

INFORMATION ON ORBITAL ELEMENTS OF THE NUMBERED MINOR PLANETS FOR 2023

We stop preparation of the Ephemerides of Minor Planets (EMP) for 2022 and for the next years. The main reason is the outdated form of the table format of ephemerides. The package AMPLE allows to calculate the ephemerides of minor planets in convenient view.

We intend to keep the table "Orbital elements of the numbered minor planets". We plan update orbital elements after each publication of observations by MPC.

Elements of all numbered minor planets (619 150) have been determined by IAA. The sets of elements are given for the epoch Feb. 25, 2023. They were determined as a result of orbit improving on the base of all kinds of optical observations available in the catalog of observations of the Minor Planet Center on Oct. 10, 2022 (radar observations have not been used at this stage).

When using these data it is necessary to take into consideration the following:

1) corrections to the initial sets of elements were determined by the least square fit of weighted conditional equations. In so doing, the observations made before 1901 were assigned weight equal to 1/16, the observations made during the time interval from 1901 to 1950 were assigned weight equal to 1/9, the observations made during the time interval from 1951 to 1995 were assigned weight equal to 1/4, and at last the observations starting from 1996 were considered as having unit weight;

2) observations of only standard accuracy were used for orbit improvement;

3) observations in right ascension and in declination were considered as independent, so that conditional equation, e.g. in right ascension, could be excluded by "the three sigma criterion" from solution whereas equation in declination could be used or vice versa;

4) observation is considered as used, if both conditional equations in right ascension and in declination or at least one of them are used for finding solution;

The elements of the numbered minor planets are given with respect to the ecliptic and equinox J2000.0. The computation of osculating elements for the new standard epoch JDT 2460000.5 = 2023 February 25.0 TT was carried out by numerical integration of relativistic equations of motion in rectangular coordinates taking into account the perturbations from Mercury to Neptune and from Pluto, Ceres, Pallas, and Vesta. Coordinates and masses of perturbing planets were taken from *DE* 440. The perturbations from the Earth and the Moon were considered separately.

The following Table gives the format of presentation of elements in files.

Number, name	H , m	M , °	ω , °	Ω , °	i , °	e	n , °/day	a , a. u.
1	2	3	4	5	6	7	8	9
1 Ceres	3.33	17.21593	73.47023	80.26013	10.58635	0.0788178	0.21411522	2.7671817
2 Pallas	4.12	357.84932	310.86487	172.91814	34.92704	0.2300844	0.21383118	2.7696317
3 Juno	5.13	351.82411	247.73654	169.84301	12.99066	0.2564677	0.22589353	2.6701369
4 Vesta	3.20	115.13300	151.59910	103.75733	7.13927	0.0887575	0.27133009	2.3630382

The first column of the Table gives the number and the name or principal provisional designation of each minor planet. The second one gives the absolute magnitude, H , that is, the brightness averaged over rotation for minor planets having known lightcurves and reduced to unit heliocentric and geocentric distances and to zero phase angle. Parameter H is provided by the Minor Planet Center.

The orbital elements (mean anomaly, M , argument of perihelion, ω , longitude of ascending node, Ω , inclination, i , eccentricity, e , mean motion, n , and semi-major axis, a) are given in the columns from 3 to 9.

The catalogue of elements can be found in the file contains elements for all 619 150 minor planets; its name is 'el_619150.txt'.

The data are presented as TXT file.

One can take elements of numbered minor planets using softwares AMPLE (<https://iaaras.ru/dept/lbss/ample/>), they are obtained in IAARAS and based on DE 440, and AMPLE3 (<https://iaaras.ru/dept/lbss/ample3/>), they are taken in the Minor Planet Center and based on DE 405.

The mentioned catalogues contain neither the errors of the orbital elements nor RMS values. These information one can find for each minor planet in Russian in "Catalogue of small bodies" (<https://iaaras.ru/dept/lbss/mpc/>) or in English in "Small Bodies Catalogue" <https://iaaras.ru/en/dept/lbss/mpc/#q=999>).