

OpenStax Astronomy, Ch.28: WS Problems (Apr-2021)

Review Questions

1. How are distant (young) galaxies different from the galaxies that we see in the universe today?
2. What is the evidence that star formation began when the universe was only a few hundred million years old?
3. Describe the evolution of an elliptical galaxy. How does the evolution of a spiral galaxy differ from that of an elliptical?
4. Explain what we mean when we call the universe homogeneous and isotropic. Would you say that the distribution of elephants on Earth is homogeneous and isotropic? Why?
5. Describe the organization of galaxies into groupings, from the Local Group to superclusters.
6. What is the evidence that a large fraction of the matter in the universe is invisible?
7. When astronomers make maps of the structure of the universe on the largest scales, how do they find the superclusters of galaxies to be arranged?
8. Describe how you might use the color of a galaxy to determine something about what kinds of stars it contains.
9. Given the ideas presented here about how galaxies form, would you expect to find a giant elliptical galaxy in the Local Group? Why or why not? Is there in fact a giant elliptical in the Local Group?
10. Can an elliptical galaxy evolve into a spiral? Explain your answer. Can a spiral turn into an elliptical? How?
11. Suppose you are standing in the center of a large, densely populated city that is exactly circular, surrounded by a ring of suburbs with lower-density population, surrounded in turn by a ring of farmland. From this specific location, would you say the population distribution is isotropic? Homogeneous?
12. Astronomers have been making maps by observing a slice of the universe and seeing where the galaxies lie within that slice. If the universe is isotropic and homogeneous, why do they need more than one slice? Suppose they now want to make each slice extend farther into the universe. What do they need to do?
13. Galaxies are found in the “walls” of huge voids; very few galaxies are found in the voids themselves. The text says that the structure of filaments and voids has been present in the universe since shortly after the expansion began 13.8 billion years ago. In science, we always have to check to see whether some conclusion is contradicted by any other information we have. In this case, we can ask whether the voids would have filled up with galaxies in roughly 14 billion years. Observations show that in addition to the motion associated with the expansion of the universe, the galaxies in the walls of the voids are moving in random directions at typical speeds of 300 km/s. At least some of them will be moving into the voids. How far into the void will a galaxy move in 14 billion years? Is it a reasonable hypothesis that the voids have existed for 14 billion years?
14. Assume that dark matter is uniformly distributed throughout the Milky Way, not just in the outer halo but also throughout the bulge and in the disk, where the solar system lives. How much dark matter would you expect there to be inside the solar system? Would you expect that to be easily detectable? Hint: For the radius of the Milky Way's



dark matter halo, use $R = 300,000$ light-years; for the solar system's radius, use 100 AU; and start by calculating the ratio of the two volumes.

15. The first objects to collapse gravitationally after the Big Bang might have been globular cluster-size galaxy pieces, with masses around 10^6 solar masses. Suppose you merge two of those together, then merge two larger pieces together, and so on, Lego-style, until you reach a Milky Way mass, about 10^{12} solar masses. How many merger generations would that take, and how many original pieces? (Hint: Think in powers of 2.)