

HOMEWORK 6

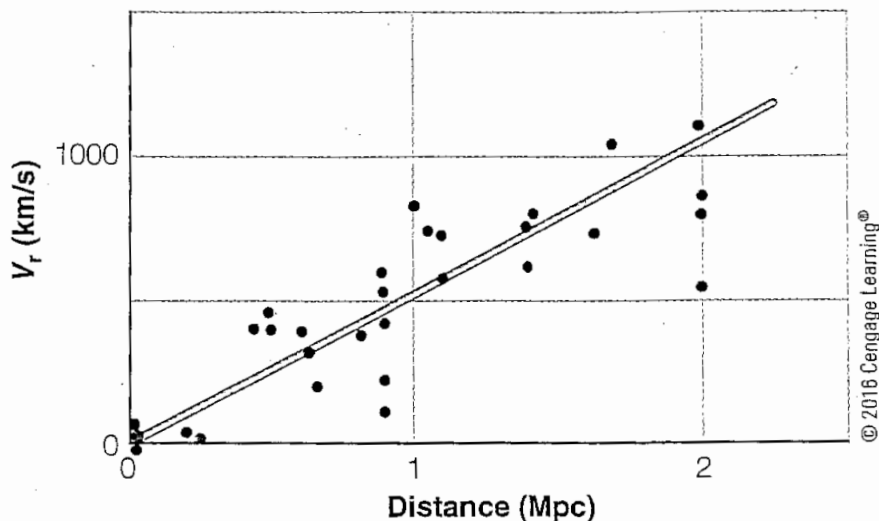
Due Thursday, December 3

Answer all questions from Part A and 1 from Part B.

Part A

- A1. Astronomers of the eighteenth and nineteenth centuries thought that the Sun was near the center of the Milky Way Galaxy since they counted the same number of stars in the disk of the Galaxy in every direction.
- The reason they were not correct is the Galaxy
- is an irregular galaxy with a chaotic shape.
 - contains dust that obscures its distant regions.
 - has the shape of a tube with the Sun near one end.
 - has two kinds of Cepheid variables, so that all distance measurements until recently were incorrect.
 - has a giant black hole at its center.
- A2. An important relation observed for Cepheid variables is that between
- mass and luminosity.
 - luminosity and temperature.
 - period and luminosity.
 - period and radius.
 - mass and temperature.
- A3. Cepheid variable stars are important to astronomy primarily because they allow us to determine stellar
- distance.
 - mass.
 - temperature.
 - pulsation period.
 - chemical composition.
- A4. If the Sun is 5 billion years old, how many times has it orbited the galaxy? Show working.
- A5. Cepheids with a period of 10 days are seen in Galaxy X. Cepheids with a period of 100 days are seen in Galaxy Y. The former are observed to be brighter than the latter. Which galaxy is closer to us? Briefly justify your answer.
- A6. Elliptical galaxies
- have more gas and dust than spirals.
 - have about the same fraction of gas and dust as spirals.
 - have much less gas and dust than spirals.
 - have a fraction of gas and dust that depends on the subclass, with E0 having more than the Galaxy, E7 less.
 - have a fraction of gas and dust that depends on the subclass, with E7 having more than the Galaxy, E0 less.
- A7. As we proceed from Sa to Sc spirals, the arms
- open up and the bulges become smaller.
 - close and the bulges become smaller.
 - open up and the bulges become larger.
 - close up and the bulges become larger.
- A8. Why are Type II supernovae never seen in elliptical galaxies?

- A9. Which of the following is the complete statement of the Cosmological Principle?
- The Universe appears the same to all observers at all times.
 - On a large scale the Universe appears the same to all observers at a given time.
 - The appearance of the Universe depends on the direction of observation.
 - The distribution of matter is uniform, but the appearance depends on the direction of observation.
 - The Universe is unchanging throughout time.
- A10. If a distant galaxy has a redshift corresponding to an expansion velocity of 6000 km/sec, what is its distance? Assume the Hubble constant is 50 km/sec/Mpc. Show all working.
- A11. Most the helium in the Sun's atmosphere was made in
- other stars
 - the Sun itself
 - the central black hole of the Galaxy
 - the Big Bang
- A12. An argument against the evolution of galaxies from spiral to elliptical is the fact that
- both types of galaxies show current star formation.
 - neither type of galaxy shows current star formation.
 - both types of galaxies contain equally old stars (10^{10} years.)
 - the oldest stars in elliptical galaxies are much older than the oldest stars in spiral galaxies.
- A13. Since quasars are at great distances with the light taking a long time to reach us, we are observing _____ objects (relative to the birth of the Universe.)
- old
 - young
 - medium age
 - dying
 - no statement concerning age may be made.
- A14. What is a Seyfert galaxy?
- A15. Hubble's first determination of what is now called the Hubble constant was too high because the calibration of Cepheid variables he used was not very good. Use his original diagram (Fig. 16-5, shown here) to estimate his first determination of the constant.



- A16. Suppose you found a spiral galaxy in which the outermost stars have orbital velocities of 150 km/s. If the radius of the galaxy is 4.0 kpc, what is the orbital period of those stars? ($1\text{ pc} = 3.1 \times 10^{13}\text{ km}$ and $1\text{ yr} = 3.2 \times 10^7\text{ seconds}$.)

Part B

- B1. a. Explain how Hubble's Law, $V = H_0 r$, is established from observations of galaxies. You are expected to discuss how the radial velocities V and the distances r are measured.
 b. All galaxies are receding from us. Does Hubble's Law then imply that our Galaxy is in a special position from which all other galaxies are fleeing? Discuss your choice of 'yes' or 'no'.
 c. If the Hubble constant were shown conclusively to be $H_0 = 200\text{ km/sec/Mpc}$, then much of what we understand of the age stars, especially of globular cluster, must be wrong. Explain why.
- B2. a. How did Shapley locate the center of the galaxy and determine our distance from it?
 b. Describe clearly *why* open clusters and globular clusters are distributed differently over the sky, i.e., what do the different distributions suggest about the history of the Galaxy?
 c. Imagine that the Sun were located in the center of the Galaxy. How would globular and open clusters then be distributed in the sky?
- B3. a. Explain the significance of Henrietta Leavitt's discovery about the brightness of Cepheid variable in the Magellanic Clouds for their use in the measurement of astronomical distances.
 b. Name and describe fully a method used to obtain distances to galaxies beyond the point at which individual stars such as Cepheids and supergiants are resolvable.
 d. Discuss how the Hubble Space Telescope revolutionized the use of Cepheid variables in determining distances to far away galaxies.
- B4. a. Describe Hubble's scheme for the classification of galaxies, E, S, SB. Include a discussion of the difference between E0 and E7 galaxies, and Sa, Sb, and Sc galaxies.
 b. Why is Hubble's 'tuning fork' diagram not thought to be an evolutionary sequence for galaxies?
- B5. a. What is the difference between the cosmological principle and the perfect cosmological principle?
 b. What is a fundamental difference between model universes built upon the cosmological principle and those built upon the perfect cosmological principle?
 c. Explain clearly why the age of an expanding evolutionary universe is inversely proportional to the Hubble constant, H_0 , i.e., $t \propto 1/H_0$.
- B6. a. What are quasars? What observations suggested that they were very luminous objects at great distances?
 b. Why do the rapid fluctuations in luminosity of a QSO indicate that the energy source must be a small object?
 c. What evidence is there that QSOs may be nuclei of galaxies?