September 17, 2004 Name:_____

Astronomy 102: Stars and Galaxies

Examination 1

Do not open the test until instructed to begin.

Instructions: Write your answers in the space provided. If you need additional space, continue on the back of each page, but indicate **clearly** that you have done so. No books, notes, or assistance from anyone is allowed. You are allowed to use, and will need, a calculator. Please **write legibly and be brief and to the point!** The exam has seven questions; each question has equal weight.

Possibly Useful Constants and Formulae

Right Ascension: North-South

Declination: East-West

Tilt of the Earth's Axis: 23.5°

Radius of the Sun: 6.96×10^5 km

Distance from the Sun to the Earth: 1.000 AU

Latitude of Nashville: 36°

Radius of the Milky Way's Disk: 30,000 pc

Distance to the Andromeda Galaxy: 800, 000 pc

$$A = \frac{h}{d} \quad (A \text{ in radians, } h \text{ and } d \text{ in the same units})$$

$$d = \frac{1}{p} \quad (d \text{ in parsecs, } p \text{ in arcseconds})$$

$$1\,\text{pc} = 206,265 \text{ AU}$$

$$1\,\text{AU} = 1.496 \times 10^{11}\,\text{m}$$

$$1\,\text{km} = 1,000\,\text{m}$$

$$\pi \text{ radians} = 180°$$

$$206,265'' = 1 \text{ radian}$$

$$60'' = 1' \qquad 60' = 1°$$

1. After volunteering for a reality TV show where you're supposed to find your way home from a random spot on Earth, you wake up on a desert island with no clue where you are. You foolishly have not yet done the *Constellations and Bright Stars* lab, so you can't use knowledge of the constellations to help you figure out where you are. However, you do notice that you find a spot above the on the sky above the horizon about which, over the course of the night, you see stars rotating *counter-clockwise*.

In the middle of the next day, the Sun passes directly overhead.

What can you say about where you are on Earth and what time of year it is, if anything? Explain.

2. Are there any latitudes on Earth where, sometime during the year, the Sun never sets over the course of a day? If so, what latitudes are these, and approximately when does this happen? If not, what is the maximum number of hours of daylight that can be observed from Earth?

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3. You wake up on a desert island, but because you had the foresight to bring a GPS device with you, you know exactly where you are. You are somewhere in the Southern hemisphere, and regret only that you didn't also bring some food. Fortunately, you are able to distract yourself from your hunger by engaging in thoughts about Astronomy.

When night comes, you face in a given direction. You see a star rise, make a low arc across the sky, and set. It takes about three hours for the star to go from rising to setting.

(a) Draw your horizon and the arc that you see, indicating the direction of the star's motion as observed by you.

(b) What direction are you facing?

(c) What, if anything, can you say about the star's declination?

4. Standing in line in the supermarket, you read the cover story from a tabloid newspaper. It describes aliens that have been coming down to Earth to mutilate cattle and perform unsavory experiments on humans. These aliens, the story asserts, have been working from a base on the dark side of the Moon over the course of the last several years.

Ignoring the bit about aliens visiting Earth (which is implausible at best), are there any scientific problems with this story? If so, what are they?

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5. It is broad daylight, with the Sun as high in the sky as it will get during the current 24-hour period. You also see the full Moon in the sky.

(a) Does this ever happen in Nashville? If so, when? If not, why not?

(b) Does this ever happen anywhere on Earth? If so, where and when? If not, what would you have to change about the Moon's orbit to make it possible for this to be observed?

6. A common school project performed in elementary schools and planetariums is a scale model of the Solar System. In this, balls are made to scale to represent the different planets, and placed at distances from each other appropriate to their real distances given the scale of the model.

Suppose you decide that this has been done enough, and want to make a scale model of something related to stars and galaxies. You consider two choices. Either, you can make a scale model of the stars in the Solar neighborhood (say the closest 20 or so stars), or of the galaxies in the Local Group (the closest 20 or so galaxies).

Would one of these scale models be easier to make? If so, which scale model would be easier to make keeping all of the scales (relative distances between objects and relative sizes of objects) correct and the same? Explain your answer.

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7. Suppose you can measure angles to within $0.002''$. Suppose you were to move to Pluto (40 AU away from the Sun) and measure parallaxes from there (just kicking back and waiting the large number of years it takes to do it).

(a) What is the distance to the farthest object you can measure using parallax?

(b) How does this compare to the size of the Milky Way? Can you measure the distance to stars on the far side of the Milky Way using parallax?

(c) If you're in an orbit around the Sun, what is the minimum size of the orbit you'd need in order to measure the distance to the Andromeda Galaxy using the method of parallax?

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