The Astronomical League

A Federation of Astronomical Societies

Astro Note E3 – What Time Is It?

Introduction – There are many methods used to keep time, each having its own special use and advantage. Until recently, when atomic clocks became available, time was reckoned by the Earth's motions: one rotation on its axis was a "day" and one revolution about the Sun was a "year." An hour was one twenty-fourth of a day, and so on. It was convenient to use the position of the Sun in the sky to measure the various intervals.

Apparent Time

This is the time kept by a sundial. It is a direct measure of the Sun's position in the sky relative to the position of the observer. Since it is dependent on the observer's location, it is also a local time. Being measured according to the true solar position, it is subject to all the irregularities of the Earth's motion. The reference time is 12:00 noon when the true Sun is on the observer's meridian.

Mean Time

Many of the irregularities in the Earth's motion are due to its elliptical orbit. In order to add some consistency to the measure of time, we use the concept of mean time. Mean time uses the position of a fictitious "mean Sun" which moves smoothly and uniformly across the sky and is insensitive to the irregularities of the Earth’s motion. A mean solar day is 24 hours long. The "Equation of Time," tabulated in almanacs and represented on maps by the analemma, provides the correction between mean and apparent time to allow for the eccentricity of the Earth's orbit.

Local Mean Time (LMT)

Local mean time is determined by the mean Sun's position relative to the local meridian of the observer. As with any "local" time, it depends on the observer's geographic location (longitude). The reference time is 12:00 noon when the mean Sun is on the observer’s local meridian.

Mean Civil Time

Also called clock time or zonal time, this is the standard time by which most of our nonastronomical activities are measured. The Earth's surface is divided into 24 time zones, each spanning 15° of longitude with some variance to accommodate political boundaries. The central meridian of each zone is precisely defined, however, to be an integral multiple of 15° longitude. The reference time for the entire zone is 12:00 noon when the mean Sun is on the central meridian of the time zone.

Universal Time (UT)

This is the basis for all civil timekeeping and is very close to the LMT at 0° longitude at the Greenwich Observatory (Greenwich, England). Hence, it is sometimes called Greenwich Mean Time or GMT. The military often uses the term "Zulu" to refer to Universal Time. Standard time broadcast by radio stations such as WWV or CHU is Coordinated Universal Time (UTC or UT1). This time is based on an atomic clock and is "corrected" by adding occasional "leap seconds" to keep it in reasonable agreement with Universal Time.

International Atomic Time (IAT)

International atomic time is the time kept by atomic clocks. The Systemme Internationale (SI) second is defined so that the frequency of a certain resonance of the cesium atom is 9,192,631,770 hertz.

Sidereal Time (ST)

Sidereal time is measured relative to the stars and is based on the true rotation period of the Earth. Since the Sun moves during the course of a day (due to Earth’s motion in its orbit) and the Sun appears to move relative to the stars, a sidereal day is 3 minutes 56 seconds shorter than a solar day. Sidereal time is measured by the position of the vernal equinox relative to the meridian. Depending on the exact reference used, sidereal time may be local (LST) or mean (MST). We use sidereal time to adjust our setting circles.

Ephemeris Time (ET)

As the name implies, this is the time upon which the ephemeris is based. It is reckoned by the orbital periods of the moon and the planets and, therefore, is not subject to the irregularities of the Earth's motion. It is a uniform measure which forms the basis of the theories of celestial dynamics. It was chosen to be close to UT during the 19th century. By the end of the 20th century, ephemeris time differed from UT by some 50 seconds. While some almanacs list an estimated correction factor for the current year, the true

correction is always determined after the fact by comparing measured planetary positions to the predicted positions.

Hour Angle

An object's hour angle is the difference between the local sidereal time and the object's right ascension. The difference is taken in such a manner that an object west of the meridian has a positive hour angle, while an object east of the meridian has a negative hour angle. The diagram shows the relationship between hour angles and sidereal time.