FRI Astronomy Lab #7

**Goal:** While past labs have familiarized you with data reduction and analysis software, this lab aims to develop your intuition for practical aspects of astronomical data acquisition. You will explore the limitations imposed by time and location on observing specific astronomical targets. These will be important considerations to keep in mind as you plan observing runs, which you will all have opportunities to participate in this semester.

**Instructions**

1. From Spotlight or the Applications directory in Finder, launch the program called Stellarium. With this planetarium software you can simulate the apparent motions of space objects. Stellarium’s many features are accessible from menus on the bottom and left sides of the screen, but these instructions will make use of numerous hotkeys, denoted with brackets. To see a list of all hotkeys, press \([F1]\) (\([fn]+[F1]\) on a Mac).

2. Press \([F6]\) to bring up the location window and set your location to Austin (Texas).
   **Q1:** What are the latitude and longitude given for Austin? (Type the answers to all these questions up. You will turn them in at the end of the lab.)

   The software will display the current local sky in Austin. Click and drag in the window to look around. Since it’s likely daytime, there’s probably not much to see besides the cardinal directions marked along the horizon.

   Press \([a]\) to turn the atmosphere off. This will allow you to see stars in the daytime, and will improve the view at night. Whether it is day or night will be apparent from the level of ground illumination.

3. As you observe how stars move in the sky, it will be useful to have a coordinate system defined. Press \([z]\) to enable the altitude/azimuth grid. This shows a star’s angular height (altitude) above the point in a particular angular direction (azimuth) on the horizon.

   Press \([F5]\) to bring up the date and time window. Advance the hours and observe the apparent motions of the stars in the sky to answer the following barrage of questions. Alternatively, you can control the smooth passage of time using \([l]\) to speed things up, \([j]\) to slow them down, and \([k]\) to restore things to a natural speed.

   Examine how stars appear to move in different regions of the sky in order to answer the following questions:

   **Q2:** Over what region of the horizon do stars rise? Set?
   **Q3:** Roughly at what angle over the horizon do they rise and set?
   **Q4:** Do all stars rise and set?
Q5: Do all stars spend the same amount of time in the sky? If not, which are up longer and what dictates that?

Q6: Do some stars appear to move faster than others? What dictates that?

Q7: There is one particular bright star that moves less than any other. Find it and click on it to view its details. What is this star called? What is its nearly constant altitude? Comment on the significance of this number.

Q8: If you wanted to record a star’s position for later repeat observations, why is the altitude/azimuth not a good coordinate system to use? How does the altitude and azimuth change with time for a particular star? Does it vary with location?

4. Astronomers prefer to use a different coordinate system for locating targets called the RA/Dec system, which stands for Right Ascention and Declination. These angular coordinates are analogous to the longitude and latitude system for identifying locations on Earth’s surface, respectively. Disable the Alt/Az system by pressing `[z]` again, and turn on the RA/Dec grid by pressing `[e]`. Observe how the stars move relative to this coordinate system to answer the next questions.

Q9: How do the stars appear to move relative to the RA/Dec coordinate system?

Q10: Does the RA/Dec position of a star vary with location on Earth?

Q11: What units are Declination displayed in? What about RA? Why might these choices make sense?

Q12: Choose a star and click on it. Watch the displayed information vary with time. Can you determine what the “Hour Angle” value means? Why is knowing the hour angle of a star useful to an observer?

Q13: Astronomers also have a preferred time reference that is more useful for observations than local terrestrial time. This is called “local sidereal time” (LST) and is defined by the RA of a point directly overhead (AKA the zenith). Why is this a practical choice?

5. One of the best studied regions of the sky is the footprint of the *Kepler* mission. *Kepler* is in a trailing-Earth orbit and observed the same patch of sky for many years. This patch of sky is located near the constellation Cygnus. Press `[F3]` to search for Cygnus. (If you’re a fan of constellations, you can use `[c]`, `[v]`, and `[r]` to toggle constellation lines, labels, and caricatures.)

Q14: Many exciting stars have be discovered by *Kepler*, and follow-up ground-based data is often desired. Using the tools of Stellarium, figure out what the best month to observe stars in the *Kepler* field is. What were your criteria for determining this?

6. Finally, take a look at how stable the RA/Dec system is on long timescales. Speed up the passage of time until the stars appear to move against the RA/Dec grid. This motion is due to the precession of the Earth’s rotation axis. Find Polaris and track its path with the precession. You may wish to turn off the ground with `[g]` and change the viewing mode with `[Command+M]` so that you don’t get dizzy and throw up. If you run to the maximum
time allowed by Stellarium, use [8] to snap back to the present day. Based on the observed motion of Polaris, determine the answers to the following questions:

Q15: How long does it take to complete one precession cycle?
Q16: What is the tilt angle of the Earth’s rotation axis?
Q17: Since the RAs and Decs of stars apparently change on long timescales, what third detail is necessary to specify when recording where to find a particular target?

7. Close Stellarium when you’re done playing with it and bask as hard as you can...