−13	0.049552
241	Germania	0.300548362594600500E−15	1.02E−12	0.134792
247	Eukrate	0.270972707241621300E−15	9.16E−13	0.121527
250	Bettina	0.196885501859924200E−15	6.65E−13	0.0883
259	Aletheia	0.628085855393638300E−15	2.12E−12	0.281688
266	Aline	0.184133018752378200E−15	6.22E−13	0.082581
268	Adorea	0.526690110925434800E−15	1.78E−12	0.236213
275	Sapientia	0.186540000000000000E−15	6.30E−13	0.083661
276	Adelheid	0.224815504884368300E−15	7.60E−13	0.100827
283	Emma	0.205281017798695800E−15	6.94E−13	0.092066
287	Nephthys	0.480337378560961000E−16	1.62E−13	0.021542
303	Josephina	0.288486840395101100E−15	9.75E−13	0.129382
304	Olga	0.688327109660540100E−16	2.33E−13	0.03087
308	Polyxo	0.724054788525813900E−15	2.45E−12	0.324728
313	Chaldaea	0.115845913374079600E−15	3.91E−13	0.051955
322	Phaeo	0.827634952130435800E−16	2.80E−13	0.037118
324	Bamberga	0.138862658985619900E−14	4.69E−12	0.622779
326	Tamara	0.189152474665620900E−15	6.39E−13	0.084832
328	Gudrun	0.291270000000000000E−15	9.84E−13	0.13063
329	Svea	0.511430939429605700E−16	1.73E−13	0.022937
334	Chicago	0.326249337943456200E−15	1.10E−12	0.146318
335	Roberta	0.147567692588891100E−15	4.99E−13	0.066182
336	Lacadiera	0.564300000000000000E−16	1.91E−13	0.025308

Table 12. Mass parameters of asteroids. (Continued: 5 of 7)

Number	Name	GM, au³/day²	GM_{ast}/GM_9	GM, km³/s²
337	Devosa	0.345150745118659600E–16	1.17E–13	0.01548
338	Budrosa	0.514076834286322000E–16	1.74E–13	0.023056
344	Desiderata	0.536890970425833500E–15	1.81E–12	0.240788
345	Tercidina	0.123175211698841300E–15	4.16E–13	0.055242
346	Hermentaria	0.220991660771765600E–15	7.47E–13	0.099112
347	Pariana	0.219491221778173700E–16	7.42E–14	0.009844
349	Dembowska	0.700787392713029200E–15	2.37E–12	0.314293
350	Ornamenta	0.141000784057630900E–15	4.76E–13	0.063237
354	Eleonora	0.158509865715968900E–14	5.36E–12	0.710894
356	Liguria	0.268161319613518200E–15	9.06E–13	0.120267
357	Ninina	0.176195602610025700E–15	5.95E–13	0.079021
358	Apollonia	0.121780979958317900E–15	4.12E–13	0.054617
360	Carlova	0.336776057435300700E–15	1.14E–12	0.151039
362	Havnia	0.808707928810328300E–16	2.73E–13	0.036269
363	Padua	0.698419453021186600E–16	2.36E–13	0.031323
365	Corduba	0.776955520962180000E–16	2.63E–13	0.034845
366	Vincentina	0.115639547136458300E–15	3.91E–13	0.051863
369	Aeria	0.573458156633685800E–16	1.94E–13	0.025719
372	Palma	0.174595572627050000E–14	5.90E–12	0.783036
373	Melusina	0.137206175961377900E–15	4.64E–13	0.061535
375	Ursula	0.455859924880692500E–15	1.54E–12	0.204447
377	Campania	0.141442289208980800E–15	4.78E–13	0.063435
381	Myrrha	0.359349348076176100E–15	1.21E–12	0.161163
385	Ilmatar	0.110318518229682800E–15	3.73E–13	0.049476
386	Siegena	0.150793337119651900E–14	5.10E–12	0.676287
387	Aquitania	0.100446598396309400E–15	3.39E–13	0.045049
388	Charybdis	0.343334441285916900E–15	1.16E–12	0.153981
389	Industria	0.622510183873803300E–16	2.10E–13	0.027919
393	Lampetia	0.155860000000000000E–15	5.27E–13	0.069901
404	Arsinoe	0.145216789548421900E–15	4.91E–13	0.065128
405	Thia	0.557648047680853900E–15	1.88E–12	0.250097
407	Arachne	0.156785041404748300E–15	5.30E–13	0.070316
409	Aspasia	0.821449999999999900E–15	2.78E–12	0.368409
410	Chloris	0.361865469702973400E–15	1.22E–12	0.162292
412	Elisabetha	0.146557349756319100E–15	4.95E–13	0.065729
415	Palatia	0.540012140874342300E–16	1.82E–13	0.024219
416	Vaticana	0.148698562934496100E–15	5.03E–13	0.066689
419	Aurelia	0.367820000000000000E–15	1.24E–12	0.164962
420	Bertholda	0.483520000000000000E–15	1.63E–12	0.216852
423	Diotima	0.211243836059995200E–14	7.14E–12	0.947399
424	Gratia	0.737998534437522900E–16	2.49E–13	0.033098
426	Hippo	0.229797581279714500E–15	7.77E–13	0.103061
431	Nephele	0.634077834952169700E–16	2.14E–13	0.028437
432	Pythia	0.187801229589892800E–16	6.35E–14	0.008423
433	Eros	0.990000118979590300E–18	3.35E–15	0.000444
442	Eichsfeldia	0.555346562874691200E–16	1.88E–13	0.024907
444	Gyptis	0.907080484411450500E–15	3.07E–12	0.406813
445	Edna	0.115342108493158500E–15	3.90E–13	0.051729
449	Hamburga	0.135581713067348800E–15	4.58E–13	0.060806

Table 12. Mass parameters of asteroids. (Continued: 6 of 7)

Number	Name	GM, a^3/day²	GM_{ast}/GM_9	GM, km³/s²
451	Patientia	0.229555939063746200E–14	7.76E–12	1.029526
454	Mathesis	0.768088477469999900E–16	2.60E–13	0.034448
455	Bruchsalia	0.228615933395781000E–15	7.73E–13	0.102531
464	Megaira	0.806351842900557800E–16	2.72E–13	0.036164
465	Alekto	0.653992577244023600E–16	2.21E–13	0.029331
466	Tisiphone	0.270714167365278100E–15	9.15E–13	0.121411
469	Argentina	0.322840000000000000E–15	1.09E–12	0.144789
471	Papagena	0.845943072895968300E–15	2.86E–12	0.379394
476	Hedwig	0.241931605646406600E–15	8.18E–13	0.108503
481	Emita	0.334070052970451900E–15	1.13E–12	0.149826
485	Genua	0.367379607992341800E–16	1.24E–13	0.016476
488	Kreusa	0.191515627988507800E–15	6.47E–13	0.085892
489	Comacina	0.548467242911317100E–15	1.85E–12	0.24598
490	Veritas	0.364149739778329100E–15	1.23E–12	0.163316
491	Carina	0.148589708382528900E–15	5.02E–13	0.06664
498	Tokio	0.129879292391702200E–15	4.39E–13	0.058249
503	Evelyn	0.111871833145007600E–15	3.78E–13	0.050173
505	Cava	0.341769850174723900E–15	1.15E–12	0.153279
506	Marion	0.197353139110484100E–15	6.67E–13	0.08851
508	Princetonia	0.341067697975348700E–15	1.15E–12	0.152964
511	Davida	0.519812697945749800E–14	1.76E–11	2.331286
514	Armida	0.293765207953148200E–15	9.93E–13	0.13175
516	Amherstia	0.696000000000000000E–16	2.35E–13	0.031215
517	Edith	0.108862665088002000E–15	3.68E–13	0.048823
521	Brixia	0.181244939644586100E–15	6.12E–13	0.081286
532	Herculina	0.931594859406562000E–15	3.15E–12	0.417807
535	Montague	0.725386164346611400E–16	2.45E–13	0.032533
536	Merapi	0.109756310328225100E–14	3.71E–12	0.492242
545	Messalina	0.194849861155712500E–15	6.58E–13	0.087387
547	Praxedis	0.281235774586576800E–16	9.50E–14	0.012613
554	Peraga	0.274856688034015000E–15	9.29E–13	0.123269
566	Stereoskopia	0.626740000000000000E–15	2.12E–12	0.281084
568	Cheruskia	0.859780218818313100E–16	2.91E–13	0.03856
569	Misa	0.611232197266831400E–16	2.07E–13	0.027413
584	Semiramis	0.217605956141594600E–16	7.35E–14	0.009759
585	Bilkis	0.117169915406794000E–16	3.96E–14	0.005255
591	Irmgard	0.200383935095216300E–16	6.77E–14	0.008987
593	Titania	0.501889934520749200E–16	1.70E–13	0.022509
595	Polyxena	0.222111336158284500E–15	7.51E–13	0.099614
596	Scheila	0.383508917087800200E–15	1.30E–12	0.171998
598	Octavia	0.615306415407552400E–16	2.08E–13	0.027596
599	Luisa	0.691187747327401000E–16	2.34E–13	0.030999
602	Marianna	0.215014674336122500E–15	7.27E–13	0.096431
604	Tekmessa	0.642603995331864300E–16	2.17E–13	0.02882
618	Elfriede	0.463868801607939000E–15	1.57E–12	0.208039
623	Chimaera	0.144979767976932900E–16	4.90E–14	0.006502
626	Notburga	0.166437787258821500E–15	5.62E–13	0.074645
635	Vundtia	0.169956695263313900E–15	5.74E–13	0.076223
654	Zelinda	0.359530000000000000E–15	1.21E–12	0.161244
449	Hamburga	0.135581713067348800E–15	4.58E–13	0.060806

Table 12. Mass parameters of asteroids. (Continued: 7 of 7)

Number	Name	GM, au³/day²	GM_{ast}/GM_9	GM, km³/s²
663	Gerlinde	0.120495494885781800E−15	4.07E−13	0.054041
667	Denise	0.909429441579076000E−16	3.07E−13	0.040787
674	Rachele	0.143837480044678900E−15	4.86E−13	0.064509
675	Ludmilla	0.159234708844922700E−15	5.38E−13	0.071415
680	Genoveva	0.995816201002551800E−16	3.37E−13	0.044661
683	Lanzia	0.104361036125065600E−15	3.53E−13	0.046804
690	Wratislavia	0.476375353165424700E−15	1.61E−12	0.213648
691	Lehigh	0.945370522582010200E−16	3.19E−13	0.042399
694	Ekard	0.149386680301335600E−15	5.05E−13	0.066998
696	Leonora	0.111777344239748500E−15	3.78E−13	0.050131
702	Alauda	0.889506728492704500E−15	3.01E−12	0.398931
704	Interamnia	0.525616867849366200E−14	1.78E−11	2.357317
705	Erminia	0.291750035064825000E−15	9.86E−13	0.130846
709	Fringilla	0.154560085386599100E−15	5.22E−13	0.069318
712	Boliviana	0.502042422129256500E−15	1.70E−12	0.225159
713	Luscinia	0.142681578483330100E−15	4.82E−13	0.063991
735	Marghanna	0.859762026371732300E−16	2.91E−13	0.038559
739	Mandeville	0.713824339752934800E−16	2.41E−13	0.032014
740	Cantabia	0.118928144393176900E−15	4.02E−13	0.053338
747	Winchester	0.621574606623668800E−15	2.10E−12	0.278767
751	Faina	0.179893748114765000E−15	6.08E−13	0.08068
752	Sulamitis	0.499820481258924800E−16	1.69E−13	0.022416
760	Massinga	0.581679210057327800E−16	1.97E−13	0.026087
762	Pulcova	0.208180128309056600E−15	7.04E−13	0.093366
769	Tatjana	0.197251539856937600E−15	6.67E−13	0.088465
772	Tanete	0.252061449253389500E−15	8.52E−13	0.113046
773	Irmintraud	0.195761609064233300E−15	6.62E−13	0.087796
776	Berbericia	0.305671194466365300E−15	1.03E−12	0.137089
778	Theobalda	0.477435477387998300E−16	1.61E−13	0.021412
780	Armenia	0.148574053476563100E−15	5.02E−13	0.066633
784	Pickeringia	0.163082309665980900E−15	5.51E−13	0.07314
786	Bredichina	0.158301988046999200E−15	5.35E−13	0.070996
788	Hohensteina	0.215815568176360100E−15	7.29E−13	0.09679
790	Pretoria	0.175589918332470000E−14	5.93E−12	0.787496
791	Ani	0.121964875174107500E−15	4.12E−13	0.0547
804	Hispania	0.226710334145990500E−15	7.66E−13	0.101676
814	Tauris	0.455595956637723700E−15	1.54E−12	0.204328
849	Ara	0.103549725015275900E−15	3.50E−13	0.046441
895	Helio	0.378647503308948400E−15	1.28E−12	0.169818
909	Ulla	0.336297549276103900E−15	1.14E−12	0.150825
914	Palisana	0.411726826839954200E−16	1.39E−13	0.018465
980	Anacostia	0.153529788855662000E−15	5.19E−13	0.068856
1015	Christa	0.125837659264500500E−15	4.25E−13	0.056436
1021	Flammario	0.761714098728426500E−16	2.57E−13	0.034162
1036	Ganymed	0.646776721323746100E−16	2.19E−13	0.029007
1093	Freda	0.287164048267019600E−15	9.70E−13	0.128789
1107	Lictoria	0.954912821588764700E−16	3.23E−13	0.042826
1171	Rusthawelia	0.624856870846376100E−16	2.11E−13	0.028024
1467	Mashona	0.111528013303481700E−15	3.77E−13	0.050019

#	Name				
1	Ceres	x,y,z	1.438681809676469747	−2.204373633189407045	−1.326397853361325874
		v_x,v_y,v_z	0.008465406136316316	0.004684247977335608	0.000466157738595739
2	Pallas	x,y,z	0.203832272462290465	−3.209619436062307152	2.623843179079393351
		v_x,v_y,v_z	0.008534313855651248	−0.000860659210123161	0.000392901992572746
3	Juno	x,y,z	0.461207259670432135	−3.006098959780790114	−0.580164049296942208
		v_x,v_y,v_z	0.008395458298285176	0.003111908045571209	0.000273059675893248
4	Vesta	x,y,z	0.182371836377417107	2.386628211277654001	0.924596062836265498
		v_x,v_y,v_z	−0.010174496747119257	0.000041478190529952	0.001344157634155624
5	Astraea	x,y,z	2.489297359488491956	1.036395265106434982	1.210563198822894787
		v_x,v_y,v_z	−0.005569115604615741	0.007959732929200320	0.003113959705731406
6	Hebe	x,y,z	1.339049495814490065	1.442775542206668801	0.579273672077323748
		v_x,v_y,v_z	−0.008775983793258694	0.009426820472364833	0.003535716141864189
7	Iris	x,y,z	1.892475267790300286	−0.848414748075139946	−0.157159319044464590
		v_x,v_y,v_z	0.002786950314570632	0.011314057384917047	0.004975132577079665
8	Flora	x,y,z	−2.119655892430383659	0.808466233981220765	0.333397871779012545
		v_x,v_y,v_z	−0.005818098320155988	−0.008811943327809565	0.002835330893491553
9	Metis	x,y,z	−2.424658333778681119	−0.125325594242630484	0.185966267773321953
		v_x,v_y,v_z	−0.001166914352512719	−0.009845348309999084	0.004559667512580128
10	Hygiea	x,y,z	2.444257569754775261	2.180591649726027814	1.628550825530954043
		v_x,v_y,v_z	−0.005924505919570356	0.005979686441736038	0.002286438610925529
11	Parthenope	x,y,z	−1.231933494613708824	−1.941584219024864808	0.548652135887457293
		v_x,v_y,v_z	0.010146729938442466	−0.004310578383941682	−0.002342316786027452
13	Egeria	x,y,z	1.110470035635196862	−1.956883630909689531	−1.669729176939996007
		v_x,v_y,v_z	0.008850484510873332	0.004168221460244788	0.000793489279402694
14	Irene	x,y,z	2.968959552750401354	0.179534605878148124	−0.441493212476667563
		v_x,v_y,v_z	0.000114431097969882	0.008313751393872647	0.003664818027075008
15	Eunomia	x,y,z	−1.438397661546355177	2.001287639171841207	0.767257269566094968
		v_x,v_y,v_z	−0.009735666014582665	−0.002981534818366074	−0.003694080871985814
16	Psyche	x,y,z	1.459069269212805553	−2.194286961057163143	−0.872045420720389042
		v_x,v_y,v_z	0.008193866970882068	0.006328897736618495	0.002167069206448382
18	Melpomene	x,y,z	−2.742133025533653790	−0.012766315168109306	0.239819478175997858
		v_x,v_y,v_z	−0.000996361773223022	−0.008953551423450837	−0.002237582813053089
19	Fortuna	x,y,z	−2.421846633153337702	−1.337431649320276250	−0.581397545560000673
		v_x,v_y,v_z	0.004769326689664416	−0.007520729608529603	−0.002981882787056496
20	Massalia	x,y,z	−0.446957693127368383	1.855382149831718607	0.478094121440758957
		v_x,v_y,v_z	−0.012511421939296488	−0.002534666129817137	−0.001141856361378328
21	Lutetia	x,y,z	−0.401500082512939060	−2.034737356634178429	−0.878857903014080954
		v_x,v_y,v_z	0.011859546440634965	−0.000138986487715931	−0.000750181020252093
22	Kalliope	x,y,z	−1.360169904369056937	−2.672544709790108275	−1.131055224812947957
		v_x,v_y,v_z	0.008015423798989894	−0.002573715371792212	−0.003469704484884123
23	Thalia	x,y,z	−1.381180931801666123	−2.177231877010123551	−0.869547456324116008
		v_x,v_y,v_z	0.007230267698506810	−0.005803206866356805	−0.004345034311979445
24	Themis	x,y,z	−1.986326887180129397	1.713080040332319402	0.782177241944561841
		v_x,v_y,v_z	−0.007376541658456220	−0.007515395858827745	−0.003291592430864249
25	Phocaea	x,y,z	1.862187339641438788	−0.320827452239953126	0.370298833532256677
		v_x,v_y,v_z	0.004047653066899725	0.012783082342996164	0.002077625994146512
27	Euterpe	x,y,z	−1.260198559466741086	1.418639340820153401	0.648923808375896249
		v_x,v_y,v_z	−0.010819473664968254	−0.006731978199858915	−0.002575089185167887

28	Bellona	x,y,z	−1.473796460584195778	1.739643135937173790	0.633933941012944979
		v_x,v_y,v_z	−0.009328149750934787	−0.007427778551081034	−0.001181230605742862
29	Amphitrite	x,y,z	−0.146988273583742862	−2.362796893883333915	−1.340108464209891492
		v_x,v_y,v_z	0.010080728492092296	−0.000192196827316014	−0.000039573406685344
30	Urania	x,y,z	−2.606330961010526526	−0.080313889098223457	−0.119443301999580323
		v_x,v_y,v_z	−0.000271687607297601	−0.009151555703778012	−0.004227028420836736
31	Euphrosyne	x,y,z	−2.344572196151709420	−2.202248246583482949	−1.499371924448428484
		v_x,v_y,v_z	0.004929226633590931	−0.003894954486494073	−0.005777736992660197
41	Daphne	x,y,z	2.186522806828394838	2.716000834079776549	0.352083724354172178
		v_x,v_y,v_z	−0.006362487833486645	0.004588916254801226	0.000658460597293756
42	Isis	x,y,z	−2.311906318139493433	1.564709507254086418	0.081663757432244743
		v_x,v_y,v_z	−0.005375422471534914	−0.006572477821943680	−0.002070451318821641
45	Eugenia	x,y,z	−1.286740660767531352	−2.064333827345071093	−0.581533957673131763
		v_x,v_y,v_z	0.009624183869937625	−0.005447390675875109	−0.002359148283535982
51	Nemausa	x,y,z	2.325725710714735328	0.919631243406134669	0.195346323188101051
		v_x,v_y,v_z	−0.004226342069996713	0.009366245889668433	0.002292473770765156
52	Europa	x,y,z	1.630504392123616197	−2.807391275567590050	−1.120111554599330095
		v_x,v_y,v_z	0.007545901962567781	0.004385628274804682	0.000681057876133087
60	Echo	x,y,z	−2.053758095409557338	0.542618601186906857	0.167604428744862921
		v_x,v_y,v_z	−0.005053755262744046	−0.010634893001978403	−0.003929518991233821
63	Ausonia	x,y,z	−0.711507633861145239	−1.727049410575609123	−0.980245752936226511
		v_x,v_y,v_z	0.011957874480153950	−0.003468676332191662	−0.001404339015793962
65	Cybele	x,y,z	−2.818818186481110377	−1.452785968979383169	−0.459547659952798004
		v_x,v_y,v_z	0.005491212616137729	−0.007709765186399763	−0.002980907967655813
69	Hesperia	x,y,z	−2.731373586077875171	−0.173990396273168008	−0.091512829062557879
		v_x,v_y,v_z	−0.000835829539403114	−0.010410309605217057	−0.002792056931756292
78	Diana	x,y,z	−2.230308915264555658	−0.612004762065796459	−0.543275243058195634
		v_x,v_y,v_z	0.001875816436270626	−0.009912063988588916	−0.005874203423004298
94	Aurora	x,y,z	1.217204321473684070	2.230213797067274853	0.349204301622864088
		v_x,v_y,v_z	−0.009480919363038220	0.003964160607269546	0.002537794862740618
97	Klotho	x,y,z	−1.909756234729403035	−2.678800550963929439	−0.452067580136410296
		v_x,v_y,v_z	0.006291707122836601	−0.005039334023207890	−0.001538832193933371
98	Ianthe	x,y,z	−2.189380245469819020	0.226114692352493402	0.112525782901568755
		v_x,v_y,v_z	−0.002121664740945849	−0.009612549934188979	−0.007843089126949381
105	Artemis	x,y,z	−2.150697286825749899	0.541875356226059646	−0.099139411741416952
		v_x,v_y,v_z	−0.000933995664699450	−0.011865009015818844	−0.000510278917224607
111	Ate	x,y,z	−2.065235972301910916	−1.395192740371126838	−0.851171268109567225
		v_x,v_y,v_z	0.005618108019220444	−0.008131544741012933	−0.003600368200049119
135	Hertha	x,y,z	−1.852065839438821637	−1.414537091163847737	−0.701764695699997887
		v_x,v_y,v_z	0.008706738823410954	−0.006122907739411309	−0.002836580152272733
139	Juewa	x,y,z	−2.286169743218249728	0.129793402866451107	0.113110508166727894
		v_x,v_y,v_z	−0.001144921173599620	−0.010129177653436634	−0.006915213503334226
145	Adeona	x,y,z	1.101693094201525502	2.046278461562542006	0.733533233415469499
		v_x,v_y,v_z	−0.010477714288306773	0.002702890747395121	0.003883525044571004
187	Lamberta	x,y,z	1.552362680005133111	−1.667017286215509042	−1.224506107407864253
		v_x,v_y,v_z	0.010026916904808853	0.004083994537401527	0.001832035781453411
192	Nausikaa	x,y,z	−2.180257484088014674	−1.605283294502194646	−1.009730329227873646
		v_x,v_y,v_z	0.006837112554701223	−0.005228654546530322	−0.002756824225065406

194	Prokne	x,y,z	1.495439006518376468	1.277354772575368669	−0.299878060343942709
		v_x,v_y,v_z	0.008680667325646010	0.010437900139680028	0.000134167930615169
216	Kleopatra	x,y,z	−2.623737352933921407	−2.141208444909570296	−0.848460319932531903
		v_x,v_y,v_z	0.005369324233200630	−0.005867957040039504	−0.000585039109819107
230	Athamantis	x,y,z	−2.280008375035697199	−0.880463965508790358	−0.645752311103840460
		v_x,v_y,v_z	0.004331702501765179	−0.009223170407939286	−0.002470255504286102
324	Bamberga	x,y,z	1.398759064223541682	−1.287476729008325105	−0.669098428660833799
		v_x,v_y,v_z	0.007164363244556328	0.009219958777618218	0.006857861727407507
337	Devosa	x,y,z	2.057440180433961707	−1.322162885949879740	−0.780976069801601058
		v_x,v_y,v_z	0.005188028188451134	0.007591643038099468	0.004670779035477783
344	Desiderata	x,y,z	−1.436281403678767443	2.243805682206950092	2.055782461490350155
		v_x,v_y,v_z	−0.006473875571808206	−0.004308997045040672	−0.001132197443002879
354	Eleonora	x,y,z	0.400598302733801259	−2.845496057705452220	−0.363223167203308106
		v_x,v_y,v_z	0.009411661670619676	−0.002169498446596223	−0.002270974488656075
372	Palma	x,y,z	−2.501245479525921134	−1.473356596063249313	−2.186348442117559632
		v_x,v_y,v_z	0.004414109643858683	−0.005694498088384558	−0.004127573934799787
405	Thia	x,y,z	−1.680813989369112971	−0.720962772281693809	−0.636265292808031457
		v_x,v_y,v_z	0.006053497060520836	−0.012004513735606900	−0.003193078939729851
409	Aspasia	x,y,z	2.627942640819607600	0.032856722306475960	1.499378874814495721
		v_x,v_y,v_z	−0.000121147420399894	0.009800913286716541	0.003214451046459611
419	Aurelia	x,y,z	−0.832205073692585229	2.925043505666565867	1.070613454084370586
		v_x,v_y,v_z	−0.007845381994993020	−0.002434064039560803	−0.001376245101202946
451	Patientia	x,y,z	1.259008304010221346	2.454041267595273634	3.690482754870751503
		v_x,v_y,v_z	−0.009063543500060710	0.003448045666261337	0.004183420491116245
488	Kreusa	x,y,z	−2.067224538805315426	−1.883392328874813781	−0.393159264399483011
		v_x,v_y,v_z	0.005745445324864604	−0.007721753293565463	−0.004781672638324677
511	Davida	x,y,z	−2.160191561573574504	1.486363108760649254	1.096959097247329984
		v_x,v_y,v_z	−0.007390695920479255	−0.007779023504823501	−0.000485540781565076
532	Herculina	x,y,z	−0.293159404090669762	−2.481691048455131111	0.725934583722743554
		v_x,v_y,v_z	0.010153432932361773	−0.002073902764508174	0.003634391919195946
554	Peraga	x,y,z	1.567515331928776900	−1.756839671087627286	3.730145653545691942
		v_x,v_y,v_z	0.007168202681128191	0.007126474516266886	0.003646321528209388
654	Zelinda	x,y,z	2.454317123300634673	−1.156415934845627709	3.118168382964153770
		v_x,v_y,v_z	0.001774157409192030	0.007979676971587295	0.004592146292516224
704	Interamnia	x,y,z	2.462835232264114715	−0.115048121589235539	0.978421928878808022
		v_x,v_y,v_z	−0.001309568805636822	0.010348987192429257	0.004812522889055394
747	Winchester	x,y,z	−0.834902081339142454	2.059697173467183607	0.613292775285328884
		v_x,v_y,v_z	−0.012134738848543374	−0.002004140070559451	0.002575815432470426
12	Victoria	x,y,z	−0.507844534173903961	2.607456081000619504	1.819717059989116925
		v_x,v_y,v_z	−0.009185378920496397	−0.000281429685500620	−0.001275015521881669
17	Thetis	x,y,z	−0.224334228105830036	−1.994047200796976282	−0.713424849893356972
		v_x,v_y,v_z	0.012457106084712540	−0.000945089974559068	−0.001398683846484221
26	Proserpina	x,y,z	−2.278602546659383776	1.125007532904078289	0.661062309969335460
		v_x,v_y,v_z	−0.004431095916543229	−0.008819825820419791	−0.004062402214390301
32	Pomona	x,y,z	−0.901728147437201644	−2.125115524966149305	−0.803811944165582326
		v_x,v_y,v_z	0.010194219116656746	−0.004774494291409794	−0.000989390504731257
34	Circe	x,y,z	−2.391157252691995083	0.282992268249411760	0.070390275547792716
		v_x,v_y,v_z	−0.001758506796666345	−0.010942908417041593	0.003566166537380931

No.	Name		x / vx	y / vy	z / vz
35	Leukothea	x,y,z	−2.185818508920677861	−0.647312389706184987	−0.427069919068639725
		v_x,v_y,v_z	0.004403906713249404	−0.010009270813997396	−0.006061965347001481
36	Atalante	x,y,z	2.077067513068779459	−0.589147154522667860	−0.516882702948444517
		v_x,v_y,v_z	0.001483717270391386	0.009307317089508693	0.008367140895652419
37	Fides	x,y,z	−2.571178583038596699	−1.322068718023980072	−0.637055179528812743
		v_x,v_y,v_z	0.003566522119529630	−0.007751964656304541	−0.003895555791525518
38	Leda	x,y,z	−1.235289907955999134	1.834720116439384707	0.766832361464905965
		v_x,v_y,v_z	−0.010386680301307009	−0.004838101200633434	−0.003684794791298678
39	Laetitia	x,y,z	2.336193952026537790	0.759000796514275100	0.022176605809523606
		v_x,v_y,v_z	−0.003257699513685890	0.010731650305157095	0.002872519477197957
40	Harmonia	x,y,z	−0.690601749410825527	−2.038615544126432422	−0.813975363544205632
		v_x,v_y,v_z	0.010841792489889901	−0.002359683762911624	−0.001881496483239468
43	Ariadne	x,y,z	2.009602895794647015	−0.308045882132810533	0.000115161076006508
		v_x,v_y,v_z	0.003565080131794708	0.010950285369215260	0.005004918573106272521
44	Nysa	x,y,z	−1.180941766350430466	1.554866402256739707	0.656611442582409666
		v_x,v_y,v_z	−0.010685573544758461	−0.006831046309965641	−0.002065889635700970
46	Hestia	x,y,z	−0.474973466355436691	−2.296851721557127579	−0.887903017375627823
		v_x,v_y,v_z	0.010895877228602094	−0.000193379625778825	−0.000061860987657291
47	Aglaja	x,y,z	1.067741941627274427	−2.006425563476340379	−1.093089277938812831
		v_x,v_y,v_z	0.010164990750471822	0.004729454222497436	0.002493051086595212
48	Doris	x,y,z	−1.620193164505671524	2.388346628469387944	0.711322099748724956
		v_x,v_y,v_z	−0.008761794768022678	−0.004974889431640200	−0.001595006590297288
49	Pales	x,y,z	−3.160577305628162748	−1.841530354628577504	−1.017849520123809803
		v_x,v_y,v_z	0.004122755888684796	−0.006077379179740559	−0.002511188490367351
50	Virginia	x,y,z	1.333238507267154427	−1.602799470048592578	−0.610763870330498060
		v_x,v_y,v_z	0.007993780997143859	0.009223622006417765	0.003430026595662231
53	Kalypso	x,y,z	−0.624015677324980311	−2.887904714321112287	−0.973890349097378372
		v_x,v_y,v_z	0.008425652319494320	−0.002165971738316451	−0.001225638323642568
54	Alexandra	x,y,z	−1.135653934893979367	−1.669000255199023952	−1.229167471346461094
		v_x,v_y,v_z	0.011014262220981971	−0.004397975120144764	−0.000793087156657538
56	Melete	x,y,z	−2.509110608187361979	−0.599826488136790070	−0.256184765903608447
		v_x,v_y,v_z	0.005001190631127405	−0.009156744414684281	−0.002380258455330665
57	Mnemosyne	x,y,z	−2.391692801502097954	−2.476663754241630322	−0.613024391539033098
		v_x,v_y,v_z	0.006142650670634989	−0.006122207358406149	−0.000426188587336327
58	Concordia	x,y,z	1.970644363722096504	1.898617820025757510	0.958334772746236052
		v_x,v_y,v_z	−0.007322186137912932	0.006519792084242099	0.002412465398938618
59	Elpis	x,y,z	−2.174043173151056330	1.754505167862759405	0.2521206662638497353
		v_x,v_y,v_z	−0.007194625470952607	−0.006696283399313014	−0.001604669222795236
62	Erato	x,y,z	−0.974153514232837803	−3.190444885566684707	−1.264820437591952285
		v_x,v_y,v_z	0.008304485139178936	−0.001176603633891707	−0.000760024384788282
68	Leto	x,y,z	2.150832185782553196	−0.472704842227096689	−0.504675337037531091
		v_x,v_y,v_z	0.003447895159962464	0.010633207649093934	0.005531722529065961
70	Panopaea	x,y,z	−0.512732908153528344	2.523947930349827118	0.619878869724124648
		v_x,v_y,v_z	−0.008876233401680499	−0.001390534286671486	0.000743421116570644
71	Niobe	x,y,z	−2.102963729152515615	1.401034628378233560	0.430525013472648932
		v_x,v_y,v_z	−0.004028656274637795	−0.007045329097739382	−0.007586343532703573
72	Feronia	x,y,z	−0.698145332366829519	2.293578863469888596	0.742562228176233741
		v_x,v_y,v_z	−0.009984751110793636	−0.002036674761053411	−0.001163542296488656

74	Galatea	x,y,z	2.002901140763306831	0.640809773926249604	0.274754411294356571
		$v_x v_y v_z$	−0.003966716076468380	0.011826725481734445	0.000411927791498145
75	Eurydike	x,y,z	−3.200842305137657107	1.220975490656682982	0.662752781812484315
		$v_x v_y v_z$	−0.003148422634162045	−0.006154368263463862	−0.003334345423877219
76	Freia	x,y,z	2.635360768423828937	1.437884630898934590	0.615131758192210332
		$v_x v_y v_z$	−0.006649269126403664	0.007319514417658025	0.002778582333891908
77	Frigga	x,y,z	−2.690246721423859899	−1.025385948689222948	−0.492898536579899738
		$v_x v_y v_z$	0.002901323944706134	−0.008214417661668621	−0.003990796639863591
79	Eurynome	x,y,z	−0.855375263619381876	−2.558706256410499424	−0.931566610102818493
		$v_x v_y v_z$	0.009085151348455443	−0.001894651404025254	−0.000307424335130962
80	Sappho	x,y,z	1.608537185631021771	−0.946571596217173794	−0.123702344488760718
		$v_x v_y v_z$	0.005907288892718746	0.011656883717961289	0.000408972489180802
81	Terpsichore	x,y,z	−0.299527408394068329	−2.820136290562028858	−1.711616630966411812
		$v_x v_y v_z$	0.008642357666503482	0.000392975155467740	0.000185079802975043
82	Alkmene	x,y,z	3.160151220673873329	−0.517688310655634809	−0.330346049201625136
		$v_x v_y v_z$	0.000372867010599650	0.007874899115079248	0.003828789513816485
83	Beatrix	x,y,z	2.537243040037000963	0.677406600928586108	0.239904468813102290
		$v_x v_y v_z$	−0.002746008298400088	0.008573152131379970	0.000465609098711521
84	Klio	x,y,z	−2.867387466643116500	0.123974227957666397	−0.213371959277415285
		$v_x v_y v_z$	0.000843918676535950	−0.007659425932435818	−0.004589100376152419
85	Io	x,y,z	2.196277362267318622	0.413880157287253360	0.828112684376031616
		$v_x v_y v_z$	−0.001029040843236626	0.011980721214998944	0.002569598620931192
86	Semele	x,y,z	2.434775829626800281	−0.701653670472491275	−0.530519782084361902
		$v_x v_y v_z$	0.002147727796190763	0.010457520401758034	0.000438193936842400
87	Sylvia	x,y,z	−3.660362899261072389	−0.885526882959144830	0.431216818732325274
		$v_x v_y v_z$	0.001817747464846094	−0.007261471114931983	−0.003982770842554424
88	Thisbe	x,y,z	0.351034977545771065	2.726034310628392613	0.255821730738119202
		$v_x v_y v_z$	−0.009085998946397741	0.002504365492940864	0.000021713673512016
89	Julia	x,y,z	0.668287897791156604	1.784401165953789501	0.391068013944257720
		$v_x v_y v_z$	−0.010183706148394674	0.005465198051083607	0.001141423763308724
90	Antiope	x,y,z	−2.527596410164981489	2.393097637265075851	0.017615823764957095
		$v_x v_y v_z$	−0.005785028160541267	−0.005353734747955876	−0.002166792449198574
91	Aegina	x,y,z	−0.087297607412163220	−2.585707806328295000	−1.234058824506656826
		$v_x v_y v_z$	0.009596957524554405	−0.000169138133959666	−0.000157156795888277
92	Undina	x,y,z	−1.042907269635494405	−2.875324060333224629	−0.930751854561716052
		$v_x v_y v_z$	0.009168658604880101	−0.001743405265776949	−0.002351877046242883
93	Minerva	x,y,z	0.585579552533172509	2.601997108680597304	0.615157088233035720
		$v_x v_y v_z$	−0.008803902414859047	0.001797983571727370	0.001256003779502425
95	Arethusa	x,y,z	2.542078873825008856	0.235650434494874460	0.762547030699050044
		$v_x v_y v_z$	−0.002373003952808578	0.010704165151006670	0.002903697708982936
96	Aegle	x,y,z	−2.188255307668921734	1.381773051127626495	0.553799995799386546
		$v_x v_y v_z$	−0.005576550150666639	−0.007277112779745350	−0.006521139973971324
99	Dike	x,y,z	2.444770853104723862	−0.615836362049607455	−0.892420122928066495
		$v_x v_y v_z$	0.005698847921220206	0.007805584032288920	0.004109108981978736
100	Hekate	x,y,z	−2.808466634462525313	1.998234760159137258	0.896765221468953100
		$v_x v_y v_z$	−0.004808839856292163	−0.006555049055444871	−0.001867365486725437
102	Miriam	x,y,z	−0.802979209614599232	2.471520362371176106	0.813851431023047911
		$v_x v_y v_z$	−0.010278712148820868	−0.000277333514340038	−0.000609446487533852

Table 13. Initial positions (au) and velocities (au/day) of the asteroids with respect to the S
Julian day (TDB) 2440400.5 (June 28, 1969) in the ICRF2 frame. (Continued: 6 of 15.)

No.	Name		x	y	z
103	Hera	x,y,z	−1.624169502869726278	−2.061934384710811141	−0.618220991356126959
		v_x,v_y,v_z	0.008815595236548105	−0.005135987476149960	−0.002424171731408047
104	Klymene	x,y,z	2.604625804466561778	0.829861198407666206	0.297592323238799750
		v_x,v_y,v_z	−0.004595135750289872	0.008958088103164810	0.003004449410220144689
106	Dione	x,y,z	1.186951890089662287	−2.641679471918139566	−1.357909134882829605
		v_x,v_y,v_z	0.008062335558122698	0.004854178905816693	0.001679190825653463
107	Camilla	x,y,z	−2.814482356149371256	−2.125615900337749942	−0.466315209535505482
		v_x,v_y,v_z	0.005016321991106533	−0.007283280755178675	−0.001833852210438387
109	Felicitas	x,y,z	−2.272223718831077210	−2.256013715954339638	−1.348118693877923713
		v_x,v_y,v_z	0.005498298783944774	−0.004679670760771524	−0.002914631877323399
110	Lydia	x,y,z	−2.913671600037018194	0.137720105704674106	0.2356482845934635972
		v_x,v_y,v_z	−0.000701525427796519	−0.008631983066179964	−0.004265106303010358
112	Iphigenia	x,y,z	2.101268187945320776	0.423210543438176201	0.263994487858637827
		v_x,v_y,v_z	−0.002085691485880794	0.011003103680878389	0.005201699139327664
113	Amalthea	x,y,z	−0.845649935641415329	2.041704300606039801	0.834445540016974907
		v_x,v_y,v_z	−0.010061995082559373	−0.004862835207405551	−0.001044300650685426
114	Kassandra	x,y,z	1.003458535932775675	2.302229181420444900	0.755029808593063345
		v_x,v_y,v_z	−0.010372485650250500	0.002522166679536860	0.000500109839771892013
115	Thyra	x,y,z	−2.132402872023013263	−1.407030770831705802	−1.230888073340032474
		v_x,v_y,v_z	0.005718496513543697	−0.006581478727881280	−0.002888515609029340
117	Lomia	x,y,z	2.270382224122074355	−1.589433030843294015	−1.113929084766832167
		v_x,v_y,v_z	0.006230326658274393	0.005926784306392254	0.005024462275567959
118	Peitho	x,y,z	2.285956748706956976	−0.605001706866287292	−0.594092775417243146
		v_x,v_y,v_z	0.001960243453552381	0.009608024580505904	0.005023973278452842
120	Lachesis	x,y,z	1.349895569447842503	2.571965525676553455	0.547065365110619428
		v_x,v_y,v_z	−0.008469966093690717	0.003282200584511912	0.001536525822077163
121	Hermione	x,y,z	1.334266785923234888	−2.574571237468854079	−1.410921022512830580
		v_x,v_y,v_z	0.008404347099665236	0.005070569717777809	0.001205938930940049
124	Alkeste	x,y,z	−2.030985757945451553	−1.291015452637479966	−0.500252551887808372
		v_x,v_y,v_z	0.006742453819955392	−0.008540992687351152	−0.003142188428784029
127	Johanna	x,y,z	0.258596371131005198	2.254521103975096531	0.302780291910047072
		v_x,v_y,v_z	−0.010847729029494223	0.000155121847092949	0.001051653942880798
128	Nemesis	x,y,z	−1.950614158630362915	1.800692994261967828	0.063538206084451820
		v_x,v_y,v_z	−0.007974900712854933	−0.005725400853334638	−0.001714798269305732
129	Antigone	x,y,z	0.173250908378126567	3.306268588514498208	0.822759553307659597
		v_x,v_y,v_z	−0.008289119212281256	−0.000667809291620008	0.001070909483343232
130	Elektra	x,y,z	0.808865897608793016	−2.931039369795729321	−0.391590456276819932
		v_x,v_y,v_z	0.008508223312724572	0.004812568858903731	−0.001548417459331940
132	Aethra	x,y,z	−0.480193840132689453	1.653722981508809205	0.319743825909667823
		v_x,v_y,v_z	−0.011837731432955296	−0.005329218981514342	−0.007488534336320045
134	Sophrosyne	x,y,z	−2.011298631478445564	1.214628009571321706	0.731179432571293253
		v_x,v_y,v_z	−0.007359702096515807	−0.006723867635909852	−0.005074877395244866
137	Meliboea	x,y,z	2.185732502051722648	−1.145086389525992177	−0.022766323557119300
		v_x,v_y,v_z	0.006166935083607356	0.010027540696906241	0.002522495066251339
140	Siwa	x,y,z	2.349717450635818938	0.565740387115059206	0.1098983118555951627
		v_x,v_y,v_z	−0.000542241084460003	0.010767145886680794	0.004484878043585674
141	Lumen	x,y,z	2.001263396461105071	0.319678076806489707	0.526316075837815478
		v_x,v_y,v_z	−0.003483509074753528	0.010893891066401524	0.006389004515172658

#	Name				
143	Adria	x,y,z	2.882421698483517147	0.042452435493852860	0.533372770997075852
		v_x, v_y, v_z	-0.000265760440917905	0.008189549513733270	0.004000544797415243
144	Vibilia	x,y,z	-3.202644502264647475	-0.708133625995427840	-0.034778692392227049
		v_x, v_y, v_z	0.001746328337486271	-0.007334586431819497	-0.003503786791915789
146	Lucina	x,y,z	-0.811168586625490406	-2.275206201114596816	-0.838736686431402201
		v_x, v_y, v_z	0.010109426082854705	-0.002536990665401319	-0.003737855276866437
147	Protogeneia	x,y,z	-0.135653717885019648	-2.925539832035890520	-1.233404347151997538
		v_x, v_y, v_z	0.009577394154474565	-0.000281048647997959	0.000208962558114589
148	Gallia	x,y,z	-2.002954304100418081	1.803600909370170810	0.356267628861884034
		v_x, v_y, v_z	-0.007969397030290469	-0.006450526750365626	0.001741973397159357
150	Nuwa	x,y,z	-0.513703300992534251	2.766574982586356590	0.080652555085234834
		v_x, v_y, v_z	-0.009840605686461229	-0.000320540289433122	-0.000310864131154414
154	Bertha	x,y,z	-2.074683900631499434	-1.800589925977038375	-0.921944736183594959
		v_x, v_y, v_z	0.006609578012061634	-0.005176399972958075	-0.006376303490757747
156	Xanthippe	x,y,z	2.923916135163274088	-0.729762768653841307	0.621849245322509500
		v_x, v_y, v_z	0.003649642497220172	0.007950919425059760	0.002003317878320057
159	Aemilia	x,y,z	-0.410767564198755042	2.618954330535652186	0.694043907397027937
		v_x, v_y, v_z	-0.010553589480557164	-0.001942707083642232	0.000168561775632459
160	Una	x,y,z	1.905452096025585851	1.518779824511213183	0.757828350346318791
		v_x, v_y, v_z	-0.007533973461247138	0.007222883364505983	0.003809404100424659
162	Laurentia	x,y,z	0.262514031180226981	2.400281690284028269	0.275022530741664051
		v_x, v_y, v_z	-0.010860656605817488	-0.000837744879289110	0.000338095109459147
163	Erigone	x,y,z	1.974914535093617252	0.857554972320634268	0.236073131153163474
		v_x, v_y, v_z	-0.006815687100308090	0.009482254283590926	0.003447148757209308
164	Eva	x,y,z	-3.040157320355995285	-1.519642316497472834	0.691762796895534549
		v_x, v_y, v_z	0.002976277102337891	-0.005406627734211578	-0.004499142864886430
165	Loreley	x,y,z	-1.922737034954617341	-1.819614502509028009	-1.400331048398380185
		v_x, v_y, v_z	0.007959370240945991	-0.006004630422629679	-0.001928143622055610
168	Sibylla	x,y,z	3.116554420775199397	-0.994993474666817534	-0.224327412952326943
		v_x, v_y, v_z	0.002733580426163316	0.008691053371313727	0.003163655969657688
171	Ophelia	x,y,z	3.452516715258505897	-0.216190157721613213	-0.255374648951711414
		v_x, v_y, v_z	0.000240618327164227	0.008055044745482540	0.003396706876313383
172	Baucis	x,y,z	-2.385328686094084105	-0.620107743369059716	-0.620470933066101904
		v_x, v_y, v_z	0.004378392174801965	-0.008170672938126655	-0.004757814902613166
173	Ino	x,y,z	0.171242886080394535	2.394184022514683009	0.745164090056066192
		v_x, v_y, v_z	-0.011142161189368808	0.002538588490091165	0.001950356324201864
175	Andromache	x,y,z	-0.474252178163027949	-2.648333222299060541	-1.305222351194791353
		v_x, v_y, v_z	0.010262122260410241	0.000548159272351288	0.000029475418796883
176	Iduna	x,y,z	-1.387628365703582611	2.833854776034395506	-0.091557754074181458
		v_x, v_y, v_z	-0.009225262571539295	-0.002671178335674209	-0.001428340199372592
177	Irma	x,y,z	2.007796292614895339	-1.022926044579357097	-0.462360572116189250
		v_x, v_y, v_z	0.004104738603731208	0.010480904746312239	0.004870438746756638
181	Eucharis	x,y,z	2.120681612712470798	-2.907144330458012238	-0.813722768281753606
		v_x, v_y, v_z	0.005865675784688143	0.005572377170526862	-0.000342831237219019
185	Eunike	x,y,z	-2.747368952622216920	-1.338746669764243169	0.422267924686840546
		v_x, v_y, v_z	0.003978039639761641	-0.008185576126933353	-0.001011821450492685
191	Kolga	x,y,z	-2.879887570364938920	0.953404430384273138	0.413481905229524382
		v_x, v_y, v_z	-0.003754265666355869	-0.008618960919399883	-0.001665556221000780

Table 13. Initial positions (au) and velocities (au/day) of the asteroids with respect to the S[un] Julian day (TDB) 2440400.5 (June 28, 1969) in the ICRF2 frame. (Continued: 8 of 15.)

195	Eurykleia	x,y,z	2.922594899011714986	0.199160094596518983	0.060339478431695619
		v_x,v_y,v_z	−0.001056479499979637	0.008538247223234249	0.005019069716262851
196	Philomela	x,y,z	2.870866810351882403	−0.754636097994081934	−0.748530242754146369
		v_x,v_y,v_z	0.003302144455379505	0.008600323162911158	0.003663627801932320
198	Ampella	x,y,z	0.543891836565843279	1.941671690331441007	0.932327670839411482
		v_x,v_y,v_z	−0.010661276142588431	0.005661564198512067	0.000542576864013208
200	Dynamene	x,y,z	−0.109999438475556419	−2.621860198978502865	−1.470414945946262097
		v_x,v_y,v_z	0.009376565385604106	0.000133656901059443	0.000810938484734692
201	Penelope	x,y,z	−2.800980089172922849	1.352246370925753505	0.554783862366244662
		v_x,v_y,v_z	−0.004186345686485028	−0.007367963765518988	−0.002243604557722191
203	Pompeja	x,y,z	1.500547182112841327	−2.086139267712977308	−1.025020464889739635
		v_x,v_y,v_z	0.008286480532474490	0.005407135390513560	0.002806033412514854
205	Martha	x,y,z	−2.770579982860186696	0.663732478579504792	−0.116643403811919136
		v_x,v_y,v_z	−0.002353576283912810	−0.009404587572302536	−0.002658971716332037
206	Hersilia	x,y,z	1.238747961716257118	−2.376780403456169921	−0.929349158559885868
		v_x,v_y,v_z	0.008918338308673593	0.004410268226602005	0.001280757530674212
209	Dido	x,y,z	2.268898815817652626	2.057453499016182351	0.209244033679382824
		v_x,v_y,v_z	−0.006436569904961379	0.005714772045042667	0.003406952267267044
210	Isabella	x,y,z	2.231740920050496513	0.842042304704040602	0.316984455862986181
		v_x,v_y,v_z	−0.004831339830972945	0.009318806983407490	0.005200751457433266
211	Isolda	x,y,z	2.711875240815070143	0.430216506380016608	0.382482385748132425
		v_x,v_y,v_z	−0.003510234716571616	0.009467947330119904	0.003781089466930833
212	Medea	x,y,z	−1.966750173220412679	−2.504391441888097258	−1.362061306592617482
		v_x,v_y,v_z	0.007097449121202490	−0.004667784575521242	−0.001897190061895615
213	Lilaea	x,y,z	2.419306968138564606	1.377064626174480303	0.236934520281399275
		v_x,v_y,v_z	−0.003663586080577670	0.008842945171148394	0.003566597801239553
221	Eos	x,y,z	1.777939852260157272	2.264787669587976702	0.685115431224176685
		v_x,v_y,v_z	−0.007376964281696770	0.006641442036154265	0.002628969249503958
223	Rosa	x,y,z	−2.914424443137129561	−0.575564316487753080	−0.183166473580308381
		v_x,v_y,v_z	0.000831640269428134	−0.009184748787445272	−0.004253682939508904
224	Oceana	x,y,z	1.306840552514852316	−1.909320111535164788	−1.052599637885983652
		v_x,v_y,v_z	0.009528257077708791	0.004737845515644764	0.002779620693421142
225	Henrietta	x,y,z	−2.528098762364009211	−1.638702365555180007	−0.383411150052558269
		v_x,v_y,v_z	0.007735421152555965	−0.006833347198704122	0.000439444841229691
227	Philosophia	x,y,z	−1.687868923923265596	2.423841903625734151	0.306304444440689938
		v_x,v_y,v_z	−0.006774671779471052	−0.005284654892018608	−0.003871706711383315
233	Asterope	x,y,z	−2.905158595265389554	0.237101371710457365	−0.201153100576835192
		v_x,v_y,v_z	−0.000352351008013982	−0.009087108811730400	−0.002949940598791083
236	Honoria	x,y,z	−0.748198375227333456	−2.637125772058928508	−0.758761586278685618
		v_x,v_y,v_z	0.010085435669044992	−0.000778370444183047	−0.000057970932084369
238	Hypatia	x,y,z	2.410309982055119260	1.056479210705921504	0.250822081348433867
		v_x,v_y,v_z	−0.004638599803102487	0.009855687835558462	0.001848375937922427
240	Vanadis	x,y,z	−2.921723067002446772	−0.802623949197874942	−0.228455192343604230
		v_x,v_y,v_z	0.001119414849423201	−0.008380246775381286	−0.003517310270921982
241	Germania	x,y,z	2.157026156705858178	−1.650363596987127091	−0.494242367750019174
		v_x,v_y,v_z	0.006296839602484864	0.007812769885222028	0.004076824994372825
247	Eukrate	x,y,z	2.169125903092219421	−0.866225171773255864	−0.996634072113313341
		v_x,v_y,v_z	0.003425982013346110	0.007075076118810707	0.007955063682203814

No.	Name				
250	Bettina	x,y,z	3.111197416227221346	−0.213218630746829368	−0.517813104094458687
		v_x,v_y,v_z	0.000132313329422579	0.00790521107554185	0.005535308622116215
259	Aletheia	x,y,z	−1.627318570822305688	−2.150337559305796731	−0.609408552011190818
		v_x,v_y,v_z	0.008749058066660119	−0.005149978486112262	−0.004087199673172721
266	Aline	x,y,z	0.229960468787527295	2.407979990359146387	0.368097186189577856
		v_x,v_y,v_z	−0.010856512774706088	0.002950023549757955	−0.001382815037831516
268	Adorea	x,y,z	0.639749669712347591	−2.794617398822625276	−1.162862315045730011
		v_x,v_y,v_z	0.009746292661459431	0.000795802448212805	−0.000055548373269038
275	Sapientia	x,y,z	2.660106410012033074	1.524565090452046204	0.589849845901316994
		v_x,v_y,v_z	−0.005534317791085139	0.006792087695683437	0.002829793913036671
276	Adelheid	x,y,z	−1.240280742637663192	2.649029697867973265	−0.023688532806399230
		v_x,v_y,v_z	−0.009129755737320335	−0.004387217468802240	−0.002182311342655559
283	Emma	x,y,z	−3.467100975427897414	0.326845469549111034	−0.273921918861556368
		v_x,v_y,v_z	−0.000408626057531563	−0.007480204767684386	−0.004047747264448866
287	Nephthys	x,y,z	2.272270153229304146	0.682382283976578408	−0.060915050989619822
		v_x,v_y,v_z	−0.002758331417138625	0.010301650913710764	0.003144420571901631
303	Josephina	x,y,z	−2.714456487118279693	−1.569383554448778861	−1.007607012785439293
		v_x,v_y,v_z	0.004977413077900846	−0.006790226956868332	−0.003754626824227870
304	Olga	x,y,z	−2.768985967086891264	0.841743117969856125	0.394982651347284053
		v_x,v_y,v_z	−0.002248382084316066	−0.008561565126572737	−0.001074438237890270
308	Polyxo	x,y,z	−1.042886921098909125	−2.332650336151194548	−0.811036990846228489
		v_x,v_y,v_z	0.009903231347078257	−0.003677357201775901	−0.001239523162032258
313	Chaldaea	x,y,z	0.771884768362409268	1.935556783718940901	0.398378002792229235
		v_x,v_y,v_z	−0.012098689536781022	0.002656162671110900	0.000678852180394095
322	Phaeo	x,y,z	−0.002682348362129571	−2.507699408031491384	−0.970531169598375820
		v_x,v_y,v_z	0.010244749836147331	0.001937251500163293	0.002228295777838911
326	Tamara	x,y,z	−2.071626956515489226	0.579660636027930942	1.193463031425092469
		v_x,v_y,v_z	−0.003544442645081844	−0.007757868782935538	−0.006335496904282256
328	Gudrun	x,y,z	−2.573274034716255709	−1.465047934437442967	−1.316844023039191125
		v_x,v_y,v_z	0.004832558218741573	−0.006280166157985758	−0.004956463301670980
329	Svea	x,y,z	−1.442616581613682669	2.004856633119884710	1.272499885424718813
		v_x,v_y,v_z	−0.008719664332914103	−0.006477652467348243	−0.000805394135272350
334	Chicago	x,y,z	3.443962847809292072	−1.324275053387580003	−0.714472534127118086
		v_x,v_y,v_z	0.003929882068712210	0.007676913891350206	0.002591553586693644
335	Roberta	x,y,z	−1.377939389741577925	−1.619477614777314223	−0.493517119258204406
		v_x,v_y,v_z	0.010492320292650055	−0.005901393082463712	−0.002553933297352890
336	Lacadiera	x,y,z	−0.658098578079305607	−1.795601132283736634	−0.719216342800300446
		v_x,v_y,v_z	0.011950088864493176	−0.003907291040290498	−0.000403494815576562
338	Budrosa	x,y,z	−2.903591948167865588	0.470290381099696342	−0.099200302996376888
		v_x,v_y,v_z	−0.001425800173495607	−0.008860750970051479	−0.004359767689390367
345	Tercidina	x,y,z	−0.007889583388479199	−2.379738144165251423	−0.650011796314688195
		v_x,v_y,v_z	0.010566766359888404	−0.000201418715010861	0.000963910315785457
346	Hermentaria	x,y,z	−2.982837107945091493	−0.700289625004069438	0.200506563052633757
		v_x,v_y,v_z	0.001487506028262646	−0.008384396621244858	−0.003812447082362887
347	Pariana	x,y,z	−0.865269383843656370	1.912864525007107019	0.057420519699953543
		v_x,v_y,v_z	−0.010024705149477772	−0.006143851860785796	−0.000494836214563871
349	Dembowska	x,y,z	−3.156748018124499122	−0.130959673144165373	0.211799005012422992
		v_x,v_y,v_z	−0.000235136952592180	−0.008001539901820919	−0.004667985924570656

Table 13. Initial positions (au) and velocities (au/day) of the asteroids with respect to the S
Julian day (TDB) 2440400.5 (June 28, 1969) in the ICRF2 frame. (Continued: 10 of 15.)

No.	Name				
350	Ornamenta	x,y,z	1.897492886578636018	1.853115584753373568	−0.168626022505561857
		v_x,v_y,v_z	−0.006802174405994125	0.006550715887629700	0.0006201849595058421
356	Liguria	x,y,z	2.403925905531135054	−1.080394157528443255	−0.637740553547901712
		v_x,v_y,v_z	0.002474022842116686	0.008698179268340399	0.0005392308524943403
357	Ninina	x,y,z	2.550147267653644079	1.285776955010184519	−0.179678885435631430
		v_x,v_y,v_z	−0.004469547804037060	0.009229935506104934	0.002753264074857219
358	Apollonia	x,y,z	2.637397004060416439	−0.033680969059450810	−0.033009209749240563
		v_x,v_y,v_z	−0.001238942541646334	0.010294117142742970	0.003742764415514056
360	Carlova	x,y,z	2.365965905770136768	0.946364028961979908	−0.104711173321544837
		v_x,v_y,v_z	−0.005043923473529931	0.009797484839798520	0.003463941512246718
362	Havnia	x,y,z	2.006016399583006038	−1.335233497908418832	−0.941832432474522863
		v_x,v_y,v_z	0.006316106482288478	0.007613525568562483	0.004015883178030646
363	Padua	x,y,z	0.447395563619500725	2.418709764219945324	1.28484276493210148
		v_x,v_y,v_z	−0.010190467851460631	0.001811104511745787	0.001955672995458056
365	Corduba	x,y,z	−0.946605401455762441	−2.952167141736141698	−0.579774951531645599
		v_x,v_y,v_z	0.008854160018258806	−0.001893748322970214	−0.000150172926506452
366	Vincentina	x,y,z	0.181803553220394987	2.727350474248680712	1.834488045213377383
		v_x,v_y,v_z	−0.009184575428991438	0.001029954077974210	0.000256959389362181
369	Aeria	x,y,z	−2.461889264933398547	1.041415912802037491	1.026022247881923644
		v_x,v_y,v_z	−0.004941491515371925	−0.008124405678199062	−0.002138953770784814
373	Melusina	x,y,z	−0.690418739044735830	−2.379811252254516063	−1.898265743321774224
		v_x,v_y,v_z	0.009694322965289898	−0.000476657325627097	−0.000644192905393674
375	Ursula	x,y,z	−1.436446171450740827	−2.028484833217823802	−1.788540836866821859
		v_x,v_y,v_z	0.009100906971536040	−0.003641283355002899	−0.001642880584566145
377	Campania	x,y,z	0.269537079909927590	2.385864264311093209	0.778604188267153829
		v_x,v_y,v_z	−0.011005666135096655	0.001823320353539882	−0.000108001402849965
381	Myrrha	x,y,z	−2.995154522909969863	−0.463362473245098105	0.425103778189245829
		v_x,v_y,v_z	0.002132868519734355	−0.009335695766624439	−0.003072148504579520
385	Ilmatar	x,y,z	2.204123556353274616	1.619262542204616961	0.359899523537142940
		v_x,v_y,v_z	−0.007197099139091408	0.005191410685294344	0.003343985294701643
386	Siegena	x,y,z	−1.541442636926875664	−2.888691935130070387	−0.066078605278559938
		v_x,v_y,v_z	0.008201852800212111	−0.003247965605600923	−0.000826380013421358
387	Aquitania	x,y,z	1.673856039456203204	2.530440646483403208	1.05238509303274774
		v_x,v_y,v_z	−0.006165312103874345	0.006354675190666645	0.002907264021179044
388	Charybdis	x,y,z	2.320935330770025118	−1.396656836528137102	−0.777937804577914949
		v_x,v_y,v_z	0.005967878297330536	0.007526833190292070	0.00104390084907098427
389	Industria	x,y,z	−0.690870585159074957	2.285976832122341484	0.972909194639388297
		v_x,v_y,v_z	−0.010061709744287462	−0.002641850906012974	−0.002795471716741464
393	Lampetia	x,y,z	0.425228759538625878	3.223104999989440304	0.691457827571683836
		v_x,v_y,v_z	−0.007669952102573410	0.003507362513697180	−0.000448442801262118
404	Arsinoe	x,y,z	−1.528713317148434614	1.538431701390180701	0.056814160805905178
		v_x,v_y,v_z	−0.006833201218737411	−0.008984287880902874	−0.001895810188518365
407	Arachne	x,y,z	−2.404168202561030032	1.294823426614003070	0.330302008894303445
		v_x,v_y,v_z	−0.005206693346373313	−0.007456531256292877	−0.004441540417027833
410	Chloris	x,y,z	−1.920013803213842740	−1.236776042431182887	−0.102806516019325112
		v_x,v_y,v_z	0.007955416951132228	−0.007973149544052796	−0.004854681062882307
412	Elisabetha	x,y,z	−0.660465882532509707	2.488779742331803213	1.036836462101317080
		v_x,v_y,v_z	−0.009611438891560443	−0.003517675356754544	0.001146633004327251

415	Palatia	x,y,z	2.248246074358777769	-0.101981217325653323	-0.299618390748721652
		v_x,v_y,v_z	-0.002060353514605755	0.011553860188848760	0.004093646216743197
416	Vaticana	x,y,z	-0.968717353915249380	2.586243865176183614	0.726458358232957346
		v_x,v_y,v_z	-0.007646026045771258	-0.004063877953498320	-0.000635412624451350
420	Bertholda	x,y,z	-3.434992155705478112	0.152957066714952405	-0.330353631186631247
		v_x,v_y,v_z	-0.000402294197824229	-0.008601469926580190	-0.003283044092787496
423	Diotima	x,y,z	-1.836130012842030368	-2.232281627979681993	-0.765829327150786887
		v_x,v_y,v_z	0.007840938442101581	-0.004797111494305463	-0.004122385161061739
424	Gratia	x,y,z	2.554859642210790316	-0.721209544624070054	-0.683662530131363688
		v_x,v_y,v_z	0.002391618765227667	0.009552423334085200	0.003497050935833218
426	Hippo	x,y,z	-2.022547942292763690	-1.005817143532471203	-1.399553685672040970
		v_x,v_y,v_z	0.005977729090057320	-0.008172230606490322	-0.004212443868015491
431	Nephele	x,y,z	2.126339087775298786	1.733215636283283103	0.556190187417207027
		v_x,v_y,v_z	-0.005642781181932892	0.008360067976273988	0.003651458241242074
432	Pythia	x,y,z	1.351686874096238222	-1.350586724406483530	-0.907107472146849059
		v_x,v_y,v_z	0.009952768047903163	0.007416663516571882	0.000909632185035547
433	Eros	x,y,z	1.052635242977920882	0.652108246501082103	0.560644019635677004
		v_x,v_y,v_z	-0.011649113662952394	0.009302582981661403	0.003194192782337934
442	Eichsfeldia	x,y,z	2.438069471682043687	0.500402393682477853	-0.018372380659463668
		v_x,v_y,v_z	-0.001598988743082291	0.009827743844217883	0.003532527264151718
444	Gyptis	x,y,z	-0.122162596591544409	-2.551357499130834761	-0.622759399088688381
		v_x,v_y,v_z	0.010779467918873202	0.001166454438831065	0.000838720795358274
445	Edna	x,y,z	-2.638867450404819515	2.337072213589934202	0.386737481707201902
		v_x,v_y,v_z	-0.005987522043549823	-0.003764390073667395	-0.004911559441873959
449	Hamburga	x,y,z	1.415715061146446185	1.814956624851498305	0.711298139664957252
		v_x,v_y,v_z	-0.010126512689018213	0.004544417521285093	0.002585888565144427
454	Mathesis	x,y,z	1.286986769213538828	-1.948980832970361732	-1.156799971769590929
		v_x,v_y,v_z	0.009804719465114024	0.003999746415627610	0.001524892144668299
455	Bruchsalia	x,y,z	-2.056825944515058957	-2.004397979321892453	-0.509262841989271742
		v_x,v_y,v_z	0.008122040874298211	-0.003536097158237312	-0.003611496524712439
464	Megaira	x,y,z	0.667444028746538631	-2.252197234941088144	-0.993641094169664063
		v_x,v_y,v_z	0.009943729528332137	0.005243255029627681	0.000165611503527442
465	Alekto	x,y,z	3.485008134627705534	0.426960893387227702	0.475918006579878372
		v_x,v_y,v_z	-0.000224571561215830	0.007624192788766146	0.003685169590851310
466	Tisiphone	x,y,z	-2.667676861175595882	1.739553822505467640	0.048087007997351904
		v_x,v_y,v_z	-0.004238745317538407	-0.006912875729415020	-0.005683670800648313
469	Argentina	x,y,z	-2.277066624323161648	-0.948290331570841527	-0.878659731572872693
		v_x,v_y,v_z	0.004890309880280551	-0.008845224571058706	-0.005480291439275048
471	Papagena	x,y,z	-2.365805692852444686	-2.593457491934213266	-0.508479129862948076
		v_x,v_y,v_z	0.005830421752087237	-0.004151641950916174	-0.003631216999264367
476	Hedwig	x,y,z	-1.681308000287230264	-1.540816635314435912	-1.120990466424186094
		v_x,v_y,v_z	0.008429343749817427	-0.006873524681428616	-0.001716598086040729
481	Emita	x,y,z	0.974450886978483366	1.931290124495535883	0.819035276347056418
		v_x,v_y,v_z	-0.010731270482033605	0.004061820639447179	0.004026303026251832
485	Genua	x,y,z	-0.684382743244631553	2.097786304663209034	0.329093928144473968
		v_x,v_y,v_z	-0.011962823721801429	-0.003569573771336420	-0.001358782018689436
489	Comacina	x,y,z	2.506508082475853438	-2.066222307541637271	-0.511544638179387667
		v_x,v_y,v_z	0.006047076129268948	0.006964815651859941	0.001033759739079085

490	Veritas	x,y,z	0.036248932914226248	−3.171478757627256950	−0.801007823894895110
		v_x,v_y,v_z	0.009313455279943360	0.000902292183295022	0.000202399971558074
491	Carina	x,y,z	−1.361895485427903063	−3.165505741951435414	−0.225387122172941129
		v_x,v_y,v_z	0.008172836509484513	−0.003408744893633426	−0.000454450885764238
498	Tokio	x,y,z	−3.141633394765953380	−0.147256452035157803	0.502336236774096112
		v_x,v_y,v_z	0.000707169938473929	−0.007915881021043106	−0.003339475619994648
503	Evelyn	x,y,z	2.469457681649797731	0.897054685380899164	1.965028284081319630
		v_x,v_y,v_z	−0.005320146486079764	0.008280168851000710	0.004381003781921793
505	Cava	x,y,z	2.051381744115417849	0.715819257149662769	−0.079692452727947352
		v_x,v_y,v_z	−0.005500358097765526	0.010138687983931836	0.000537786900180824
506	Marion	x,y,z	2.338637506038451885	−2.236463709683592427	−0.970896012702498035
		v_x,v_y,v_z	0.005454153770407211	0.004892127964045382	0.002004916880315759
508	Princetonia	x,y,z	−1.834398047688895250	2.033726007866053731	1.680737578756668515
		v_x,v_y,v_z	−0.007530022629651348	−0.005443148627532285	−0.002038851357460140
514	Armida	x,y,z	−1.795059498387787666	2.342984019721451094	0.883644880995315685
		v_x,v_y,v_z	−0.008098171175524310	−0.004726881362335257	−0.002646867999807014
516	Amherstia	x,y,z	3.099051382763043705	0.296225047046435163	0.533503755281144221
		v_x,v_y,v_z	0.000113246728749009	0.007155567486568640	0.000800497397851449
517	Edith	x,y,z	0.558320524452791234	−3.192588255468263636	−1.370798827031080469
		v_x,v_y,v_z	0.008142074640245637	0.002287166228260470	0.003001503486262574
521	Brixia	x,y,z	−2.549496878032234903	−2.363059656332096470	−0.504053344408389448
		v_x,v_y,v_z	0.005060051620143621	−0.004986735600834600	−0.003179245956564224
535	Montague	x,y,z	−2.316646842841627585	0.712595568810880105	0.361735594256191306
		v_x,v_y,v_z	−0.003949779425587768	−0.009578278138314685	−0.003755534201261866
536	Merapi	x,y,z	−2.750766666063489296	−2.439053500410161668	−0.616255994545442776
		v_x,v_y,v_z	0.005689626184352026	−0.004264313174264865	−0.004857657183703378
545	Messalina	x,y,z	−3.088249528284030543	1.764074066249742057	0.869124506509039163
		v_x,v_y,v_z	−0.003538173057074548	−0.006065837986010540	−0.004381735842294599
547	Praxedis	x,y,z	1.676299422983591914	1.266883169004290302	0.274007651900779895
		v_x,v_y,v_z	−0.007644163901651690	0.010654276917228497	0.000077163650864902
566	Stereoskopia	x,y,z	3.108217299055801242	−0.038924752084866489	−0.306684557850228134
		v_x,v_y,v_z	0.000163401251640635	0.009232636979490162	0.004135544106424715
568	Cheruskia	x,y,z	2.499292317070373137	−0.704732562382201388	0.596817158342859422
		v_x,v_y,v_z	0.000384461732460371	0.010401955137544539	0.003335461022407042
569	Misa	x,y,z	−0.314868951447094259	−2.848132605531735528	−1.283448671165868582
		v_x,v_y,v_z	0.008734805915040946	−0.000862116582237407	−0.000205188117724297
584	Semiramis	x,y,z	−2.503710281861984743	−0.998160106756301402	−0.996565071101295330
		v_x,v_y,v_z	0.004900032034025778	−0.007159666424074737	−0.002463187315737590
585	Bilkis	x,y,z	1.912791286329316831	1.539478930510618904	0.440912149264970965
		v_x,v_y,v_z	−0.007907529478716448	0.006999464858132820	0.000197659791951032
591	Irmgard	x,y,z	3.001474010271674153	−0.872392399734546298	−0.271674947450289361
		v_x,v_y,v_z	0.003412279465211854	0.006515819416529907	0.004916384720291039
593	Titania	x,y,z	−0.426142954823842124	−2.875072915506421189	−1.351850274140791841
		v_x,v_y,v_z	0.008043320855626214	−0.000800619582345174	−0.003093655045037652
595	Polyxena	x,y,z	−2.275279297558304492	−1.787230083745405596	−1.091452381026450702
		v_x,v_y,v_z	0.006946976359411234	−0.004847860891067480	−0.005228807026657581
596	Scheila	x,y,z	2.068249321573481403	2.559630685610615686	0.793577660766494164
		v_x,v_y,v_z	−0.006190047319295022	0.004343781071425733	0.002004070640552158

598	Octavia	x,y,z	−1.508523042247438273	1.946258357215855606	1.74114109004084749
		v_x,v_y,v_z	−0.009625203890116693	−0.004100840847587676	0.000525696328445862
599	Luisa	x,y,z	−2.896166748961349846	1.273195801188978791	3.640818403618105270
		v_x,v_y,v_z	−0.004659866001601793	−0.005499407621023489	−0.002708296082629357
602	Marianna	x,y,z	2.236421484533403614	0.256457028560368107	0.531502491866831517
		v_x,v_y,v_z	−0.002987755039934792	0.010015170339145833	0.0003007115827480249712
604	Tekmessa	x,y,z	−2.443492364975899278	−2.553672554973274167	−1.297289046740899066
		v_x,v_y,v_z	0.006146762368787255	−0.004416770321035214	−0.002442816546685167
618	Elfriede	x,y,z	2.516097127945998935	1.510176140872574457	−0.283377085143805829
		v_x,v_y,v_z	−0.004157210144504098	0.008684469448787927	0.0003885209090645422
623	Chimaera	x,y,z	−2.409466239800548415	−0.465525463994251487	−0.851563289724215688
		v_x,v_y,v_z	0.002342861813000729	−0.008762166195659019	−0.005029967766286956
626	Notburga	x,y,z	−3.035450076806275543	0.421864008988716566	−0.127583860826996742
		v_x,v_y,v_z	−0.001866697145881276	−0.005612944658928348	−0.006561241265170950
635	Vundtia	x,y,z	2.006725589468375315	−2.376415931764492395	−0.496002046851244771
		v_x,v_y,v_z	0.006841157951777630	0.006652586659241708	0.0001565035661244263
663	Gerlinde	x,y,z	2.983897565601330903	1.397628190931970991	3.091574612026383173
		v_x,v_y,v_z	−0.004331655563956410	0.007414701609598470	0.0000530966741235238
667	Denise	x,y,z	−2.421777915332062658	−2.295475988992165650	0.452580813773379109
		v_x,v_y,v_z	0.004815408543036114	−0.007668419938770380	−0.000993922465387279
674	Rachele	x,y,z	−0.235827957791626630	2.008846377619600601	0.9239571728159498454
		v_x,v_y,v_z	−0.011860879067687655	−0.002375626722544034	0.001425555621865033
675	Ludmilla	x,y,z	0.001979483768247084	2.107337311005498902	0.5370011327043579530
		v_x,v_y,v_z	−0.012117274959326541	0.001965172863672976	−0.001430686736150516
680	Genoveva	x,y,z	−2.483498644334699357	1.961237812146513712	0.5122017516184655506
		v_x,v_y,v_z	−0.004535242841718457	−0.005563771866247991	−0.003051609814162152
683	Lanzia	x,y,z	−0.038757248577513628	−2.929038122705282188	−1.100369444712229416
		v_x,v_y,v_z	0.009189739037992875	−0.001698156106930820	0.0002602487296413445
690	Wratislavia	x,y,z	−1.572098580880649132	−2.754041913568673561	−1.335506562200244884
		v_x,v_y,v_z	0.008204336231111772	−0.003237602143731366	0.000474631125854728
691	Lehigh	x,y,z	−2.600679234384931426	−2.131333554500724148	−0.280098141039464121
		v_x,v_y,v_z	0.005334054469881479	−0.005798095800458341	−0.003891386736724764
694	Ekard	x,y,z	−2.073828833200439092	−1.723446960059183167	−0.871272150977313808
		v_x,v_y,v_z	0.008389896606921710	−0.005221711697173810	0.000631908650981562
696	Leonora	x,y,z	−2.528679514939249806	−2.344092579990681102	−1.934926268906861813
		v_x,v_y,v_z	0.005658575767356208	−0.004750757197783061	−0.001445326359372374
702	Alauda	x,y,z	0.731086409189228292	2.576019002727282015	0.840680315316418403
		v_x,v_y,v_z	−0.008610612355498393	0.003701586218457099	−0.001273396941220973
705	Erminia	x,y,z	1.527810127063314871	−1.738330529507490452	−2.020057855746948849
		v_x,v_y,v_z	0.008204195294184936	0.003409657750114686	0.0003528767177190933
709	Fringilla	x,y,z	1.932009598635754166	1.322621695446154488	0.886519279952832973
		v_x,v_y,v_z	−0.006619431762339829	0.007378506450047627	0.0004203577713780057
712	Boliviana	x,y,z	−2.181214001606280206	1.349361062281813073	−0.026299365363868094
		v_x,v_y,v_z	−0.006970304527136179	−0.007493618475270048	−0.003330760378138190
713	Luscinia	x,y,z	0.602542358281345058	−2.935328109946095054	−0.752927362734930772
		v_x,v_y,v_z	0.009618230119085674	0.002849533333089440	0.001959410111945836
735	Marghanna	x,y,z	−2.970874542187170952	−1.503348928425136677	−0.336696621923833705
		v_x,v_y,v_z	0.005083914736085787	−0.004623872868731655	−0.004610217116933856

739	Mandeville	x,y,z	2.506148925696726870	−1.504824362532233950	−0.834400633180084061
		v_x,v_y,v_z	0.005428727641429763	0.007553927772582291	−0.000302902354564315
740	Cantabia	x,y,z	3.314248241247279569	−0.064714374102698397	−0.617044240710776459
		v_x,v_y,v_z	0.000448233529388049	0.008426445083442220	0.0002733213589088293
751	Faina	x,y,z	−2.301643137177721954	0.965649183773619191	1.182110401173152026
		v_x,v_y,v_z	−0.005854981025964248	−0.007733688166168566	−0.002054122576185711
752	Sulamitis	x,y,z	2.048812749653873055	1.241773705314024706	0.317962157290045455
		v_x,v_y,v_z	−0.006453759688972923	0.008038950160103676	0.0004297655236858543
760	Massinga	x,y,z	3.670126642304055498	−1.151050350627846441	−0.367902633175755500
		v_x,v_y,v_z	0.002369603147829039	0.005888743311020824	0.0004396658729641872
762	Pulcova	x,y,z	3.175342326316428654	−1.199205892203630830	−0.047622057373297624
		v_x,v_y,v_z	0.002109743357951093	0.007234201884231036	0.0004880661946113063
769	Tatjana	x,y,z	0.509160148400431334	−2.303342379809931284	−1.333719406992519119
		v_x,v_y,v_z	0.010933982442492730	0.002495895480057548	0.0003468838301451201
772	Tanete	x,y,z	2.906025830739782823	0.647310471297706802	−1.267907728397291933
		v_x,v_y,v_z	0.001010921533345003	0.007595842568837846	0.0005064697781475233
773	Irmintraud	x,y,z	−1.324784143882017373	−1.754236649382118429	−1.608060869413702854
		v_x,v_y,v_z	0.009439627055445330	−0.004735182301384725	−0.001496436978411633
776	Berbericia	x,y,z	−2.430375861485484013	1.244119991480070464	1.4499556777478691094
		v_x,v_y,v_z	−0.006193479474740193	−0.007012659876802435	−0.001255056722427736
778	Theobalda	x,y,z	2.578770540715112691	0.484679459667908804	0.746658068287141652
		v_x,v_y,v_z	−0.005606680738267385	0.008333234968279160	0.0004809669391709696
780	Armenia	x,y,z	−2.947260333629879270	1.443734931655717310	0.3745070083337502465
		v_x,v_y,v_z	−0.004292145745643914	−0.007903853241575533	−0.000226820581777773
784	Pickeringia	x,y,z	−1.216179274985955239	−1.725991913871303796	−1.130983048638923849
		v_x,v_y,v_z	0.010795481346361395	−0.004416936010313539	−0.003972330176354399
786	Bredichina	x,y,z	−0.640973967234059860	3.011946086754773155	1.482664510763615384
		v_x,v_y,v_z	−0.008114458019644099	−0.003635735760200800	0.0000726237470920756
788	Hohensteina	x,y,z	−2.065161763450813925	−1.731735607044430303	−0.269841031252473607
		v_x,v_y,v_z	0.007166218568798618	−0.008400928402379429	−0.001362268879167860
790	Pretoria	x,y,z	−3.312660708096480278	0.159833898455113310	−1.180393653213523963
		v_x,v_y,v_z	0.001800283505532356	−0.008606461983801833	−0.001971983915071157
791	Ani	x,y,z	−0.693006042192073846	−2.790965988787078800	−0.471075353887803139
		v_x,v_y,v_z	0.010149322918663708	−0.000178409023167429	−0.002316736158141167
804	Hispania	x,y,z	1.180236347016857978	−1.755994298920930508	−1.316225480612562171
		v_x,v_y,v_z	0.009748138526187236	0.004495021926921983	0.0004245447086389762
814	Tauris	x,y,z	−2.643337763228612580	−3.043511779699754172	−0.187636072682489108
		v_x,v_y,v_z	0.005375474685596784	−0.003186610433694088	−0.003752983540055900
849	Ara	x,y,z	−2.400436417716211412	−1.377376257048356312	−0.903371236042467940
		v_x,v_y,v_z	0.006630709229090170	−0.008101548494299360	0.0000290406058693144
895	Helio	x,y,z	−1.153864786573528756	−2.970641315024131757	−1.742880474756495213
		v_x,v_y,v_z	0.006900378729138242	−0.004383767421712856	0.0001915953866110696
909	Ulla	x,y,z	2.643585779564476823	−1.912997619870260957	−0.715076842818698211
		v_x,v_y,v_z	0.005129680510801807	0.008209415548612537	0.0000169376652986247
914	Palisana	x,y,z	0.598245936709027260	−1.827975513352569470	−0.273954790847752927
		v_x,v_y,v_z	0.011446713245858879	0.003314424689681761	0.0006488303174133064
980	Anacostia	x,y,z	−3.175758333328849048	0.485972795063543628	−0.719059100789527061
		v_x,v_y,v_z	−0.000142109533888624	−0.007460640782612650	−0.004030038096555623

1015	Christa	x,y,z	−1.566656583058677832	2.568332206936112527	1.085692881000842158
		v_x,v_y,v_z	−0.008675523560380710	−0.004175198720726467	−0.000110280407398696
1021	Flammario	x,y,z	−2.936407649398657060	0.239975615662415969	0.837347923291067331
		v_x,v_y,v_z	−0.003624193796013200	−0.008360760098837189	−0.001485430871488255
1036	Ganymed	x,y,z	−2.506653200603659926	2.486748461463569093	−0.616157838784046952
		v_x,v_y,v_z	−0.006637194622358507	−0.002518711399848999	−0.001898585862499638
1093	Freda	x,y,z	−2.277804058924099539	−1.843336426423987318	−0.338410936166434473
		v_x,v_y,v_z	0.007229516437050462	−0.003691334503305957	−0.006389991099609126
1107	Lictoria	x,y,z	−2.569057933925188664	−1.937453059103700248	−0.421229684865389586
		v_x,v_y,v_z	0.004720513971195381	−0.007449150358726622	−0.003422150642625780
1171	Rusthawelia	x,y,z	2.560542567362555477	−1.071816228353758005	−0.550580177371690072
		v_x,v_y,v_z	0.002594814272586507	0.009717147787535695	0.003755086238400567
1467	Mashona	x,y,z	0.966768996929490920	−2.152669618944333507	−1.688772902845859569
		v_x,v_y,v_z	0.009795683288059361	0.001634297002254343	0.004184325487804071

References

[1] W. M. Folkner, J. G. Williams, and D. H. Boggs, "The Planetary and Lunar Ephemeris DE421," *The Interplanetary Network Progress Report*, vol. 42-178, Jet Propulsion Laboratory, Pasadena, California, pp. 1–34, August 15, 2009.
http://ipnpr.jpl.nasa.gov/progress_report/42-178/178C.pdf

[2] E. M. Standish, X X Newhall, J. G. Williams, and W. M. Folkner, *JPL Planetary and Lunar Ephemerides*, Richmond, Virginia: Willmann-Bell, Inc., 1997.

[3] X X Newhall, "Numerical Representation of Planetary Ephemerides," *Celestial Mechanics*, vol. 45, pp. 305–310, 1989.

[4] E. M. Standish and J. G. Williams, "Orbital Ephemerides of the Sun, Moon, and Planets," *The Explanatory Supplement to the Astronomical Almanac, Third Edition*, eds. S. Urban and P. K. Seidelmann, Mill Valley, California: University Science Books, pp. 305–345, 2012.

[5] J. G. Williams, D. H. Boggs, C. F. Yoder, J. T. Ratcliff, and J. O. Dickey, "Lunar Rotational Dissipation in Solid Body and Molten Core," *Journal of Geophysical Research*, vol. 106, pp. 27933–27968, 2001.

[6] J. G. Williams and D. H. Boggs, "Lunar Core and Mantle: What Does LLR See?", *Proceedings of the 16th International Workshop on Laser Ranging, SLR — the Next Generation*, ed. Stanislaw Schillak, October 2008, Poznan, Poland, pp. 101–120, 2009.
http://www.astro.amu.edu.pl/ILRS_Workshop_2008/index.php

[7] P. Kuchynka and W. M. Folkner, "A New Approach to Determining Asteroid Masses from Planetary Range Measurements," *Icarus*, vol. 222, pp. 243–253, 2013.

[8] D. L. Matson, G. J. Veeder, E. F. Tedesco, L. A. Lebofsky, and R. G. Walker, "IRAS Survey of Asteroids," *Advances in Space Research*, vol. 6, pp. 47–56, 1986.

[9] J. R. Masiero, A. K. Mainzer, T. Grav, J. M. Bauer, R. M. Cutri, et al., "Main Belt Asteroids with WISE/NEOWISE: I. Preliminary Albedos and Diameters," *Astrophysical Journal*, vol. 741, article 68, 20 pages, 2011.

[10] E. F. Tedesco, P. V. Noah, M. Noah, and S. D. Price, "The Supplemental IRAS Minor Planet Survey," *Astronomical Journal*, vol. 123, pp. 1056–1085, 2002.

[11] C. Ma, E. F. Arias, G. Bianco, D. A. Boboltz, S. L. Bolotin, et al., "The Second Realization of the International Celestial Reference Frame by Very Long Baseline Interferometry," *IERS Technical Note No. 35*, International Earth Rotation and Reference Systems Service, Verlag des Bundesamts für Kartographie und Geodäsie, Frankfurt, Germany, 2009.

[12] O. Titov, S. B. Lambert and A.-M. Gontier, "VLBI Measurement of the Secular Aberration Drift," *Astronomy and Astrophysics*, vol. 529, pp. A91–A97, 2011.

[13] J. D. Giorgini, D. K. Yeomans, A. B. Chamberlin, P. W. Chodas, R. A. Jacobson, et al., "JPL's On-Line Solar System Data Service," *Bulletin of the American Astronomical Society*, vol. 28, p. 1158, 1996.

[14] A. Fienga, H. Manche, J. Laskar, and M. Gastineau, "INPOP06: A New Numerical Planetary Ephemeris," *Astronomy and Astrophysics*, vol. 477, pp. 315–327, 2008.

[15] E. V. Pitjeva, "Influence of Asteroids and Trans-Neptunian Objects on the Motion of Major Planets and Masses of the Asteroid Main Belt and the TNO Ring," *Proceedings of the International Conference on Asteroid–Comet Hazard — 2009*, eds. A. M. Finkelstein, W. F. Huebner, and V. A. Shor, St. Petersburg, Russia, pp. 237–241, 2010.

[16] M. Soffel, S. A. Klioner, G. Petit, P. Wolf, S. M. Kopeikin, et al., "The IAU 2000 Resolutions for Astrometry, Celestial Mechanics, and Metrology in the Relativistic Framework: Explanatory Supplement," *Astronomical Journal*, vol. 126, pp. 2687–2706, 2003.

[17] A. Fienga, J. Laskar, T. Morley, H. Manche, P. Kuchynka, et al., "INPOP08, A 4-D Planetary Ephemeris: From Asteroid and Time-Scale Computations to ESA Mars Express and Venus Express Contributions," *Astronomy and Astrophysics*, vol. 507, pp. 1675–1686. 2009.

[18] G. Petit and B. Luzum, "IERS Conventions (2010)," *IERS Technical Note No. 36*, International Earth Rotation and Reference Systems Service, Verlag des Bundesamts für Kartographie und Geodäsie, Frankfurt, Germany, 2009.

[19] A. W. Irwin and T. Fukushima, "A Numerical Time Ephemeris of the Earth," *Astronomy and Astrophysics*, vol. 348, pp. 642–652, 1999.

[20] A. S. Konopliv, S. W. Asmar, W. M. Folkner, O. Karatekin, D. C. Nunes, et al., "Mars High-Resolution Gravity fields from MRO, Mars Seasonal Gravity and Other Dynamical Parameters," *Icarus*, vol. 211, pp. 401–428, 2011.

[21] J. H. Lieske, T. Lederle, W. Fricke, and B. Morando, "Expression for the Precession Quantities Based on the IAU (1976) System of Astronomical Constants," *Astronomy and Astrophysics*, vol. 58,pp. 1–16, 1977.

[22] J. H. Lieske, "Precession Matrix Based on IAU (1976) System of Astronomical Constants," *Astronomy and Astrophysics*, vol. 73, pp. 282–284, 1979.

[23] P. K. Seidelmann, "1980 IAU Theory of Nutation: The Final Report of the IAU Working Group on Nutation," *Celestial Mechanics*, vol. 27, pp. 79–106, 1982.

[24] A. Einstein, L. Infeld and B. Hoffmann, "The Gravitational Equations and the Problem of Motion," *Annals of Mathematics,* vol. 39, pp. 65–100,1938.

[25] C. M. Will and K. Nordtvedt, "Conservation Laws and Preferred Frames in Relativistic Gravity: I. Preferred Frame Theories and an Extended PPN Formalism," *Astrophysical Journal*, vol. 177, pp. 757–774, 1972.

[26] T. D. Moyer, *Formulation for Observed and Computed Values of Deep Space Network Data Types for Navigation*, Monograph 2, Deep-Space Communications and Navigation Systems Center of Excellence (DESCANSO), Deep-Space Communications and Navigation Series, Jet Propulsion Laboratory, Pasadena, California, October 2000. http://descanso.jpl.nasa.gov/Monograph/series2/Descanso2_all.pdf

[27] C. F. Yoder, "Effects of the Spin-Interaction and the Inelastic Tidal Deformation on the Lunar Physical Librations," *Natural and Artificial Satellite Motion,* ed. P. E. Nacozy and S. Ferraz-Mello, Austin, Texas: University of Texas Press, pp. 211–221, 1979.

[28] D. H. Eckhardt, "Theory of the Libration of the Moon," *Moon and Planets*, vol. 25, pp. 3–49, 1981.

[29] P. L. Bender, D. G. Currie, R. H. Dicke, D. H. Eckhardt, J. E. Faller, et al., "The Lunar Laser Ranging Experiment," *Science*, vol. 182, pp. 229–238, 1973.

[30] J. O. Dickey, P. L. Bender, J. E. Faller, X X Newhall, R. L. Ricklefs, et al., "Lunar Laser Ranging: a Continuing Legacy of the Apollo Program," *Science*, vol. 265, pp. 482–490, 1994.

[31] J. B. R. Battat, T. W. Murphy, Jr., E. G. Adelberger, B. Gillespie, C. D. Hoyle, et al., "The Apache Point Observatory Lunar Laser-Ranging Operation (APOLLO): Two Years of Millimeter-Precision Measurements of the Earth–Moon Range," *Publications of the Astronomical Society of the Pacific*, vol. 121, pp. 29–40, 2009.

[32] P. J. Shelus, "MLRS: A Lunar/Artificial Satellite Laser Ranging Facility at the McDonald Observatory," *IEEE Transactions on Geoscience and Remote Sensing*, Ge-23, pp. 385–390, 1985.

[33] M. R. Pearlman, J. J. Degnan, and J. M. Bosworth, "The International Laser Ranging Service," *Advances in Space Research*, vol. 30, pp. 135–143, 2002.

[34] E. Samain, J. F. Mangin, C. Veillet, J. M. Torre, P. Fridelance, et al., "Millimetric Lunar Laser Ranging at OCA (Observatoire de la Côte d'Azur)," *Astronomy and Astrophysics Supplement*, vol. 130, pp. 235–244, 1998.

[35] T. W. Murphy, Jr., E. G. Adelberger, J. B. R. Battat, L. N. Carey, C. D. Hoyle, et al., "The Apache Point Observatory Lunar Laser-Ranging Operation: Instrument Description and First Detections," *Publications of the Astronomical Society of the Pacific*, vol. 120, pp. 20–37, 2008.

[36] P. Kuchynka and W. M. Folkner, "Station-Specific Errors in Mars Ranging Measurements," *The Interplanetary Network Progress Report*, vol. 42–190, Jet Propulsion Laboratory, Pasadena, California, pp. 1–11, August 15, 2012.
http://ipnpr.jpl.nasa.gov/progress_report/42-190/190C.pdf

[37] D. W. Curkendall and J. S. Border, "Delta-DOR: The One-Nanoradian Navigation Measurement System of the Deep Space Network — History, Architecture and Componentry," *The Interplanetary Network Progress Report*, vol. 42–193, Jet Propulsion Laboratory, Pasadena, California, pp. 1–46, May 15, 2013.
http://ipnpr.jpl.nasa.gov/progress_report/42-193/193D.pdf

[38] D. L. Jones, E. Fomalont, V. Dhawan, J. Romney, W. M. Folkner, et al., "Very Long Baseline Array Astrometric Observations of the Cassini Spacecraft at Saturn," *Astronomical Journal*, vol. 141, no. 29, 10 pages, 2011.

[39] M. A. C. Perryman, L. Lindegren, J. Kovalevsky, E. Høg, U. Bastian, et al., "The Hipparcos Catalogue," *Astronomy and Astrophysics*, vol. 323, pp. L49–L52, 1997.

[40] J.-F. Lestrade, D. L. Jones, R. A. Preston, R. B. Phillips, M. A. Titus, et al., "Preliminary Link of the HIPPARCOS and VLBI Reference Frames," *Astronomy and Astrophysics*, vol. 304, pp. 182–188, 1995.

[41] E. E. Barnard, "Micrometer Observations of the Satellite of Neptune at the Oppositions of 1903–1904," *Astronomical Journal*, vol. 25, pp. 41–42, 1906.

[42] E. E. Barnard, "Observations of the Satellite of Neptune at the Opposition of 1906–7," *Astronomical Journal*, vol. 25, p. 164, 1907.

[43] E. E. Barnard, "Observations of the Satellite of Neptune at the Oppositions 1907–8 and 1908–9, Made with the 40-inch Telescope," *Astronomische Nachrichten*, vol. 181, pp. 321–326, 1909.

[44] E. E. Barnard, "Observations of the Satellites of Uranus," *Astronomical Journal*, vol. 26, pp. 47–50, 1909.

[45] E. E. Barnard, "Micrometer Measures of the Satellites of Saturn in the Years 1910, 1911, and 1912," *Astronomical Journal*, vol. 27, pp. 116–129, 1912.

[46] E. E. Barnard, "Observations of the Satellite of Neptune, 1910–1912," *Astronomical Journal*, vol. 27, pp. 111–112, 1912.

[47] E. E. Barnard, "Observations of the Satellites of Uranus," *Astronomical Journal*, vol. 27, pp. 104–106, 1912.

[48] E. E. Barnard, "Observations of the Satellites of Saturn," *Astronomical Journal*, vol. 29, pp. 33–37, 1915.

[49] E. E. Barnard, "Observations of the Satellites of Uranus," *Astronomical Journal*, vol. 29, pp. 39–40, 1915.

[50] E. E. Barnard, "Observations of the Satellite of Neptune," *Astronomical Journal*, vol. 30, pp. 2–4, 1916.

[51] E. E. Barnard, "Observations of the Satellites of Saturn at the Opposition of 1915–16," *Astronomical Journal*, vol. 30, pp. 33–40, 1916.

[52] E. E. Barnard, "Observations of the Satellite of Neptune," *Astronomical Journal*, vol. 30, pp. 214–216, 1917.

[53] E. E. Barnard, "Observations of the Satellite of Neptune," *Astronomical Journal*, vol. 32, pp. 103–104, 1919.

[54] E. E. Barnard, "Observations of the Satellites of Uranus," *Astronomical Journal*, vol. 32, pp. 105–107, 1919.

[55] E. E. Barnard, "Measures of the Satellites of Saturn and Position-Angles of the Ring," *Astronomical Journal*, vol. 37, pp. 157–172, 1927.

[56] E. E. Barnard, "Micrometer Observations of Neptune," *Astronomical Journal*, vol. 37, pp. 130–132, 1927.

[57] E. E. Barnard, "Observations of the Satellites of Uranus," *Astronomical Journal*, vol. 37, pp. 125–127, 1927.

[58] M. Assafin, J. I. B. Camargo, R. Vieira Martins, A. H. Andrei, B. Sicardy, et al., "Precise Predictions of Stellar Occultations by Pluto, Charon, Nix, and Hydra for 2008–2015," *Astronomy and Astrophysics,* vol. 515, pp. A32, 2010.

[59] D. K. Srinivasan, M. E. Perry, K. B. Fielhauer, D. E. Smith, and M. T. Zuber, "The Radio Frequency Subsystem and Radio Science on the MESSENGER Mission," *Space Science Reviews*, vol. 131, pp. 557–571, 2007.

[60] J. D. Anderson, G. Colombo, P. B. Esposito, E. L. Lau, and G. B. Trager, "The Mass, Gravity Field, and Ephemeris of Mercury," *Icarus*, vol. 71, pp. 337–349, 1987.

[61] Yu. N. Aleksandrov, A. S. Vyshlov, V. M. Dubrovin, A. L. Zaitsev, S. P. Ignatov, et al., "Radar Observations of Mars, Venus, and Mercury at a Wavelength of 39 cm in 1980," *Soviet Physics Doklady*, vol. 25, pp. 945–947, 1981.

[62] J. K. Harmon, D. B. Campbell, D. L. Bindschadler, J. W. Head, and I. I. Shapiro, "Radar Altimetry of Mercury: A Preliminary Analysis," *Journal of Geophysical Research*, vol. 91, pp. 385–401 ,1986.

[63] R. F. Jurgens, F. Rojas, M. Slade, E. M. Standish, and J. F. Chandler, "Mercury Radar Ranging Data from 1987 to 1997," *Astronomical Journal*, vol. 116, pp. 486–488, 1998.

[64] J. D. Anderson, R. F. Jurgens, E. L. Lau, and M. A. Slade, "Shape and Orientation of Mercury from Radar Ranging Data," *Icarus*, vol. 124, pp. 690–697, 1996.

[65] D. B. Campbell, R. B. Dyce, R. P. Ingalls, G. H. Pettengill, and I. I. Shapiro, "Venus Topography Revealed by Radar Data," *Science*, vol. 175, pp. 514–516, 1972.

[66] Yu. N. Aleksandrov, V. K. Golovkov, V. M. Dubrovin, A. L. Zaitsev, V. I. Kaevitser, et al., "The Reflection Properties and Surface Relief of Venus; Radar Surveys at 39-cm Wavelength," *Soviet Astronomy*, vol. 24, pp. 139–146, 1980.

[67] D. B. Campbell and B. A. Burns, "Earth-Based Radar Imagery of Venus," *Journal of Geophysical Research*, vol. 85, pp. 8271–8281, 1980.

[68] E. M. Standish and R. W. Hellings, "A Determination of the Masses of Ceres, Pallas and Vesta from Their Perturbations Upon the Orbit of Mars," *Icarus*, vol. 80, pp. 326–333, 1989.

[69] A. S. Konopliv, C. F. Yoder, E. M. Standish, D.-N. Yuan, and W. L. Sjogren, "A Global Solution for the Mars Static and Seasonal Gravity, Mars Orientation, Phobos and Deimos Masses, and Mars Ephemeris," *Icarus*, vol. 182, pp. 23–50, 2006.

[70] A. Fienga, J. Laskar, P. Kuchynka, H. Manche, G. Desvignes, M. Gastineau, I. Cognard, and G. Theureau, "The INPOP10a Planetary Ephemeris and Its Applications in Fundamental Physics," *Celestial Mechanics and Dynamical Astronomy,* vol. 111, pp. 363–385, 2011.

[71] R. C. Stone, D. G. Monet, A. K. B. Monet, R. L. Walker, H. D. Ables, A. R. Bird, and F. H. Harris, "The Flagstaff Astrometric Scanning Transit Telescope (FASTT) and Star Positions Determined in the Extragalactic Reference Frame," *Astronomical Journal*, vol. 111, pp. 1721–1742, 1996.

[72] R. C. Stone, "CCD Positions for the Outer Planets in 1995 Determined in the Extraga-
lactic Reference Frame," *Astronomical Journal*, vol. 112, pp. 781–787, 1996.

[73] R. C. Stone, "CCD Positions for the Outer Planets in 1996–1997 Determined in the
Extragalactic Reference Frame," *Astronomical Journal*, vol. 116, pp. 1461–1469,1998.

[74] R. C. Stone and F. H. Harris, "CCD Positions Determined in the International Celestial
Reference Frame for the Outer Planets and Many of Their Satellites in 1995–1999,"
Astronomical Journal, vol. 119, pp. 1985–1998, 2000.

[75] R. C. Stone, "Positions for the Outer Planets and Many of their Satellites: IV. FASTT Ob-
servations Taken in 1999–2000," *Astronomical Journal*, vol. 120, pp. 2124–2130, 2000.

[76] R. C. Stone, "Positions for The Outer Planets and Many of Their Satellites: V. FASTT Ob-
servations Taken in 2000–2001," *Astronomical Journal*, vol. 122, pp. 2723–2733, 2001.

[77] R. C. Stone, D. G. Monet, A. K. B. Monet, F. H. Harris, H. D. Ables, et al., "Upgrades to
the Flagstaff Astrometric Scanning Transit Telescope: A Fully Automated Telescope for
Astrometry," *Astronomical Journal,* vol. 126, pp. 2060–2080, 2003.

[78] M. Vasilyev, G. Krasinsky, M. Sveshnikov, G. Gorel, and L. Gudkova, "Improving of
Ephemerides of Jupiter Using Observations of Galilean Satellites Made in Nikolaev
in 1962–1997," *Trudy IPA RAN (Proceedings of Institute of Applied Astronomy),* vol. 5,
pp. 176–189, 2000.

[79] L. Helmer and L. V. Morrison, "Carlsberg Automatic Meridian Circle," *Vistas in Astrono-
my*, vol. 28, pp. 505–518, 1985.

[80] V. P. Rylkov, V. V. Vityazev, and A. A. Dementieva, "Pluto: An Analysis of Photographic
Positions Obtained with the Pulkovo Normal Astrograph in 1930–1992," *Astronomical
and Astrophysical Transactions*, vol. 6, pp. 251–281, 1995.

[81] B. Luzum, N. Capitaine, A. Fienga, W. Folkner, T. Fukushima, et al., "The IAU 2009 Sys-
tem of Astronomical Constants: The Report of the IAU Working Group on Numerical
Standards for Fundamental Astronomy," *Celestial Mechanics and Dynamical Astronomy*,
vol. 110, pp. 293–304, 2011.

[82] J. C. Ries, R. J. Eanes, C. K. Shum, and M. M. Watkins, "Progress in the Determina-
tion of the Gravitational Coefficient of the Earth," *Geophysical Research Letters*, vol. 19,
pp. 529–531, 1992.

[83] P. Dunn, M. Torrence, R. Kolenkiewicz, and D. Smith, "Earth Scale Defined by Modern
Satellite Ranging Observations," *Geophysical Research Letters*, vol. 26, pp. 1489–1492,
1999.

[84] J. C. Ries, "Satellite Laser Ranging and the Terrestrial Reference Frame: Principal Sources
of Uncertainty in the Determination of the Scale," *Geophysical Research Abstracts*, vol. 9,
no. 10809, EGU General Assembly, Vienna, Austria, April 15–20, 2007.

[85] A. S. Konopliv, R. S. Park, D.-N. Yuan, S. W. Asmar, M. M. Watkins, et al., "The JPL Lu-
nar Gravity Field to Spherical Harmonic Degree 660 from the GRAIL Primary Mission,"
Journal of Geophysical Research, vol. 118, pp. 1415–1434, 2013.

[86] F. G. Lemoine, S. Goossens, T. J. Sabaka, J. B. Nicholas, E. Mazarico, et al., "High-Degree Gravity Models from GRAIL Primary Mission Data," *Journal of Geophysical Research*, vol. 118, pp. 1676–1698, 2013.

[87] M. Emilio, J. R. Kuhn, R. I. Bush, and I. F. Scholl, "Measuring the Solar Radius from Space During the 2003 and 2006 Mercury Transits," *Astrophysical Journal*, vol. 750, article 135, 8 pages, 2012.

[88] B. A. Archinal, M. F. A'Hearn, E. Bowell, A. Conrad, G. J. Consolmagno, et al., "Report of the IAU Working Group on Cartographic Coordinates and Rotational Elements: 2009," *Celestial Mechanics and Dynamical Astronomy*, vol. 109, pp. 101–135, 2011.

[89] L. Iorio, H. I. M. Lichtenegger, M. L. Ruggiero, and C. Corda, "Phenomenology of the Lense–Thirring Effect in the Solar System," *Astrophysical Space Science*, vol. 331, pp. 351–395, 2011.

[90] J. Baer and S. R. Chesley, "Astrometric Masses of 21 Asteroids and an Integrated Asteroid Ephemeris," *Celestial Mechanics and Dynamical Astronomy*, vol. 100, pp. 27–42, 2008.

[91] J. Baer, S. R. Chesley, and R. D. Matson, "Astrometric Masses of 26 Asteroids and Observations on Asteroid Porosity," *Astronomical Journal*, vol. 141, article 143, 12 pages, 2011.

[92] F. Marchis, D. Hestroffer, P. Descamps, J. Berthier, C. Laver, and I. de Pater, "Mass and Density of Asteroid 121 Hermione from an Analysis of Its Companion Orbit," *Icarus*, vol. 178, pp. 450–464, 2005.

[93] P. Descamps, F. Marchis, T. Michalowski, F. Vachier, F. Colas, et al., "Figure of the Double Asteroid 90 Antiope from Adaptive Optics and Light-Curve Observations," *Icarus*, vol. 187, pp. 482–499, 2007.

[94] F. Marchis, P. Descamps, M. Baek, A. W. Harris, M. Kaasalainen, et al., "Main Belt Binary Asteroidal Systems with Circular Mutual Orbits," *Icarus*, vol. 196, pp. 97–118, 2008.

[95] F. Marchis, P. Descamps, J. Berthier, D. Hestroffer, F. Vachier, et al., "Main Belt Binary Asteroidal Systems with Eccentric Mutual Orbits," *Icarus*, vol. 195, pp. 295–316, 2008.

[96] D. K. Yeomans, P. G. Antreasian, J.-P. Barriot, S. R. Chesley, D. W. Dunham, et al., "Radio Science Results During the NEAR-Shoemaker Spacecraft Rendezvous with Eros," *Science*, vol. 289, pp. 2085–2088, 2000.

[97] M. Pätzold, T. P. Andert, S. W. Asmar, J. D. Anderson, J.-P. Barriot, et al., "Asteroid 21 Lutetia: Low Mass, High Density," *Science*, vol. 334, pp. 491–492, 2011.

[98] A. S. Konopliv, J. K. Miller, W. M. Owen, D. K. Yeomans, J. D. Giorgini, et al., "A Global Solution for the Gravity Field, Rotation, Landmarks and Ephemeris of Eros," *Icarus*, vol. 160, pp. 289–299, 2002.

[99] C. T. Russell, C. A. Raymond, A. Coradini, H. Y. McSween, M. T. Zuber, et al., "Dawn at Vesta: Testing the Protoplanetary Paradigm," *Science*, vol. 336, pp. 684–686, 2012.