March 23, 2006

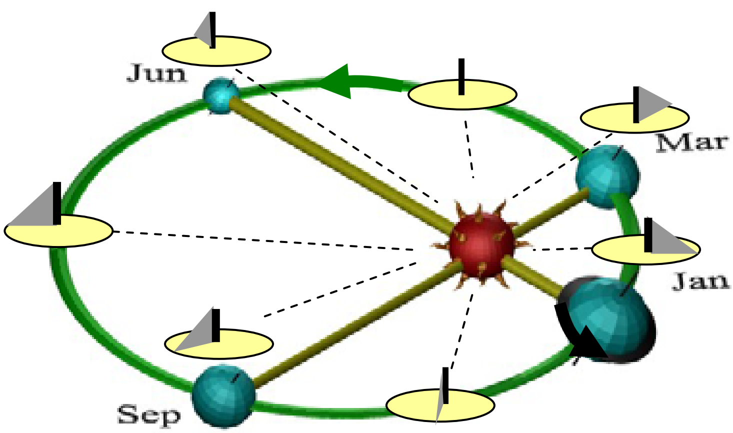
ECLIPTIC DIALS THAT CAN INDICATE THE DATE

This book was developed without presenting any significant details of the ecliptic, the declination of the sun being the major feature. The ecliptic as opposed to declination becomes important when moving from a dial using the hour angle, azimuth, or altitude, towards lunar and stellar timekeeping, and the astrolabe.

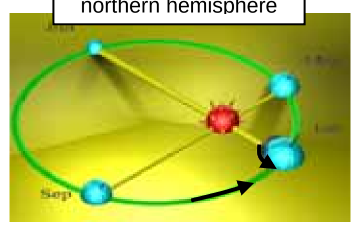
This section, inspired by John Foad's article in a sundial journal, discusses the ecliptic in a practical sense, and presents a version of a date and time dial in keeping with the general design look and feel of the Illustrating Shadows dials.

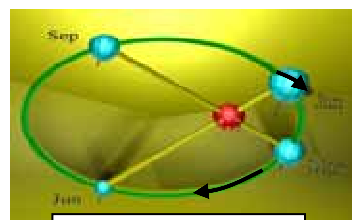
The ecliptic is the plane made by the earth's orbit around the sun, and if a dial plate was placed on it and moved with the earth as it orbits the sun, then in one year the shadow of the gnomon would rotate about 360 degrees. About, because things are not that tidy. Because it would take one year for the gnomon's shadow to rotate around that dial plate, and since that is one calendar cycle, it is possible to build a calendar dial using the ecliptic, as opposed to using declination lines.

The earth's orbit is 23.5 degrees from the earth's polar axis. The pictorial below to the left shows several dial plates around the earth's annual orbit as viewed from above the north.



northern hemisphere





southern hemisphere

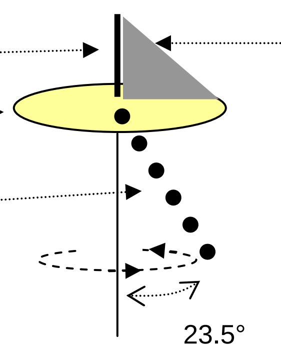
Above to the right, the northern hemisphere is viewed from above the north and looking down, and the southern hemisphere is viewed from below the south while looking up.

gnomon for the dial plate on the ecliptic

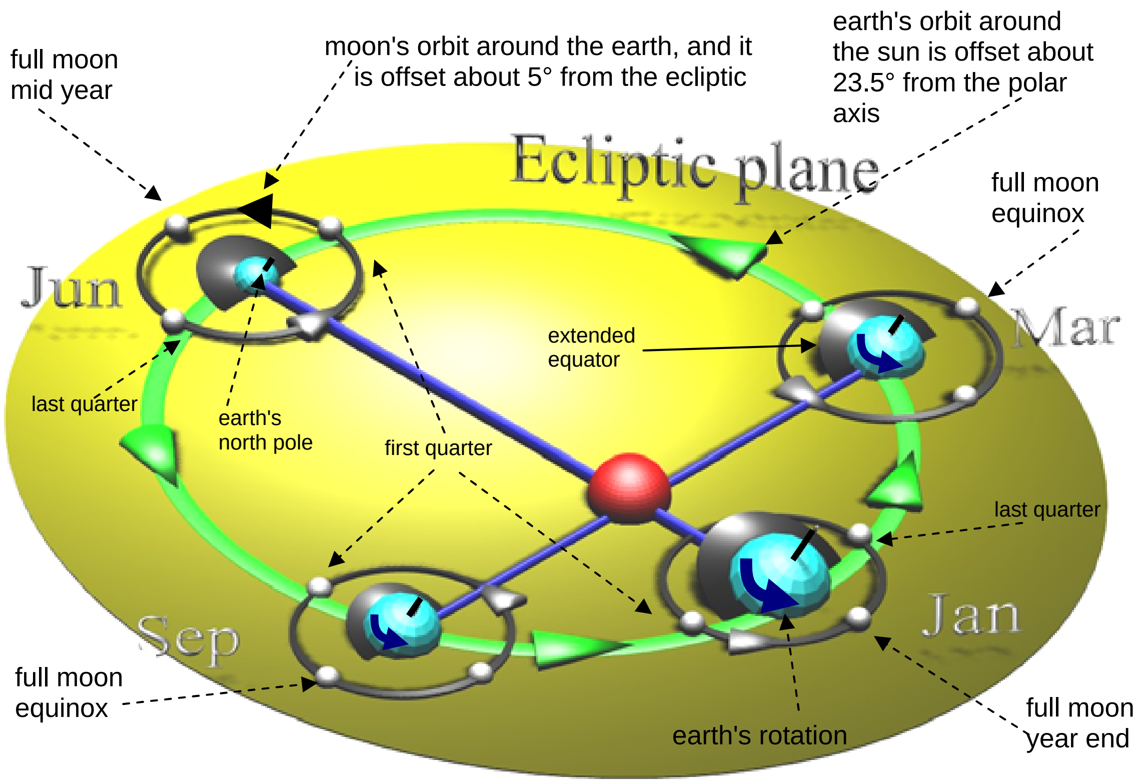
dial plate resting on the ecliptic

earth's polar axis offset by 23.5 degrees, and this will rotate around the ecliptic gnomon daily.

These are approximations due to the factors that generate the equation of time, and so on.



The shadow is of course not a triangle, it would be an infinitely long box in the direction away from the sun. The triangle is used to more clearly indicate "a" shadow.



There are some interesting results that come from such dynamics. First, how the intersection of the ecliptic varies throughout the day and the year. Second, how to construct a simple device to indicate the ecliptic and thus the date. Third, an understanding of the ecliptic, useful for locating the moon and the planets based on the seasons.

The ecliptic plane slices the earth, however, the slice angle varies by the second. The slice in the morning differs from the evening, and they both differ from noon. It differs by the season.

In the context of a full moon, in the December January time frame or year end, the full moon is effectively above the extended equator, so the full moon rises from the northeast and sets in the northwest. Mid year in June at full moon the moon is effectively below the extended equator, so the full moon rises in the southeast and sets in the southwest. For full moons at the March and September equinoxes, moonrise and moon set happens from the east to the west, the moon is effectively on the extended equator. The full moon path differs in the winter, summer, and equinoctial times. For full moons, the lunar path is almost the same as the sun's path 6 months in the past or future.

The first quarter moon's apparent path varies from the full moon. For example look at the first quarter moon in the December January timeframe. The moon rises during the daytime from the east, sets in the west, as the moon is effectively on the extended equator.

The lunar orbit is actually offset by about 5° from the ecliptic, which can add to the variation, thus the above pictorial is stylistic as well as not to scale. Some time can be well spent on the pictorial above to see how the apparent lunar orbit varies by the month as well as by the season for several selected hours.

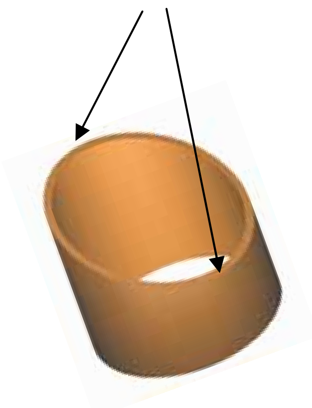
The planets are mostly in the same plane as the earth with respect to the sun, thus the planets apparent path in the sky will also vary seasonally.

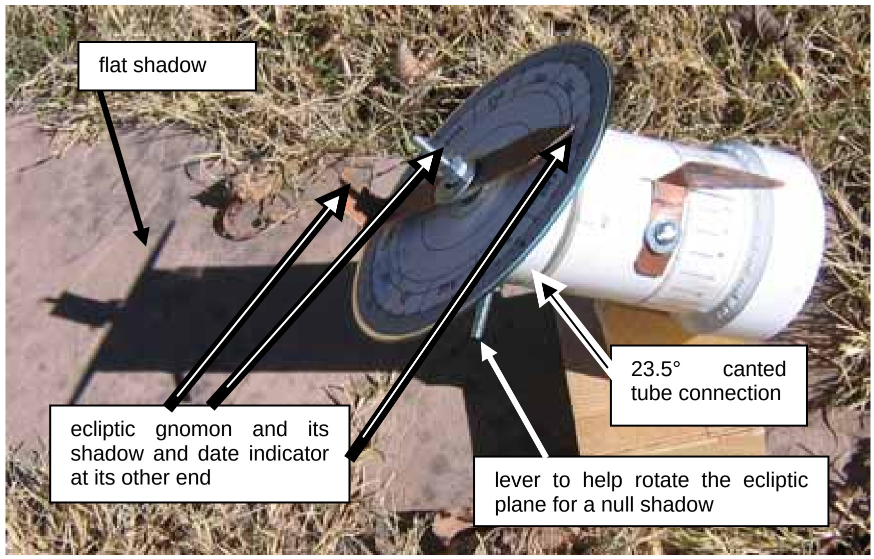
From this daily and seasonal variation of the ecliptic intersection with the planet earth, comes an explanation of lunar activity, as well as the method for designing a calendar dial using the ecliptic.

The remaining question is how to build an ecliptic dial.

On a polar axis alignment such as the style of an hour angle gnomon, a canted device is built that rotates 23.5 degrees around the polar axis. In the picture below, PVC tubing was employed. To the 23.5 degree canted rotating tube is affixed a plate, in this case from an unused computer CD.

December 21 and June 21 are at the low and high points of the canted slope.





When the date wheel is affixed, June 21 is at one end, and December 21 is at the other. Of course, the winter solstice is when the sun's declination is lowest in the sky, and the summer solstice is when the sun's declination is highest. In the northern hemisphere, December 21 would be at that low point, June 21 would be at the high.

A normal rotating gnomon is used to indicate the time on a linear plate. And the canted section is rotated around the polar axis until the dial plate casts a flat shadow. A rotating cursor is moved until the ecliptic gnomon casts a shadow as shown above, and the other end points to the date.

There are usually two locations at any time when the ecliptic dial plate casts a null shadow, this matches the two dates for any given sun declination, the solstices being the exception. Some degree of awareness about the probable month is likely to be beneficial at this point.

Just as the equation of time exists for the minutes to adjust a time dial, similarly an equation of day exists for the date. This is a sine wave indicating about plus or minus a couple of days, this is subtracted in the first half of the year from the indicated date, added for the second half.

Appendix 9 has a template for an ecliptic dial which can be scaled. It was designed with a computer CD in mind for the ecliptic plate, and for a 2.25 outer diameter PVC pipe.

This is not an all inclusive guide to ecliptic dials, rather a starting point from which to work, and that starting point is a working ecliptic dial.