Announcements

- **Reading quiz.** There is no reading quiz due for tonight, Tuesday October 14. The next one is assigned for this week’s reading (see assignment below), and is due next Tuesday night (October 21) at 11:55 PM. It will become available to take at the textbook website at 12:05 AM Wednesday, October 15.

Reading Guide and Homework Assignment

*(Week #7 On-Line Reading Quiz Due: Tuesday, October 21, 11:55 PM)*

This week we continue our study of light, and read from two different sources: Your Course Reader and your textbook. Note that there is significant overlap in the material between the two sources (i.e., both cover the wave properties of light); however, since understanding light is so important, I am assigning both readings to make sure you get it! In general, I prefer the presentation given in the Course Reader over that in the textbook, but it is useful to see it all discussed in both places. Note that the order of the reading assignments below follows the presentation order given in class, and so it skips around a bit.

1. **Course Reader:** Pages 191 – 203: *Light Waves and Putting Your Knowledge of Light to Use.*

   Here is an excellent description of the wave properties of light, provided by these excerpts taken from a different astronomy text. The emphasis given follows very closely how we covered the material in class, so read carefully. Note that on pages 197 - 199 you get a nice review of the 3 types of spectra (e.g., Kirchoff’s Laws of Spectral Analysis), discussed last week. Following a description of the Doppler Effect, the reading ends on page 203 with a nice wrap-up of the essential properties of light.

2. **Text:** Chapter 4, Sections 4.1.1 4.1.2, 4.2.1, 4.6: *The Nature of Light — Maxwell’s Theory of Electromagnetism, The Wave-Like Characteristics of Light, The Electromagnetic Spectrum — Types of Electromagnetic Radiation, and The Doppler Effect.* (Also, be sure to read all of the introductory material to the chapter on pages 85 and 86, before beginning with §4.1.1.)

   These readings essentially present the same material as the previous assignment, but do so with somewhat different pedagogy and emphasis. Begin by reading again 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). The next 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! Finally, in §4.6, read 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.

3. **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.
4. **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/, as well as through iTunes. An excellent discussion of how and what we have discovered about extrasolar planets.

5. **On-line tutorial: On the “Week7 tutorial” 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.

6. **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.

→ **Optional Astronomy Podcast, from Astronomycast.com: Episode 81: The Wave-Particle Duality of Light**, available at http://www.astronomycast.com/, as well as through iTunes. Wondering exactly how light sometimes behaves as a wave and sometimes as a particle? Then this podcast is for you!

7. **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.

8. **Text – Section 4.5: Formation of Spectral Lines.**

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.

9. **On-line reading quiz (Due: 11:55 PM, Tuesday, October 21): 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, October 15. It consists of 10 multiple choice questions. **You must complete this on-line quiz by 11:55 PM Tuesday, October 21.** As always, you may take the quiz twice.