General Astronomy (29:61)
Fall 2012
Lecture 2 Notes , August 22, 2012

1 Overview of the Solar System

1.1 Terrestrial Planets

The innermost 4 planets are Mercury, Venus, Earth, and Mars. Their average distances from the Sun are 0.387, 0.723, 1.00, and 1.524 astronomical units (AU) from the Sun, respectively. You can find these data in Appendix A3 of the textbook.

The *astronomical unit* AU is the average distance between the Earth and the Sun, and is 1.496×10^{11} meters, $= 1.496 \times 10^{8}$ kilometers.

Instead of the term *average distance* between a planet and the Sun, we will use (an apparently hopelessly more complicated) term *semimajor axis* of the orbit of a planet. The reason for this choice will become clear later. The two concepts are equivalent.

Sizes of the terrestrial planets The equatorial radius of the Earth is 6.38×10^{6} meters = 6378 kilometers. The Earth is the largest of the terrestrial planets. A picture showing the relative sizes of the terrestrial planets is in the online slides and pictures.

The terrestrial planets are "big rocks" like the Earth. They all have surfaces you could stand on, although in most cases you wouldn't want to. Look at the picture of the surface of Mars in the online figures.

1.2 Jovian Planets

The *semimajor axes* of the orbits of the Jovian planets are 5.20, 9.54, 19.18, and 30.06 AU, respectively. See Appendix A3 of your book. Jupiter and Saturn are easily visible to the naked eye, and both are in the night sky now. Uranus and Nepture are so far away that they are invisible without binoculars. At the present time, both of them are high in the sky later in the night. Uranus is in the constellation of Pisces, and Neptune is in Aquarius.

Look at the online slide showing the relative sizes of the Jovian planets. This slide also shows the relative size of Earth to the Jovian planets. The Jovian planets are **huge**. Jupiter is about 11 times the diameter of the Earth, and has 318 times its mass.

The Jovian planets are *entirely* different from the terrestrial planets in mass, size, and chemical composition (stay tuned for later in the semester). There really should be different names for the two types of objects.

The orbital periods of the Jovian planets increase as they get further from the Sun. This is obvious if you watch them in the night sky over many years.

1.3 The plane of the ecliptic

The JPL solar system simulator shows all of the planets in the plane of the screen. However, this is nearly an accurate representation of things.

The *plane of the ecliptic* is the plane of the Earth's orbit around the Sun. The intersection of two planes is a line, and there will be an opening angle between the planes. In the case of planetary orbits, this angle is called the *orbital inclination*, or just the *inclination*.

In the case of the major planets, the inclinations are small angles,

- Mercury $\iota = 7^\circ$
- Venus $\iota = 3.4^\circ$
- Earth $\iota = 0^\circ$ (definition)
- Mars $\iota = 1.8^\circ$
- Jupiter $\iota = 1.3^\circ$
- Saturn $\iota = 2.5^\circ$
- Uranus $\iota = 0.8^\circ$
- Neptune $\iota = 1.8^\circ$

The fact that the orbits of all the major plaents are nearly the same is an important hint to the origin of the solar system.

The existence of this (nearly) common plane of the ecliptic containing the orbits of all the major planets (and the Moon) is crucial for the appearance of the night sky as we see it.

1.4 Satellites of the Planets

There are other kinds of objects in the solar system besides the major planets. Several of the planets have moons, or satellites orbiting them. Several of these satellites are larger than our Moon. Perhaps the most interesting is the moon Titan of Saturn. Titan is easily visible in a small telescope, but unfortunately we probably won't get a chance to see it this semester. The radius of Titan is 2575 km, versus 1738 for our Moon.

Titan is the only moon with a "real" atmosphere, and this makes it very interesting. Look at the picture of Titan in the online figures and diagrams. The moon Europa of Jupiter is also very interesting. We will talk about both of these later in the semester.

1.5 Other kinds of objects in the solar system

There are several other classes of interesting objects in the solar system. These include

1. dwarf planets (includes asteroids like Vesta)
2. Kuiper Belt objects (the leftovers from the formation of the solar system. The most famous is Pluto).
3. Comets

1.6 Outer Limits to the Solar System

As mind-boggling as distances to the Jovian planets are, there are spacecraft much further out. The Voyager 1 and Voyager 2 spacecraft, launched in the 1970s, are now 121 and 99 AU from the Earth. Both have experiments from the University of Iowa, and some experiments are still working on both spacecraft. They are both in the boundary region between the solar system and interstellar space.

1.7 The physical laws of the solar system

A goal of solar system astronomy is not just a travelog, but the undertaking to understand the physical laws that govern the solar system. Look at the orbit of Sedna on the homepage for the course and think about why it is as it is.