Announcements

- **Reading Quiz due tonight!** The Reading Quiz for last week (“Week6 quiz”) is due tonight, Tuesday, March 4, by 11:55 PM. After that time, this reading quiz will no longer be available, and **no late assignments will be accepted for any reason.**

Reading Guide and Homework Assignment

*(Week #7 On-Line Reading Quiz Due: Tuesday, March 11, 11:55 PM)*

This week we continue reading in Chapter 4, on light and matter, and also include an interesting application of the wave property of light known as the Doppler Effect to discover planets orbiting stars other than our Sun. Note that the order of the reading assignments below follows the presentation order given in class, and so it skips around a bit.

1. **Text: Chapter 4, Sections 4.1.1 and 4.1.2:** The Nature of Light — Maxwell’s Theory of Electromagnetism and The Wave-Like Characteristics of Light. (Also, be sure to read all of the introductory material to the chapter on pages 85 and 86, before beginning with §4.1.1.)

   Read here about the wave characteristics of light. As was discussed in class, depending on the experimental setup, light can behave as either a wave (an electromagnetic wave) or a particle (a photon). Here you consider light’s wave-like characteristics.

2. **Text: Chapter 4, Section 4.2.1:** The Electromagnetic Spectrum — Types of Electromagnetic Radiation.

   This section introduces the concept of the electromagnetic spectrum, and the idea that visible light is just one type of electromagnetic radiation, namely the range of light characterized by wavelengths between 400 nm (violet light) and 700 nm (red light). Also note the discussion of how Earth’s atmosphere blocks most of the electromagnetic spectrum from reaching Earth’s surface; this is one major reason we put some telescopes in space, above Earth’s atmosphere!

3. **Text: Chapter 4, Section 4.6:** The Doppler Effect.

   Read here about The Doppler Effect: a fundamental effect that occurs for waves when the source of the waves is in motion relative to an observer. We shall find the Doppler effect to be a critical tool that astronomer’s use to deduce the velocities of astronomical objects. Note that Doppler shifts only occur for radial velocities; that is, for objects moving towards or away from the observer. The last part of this section defines the important terms redshift and blueshift, and even quantifies the degree of the wavelength shift for a given relative velocity. Note that we shall not be using the formulas the book presents on p. 104 in this class, other than in the qualitative sense that the greater the velocity, the greater the red(blue)-shift.

4. **Text: Chapter 8, Sections 8.4.3 and 8.4.4:** Radial Velocity and Proper Motion.

   These sections finish up the discussion of the motions of celestial objects, and how we detect them. Be sure to understand the difference between radial velocity and proper motion, and how each are measured.

5. **Text: Chapter 12, Sections 12.4.1 and 12.4.2:** Planets Beyond the Solar System: Search and Discovery — Search for Orbital Motion and The Discovery of Planets.

   Read here about the exciting discoveries of planets beyond our solar system being made by the likes of Geoff Marcy, about whom we spoke in class this week. The key thing to understand from this reading is the method by which the discoveries are made: i.e., by using the Doppler Shift to detect the “telltale wobble” of stars with planets. This approach is nicely summarized by Figure 12.16.

   → Optional Astronomy Podcast, from Astronomycast.com: Episode 2: In Search of Other Worlds, available at http://www.astronomycast.com/ (scroll down to find the second episode, along the right-hand side of the page), as well as through iTunes. An excellent discussion of how and what we have
discovered about extrasolar planets. (As discussed in last week’s Handout, please note that listening to these podcasts is completely OPTIONAL, as they will never contain any additional material that you are responsible for that is not also covered by the required reading assignment. In all likelihood, though, they will help you better understand the material for which you are responsible, so I highly recommend them!)

6. On-line tutorial: On the “Week7_tutorial: Part 1” section of the textbook website, look at the Astronomy Exercise called “Extra-solar Planets”. We looked at this one in class together; look at it again, as gaining a full understanding of how unseen planets orbiting other stars are detected serves as an excellent review of the Doppler effect.

7. Text: Section 4.1.3: Light as a Photon.

Having completed our description of the wave-like characteristics of light, this section introduces us to the idea that light, specifically when it interacts with matter, can exhibit particle-like qualities. Thus, we have the introduction of the concept of a photon: An individual particle of light.

8. Text: Section 4.4.3: The Bohr Atom.

Having now answered some fundamental questions about the nature of light, this section probes the next obvious questions: What is the basic model to have in mind when thinking about an atom, and how does light interact with atoms? It should cover fairly familiar territory for those of you who had high-school chemistry and/or physics. Importantly, it introduces the idea that an atom can emit or absorb light when its electrons jump up or down in their energy states. The amount of energy contained in one “packet”, or photon, of light, is given by the equation (given on p. 100 of the text):

\[ E = h \times f, \]

where \( E \) is the energy, \( h \) is a constant (called Planck’s constant), and \( f \) is the frequency of the light. At its heart, this equation tells us that the higher the frequency of the light, the more energy per photon it has. This is where the idea that X-rays are more energetic than visible light rays comes from: X-ray photons have a much higher frequency than do optical photons, and, hence, pack more energy per photon.


The material presented here, and gone over in class, may be new to some of you. Pay particular attention to Figure 4.18 (actually presented in class last week): an understanding of this diagram is crucial to your understanding of the spectra of astronomical sources that we shall be looking at throughout the course.

10. On-line tutorial: On the “Week7_tutorial: Part 2” section of the textbook website, look at the Astronomy Exercise called “Emission and Absorption Spectra”. This is an excellent overall review of how both emission and absorption lines are produced in a spectrum through the quantum “jumping” of electrons. Make sure you understand this one!


This reading introduces you to the concept that the apparent brightness of a source (i.e., how bright it looks), depends on how far away the source is; in fact, the relationship between apparent brightness and distance is yet another example of an inverse-square law encountered in astronomy (an earlier example that we considered in this course is the strength of gravity).

12. On-line tutorial: On the “Week7_tutorial: Part 2” section of the textbook website, look at the Active Figure called “Apparent Brightness”. This gives a more intuitive feel for the inverse-square law of light diminution.

13. On-line reading quiz (Due: 11:55 PM, Tuesday, March 11): Take this week’s reading quiz by clicking on the “Week7_quiz” assignment at the on-line textbook web-site. The Reading Quiz will become available to you at 12:05 AM, Wednesday, March 5. It consists of 10 multiple choice questions. You must complete this on-line quiz by 11:55 PM Tuesday, March 11. As always, you may take the quiz twice.