September 12, 2004 Name:_____

Astronomy 102: Stars and Galaxies

Sample Review Examination 1

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 eight 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

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

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

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

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

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

$$\pi \text{ radians} = 180°$$

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

$$60'' = 1' \qquad 60' = 1°$$

REVIEW How far off of the Southern horizon is the Sun at noon on December 22 as observed by somebody at a latitude of 23.5° north?

REVIEW You are in Nashville, facing the due western horizon. Draw the horizon, and draw a compass rose on the sky indicating which way is North, South, East, and West *on the sky* just over the horizon.

REVIEW The moon is at first quarter phase. You look outside, and see it 45° above your western horizon. Is the moon rising or setting? Approximately what time is it?

REVIEW Suppose you were at an art exhibit and saw the drawing below, featuring a crescent moon in a night sky over the horizon.

For purposes of this problem, ignore all offense to your artistic sensibilities, and consider only offense to your astronomical sensibilities.

Is this picture realistic? If so, what time of day must it be? If not, what is the (astronomical) problem with the picture?

REVIEW You embark from Earth on an inergalactic cruise.

(a) You pass Pluto. Are you an appreciable fraction of the way to the nearest star, Alpha Centauri? If not, explain. If so, very roughly what is that fraction?

(b) You pass Alpha Centauri. Are you an appreciable fraction of the way to the edge of the galaxy? If not, explain. If so, very roughly what is that fraction?

(c) You pass the edge of the Galaxy's disk. Are you an appreciable fraction of the way to the Andromeda galaxy? If not, explain. If so, very roughly what is that fraction?

REVIEW One of the largest known stars is Betelgeuse in the constellation of Orion. We have measured its distance to be 650 light-years. Astronomers have also determined that its diameter is 500 times larger than that of the Sun. Determine the apparent angular diameter of Betelgeuse (in arcseconds) as seen from the Earth.

REVIEW

(a) The Virgo cluster approximately 30 giant galaxies (i.e. galaxies like the Milky Way, in contrast to dwarf galaxies) packed in a sphere of diameter 3 Mpc (where 1 Mpc=10^6 pc). If each giant galaxy masses $10^{12}\,M_\odot$, what is the mass density in the core of the Virgo cluster (in units of $M_\odot/pc^3$)?

(b) There are 23 stars within 3.5 pc of the Sun, with an average mass of about $0.6\,M_\odot$. What is the mass density in the Solar neighborhood (in units of $M_\odot/pc^3$).

(c) Does anything strike you as odd about the comparison of (a) and (b), given what we've discussed previously about the size:distance ratios for stars and galaxies? How can you reconcile this oddness, if it exists? (Hint: consider an analogy which uses the words "cottonball" and "bullet".) (Hint 2: just because this question suggests uses of "cottonball" and "bullet" does not necessarily mean that you will profit from using those words on one of the questions on the actual exam!)

REVIEW Suppose you are desigining a project for Astronomy 222, Observational Astronomy. You want to measure the distance to a near-earth asteroid using parallax. You have two small small telescopes you can use, one at Dyer Observatory (in Nashville) and one in Arizona. The two telescopes are 2000 km away from each other.

You take a simultaneous picture of the astroid from each telescope, and compare the position of the asteroid to background stars. This gives you the angular offset between the asteroid as seen from the two locations to a precision of $2''$.

(a) Draw a picture that shows what you've done above. Indicate on this picture what measurement is 2,000 km. Label with d the distance from the Eearth to the asteroid.

(b) What is the farthest an asteroid can be without being too far for you to measure its distance given the precision of your parallax measurement? (Hint: if you come up with an answer that is measured in parsecs or tenths of parsecs, you've done something very wrong.)

(c) How does your answer in (c) compare to the distance from the Earth to the Moon, and to 1 AU (the distance from the Earth to the Sun)?

(d) (Bonus.) Where do you want the asteroid to be in the sky as seen from the each observatory so as to make the best possible measurement? (I.e. near rising, near setting, directly overhead, a little east of overhead, or a little west of overhead?) (No, there won't be any "Bonus" questions on the actual test.)