EVOLUTION OF SCIENTIFIC THOUGHT
LABORATORY II
RETROGRADE MOTION

In this experiment, we will work with the program XEphem to become familiar with a few constellations, and to see what a retrograde loop might look like if you were watching it day by day.

Please feel free to play around with the program. You are welcome to use it anytime the computer is free.

Follow the instructions for running XEphem to get started. It may help to have the program documentation that is included at the end of this write-up

Note that you can make a copy of the screen on the printer. Get copies of interesting displays for your lab book.

When the program comes up, it shows the sky at the time to which the internal clock of the computer is set.

Part I

Start by setting the view to show the sky is shown as it would appear to you facing North. We will start by setting the sky for about 11 pm, and then zooming in on a few familiar constellations. Here is the procedure:

1. Set the time for sometime after dark—say, 9 pm (or 21:00 hours) Press update. If you have not already done so, bring up a Sky View.

2. Be sure you are in Azimuth-Altitude mode.

3. Set the Azimuth to 0° (facing North) and the Altitude to 45° (our latitude, and hence the angle above the horizon at which we see the North Star. The North Star should now be in the middle of the window.

4. Zoom in using either the Field of View slider bar (left side of window) or the Draw Region of Interest button.

See if you can pick out

- the big dipper and the little dipper; the North Star at the end of the handle of the little dipper;

- the constellation Draco, the dragon, which winds between the two dippers;

- the W-shaped constellation Cassiopeia, above and to the East of the dippers (where will it be later in the evening?);

- and finally, the bright yellow star Capella in the constellation Auriga. To find Capella, start at the big dipper, and use the pointer stars of the dipper to find the North Star. Then, move off at a little less than 90. You will arrive at Capella. If necessary, zoom in on Auriga, an oval-shaped constellation, and be sure you can identify Capella.

Part II

Now let's look for some planets. Start by enlarging the field of view. Then set the Azimuth to 180° (South). Be sure the ecliptic is on (it should be a line of red dots) and then see what planets are present. You can also use the Locate menu item to help track down the planets. Persuade yourself that the planets lie close to the ecliptic.

Next, pick a planet and plot it's path over an extended period, to see if you can find it going through a retrograde loop. (What would you see the planet do if you were watching it, night by night, through this period?) Here is the procedure:

1. Choose the starting date on the main window, and press "Update."

2. In the Sky View window, right-click on the planet and choose "Create Trail." Pick appropriate choices for Interval and Label (it is likely to take some experimentation to find the best choice) and see what trails result. They can of course be modified later.

Find a few other examples of retrograde loops. One convenient example might be the loop Mars went through in the fall and early winter of 1990. Set the date to somewhere in this period. At that time Mars was in the constellation Taurus (the Bull), close to the brightest star in Taurus, the red star Aldebaron, the red eye of the bull. Note that Mars is considerably the brighter of the two. Aldebaron is itself at one end of a V-shaped cluster of stars, the Hyades. See if you can identify all of these objects.

Note also the cluster of stars called the Pleiades (or Seven Sisters). This constellation is shaped like a small cup—it is very impressive if you look at it through binoculars, even fairly low-powered ones. It should be above and to the right of Mars---that is, higher in the sky, and farther to the East. Zoom in on it at a high enough magnification to see the cup shape.

See if you can find one or two other retrograde loops for any of the planets. Pick any year or years you like—for example, was anything interesting going on in the sky on your birthday? You can also look at one or two constellations—Orion is one that many people can recognize—it is bright and easy to pick out.

Finally, it might be fun to set the clock back several thousand years, and see the effect of the precession of the equinoxes—Polaris was not the North Star back then!

Print as many of these views as seem interesting, and include them with your report.

XEPHEM

Xephem is a program that shows the sky as it would appear from any perspective, anywhere on earth, and over a wide range of dates. To start the program, double-click on the XEphem icon. A background window will pop up, and then after a few seconds, the XEphem main program window will appear.

This window allows one to choose location, date, time, and a number of others. Set the date and time to the appropriate values and then click on the "Update" button on the bottom of the window. Then pull down the View menu at the top and click on "Sky View."

You should now see the sky as it appears at the date and time you have chosen. Start by playing around with the program. Note the following features:

1. You have a choice of coordinate systems:

   - Right Ascension and Declination—you already are familiar with this system from the first experiment. Here, it will be most useful when tracking the positions of planets.

   - Altitude and Azimuth—These coordinates are from the perspective of someone looking at the sky. Azimuth tells you in what direction you are looking—0° is North, 90° is East, and so on. Altitude specifies the number of degrees above the horizon.

   You can toggle back and forth between the two, using either the coordinates button on the left side of the window, or from the Control menu at the top of the screen.

   You can set the values of these coordinates using the slider buttons at the bottom and the right side of the window.

2. You can zoom in on any particular part of the sky in either of two ways:

   - Move the slider bar on the left side of the window; or

   - Find the "Draw region of interest" button on the right side of the window. Click on it, use the mouse to draw a rectangle around the region you want to zoom in on, and then click on the "Zoom in" button on the right side of the window.

3. The various buttons around the window allow you to turn on or off

   - stars
   - planets
   - the ecliptic
   - constellation outlines
   - coordinate grid

   and a good bit more.

4. You can print any screen. To do so, click on the Control menu, and choose print. Click on the print button (to make sure you are printing and not saving a file to disk) and then click on OK. This system usually works; but if you run into any trouble, one

can save the view of the sky to a disk, and print it from a separate program. You can also use this feature to save files of any views (the sky on your birthday?) that you might like to keep.

NOTE: The print dialog box sometimes gets buried behind the program; if it doesn't appear, watch for it to show up on the Windows Taskbar (the bar that is usually along the bottom of the screen.

5. There is a good deal more the program can do. You can get views of the solar system and a number of the planets, for example. Feel free to play around.