Name_____ **Section**_____

Partner(s)_____ **Date**_____

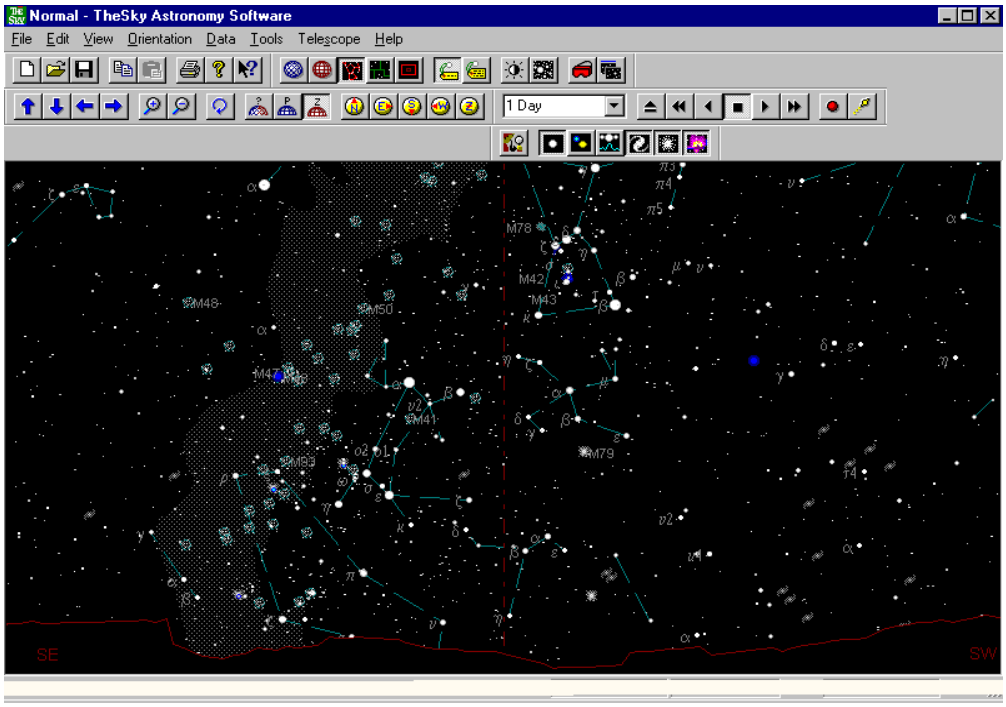
CHARTING THE HEAVENS USING A VIRTUAL PLANETARIUM

You have had the opportunity to look at two different tools to display the night sky, the celestial sphere and the star chart. You are now acquainted with constellations and their boundaries, right ascension and declination, and non-planetary celestial object motion over time. Wouldn't it be great if you could chart the night sky on a given date and time for a particular location and watch the changes in an animated time sequence? Or wouldn't it be interesting to see how the sky appeared to our ancestors or how it will look to our descendants? This is possible with a planetarium where a projector can be set to display celestial objects for a given date and time on a domed surface and show motion of stars and planets.

Although we do not have a planetarium, we can generate a "virtual sky" by simulating celestial displays and motion using a computer program such as TheSky™ or Red Shift™. These programs will allow you to select a location, date, and time for sky viewing. They also permit you to select the objects to be seen along with constellation and sky coordinate lines. You can set the sky in motion to see how the celestial display will change with time as the Earth rotates.

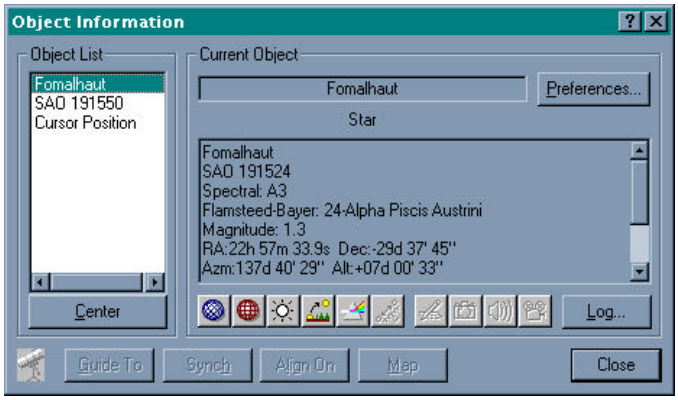
Starting TheSky™

To begin the program **TheSky™** go to **Start**, then **Programs**. Locate **TheSky** and select **TheSky Level II CD-ROM**. When the program finishes loading you should see a display similar to the one below.



The top of the screen contains controls that change the screen display. This section is gray with a variety of menus and button icons. The lower section of the screen is the sky display. This is usually black with sky objects plotted in white or color. The red solid line toward the bottom of the display represents the horizon. The direction you are looking toward (SW, NE, E) on the display is printed under the horizon line. The ecliptic is displayed as a yellow dotted line and the meridian for the location selected is displayed as a red dotted line (visible in north and south looking views).

Using The Cursor



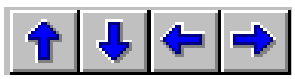
When you place the cursor, controlled by the mouse, on the screen display object and click you will see a box appear like the one here. It will provide the object name (if it has one), any astronomical catalog identification number, and information about the object. Sometimes object files needed to identify an object are not loaded on the computer you are using and the CD-ROM with the files is not available. The white object list box will indicate that file is not available.

The mouse-controlled cursor is used to change the screen display using options on the toolbar or in pull-down menus.

TheSky™ Toolbars and Menus

TheSky™ has a series of toolbars that make it easy for you to control what you see on the screen. The toolbars are located at the top of the screen and consist of small icons on buttons. When a button appears to be depressed, it means that this function or option is active. You can turn an option on or off by pressing on the icon with the left button of the mouse. Below is a brief description of the various options.

Scrolling the Sky



These arrow buttons allow you to change your view left to right and up

and down. If you push the up arrow, the screen view will shift so the center of the display is a point higher in the night sky.

Zooming In and Out

The magnifying glasses permit you to look more closely at the current sky display or to see more objects in the display. To magnify (see less of the sky, closer), select the + button. Doing the same thing with the - button will zoom out (show more of the sky). If the button becomes entirely gray, you have reached the limit of the zoom.

Look Commands

If you want to change your view so that you are looking in a specific direction (north, south, east, west or up (zenith)) you can do it with these buttons. Selecting Z will change the screen display and show what you would see if you were looking straight up toward the zenith.

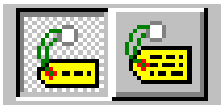
Moving in Time (Time Skip)

You can change the time of the display easily with these buttons. The pull-down window allows you to select the amount of time that you want to skip (second, minute, hour, day). The single left or right arrow points move you one time unit. The double arrow points begin a sequence that continually changes the display by the time unit. Right arrows are forward in time, while left arrows move the display back in time. The double arrows generate an animation of the sky over time. You stop the motion with the square. The up arrow point resets the date and time to the initial conditions.

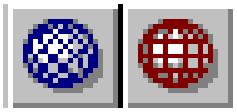
Displaying Objects

Sometimes you want to control the number of objects that are displayed on your screen. You can do that easily with this set of buttons. When the button is selected, the objects are displayed. From left to right, these buttons control:
STARS DOUBLE STARS VARIABLE STARS GALAXIES CLUSTERS NEBULAE

Labeling Objects on the Screen



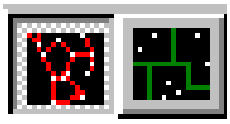
You can label the objects on the screen with these buttons. Because they add a lot of information to the screen it is best to leave these unselected unless you are searching for a particular object.



Displaying Grids and Patterns

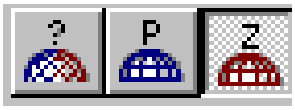
Sometimes it is convenient to have a reference grid placed on the sky display.

The left (blue) grid marks coordinates of the celestial sphere, right ascension and declination. The right (red) button shows coordinates with respect to the local horizon, altitude, and azimuth.

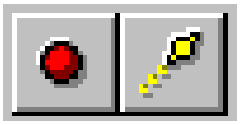


If you want to display the classical constellation patterns, you can select the left button of the two shown here. The right button will display the boundaries of each constellation as you saw on the celestial sphere.

Orienting Yourself



The Sky™ can simulate your view from different perspectives. If you select Z (zenith up) the display is referenced to the horizon. This is the orientation you want when you are trying to simulate the actual view from your observing site. You will see a horizon line drawn near the bottom of the sky display. The P (pole up) view uses equatorial referencing and is better when you are just looking at celestial objects and are not concerned about the horizon or zenith location. The ? allows you to rotate the display to any angle using a circular arrow key to the left of it (not shown here but can be seen on the toolbar graphic on page 2).

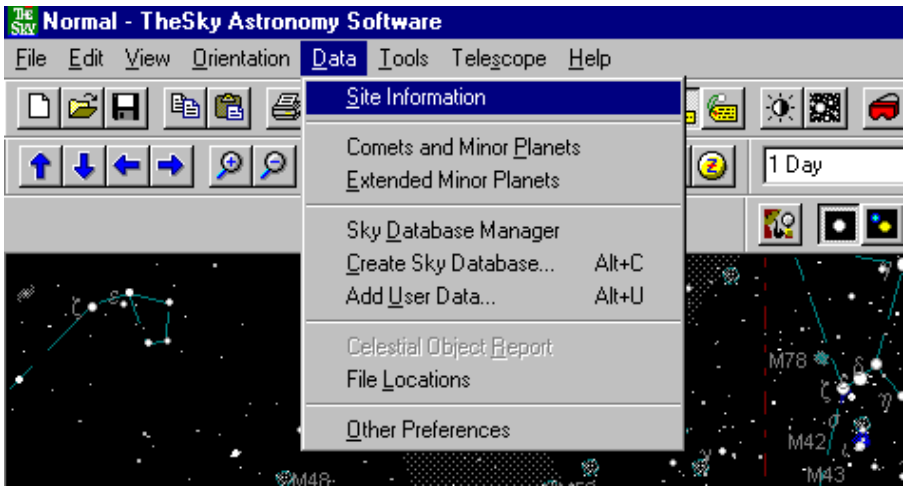


Leaving Tracks

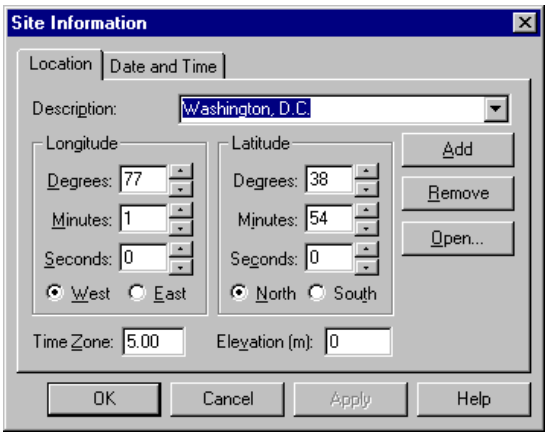
Sometimes it is convenient to monitor the path of an object like the planet Mars by having the object leave a trail. The buttons shown here will allow you to do that. The yellow button (right one) will allow you to select the objects that will leave a trail and the type of trail. Selecting the red dot button will turn on the tracking feature. The trails will show when the time skip feature is used to put the sky in motion.

Setting Your Site, Date, and Time

To set the location, date, and time for your sky view you will use one of the "Data" menu. Click on Data and you will see a selection called "Site Information" as shown below.

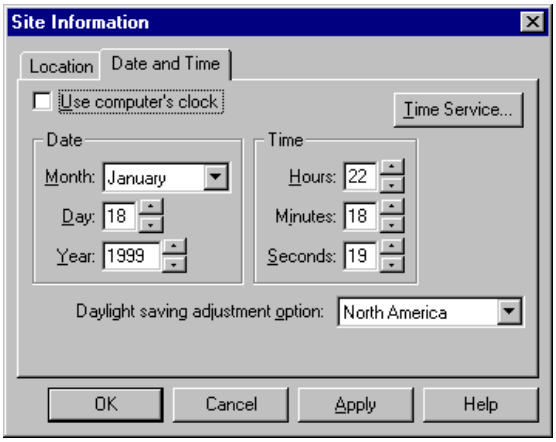


When you click on “Site Information” it will provide the following screen shown here:



In the “Location” folder you can select the site. If the Description box does not display Washington, D.C. you can change it with the pull down menu. You will note that the longitude and latitude for Washington are also displayed. This menu has many US cities preprogrammed. You can also select a site by typing its longitude and latitude in the appropriate boxes.

If you click “Date and Time” folder, you can select the time for the sky display. The default is to use the computer clock. This will happen when the “Use computer’s clock” is checked. You can set the date to be any value from 4712 B.C. (-4712) to 10,000 A.D. The time is expressed in a way that avoids the use of AM and PM. For example, 10 PM is 22 hours. Be sure to check “Apply “ and “OK” before returning to the display or the display will not reflect the changes you made.



Activity 1: The Nightly Motion of Stars

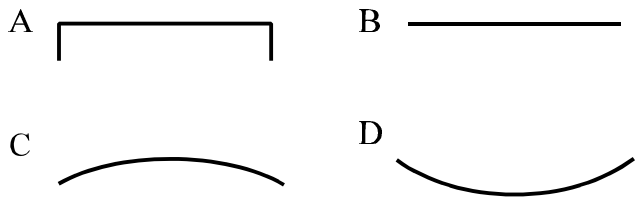
To look at the motion of the stars over a period of time we can set a site and time and put the sky in motion

- Set the date for today and the location for Washington, D.C. using the Data menu.
- Use the **Look Command** to View south.
- Set the orientation on the tool bar for **Zenith Up.**
- Turn off ALL objects except the stars. Turn on the constellation patterns.
- Go to the **Time Skip** icons and be sure the time interval is set for 1 minute. Click on the double arrow pointing right to start the sky motion to the future. You can stop the motion with the square or reverse the motion with the left arrows.

  Note: The stars do not change position with respect to each other in the night sky over the time period shown here. Any apparent motion of the stars compared to their neighbors is an artifact of the program.

1. Observe the night sky in motion looking south.
Describe the motion.

What is the path taken by the stars when viewing to the south? _____



Now change your view to north, and start the motion after resetting the time to your initial conditions.

2. Observe the night sky in motion looking north.
Describe the motion.

Illustrate the path taken by the stars when viewing to the north.

Is there any star that is not following the path above? If so, identify it.

Does the Big Dipper go below the horizon? Explain.

Now go back to the "Date and Time" folder and change the year to 5000. Click on "Apply" and then "Close."

3. Observe the night sky again looking north as you did just above.
Describe the motion.

What is different in the year 5000? Describe it.

Either using the celestial grid or cursor, determine the right ascension and declination of Polaris in 5000.

RA _____ DEC _____

Activity 2: Observing Planetary Motion

- Set the date for today
- Set the orientation on the tool bar for **Pole Up.** This will keep the stars in the same position on the screen all the time.
- Use the **Scroll arrows** to position the yellow ecliptic line centrally on the screen. Zoom out to get a more encompassing sky view
- Turn off ALL objects except the stars. Turn off all grids, boundaries, and labels.
- To see the path of the planets, go to the tool bar select the red dot button that turns on the tracks.
- Go to the **Time Skip** icons and be sure the time interval is set for 1 day. Click on the double arrow pointing right to start the sky motion to the future. You can stop the motion with the square or reverse the motion with the left arrows.

1. Observe the motion of the planets.
   What is changing?

   What is not changing?

2. Now turn the stars off and turn the tracking on. Start the motion again and let it run awhile. If the tracking marks become too numerous, turn the tracking button off and then on again to clear the marks and restart motion. What do you notice about the planets' motion? Describe or illustrate it.

More Advanced Virtual Planetarium Activities

Activity 3: Looking East at Different Latitudes

- Set the **Look Command** to the East.
- Select the orientation for **Zenith Up**.
- The time skip should be set at a 1 minute interval.

1. View the eastern horizon for the following four locations which can be set in the "Location" folder. Record the latitude for the locations given below. Put the sky in motion for each location, observe, and sketch the motion paths below in the boxes. Use a series of arrows to show direction.

North Pole - Latitude _____

Washington, DC - Latitude _____

Equator - Latitude _____

Southern Hemisphere - Latitude _____

2. Explain the pattern based on the varying positions on Earth.

3. Predict what the pattern would look like in Canada, say half way between the north pole and Washington, D.C.

4. Predict the path of motion looking <u>west</u> in Washington, D.C.

Activity 4: The Changing North Star

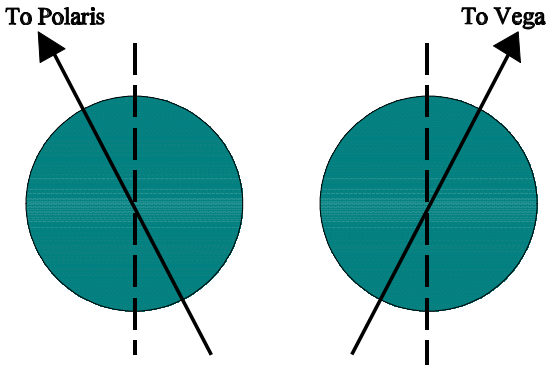
Reset conditions to Washington, D.C. on 16 August 1999 at 22 hours, 4 minutes. View should be set to the north with the zenith grid (red button). Zoom out so that both Polaris and the zenith can be viewed.

1. Identify the star at the zenith. _____ Print this star field.

   The star is Vega, which was our north star about 13,000 years ago and will be again in 13,000 years. This is due to the precession of the Earth's axis. Think of a toy top spinning and the axis changes with time, both rotating around and wobbling.

2. How many degrees apart are Polaris and Vega?

3. The Earth's rotation axis is tilted 23.5^o with a wobble of ± 1.5^o (variation). What is the maximum angle, considering the variation, for the axis making a complete swing?



Maximum Precession

4. How does the measured angle from the star field compare to your maximum angle calculated above?

5. Now on the printed star field using a ruler, draw a line connecting Polaris and Vega. Find the mid-point of this line. Set a compass to this distance and place the pointed end at the mid-point. Draw a circle with the compass and you will have approximately identified the path of the precession of the Earth's axis over time. It takes about 26,000 years to complete one cycle. List three other possible stars on the path (circle) that could have been north stars. The axis, as it precesses, also wobbles, so you can go a little off the circle to get these stars.

   1. _____ 2. _____ 3. _____

6. About 2700 years ago, a small star was the north star. Set the time to -2700 years (2700 BC) and observe the motion to identify this star. You may want to turn the labels on.

   North star at -2700 years _____ in the Constellation _____

   What was occurring in history at this time?

7. Which direction is the north celestial pole going to migrate? Show with an arrow on the precession circle.

Software used in this activity is TheSky™ Astronomy Software, Version 5, 1999, by Software Bisque, Golden CO.