

TEST #2
Apr 22, 2021

1. Among his other achievements, Harlow Shapley is celebrated because he demonstrated that we are *not* in the center of the Milky Way. How did he do that?
2. Globular clusters shaped our understanding of the universe, and especially its age, in many ways.
 - (a) What are globular clusters and where do we find them?
 - (b) How do we determine their age by using the H-R diagram?
 - (c) How old are the oldest globular clusters?
 - (d) What are some of the uncertainties in determining their ages?
3. Henrietta Leavitt's work on Cepheids allowed for a true paradigm shift in modern day astronomy. Explain what her contribution was (i.e. what empirical relationship did she observe), what was the immediate consequence in relation to measuring distances, and why astronomers got it wrong first before finally getting it right?
4. The main underlying principle in modern cosmology is the cosmological principle.
 - (a) What three assumptions underlie the cosmological principle?
 - (b) What implication does the cosmological principle have on the origin of the observed recession of galaxies as described by Hubble's law?
 - (c) How do we go from Hubble's law to the age of the universe?
 - (d) How can we make sense of the fact that we live in a finite, young universe that has no center and no edge?
5. Betelgeuse is a red supergiant in the Orion constellation. Let's figure out some basic properties of this star.
 - a) Read off absolute magnitude for Betelgeuse and convert it to luminosity (expressed in solar luminosity, i.e. L/L_{\odot}).
 - b) What is the mass of Betelgeuse (expressed in solar mass)?
 - c) How far is Betelgeuse if its apparent magnitude is 0.58?
 - d) The surface temperature of Betelgeuse is around 3500 K. What is its radius?

Absolute magnitude of the Sun is 4.83 and its surface temperature is 5772 K.

6. White dwarfs have been used to determine one of the lower limits for the age of the Universe. What unique property do white dwarfs possess that allows us to determine their ages quite reliably? How did we figure out what is the *oldest* white dwarf out there? What is the age of the oldest white dwarf? How would your answer differ if the universe were significantly older or significantly younger?

