

Astronomy 16 – Modern Astrophysics

Fall 2014

Week 2

Questions for the week:

1. How bright is the full Moon relative to the Sun?
2. How much does Jupiter weigh?

By the end of the week, you will be able to answer these questions.

Topics:

Circular motion, centripetal acceleration

Newtonian gravity, orbits, Kepler's third law, and mass determination

Kepler's first and second laws

Basics of electromagnetic radiation, wavelength and frequency, photon energy, the parts of the spectrum

Three types of spectra, connection to atomic physics

I anticipated that the material from our first week's assignment would require some time at the beginning of week 2 to wrap up. And indeed, we'll be spending most of Tuesday's class finishing up the inverse square law of light and then moving on to gravity and orbits. Toward the end of Tuesday's class we'll begin radiation. And Thursday will focus on much of the rest of radiation, which we'll wrap up on Tuesday of week three.

Reading:

Read the first page of Ch. 5 (p. 111) carefully, and study Table 5.1 on p. 112. Then skim the next few pages, which are a pretty careful derivation of the quantized energy levels of a single electron atom (like neutral hydrogen). Start reading carefully again at the bottom of p. 115, which quotes the energy level formula result (eq. 5.21) and read through the end of the section (p. 118). Study Fig. 5.2 and its description. I'm hopeful we'll have time to discuss this material on Tuesday, but if you're pressed for time, it's OK to simply have this read by Thursday.

For Thursday, the 11th, read Sec. 5.2 and 5.3.

Important concepts and related facts to keep in mind as you read, and make sure you can answer while/after you've done the reading. We will discuss all of these in class this week.

Here are left-over topics from last week's assignment:

You should be familiar with Newtonian gravity (eq. 3.1 on p. 62) and also you should review the basics of uniform circular motion (not covered directly in the reading), especially the expression for centripetal acceleration for uniform circular motion with speed v and radius of motion r .

How do you think about an orbit? What keeps the orbiting object moving in a circle? (Always consider circular orbits of a light object orbiting a much heavier object, first – it's the easiest case to analyze.)

Make sure you understand Galileo's observations of Venus and how they showed that the Ptolemaic Earth-centered system couldn't be right and how they were consistent with the Copernican Sun-centered system.

And here are some topics on radiation from Ch. 5 to pay special attention to:

Light have wave-like and particle-like properties.

Photons are particles of light with a particular amount of energy (which does not have to do with the photon's speed – all photons have the same speed, and a photon is massless and so does not have kinetic energy in the classical sense). The photon's energy is related to the frequency of the wave description of the photon by Planck's constant, h .

The wave description of light relates the frequency to the wavelength (their product is the speed of the wave).

The quantized energy levels of an atom lead to line spectra as electrons make transitions from one discrete (i.e. having a specific energy) level to another. See eqs. 5.22, 5.23 and Fig. 5.2. Upward transitions in the electric potential of the nucleus require (so, *absorb*) photons with energy equal to the energy level difference, while downward transitions can produce (so, *emit*) photons with that energy.

Because energy levels do not have totally precise energies (due to the Heisenberg uncertainty principle) and for other reasons as well, such as random thermal motion of the emitting or absorbing atoms, spectral lines have finite widths (and particular shapes).