

OpenStax Astronomy, Ch.25: WS Problems (Apr-2021)

Review Questions

1. Explain why we see the Milky Way as a faint band of light stretching across the sky.
2. Explain where in a spiral galaxy you would expect to find globular clusters, molecular clouds, and atomic hydrogen.
3. Describe several characteristics that distinguish population I stars from population II stars.
4. Briefly describe the main parts of our Galaxy.
5. Describe the evidence indicating that a black hole may be at the center of our Galaxy.
6. Explain why the abundances of heavy elements in stars correlate with their positions in the Galaxy.
7. What will be the long-term future of our Galaxy?
8. Suppose the Milky Way was a band of light extending only halfway around the sky (that is, in a semicircle). What, then, would you conclude about the Sun's location in the Galaxy? Give your reasoning.
9. The globular clusters revolve around the Galaxy in highly elliptical orbits. Where would you expect the clusters to spend most of their time? (Think of Kepler's laws.) At any given time, would you expect most globular clusters to be moving at high or low speeds with respect to the center of the Galaxy? Why?
10. Shapley used the positions of globular clusters to determine the location of the galactic center. Could he have used open clusters? Why or why not?
11. Consider the following five kinds of objects: open cluster, giant molecular cloud, globular cluster, group of O and B stars, and planetary nebulae.
 - A. Which occur only in spiral arms?
 - B. Which occur only in the parts of the Galaxy other than the spiral arms?
 - C. Which are thought to be very young?
 - D. Which are thought to be very old?
 - E. Which have the hottest stars?
12. The dwarf galaxy in Sagittarius is the one closest to the Milky Way, yet it was discovered only in 1994. Can you think of a reason it was not discovered earlier? (Hint: Think about what else is in its constellation.)
13. Why does star formation occur primarily in the disk of the Galaxy?
14. Where in the Galaxy would you expect to find Type II supernovae, which are the explosions of massive stars that go through their lives very quickly? Where would you expect to find Type I supernovae, which involve the explosions of white dwarfs?
15. Assume that the Sun orbits the center of the Galaxy at a speed of 220 km/s and a distance of 26,000 light-years from the center.
 - A. Calculate the circumference of the Sun's orbit, assuming it to be approximately circular. (Remember that the circumference of a circle is given by $2\pi R$, where R is the radius of the circle. Be sure to use consistent units. The conversion from light-years to km/s can be found in an online calculator or appendix, or you can



calculate it for yourself: the speed of light is 300,000 km/s, and you can determine the number of seconds in a year.)

- B. Calculate the Sun's period, the "galactic year." Again, be careful with the units. Does it agree with the number we gave above?

16. If our solar system is 4.6 billion years old, how many galactic years has planet Earth been around?

17. The best evidence for a black hole at the center of the Galaxy also comes from the application of Kepler's third law. Suppose a star at a distance of 20 light-hours from the center of the Galaxy has an orbital speed of 6200 km/s. How much mass must be located inside its orbit?

18. The next step in deciding whether the object in Question 17 is a black hole is to estimate the density of this mass. Assume that all of the mass is spread uniformly throughout a sphere with a radius of 20 light-hours. What is the density in kg/km^3 ?

$$V = \frac{4}{3}\pi R^3$$

(Remember that the volume of a sphere is given by $V = \frac{4}{3}\pi R^3$.) Explain why the density might be even higher than the value you have calculated. How does this density compare with that of the Sun or other objects we have talked about in this book?