

General Astronomy (29:61)  
Fall 2013  
Lecture 4 Notes , Sept. 04, 2013

## 1 The Celestial Equator and the Ecliptic

The Celestial Equator is the intersection of the Earth's equatorial plane with the celestial sphere, and it is a great circle on the celestial sphere. The ecliptic is the intersection of the *plane of the ecliptic* with the celestial sphere, and it is a great circle on the celestial sphere. They are not the same great circle, but are inclined with respect to each other at  $23.5^\circ$ .

Why is this so? What is it telling us about the solar system?

### 1.1 The vernal equinox and autumnal equinox

The celestial equator and ecliptic intersect at two points on the celestial sphere. One of these is the *autumnal equinox*. The Sun is here on the first day of autumn. The second is the *vernal equinox*. The Sun is at the vernal equinox on the first day of spring.

The Sun will be at the vernal equinox at 3:44 PM, Sunday, September 22 this year.

## 2 Seasonal Changes in the Night Sky

A very fundamental fact of astronomy, known to all human societies, is that the location of the constellations in the night sky changes through the year. We will clearly see this during the course of the semester.

This results from the revolution of the Earth around the Sun. You can clearly figure this out from the SC1 charts. A particularly striking illustration of this is provided by the movies from the C3 coronagraph on the SOHO spacecraft (see the spacecraft web page on the course web page).

## 3 The Motion of the Moon and Planets

The planets are moving, approximately in the *plane of the ecliptic*, with different orbital periods. The *inclinations* of the orbits of the major planets and the Moon,

or angles at which the orbital planes intersect the plane of the ecliptic, are typically only a few degrees. We therefore see them approximately in the direction of the ecliptic.

The motion of the planets can be somewhat complicated. On the average, all the major planets move from west to east as part of their revolution around the Sun. However, they are also seen to undergo *retrograde* motion, in which they move from east to west for a while. This is called *retrograde motion*, and is particularly pronounced for Mars.

### 3.1 The ecliptic on the sky

Take a look at the ecliptic on the SC1 chart. It is the "sine wave" like line. Note the constellations it passes through.

## 4 Precession of the Equinoxes

The Greek philosopher Hipparchus first noted that the right ascension and declination of stars were different in his time than they had been recorded by earlier astronomers.

We now know that this is due to the *precession of the equinoxes*. This is fundamentally due to the precession of the Earth's rotation axis (see Figure 1.10). Precession occurs when a rotating object is subject to a torque. The precession period is 25800 years. Since the location of the north celestial pole is changing, the declination of stars will change. Furthermore, since the intersection of the celestial equator with the ecliptic changes as well, the right ascension changes.

The precession of the Earth's rotation axis, together with periodic variations of a number of properties of the Earth's orbit, is believed by many scientists to be responsible for the Ice Ages on Earth.

## 5 Astronomical Fundamentals of Time

Astronomical phenomena help define our idea of time, and the measurement of time is tied inextricably with astronomy. Our fundamental terms for units of time, the day, and month, and the year, all relate to astronomical cycles.

## 5.1 The Day

You might think the definition of the day is ridiculously simple. However, in reality you have to be careful on how you define it. The book defines the day as “*the interval between successive transits of a celestial object*”.

The most common (and seemingly only) choice for this celestial object is the Sun. This leads to the definition of the **Solar Day**.

However, you could also choose a star, such as Vega, and measure the day to be the time between successive transits. This is the definition of the **Sidereal Day**. Aren't these the same?

No they aren't.