Homework #1: Scale of the Universe and Sky Motions

ASTR/PHYS 1060, The Universe, Dan Wik

Due Tuesday, Sept. 5th at the beginning of class

Instructions

Complete on a separate piece of paper, answering in complete sentences, and showing all work (math calculations) clearly. Working with others is permitted, but all work must be your own.

Part I. Astronomical Scales

The Universe turns out to be a pretty big place. To comprehend the large distances involved, we need to use different units than the conventional miles and kilometers. For example:

- within the Solar System, a convenient unit of measurement is the average Earth-Sun distance, called an astronomical unit (AU).
- For bigger distances, we use the light year (LY), the distance that light travels in one year. We can also measure distances in light minutes and light seconds (see Fig. 1.2 in your book).

To get a better sense of the scale of the Universe, we will look at the time it would take to travel to the nearest star using current spacecraft.

Voyager 1 is the most distant man-made object. It is currently located at the edge of our solar system, about 33 light hours away from Earth. It is also one of the fastest man made objects. Voyager 1 is traveling about 60× faster than an airplane, meaning it travels the distance a plane travels in an hour (about 600 miles) in one minute.

Question 1) Light takes 8.3 minutes to travel from the Sun to the Earth. How many times farther away from the Sun is Voyager 1 than is the Earth from the Sun? (Note that this number is by definition Voyager 1's distance in AU.)

Question 2) Voyager 1 was launched in 1977. Assuming it has been traveling at the same speed ever since, calculate how many light hours Voyager 1 travels in one year.

Question 3) The nearest star to our own is Proxima Centauri at 4.2 light years away. If Voyager 1 was headed in the direction of Proxima Centauri, how many years would it take to reach it (hint: use your answer to Q2)? Comment on the feasibility of traveling to nearby stars at the speeds of our current spacecraft.

Question 4) Radio waves travel at the speed of light. How long would it take (assuming a negligible response time) to send a radio message to Voyager 1 and receive its reply after it reached Proxima Centauri?

Question 5) All of the stars that you see in the night sky live in our own Milky Way Galaxy. The most distant ones visible to your naked eye are about 1000 LY away. Copy the cartoon Milky Way below to your paper, and then draw a circle on it representing the region you can see.

Milky Way Galaxy: 10^5 LY side to side

Position of Our Solar System
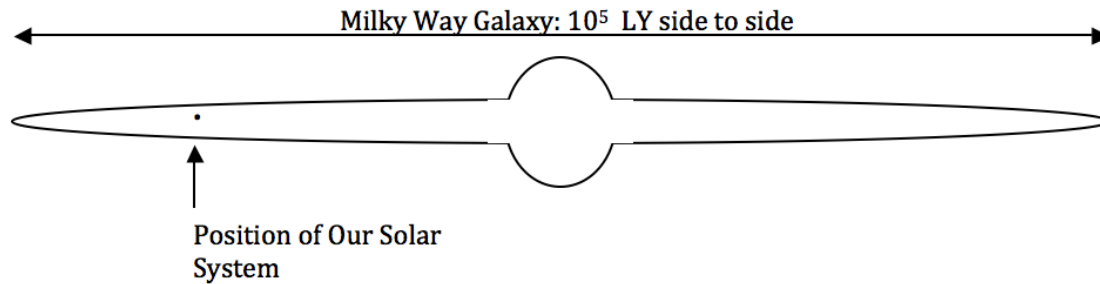
Part II: Patterns in the Sky

Question 6A) Salt Lake City has streets that run perfectly East-West. You might notice traffic in the morning and evening is worse on these streets within a few weeks of the equinoxes: explain why [use complete sentences].

Question 6B) Based on your answer to 6A, if you work in the city during the day, would you rather live east or west of the city?

Question 7) You can often make out the unlit portion of the moon during crescent phases near new moon. This is because of a phenonmenon called earthshine, where sunlight reflects off Earth, then reflects off the moon and comes to your eye. Draw a picture of the Sun, Moon, and Earth during the crescent phase and draw the path this light takes to come to you.

Question 8) A future excursion suggestion: there will be an annular solar eclipse in Utah sometime in the coming years. Explore the webpage and links from:

http://eclipse.gsfc.nasa.gov

to figure out: **A)** on what day will it be, **B)** near what city in Utah you could go to see it, and **C)** at roughly what time of day you would see the solar eclipse there.