ASTRONOMY 150: HOMEWORK 2 - SAM HEMANN

29. To know certain properties of a star, you must first determine the star's distance. For other properties, knowledge of distance is not necessary. Into which of these two categories would you place each of the following properties: size, mass, temperature, color, spectral type, and chemical composition? In each case, state your reason(s).

None of these properties require us to know the distance to the star:

Chemical composoition - We can look at a star's absorbtion and emission spectrums to determine the makeup

Color - measuring the brightness of the star through red, blue, and green filters allows us to measure color.

Temperature - this can be determined from the color via Wien's law or measurments of the spectral lines

Size - the luminosity and temperature of a star can be used with Boltzmann's law, where energy is relative to the surface area

Mass - for binary systems, we can use kepler's law once we observe the center of mass between the two stars, since the stars rotate around each other in a eliptical fashion. If we can't detect a center of mass we can look at the redshift and blushift of binary systems to derive the mass from the orbital period.

31. In the constellation Cygnus, Albireo is a visual binary system whose two components can be seen easily with even a small, amateur telescope. Viewers describe the brighter star as "golden" and the fainter one as "sapphire blue".

a. What does this description tell you about the relative temperatures of the two stars?

It suggests the brighter, golden star is cooler than the dimmer, sapphires star. This is because of the of the blackbody radiation of the stars, where more energy emmitted yields a more blueish light.

b. What does it tell you about their respective sizes?

The golden star is likely much larger than the sapphire one, because hotter stars emit more energy. Since the cooler, golden star is emmiting more light, it must have a lot more surface area than the sapphire star to appear brighter.

32. Very cool stars have temperatures around 2500 K and emit Planck spectra with peak wavelengths in the red part of the spectrum. Do these stars emit any blue light? Explain your answer.

Yes, although much less than yellow and red light. This is due to the blackbody curves of a star around 2500K increasing in brightness as the wavelength of light is longer.

36. binary system has been determined, it can be assumed that all other stars of the same spectral type and luminosity class have the same mass. Why is this a safe assumption?

All stars are essentially massive fusion reactors adhering strictly to the same laws of physics. Since the spectral type and luminosity are directly related to the results of nuclear reactions, we can assume stars that share these properties are similar in mass.

38. Very old stars often have very few heavy elements, while very young stars have much more. What does this difference imply about the chemical evolution of the universe?

It certainly suggests a big-bang start to the universe, where only hydrogen and helium existed. As stars fused these into heavier atoms and dispersed them when dying, the overall ratio of heavier elements in the universe increased.

51. Rigel (also in Orion) has a Hipparcos parallax of 0.00412 arcsec. Given that Betelgeuse and Rigel appear equally bright in the sky, which star is actually more luminous? Knowing that Betelgeuse appears reddish while Rigel appears bluish white, which star would you say is larger and why? [Betelgeuse has a paralax of 0.00763+-0.000164 arcsec]

$$d_{Rigel}\ \alpha\ \frac{1}{p} = \frac{1}{0.00412\ arcsec} = 242.718\ pc = 791.640\ ly \tag{1}$$

$$d_{Betelgeuse}\ \alpha\ \frac{1}{p} = \frac{1}{\approx 0.00763\ arcsec} \approx 118\ pc \approx 385\ ly \tag{2}$$

Because Rigel is about twice as far away, it's luminosity is cut in half (by the inverse squared law), so it must be twice as bright as Betelgeuse for the two stars to appear the same to us. Given that it is also hotter (bluer), their sizes may be pretty similar, since Rigel emits more light relative to its surface area.