ASTR 371, Fall 2016

Review I

1. Introduction and Overview (Chap 1, Lecture Notes)
   1.1 Introduction to modern astronomy and astrophysics
       Understand how astronomers conduct research using scientific methods.
   1.2 Introduction to the solar system
       Must know the major members of the solar system.
   1.3 Introduction to the Sun
       Understand why we study the Sun.
   1.4 Size and distance
       a. Must understand the concept of angular measurement and the units: degrees, arcminutes, arcseconds. Must be able to convert between the above units.
       b. Must understand the meaning of small-angle formula and know how to use it to relate angular size, linear size, and distance of an object. Must know correct units in this formula.

       Small angle formula: \[ D = \frac{\alpha d}{206265} \]

       c. Must understand the astronomical units of distances. Must know what are Astronomical Unit and light year.
          1 AU = 1.50 \times 10^{11} m
          1 ly = 9.46 \times 10^{15} m
       d. Must understand the concepts of the plane of the sky and line of sight.
   1.5 Power-of-ten notation:
       Must know how to write numbers using powers-of-ten notation.

2. The Nature of Light (Chap 5, lecture notes)
   2.1-2.3 Wave-particle properties of light
       a. Must know that light travels at a very high speed, \( c = 3.0 \times 10^8 \) m/s in vacuum.

       Know the history of measuring the speed of light. It is also useful to know that it takes 500 seconds, or about 8 minutes, for light to travel 1 AU, i.e., between Earth and the Sun.

       b. Understand Newton’s experiment of passing light through a prism and to prove that sun light is a combination of light of different colors.

       c. Must know the wave properties of light: \( c = \lambda \nu \). Must understand that the color of light is determined by the wavelength. Must know that light is electromagnetic radiation. Know roughly the wavelength range of visible light at different colors, infrared, microwave, radio, ultraviolet, and X-rays.

       d. Must know how the shape of the continuum radiation by a hot dense object (a blackbody) depends on its surface temperature.

       e. Must know Wien’s law and how to use it to relate the temperature and peak radiation wavelength of a hot dense object. Must know the units of each term in the equation.

       Wien’s law: \[ \lambda_{\text{max}} = \frac{0.0029 \text{ K m}}{T} \]
f. Must know Stefan-Boltzmann law and how to use it to estimate the radiation energy flux.

Stefan-Boltzmann law: \( F = \sigma T^4 \)

- \( F \) = energy flux, in joules per square meter per second
- \( \sigma \) = a constant (Stefan-Boltzmann constant) = \( 5.67 \times 10^{-8} \) W m\(^{-2}\) K\(^{-4}\)
- \( T \) = object’s temperature, in Kelvin

g. Must know the wave-particle duality of light, the meaning of a photon, and the energy of a photon – Planck’s law. Understand the significance of Planck’s law.

\[
E = h\nu = \frac{hc}{\lambda}
\]

\((h = \text{Planck’s constant} = 6.625 \times 10^{-34} \text{ J s})\)

2.4-2.5 Spectral lines and Doppler effect

a. Must know in what situations (by an opaque object or gas) emission and absorption lines are produced.

b. Understand formation of emission and absorption lines from the point of view of atomic structure. Must understand whether a photon is emitted or absorbed when an electron jumps from one orbit to another. Understand why spectral lines are indicators of the chemical composition of the light source, such as a gas and an atmosphere.

c. Know about Hydrogen Balmer series.

d. Must know what is Doppler effect. Must be able to calculate the velocity of the light source from Doppler shift (see Example 13 in lecture notes and the homework problems).

\[
\frac{\Delta \lambda}{\lambda_0} = \frac{\lambda - \lambda_0}{\lambda_0} = \frac{\nu}{c}, \quad \nu \ll c
\]

3. Optics and Telescopes (Chap 6, lecture notes)

a. Understand the basic principle of how a refractor and a reflector form images of celestial objects.

b. Know what are objective lens, objective mirror, eyepiece, focal plane, and focal length.

c. Understand why astronomers prefer to use reflectors over refractors for big telescopes.

d. Must understand why it is important to have large mirrors.

e. Must know what properties of a telescope determine how large (angular magnification) and how bright (light gathering power) an image is.

f. Must know the concept of angular resolution (sharpness of an image) and what determines the theoretic angular resolution of a telescope.

Diffraction limited angular resolution: \( \theta = 2.5 \times 10^5 \frac{\lambda}{D} \) (must know the units).

g. Must know the practical limits to the angular resolution. Must know the advantages of placing telescopes in remote locations and at high altitudes.

h. Qualitatively know how adaptive optics work.

i. Qualitatively know the technique to form images in radio wavelength.

j. Must know the advantages of putting telescopes in orbit.

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