**Motions in the Sky**

Introduction

This exercise should help you become familiar with the night sky, and introduce you to observations of how things appear to move. To do this, we will be using a free planetarium program called *Stellarium*.

Setup:

If you have not already done so, boot up your computer. You can log in using your regular UST login. Bring up *Stellarium* using the icon on the desktop. The program automatically assumes a date, time and location. This *should* be set to St. Thomas: Latitude **N45° 30’ 0.00”**, longitude: **W93° 0’ 0.00”**, and altitude of **38 m**. If these are not set correctly, see me. The location and time menus can be found by placing your cursor near the left side of the screen.

Quickly review the following vocabulary before proceeding. You can always come back to it if you need to.

**Zenith**: The zenith is the point on the celestial sphere that is directly overhead.

**North/South Celestial Pole**: The North Celestial Pole is the point on the celestial sphere directly above the Earth’s North Pole. The South Celestial Pole is directly opposite this (above the South Pole).

**Horizon**: The horizon is a “line” on the celestial sphere where each of its points is exactly 90° from the zenith (this means we’re ignoring things like trees, and if we lived someplace like Colorado, mountains.). Objects above the horizon can be seen. Those below the horizon can not.

**North/South Point**: The north point is the point on the horizon that is directly beneath the North Celestial Pole. The South Point is directly opposite this. *Note that this definition works here in the northern hemisphere of the Earth, but needs adjusting if you’re observing in the southern hemisphere.*

**Meridian**: The meridian is the vertical circle that passes through the celestial poles (also the north and south points) and the zenith.

**Altitude**: The altitude of an object is equal to the angle, in degrees, measured directly up from the horizon to the object. The range of altitudes is +90° to -90°.

**Azimuth**: The azimuth of an object is the angle, in degrees, from the north point *along the horizon*, to the point where the object is (drop down a line along the celestial sphere to the horizon to find this spot). This angle increases to the right and the range of azimuth is 0° to 360°.

**Latitude**: Your position on Earth is given in terms of latitude and longitude. For this lab, only your latitude will matter. Your latitude measures your angular distance along the Earth’s surface from the equator. The latitude of the Twin Cities is 45°.

Part 1: Motions of Stars

Let’s take a look at the stars. We will investigate the motions of the stars in the four cardinal directions (N E S W). Drag the horizon around until you are facing due **south**. Turn off the atmosphere in the lower menu.

1. You are facing south. Which direction is to your left? Right?

Click the time steps so the clock is counting up, then click the “fast forward” three or four times so that you can see the stars move.

1. Describe the motions of the stars you see. What general direction do they move? Do they all start (or end) at the same spot on the horizon? Where are they highest in the sky?
2. Take a look at the three remaining directions. Describe the motions of the stars:
   1. East
   2. West
   3. North
3. Is there anything surprising about the motion of the stars in any of those directions?
4. Can you find the north star? How do you know it’s the right one? Click on it. What’s its official name?
5. Looking north, are there any stars that do not set? Which direction do the stars move above the north star? Which direction do they move below the north star? Can you give the overall motion a name?
6. What is *causing* the stars to move in this way?
7. Take a look at the altitude of the north star (and write it down). What do you think would happen if you were to change location more northward? What would its altitude be if you were standing at the north pole?
8. Would it matter what time of day it was? Why or why not?

We’ve just investigated the motion of stars throughout a few hours or a day. Let’s take a look now what happens at the same time of day, but over several months. Face south once more and stop the clock. You want to the time of day to stay the same but the *days* to increase.

1. Choose one constellation to watch (to make things easier). Click the days forward and describe the motion you see.
2. What causes this motion?

Let’s go back to looking at the sun. Return the date and time to today at noon (standard time), and look due south. It may help in this exercise to get the time the sun is directly on the meridian. Make sure your atmosphere is still off.

1. What constellation is the sun in (or near) today? If it is “between” two constellations indicate this.
2. Move the date forward one month. Which direction do the constellations shift? What constellation is the sun in now?
3. Continue moving the date by one month each step. List the constellations that the sun appears to be in, in order:
4. What *causes* the sun to appear to move through these constellations?
5. These constellations are called the **zodiac**, or the zodiacal constellations. Why do you think they are important?

The **ecliptic** is an imaginary line through the apparent path of the sun throughout the year. We will see more about the ecliptic in the future, but for now you can turn on the imaginary line by going to the left menu, clicking on “sky and viewing options”. In the markings tab there is a checkbox for “ecliptic line”.

1. Run the time forward day by day (click and hold) and watch the sun travel along the line. Go for at least several months.
   1. Do you notice anything interesting about the line itself?
   2. What do you notice about the planets (especially Venus and Mercury)?