Physics 131: Survey of the Universe
Spring 2003-2004
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Homework assignment 3

Due in class at 12:30 p.m. Thursday, April 22. Please write your work and answers on a separate sheet of paper, with your name at the top and all pages stapled together.

1. Parts of the Electromagnetic Spectrum

(a) Give an example of a source of each of the following types of light: near infrared, x-ray, radio, optical, near ultraviolet, far infrared. (Hint: you may look through the textbook for ideas, but the example you give does not have have to be an astronomical source. You could use the relation $\lambda = 0.0029/T$ to find the necessary temperature and then find objects with that temperature.)

(b) Of the wavelength bands in part (a), which has the shortest *wavelength*?

2. Blackbody Spectrum

(a) If a star's peak emission is at a wavelength of 500 nm, what is the temperature of its photosphere?

(b) What is the frequency of that peak emission?

(c) What kind of radiation is that emission? (In other words, in which of the bands listed in problem 1a?) Can you see this light with your eyes?

3. Redshift or Blueshift?

Suppose a star *emits* most of its light at a wavelength of 600 nm and that we observe its light at a wavelength of 800 nm.

(a) At what velocity is the star moving? Give your answer as a fraction of the speed of light.

(b) Is the light *redshifted* or *blueshifted*? Explain your answer.

(c) Is the star moving *towards* us or *away* from us? How do you know?

4. Spectral Lines

(a) You observe a star that has surface temperature $T = 10^4$K. Between you and the star lies a cloud of gas with temperature $T = 100$K. Do you expect the star's spectrum to have *absorption* lines or *emission* lines. Explain why.

(b) A type II supernova (the explosive end state of a massive star) sends high-energy radiation into the surrounding interstellar gas. Do you expect to see *absorption* lines or *emission* lines in the spectrum of this gas? Explain why.

6. Turn up the heat! Temperature and luminosity

The Sun has a surface temperature of $T = 5800$K and luminosity of $L = 2 \times 10^33$ergs/s. What is the luminosity of a star that has the same size but a temperature of 2×10^4K?

5. Angular Resolution

(a) What is the smallest angle that you could resolve with a telescope that has a 1 meter mirror, observing at a wavelength of 500 nm? (ignore the effects of the atmosphere)

(b) If you use this same telescope to observe light at a wavelength of 750 nm, can you resolve smaller or larger angles? Why and by what factor?

(c) How does the angular size of the smallest observable details change if you could see the same objects with a 10 meter diameter telescope? (again, ignore the effects of the atmosphere)

(d) In reality, when we observe celestial objects from the surface of the Earth, their images are blurred by refraction in the atmosphere, which causes all images to be blurred on a scale of $\theta \sim 1$ arcsec. Answer problem (c) again, now *including* the effects of the atmosphere.