

# Astronomy 2115

Fall 2023

# Homework #1

Due Thursday, Aug. 31 at beginning of class

For full credit you must write your solutions neatly and include all work. Do not forget the units on every quantity that has them. Be sure to do all 12 problems.

1) The diameter of the Sun is  $1.4 \times 10^{11}$  cm, and the distance to the closest star, Proxima Centauri, is 4.2 ly. Suppose you want to build an exact scale model of the Sun and Proxima Centauri, and you are using a ball 30 cm in diameter to represent the Sun. In your scale model, how far away would Proxima Centauri be from the Sun in km?

2) The Sun's mass is  $1.99 \times 10^{30}$  kg, three quarters of which is hydrogen. How many hydrogen atoms does the Sun contain?

3) The star Altair is 5.15 pc from Earth. (a) Give the distance to Altair in km; (b) How long does it take for light from Altair to reach Earth in years?

4) At what distance (in meters) would a person have to hold a 2-Euro coin (diameter 2.6 cm) in order for the coin to subtend an angle of (a) 1 degree; (b) 1 arcmin; (c) 1 arcsec?

5) The Orion nebula is about 30 ly across and is 1500 ly from Earth. Calculate its angular diameter in degrees and compare this to the angular diameter of the Moon.

6) Your cell phone works as both a radio transmitter and receiver. Say you receive a call at a frequency of 880.65 MHz. What is the wavelength in meters?

7) (a) What is a blackbody? (b) In what way is a blackbody black? (c) If a blackbody is black, how can it emit light? (d) If you were to shine a flashlight beam on a perfect black body, what would happen to the light?

8) The bright star Bellatrix in the constellation Orion has a surface temperature of 21,500 K. (a) What is its wavelength of maximum emission in nanometers? (b) What color is it?

9) The star Alpha Lupi (the brightest star in the Lobo constellation), has a surface temperature of 21,600 K. How much more energy is emitted each second from each square meter of Alpha Lupi compared to the Sun's surface?

10) The bright star Sirius in the constellation of Canis Major has a radius of  $1.67 R_{\text{sun}}$  and a luminosity of  $25 L_{\text{sun}}$ . (a) Use this information to calculate the energy flux at the surface of Sirius. (b) Use your answer in (a) to calculate the surface temperature of Sirius.

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11) Instruments on board balloons and spacecraft detect 511 keV photons coming from the Galactic Center (note  $1 \text{ keV} = 1000 \text{ eV}$ ). What is the wavelength of these photons and what part of the electromagnetic spectrum are they from?

12) The star cluster NGC 346 is located in the Small Magellenic Cloud (SMC), a small galaxy near our Milky Way Galaxy. The SMC is moving away from us at 158 km/s. At what wavelength does the red  $H\alpha$  line of hydrogen appear?

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