Naked Eye Astronomy, Day 1: The Stars

1. Introduction
   (a) In this course we will focus on astronomical phenomena that can be observed with the naked eye. (At the very end of class we will talk about some things that can be seen with a small telescope.)
   (b) Our goal is to first observe these phenomena and recognize certain patterns that occur.
   (c) Then we will consider some possible explanations for these phenomena. These explanations are what we call scientific theories. Ideally, a scientific theory should allow us to "predict" natural phenomena, but it should also give us some insight into WHY those things occur just the way they do and not some other way.
   (d) That's not all we demand from our scientific theories. We may also expect them to be simple or elegant or beautiful. We often want them to fit well with OTHER scientific theories. We want them to be falsifiable (in other words, some observation COULD disagree with our theory) but not yet falsified (not actual observation HAS yet disagreed with the theory). We may even want our scientific theories to fit with other, non-scientific, beliefs (religious, philosophical, "common sense").
   (e) It's hard to satisfy all of these requirements, but the closer a theory comes to fulfilling these criteria the more likely we are to choose it over other theories that don't fulfill the criteria as well.
   (f) Please ask questions at ANY TIME.
   (g) Web page with resources for the course: `https://osp.berry.edu/nakedeye.html`.
2. Observing the Stars (in Stellarium)
   (a) Stellarium: free planetarium software for your computer. Feel free to get your own copy and play around with it. It will let you observe things that you can see with your own eyes, but much more conveniently! (E.g. observations that would take years can be done in a couple of minutes.)
   (b) Observing an individual star
      i. To make observing easier we will turn off the atmosphere so we can see the stars during the day. That's not very realistic, but if we planned carefully we could make these observations in the real sky at nighttime.
      ii. Find Sirius. Where does it rise? When does it rise? Where does it set? When does it set? How long is it above the horizon?
      iii. Jump ahead a month. Repeat these observations for Sirius. What changes? What doesn't change?
      iv. Repeat for Vega. How is it different from Sirius?
      v. What kind of path do these stars follow? (Looks like part of a circle.)
      vi. Repeat for Polaris. What is different about this star? Why is this star so important, practically speaking?
   (c) Observing stars collectively
      i. Do the stars move relative to each other?
      ii. Discuss constellations, show them in Stellarium.

iii. What is the shape of the path followed by a given star? (Looks like part of a circle.)

(d) Transit times

i. Define the meridian line (from north through zenith to south). Define a transit (when a star crosses the meridian).

ii. Measure time between transits for Sirius. Is that what you expected?

iii. Measure time between transits for Vega. How does this compare to the value for Sirius?

iv. Does this reinforce or contradict the idea that all stars move as a collective?

3. The Celestial Sphere: our first scientific model/theory

(a) The idea that all stars move around the sky as a collective suggests our first model: the Celestial Sphere. This is the idea that all stars are stuck on a giant transparent sphere that spins around a fixed axis. We are located at the center of that sphere.

(b) Show Celestial Coordinates model. Discuss the general structure of the model. Note that the model ASSUMES that stars continue on their circular paths when they are below the horizon. Does that seem reasonable? Do we actually know what happens to stars when they are out of sight?

(c) Highlight Sirius and use the pointer to trace its motion. Do the same for Vega. Now set the pointer to point at Polaris. What does it do? Discuss the idea of the north celestial pole. The axis of the celestial sphere's rotation must pass through this point.

(d) The Celestial Sphere model reproduces all of our star observations, but it also predicts some other things that we cannot test or observe (that stars continue moving along a circle when they are below the horizon, that all stars lie at the same distance from us, that there is a south celestial pole and stars near it that we can never see).

4. (If time remains) A Big Question: what is really spinning, the celestial sphere or us?

(a) Show Earth and Stars simulation. Discuss the issue of the size of the Earth relative to the celestial sphere, as well as the horizon plane for a particular location on Earth.

(b) Show model with rotating CS. This looks just like the simulation we saw before.

(c) Now switch to Rotating Earth. How does the direction of Earth's rotation in this version compare to the direction of the CS's rotation in the previous version?

(d) Note that both version produce EXACTLY THE SAME visual effects in the Sky View window. So we cannot tell with our eyes whether it is the celestial sphere or the Earth that rotates.

(e) Note that we are assuming a spherical Earth - we will discuss the reasons for thinking Earth is a sphere later on.

5. Questions and conversation.