

ASTR 120 Problem Set 2: Due Tuesday, September 12, 2017

General reminders: You must show all your work to get full credit. Also, if any website was useful, you need to give the URL in your answer. Note that any website is fair game; you just have to cite it. If any book including our textbook was useful, you need to indicate where in the textbook you used a particular fact. This will be true in all homeworks.

1. [5 points] You know that the Sun appears to rise in the east.
 - a. Suppose that a planet in a different stellar system spins in the same direction it orbits; we will call that direction west to east. The planet goes around its star once per 3 Earth years, and rotates once per 7 Earth hours. For an inhabitant of that planet, in what direction does that planet's star appear to rise?
 - b. A different planet around that same star is much closer; it orbits and rotates in the same direction as the first planet, but the orbit around the star is once per 4 Earth days, and its rotation is once per 6 Earth days. In what direction does the star appear to rise as seen from that second planet?
2. [5 points] "But I am constant as the northern star, of whose true-fixed and resting quality there is no fellow in the firmament." Shakespeare put those words in the mouth of Julius Caesar, shortly before Caesar was assassinated in 44 BC; he meant that the north star doesn't appear to move, unlike other easily visible stars. Suppose that Polaris (the "northern star" in the quote above) is currently exactly in the direction of the North Pole (it's actually about 0.75° away), and that precession of the equinoxes causes the direction of Earth's rotation to move in a circle of angular radius 23.5° , with a full cycle happening every 26,000 years. Calculate the angular distance that Polaris was from due north in 44 BC. Compare that angular distance with the size of your hand at arm's length (and show your calculation). How would you rate Shakespeare's astronomical knowledge?
3. [5 points] We learned that an arcsecond is $1/60$ of an arcminute, which is $1/60$ of a degree. With that in mind:
 - a. Calculate the number of *square* arcseconds there are in the full sky. To do this, first recall how many steradians there are in a sphere, and then proceed with your calculation.
 - b. Suppose that, as a round number, there are roughly 100 billion moderate- to large-sized galaxies in the universe. Divide the number of square arcseconds by the number of galaxies to determine how many square arcseconds are there per galaxy. The answer to this question has bearing on how accurately you have to determine the direction to a source to be sure that you have correctly identified its host galaxy.

4. [5 points] Look up the physical diameter of the Moon and Sun, in kilometers, and their closest and farthest distances from the Earth. Using this information:

- a. Derive the largest possible angular diameter of the Moon as seen from the Earth.
- b. Derive the smallest possible angular diameter of the Sun as seen from the Earth.
- c. Using your answers to a. and b., derive the longest possible duration of a total solar eclipse, given that a synodic month is about 29 days. **Important note:** this calculation will give you the longest possible duration of an eclipse *if the Earth were not rotating*. You can look up the longest possible duration of an eclipse as seen by an observer rotating with the Earth, to compare with your answer and give an idea of how important the Earth's rotation is in determining eclipse durations.

5. [5 points] In class we did a calculation to compare the flux range caused by changing distance from the Sun, with the flux range caused by the tilt of the Earth.

- a. Do the same calculation for a point on the equator of the Earth.
- b. Do the same calculation for a point at 40 degrees north latitude (about College Park's latitude) on Mars. To do this you will need to look up the eccentricity of Mars' orbit as well as the tilt of its rotational axis to its orbital plane. Please give the URL of the webpage you used to find this information.

As always, you need to show all your work.

Bonus Question [2 points]

Astronomers often roll their eyes when people confuse them with astrologers. Indeed, astrology has some inherent contradictions. To explore one of them, do Web research (and, as always, list the URLs for the pages you used):

- a. Determine the dates the Sun is in Leo according to astrology, do the same for Virgo, and so on for the twelve Zodiacal signs.
- b. Determine which official constellations the Sun is actually in as a function of date in the year. Why is there a difference?