

A Brief Column for the Beginning Stargazer Introducing a New Astronomical Term Each Month

Astronomy is rich with terminology. This column will help beginning stargazers ease into the world of astronomy by *briefly introducing* a new but *basic astronomical term* (word, acronym or abbreviation) each month. This list, which began January 1999 with the letter *a*, is alphabetical but uses successive letters for each month's entry. (We will return to the letter *a* after twenty-six months.)

Note: One year ago, this column discussed the **month**. With the beginning of the new astronomical millennium we discuss the **year**.

Word of the Month for January 2001

year A period of time equal to approximately 365 days or 12 months or 52 weeks, and derived approximately from the time for the passage of the four seasons.

More generally, a period of time based on the orbit of the Earth around the Sun. This results in many types of years according to the reference point. In addition to the "calendrical year," astronomy recognizes many "astronomical years." The following table summarizes several astronomical year types giving approximate lengths (in days). The calendrical year listed is the *common civil year*.

Type	Reference	Length (d)
Anomalistic	apsis to apsis ¹	365.259 64
Besselian	tropical year	365.242 20
Calendrical	tropical year	365 or 366
Eclipse	Moon's node to node ²	346.620 03
Gaussian	Kepler's Law for a = 1	365.256 90
Julian	tropical year	365.25
Sidereal	fixed star to fixed star	365.256 36
Tropical	equinox to equinox ³	365.242 19

Various economic and political systems, including different cultures and religions, also recognize other

lengths as a calendar year. For example: a tax-reckoning year, a farming year, and an Islamic year.

Table Notes

¹**Apsis** (or **apse**) The point of greatest or least distance of the orbit of a celestial body from a center of attraction. For the Earth, the closest point to the Sun is called *perihelion*, and farthest point, *aphelion*.

²**Node** The two points of an orbit where the orbit crosses the *ecliptic* plane (mean plane of Earth's orbit around Sun).

³**Equinox** The two points on the celestial sphere where the *ecliptic* (Sun's apparent path on the sky) intersects the *celestial equator*. The Sun passes from south to north at the *vernal equinox* (about March 21) and north to south at the *autumnal equinox* (about September 23).

Besides the civilian (or *Gregorian*) calendar year, most people have only some familiarity with the *sidereal* and *tropical years*. However, a detailed discussion of year types is complex and involves an understanding of several other astronomical terms and topics. The following notes are, therefore, necessarily brief and only give a short, general discussion of some basic *astronomical years*. (A discussion of *civilian years* is too lengthy to include.)

Anomalistic Year Time between successive passages of Earth through *perihelion* (closest point to Earth). The Earth's orbit slowly rotates in space due to *perturbations* from the other planets. This makes the *anomalistic year* about 25 minutes longer than a *tropical year* (a return to the *same equinox*) and about five minutes longer than a *sidereal year* (a return to the *same fixed point*). [Anomalistic refers to deviating from the normal (i.e., *sidereal*) year.]

Besselian Year Time required for the mean Sun's *right ascension* (RA) to increase by 24 hours. (*Right ascension* is a west-east celestial coordinate analogous to *longitude* on the Earth.) The *Besselian year* is useful in specifying the *epoch* of a *celestial coordinate system*. (An *epoch* is a precise moment when given celestial coordinates or orbital elements are strictly correct. That is, an *epoch* is a time arbitrarily selected

as a point of reference.)

The *Besselian year* begins when the mean Sun's RA is 8h 40m. This value was chosen to correspond approximately to January 1. In 1976, the *Besselian year* was defined as the length of the *tropical year* in 1900.

The *Besselian year* is shorter than the *tropical year* by 0.148T, where T is centuries from *Besselian year* 1900.0 (written B1900.0). Since 1984, the *Julian year* has replaced the *Besselian year*. (See *Julian year*.)

Calendrical Year The number of days treated as one year for civil or religious purposes. The length of the year may vary in the same calendar. For example, the *Gregorian year* contains 365 or 366 days (a leap year) and the *Islamic year* 354 or 355 days (a leap year). The *Hebrew year* has six possible year lengths (353, 354, 355, 383, 384 and 385 days). The latter three years are considered leap years due to the inclusion of an extra *month* of 30 days.

Leap years that include an extra *day* (as in the *Gregorian calendar*) use this extra day to help bring the calendar year into agreement with the *tropical year*. A calendar year has an integral number of days but the *tropical year* contains about 365¼ days. The various year lengths in calendars, as the Hebrew calendar, also try to make the average year similar to the *tropical year*. This is more complex to do because the Hebrew calendar uses months that are 29 or 30 days long, a period based on the *lunar synodic period* of approximately 29½ days. (Thus, twelve "lunar months" yield a year with only 354 days.)

Eclipse Year The time between successive passages of the Sun through the same *node* of the Moon's orbit. It is important when determining the occurrences of lunar and solar eclipses.

The *nodes* of the Moon regress westward around the *ecliptic* (Sun's apparent path on the sky) about 19 degrees per year. This makes the *eclipse year* about 18.6 days shorter than the *tropical year*.

Gaussian Year A period defined by *Kepler's Third (Harmonic) Law* using the *Gaussian gravitational constant*. This year is used to define the Earth's mean distance from the Sun (*an astronomical unit*).

Julian Year A period of exactly of 365.25 days and the basis of the *Julian Calendar*. Since 1984 standard *epochs* have been defined in terms of *Julian years*,

replacing the use of the *Besselian year*.

Celestial coordinates are usually specified by an *epoch*. It is now conventional to denote a *Besselian epoch* with the letter "B" (e.g., B1950.0) to distinguish it from a *Julian epoch*, prefixed by the letter "J" (e.g., J2000.0).

Sidereal Year The mean time between successive passages of Sun through the *same star*. [Sidereal means of or relating to the stars (i.e., "fixed").]

The *sidereal year* is essentially the period of the Earth's orbital revolution around the Sun with reference to the stars. Because of *precession* (see *tropical year*), the *sidereal year* is about 21 minutes longer than the *tropical year*.

Tropical Year The time between successive passages of the Sun through the *mean equinox*, as from *vernal equinox to vernal equinox*. This is the time for the seasons to recur. [Tropical refers to the seasons.]

The *tropical year* differs slightly from the *sidereal year* (period of Earth's revolution around the Sun); the *tropical year* is about 21 minutes shorter.

This difference occurs because the *equinox* moves westward along the *ecliptic* due to *precession* (see below). That is, the westward motion of the *vernal equinox* along the *ecliptic* allows the Sun to return to the *vernal equinox* before the Sun has had a chance to return to the same fixed point ("star"). It is as if the "starting gate" (*vernal equinox*) has moved to meet the moving Sun shortening the time to run once around the "race course."

Note: *Precession of the equinoxes* is the sliding motion of the *vernal equinox* along the *celestial equator*. It is primarily the result of the combined gravitational pull of the Sun and Moon on the Earth's equatorial bulge. (The other planets contribute slightly.) This causes the *vernal equinox* to move slowly westward along the *ecliptic* by about 50.3 arc seconds per year. (An *arc second* is 1/3600 of a degree.) The *precessional period* is about 26,800 years. ✨

References. J. Mitton 1991, *Concise Dictionary of Astronomy* (Oxford Univ. Press); I. Ridpath 1997, *A Dictionary of Astronomy* (Oxford Univ. Press); *Explanatory Supplement to the Ephemeris*, 1961; *Explanatory Supplement to the Astronomical Almanac*, 1992, ed. P.K. Seidelmann.