ed from Earth.) You
the star (by
be 3 pc. The distant
are wrong; the dis-
the problem?

2.16. How would parallax measurement improve if we could do our observations from Mars?

2.17. As we determine the astronomical unit more accurately, how does the relationship between the AU and the parsec change?

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e m = −1 and
is the ratio of
stars?
f the Sun is −26.8,
he Sun appear than
as m = −1?
odulus of the Sun?
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nergy fluxes, f and
e an approximate
de difference Δm
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(Hint: Use the
x ≪ 1.)
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e have three stars
d f_3, and we

wavelength being 501.00 nm and 510.00 nm. What do you conclude?

*2.10. (a) Use equation (2.9) to derive ν_{max}, the frequency at which $I(\nu, T)$ peaks. Convert this ν_{max} into a wavelength λ_{max}. (b) Use equation (2.10c) to find the wavelength at which it peaks. (c) How do the results in (a) and (b) compare?

2.11. For a 300 K blackbody, over what wavelength range would you expect the Rayleigh–Jeans law to be a good approximation?

2.12. Derive an approximation for the Planck function valid for high frequencies ($h\nu \gg kT$).

2.13. As we will see in Chapter 21, the universe is filled with blackbody radiation at a temperature of 2.7 K. (a) At what wavelength does the spectrum of that radiation peak? (b) What part of the electromagnetic spectrum is this?

2.14. (a) We observe the blackbody spectrum from a star to peak at 400 nm. What is the temperature of the star? (b) What about one that peaks at 450 nm?

2.15. Derive an expression for the shift $\Delta\lambda$ in the peak wavelength of the Planck function for a blackbody of temperature T, corresponding to a small shift in temperature, ΔT.

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2.16. Calculate the energy per square centimeter per second reaching the Earth from the Sun.

2.17. How does the absolute magnitude of a star vary with the size of the star (assuming the temperature stays constant)?

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art of the spec-
λ_2) with (ν_1
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and 500.10 nm.
ncy of equation

2.18. (a) What is the energy of a photon in the middle of the visible spectrum ($\lambda = 550$ nm)? (b) Approximately how many photons per second are emitted by (i) a 100 W light bulb, (ii) the Sun?

2.19. If we double the temperature of a blackbody, by how much must we decrease the surface

2.20. (a) How does the absolute bolometric magnitude vary with the temperature of a star (assuming the radius stays constant)? (b) Does the absolute visual magnitude vary in the same way?

*2.21. For a star of radius R, whose radiation follows a blackbody spectrum at temperature T, derive an expression for the bolometric correction.

2.22. Suppose we observe the intensity of a blackbody, I_0, in a narrow frequency range centered at ν_0. Find an expression for T, the temperature of the blackbody in terms of I_0 and ν_0. (a) First do it in the Rayleigh–Jeans limit and (b) in the general case.

*2.23. Suppose we receive light from a star for which the received energy flux is given by the function $f(\lambda)$. Suppose we observe the star through a filter for which the fraction of light transmitted is $t(\lambda)$. Derive an expression for the total energy detected from the star. (Hint: Start by thinking of the energy detected in a small wavelength range.)

2.24. What is the distance to a star whose parallax is 0.1 arc sec?

2.25. Derive an expression for the distance of an object as a function of the parallax angle seen by your eyes?

2.26. (a) If we can measure parallaxes as small as 0.1 arc sec, what is the greatest distance that can be measured using the method of trigonometric parallaxes? (b) By what factor will the volume of space over which we can measure parallax change if we can measure to 0.001 arc sec? (c) Why is the volume of space important?

2.27. If we lived on Mars instead of the Earth, how large would the parsec be?

2.28. Suppose we discover a planet orbiting a nearby star. The distance to the star is 3 pc. We observe the angular radius of the planet's orbit to be 0.1 arc sec. How many AU from the star is the planet? (Hint: You can solve this problem by "brute force", converting all the units. For an easier solution, think about what the answer would be if the star were 1 pc from us and the angular radius of the orbit were 1 arc sec, and then scale the result accordingly.)

2.29. Derive an expression for the distance to a star in terms of its distance modulus.

2.30. If we make a 0.05 magnitude error in measuring the apparent magnitude of a star, what error does that introduce in our distance determination (assuming its absolute magnitude is known exactly)?

Computer problems

2.1. Make a fourth column for Table 2.1, showing the range of photon frequencies for each part of the spectrum. Make a fifth column showing the range of photon energies for each part of the spectrum. Make a sixth column showing the temperatures that blackbodies would have to peak at the wavelengths corresponding to the boundaries between the parts of the spectrum

2.2. Make a graph of the magnitude difference $M_B - M_V$ as a function of temperature for a temperature range of 3000 K to 30 000 K. To simplify the calculation you may assume that magnitudes are determined in a narrow range of wavelengths around the peak of each filter.

2.3. For the Sun, plot the difference between the Rayleigh–Jeans approximation and the Planck formula, as a function of wavelength, for wavelengths in the visible part of the spectrum.

2.4. For the Sun, calculate the energy given off over the wavelength bands that correspond to the U, B and V filters. Use this to estimate the colors $U - B$ and $B - V$.