AST 840, Spring 2018

Stellar Astrophysics

Pre-class Assignment 0—Warm-up Problems

There are a number of small physics problems and facts that practicing astrophysicists should have at their fingertips. This assignment is a refresher on these topics and a warm-up for the course.

1. What are the ranges of photon energies (in units of eV) and wavelengths (in nm or Å) for the infrared, visible, UV, and X-ray bands?

2. How are magnitudes defined? What change in magnitude corresponds to a factor of 2 change in specific flux?

3. Which standard filter most closely resembles the response of a human eye? What is the approximate limiting magnitude for the human eye in this band? At this limiting magnitude, about how many photons per second would be striking the retina? How far away could a sun-like star be placed and still be visible to the naked eye?

4. What is the size of a H atom in cm? In Å? What is an expression for its size in terms of physical constants? Suppose the proton were replaced with a positron: how would the size of the system change?

5. What is the binding energy of the H atom in eV? Express the binding energy in terms of physical constants. What is the equivalent energy in degrees Kelvin? What photon wavelength (in nm or Å) corresponds to this energy?

6. What is the typical size scale for an atomic nucleus in cm? in fm?

7. In a simple one-dimensional "random walk," steps of unit length are taken to the left or right with equal probability. Let the position of the walker after n steps be x_n. Find the probability distribution for x_n, its expectation value $\langle x_n \rangle$, and the expectation value of $\langle x_n^2 \rangle$.

8. Suppose you compress an ideal monatomic gas adiabatically to twice its original pressure. By what factor did the density change? By what factor did the temperature change?

9. For an ideal monatomic gas of pressure P and mass density ρ, what is the adiabatic sound speed?

10. Estimate the mean free path of a typical air molecule in your room.

11. Which panel in Fig. 1 shows a power-law? An exponential? What is the index of the power-law?

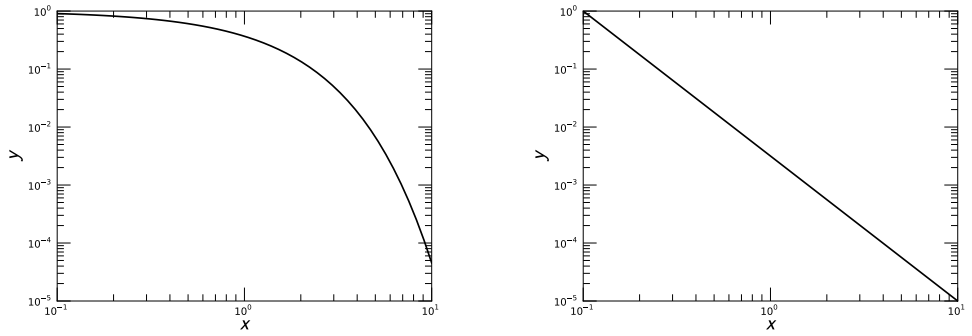

Figure 1: Two log-log plots.

12. A source produces photons within a narrow range of wavelengths $\Delta\lambda$ about a mean wavelength λ. What is the average energy E and spread in energies ΔE of these photons?