

OpenStax Astronomy, Ch.29: WS Problems (Apr-2021)

Review Questions

1. What are the basic observations about the universe that any theory of cosmology must explain?
2. Describe some possible futures for the universe that scientists have come up with. What property of the universe determines which of these possibilities is the correct one?
3. What does the term Hubble time mean in cosmology, and what is the current best calculation for the Hubble time?
4. Which formed first: hydrogen nuclei or hydrogen atoms? Explain the sequence of events that led to each.
5. Describe at least two characteristics of the universe that are explained by the standard Big Bang model.
6. Describe two properties of the universe that are not explained by the standard Big Bang model (without inflation). How does inflation explain these two properties?
7. Why do astronomers believe there must be dark matter that is not in the form of atoms with protons and neutrons?
8. What is dark energy and what evidence do astronomers have that it is an important component of the universe?
9. Thinking about the ideas of space and time in Einstein's general theory of relativity, how do we explain the fact that all galaxies outside our Local Group show a redshift?
10. Astronomers have found that there is more helium in the universe than stars could have made in the 13.8 billion years that the universe has been in existence. How does the Big Bang scenario solve this problem?
11. Describe the anthropic principle. What are some properties of the universe that make it "ready" to have life forms like you in it?
12. Describe the evidence that the expansion of the universe is accelerating.
13. Suppose the universe expands forever. Describe what will become of the radiation from the primeval fireball. What will the future evolution of galaxies be like? Could life as we know it survive forever in such a universe? Why?
14. Some theorists expected that observations would show that the density of matter in the universe is just equal to the critical density. Do the current observations support this hypothesis?
15. There are a variety of ways of estimating the ages of various objects in the universe. Describe two of these ways, and indicate how well they agree with one another and with the age of the universe itself as estimated by its expansion.
16. Since the time of Copernicus, each revolution in astronomy has moved humans farther from the center of the universe. Now it appears that we may not even be made of the most common form of matter. Trace the changes in scientific thought about the central nature of Earth, the Sun, and our Galaxy on a cosmic scale. Explain how the notion that most of the universe is made of dark matter continues this "Copernican tradition."

17. The anthropic principle suggests that in some sense we are observing a special kind of universe; if the universe were different, we could never have come to exist. Comment on how this fits with the Copernican tradition described in Exercise 19.

18. Penzias and Wilson's discovery of the Cosmic Microwave Background (CMB) is a nice example of scientific *serendipity*—something that is found by chance but turns out to have a positive outcome. What were they looking for and what did they discover?

19. It is possible to derive the age of the universe given the value of the Hubble constant and the distance to a galaxy, again with the assumption that the value of the Hubble constant has not changed since the Big Bang. Consider a galaxy at a distance of 400 million light-years receding from us at a velocity, v . If the Hubble constant is 20 km/s per million light-years, what is its velocity? How long ago was that galaxy right next door to our own Galaxy if it has always been receding at its present rate? Express your answer in years. Since the universe began when all galaxies were very close together, this number is a rough estimate for the age of the universe.