# Overview

**This help file is designed for people, who know to work with Windows 95/98 and who are familiar with astronomy, ephemerides, celestial mechanics and so on.**



Sorry I am not a native english speaker - pardon me for some mistakes in my english.
If there are painful mistakes in this help-file or in the software itself, please let me know it. Just send an e-mail to <m.dings@hmt.uni-sb.de>.

If you have ideas or wishes making this software better (besides some language-mistakes) you should contact me too.

# How to contact me

Please feel free to report bugs, errors, suggest improvements, tell me your opinion to this software and - last not least - tell me my english - mistakes. Note: I will only answer, if your mail has an informative subject-line (not such as "Hello" or "Help") and if you give your full realname. My e-mail address is m.dings@hmt.uni-sb.de.

So if you have some ideas, how Ephemeris Tool could become more useful: let me know them.

If you have trouble or questions around Ephemeris Tool you may contact me per e-mail, too. And if you find interesting sources to celestial mechanics in the web or elsewhere: please let me know it.

But don't forget: I will ignore anonymous mails.

# Please read this

Ephemeris tool tries to support both european and UK/US-English conventions for date, time, decimal-format and so on. If there is any trouble with this: please contact me by e-mail. I cannot test Ephemeris Tool on my german windows 95-system with all those international settings. Nevertheless: I try to avoid any problems with international settings as well as I can.

## Legal Stuff

You do not have to pay any money, if you are using this software obtaining the following conditions. Ephemeris Tool is copyrighted freeware. All rights are preserved.

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I cannot give any support to Ephemeris Tool. But if you find bugs or if you have ideas, how to make Ephemeris Tool more usefull: contact me by e-mail.

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# Bugs

1) Before printing make sure, that the paper-format is set to correctly. Use "File|Printer Setup..." or the "File|Print..." Dialog to check for the correct settings.

2) If you insert a new spreadsheet into a worksheet, fixed columns and rows in the sheet before will be removed.

3) Some characters in time/date settings make trouble with the Ephemeris Tool - spreadsheet. I guess, you may not use characters, which have special meanings in the c-language resp. in the windows-surrounding. Please do not use "#" or "*" in date/time - settings!

Please report other bugs to m.dings@hmt.uni-sb.de

# Getting started

# About Ephemeris Tool

see also: The basic concept of Ephemeris Tool

Ephemeris Tool is a spreadsheet-software to calculate ephemeris tables and save *.xls 5, *.xls 4 or *.csv-files.

Since windows became a standard on many personal computers, there are lost of shareware and some freeware-programs showing the sky, printing maps and simulating the movement of the planets. But I do not know more than two, three programs to calculate ephemerides. Ephemeris Tool will do just this. It won't show any pictures or charts - but it will create *.xls-compatible files.

The best way to use Ephemeris Tool is: create tables with it and use as standard-windows-spreadsheet - software, to handle with your ephemeris-data.

Thanks to

... Keith Burnett, Yaakov Loewinger and Steve Barhydt for some good ideas to improve Ephemeris Tool and for helping me to get rid of some awful bugs!
... Paul Schlyter for the formula to calculate the Moon's magnitude
... Jan Goyvaerts for Code to the "Tip of the day"
... Martin Stingl for the help in calculating the positions of Saturn's moons.
... Jan Goyvaerts for sharing his "Tip of the day" - code.
... John Sabia for reporting some bugs and giving me the idea for a good new feature.
... Andre Wullf and Alexey Afinogenov for reporting some bugs concerning the setup of Ephemeris Tool.
... Bob Pickle, Luc Desamore, Bruce Andrews and Marco Peuschel for reporting some bugs.
... Stephan R. Schilling for providing webspace, reporting bugs and giving some good ideas to improve Ephemeris Tool.
... Dima Chernev for many good suggestions for improvements, especially concerning eclipses,
... Robert Jurjevic for some ideas to improve Ephemeris Tool and for reporting bugs.

# User-defined star or nebulae - catalogues

If you create catalogues with stars or deep-sky objects you can calculate ephemerides for single objects in these catalogues or for all objects in a file at a single moment.

The catalogues have a well defined format. The best would be to have a look at the sample-file user.csv.

**Description of the file-format:**

The files must be Windows-textfiles in the *.csv-format.

The first line of every file must be

:EPHTL USER
The first line may NOT be changed!

Decimal-Separator is ",", as usual in Germany. Comma-Separator is ";". Commentary lines must begin with ":"

Data-Format:

:name;RA(hh,mmssd);DEC(gg,mmssd);ProperMotionRA(sec per year, as Seconds of TIME!);ProperMotionDEC(sec per year, as seconds of DEGREE);epoch and Equinox(year with decimals);Magnitude (m,d...);

The magnitude-value is optional and would not be used for any calculations

# The basic concept of Ephemeris Tool

The concept of Ephemeris Tool is based on four elements:

(1) You can create single ephemerides of sun, moon, Planets, Asteroids, Comets, Satellites and some other, useful stuff.
(2) You can create ephemeris-tables. Time, steps and values may be selected as you like it.
(3) You can change between high-performance methods and high-precision methods (as there are: VSOP-theories, ELP2000 lunar theory, numerical integration of asteroids and comets)
(4) You may use Ephemeris Tool as spreadsheet - even without using any astronomical stuff!

Using a spreadsheet as surface, there are three advantages:
a) Many windows-users know, how to handle with a spreadsheet,
b) you can save your date as *.xls or *.txt-files and use them in many other windows-standard-software,
c) it is easy to edit or print the tables.

One problem is: writing into a spreadsheet, the performance of the Ephemeris Tool calculation-engine is not as good as the performance of Ephemeris Tool, which didn't have such a comfortable interface...

And the performance of the Ephemeris Tool is not as good, than the performance of professional standard-software. So, the best method to use Ephemeris Tool is:
- Create your ephemeris - data with this software and save it into *.xls-files,
- work with these files and edit them with your windows-spreadsheet.

# International settings

I tried to make Ephemeris Tool fit for several national time/date/number-settings. So date and time will be displayed in the form, you set in your Windows 95 - system. But there are some restrictions:
a) Dates before the year 1 (0, -1, -2 ... since Ephemeris tool does **not** use the historical, but the scientific way to count the years before 1) cannot be displayed in windows-standard,
b) Some characters ("#", "*") may not appear in your windows - settings,
c) User-defined files with asteroids, comets etc. have a special format, that cannot be changed. For instance: if you defined the colon (,) as list-separator in windows, you have instead of this to use the semi-colon (";") in my special *.csv-format.

Another problem: date and time, which you want to type into dialog-boxes must have the german format dd.mm.yyyy and hh:mm[:ss]. To make it easier for international users, I put in every dialog box, that handles with time and date, additional components. So you can put year, month and day in separated fields, esp. the date into a calendar-control! In case of time you can enter hours, minutes and seconds separately.

# Set date and time

Using the menu command "Time and location|Time and location..." you get the "Date and Time" Dialog box. There you can enter the date in the (german) format "dd.mm.yyyy" directly under "Date" or step by step, entering year, month and date (using the calendar-tool).

In the same way you can enter time as "hh:mm:ss" or separately for hours, minutes and seconds.

Then you may enter time zone (west: negative), geographic longitude (west: positive) and geographic latitude. The angles are required in the format (g)g°mm'ss' or (g)g.mmss, but always in minutes and seconds of degrees, not in decimals. Typing an name for location is optional.

You also can load geographic locations from a database, pressing the button "Load from Database...". Then the "Geographic location" - dialog box appear. If there is a file with geographic locations in use, in the list box the available locations appear. You can search on by typing some characters in the "searching for.." field.

Ephemeris tool will use the location for the calculation of
a) topocentric coordinates (RA and Dec.),
b) azimuth, altitude and hour angle,
c) local circumstances of solar eclipses.

Ephemeris tool will use the date and time as
a) first date for any ephemeris table,
b) actual date for single ephemerides (not tables),
c) starting date, if you want to calculate the next solar or lunar eclipse or conjunctions and so on.

# Orbital elements for satellites

With the command "Settings|Satellites" you can load files with orbital elements for earth-satellites. These files must be windows-textfiles with the extension *.tle. The format must exactly be the NORAD Two Line Orbital Element - Format.

Please note, that files with orbital elements for satellites are valid for a very short period (some days/weeks) only. You can get new versions in the www.

Here an example for the tle-format:

```
Mir
1 16609U 86017A    97199.76757194 -.00000087   00000-0   52867-5 0   4696
2 16609   51.6551 287.2197 0003857 276.2210   83.8366 15.59550949651958
Alouette 1
1 00424U 62049A    97196.66279883   .00000045   00000-0   42449-4 0   3037
2 00424   80.4637 255.4885 0024450 101.0664 259.3232 13.67899049736132
ATS 1
1 02608U 66110A    97196.68246129 -.00000048   00000-0   10000-3 0    279
2 02608   14.4853 348.5936 0005443   95.1667 264.9261   1.00294752 28810
```

Important: in the *.tle-textfiles may be no comments or blank lines. All datasets must have this format:
1. Row: Name of the satellite,
2. row: data 1
3. row: data.

Then the next dataset must follow without any blank lines or comments between. Otherwise the file would not be loaded completely.

If Ephemeris Tool could not open a *.tle-file, a sample-dataset with elements for the russion "Mir"-station will be used. But the elements will probably be invalid, when you got your copy of Ephemeris Tool.

# Show single ephemerides

After setting up time and date, you can get information from the menu "Tools".

You get single single ephemerides, no tables. These information are good for quick information. They can't be stored. They will be shown only in dialog-boxes.

Using the command "conjunctions" and "find events" you can search for conjunctions between two planets (resp. a planet an the moon) or search for maxima or minima (perihelion, aphelion and so on).

# Set up ephemeris tables

These steps are necessary, to get a special ephemeris-table:

1. Fix starting date and time for the table. You can do this either in the Date and Time - Dialog or by the next step.

2. Fix ending date and interval between two table-values. Therefore use the "Time and location| Ephemeris period" - Menu-command. The "Period for ephemeris" - dialog will appear. There you can enter both starting and ending date for your table. Use the controls in the same way, as in the Date and time - Dialog. Enter also a time interval between two table-values.

By marking "Set final calculation automatically" you can achieve, that Ephemeris Tool 32 stops calculation after a defined time-interval of some days and hours after starting date.

3. Select the values for your ephemeris table. This can be done with the dialog "Configuration of Ephemeris-Tables". You call it by the menu - option "Settings|Ephemeris setup". Check the values, you want to calculate and display in your ephemeris table. Some values are given only with special objects (e. g. orbital elements only, when calculating an ephemeris by numeric integration).
Use the "templates" - Buttons for changing the settings to some often used configurations.

4. At last you may change the default headers for your table, using the menu-option "Settings|Column Headings".

# Create an ephemeris table

Select a command in the Menu "Ephemerides" to write a table into the active worksheet.

Note: **anything**, that is written in the active sheet, will be deleted, if you create a new ephemeris table! You can restore the table before, if you use the "Ephemerides|Undo last table calculation" - command.

Use the menu "File", to save your table. Besides the *.xls format (xls 4 or 5), you can export the active sheet (not the whole worksheet!) into a text file (where columns are separated by tabs).

Of course you can print your table as usual in windows-spreadsheets.

# Calculate orbits for asteroids and comets

One of the most interesting features of Ephemeris Tool is, to calculate ephemerides of objects, from which you have the orbital elements, but no ephemeris. This might perhaps be, if a new comet has been discovered.

There are two possibilities to use user defined orbital elements. In both cases, you have to use one of the commands in the menu "Objects". The procedure is now shown for comets. Calculating asteroid-positions is nearly the same.

**1. Calling the dialog-box"Orbital elements for comets"**

Therefore you must use the command "Settings|Comets". There are two methods to enter orbital elements in the appearing dialog box:

a) Entering orbital elements manually

There you can type in the usual orbital elements. Attention: there must be a "," as separator for decimals. The angles must have decimal format, as usual in sources for celestial mechanics. Typing in a name for the object is optional.
A better method is the following one:

b) Loading orbital elements from csv-files

On the top of the dialog-box you find a group-box "Using file with orbital elements". If such a file is in use at the moment, there is a name of an object displayed in the list-box "Objects". Scrolling in the list box you can select an object. The elements appear below in dialog box.

You also can search for an object, typing a part of its name in the field "searching for:". Checking the option "search at the beginning of the words" the letters "Hale" wouldn't show comet "P/Hale-Bopp", but perhaps "Halley"!

May be, there is no file with orbital elements for comets in use. Then a hint in red letters will appear. Ephemeris Tool tries to open a file "kometen.csv" automatically when starting or the file, which was used while saving the configuration used at the moment. Use the "Open database..." - button to browse for a file with orbital elements.

**2a. Calculating an ephemeris for comets without perturbations**

If orbital elements are in use, the menu-options "Ephemerides|Comet" and "Tools|Comet" are enabled. Using this menu-command, you calculate very quickly positions without the influence of the perturbations by the planets.

**2b. Calculating an ephemeris for comets including the perturbations by the planets**

If orbital elements are in use, the menu-option "Ephemerides|Comet (Perturbations)" is enabled. Using this menu-command, you calculate very quickly positions including the influence of the perturbations by the planets. Ephemeris tool starts a numeric integration of the comet's positions back or forward to the starting time for the ephemeris. Then the positions are calculated (by numeric integration, too) to the end of the ephemeris-period.

# Create Data for Files

With the commands of this menu you can integrate single Asteroids or Comets or files with orbital Elements of Asteroids resp. Comets to a new osculation-epoch. Ephemeris Tool will write the results to the active sheet, just in that format, that is requiered by the files with orbital elements for comets or asteroids. If you save the active sheet with File|Save as csv-file... you will get a file with orbital elements that could be loaded by Ephemeris Tool directly.

# Advanced techniques

**Overview on a complete File with osculating orbital elements**

If you loaded a file with orbital elements for asteroids or comets, you can get
a) an ephemeris of all bodies in the file by the commands Ephemerides|All asteroids (resp. comets),
b) an numerical integrated ephemeris by the commands Numerical Integration|All asteroids (resp. comets).

The last mentioned option can be used to transform osculating orbital elements into another epoch. Therefore you should select the required orbital elements in the Configuration|Ephemeris Setup - Dialog Box.

**Saving and restoring different configurations**

Almost all possible settings in Ephemeris Tool can be stored into configuration-files (*.ocf). Use the commands form "Configuration"-Menu. You can also create a configuration file named "ephtl3.ocf". If it is stored in the default Ephemeris Tool - folder, it will be loaded when starting the program.

When loading a configuration-file, time settings (starting and ending time for ephemerides) are loaded too - except, when starting Ephemeris Tool. Then always your computers clock date and time are used.

You can start Ephemeris Tool by dragging and dropping a configuration file on the programm-icon or by a special command-line (for instance: c\programms\ephtl\ephtl3.exe d:\data\MyConfig.ocf.

**User defined data-files**

Files with orbital elements or geographic coordinates may be edited or created as you need it. These files must be in *.csv-Format too. For more information see:
Files with orbital elements for asteroids
Files with orbital elements for comets
Files with geographic coordinates

For quick access you can use the binary format for loading orbital elements from files.

**Selecting output format**

With the command "Settings|Output in decimals" you can select, whether the ephemerides are displayed and stored
a) as angles with minutes and seconds of degrees (or hours, in case of RA), for instance 10°30'00" or
b) as degrees with decimals: 10,5000°.

Besides this, you can decide, whether Ephemeris Tool should write Dates and Times as
a) Formatted strings,
b) Formatted numbers

into the active sheet. You can change between both options using the command "Settings|Date and Time as strings".

**Using full more accurate planetary and lunar - theories**

Normally Ephemeris Tool 32 calculates the Ephemerides for Sun, Mercy, Venus ... Neptune using the (shortened) version of Newcomb's theories. You can calculate them by the modern VSOP87-theories, too. If you do so, Pluto's positions are calculated with enhanced precision and for the years 1700 to 2100

(instead of 1900 to 2100). The moon - positions may be calculated by the ELP2000 - theory.

Therefore you have to remove the vsop87*.dll's and the elp2000.dll in your Windows-Folder by an upgrade-version of these files (* stands for "c", "d" resp. "a"). Doing this, you can change between both calculation-modes by the menu-command Settings|Use VSOP87... (followed by the specific theory).

In the status bar the theory, which is in use for the moment, is shown.

Note, that the more precise theories need much more time to calculate. Especially the performance of numeric integrated positions of comets or asteroids will decrease!

**Databases with planetary positions**

There is another method for calculation planetary positions which is both very quick and accurate: You can use File|Tools|Create Databases (only when the vsop87c-dll is installed) to create files with planetary positions. If you copy those files (9 files for sun, mercury, venus, mars ... pluto) into your Ephemeris Tool Folder, then a new Menu Item "Settings|Read positions from files" will appear. Check this option to get a new calculation mode, which is
a) very quick, especially when integration asteroids or comets,
b) nevertheless nearly as accurate as when using the vsop87c-theory.

Besides this you can create another kind of database, that contains data especially for numerical integrations of asteroids or comets. This file ("pos.vsp") contains data for all planets in only one file. You can create it with File|Tools|Create Databases too. Put the file into your Ephemeris Tool Folder, and a new Menu Item "Settings|Integrations from Database" will appear. So numerical integrations may be three or four times faster than by using the newcomb-mode.

These modes are valid only for 1900 up to 2100 or 2200.

**Compute visibilities and ephemerides for earth-satellites**

With Settings|Satellites you can open a *.tle-file with orbital elements for earth-satellites. It is important, that the orbital elements are not too old. The file must exactly have the NORAD-two-line-elements - format. Then you can
a) compute an ephemeris-table for the satellite, you selected in the mentioned Settings|Satellites - dialog with the command Ephemeris|Satellite
b) or compute the visibility for all satellites in the file for the current date, time and location by Ephemeris| All Satellites
c) display the current visibility or find a visibility bei Info|Satellite visibility.

# Add-ons

As default Ephemeris tool uses the very quick truncated theories of Newcomb and Brown. Since they are truncated, they are not high-precise. But installing some upgrades, Ephemeris Tool could use the VSOP87-theories and the ELP2000-theory. In this case, the Pluto-positions are better, too (and valid for 1700 to 2100).

The following dll's and theories could be used:

| File | Theory | xyz-coordinates | x'y'z' (velocities) | perform |
|---|---|---|---|---|
| - | Newcomb | low precision | low precision | very hig |
| - | Brown | low precision | low precision | very hig |
| vsop87d.dll | VSOP87D | high precision | low precision | medium |
| vsop87c.dll | VSOP87C | high precision | high precision | slow |
| vsop87a.dll | VSOP87A | high precision | high precision | good |
| vsop82.dll | VSOP87 | | | |
| elp2000.dll | ELP2000 | high precision | high precision | very slo |

All these dll's are available on the "Jupiter3 CD" form Daniel Roth, Roth EDV. The vsop87c dll and sometimes the elp2000 dll are available on my web-site. The dll's are compiled with Borland Delphi 2.01, with the stdcall-command. So I hope, they could be used with c++ or other Windows 32-Bit - Systems.

**Databases with planetary positions**

You can use my File|Tools|Create Database (only when the vsop87c-dll is installed) to create files with planetary positions. If you copy them (9 files for sun, mercury, venus, mars ... pluto) into your Ephemeris Tool Folder, then a new Menu Item "Settings|Read positions from files" will appear. Check this option to get a new calculation mode, which is
a) very quick, especially when integration asteroids or comets,
b) nevertheless nearly as accurate as when using the vsop87c-theory.

The files need between 30 and 45 MB on your harddisk. They are valid only for 1900 up to 2100 or 2200.

Besides this you can create another kind of database, that contains data especially for numerical integrations of asteroids or comets. This file ("pos.vsp") contains data for all planets in only one file. You can create it with File|Tools|Create Database, too. Put the file into your Ephemeris Tool Folder, and a new Menu Item "Settings|Integrations from Database" will appear. So numerical integrations may be three or four times faster than by using the newcomb-mode.

The "pos.vsp" - file needs at least 12 MB on your harddisk.

# Creating osculating orbital elements for asteroids and comets

You can calculate high-precision-ephemerides by using the menu-commands Integration|Asteroid orbit or Integration|Comet orbit. But this method to calculate ephemerides is slow. Faster is it, to calculate positions by the osculating orbital elements (Ephemerides|Asteroid or Tools|Asteroid, resp. Comet). These ephemerides have a good precision, if the time-period is nearly the same of the element's epoch.

If you want to create osculating elements for other epochs, use the above mentioned menu-commands Integration|Asteroid resp. Comet orbit and select in the Settings|Ephemerides Setup - Dialog Box only the output-options for orbital elements (or use the "orbital elements..." - buttons in the group-box "Templates"). You can save the resulting table then work with it in your spreadsheet or word-processor or use it in your own Ephemeris Tool - csv-files with orbital elements.

# Orbital Elements VSOP87

If the vsop82.dll is installed, you can compute the orbital elements of the planets on the actual used date and time, based on the vsop87-modell (which gives the orbital elments for J2000).

If you installed this add-on - dll, you can also get the orbital elements in the ephemeris-tables of the plantes (for one planet at several times)..

# Installing the dll-upgrades

The vsop87d.dll, vsop87c.dll, vsop87a.dll, vsop82.dll and elp2000.dll can be used, to remove the dummy-versions of these dll's in your windws-95-system-folder (typically c:\windows\system). So you can calculate ephemerides with Ephemeris Tool with the full precision of the VSOP87 resp. ELP2000 - theories.

1. Close Ephemeris Tool.
2. Make a backup of the old, small version of vsop87*.dll resp. elp2000.dll.
3. Unzip the vsop87*.exe-file by double-clicking on the file (resp. the elp2000.exe-file!).
4. The new dll should be expanded into a separate folder automatically.
5. Move the new, big dll to your windows\system-folder.

After restarting Ephemeris Tool the calculation by VSOP87* resp. ELP2000 besides Newcomb/Brown-theories should be possible now.

Note: Pluto's orbit is not given by the VSOP-Theory. Using the vsop87-theory with Ephemeris Tool, Pluto's coordinates will be calculated by a representation of the numerical integration DE200 of Jet Propulsion Laboratory. The precision is much better 1" in ecliptic longitude.

# Creating user defined data-files

see also:
You can create or modify files with
- geographic locations,
- orbital elements for asteroids,
- orbital elements for comets,
- variable stars,
- orbital elements for satellites,
- starting values for numeric integrations,
- observations for orbit-determination,
- features on a planetary surface or atmosphere
- user-defined star or nebulae - catalogues

and use them for comfortable input of locations (Menu Time and "Location|Geographic location") or calculation ephemerides for comets or asteroids (Menu "Objects" for selecting or entering orbital elements).

The data-files themselves cannot be modified or created with Ephemeris Tool 32 itself. But what you need is only an Windows Editor - nothing more.

The data format of the files is csv - comma separated values. In the specific Ephemeris Tool 32 - Format these files use
- ";" (Semicolon) for separating columns
- "carriage returns" for separating rows. For example:

Key West, Florida (USA);81,48;24,33;-5
Kiel, Deutschland;-10,085;54,203;1

The carriage return at the end of the lines is invisible, of course. But you can see, that the database-fields in the columns are separated with ";".

Other important conventions for Ephemeris Tool 32 data-files in *.csv-Format:

1. All angles and time-values must have the format (g)g,mmss ord (h)h,mmss (with minutes and seconds of degrees resp. hours - not decimals).
2. The integer part and the minutes/seconds must be separated by comma (,)!
3. The columns must be separated by semicolons (;) - see above.
4. Comments must begin with ":". After comments there may be no values any more
5. Every line must begin with values (no spaces!) or with :for comments.

Files with geographic locations
Files with orbital elements for asteroids
Files with orbital elements for comets
Files with starting values for numeric integrations

# Files with geographic locations

Geographic locations can be stored in *.csv-files where rows separated by carriage return, columns by semicolons (;). You can create these files with any windows editor. If you build them with spreadsheets, make sure, that ";" is used for separating columns. Also very important: use "," for decimal numbers (as usual in Europe), not "." as usual in USA.

Files with geographic locations must have a special format:

1. The first line must be the following:
:ORTDATEI ORION!

Otherwise Ephemeris Tool 32 wouldn't recognize it as file with locations!

2. Comments must begin with ":" After a complete data-set there may not be further characters!

3. The entries must be exactly the following:
name, longitude, latitude, time zone

where
name: is the name of the location
longitude: geographic longitude, east is negative, west positive
latitude: geographic latitude
time zone: difference between local time zone and UT, west negative and east positive!

The angles must have the format (g)g,mmss (separated by comma). For instance: 23,5959 for 24° minus one second of degree.

The file "orte.csv"

You can use the file "orte.csv" as example for your own files. You can modify it (add or delete data sets).

Nota bene: The altitude above sea-level can be entered in Ephemeris Tool 32 - but can't be stored in files!

# Files with orbital elements for asteroids

Orbital elements for asteroids can be stored in *.csv-files where rows separated by carriage return, columns by semicolons (;). You can create these files with any windows editor. If you build them with spreadsheets, make sure, that ";" is used for separating columns. Also very important: use "," for decimal numbers (as usual in Europe), not "." as usual in USA.

Files with orbital elements for asteroids must have a special format:

1. The first line must exactly be the following:

:BAHNELEMENTE PLANETOIDEN ORION!
Otherwise Ephemeris Tool 32 wouldn't recognize it as file with elements for asteroids!

2. Comments must begin with ":" After a complete data-set there may not be further characters!

3. The entries must be exactly the following:
name, a,e,i,kn,per,m,n,aequin,Epoche(JD),vis

where
name: is the name of the asteroid
a: semi major axis (in AU)
e: orbital eccentricity
i: inclination
kn: longitude of the ascending node
per: argument of perihelion
m: mean anomaly
n: mean motion in degrees/day
aequin: equinox
Epoche (JD): Epoch of the mean anomaly as julian date
H: parameter for calculating visual magnitude.
G: second parameter for magnitude (may be blank)

Note: It is not necessary to give a value for n. If you don't know the correct mean motion for an asteroid, use the value "0". Ephemeris Tool 32 will calculate the correct value from the semi major axis, supposing, that the mass of the asteroid would be zero, too.

The angles must have the decimal format (g)g,xxxx (separated by comma). For instance: 23,3333 for 23°20'.

The file "planeten.csv"

You can use the file "planeten.csv" as example for your own files. You can modify it (add or delete data sets). Nota bene: there are no "planets", but asteroid (minor planets) in this file, of course.

# Transformations

You can convert coordinates from one of the following systems into another:

Equatorial coordinates in the equinox of the date, J2000 or B1950,
Ecliptical coordinates in the equinox of the date, J2000 or B1950,
Galactical coordinates,
Altitude and Azimuth in the horizon-system.

1. Select the (desired) coordinate-system.
2. Enter the values as hours resp. degrees **with decimals**. For example: 3,5000 for three and a half degree.
3a. You may also enter the values as degrees resp. hours with minutes and seconds. For example: 3,3000, again for three and a half degree.
3b. Then press the DMS->DEG-Button, to convert value into hours resp. degrees with decimals.
4. Select another coorinate-system to see the values, computed in this system.

If you press the "OK"-Button, the complete coordinate-sets are written into the active sheet.

# Files with orbital elements for comets

Orbital elements for comets can be stored in *.csv-files where rows separated by carriage return, columns by semicolons (;). You can create these files with any windows editor. If you build them with spreadsheets, make sure, that ";" is used for separating columns. Also very important: use "," for decimal numbers (as usual in Europe), not "." as usual in USA.

Files with orbital elements for comets must have a special format:

1. The first line must exactly be the following:

:BAHNELEMENTE KOMETEN ORION EXT!

2. Comments must begin with ":" After a complete data-set there may not be further characters!

3. The entries must be exactly the following:
name, q, e, i, kn, per, aequin, Perihelzeit (JD), vis, hparam, Epoche (JD)

where
name: is the name of the comet
q: perihelion distance, in AU
e: orbital eccentricity
i: inclination
kn: longitude of the ascending node
per: argument of perihelion

aequin: equinox
Perihelzeit (JD): Time of the passage through the perihelion as julian date
vis: parameter for calculating visual magnitude.
hparam: the second coefficient for calculating the visual magnitude
Epoche (JD): Epoch, when the osculating elements are exactly valid.

The angles must have the decimal format (g)g,xxxx (separated by comma). For instance: 23,3333 for 23°20'.

The file "kometen.csv"

You can use the file "kometen.csv" as example for your own files. You can modify it (add or delete data sets).

# Using data-files in binary format

With Ephemeris tool you can calculate ephemerides for more than 16000 (exactly 16382) asteroids resp. comets for on moment. So it may be, that you have *.csv-files with 16000 or more objects in use.

Reading such big files goes slowly. It would become much faster, if it were no text files, but binary files. Therefore in Ephemeris Tool 32 two binary formats are defined:

1. *.opl: files with orbital elements for asteroids,
2. *.oko: files with orbital elements for comets.

This is the way to create and load binary files:

(shown for asteroids, the same procedure will work for comets)

1. Choose Objects|Asteroids.
2. Use in the dialog box the button "Open Database with orbital elements..." for loading a *.csv-file with orbital elements for asteroids.
3. Use the button "Save as binary file..." to export the csv-file into a binary file. You must give a file-name for the new file as usual.
4. Again use the "Open Database with orbital elements..."-button. Now select the *.opl-file-type an load the new file. Reading the file will be faster then before (in the *.csv-format).

# Something about coordinate-systems and exactness of the calculations

**Exactness of calculations**

For the planets, sun and moon the calculations obtain the perturbations. For comets and asteroids the orbits can be calculated as
1. "Kepler-Orbits" - without calculation the perturbations by the planets,
2. Numeric Integrations of the orbits, starting at the epoch of osculating orbital elements. So the calculation may be very slow, if the time for the ephemeris and the epoch of the orbital elements have a difference of many years.

There are two methods for calculating planetary/lunar ephemerides with this software:

a) Using Newcomb's theories (quick, but not high accuracy):

For the years 1750 to 2250 the precision of the positions of sun, moon, mercury, venus, mars will probably be about 1 to 5 seconds of degrees. The precision of the positions of Jupiter, Saturn, Uranus and Pluto are better then 11 seconds of degrees, in case of Neptune between 3 and 40 seconds of degrees. In case of the moon's longitude there may be a mistake of 1 second of degrees (or lower).

b) Using the VSOP87-theory resp. the ELP2000-theory (slow, but high accuracy):

Installing some upgrade-dlls, you can get nearly the full precision of the vsop87-theory. The heliocentric coordinates will be better then 1" for Sun, Mercury up to Neptune! Using the ELP2000-theory, the error in calculating moon-positions will be some meters (Nota bene: meters)!
Pluto's orbit is not given by the VSOP-Theory. Using the vsop87-theory with Ephemeris Tool 32, Pluto'S coordinates will be calculated by a representation of the numerical integration DE200 of Jet Propulsion Laboratory. The precision is much better 1" in ecliptic longitude.

Using the VSOP87C-theory, velocities **and** locations will be given in perfect precision. VSOP87D-theory in this Ephemeris Tool - Implementation gives only precise locations. Velocities are not as well. But therefore, the performance is better!

Pluto's positions can be calculated only between 1890 (1700 in if you use the VSOP-theory) and 2100.

The positions of Jupiter's satellites have a precision of about 15 seconds in time. For the moment the positions of Saturn's satellites are not precise. I guess, there may be mistakes of some minutes up to 2, 3 hours (in case of Titan's conjunctions). For later releases I am going to improve the precision.

The phases of the moon and lunar eclipses have errors of some minutes - calculation of equinoxes and solstices too.

The results are often display with 4 decimals. When exporting in csv-files, the will be stored with 5 decimals.
Physical ephemerides won't be needed in high precision. The error calculation central meridians is about 0,1 or 0,2 degrees. Rising, transit and setting may have errors of 5 minutes in case of comets or asteroids (when they are moving quickly). The precision for sun- and moon rise is higher. But there may be a mistake of +- 1 Minute in the time of the sun's transit.

**Coordinate-systems**

The coordinates are usually apparent coordinates in the equinox of the date. That means, they are corrected for precession, nutation, aberration and the effect of light-time.

In addition to this the topocentric coordinates are corrected for geographic position and altitude. Topocentric coordinates are also used for
calculation the physical ephemerides. But only in case of the moon there is an important effect on physical ephemerides.

Coordinates for the second, user-defined equinox (default: J2000) are corrected for light-time - effect, not for nutation and aberration.

Heliocentric coordinates are geometric coordinates. They are not corrected for light-time effects.

All distances are expressed in AU, except the moon: there are given units of the earth-radius.

The coordinates for asteroids and comets have often errors, which are greater as the above mentioned effects - because there are "osculating" orbital elements used, without calculating perturbations by the planets.

# About input-format

For the input of angles there are three possibilities:
1. gg°mm'ss"
2. gg.mmss
3. gg,mmss

There is one important exception: Typing geographic latitude and longitude there are two possibilities:
1) If there is a [°] or ['] - character, Ephemeris Tool 32 will read your input as angle in the ° ' "-Format (for example 51°30'00").
2) If there is a [.] or ['] - character, but no [°] or ['] - character, Ephemeris Tool will read your input as angle in degrees with decimals (for example 51,50° resp. 51.50°).

Times may be entered quickly in (h)h:mm:ss. But for international users especially there is a special option in every dialog-box, that handles with time: you can enter hour, minute and second separately.

The difference DT=ET-UT: here seconds of time are required.

Dates may be entered quickly in the (german) dd.mm.yyyy-format. But for international users there is again a special option in every dialog-box, that handles with dates: you can enter year, month and day separately.

The orbital elements of asteroids and comets use the format "degrees with decimals". This is the usual format, in which orbital elements are given. In these files Ephemeris Tool uses only the decimal - comma (,) as usual in Europe, not the point (.) as usual in USA!

Besides this Ephemeris Tool uses your Windows-95-setting to decide, whether "." or "," is used as decimal-separator. Also the separators for date and time are used as well as possible.

# About output-format

**1. Output in the main window (grid) of Ephemeris Tool 32**

There are two possibilities:

a) Menu-option "Configuration|Output in decimals" is not checked:
Then all angles are given as xx°yy'zz' or xxhyymzzs, except altitude and azimuth in horizon - system. They are given as degrees with decimal, also the most physical ephemerides. Higher precision would be senseless. Therefore rising, transit and setting are given with accuracy of +- 1 minute in time.

Because the angles are given with ° and ' - characters, they can be used easily in software, witch can bring them directly into a good layout for printing, publishing and so on.

b) Menu-option "Configuration|Output in decimals" is checked:
All angles are given as degrees with decimals. So you can much better work with them in spreadsheets, analyzing them and use them for further calculations.

**2. Something special about physical ephemerides**

Physical ephemerides are given as degrees with decimal(s). The semi-diameters of sun and moon haven minutes and seconds of degrees (xx'yy''). The diameters of the planet's disks are given as seconds of degrees with decimals.

The illuminated part ("k") is given as value between 0 and 1, not as percent (as found sometimes).

**3. Output in dialog-boxes (single ephemerides)**

Here all angles are display only as degrees with minutes and seconds, time-values as hours with minutes and seconds.

**4. International settings**

As far as possible Ephemeris Tool uses the Windows 95 - settings of your special Windows-installation to decide, what separators (. , ; / -) are used for decimal numbers, dates, times and so on.

# File-types used in Ephemeris-Tool

You can save your Ephemeris Tool - worksheets as

a) *.xls, Version 4,
b) *.xls, Version 5 resp. Windows 95,

files. This special format can be read by most of the Windows 16 or 32 - bit spreadsheets.

Another possibility is to save the active (!) sheet (only!) as *.txt-file (separated by tabs).

Other Ephemeris Tool - file - formats are:

*.ocf-files: configuration files, including settings for time, location, period and interval for ephemeris-tables, selected values to be display in tables, colors, grid-layout, fonts and so on.
*.csv-files: text files, columns separated by ";" (semicolons). These files are very good for exchanging data between different applications. In Ephemeris Tool there are used for databases with locations or orbital elements, which you can create or modify as you want.

# Spreadsheet functions

Ephemeris Tool should not replace a professional spreadsheet. Instead of this, there are some functions, that may be useful.

But the best way to use Ephemeris Tool is to create ephemeris tables with it, save it to *.xls-files and use them in your windows-spreadsheet.

| | |
|---|---|
| ABS | Returns the absolute value of a number. |
| ACOS | Returns the arc cosine of a number. |
| ACOSH | Returns the inverse hyperbolic cosine of a number. |
| ADDRESS | Creates a cell address as text. |
| AND | Returns True if all arguments are true; returns False if at least one argument is false. |
| ASIN | Returns the arcsine of a number. |
| ASINH | Returns the inverse hyperbolic sine of a number. |
| ATAN | Returns the arctangent of a number. |
| ATAN2 | Returns the arctangent of the specified coordinates. |
| ATANH | Returns the inverse hyperbolic tangent of a number. |
| AVERAGE | Returns the arithmetic mean of the supplied numbers. |
| CEILING | Rounds a number up to the nearest multiple of a specified significance. |
| CHAR | Returns a character that corresponds to the supplied ASCII code. |
| CHOOSE | Returns a value from a list of numbers based on the index number supplied. |
| CLEAN | Removes all nonprintable characters from the supplied text. |
| CODE | Returns a numeric code representing the first character of the supplied string. |
| COLUMN | Returns the column number of the supplied reference. |
| COLUMNS | Returns the number of columns in a range reference. |
| CONCATENATE | Joins several text strings into one string. |
| COS | Returns the cosine of an angle. |
| COSH | Returns the hyperbolic cosine of a number. |
| COUNT | Returns the number of values in the supplied list. |
| COUNTIF | Returns the number of cells within a range which meet the given criteria. |
| COUNTA | Returns the number of nonblank values in the supplied list. |
| DATE | Returns the serial number of the supplied date. |
| DATEVALUE | Returns the serial number of a date supplied as a text string. |
| DAY | Returns the day of the month that corresponds to the date represented by the supplied number. |
| DB | Returns the real depreciation of an asset for a specific period of time using the fixed-declining balance method. |
| DDB | Returns the depreciation of an asset for a specific period of time using the double-declining balance method or a declining balance factor you supply. |
| DOLLAR | Returns the specified number as text, using currency format and the supplied precision. |
| ERROR.TYPE | Returns a number corresponding to an error. |
| EVEN | Rounds the specified number up to the nearest even integer. |
| EXACT | Compares two expressions for identical, case-sensitive matches. True is returned if the expressions are identical; False is returned if they are not. |
| EXP | Returns e raised to the specified power. |
| FACT | Returns the factorial of a specified number. |
| FALSE | Returns the logical value False. |
| FIND | Searches for a string of text within another text string and returns the character position at which the search string first occurs. |
| FIXED | Rounds a number to the supplied precision, formats the number in decimal format, and returns the result as text. |
| FLOOR | Rounds a number down to the nearest multiple of a specified significance. |
| FV | Returns the future value of an annuity based on regular payments and a fixed interest |

rate.
HLOOKUP Searches the top row of a table for a value and returns the contents of a cell in that table that corresponds to the location of the search value.
HOUR Returns the hour component of the specified time in 24-hour format.
IF Tests the condition and returns the specified value.
INDEX Returns the contents of a cell from a specified range.
INDIRECT Returns the contents of the cell referenced by the specified cell.
INT Rounds the supplied number down to the nearest integer.
IPMT Returns the interest payment of an annuity for a given period, based on regular payments and a fixed periodic interest rate.
IRR Returns internal rate of return for a series of periodic cash flows.
ISBLANK Determines if the specified cell is blank.
ISERR Determines if the specified expression returns an error value.
ISERROR Determines if the specified expression returns an error value.
ISLOGICAL Determines if the specified expression returns a logical value.
ISNA Determines if the specified expression returns the value not available error.
ISNONTEXT Determines if the specified expression is not text.
ISNUMBER Determines if the specified expression is a number.
ISREF Determines if the specified expression is a range reference.
ISTEXT Determines if the specified expression is text.
LEFT Returns the leftmost characters from the specified text string.
LEN Returns the number of characters in the supplied text string.
LN Returns the natural logarithm (based on the constant e) of a number.
LOG Returns the logarithm of a number to the specified base.
LOG10 Returns the base-10 logarithm of a number.
LOOKUP Searches for a value in one range and returns the contents of the corresponding position in a second range.
LOWER Changes the characters in the specified string to lowercase characters. Numeric characters in the string are not changed.
MATCH A specified value is compared against values in a range. The position of the matching value in the search range is returned.
MAX Returns the largest value in the specified list of numbers.
MID Returns the specified number of characters from a text string, beginning with the specified starting position.
MIN Returns the smallest value in the specified list of numbers.
MINUTE Returns the minute that corresponds to the supplied date.
MIRR Returns the modified internal rate of return for a series of periodic cash flows.
MOD Returns the remainder after dividing a number by a specified divisor.
MONTH Returns the month that corresponds to the supplied date.
N Tests the supplied value and returns the value if it is a number.
NOT Returns a logical value that is the opposite of its value.
NOW Returns the current date and time as a serial number.
NPER Returns the number of periods of an investment based on regular periodic payments and a fixed interest rate.
NPV Returns the net present value of an investment based on a series of periodic payments and a discount rate.
ODD Rounds the specified number up to the nearest odd integer.
OFFSET Returns the contents of a range that is offset from a starting point in the spreadsheet.
OR Returns True if at least one of a series of logical arguments is true.
PI Returns the value of pi.
PMT Returns the periodic payment of an annuity, based on regular payments and a fixed periodic interest rate.
PPMT Returns the principle paid on an annuity for a given period.
PRODUCT Multiplies a list of numbers and returns the result.
PROPER Returns the specified string in proper-case format.

PV Returns the present value of an annuity, considering a series of constant payments made over a regular payment period.
RAND Returns a number selected randomly from a uniform distribution greater than or equal to 0 and less than 1.
RATE Returns the interest rate per period of an annuity, given a series of constant cash payments made over a regular payment period.
REPLACE Replaces part of a text string with another text string.
REPT Repeats a text string the specified number of times.
RIGHT Returns the rightmost characters from the given text string.
ROUND Rounds the given number to the supplied number of decimal places.
ROUNDDOWN Rounds a number down.
ROUNDUP Rounds the given number up to the supplied number of decimal places.
ROW Returns the row number of the supplied reference.
ROWS Returns the number of rows in a range reference.
SEARCH Locates the position of the first character of a specified text string within another text string.
SECOND Returns the second that corresponds to the supplied date.
SIGN Determines the sign of the specified number.
SIN Returns the sine of the supplied angle.
SINH Returns the hyperbolic sine of the specified number.
SLN Returns the depreciation of an asset for a specific period of time using the straight-line balance method.
SQRT Returns the square root of the specified number.
STDEV Returns the standard deviation of a population based on a sample of supplied values. The standard deviation of a population represents an average of deviations from the population mean within a list of values.
STDEVP Returns the standard deviation of a population based on an entire population of values. The standard deviation of a population represents an average of deviations from the population mean within a list of values.
SUBSTITUTE Replaces a specified part of a text string with another text string.
SUM Returns the sum of the supplied numbers.
SUMIF Returns the sum of the specified cells based on the given criteria.
SUMSQ Squares each of the supplied numbers and returns the sum of the squares.
SYD Returns the depreciation of an asset for a specified period using the sum-of-years method. This depreciation method uses an accelerated rate, where the greatest depreciation occurs early in the useful life of the asset.
T Tests the supplied value and returns the value if it is text.
TAN Returns the tangent of the specified angle.
TANH Returns the hyperbolic tangent of a number.
TEXT Returns the given number as text, using the specified formatting.
TIME Returns a serial number for the supplied time.
TIMEVALUE Returns a serial number for the supplied text representation of time.
TODAY Returns the current date as a serial number.
TRIM Removes all spaces from text except single spaces between words.
TRUE Returns the logical value True. This function always requires the trailing parentheses.
TRUNC Truncates the given number to an integer.
TYPE Returns the argument type of the given expression.
UPPER Changes the characters in the specified string to uppercase characters.
VAULUE Returns the specified text as a number.
VAR Returns the variance of a population based on a sample of values.
VARP Returns the variance of a population based on an entire population of values.
VDB Returns the depreciation of an asset for a specified period using a variable method of depreciation.
VLOOKUP Searches the first column of a table for a value and returns the contents of a cell in that table that corresponds to the location of the search value.

| | |
|---|---|
| WEEKDAY | Returns the day of the week that corresponds to the supplied date. |
| YEAR | Returns the year that corresponds to the supplied date. |

# Menu reference



**?:** Use the command in the "Help"-menu to get help or information about the installed release of Ephemeris Tool (Help|About).

# Objects

With the commands of this menu you can setup orbital elements for asteroids, comets, satellites or variable stars.

| | |
|---|---|
| Asteroids... | Enter orbital elements for asteroids or load them from a file. |
| Comets... | Enter orbital elements for comets or load them from a file. |
| Load from MPEC | Reads orbital elements (of asteroids or comets) from MPEC-circulars. |
| Satellites... | Select a satellite, load orbital elements for satellites and enter settings for computation. |
| Variable stars... | Select a variable star or load a file with variable stars |

# File

In the menu "file" you find the command to open, save, export or print files and to quit Ephemeris Tool

New — Close the file, that is opened for the moment and create a new file.
Open... — Open an existing file.
Save — Save the worksheet into the actual opened *.xls-file.
Save as... — Save the worksheet under a new file-name as *.xls (Version 4 or 5) - file.
Save as text file — Save the active sheet in the worksheet as tabbed-text-file.
Save as csf-file — Save the active sheet in the worksheet as comma-separated file.
Tools
- File-Browser — Shows a file-browser
- Create Databases — Creates files with pre-calculated positions to enhance the performance of calculations and numerical integrations.
- Astorb-Databasetool — Converts the astorb-database of the Lovell-Observation to the Ephemeris Tool - format.

Show File in/Start... — Starts an external application, preferablely Excel.
Page setup — Setup for printing the active sheet.
Print area
- Define: Defines a print area in the active sheet
- Remove: Removes an existing print area in the active sheet

Printer setup — Select and configurate a printer
Print — Prints the active worksheet.
Quit — Close Ephemeris Tool.

Besides this you get in the file menu quick access to the last opened files.

# File formats for orbital elements

Ephemeris tool allows to open files or save into files with orbital elements in different formats. Supported are some important file-formats of other astronomy-software.

## Asteroids

**Import (open)**
Ephemeris tool (*.csv)
Ephemeris tool binary (*.ocf)
Home Planet
Skymap
ASTORB-Database (Lovell Observatory)

**Export (save as)**
Ephemeris tool (*.csv)
Ephemeris tool binary (*.ocf)
Home Planet
Skymap

## Comets

**Import (open)**
Ephemeris tool (*.csv)
Ephemeris tool binary (*.oko)
Home Planet
Skymap
Guide

VDS Germany (Comet-workshop)

**Export (save as)**
Ephemeris tool (*.csv)
Ephemeris tool binary (*.o
Home Planet
Skymap
Guide

# Status Bar

The status bar can be enabled or disabled by the menu - command "View|Status bar".

It shows

a) the actually used settings for date and time,
b) the actually used settings for geographic location,
c) the number of decimals used for numeric integrations of asteroids or comets,
d) whether the ephemerides are given in h/° mm ss or as h/° with decimals,
e) the actually used lunar theory (Brown or ELP2000)
f) the actually used planetary theory (Newcomb or VSOP87).

By double-clicking on one of these elements, you can change the referring values. This in not possible in case of the calculation-methods, if the upgrade-dll's (VSOP/ELP2000) are not installed.

Calculating an ephemeris table, in the status bar a progress-bar is shown.

# Using the mouse

**Left mouse button**

Double-Click with the left mouse-button has the following effects:
- in program - window the Dialog "Change global layout of the grid" will appear,
- on elements of the status-bar: dialog-boxes to modify the elements you clicked on will appear,
- on the tool bar: it will disappear.

**Right mouse button**

Using the right mouse-button you will get a context-menu (in the program-window, tool bar, status-bar and some dialog-boxes).

# Hotkeys

Hotkeys for using the spreadsheet
Hotkeys for ephemeris calculation

**Others:**

| | |
|---|---|
| CTRL+N | File new |
| CTRL+O | File open... |
| CTRL+P | File print... |
| CTRL+S | File save |
| F1 | Calls the windows-help |
| F12 | Shows the file-browser |

# Working with sheets

An Ephemeris Tool file is a collection of one or more sheets. A new file has at first only one sheet.

To insert further sheets use "Insert|Sheet" (or SHIFT+ALT+F1)

Delete a sheet by "Edit|Delete sheets"

To rename a sheet make a double-click on the sheet tab or use "Edit|Rename table"

To move a sheet use "Edit|Move sheet"

To activate a sheet, click with the mouse on the sheet tab or press the ALT-key and use page up/down-key.

You can edit more than one sheet together, if you select a group of sheets.

**To select multiple worksheets:**

Use one of the following key\mouse combinations, depending on whether you want to select adjacent or non-adjacent worksheets:
CTRL-Click on sheet tab Selects or deselects non-adjacent sheets. Any other selected worksheets remain selected.
SHIFT-Click on sheet ta Selects all adjacent worksheets between the active worksheet and the worksheet you clicked on. All other worksheets are deselected.

**Remove multiple worksheet-selection:**

Click on an unselected tab or - if all sheets are selected - press the CTRL-Key and click on a sheet-tab..

# Hotkeys for using the spreadsheet

ENTER When in edit mode, accepts the current entry. When a range is selected accepts the current entry and moves active cell vertically to next cell in selection.
SHIFT + ENTER When in edit mode, accepts the current entry. When a range is selected accepts the current entry and moves active cell vertically to previous cell in selection.
TAB When in edit mode, accepts the current entry and moves the active cell horizontally to right.
SHIFT +TAB When in edit mode, accepts the current entry and moves the active cell horizontally to left.
F2 Enters edit mode. While in editing mode, F2 displays the Cell Text dialog box, in which you can enter multi-line data entries.
F9 Recalculates workbook.
DEL May clear current selection depending on the setting of the AllowDelete property.
Escape Cancels current data entry or editing operation.
F4 Switches between absolute and relative cell-references.
Alt+F8 Spreadsheet-options.
Alt+Umsch+F1 Inserts a new sheet.

**Moving in sheets**

Up Arrow Moves active cell up one row.
Down Arrow Moves active cell down one row.
Left Arrow Moves active cell left one column.
Right Arrow Moves active cell right one column.
CTRL Up/Down/Left/Right Moves to the next range of cells containing data. If there is no additional data in the direction in which you are moving, moves to the edge of the worksheet.
Page Up Moves up one screen.
Page Down Moves down one screen.
CTRL+Page Up Moves left one screen.
CTRL+Page Down Moves right one screen.
Home Goes to first column of current row.
End Goes to last column of current row that contains data.
CTRL+Home Goes to row 1 column 1.
CTRL+End Goes to last row and column that contains data.
CTRL+G Calls the "goto"-dialog-box
CTRL+F Find
CTRL+E Replace

Scroll lock Causes the view window to scroll without changing current selection with all movement keys except Home, End, CTRL Home, and CTRL End.
SHIFT plus any movement key Extends the current selection.

**Editing cells**

Ctrl+C Copy
Ctrl+V Paste
Ctrl+X Cut
Del May clear current selection depending on the setting of the AllowDelete property.

Ctrl+Shift+F Formats the selected range as bold.
Ctrl+Shift+K Formats the selected range as italic.
Ctrl+Shift+U Formats the selected range as underlined.

**Formatting Numbers**

| | |
|---|---|
| Ctrl+1...Ctrl+9: | 1...9 decimals for numerical values |
| Ctrl+0 | 10 decimals for numerical values |
| Alt+1...Alt+5 | 11...15 decimals for numerical values |

# How to handle the Ephemeris Tool - spreadsheet

Ephemeris tool should not replace your spreadsheet. So the following hints are short. It would be helpful, if you have some experience with standard-spreadsheet-software.

# Hotkeys for ephemeris calculation

| | |
|---|---|
| CTRL+D | Set date and time |
| CTRL+J | Set the julian date |
| CTRL+Z | Undo last table-action |
| CTRL+F7 | Satellite-Ephemeris |

| | |
|---|---|
| F3 | Coordinate conversion |
| F5 | Overview about Sun, Planets, Moon |
| F6 | Central meridian |
| F7 | Info\|Satellites-Dialog |
| F8 | Set the configuration of ephemeris-tables |
| F9 | Switch between decimal and °/h mm ss - format |
| F11 | Start numeric integration |

| | |
|---|---|
| CTRL+F3 | Find events |
| CTRL+F8 | Set the period for an ephemeris table |
| CTRL+F9 | Date and time as strings |
| CTRL+F11 | Set starting values for numeric integration |

| | |
|---|---|
| ALT+F8 | Options |

| | |
|---|---|
| SHIFT+F3 | Find conjunctions |
| SHIFT+F7 | All satellites |
| SHIFT+F8 | Set the defaults for column headings |
| SHIFT+F11 | Set outputs for numeric integration |

| | |
|---|---|
| CTRL+ALT+F8 | Settings for orbit determination |

| | |
|---|---|
| SHIFT+CTRL+S | Settings\|Satellites-Dialog |
| SHIFT+CTRL+F 11 | Read State-Vector |

**Macros:**

| | |
|---|---|
| SHIFT+CTRL+F1 | DEG->DMS |
| SHIFT+CTRL+F2 | DMS->DEG |
| SHIFT+CTRL+F3 | Time->DEG |
| SHIFT+CTRL+F4 | DEG->Time |
| SHIFT+CTRL+F5 | Layout->Number |
| SHIFT+CTRL+F6 | Number->° ' "-Layout |
| SHIFT+CTRL+F7 | Number-> h m s-Layout |
| SHIFT+Strg+F8: | Write Date and Time into sheet |
| SHIFT+Strg+F9: | Write UT into sheet |
| SHIFT+Strg+F10: | Write geogr. location into sheet |

# Entering values in cells

To enter a value into a cell:
1. Put the mouse-pointer into the cell.
2. Enter a number, a string or a formula (starting with '=').
3. Finish with ENTER.

Until you pressed ENTER, you can undo with ESC.

Examples:

| | |
|---|---|
| 2556431.5 | (Number) |
| 1-1-1996 | (Date) |
| Überschrift | (Text) |
| =A2 | (Formula) |
| | |
| =PI() | (Formula) |

To enter values in several cells step by step you can first select a range with the mouse. After pressing enter the active cell moves automatically.

In respect of decimal-formats, date- and time-formatting Ephemeris Tool will try to use your Windows 95 - settings.

# Editing of values in cells

To edit a cell (number, formula, text)
- put the cursor into this cell and press F2 or
- double-click into the cell..

Pressing F2 for two times, an dialog-box appears. There you could enter cell-entries with more than one line.

Use "View|Edit bar" to show/hide the edit bar, where you can edit the active cell directly.

While you did not press ENTER, you can undo your inputs pressing ESC..

Use also the commands of the "Edit"-Menu.

# Auto-filling of cells

The auto-fill-function allows, to fill columns or rows with data automatically. Select a cell, click on the "auto-fill"-symbol right down at the cell and drag it to the direction you want. Values or formulas will be copied automatically to the selected range.

When you move the mouse-pointer on the auto-fill-symbol, it will change.

# Satellite visibility

Use the "Satellites"-Dialog to
1. Select a satellite from the Listbox. The current coordinates of the object will be shown.
2. Search for a visibility of a satellite. A visibility is found, when the altitude above the horizon is > 0°, the satellite is not eclipsed and the height of the sun is smaller, than you selected in Settings|Satellites. The search can be canceld by the cancel-button.
3. With the buttons "Step back" and "Step foreward" you can change the time in steps of 10 seconds to see, how the coordinates of the satellite change.

Pressing "Close and use new settings" will change
a) Date and Time,
b) the selected satellite
in further calculations with Ephemeris Tool.

The selected satellite can be changed also with Settings|Satellites.

# Selecting ranges

**Select a range with the mouse:**
Click into the first cell and, move the mouse-pointer to the last cell.
If you press the CTRL-key, you can select more then one cell-range.

**Select a range with the keyboard:**
Print SHIFT and use the arrow-keys to set the selection.

Clicking on row- or column-headings you select the total row/column. Click on the first colums/row-head (left/top), you select the complete sh sheet.

You can move the mouse over more than one colums/row-head to select several columns/rows.

# Moving, inserting or deleting of cells

To move cells or ranges, click with the mouse on the range and move it to the destination. All data in the new range will be overwritten!

To insert new cells, use "Insert|Cells".
To delete cells use "Edit|Delete cells...".

# Formatting columns and rows

You can format row-height or column widths by the commands in the menu "Format", the context-menu or using the mouse.

**To change column widths with the menu-command:**

1. select the range with the mouse,
2. use the command in the main-menu or the pop up menu (pressing the right mouse-button)..

Use the same procedure to change the row-heights.

You can change the width/height manually or automatically. Automatically means, that height/width will be fitted to the longest/highest entry in the column/row. In the pop up - menu "Both" will fit height and width together.

**To change column widths and row-heights with the mouse:**

move the mouse-pointer to a heading - edge. The mouse-pointer will change its face. Now drag the colums/row as far as you need.

**To change column widths and row-heights with the mouse automatically:**

double-click with the mouse on a heading. To select more than one heading, you have to press the STRG-Key.

Selecting the complete sheet with the mouse and changing column width resp. row-height, the new value would become the default for the complete sheet.

# Formatting cells

Use the commands of the "Format"-Menu or the buttons in the Tool Bar to format

-Cells: font,
orientation,
numbers (common, currency, decimal, percent and so on)

Borders (around the cells),
patterns,

and colums widths resp. row-heights.

Besides this you can do the following things with the format-menu:

Fixing rows/columns,
show/hide formulas
enable/disable cell-protection.

# Use functions and operators in formulas

Mathematic operators:
+, -, *, /, ^ and %.

& connects strings.

# Working with the spreadsheet-functions

To enter a formula into a cell, you have to start with "=". Otherwise your entry will be read as text.
Examples:

| | |
|---|---|
| =ABS(B1) | gives the absolute value of cell B2. |
| =ABS(-2) | gives 2 as absolute value of -2. |

All arguments of functions must be included into (). More than one argument must be separated by the Windows-95 - list-separator. In Germany this will be ";" in most cases. In UK or USA it usually will be ",".

Examples:

| | |
|---|---|
| =ATAN2(A1,A2) | gives the arcus-tangens of the x value in cell A1 and the y-values in A2. |
| =NOW() | gives the time of the computer's clock. |
| =NOW | gives an error, missing the ()! |

# Edit

Cut Cut contents Of a cell Or a range..
Copy Kopieren des Inhalts contents Of a cell Or.
Paste Fügt den Cut der Zwischenablage ab der aktuellen Position auf dem Tabellenblatt ein.
Delete All Deletes the content of a cell or a sell-range.
Formattings Deletes only formattings.
Formulas Deletes only formulas.
Got to... Go To a cell, a range or a name.
Sort... Sorts the selected range.
Delete cells... Deletes cells in the selected range.
Delete sheet Deletes the selected sheet.
Rename sheet... Renames the selected sheet.
Move sheet... Moves the selected sheet to another position in the worksheet.
Undo last table calculation Deletes the active ephemeris-table and restores the table, that was calculated before.

# View

| | |
|---|---|
| Spreadsheet | Shows/hides the spreadsheet. |
| Edit Bar | Shows/hides the edit bar. |
| Status Bar | Shows/hides the Status bar. |
| Tool Bar | Shows/hides the toolbar. |
| Break Tool Bar | Allows, to show the tool bar in two lines |
| Ephemeris Setup Toolbar | Shows/hides the second toolbar. |
| Show Hints | Shows/hides the hints in some dialogs. |
| Show Tips of the Day | Shows/hides the Tips of the day dialog when startin Ephemeris Tool. |
| Show Warnings | Enables/disables warnings, if slow calculation-methods are choosen. |
| English Version | Switches between german and english language. |

# Insert

| | |
|---|---|
| Cells... | Inserts new, empty cells into the selected range and moves the existing cells to another place. |
| Sheet | Inserts an new sheet into the worksheet. |
| Names... | Renames a cell or a range in the active sheet. |
| Page break | Inserts a page break. |
| Remove page break... | Removes a page break. |

# Format

| | | |
|---|---|---|
| Layout | | Layout of the simple Datagrid (not the Spreadsheet) |
| Colors | | Colors of the simple Datagrid (not the Spreadsheet) |
| Cells | Font | Changes the font in the selected cells. |
| | Orientation | Changes the orientation of the entries in the selected cells. |
| | Numbers | Changes the number-(resp.- date, time-) format in the selected cells. |
| | Border | Use a border-style for the selected cells. |
| | Pattern | Use a pattern for the selected cells. |
| | Protection... | Protects cells against changes. |
| | Bold | Formats the selected ranges as bold. |
| | Italic | Formats the selected ranges as italic |
| | Underlined | Formats the selected ranges as underlined. |
| Height | Height... | Changes the height of the selected range. |
| | Set height automatically | Fits the height of the selected range to contents of the cells. |
| Width | Width... | Changes the width of the selected range. |
| | Set height automatically | Fits the width of the selected range to contents of the cells. |
| Decimals | | Puts the number-format in the selected cells directly to 1...15 decimals |
| Show Formula | | Shows formula instead of values. |
| Protect cells | | Enables/disables cell-protection. |
| Fix | | Fixes tows/columns as headers. |

# Time and location

| | |
|---|---|
| Time and location | Enter civil date, time and geographic location |
| Julian date | Enter julian date |
| Now | Use system-time of your PC |
| Time as day with fraction | Enter date and time as year, month, day with hours/24 as decimals |
| Daylight saving | Enable/disable daylight saving |
| Ephemeris period | Fix starting and ending date of a ephemeris-table and the distance between two table-values |
| Geographic location | Set geographic location or load from file. |

# Settings

With the first commands of the "Settings"-menu you can create or open configuration-files (*.ocf). In such files you can save settings for time, location, table-design and so on.

Ephemeris Tool would try to open an "ephtl2.ocf"-file in the default Ephemeris-Tool-folder when starting. There you can store your favorite settings.

The other menu options allow to specify the format of epehemeris tables and the design of these tables.

| | |
|---|---|
| File new | Create a new configuration-file |
| File open... | Open an existing configuration-file |
| File save | Save into the actual used configuration-file |
| File save as... | Save the actual used configuration under another filename. |
| Ephemeris setup | Select the values, that you want to calculate in an ephemeris table. |
| Column headings | Enter new default values for the column-headings. |
| Options | Settings for numerical values (occultations, rise/setting/twighlight, accuray of computations) |
| Spreadsheet Options | Settings and defaults for the spreadsheet (no astronomical settings) |
| Output in decimals | Change between h/° mm ss - format and °/h with decimals |
| Time and Date as strings | Times and dates can be written as strings or as formatted numbers into cells. |
| Use Newcomb Theories | Use the quick Newcomb-Planetary theories. |
| Use VSOP87C | Uses the VSOP-Theory |
| Positions from Database | Calculates ephemerides from pre-calculated databases. |
| Integrations from Database | Uses database with postions to enhance the performance of numeric integrations. |
| Use ELP2000 | Uses the ELP2000/28-Theory |
| Setup External Application | Defines, which external software could be started directly from the File-Menu |

# Ephemerides

With the commands in the menu "Ephemerides" you compute ephemeris tables, which you can store into files. The computation goes quickly, because there are no numeric integrations, but analytical methods or 2-bodies-methods in use.

Sun...Pluto Computes ephemeris-tables for the sun, moon and planets (including perturbations).
Moon, Ephemeris Computes an ephemeris-table for the moon
Moon, Occultations Occultations of stars or planets by the moon. Use "Settings|Ephemeris setup" and there: "Occultations" to configurate this option
Moon, Phases of the moon Computes a table with the moon-phases for the actual used year.
Overview Computes a table with the ephemerides for sun and moon and all planets but for only one single date
Central meridian Computes the times of the passage of a feature on Mars, Jupiter or Saturn through the central meridian
Asteroid/Comet Ephemeris table for the actual chosen asteroid/comet
Variable star Table with maximum/minimum times of variable stars
All Asteroids/Comets Ephemeris table for all asteroids/comets, but for only one single date
Satellites: Satellites of Jupiter/Saturn Ephemeris table for the position of Jupiter's/Saturn's brightest moons
Eclipses: Solar eclipse Computes the next solar eclipse after the actual used date.
Lunar eclipse Computes the next lunar eclipse after the actual used date.
Find solar eclipses Searching for eclipses during the actual used ephemeris-period.
Find lunar eclipses Searching for eclipses during the actual used ephemeris-period.
Earth-Satellites Satellite Computes ephemerides for the selected satellite.
All Satellites Computes ephemerides for the all satellites in the current loaded *.tle-file for the actual used date and time.
Seasons Computes the seasons for the actual used year.
VSOP-Tools: State vector (optional)
Orbital Elements VSOP87 (optional)

# State vector

If the additional ddl-upgrades vsop87c.dll or vsop87a.dll are installed you can calculate the locations and velocities of the planets by these theories for the actually used date and time. Pluto's coordinates will be computed by series according to the DE/LE200-integration.

# Solar eclipse

Computes the next solar eclipse after the current used date. If there is an eclipse at the actual used geographic location, the local circumstances are computed, too.

# Satellites of Jupiter/Saturn

These options in the menu "Ephemerides" calculates tables for the positions of the brightest Jupiter/Saturn-satellites. The values are rectangular coordinates, related to the center of the planet. Positive values mean western and northern positions resp. a position behind Jupiter (z-coordinates). The values with an "S" represent heliocentric positions. So you can compute eclipses and shadow-transits.

Saturn's moons may have errors in 60-100 Minutes. But the gallilean Jupiter-satellites are computed with very little errors (about 1 minute).

# All Asteroids/Comets

With this command you compute for all asteroids, for which orbital elements are loaded, an ephemeris for the actual used date and time.

You can load files with orbital elements by "Settings|Asteroids/Comets".

# Asteroid/Comet

These commands in the "Ephemeris"-menu computes ephemerides based on osculating orbital elements for asteroids/comets. The command are only enabled, if there are orbital files for these bodies available.

The calculations obtain perturbations by the planets!

# Integration

With the commands in the menu "Integration" you compute tables, which you can store into files. The computation is based on numerical integrations. So it may be very slow, if a long time distance has to be computed.

You can calculate with the commands of the "Integretation"-menu orbits for asteroids and comets, starting with osculating elements and then calculating later or earlier positions by numeric integration, obtaining the perturbations by the planets. You can also calculate orbits using the "Runge-Kutta"-method.

Besides ephemerides you also can compute osculating orbital elements for epochs in the future or past.

If you installed the VSOP87-upgrades, you should **not** use these methods while calculating ephemerides by numeric integration. Otherwise the performance would decrease rapidly. The accuracy of Newcomb-theories is good enough for calculating the perturbations.

Asteroid/Comet orbit
All Asteroids/Comets
Create Data for Files
Integration method...
Starting conditions
Formatting output

| | |
|---|---|
| Write State Vector | Writes the actually used state vector to the active sheet. |
| Read State Vector | Reads a state vector from the active sheet. |
| Integrate | Starts the integration with the actual used starting conditions and output-options. |

Open File...
Save File as...

# Asteroid/Comet orbit

Generates an ephemeris-table, based on the actual used osculating orbital elements for the asteroid/comet. The positions are calculated by numeric integration. The perturbations of the planets are included.

These Menu-options are disabled, if nor orbital elements for asteroids or comets are loaded. You can select an asteroid/comet with the menu-commands in the menu "Settings".

# Integration|All Asteroids/Comets

With this command you compute numerical integrated ephemerides for all asteroids/comets, for which orbital elements are loaded.

You can load files with orbital elements by "Settings|Asteroids/Comets". If no elements are in use, the commands All Asteroids/Comets are disabled.

# Integreation method

Here you can select, whether the Runge-Kutta - integrator (quick) or the adams-method (better accuracy) is used.

You can also select the precision of calculation. The numeric integration of asteroid- or comet-orbits need much time. If the calculation is done with precision of 12 or 14 decimals, it could become very slow.

For integrations about very long time 12 decimals are needed. Note, that the real precision is 2 or 3 decimal worse. The default is 10 decimals.

For better performance you can select the "Always use newcomb-theories"-option. Even, when VSOP-theories are used, for numeric integrations of asteroids and comets then the very quick (and in this case sufficient accurate) newcomb-theory is used.

You can also change the precision by double-click on that status-bar section, which shows the precision.

Under **Perturbers** you can select, for which planets the perturbations on asteroids or comets should be calculated when integration or improving orbits.

# Starting conditions

With the dialog "Starting conditions for numeric integrations" you can enter the starting cartesian coordinates for a numeric integration manually (or by loading from a *.csv-textfile). After any integration the new, actual values are shown.

You have to enter:
1. The components of the vector with positions (x,y,z) and velocities (x1,y1,z1) as **equatorial** cartesian coordinates (in UE resp. UE/day) and a name for each body.
2. The masses of the bodies, expressed in unit of the sun-mass divided by the objects mass (m_sun/m). If the bodies have the mass 0 please enter exactly this (don't worry: there will be no division by zero!).
3. The number of bodies (between 2 and 14).
4. JD: the julian date of the coordinates (of course the same for all bodies!).
5. The equinox, expressed in julian dates (there are special buttons for the most important equinoxes).
6. Check the option "Reduce coordinates..." to get heliocentric coordinates after any integration-step (that will be: "heliocentric" coordinates, when body 1 is representing the sun).
7. Use the "Reset"-button to restore the origin values.
8. Button "Open File": Here you can load a *.csv-file with starting values for a numeric integration.
9. Button "Save File": You can save the actual values into a *.csv-file.

Note: body 1 should be (in case of the solar system) the sun. The set of coordinates is then:
Sun;0;0;0;0;0;0;1 ("1" means just one solar mass).

# Format of files with starting values for numeric integrations

You can save starting values for an integration by the Runge-Kutta-method into a *.csv-file. You can load it by the menu-option "Integration|open file".

In the csv-files, rows have to be separated by carriage return, columns by semicolons (;). You can create these files with any windows editor. If you build them with spreadsheets, make sure, that ";" is used for separating columns. Also very important: use "," for decimal numbers (as usual in Europe), not "." as usual in USA.

The first line in each file must be exactly the following:
:name;x;y;z;x1;y1;z1;1/m;jdequinox;jd

Name: a string with the name of the body
x;y;z; heliocentric equatorial, cartesian coordinates of the location,
x1;y1;z1; heliocentric equatorial, cartesian coordinates of the velocity,
1/m: the reziproc value of the mass, in units of the sun's mass. For bodies "without" mass enter 0 (don't worry: there will be no Division by zero!).
jdequinox: Julian date of the equinox. Of course, all bodies must have the same equinox!

jd: julian Date of the coordinates (the same, of course, for all bodies!).

More then 14 bodies will be ignored.

Comments must begin with ":".

In case of the solar system, body 1 should be the sun. The first row (besides the very first line) should be like this:
Sun;0;0;0;0;0;0;1;2451545;2450600,5

# Formatting output

By the dialog "Select output for numerical integration" you can set, in which form the results of an numeric integration shall be given in an ephemeris table.

1. Select object for output

Here the bodies, which take part in the integration, are shown. Check those, for which you want to see the results.

2. Output format

a) Mode: Select orbital elements or coordinates. The output of orbital elements should be formatted by "Settings|Ephemeris Setup". When you select "coordinates", you can elect some precise options in the actual dialog (see below).
Ecliptical orbital elements are computed correctly only then, when the coordinates were given as heliocentric equatorial coordinates! Then body 1 should be the sun.

b) Type: Select between cartesian or polar coordinates. In both cases the coordinates are "geometric" coordinates - not corrected for aberration or light-time-effect.

c) Reference: select between ecliptical or equatorial reference-frame.
Important: The starting - values for integrations are always equatorial coordinates!

d) Origin of coordinates: "Heliocentric" reduces all coordinates to body 1. Therefore it should be the sun! "Planetocentric" reduces the coordinates to the body selected in the combo box "Reduce coordinates to this body". Planetocentric does not mean automatically "geocentric". But the reduction does **not** include aberration or light-time correction! The planetocentric coordinates are "geometric"!

e) "Show civil dates besides julian": is this checked, you will get the civil date besides the julian in the ephemeris - table.

f) "polar coordinates as decimals": is this not checked, the angles will be shown as degrees with decimals (or - in case of RA) as hours and decimals, otherwise as gg/hh.mmss. This option has the same effect as "Settings|Output in decimals"!

g) "Numbers of (displayed) decimals": here you can select the displayed numbers of decimals - not the precision for the calculation. There For use "Integration|Precision of calculation".

h) "Numbers of (displayed) decimals for polar coordinates": Select the numbers of shown decimals for polar coordinates only.

3. Settings for integration steps

a) Time between two steps: enter the (positive or negative) time steps in days (with hours/24 as decimals). This will have influence on the precision! For Mercury or Venus the step should not be longer then 0,5 days. For "slower" bodies greater steps will work.
b) Number of iterations: enter the number of steps, that you want for the actual calculation.
c) Show results after each ... step: not every calculation-step must be displayed!

All these settings would be stored into configuration-files, if you do so!

# Integration|Open File

With this command you can load a *.csv-file with starting values for a numeric integration.

# Integration|Save File as...

With this command you can save the actual starting-values for a numerical integration into a *.csv-file.

# Satellites

Use the "Satellites"-Dialog from the "Objects"-Menu to

1. Select a satellite for computation. Above the listbox with the satellite-names the file, which is currently in use, is displayed. If there is no file loaded, a sample-dataset with orbital elements of the "Mir"-station is used.
2. Load a *.tle-file with NORAD two-line-elements (Button "Open file with orbital elements").
3. Set options for the calculation of satellite-positions:
a) Days before or after the epoch of the elements, for which positions may be calculated. Orbital elements for satellites are valid for a short space (some days or weeks). Here you can enter the period, in which only ephemerides may be calculated.
b) Setting for the sun's altitude resp. the twilight, in which satellites were recognized as visible. This is important, if you search for a satellite's visibility with the Info|Satellite visibility - command.

**Important:** Satellite-ephemerides can be computed only for dates between 1957 and some decades after the present (which is definded for Ephemeris Tool by the setting of your system-clock). For other dates the satellite-commands in the menus are disabled.

# Tools

With the commands of the menu "Tools" you get some single-event-informations, displayed in dialog-boxes, not in ephemeris-tables and some usefull tools for calculations.

| | |
|---|---|
| Sun...Moon | Ephemerides for the objects of the solar system (obtaining the perturbations) for the actually used date and time.. |
| Asteroid/Comet | Ephemerides, based on osculating orbital elements, (without perturbations) for the actually used date and time.. |
| Find events | Finds extremums as maximum of brightness, perihelion and so on |
| Conjunctions | Finds conjunctions between two planets (including the moon). |
| Satellite visibility | Show the actual position of a satellite and find visibilities. |
| Orbit determination | Determination of 2-body-orbits by the (approximate) Gauss-method. |
| Macros | Applies macros to table-entries. |
| Transformations | Convert coordinates between different coordinate-systems. |
| Two Body Problem: | |
| Mean motion | Calculate the mean motion of a body in the solar system from the given semimajor-axis. |
| Perihelion Distance | Calculate the perihelion distance from the given semimajor-axis. |
| Precession of orbital elements | Transformation of orbital elements form one equinox to another |

# Files with variable stars

To compute the times of maximum or minimum brightness of variable stars, a file with coordinates and epochs of these stars als *.csv-files mus be loaded.

In csv-files rows separated by carriage return, columns by semicolons (;). You can create these files with any windows editor. If you build them with spreadsheets, make sure, that ";" is used for separating columns. Also very important: use "," for decimal numbers (as usual in Europe), not "." as usual in USA.

Files with variable stars must have a special format:

1. The first line must be the following:
:ELEMENTE VARIABLE ORION!

Otherwise Ephemeris Tool 32 wouldn't recognize it as file with variable stars!

2. Comments must begin with ":" After a complete data-set there may not be further characters!

3. The entries must be exactly the following:

Name,RA,DK,MMax,MMin,Epoche,Period,Equinox,Type

where
**name:** is the name of the star
**RA and DK** are rect ascension and declination,
**MMax and MMin** are the maximum resp. minimum magnitude,
**Equinox** is the equinox of the position of the star (see above RA and DK). RA and DK are given as h.mm resp. g.mm (hours/degrees with minutes, separated by ",", as usual in Germany).
**Type** is a code for the typ of variability:

- b: Eclipsing binary stars,
- c: Cepheid or RR-Lyrae - star,
- m: long periodic variable star, for example "Mira" (Omicron Ceti).

The angles must have the format (g)g,mmss (separated by comma). For instance: 23,5959 for 24° minus one second of degree.

You can use the file "variab.csv" as example for your own files. You can modify it (add or delete data sets).

# References

Besides my own algorithms I used informations in these books:

Bartsch, Hans-Jochen: Mathematische Formeln. Leipzig 1982.
Burkhard et al.: Ahnert's Kalender für Sternfreunde. Leipzig; Berlin; Heidelberg.
Elsässer et al.: Sterne und Weltraum. Zeitschrift für Astronomie. Heidelberg.
Hempe; Molt: Sterne im Computer.Köln 1986.
Meeus, Jean: Astronomische Algorithmen. Leipzig; Berlin; Heidelberg 1992.
Menzel, Donal H.: Kosmos Taschenatlas Astronomie. Stuttgart 1967.
Montenbruck; Pfleger: Astronomie mit dem Personal Computer. Berlin; Heidelberg et al. 1994.
Montenbruck, Oliver: Grundlagen der Ephemeridenrechnung. München 1989 (?).
Seidelmann, P. Kenneth (Editor): Explanatory supplement to the astronomical almanac. Nill Valley, CA, 1992.
Voigt, Hans Heinrich: Abriß der Astronomie. Mannheim; Wien; Zürich 1980.
Wepner, Wolfgang: Mathematisches Hilfbuch für Studierende und Freunde der Astronomie. Düsseldorf 1985.

The VSOP - theory and the ELP2000-theory are available at ftp://ftp.bdl.fr/pub/ephem/.
Further public-domain-sources from the CD's "Astronomie Software Serve" and "Jupiter" of Roth EDV were used.

# Central meridian

With this featur you can compute an ephemeris of the transit-times of featurs on the surface of Mars or the clouds of Jupiter and Saturn. You will get a Dialogue "Transit of objects on a plantet's surface surface":
1. Select an object resp. Rotation-System, clicking on one of the five radio-buttons.
2. Enter the longitude of the feature on the planetary surface resp. atmosphere (as ° with Decimals).
3. Enter a descritpion for the feature into the second edit-field (for instance GRS for "Great Red Spot on Jupiter). This name will be used as column-heading in the ephemeris-table.

You can load these data from files with planetary features (Button "Load from file"). These files must have a special format. The extension must be *.csv. When a file is loaded, the comboboxes show the available features for the 3 planets resp. 5 Rotation-Systems.

Select a feature in the combobox, and the edit-fields will be filled automatically.

When you press the "OK" - button, a ephemeris with dates and times of the passage of the feature through the central-meridian will be created.

# Files with features on a planetary surface or atmosphere

Featurs on the surface of Mars or the atmospheres of Jupiter and Saturn can be stored in *.csv-textfiles and loaded by the dialog "Transit of objects on a plantet's surface surface".

In the csv-files, rows have to be separated by carriage return, columns by semicolons (;). You can create these files with any windows editor. If you build them with spreadsheets, make sure, that ";" is used for separating columns. Also very important: use "," for decimal numbers (as usual in Europe), not "." as usual in USA.

Those files must obtain the following conventions:

1. Every file must begin with **exactly** this string:

:LONGITUDES!

Comments must begin with a ":". After a complete dataset, there may not be any characters.

Every dataset (line) must have the following entries, separated by ";":

Rotationsystem, Longitude, description

Rotationsystem: one of the following strings:

| | |
|---|---|
| Mars | for Mars |
| Jupiter1 | for System 1 of Jupiter |
| Jupiter2 | for System 2 of Jupiter |
| Saturn1 | for System 1 of Saturn |
| Saturn3 | for System 3 of Saturn |

Longitude: the planetocentric longitude of the feature..
Descritption: a name of the feature on the surface of Mars or the atmosphere of Jupiter or Saturn.

You can use the file Longitud.csv as example for your own files. You can modify it (add or delete data sets).

# Format of the files with observations

Ephemeris Tool has two formats for files with observations for orbit-determination:

1. The binary "*.obs"-format. You can create it by showing a file with orbital elements and then save as *.obs-file.

2. Textfiles: you can create with with an external editor or as shown above.

The format for textfiles with observations is:

**(Note: do not enter the line numbers!)**

```
1ephtl observations
2 1997.8
3 2000.0
4 1997 11 22 22.133   22 37 00.2   -21 00 09 0 0 0 7.1     -7 22 12.30   51 51 40.00
5 1997 11 24 22.133   22 38 14.00 -20 45 25 0 0 0 7.3      0   0   0.00   51 51 40.00
6 1997 11 28 22.133   22 40 53.6   -20 15 05 0 0 0 7.5     -7 22 12.30   51 51 40.00
7 1997 12 02 22.133   22 43 48.2   -19 43 39 0 0 0 7.8     -7 22 12.30   51 51 40.00

8 (etc.)
```

Line 1: file-signature,
Line 2: equinox of the observations,
Line 3: equinox of the orbital elements,
Line 4 - 6 and more: datasets with observations in the following format::
jjjj mm tt hh.xxxx hh mm ss.xx +/-gg.mm.ss.x xx.xx gg.mmssx gg.mmssx,
year, month, day, UT, RA, dec, mag, geogr. longitude., geogr. latitude.

The decimal-separator **must** be '.'!

# Orbit determination

The commands of the Menus "Orbit determination" allow to compute a first, raw orbit (2 - body - problem, without perturbations) by the method of Gauss or orbit improvement by the Laplace-method..

Therefore at least three observations of an object, stored into files, are necessary.

Menu commands:

**Orbit determination...**

A dialog-box for opening a file with observations appears. After selecting a file another dialog appears. There you can select at least three observations to find a first, raw orbit. Pressing "ok" a Dialog with the observations and the residuals (observated - calculated positions) is shown. You can going on with the iterativ orbit improvement, until the residuals are small. Then you could close the calculation or reload another selection of observations (or all of them).

**Gauss...**

A dialog-box for opening a file with observations appears. After selecting a file Ephemeris Tool computes for every triplett of three observations the corresponding orbit.

If the computations seems instable or wrong, a hint is shown. Use "Settings|Orbit determination..." to set some options for calculating and displaying the results.

**Get observations**

This command writes a frame on the active spreadsheet. You can enter values of at least three observations (or more, of course) and the equinox of observations and elements.

You have to enter angles and RA-values as gg,mmssxx (where "," is the comma-separator of your Windows-language-settings, gg are hours or degrees, mm minutes and ss seconds with decimals, for example: 12,30302).

**Save from sheet...**

Save observations (in the active sheet) into textfiles or binary files with observations.

**Save state vector from sheet...**

With this macro you can load a state vector with x, y, z, vx, vy, vz (in AU resp. AU/day) and JD from the active sheet. Therefore the 7 values must be written into one row. The 7 columns must be selected with the mouse bevor calling this menu-option.

Then a dialog-box appears, which shows the state-vector and a "Save state vector..."-button.

**Show file...**

Show the content of a file with observation without computing orbits. You can edit the values and then "Save from sheet..." again.

**Settings**

Allows to specify some options as Julian Date of the Mean Anomaly and so on.

See also:

Integration method...
Format of the files with observations

# Macros

The macro menu allows to change values in spreadsheets in a very quick way. To apply a macro

1) select the active cell or make a (single or multiple) selection,
2) apply one of the macro-menu-commands.

Immediately the values will be changed by the macro.

**Macros:**

DEG->DMS: changes 2,75 to 2,45 (degrees with decimals to degrees with minutes and seconds of degrees)
DMS->DEG: changes 2,45 to 2,75 (degrees with minutes and seconds of degrees to degrees with decimals)
Time->DEG: changes 2:30:00 to 2,500
DEG->Time: changes 2,500 to 2:30:30
Layout->Number: changes 2°20'23" or 2h20m23s to 2,2023