Guide to the Extended Versions of MPC Data Files Based on the MPCORB Format

Last updated: 2016/04/19

by J.L. Galache

Introduction

The Minor Planet Center (MPC) has been providing the orbits of minor planets in the form of a file, MPCORB.DAT, since the mid '90s (1990s, not 1890s). Back then there were only a few thousand known asteroids, compared to the several hundred thousand of today, so a flat text file was the appropriate way to circulate these data. It was also a time when most orbit computations were programmed in Fortran, which ingested data no other way.

MPCORB.DAT has therefore always been, and continues to be, a fixed-width file (see Table 1 for the current format description[1]). In fact, all original data files available on the MPC website are flat text files (even the orbits files provided for planetarium-type/sky simulation software packages are simply text files of varying format[2]).

In the early years of the 2010s, possibly due to the rising popularity of the scripting language Python amongst astronomers, and an increased interest from developers wanting to write asteroid-themed tools, requests were received to provide data in other, easier to parse formats, e.g., JSON, CSV, SQL, etc.

At the same time, astronomers and developers alike wanted more information than was currently been provided in MPCORB.DAT; information that did exist on the MPC website in other, often hard to find, files. Here was an opportunity to add some new data to existing files, while also making them available in other formats.

Providing the core of the MPC's datafiles in JSON format is a step towards a more flexible supply of data to the world. As time permits, it is hoped other formats will follow.

This document provides information on these new files.

Any comments can be sent through the MPC Contact page.

The “extended” Family of Files

For files that adhere to the MPCORB data format, new versions have been created called [FILENAME]_extended.dat and [FILENAME]_extended.json. Table 2 lists the files available in “extended” versions. Note that these files are only available Gzipped.

Contents of the extended DAT files

These files retain the fixed-width column structure of the original MPCORB format (see Table 1) but have some extra columns added at the end. See Table 3 for the listing.

1 Also found at its primary location: http://www.minorplanetcenter.org/iau/info/MPOrbitFormat.html.
2 They can be found at: http://www.minorplanetcenter.net/iau/Ephemerides/SoftwareEls.html.

Table 1: MPCORB format description.

Columns	Format[3]	Use
1–7	a7	Number or provisional designation (in packed form)
9–13	f5.2	Absolute magnitude, *H*
15–19	f5.2	Slope parameter, *G*
21–25	a5	Epoch (in packed form, .0 TT)
27–35	f9.5	Mean anomaly at the epoch (degrees)
38–46	f9.5	Argument of perihelion, J2000.0 (degrees)
49–57	f9.5	Longitude of the ascending node, J2000.0 (degrees)
60–68	f9.5	Inclination to the ecliptic, J2000.0 (degrees)
71–79	f9.7	Orbital eccentricity, *e*
81–91	f11.8	Mean daily motion (degrees per day)
93–103	f11.7	Semimajor axis, *a* (AU)
106	i1	Uncertainty parameter, *U*
	a1	If this column contains 'E' it indicates that the orbital eccentricity was assumed. For one-opposition orbits this column can also contain 'D' if a double (or multiple) designation is involved or 'F' if an e-assumed double (or multiple) designation is involved.
108–116	a9	Reference
118–122	i5	Number of observations
124–126	i3	Number of oppositions
For multiple-opposition orbits:		
128–131	i4	Year of first observation
132	a1	'-'
133–136	i4	Year of last observation
For single-opposition orbits:		
128–131	i4	Arc length (days)
133–136	a4	'days'
138–141	f4.2	r.m.s residual (")
143–145	a3	Coarse indicator of perturbers (blank if unperturbed one-opposition object)
147–149	a3	Precise indicator of perturbers (blank if unperturbed one-opposition object)

3 Fortran 77/90/95/2003/2008 format specifier.

<table>
<tr><th>Columns</th><th>Format</th><th>Use</th></tr>
<tr><td>151–160</td><td>a10</td><td>Computer name</td></tr>
<tr><td rowspan="5">162–165</td><td rowspan="5">z4.4</td><td>4-hexdigit flags
This information has been updated 2014 July 16, for files created after 18:40 UTC on that day. Classification of distant-orbit types will resume after we ingest data from an outside collaborator.
The bottom 6 bits (bits 0 to 5) are used to encode a value representing the orbit type (other values are undefined):</td></tr>
<tr><td>
<table>
<tr><th>Value</th><th>Orbit Type</th></tr>
<tr><td>1</td><td>Atira</td></tr>
<tr><td>2</td><td>Aten</td></tr>
<tr><td>3</td><td>Apollo</td></tr>
<tr><td>4</td><td>Amor</td></tr>
<tr><td>5</td><td>Object with q < 1.665 AU</td></tr>
<tr><td>6</td><td>Hungaria</td></tr>
<tr><td>7</td><td>Phocaea</td></tr>
<tr><td>8</td><td>Hilda</td></tr>
<tr><td>9</td><td>Jupiter Trojan</td></tr>
<tr><td>10</td><td>Distant object</td></tr>
</table>
</td></tr>
<tr><td>Additional information is conveyed by adding in the following bit values:</td></tr>
<tr><td>
<table>
<tr><th>Bit</th><th>Value</th><th>Use</th></tr>
<tr><td>6</td><td>64</td><td>Unused or internal MPC use only</td></tr>
<tr><td>7</td><td>128</td><td>Unused or internal MPC use only</td></tr>
<tr><td>8</td><td>256</td><td>Unused or internal MPC use only</td></tr>
<tr><td>9</td><td>512</td><td>Unused or internal MPC use only</td></tr>
<tr><td>10</td><td>1024</td><td>Unused or internal MPC use only</td></tr>
<tr><td>11</td><td>2048</td><td>Object is NEO</td></tr>
<tr><td>12</td><td>4096</td><td>Object is 1-km (or larger) NEO</td></tr>
<tr><td>13</td><td>8192</td><td>1-opposition object seen at earlier opposition</td></tr>
<tr><td>14</td><td>16384</td><td>Critical list numbered object</td></tr>
<tr><td>15</td><td>32768</td><td>Object is PHA</td></tr>
</table>
</td></tr>
<tr><td>Note that the orbit classification is based on cuts in osculating element space and is not 100% reliable.
Note also that certain of the flags are for internal MPC use and are not documented.</td></tr>
<tr><td>167–194</td><td>a</td><td>Readable (unpacked) designation</td></tr>
<tr><td>195–202</td><td>i8</td><td>Date of last observation included in orbit solution (YYYYMMDD format)</td></tr>
</table>

Table 2: List and description of extended files.

File Name	Derived from	Objects Listed
mpcorb_extended.dat mpcorb_extended.json	MPCORB.DAT	All the asteroids with calculated orbits contained in the MPC database
nea_extended.dat nea_extended.json	NEA.txt	Only the Near Earth Asteroids[4]
pha_extended.dat pha_extended.json	PHA.txt	Only the Potentially Hazardous Asteroids[5]
distant_extended.dat distant_extended.json	Distant.txt	TNOs[6], Centaurs and SDOs[7]
daily_extended.dat daily_extended.json	DAILY.DAT	Asteroids with orbits from the latest DOU (Daily Orbit Update) *MPEC*
unusual_extended.dat unusual_extended.json	Unusual.txt	Asteroids with $e \geq 0.5$ or $q > 6$ AU
neam[NN]_extended.dat neam[NN]_extended.json	NEAm[NN].txt	Elements of NEAs for current epoch minus NN days, NN = 00–15
neap[NN]_extended.dat neap[NN]_extended.json	NEAp[NN].txt	Elements of NEAs for current epoch plus NN days, NN = 01–15

Table 3: Data added to MPCORB format in extended DAT files.

Columns	Format[8]	Use
203–215	f13.5	Time of perihelion (Julian Date)
217–226 228–237 ...etc.	a9	Additional designations for the object, if any exist, in unpacked form

Contents of the extended JSON files

JSON[9] (JavaScript Object Notation) is a lightweight data-interchange format that's easy for both humans and machines to read. While the files are text-based, the data are represented as objects consisting of attribute–value pairs, and are thus not displayed nor organised as a table.

4 The MPC defines NEAs as asteroids with perihelia, $q < 1.3$ AU.
5 A PHA is defined as an NEA with absolute magnitude, $H \leq 22$ (approximate size ≥ 140m), and a Minimum Orbit Intersection Distance, MOID ≤ 0.05 AU.
6 Trans Neptunian Objects.
7 Scattered Disk Objects.
8 Fortran 77/90/95/2003/2008 format specifier.
9 http://www.json.org

Table 4 lists all the attributes included in the extended JSON files. When an asteroid does not posses an attribute, it is simply omitted. For example, asteroid (14) Irene has a principal provisional designation (A906 QC) and 2 other provisional designations; in the JSON file these two are provided as `"Other_desigs": ["A913 EA", "1952 TM"]`. Asteroid (30) Urania does not have any extra provisional designations, and therefore its entry does not contain an `"Other_desigs"` attribute.

Table 4: Contents of the extended JSON files.

Attribute	Type	Description
Name	string	Name, if the asteroid has received one
Number	string	Number, if the asteroid has received one; this is the asteroid's permanent designation
Principal_desig	string	Principal provisional designation (if it exists)
Other_desigs	string	Other provisional designations (if they exist)
H	float	Absolute magnitude, *H*
G	float	Slope parameter, *G*
Epoch	float	Epoch of the orbit (Julian Date)
a	float	Semimajor axis, *a* (AU)
e	float	Orbital eccentricity, *e*
i	float	Inclination to the ecliptic, J2000.0 (degrees)
Node	float	Longitude of the ascending node, ☊, J2000.0 (degrees)
Peri	float	Argument of perihelion, ω, J2000.0 (degrees)
M	float	Mean anomaly, *M*, at the epoch (degrees)
n	float	Mean daily motion, *n* (degrees/day)
U	string	Uncertainty parameter, *U* (integer with values 0–9; but refer to entry in Table 1 for other possible values)
Ref	string	Reference
Num_obs	integer	Number of observations
Num_opps	integer	Number of oppositions
Arc_years	string	Only present for multi-opposition orbits (year of first observation – year of last observation)
Arc_length	integer	Only present for 1-opposition orbits (days)
rms	float	r.m.s. residual (")
Perturbers	string	Coarse indicator of perturbers used in orbit computation
Perturbers_2	string	Precise indicator of perturbers used in orbit computation

Attribute	Type	Description
Last_obs	string	Date of last observation included in orbit solution (YYYY-MM-DD format)
Hex_flags	string	4-hexdigit flags (refer to entry in Table 1 for explanation; in JSON format this information has been decoded and is supplied in individual keywords)
Computer	string	Name of orbit computer (be it a person or machine)
orbit_type	string	Possible values: • Atira • Aten • Apollo • Amor • Object with perihelion distance < 1.665 AU • Hungaria • MBA • Phocaea • Hilda • Jupiter Trojan • Distant Object • Unclassified
NEO_flag	integer	Value = 1 if flag raised, otherwise keyword is absent
One_km_NEO_flag	integer	Value = 1 if flag raised, otherwise keyword is absent
PHA_flag	integer	Value = 1 if flag raised, otherwise keyword is absent
One_opposition_object_flag	integer	Value = 1 if flag raised, otherwise keyword is absent
Critical_list_numbered_object_flag	integer	Value = 1 if flag raised, otherwise keyword is absent
Perihelion_dist	float	Perihelion distance (AU)
Aphelion_dist	float	Aphelion distance (AU)
Semilatus_rectum	float	Semilatus rectum distance (AU)
Orbital_period	float	Orbital period (years)
Synodic_period	float	Synodic period (years)

A note on packed designations

When an asteroid is discovered it is assigned a unique provisional designation by the MPC (under authority of the International Astronomical Union), which consists of the year of discovery, a letter denoting which half-month it was discovered in ('A' for the first half of January, 'B' for the second half, etc.; the letter 'I' is skipped), followed by another letter establishing the order in which it was designated ('A' for the first asteroid, 'B' for the second, etc., again, skipping the letter 'I'. The 25th

asteroid discovered in a half month will be denoted by 'Z', and for the 26th a subscript number is introduced such that it would be denoted by 'A_1' (most often written as 'A1'). For example, the 20th asteroid discovered in the second half of April of 1994 was designated '1994 HU'; the 312th asteroid discovered in the first half of August of 2005 was designated '2005 PM12'. For a complete explanation refer to the MPC's page on New- And Old-Style Minor Planet Designations.

While designations in this form are useful for humans to read, they are hard to place in order for computers; for this reason, a packed designation format was developed, which allowed algorithms to easily loop through the asteroids in designation order. For the two examples above, '1994 HU' becomes 'J94H00U' and '2005 PM12' becomes 'K05P12M', in packed form.

In the MPCORB file format, each asteroid is identified in the first column by its designation in packed form. For a complete explanation of the packed format refer to the MPC's page on Packed Provisional and Permanent Designations. In the JSON format files, all designations are provided unpacked.