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# The Minor Planet Ephemeris Service

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This manual describes the extended and new features of the MPC's web-based Minor Planet Ephemeris Service

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# Guide to the MPES

This guide is intended to help users of the MPC's Minor Planet (& Comet) Ephemeris Service learn about the facilities offered by this web-based service. This is an updated version of the guide, explaining the additional features that have been added since the last version of the guide. These additional features can be recognized by the use of single black bars on the right-hand side of the page.

## 1: The MPES

The MPES has been designed as a powerful, yet easy to use, ephemeris generator geared towards observers. It has been extended many times since it was first put on-line, but has been rewritten from scratch on two occasions to take advantage of new web-server machines and more advanced library routine. Many of the extensions have been made following requests and comments from numerous observers.

The service is still (preferably) to be called the MPES, even though the service now has more complete support for comets.

## 2: Accessing the MPES

The MPES is accessible on the Web at either of the two URLs below:

<http://www.minorplanetcenter.org/iau/MPEph/MPEph.html>  
<http://www.minorplanetcenter.net/iau/MPEph/MPEph.html>

The top of this page will look similar to:

### Minor Planet & Comet Ephemeris Service

This webpage serves three purposes:

1. To allow an observer to get ephemerides (utilizing the latest published elements) and/or elements for an arbitrary set of (up to 100) minor planets or comets.
2. To allow an observer to check the current observability of an arbitrary set of (up to 100) minor planets, then to get ephemerides and/or elements for those deemed to be observable.
3. To allow an observer to prepare an HTML document that can be placed on their own website, with the aim of encouraging others to perform follow-up astrometry of their minor planet discoveries. Of course, this facility can also be used to generate a page for any arbitrary set of minor planets (see [this example](#) or pages).
  - Once a page has been placed on your site, you can forget about it. You do not need to update the page as orbits are improved or as objects are identified or numbered--this is all handled transparently by this service. You need only modify the page as you discover new objects.

In either case, enter your list of desired objects in the text-area indicated. By default, ephemerides will be returned. If you desire a HTML document to be returned, check the appropriate box. Further options, specific to each purpose are accessible further down this page.

[A PDF document describing the use of the MPES is available.](#)

[Information on any known problems with this service is available.](#)

## 3: Selecting Type of Data Output

The MPES can return data in a number of different formats. These types are as follows:

## Guide to the MPES

- Ephemerides
- Summary ephemerides
- HTML pages
- Orbital element data files (in any one of multiple formats)

Orbital elements return will be discussed in section 11.

To select any of the first three types, select the appropriate radio icon below the two action buttons. In the example below, the user is requesting ephemeris return.

The screenshot shows a web form with two buttons at the top: "Get ephemerides/HTML page" and "Reset form". Below the buttons are three radio buttons with labels: "Return ephemerides" (which is selected), "Return summary", and "Return HTML page".

### 4: Ephemeris Limits

Ephemerides are in the UT timescale. For future ephemerides, the conversion from a uniform computational timescale to UT is via predicted values of  $\Delta T$  extrapolated from recent past behavior.

By default, ephemerides start 'now' and run for 21 days at 1-day intervals.

Ephemerides for objects with perturbed orbits may have start dates in the time period 1900 Jan. 1–2099 Dec. 31.

Ephemerides may be generated at a user-specified interval of days, hours, minutes or seconds and are limited to a maximum of 1440 dates. In addition, the maximum allowable difference between the start and end dates of an ephemeris is 4000 days. If you request a 400-date ephemeris at 20-day intervals, the request will be silently truncated to 201 dates at the same interval.

If the requested start date is not an integral interval of the requested interval and the requested interval is in hours, minutes or seconds, the start date is adjusted to the previous integral number of hours, minutes or seconds, as appropriate. For example, if you request an  $n$ -hourly ephemeris starting 'now' and 'now' happens to be  $18^{\text{h}}34^{\text{m}}23^{\text{s}}$  UT, the start time will be adjusted to be  $18^{\text{h}}$  UT. Similarly, if you request a  $n$ -minute interval ephemeris, the start time will be adjusted to  $18^{\text{h}}34^{\text{m}}$  UT.

### 5: Entering Dates

There are many different formats of dates that are recognised by the MPES. The acceptable forms for entering dates are shown below:

- 2003 06 10 (0<sup>h</sup> UT on 2003 June 10)
- 1965 12 10.5 (12<sup>h</sup> UT on 1965 Dec. 10)
- 1903 09 10 12 (12<sup>h</sup> UT on 1903 Sept. 10)
- 2003 July 10 (0<sup>h</sup> UT on 2003 July 10)
- 2023 June 10.75 (18<sup>h</sup> UT on 2023 June 10)
- 1998 Jan. 10 121314 (12<sup>h</sup>13<sup>m</sup>14<sup>s</sup> UT on 1998 Jan. 10)
- 1923-06-23 (0<sup>h</sup> UT on 1923 June 23)
- 1930-Feb-18 19 (19<sup>h</sup> UT on 1930 Feb. 18)
- 1997/03/31 (0<sup>h</sup> UT on 1997 Mar. 31)

- 1945/11/05.5 (12<sup>h</sup> UT on 1945 Nov. 5)
- 1986/Jan/28 05 (5<sup>h</sup> UT on 1986 Jan. 28)
- 1956:05:16 1734 (17<sup>h</sup>34<sup>m</sup> UT on 1956 May 16)
- 1965:May:16 1922 (19<sup>h</sup>22<sup>m</sup> UT on 1965 May 16)
- JD 2451000.5 (0<sup>h</sup> UT on 1998 July 6)
- MJD 51000 (0<sup>h</sup> UT on 1998 July 6)

## 6: Selecting Objects by Designation

Selecting objects by designation is the preferred method of choosing objects.

Objects may be identified by designation or by name. Enter a list of designations or names below (one entry per line, excess entries will be ignored):

```
(3202)
1997 XF11
1971 QC2
```

In the example above, the user is requesting one numbered and two unnumbered minor planets. As it happens, 1997 XF<sub>11</sub> is the principal designation for (35396) and 1971 QC<sub>2</sub> is a non-principal designation for (13423): this will not trouble the MPES, which will happily return the numbered orbits for these two objects.

The valid forms of designation input are:

- (3202)                      Numbered minor planet (3202)
- 14829                      Numbered minor planet (14829)
- 1997 XF11                Unnumbered minor planet 1997 XF<sub>11</sub>
- 1P                            Comet 1P/Halley
- C/2003 A2                Comet C/2003 A2 (Gleason)
- P/2003 CP7                Comet P/2003 CP<sub>7</sub> (LINEAR-NEAT)

In addition, designations may also be entered in the following packed formats:

- 00233                      Numbered minor planet (233)
- K03A07A                Unnumbered minor planet 2003 AA<sub>7</sub>
- PK03C07P                Comet P/2003 CP<sub>7</sub> (LINEAR-NEAT)
- 0039P                      Comet 39P/Oterma

For comets, it is not necessary to know whether a particular comet's prefix is C/ or P/. As long as you include one of these prefixes, the correct comet will be located.

There is no support (current or planned) for the internal record numbers used by the JPL Horizons system.

## 7: Selecting Objects by Name


Both minor planets and comets may be searched for by name. The entered names must be complete (no partial names) but are not case sensitive: e.g., entering "GrAfF" will locate numbered minor planet (3202) Graff. Comet names must be prefaced by either C/ or P/ (it does not matter which). If a comet name is not

unique, the first match will be returned. If you wish to access a comet with a non-unique name, you are strongly recommended to use the designation.

Examples of valid entry follow:

- Encke (9134) Encke
- Africa (1193) Africa
- Africano (6391) Africano
- P/Encke 2P/Encke
- C/Encke 2P/Encke
- C/Gleason C/2003 A2 (Gleason)

Objects may be identified by designation or by name. Enter a list of designations or names below (one entry per line, excess entries will be ignored):



## 8: Ephemeris Options

The required options for the returned ephemerides are set using the section below:

***Ephemeris Options (applicable only if selecting ephemeris return):***

By default, ephemerides are geocentric, begin now and are for 20 days at 1 day intervals.

Ephemeris start date:  Number of dates to output:

Ephemeris interval:  Ephemeris units:  days  hours  minutes  seconds

You may enter an observatory code or your observing site's coordinates:

Observatory code:

Longitude:  ° E, latitude:  °, altitude:  m.

Longitudes and latitudes should be entered in decimal degrees.

Display positions in:  truncated sexagesimal or  full sexagesimal or  decimal units

Total motion and direction  
 Separate R.A. and Decl. coordinate motions  
 Separate R.A. and Decl. sky motions

Display motions as:  "/sec  "/min  "/hr  °/day

Generate perturbed ephemerides for unperturbed orbits

Also display elements for epoch:

The use of each of the sections displayed above will be explained below.

### Ephemeris start date

Enter the desired start date in one of the formats detailed in section 5. If left blank, the start date defaults to the current date and time (possibly modified by the desired interval).

In the example the user is requesting a start date of 18<sup>h</sup> UT on 2003 July 18.

### **Number of dates to output**

Enter the number of ephemeris dates desired. If left blank, the number defaults to either 21 (if the ephemeris unit is daily), 49 (if hourly), 121 (if minutely) or 301 (if secondly). The maximum allowable number of ephemeris dates is 1441 (for all types of ephemeris unit).

In the example above, the user is requesting 72 ephemeris positions.

### **Ephemeris interval**

Enter the dimensionless ephemeris interval. E.g., if your desired interval is 6 hours, enter '6'. If left blank, the number defaults to 1.

In the example above, the user is using the default 1.

### **Ephemeris units**

Select the desired ephemeris units (days, hours, minutes or seconds) using the radio icons.

In the example above, the user has selected the 'hours' radio icon to get an hourly ephemeris.

### **Offset from 0h UT**

For daily-interval ephemerides, it is possible for the daily position to be output at some other time than 0h UT. It was always possible to specify a non-0h UT start date for a daily ephemeris, but this new feature makes things easier.

### **Observatory code**

By default, supplied ephemerides are geocentric. Topocentric ephemerides may be selected by entering a three-character observatory code.

In the example above, a topocentric ephemeris is being requested for site 704 (Lincoln Laboratory ETS, New Mexico)

### **Longitude, Latitude and Altitude**

If you do not have an observatory code for your observing site, you may enter your longitude, latitude and altitude above sea level into these three writable icons. The longitude and latitude should be entered in decimal degrees. Longitude is to be given as 0°–360° E of Greenwich. Latitude is to be given as –90°– +90° (positive north of the equator, negative south).

### **Display positions in**

The returned ephemeris positions can be given in a number of formats:

- truncated sexagesimal: right ascensions are given in the form 13<sup>h</sup>13<sup>m</sup>.76 and declinations in the form +17°23'.9;
- full sexagesimal: the default, right ascensions are given in the form 18<sup>h</sup>56<sup>m</sup>23<sup>s</sup>.3 and declinations in the form –56°07'51";
- decimal: right ascensions are given in decimal hours, declinations in decimal degrees;
- heliocentric position vector (in AU);

- heliocentric position and velocity vector (in AU); or
- geocentric position vector (in AU).

In the example above, the default is selected.

### **Motions**

The motion can be displayed in a number of formats:

- Total motion and direction
- Separate R.A. and Decl. coordinate motions
- Separate R.A. and Dec. sky motions

and can be given as:

- arcseconds per second
- arcseconds per minute
- arcseconds per hour
- degrees per day

If requesting separate R.A./Decl. motions, the R.A. sky motions include a  $\cos \delta$  term. The R.A. coordinate motions do not include this term.

In the example above, separate R.A. and Decl. sky motions in "/min have been requested.

### **Suppress output if sun above local horizon**

This check box allows you to suppress output of ephemeris data if the sun is above the local horizon. This option works only for topocentric ephemerides.

### **Suppress output if object below local horizon**

This check box allows you to suppress output of ephemeris data if the object is below the local horizon. This options works only for topocentric ephemerides.

### **Generate perturbed ephemerides for unperturbed orbits**

This check box allows you to include perturbations in the calculation of the ephemeris of an object with an unperturbed orbit. This option treats an unperturbed orbit as though it were a perturbed orbit, the epoch being assumed to be the 20-day epoch date near the mid-point of the observed arc. This feature is likely to be most useful for searching for short-arc one-opposition minor planets at other oppositions.

### **Measure azimuths from...**

There is no IAU-approved standard for the measurement of azimuths. Previously the MPES only output azimuths westwards from the south meridian. You may now optionally have azimuths measured eastwards from the north meridian. The default remains westwards from the south meridian.

### **Also display elements for epoch**

This writable icon allows you to enter an MPES-compatible date (epoch) for which you wish to obtain elements. This option works only for perturbed orbits and the other-epoch orbit is displayed after the ephemeris. The epoch requested must be within the range of dates covered by the requested ephemeris.



You may also get a set of elements uniformly distributed over a specified date range by using the following form:

<MPES-compatible date>,<MPES-compatible date>[,<desired interval (hrs)>]

where items enclosed in brackets are optional. So the following forms would be valid:

2005 Aug. 28, 2005 Aug. 31	Elements at daily intervals over specified range
2005 Aug. 28, 2005 Aug. 31, 6	Elements at 6-hourly intervals over specified range
2006 Jan. 13, 2007 Jan. 1, 240	Elements at 10-day intervals over specified range
2011 Oct. 22, 2013 Nov. 8, 960	Elements at 40-day intervals over specified range

The dates requested must lie within the period covered by the ephemeris for output to occur.

## 9: Ephemeris Return

When you select ephemeris return, the type and amount of information that gets returned depends on the options you chose. The example below uses 1971 QC<sub>2</sub> (which is a non-principal designation belonging to a numbered minor planet) as the test object and generates a 704-topocentric ephemeris for 72 dates at hourly intervals from 18<sup>h</sup> UT on 2003 July 18, with 8-line MPC element return and full residual block.

The order of the information returned is:

- Title line. If you entered a non-principal designations, the principal designation is shown first, followed by '=', then the designation you entered.
- For minor planets, a link is provided to a script that will return all the designations corresponding to the object you selected.
- For numbered minor planets that have been named, a link is provided to the citation that accompanied the naming in the *Minor Planet Circulars*. Please note that not all named minor planets have this information available at time of writing: if you select such an object, an informational message will be displayed informing you that the citation is unavailable.
- For objects with uncertainty information, a count will be displayed showing how many variant orbits are available.
- Orbital elements (if selected). For perturbed solutions, elements are given for the current standard epoch. If full display of orbital elements is not selected, there will be a line giving a summary of the orbit used for generation of the ephemeris.
- Residual block (if selected). This will be either a full or partial residual block, depending whether you request display of a specific observatory code's residuals. If a residual block is unavailable for some reason, an informational message will appear.

## Minor Planet Ephemeris Service: Query Results

Below are the results of your request from the Minor Planet Center's Minor Planet Ephemeris Service. Ephemerides are for observatory code 704.

(13423) Bobwoolley = 1971 QC2

Display all designations for this object Show naming citation

Epoch 2006 Mar. 6.0 TT = JDT 2453800.5 MPC  
M 155.00918 (2000.0) P Q  
n 0.21624248 Peri. 91.52682 +0.95259316 -0.29664964 T =  
a 2.7490040 Node 285.73346 +0.24370252 +0.87692519 Q =  
e 0.0740243 Incl. 4.02529 +0.18214101 +0.37815499  
P 4.56 H 12.7 G 0.15 U 0  
From 415 observations at 9 oppositions, 1971-2006, mean residual 0".55.

Residuals

19710727	095	0.1-	0.9+	20010320	699	0.3-	0.3+	20040923	704	0.5-	0.2-
19710819	808	0.1-	0.6-	20010418	704	(0.2+	2.1+)	20041009	704	0.1-	0.4+
19850816	095	(9.9-	5.1+)	20010418	704	0.1-	1.7+	20041009	704	0.1-	0.2+

Then follows:

- A line indicating the date of last observation of the object, an indication of whether the ephemeris is perturbed or unperturbed and a reference to the orbit publication.
- For numbered minor planets, the discovery date, site and discoverer(s) are listed.
- For minor planets, a statement of whether further observations are desired.
- As an *aide-mémoire* the packed form of the designation (as used on astrometric observation records) is then shown.
- For minor planets, the absolute magnitude is also displayed between square brackets.
- Finally, comes the ephemeris...

Last observed on 2002 June 12. Perturbed ephemeris below based on elements from MPO 27570.

Discovery date : 1999 11 13  
Discovery site : Fountain Hills  
Discoverer(s) : Juels, C. W.

Further observations? None needed at this time.

13423											
Date	UT	R.A. (J2000)	Decl.	Delta	r	El.	Ph.	V	Sky Motion "/min	Object "/min Azi. Alt.	Sun Alt.
2003 07 18 18		22 01 56.8	-08 39 14	1.732	2.636	146.0	12.4	16.7	-0.28	-0.014 106 -37	+70
2003 07 18 19		22 01 55.7	-08 39 14	1.731	2.636	146.1	12.4	16.7	-0.28	-0.015 119 -49	+77
2003 07 18 20		22 01 54.6	-08 39 15	1.731	2.636	146.1	12.4	16.7	-0.28	-0.016 128 -50	+74

The ephemeris information that is displayed depends on whether the ephemeris is geocentric or topocentric.

For both types of ephemeris the following information is displayed:

- Date and time in YYYY MM DD hhmmss form.
- J2000.0 R.A. and Decl.
- Delta, the distance from the observer to the object (in AU)
- r, the distance from the sun to the object (in AU)
- El., the solar elongation of the object (in °)
- Ph., the phase angle of the object (in °)

- Predicted magnitude. For minor planets this is the visual magnitude and is labelled  $V$ . For comets, it is labelled either  $m_1$  (total magnitude) or  $m_2$  (nuclear magnitude).
- The on-sky motion of the object (format depends on user options).

For topocentric ephemerides, there then follows the local observing circumstances:

- The azimuth (in  $^\circ$ ) and altitude (in  $^\circ$ ) of the object.
- The altitude of the sun (in  $^\circ$ ).
- The moon phase, distance of the object from the moon (in  $^\circ$ ) and the altitude (in  $^\circ$ ) of the moon.

There then follows information about the on-sky uncertainty (for objects with uncertainty information, see section 14).

For objects with Väisälä orbits, the columns containing the two distances and the phase are not present.

## 10: Summary Return

Summary return produces a more compact listing than ephemeris return. By selecting the relevant check boxes it is possible to get full ephemeris output from a summary page.

**Minor Planet Ephemeris Service: Query Results**

Below are the results of your summary request from the Minor Planet Center's Minor Planet Ephemeris Service. This summary lists the current J2000.0 coordinates, visual magnitude and solar elongation of the selected minor planets, as well as information on the date of last observation (where available), forthcoming opposition data, details on the orbit and a comment on the desirability of obtaining further observations. The opposition date lists the date of the next opposition and the declination and visual magnitude at that time. If further observations are desirable, the parenthetical quantities are the elongation, the declination and the visual magnitude at the first date given.

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R.A.	Decl.	V	El.	Last obs.	Next opp. / Decl. / V	Orbit	<u>Further obs.</u>
<input checked="" type="checkbox"/> (13423) Bobwoolley = 1971 QC <sub>2</sub>	22 01 -10.2	17.6	107	2002/06/12	2003/08/17 -10 16.0	5 opps, 1971-2001, MPO 27570	None needed

The output for each object consists of two lines. The first line contains the check box (which is selected by default) and the designation. The second line contains the low-precision values (from a two-body computation) of the current J2000.0 R.A. and Decl., visual magnitude and solar elongation. It is then followed by the date of the last observation, the date of the next opposition and the declination and visual magnitude at that time. Then follows details of the orbit and information on whether further observations are desirable.

For comets, the magnitude is omitted, as is the information on the date of last observation and the next opposition.

If you selected ephemeris options on the main MPES page, those options will be copied through onto the summary page.

## 11: Orbital Element Return

Orbital element return is selected by clicking one of the radio icons on the screen below. If you select 'MPC 8-line' format (as in the example) the orbital elements

will be displayed above the ephemerides. If you select one of the other formats, the ephemerides will not be displayed and your browser should bring up a 'save box', allowing you to save a file containing orbital elements for the objects you requested to your local disk.

Format for elements output:

<input type="radio"/> none	<input type="radio"/> MPC 1-line	<input checked="" type="radio"/> MPC 8-line
<input type="radio"/> SkyMap (SkyMap Software)	<input type="radio"/> Guide (Project Pluto)	<input type="radio"/> xephem (E. Downey)
<input type="radio"/> Home Planet (J. Walker)	<input type="radio"/> MyStars! (Relative Data Products)	<input type="radio"/> TheSky (Software Bisque)
<input type="radio"/> Starry Night (Sienna Software)	<input type="radio"/> Deep Space (D. S. Chandler)	<input type="radio"/> PC-TCS (D. Harvey)
<input type="radio"/> Earth Centered Universe (Nova Astronomics)	<input type="radio"/> Dance of the Planets (ARC)	<input type="radio"/> MegaStar V4.x (E.L.B. Software)
<input type="radio"/> SkyChart 2000.0 (Southern Stars Software)	<input type="radio"/> Voyager II (Carina Software)	<input type="radio"/> SkyTools (CapellaSoft)
<input type="radio"/> Autostar (Meade Instruments)		

If you select 8-line MPC format, you may display the residual block for the objects selected:

Show residuals blocks. Show only residual lines containing observations from code  .

Minor planets with perturbed orbits will display or return elements for the current standard epoch.

Comets with perturbed orbits will display or return elements for the 40-day epoch closest to a time of perihelion near to the requested ephemeris dates.

Residual block display is possible for perturbed orbits (and for unperturbed orbits published on or after *MPEC* 2003-L54) if you select the MPC 8-line option. It is also possible to show only those lines of the residual block that contain observations from a specific observatory code.

Users are warned that some residual blocks (typically belonging to low-numbered minor planets) consist of thousands of lines. Also, not all residuals blocks are available to the MPES.

## 12: HTML Options

If you are requesting HTML page return, you can select various options by filling in the section show below:

***HTML Document Options (applicable only if selecting HTML return):***

Both these are optional. A default will be supplied for the title.  
The default base URL is null.

Title for document:

Base URL for document:

All objects should be  selected or  unselected by default.

Lists of objects and software types should be  centered or  uncentered.

Return  list of objects or  link to summary page.

Note that the returned document will require you to add some introductory remarks. Default text for this is supplied, but should be replaced.

All of these are optional. Appropriate defaults, as shown, will be used when omitted.

**Title for document**

This is the text that you wish to have displayed as the title on the returned page. It defaults to “A Minor-Planet Follow-Up Page”.

**Base URL for document**

If you know where the returned page will be placed on your website, you can enter the relevant full or partial URL here. It will be incorporated into the header of the returned HTML page.

**All objects should be...**

By default, the returned HTML page will have all the chosen objects pre-checked (i.e., once the page is placed on your website, all a user has to do to get ephemerides for all the objects is click the “Get ephemerides” icon). You may choose to have none of the chosen objects pre-checked.

**List of objects and software types...**

These lists can be centered or uncentered on the returned HTML page.

**Return...**

This option allows you return either a page with the selected objects simply listed or a page with a summary listing of the selected objects.

**13: HTML Return**

The returned HTML page will look similar to:

### My Own Follow-Up Page!

**\*\* You (the owner of this page) should save the source file for this page and then replace this text with some introductory remarks of your own! If you (someone other than the page owner) are reading this, the owner of the page has not quite set up correctly, however, the page should still work normally! \*\***

Other observers also have their own follow-up pages, check out [this list of links](#).

A [PDF document describing the use of the MPES](#) is available.

[Information on any known problems with this service](#) is available.

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Astrometric observations of any of the following objects should be sent directly to [mpc@cfa.harvard.edu](mailto:mpc@cfa.harvard.edu). Updated orbits will be available automatically through this page.

Display  ephemerides or  summary

The following objects are available:

- (3202) Graff
- (35396) 1997 XF11
- (13423) Bobwoolley

You should replace the text between the double asterisks with some appropriate introductory text of your own before putting the page on-line.

## **14: Variant Orbits and Uncertainty Regions**

The MPES allows users to gain access to the variant orbit elements that are used to generate the plots and lists of uncertainty regions. To request the  $n$ -th variant orbit for a particular object put the required number, enclosed in square brackets, after the designation: e.g., “2004 EC104 [23]” would return variant orbit number 23 for 2004 EC<sub>104</sub>. The variant orbit numbers are displayed when requesting textual uncertainty information and a count of how many variant orbits are available is returned in the header of the ephemeris output.

Requests for variant orbits at or near a specified L-O-V sigma may be made by specifying, e.g., “[sigma=-1.7]” instead of a variant orbit number. The closest variant orbit to the requested L-O-V sigma will be selected.

Residual blocks are not available for variant orbits and no uncertainty information is displayed.

The size of the semi-major axis (in arcseconds) and the position angle of the major axis of the  $n$ - $\sigma$  uncertainty region are displayed for each ephemeris date in the ephemeris return page. The position angle is measured eastwards from north. The uncertainty-information feature is intended for current dates only and the information is suppressed for dates more than 400 days from the current standard epoch. At present the MPES allows access to only the 3- $\sigma$  uncertainties: other services allow access to 1- $\sigma$  and 2- $\sigma$  values as well.

Both these updates apply only to objects with uncertainty information. This is now most minor planets with perturbed orbit solutions.

## **15: What Objects are Accessible in the MPES?**

The current list of objects accessible in the MPES is as follows:

- All numbered minor planets.
- All multi-opposition minor planets.
- All one-opposition minor planets with perturbed orbit solutions.
- All one-opposition minor planets with general unperturbed orbit solutions.
- One-opposition minor planets with Väisälä elements.  
(The completeness for non-current time periods of these elements is not guaranteed.)
- All numbered periodic comets at observed returns from 1900.
- All non-sungrazing C/ and unnumbered P/ comets observed since 1970.

Note that it is the user’s responsibility to determine whether a returned ephemeris is likely to be any use. For instance, using a Väisälä orbit to generate an ephemeris for a main-belt minor planet starting five years after the last observation is utterly pointless! The same comment applies even five months later. One month either

side of the observed arc is likely the useful limit for a Väisälä-based ephemeris for a main-belt object. For distant TNOs, a Väisälä-based ephemeris is likely good several months from the observed arc. With general orbit solutions, extrapolating a seven-day arc into the next opposition is unlikely to produce a useful result. On the other hand, observers have successfully made direct recoveries at the next opposition of objects with observed arcs around 30 days. By the time a one-opposition arc is extended to 60 days or more, direct recovery at the next opposition is often rather easy (although the apparition will probably not be as favourable).

## **16: Comparison with Other Sources**

There may be differences between the predictions provided by the MPES and those provided by other on-line services. In general these differences will be small and (assuming that the orbits are based on identical observations) will typically be noticeable only for NEAs close to the earth. These differences are due to a number of factors, the principal reasons being that the initial orbits are often slightly different due to different selection and/or weighting of observations or that the integrations proceed slightly differently using different planetary ephemerides (the MPC is currently using DE-403). In addition, comparison of future UT ephemerides is complicated by the use of different  $\Delta T$  values (since these cannot be determined in advance).

## **17: Compatibility with old MPES**

We have attempted to preserve the cgi interface from the old MPES in the new MPES. We think we have succeeded: all the old form tags still work and the new MPES has appropriate defaults for any missing new form tags. However, it is the recommendation of the MPC that observers who have generated follow-up pages in the past now regenerate those pages to allow access to the extended and new features of the MPES.

## **18: Comet Magnitudes**

The MPES is using the currently accepted system of comet ephemeris magnitudes. There is an IAU Working Group looking into revamping the cometary magnitude system. Fundamental changes in the way comet ephemeris magnitudes are presented are to be expected. If and when the WG report is accepted, the MPES will be modified to present the new system of cometary magnitudes.

## **19: Script Access to the MPES**

Limited available staff make it impractical for the MPC to actively support user-written remote script access to the MPES. However, examination of this document and the HTML source code for the MPES should allow any web/cgi programmer to write scripts or programs that access the MPES directly. Any questions (directed to [gwilliams@cfa.harvard.edu](mailto:gwilliams@cfa.harvard.edu)) will be answered as time permits.

Writers of automated scripts are requested that they ensure that their scripts are working properly and do not put undue strain on our web server. We have the

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ability to deny access to the MPES by IP address or domain, and we will not hesitate to block wayward automated scripts. Getting the IP address or domain unblocked will require convincing us that the problem will not reoccur!