# Sun Moon Planets

This program is provided free for use by anyone with an interest in astronomy. There are no warranties on this program. The calculated data is reasonably accurate to the best of my knowledge.

I wish to acknowledge Jean Meeus and his book *Astronomical Algorithms,* PJ Naughter for his coding insights, also, Oliver Montenbruck and Thomas Pfleger's book *Astronomy on the Personal Computer*.
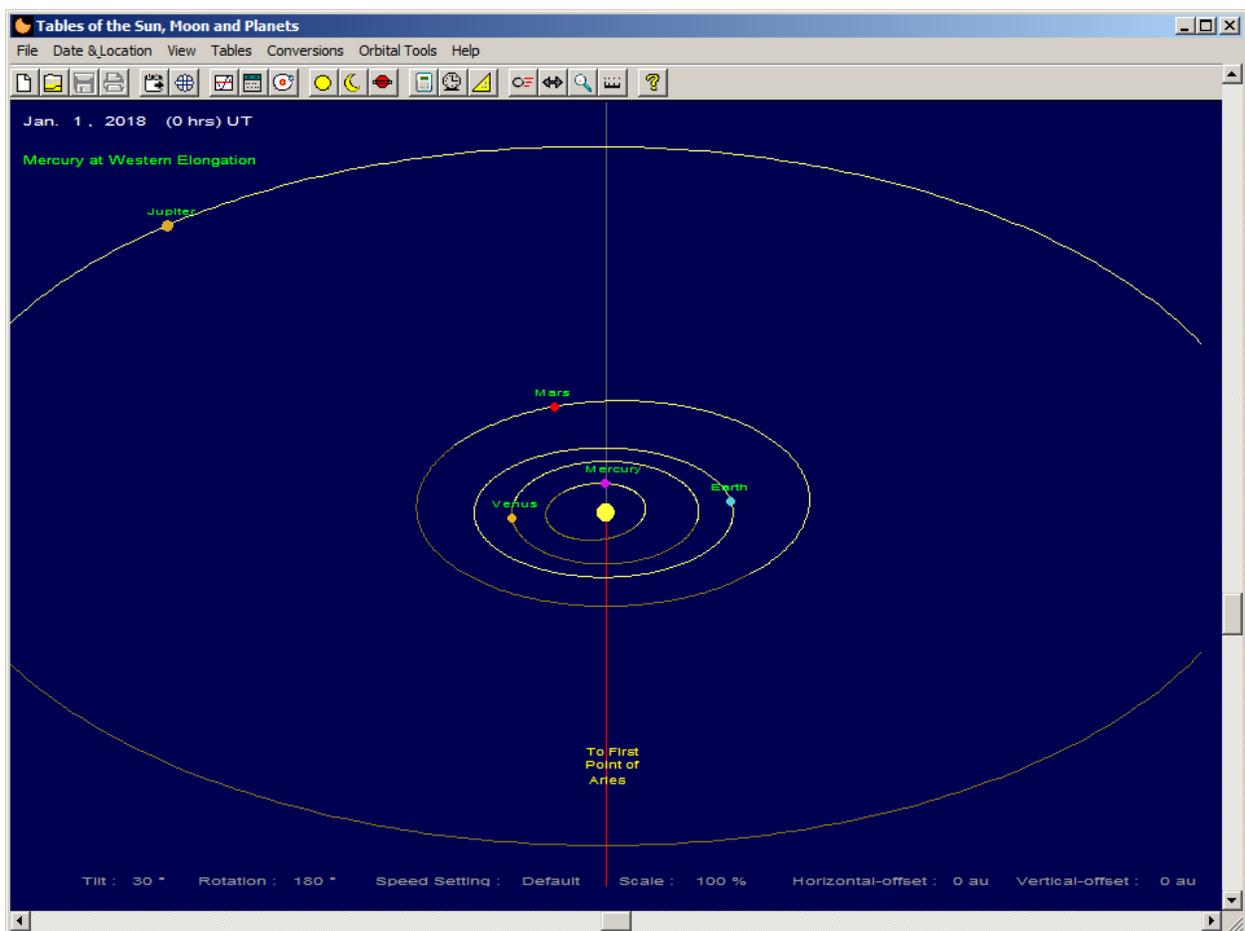
The opening screen of the program displays the daily motions of the planets as they orbit around the Sun and notifies the user of any events or phenomena that may be happening on that day. The program also provides a set of informative tables regarding the Sun, Moon, and planets.

Sun Tables include:

- Sun data such as its distance, equatorial , ecliptic and, horizontal coordinates.
- Sun rise, transit and set times.
- Sun ephemeris.
- Solar eclipse tables.

Moon Tables include:

- Moon data such as its distance, equatorial , ecliptic and, horizontal coordinates.
- Moon rise, transit and set times.
- Moon ephemeris.
- Daily Moon phase angles.
- Quarterly phases of the Moon.
- Lunar eclipse tables.

Planet Tables include (for each major planet):

- Planet data such as its distance, equatorial , ecliptic and, horizontal coordinates.
- Planet rise, transit and set times.
- Planet ephemerides.
- Planetary phenomena.
- Earth equinox and solstice dates.

Each of the tables allow you to enter a date (between 1900 and 2100) to determine a variety of information about the Sun, Moon or any of the major planets. You may also copy any selected data and paste it into a text file which can be used as your own personal observing guide.

The program also provides a set of tools to change the date or to animate the motion of the planets as they orbit the Sun.

Menu Items

File

The **File** menu item allows you to create or open a standard ascii text file so that you can copy data from the tables, edit them, add notes, save it or print it out.

Date & Location

The **Date** menu item allows you to **Select a Date** between 1900 and 2100. This date applies only to the opening screen showing the position of the planets. It does not apply to any of the tables.

The **Location** menu item allows you to **Set Location.** This is typically your home location. The selected location is applied to several of the tables to provide you with local times of the events (such as rise, transit and set times).
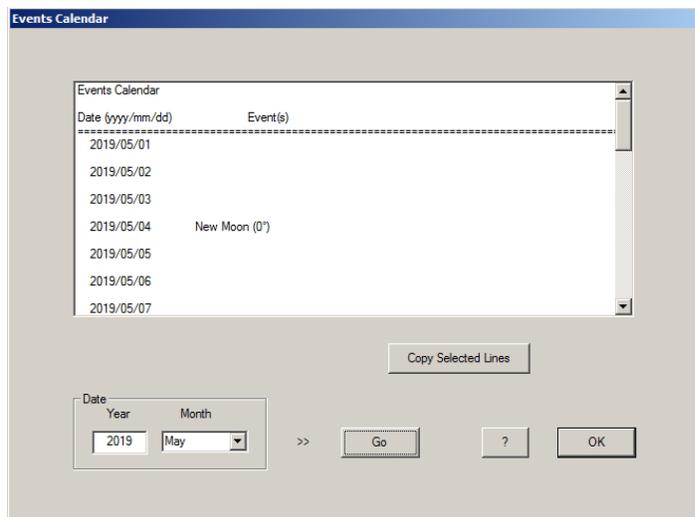
View
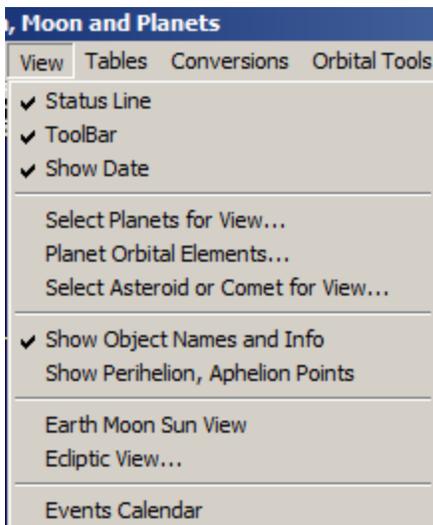
The **View** menu item allows you to turn on or off some of the features such as the **Status Line** and **ToolBar**.

You can also select **Planets for View**; it gives you a set of check boxes to choose which planets and their orbits you wish to show on the main screen. You may also turn on or off the planet names and any associated date including points of perihelion or aphelion.
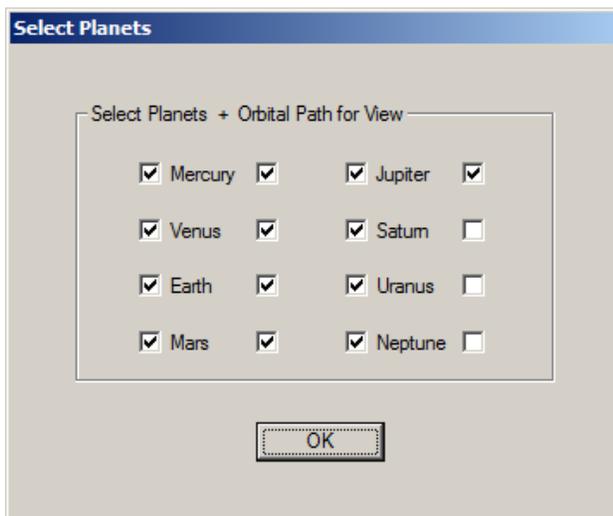
The **View** menu also allows you to change the main screen to show the Earth and Moon as they orbit the Sun (**Earth Moon Sun View**). This is a handy feature when studying lunar and solar eclipses or just phases of the Moon.

There is also an **Events Calendar.** Just select the year and month to see a listing of any events for the month.


The next item in the View menu is the **Ecliptic View**.

This view shows the path of the Sun, Moon and planets as they follow the ecliptic from 0 to 24 hours Right Ascension.
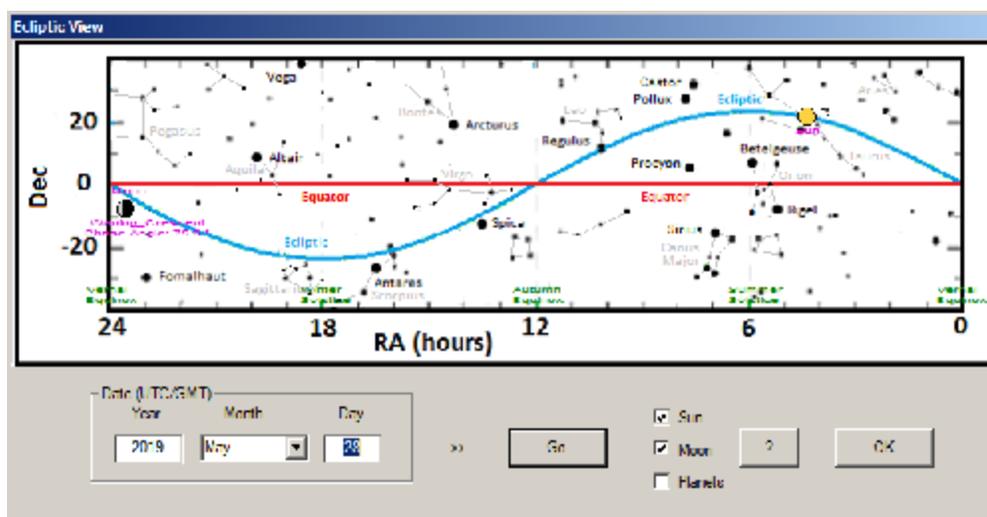
The last item in the View menu is **Planet Orbital Elements**. This provides a listing of the orbital elements for each planet (a, e, i, N, p, L). These orbital elements are used to determine a planet's position at any time.
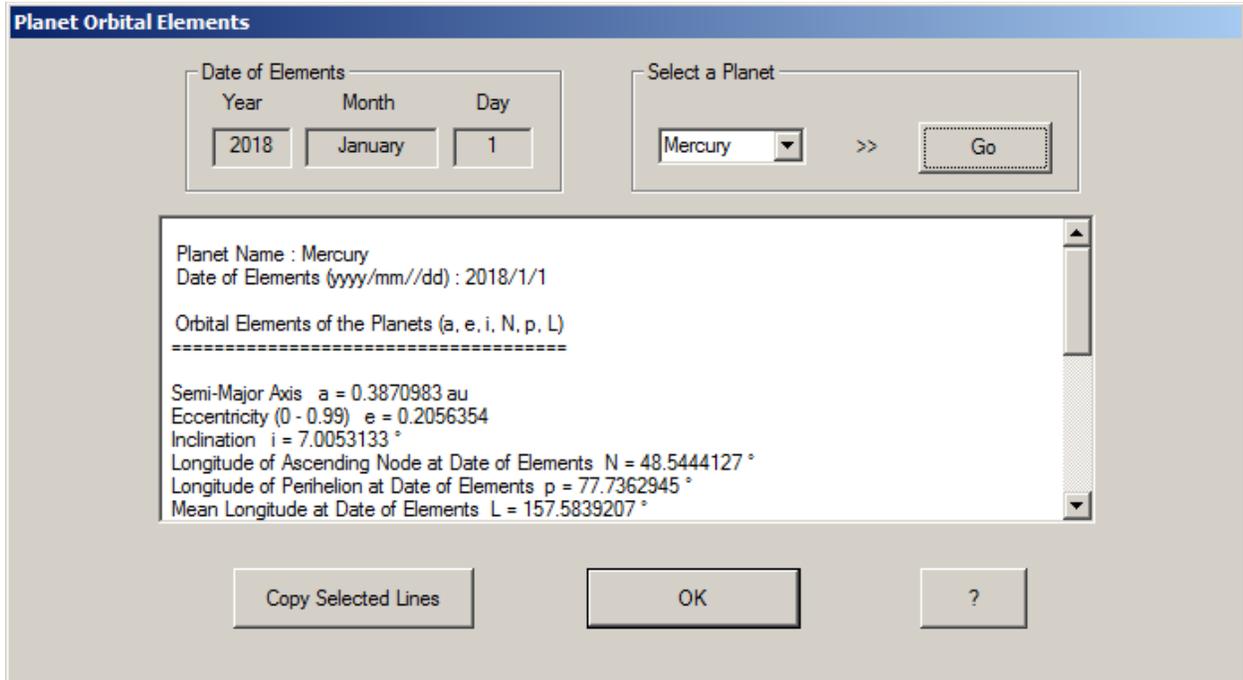
Tables
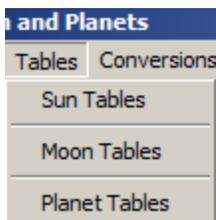
The Tables menu item contains: **Sun Tables**, **Moon Tables** and **Planet Tables**.

As described above, these tables provide a great deal of information regarding the Sun, Moon and planets.

You may enter a date and location as needed to calculate the type of data as listed in the tabs along the top row of the dialog box.

Sun Tables

Sun Data | Sun Rise, Transit, Set | Sun Ephemeris | Solar Eclipse Tables

Location
Prime_Meridian

Time Zone
0

Latitude
51.4772 ° N

Longitude
0 °

Change Location

Date - Time (UTC/GMT)

Year	Month	Day
2018	January	1

Hour	Minute	Second
0	0	0

Change Date and Time

Sun Data

Date - Time (Greenwich) : 2018/1/1 - 0:0:0

Date - Time (Local) : 2018/1/1 - 0:0:0

Julian Day : 2458119.500000

Distance = 0.98 a.u.
Semi Diameter = 0.271 °

Solar Equatorial Coordinates at Date-Time :
Sun Right Ascension (alpha) : 18 h 45 m 43 s
Sun Declination (delta) : - 23 ° 1 ' 9 "

Geocentric Ecliptic Coordinates at Date-Time :
Ecliptic Longitude (lambda) : 280.50713
Ecliptic Latitude (beta) : 0.00427

Copy Selected Lines | ?

OK

Moon Tables

Moon Data | Moon Rise, Transit, Set | Moon Ephemeris | Daily Moon Phase Angles | Quarterly Phases of the Moon | Lunar Eclipse Tables

Location
Prime_Meridian

Time Zone
0

Latitude
51.4772 ° N

Longitude
0 °

Change Location

Date - Time (UTC/GMT)

Year	Month	Day
2018	January	1

Hour	Minute	Second
0	0	0

Change Date and Time

Moon Data

Date - Time (Greenwich) : 2018/1/1 - 0:0:0

Date - Time (Local) : 2018/5/1 - 0:0:0

Julian Day : 2458119.500000

Distance : 357402.286 km
Semi Diameter : 0.279 °

Lunar Equatorial Coordinates at Date-Time :
Right Ascension (alpha) : 5 h 38 m 0 s
Declination (delta) : + 19 ° 19 ' 11 "

Geocentric Ecliptic Coordinates at Date-Time :
Ecliptic Longitude (lambda) : 84.799 °
Ecliptic Latitude (beta) : -4.016 °

Copy Selected Lines | ?

OK

Planet Tables

Planet Data | Planet Rise, Transit, Set | Planet Ephemerides | Planetary Phenomena | Earth Equinox / Solstice Dates

Select a Planet >> Mercury

Location: Prime_Meridian
Time Zone: 0
Latitude: 51.4772 ° N
Longitude: 0 °

Change Location

Date-Time (UTC/GMT)

Year: 2018
Month: January
Day: 1

Hour: 0
Minute: 0
Second: 0

Change Date and Time

Planet Data

Planet Name : Mercury

Date - Time (Greenwich) : 2018/1/1 - 0:0:0

Date - Time (Local) : 2018/1/1 - 0:0:0

Julian Day : 2458119.500000

Distance Earth to Planet = 0.999 au
Distance Sun to Planet = 0.389 au
Planet Phase Angle = 76.5 °
Planet Magnitude = -2.4
Planet Semidiameter = 3.36 "

Planet Equatorial Coordinates at Date-Time :
Right Ascension (alpha) : 17 h 8 m 24 s
Declination (delta) : - 20 ° 53 ' 32 "

Copy Selected Lines   ?

OK

Conversions

This menu item allows you to make conversions as follows:

- Date-Time to/from Julian Day
- Greenwich Date-Time to Sidereal
- DMS to/from Degrees

Date-Time <> Julian Day Conversion

Enter Calendar Date

Year	Month	Day
2018	January ▼	1

Hour	Minute	Second
0	0	0

Convert to Julian Day

Enter Julian Day Number

2458119.500000

Convert to Calendar Date

0 hours corresponds to Julian Day fraction of .5
12 hours corresponds to Julian Day fraction of .0

?   OK

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anets

Conversions   Orbital Tools   Help

Date-Time <> Julian Day...
Greenwich Date-Time -> Sidereal...
DMS <> Degrees...

Greenwich Date-Time -> Sidereal Conversion

Enter Date-Time at Greenwich (UT)

Year	Month	Day
2018	January ▼	1

Hour	Minute	Second
0	0	0

Convert to Sidereal Time

Mean Sidereal Time at Greenwich

Hour	Minute	Second
6	42	23.8177

?   OK

DMS <> Degree Conversion

Enter Degrees, Minutes, Seconds

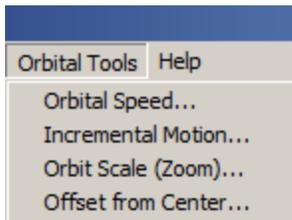| Deg	Min	Sec
20	30	36

Convert DMS to Degrees

Enter Degrees

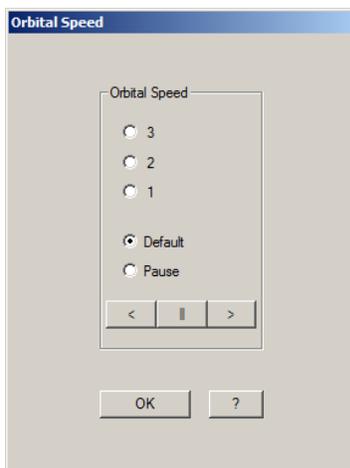20.51000

(degrees)

Convert Degrees to DMS

?   OK

Orbital Tools

This menu item provides tools such as **Orbital Speed** that allows you to animate the main screen so that you can see the planets orbiting the Sun. You can also see the Moon orbiting Earth as both orbit the Sun.


There is also a tool for **Incremental Motion** so that you can move forward or reverse in time by a day, month. 3 months, 6 months or a year.
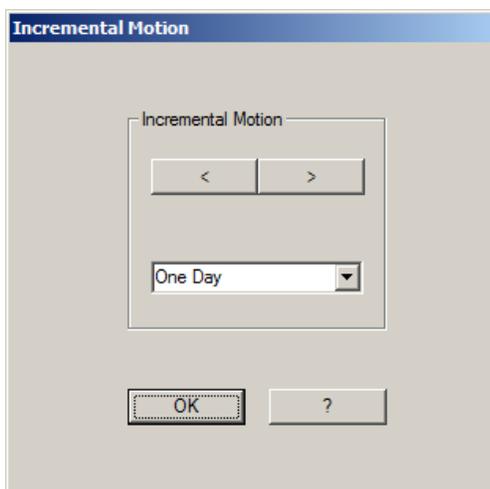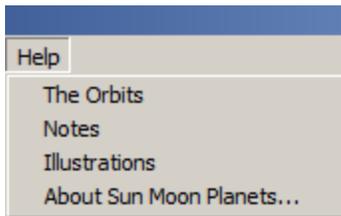
An **Orbit Scale (Zoom)** tool for scaling the main screen larger or smaller. This allows you to see the orbital path of Neptune far out in the solar system.
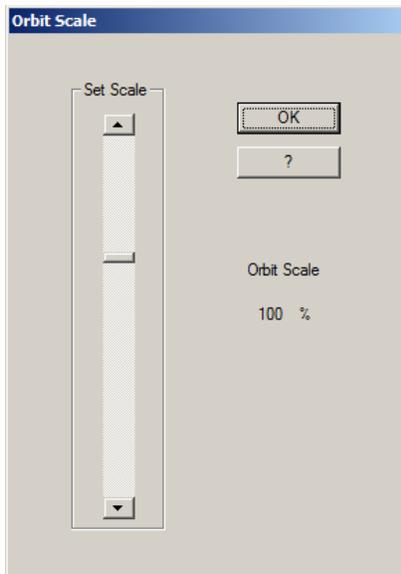
An Offset from Center tool allows you to shift the center of the solar system around the screen to improve the view if necessary.
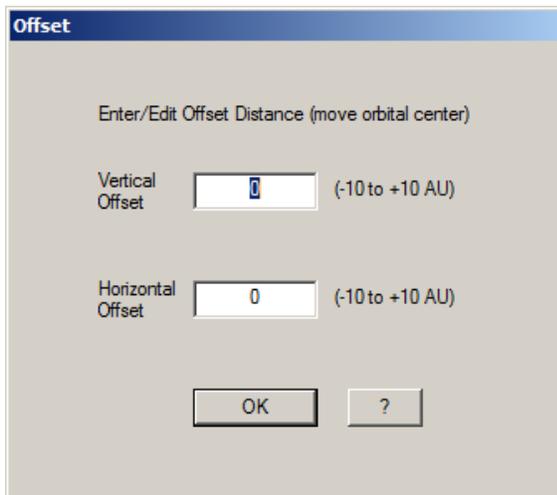
Help

The **Help** menu item provides various information regarding **The Orbits** plus a set of **Notes** and **Illustrations** that explain some of the terminology.

Examples of How to Use this Program

1) The opening screen of the program shows the position of the planets at the present date (0 hours UT). Use the menu item **Select a Date** to change the year to the next year or the previous year. Again note the position of the planets, particularly that Earth is still in the same position and Mars has moved approximately halfway around its orbital path. Try advancing the month and days and note the changing position of the planets. Approximately how long did it take for Mercury and Venus to make a complete orbit around the Sun?

Definitions:
Synodic Period - Time between two successive identical positions of a planet as seen from Earth.
Sidereal Period - True orbital period of a planet, the time required for the planet to complete one full orbit of the Sun.

2) On the opening screen adjust the vertical slider (right-hand side of screen) to about the mid-position. Note all the planets appear to be orbiting in a flat plane. This plane is called the Ecliptic. Click on **View** and select **Ecliptic View**. In the dialog box click the check box to show the planets. Note how the planets are all very close to the blue line (Ecliptic). The blue line gives the RA and Dec of any planet, Moon or the Sun at any date. Inside the dialog box adjust the date by increasing the month and clicking the **Go** button. Note the motions along the Ecliptic of the Sun, Moon and planets.

Definition:
Ecliptic - an imaginary line on the sky that marks the apparent path the Sun follows over the course of one year.

3) Click **View** and select **Earth Moon Sun View.** Note the position of the Moon with respect to Earth. Click on **Select a Date** again and advance the days one at a time to 7 days. How far did the Moon go around the Earth? Advance the month by one month. How far did the Earth go around the Sun? How far did the Moon go around the Earth?

4) Reset the screen to show planets orbiting the Sun. Set the date to March 20 (or March 21 - depending on the year).

Click menu item Tables and select Sun Tables. Click the tab Sun Ephemeris and set the date to March 20. In the first row of data (Sun Ephemeris tab) take note of the Date, RA and Dec. The RA of the Sun should be close to 0 (or 24) hours. Look at the relative position of the Sun with respect to the Earth. The Earth should be directly in-line with the Sun and in opposition to the First Point of Aries. Next, find the date when RA of the Sun is equal to 12 hours (in September). Set that date for the main screen and note that Earth will be in conjunction with the First Point of Aries and in-line with the Sun. At RA of the Sun equal to 24 hours, Earth be back where it was on March 20.

Definitions:
Right Ascension (RA) - Right Ascension is measured from the Sun at the March equinox (Sun is at the First Point of Aries). This is where the Sun crosses the celestial equator from south to north at the March equinox (also called vernal Equinox).
Declination (Dec) - the angular distance of a point north or south of the celestial equator.

5) Click menu item Tables and select Planet Tables. In the dialog box click the tab Earth Equinox / Solstice Dates. Note the date of the June (Summer) Solstice. Click the screen menu item Date and change the month and day to the date shown in the Planet dialog box. On the main screen you should see the relative position of the Sun and Earth at the Summer Solstice (compared to the direction of the First Point of Aries). Repeat this procedure using the dates in the dialog box to see the position of Earth with respect to the Sun at the Winter Solstice in December.

6) Click View and select **Earth Moon Sun View**. Click menu item **Tables** and select **Moon Tables**. In the dialog box click the tab **Quarterly Phases of the Moon**. In the listing find the date of the next New Moon. Click the menu item **Date** and change the year, month and day to the date shown in the dialog box. Then close the dialog boxes and observe the position of the Earth, Moon and Sun on the screen. The Moon should be in-line (conjunction) with the Sun. Keep in mind that the positions of the Earth and Moon were calculated at 0 hours UT but the time of the New Moon may be a few hours more or less than that.

Repeat this procedure to view the position of the Moon at First Quarter, Full Moon and Last Quarter.

You can also observe this using the Ecliptic View dialog box. By changing the dates you can observe the position of the Moon in relation to the Sun.

7) Click View and select **Earth Moon Sun View**. Click menu item **Tables** and select **Sun Tables**. In the dialog box click the tab **Solar Eclipse Tables**. In the listing find the date of the next Total Solar Eclipse. Click the menu item **Date** and change the year, month and day to the date shown in the dialog box. Then close the dialog boxes and observe the position of the Earth, Moon and Sun on the screen. The Moon should be in-line between the Sun and Earth. You may also note in the green text on the top left side of the screen that it indicates a *New Moon* and the *Solar Eclipse* at a given time UT. Note that on the screen the Moon may not be completely in position since the position of the Earth and Moon were calculated at 0 hours UT and the solar eclipse probably occurs several hours later (solar eclipses don't occur at midnight).

8) Click View and select **Earth Moon Sun View**. Click menu item **Tables** and select **Moon Tables**. In the dialog box click the tab **Lunar Eclipse Tables**. In the listing find the date of the next Total Lunar Eclipse. Click the menu item **Date** and change the year, month and day to the date shown in the dialog box. Then close the dialog boxes and observe the position of the Earth, Moon and Sun on the screen. The Moon should be in opposition to the Sun. You may also note in the green text on the top left side of the screen that it indicates a *Full Moon* and the *Total Lunar Eclipse* at a given time UT. Note that on the screen the Moon may not be completely in position since the position of the Earth and Moon were calculated at 0 hours UT and the lunar eclipse may occur a few hours before or after 0 hours UT (midnight).

9) Click View and de-select **Earth Moon Sun View**. You should be showing the main screen with all the planets. Click menu item **Tables** and select **Planet Tables**. In the dialog box click the tab **Planetary Phenomena**. From the combo box select the planet Mercury and click the **Go** button. In the listing find the date of the next Superior Conjunction. Click the menu item **Date** and change the year, month and day to the date shown in the dialog box. Then close the dialog boxes and observe the position of the Earth, Mercury and the Sun. To improve the view you might move the vertical slider to the bottom and then use the **Scale Tool** to enlarge the orbits.

10) On the main screen with all the planets, click menu item **Tables** and select **Planet Tables**. In the dialog box click the tab **Planetary Phenomena**. From the combo box select the planet Mars and click the **Go** button. In the listing find the date of the next Opposition. Click the menu item **Date** and change the year, month and day to the date shown in the dialog box. Then close the dialog boxes and observe the position of the Earth, Mars and the Sun. To improve the view you might move the vertical slider to the bottom and then use the **Scale Tool** to enlarge the orbits. Note the green text on the top left side of the screen - *Mars at Opposition*.

There are many other features in this program for you to discover. Be careful to set the dates on the main screen to the dates obtained in the Sun, Moon, and Planet dialog boxes.

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