

1. **Motion of the Brightest Stars.** (10 pts.) The 16 brightest stars that are visible from the northern hemisphere are Sirius, Arcturus, Vega, Capella, Procyon, Rigel, Betelgeuse, Altair, Aldebaran, Spica, Antares, Pollux, Fomalhaut, Deneb, Regulus, and Castor. Choose one of them, and find (1) (1 pt.) the coordinates of the star, (2) (2 pts.) the date on which it is visible on the meridian at sunset, and (3) (2 pts.) the date on which it is rising at sunset. The meridian is the great circle line that passes through the celestial pole and the zenith. Give the declination in degrees and the right ascension in hours and minutes. (4 pts.) Explain how you found the dates. For simplicity, assume that you are on the equator.

(When only one month is listed, it can be late the month before or early the month after, this range is due to varying definitions of sunset and the inaccuracy of using the celestial sphere to measure.)

Star	Part 1	Part 2	Part 3
Sirius	6h 45min, -17 deg	April	January
Arcturus	14h 15min, 20 deg	July	April
Vega	18h, 40min, 39 deg	October	July
Capella	5h 10min, 47 deg	March	December
Procyon	7h 35min, 6 deg	April	January
Rigel	5h 10min, -8 deg	March	December
Betelgeuse	5h 55min, 8 deg	March-April	December-January
Altair	19h 50min, 6 deg	October-November	July-August
Aldebaran	4h 35min, 16 deg	February-March	November-December
Spica	13h 25min, -11 deg	June	March
Antares	16h 30min, -26 deg	August-September	May-June
Pollux	7h 45min, 28 deg	April	January
Fomalhaut	22h 57min, -29 deg	December	September
Deneb	20h 41min, 45 deg	October-November	July-August
Regulus	10h 8min, 12 deg	May-June	February-March
Castor	7h 34min, 32 deg	April	January

For question 2, put the star on the meridian by turning earth. I assume you are in Michigan. Then move the sun until it is setting, which is toward California. Then read the date next to the sun.

Alternatively, you can calculate. If the star is on the meridian at sunset, the star is 6h ahead of the sun. That makes the sun's position

$$\text{R.A. of the star} - 6\text{h.}$$

The sun is at zero right ascension on Mar. 21. So, convert the sun's position from R.A. into time and add it to Mar. 21 to find the date.

For (3) you do basically the same thing, but now subtract 12h from the stars position. So your answer will be very close to 3 months before your answer to (2)

2. The coordinates of the center of the Milky Way galaxy are  $17^{\text{hr}}39^{\text{min}}$  right ascension and  $-29^{\circ}$  declination.

- a. (5 pts.) When is the best time of year to observe it? Explain how you can figure this out from knowing that the right ascension of the sun is  $0^{\text{hr}}0^{\text{min}}$  on the vernal equinox.

You want to observe for the longest part of the night, which means it rises at sunset and sets at sunrise. In the figure, left is 0hr. Therefore the galactic center (18hr) is up. On 6/21, the sun is setting when 18hr is rising.

- b. (2 pts.) Is it better to observe it from Michigan or from Chile in South America? Explain your reasoning.

It is better to observe in Chile. Because the declination is  $-29^\circ$ , it passes overhead at latitude  $-29^\circ$ , which is in Chile. In Michigan, at  $+44^\circ$  latitude, it is at best only  $17^\circ$  above the horizon.

3. **A mental model of the sky**, which we introduced in class.

- a. (5 pts.) A star rises at 8 pm. When does it rise two months from now? Explain how you deduced the answer.

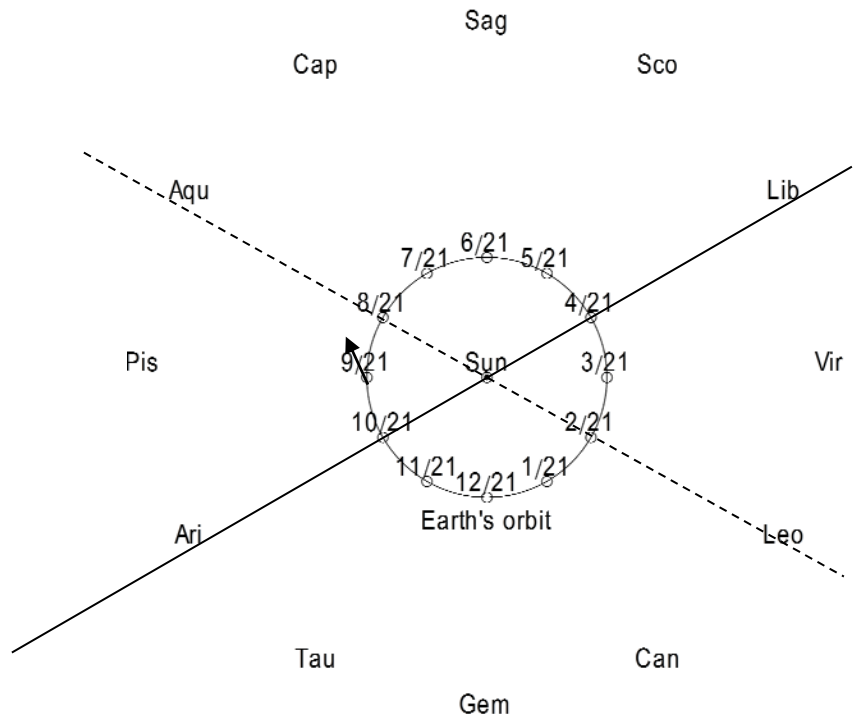
Today is close to 9/21. The arrow on the figure is you at 8pm, and the line is the horizon. (Note that because the constellations are many, many times as far from us as the sun, that to see what is somewhere in relation to the earth you have to shrink the earth's orbit essentially down to where the sun is.) The horizon turns counterclockwise with the earth. Therefore Aries is rising.

The dashed line is the horizon at noon on 11/21. (Aquarius is rising at noon.) Two hours later, Pisces is rising, and at 4pm, Aries is rising. (Every two hours, a new constellation of the zodiac is rising.)

Alternatively, you can reason this way: 2 months = 4 hours of right ascension. As time goes by, stars rise earlier. Therefore it will rise 4 hours sooner at 4pm.

- b. (5 pts.) Which constellation of the Zodiac is high in the sky at sunset tonight? Explain how you deduced the answer.

Today is nearest to 9/21. Draw the horizon, which runs from Pisces to Virgo. The sun is on the horizon. The upper half of the sky is visible. A little later, the horizon turns counterclockwise and the sun goes below the horizon. Therefore Sagittarius will be highest at sunrise.



(Note that if you said your sunset was at 8pm, then Cap would be high in the sky)