Naked Eye Astronomy, Day 4: The Spherical Earth

1. Review
   (a) Please ask questions at ANY TIME.
   (b) Web page with resources for the course: `https://osp.berry.edu/SeniorScholars`.
   (c) Recall the following from our previous observations made from Rome, GA:
      i. The north celestial pole (near Polaris) sits about 34 degrees above the horizon, due North.
      ii. On the summer solstice the Sun rises about 5 AM, reaches an altitude of 77.5 degrees at local noon, then sets around 7 PM.
      iii. On the winter solstice the Sun rises about 7 AM, reaches an altitude of 32.5 degrees at local noon, then sets around 5 PM.
      iv. On the equinoxes the Sun rises at 6 AM (due East), reaches an altitude of 56 degrees at local noon, and sets at 6 PM (due West).
   (d) Now we will take a look at how these patterns change if we move to a new location on Earth.

2. Changes in Latitude: moving North and South
   (a) The stars
      i. In Stellarium, start in Rome. Note altitude of Polaris. Show that Canopus is just barely visible in the South if you look at the right time.
      ii. Now move to Stockholm at latitude 59 degrees north. Where is Polaris now? Is Canopus visible?
      iii. Now move to Mumbai at latitude 19 degrees north. Where is Polaris? Is Canopus visible, and does it get up higher in the sky than in Rome? Note that new stars are visible (such as Rigil Kentaurus, or Alpha Centauri).
      iv. Now try Rio de Janeiro. Where is Polaris? Is there a bright star at the south celestial pole? Show Magellanic Clouds.
   (b) The sun
      i. Use Gnomon simulation, look at local noon altitude vs. day. Show Rome (lat 34 N) first. Varies by 23.5 degrees about 56 degrees.
      ii. Now go to lat 59 N and repeat. Varies by 23.5 degrees about 31 degrees. Note how low the sun is on the winter solstice! Variation of hours of daylight becomes more extreme (4 hours on WS, 17 hours on SS).
      iii. What happens at 66.5 degrees N? (Arctic Circle) On WS the sun never rises. On SS the sun never sets.
      iv. What happens at the North Pole? Sun circles the sky for 6 months (spiraling up and then down) during summer, then disappears for 6 months during winter.
      v. What happens at 23.5 degrees N? (Tropic of Cancer) Sun is directly overhead on SS.
      vi. Likewise the southern hemisphere has the Tropic of Capricorn at 23.5 degrees S and Antarctic Circle at 66.5 degrees S.
   (c) Modeling these changes

i. All of these changes indicate that as we move north or south the celestial sphere appears to rotate in the opposite direction (south or north).

ii. This behavior makes sense if the Earth's surface is curved in a north-south direction. Moving north or south then changes our ORIENTATION relative to the celestial sphere. Show Earth and Stars model, as well as Celestial Globe model to show how Sun is affected.

iii. The Ancient Greeks used this evidence and more (ships disappear hull first over the horizon, the Earth's shadow in a lunar eclipses always appears circular, etc) to conclude that the Earth has a spherical shape.

3. A matter of time: moving East and West

- In Stellarium find local noon time in Rome. Then find local noon in Savannah. Why are they different?
- Local astronomical time differs for observers at different longitudes.
- LOCAL astronomical events (local noon, star transits, etc) happen at the same local astronomical time for different observers, but these events do not happen at the same time on a universal clock.
- GLOBAL astronomical events (lunar eclipses, etc) happen at earlier times for observers farther West, but happen at the same time on a universal clock.
- Why don't we use a universal clock? (do you want the sun up high in the sky at midnight?)
- Why don't we use local astronomical time? (for millenia that was what people did, but railroads and telegraph systems created a need for a more uniform, but not COMPLETELY uniform, time system - thus time zones were created)
- Don't ask me about daylight savings time - I can't explain that!

4. Questions and conversation.