ASTRONOMICAL GLOSSARY

J. E. GORE, F.R.A.S.

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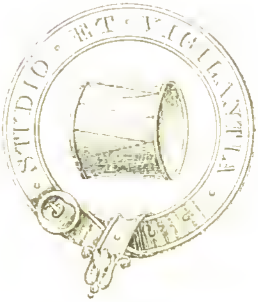
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AN

ASTRONOMICAL GLOSSARY

OR

Dictionary of Terms Used in Astronomy

*WITH TABLES OF DATA AND LISTS OF
REMARKABLE AND INTERESTING
CELESTIAL OBJECTS*

BY

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PREFACE.

THE following GLOSSARY contains an explanation of all the terms and names generally used in books on Astronomy, and it is hoped that it will be found useful as a work of reference both to the beginner and the advanced student.

TABLES are added containing the latest values of Astronomical Constants, details of the Planets and Satellites of the Solar System, and lists of Remarkable Red, Variable, and Binary Stars.

J. E. G.

October, 1893.

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Month, Draconic. Same as MONTH, NODICAL, which see.

AN ASTRONOMICAL GLOSSARY.

A.

Aberration of Light. An apparent displacement in the position of the stars due to the effect of the earth's motion in its orbit round the sun combined with the progressive motion of light. The result is that "a star is displaced by aberration along a great circle joining its true place to the point on the celestial sphere towards which the earth is moving" (Barlow and Bryan's *Mathematical Astronomy*, p. 298). The amount of aberration is a maximum for stars lying in a direction at right angles to that of the earth's motion. This is known as the "constant of aberration," and its value in seconds of arc is 206,265 multiplied by the velocity of the earth and divided by the velocity of light, or about 20·5″. The motion of the earth on its axis also produces a small aberration called the Diurnal Aberration, but the coefficient of this is very small—only 0·32″—and almost imperceptible in observations. For a star on the celestial equator, viewed from the earth's equator, the time of transit would be retarded by diurnal aberration by only $\frac{1}{50}$th of a second, which could hardly be observed.

Absorption of Light. A supposed diminution in the brightness of very distant stars by absorption of their light in the luminiferous ether of space. It is also termed the "extinction of light." That such an absorption of light really takes place in the ether has not, however, been well established.

Acceleration. Secular of moon's mean motion. A slow increase in the velocity of the moon's mean orbital motion round the earth due to the change in the eccentricity of the earth's orbit round the sun.

Achernar. A name applied to the star α Eridani. Derived from the Arabic *âchir al-nahr*, "the end of the river" (Eridanus).

Achromatic. A refracting telescope in which the lenses are so constructed that an image of an object practically free from colour is formed.

Acolyte (an attendant). A term sometimes applied to a faint star seen in the same field of view with a much brighter one.

Acronical. When a celestial body rises or sets with the sun it is sometimes said to rise acronically.

Adara. A name sometimes applied to ε Canis Majoris. Derived from the Arabic *al-adzârî*, "the virgins," a term applied by the old Arabian astronomers to the stars o^2, δ, ε, and η Canis Majoris.

Aërolite. A term applied to a kind of meteoric stones which occasionally fall from the sky, and which are composed almost entirely of stone, with little or no iron.

Æther. See Ether.

Aish. An ancient name for the Great Bear or Plough.

Albedo of a Planet. The proportion of the sunlight reflected from a planet's surface compared with the total amount received from the sun.

Albirco. A name applied to the star β Cygni.

Alchiba. A name sometimes applied to the star α Corvi.

Alcor. A small star closely *following* the star ζ

Ursæ Majoris (Mizar). It is otherwise known as *g* or 80 Ursæ Majoris.

Alcyone. A name applied to the star η Tauri, the brightest star in the Pleiades.

Aldebaran. A name applied to the first magnitude star α Tauri. Derived from the Arabic *al-dabarân*, "the follower," because it follows the Pleiades.

Alderamin. A name applied to the star Cephei. Derived from the Arabic *al-dzirâ al-jamîn*, "the right arm" (of Cepheus).

Aldhibaïn. A name applied by the Arabian astronomers to the stars η and ζ Draconis. The word means "the two jackals."

Alfeta. A name given in the Almagest to the star α Coronæ Borealis.

Algeiba. A name sometimes applied to the star γ Leonis.

Algenib. A name sometimes applied to the star γ Pegasi. Probably a corruption of the Arabic *djanâh al-farras*, "the wing of the horse."

Algol. From the Arabic *ras al-gûl*, "the head of Algol" (Medusa). The famous variable star β Persii. The period of variation from minimum to minimum was, in 1696, about 2 days 20 hrs. 48 mins. 59 secs., but has now diminished to 2 days 20 hrs. 48 mins. 51 secs. The star remains constant in light for the greater portion of its period, and the whole of the light fluctuations take place in a period of about 10 hours. The variation of light is from 2·3 to 3·5 magnitude.

Algorab. A name sometimes applied to the star α Corvi.

Algores. A name sometimes applied to the star δ Corvi.

Alhena. A name sometimes applied to the star γ Geminorum. From the Arabic *al-hanat.*

Alioth. A name sometimes applied to the star ε Ursæ Majoris.

Alkaid. A name sometimes applied to the star η Ursæ Majoris.

Alkalurops. A name sometimes applied to the star μ Boötis.

Alkes. A name sometimes applied to the star α Crateris.

Almack. A name sometimes applied to the star γ Andromedæ.

Alnilam. A name sometimes applied to the star ε Orionis.

Alnitak. A name sometimes applied to the star ζ Orionis.

Alphard. A name sometimes applied to the star α Hydræ. From the Arabic *al-fard,* "the solitary one," because there is no other bright star near it.

Alphecca. A name applied to the star α Coronæ Borealis, "the gem of the coronet." From the Arabic *al-munîr min al-fakka,* "the brilliant of the crown."

Alpherat. A name applied to the star α Andromedæ.

Alphirk. A name sometimes applied to β Cephei.

Alshain. A name sometimes applied to β Aquilæ.

Altair. A name applied to the bright star α Aquilæ. From the Arabic *al-tâir.*

Altitude. The angular elevation of a star above the horizon, measured on a great circle passing through the star and zenith. The measured angle must be corrected for the effect of refraction, which tends to apparently raise the star above its true position.

Altitude and Azimuth Instrument. A telescope mounted so as to be movable about a horizontal and also a vertical axis. It is also called an *altazimuth*. The Small telescopes are usually mounted in this way. The theodolite, used in surveying, is an altazimuth.

Aludra. A name sometimes applied to the star η Canis Majoris.

Alwaid. A name sometimes applied to the star β Draconis. It is derived from the Arabic *al-awâidz*, "the old camels," a term given by the Arabians to the stars ν, β, ξ, and γ Draconis, which form, with ι Herculis, the well-known cross, marking the head of the Dragon and the left foot of Hercules.

Amplitude. The angular distance of a celestial body when rising or setting from the east or west points of the horizon. The amplitude is measured on the horizon.

Andromeda (the Chained Lady). One of the northern constellations.

Andromeda Nebula. The great nebula in Andromeda known to astronomers as 31 Messier. It lies closely preceding the 4½ magnitude star ν Andromedæ. It is visible to the naked eye on a clear, moonless night, and is a conspicuous object with small telescopes, and even with a good binocular field-glass. It seems to have been familiar to the ancients, as it is mentioned by the Persian astronomer Al-Sufi, who wrote a description of the heavens in the tenth century.

Andromedes. A meteor shower, visible about November 27th in each year. It appears to radiate from a point near γ Andromedæ (25° + 43°). The meteors are very slow and trained.

Angle. The inclination of one straight line to another.

Angle of Eccentricity. In an ellipse, the angle between the minor axis and a line drawn from the extremity of the minor axis to the focus of the ellipse. The size of this angle is the eccentricity of the ellipse.

Angle of Position. The position of the line joining the components of a double star, with reference to the circle of declination passing through the principal star of the pair. The zero is at the north point, and the angles are measured from 0° to 360°, from the north point round by east, south, and west. For example, if the position angle is 90°, the companion is due east of the primary stem; if 180°, it is exactly south of it; and if 270°, it is due west.

Angle of Situation. The angle between the circles of declination and of latitude passing through a given star.

Angular Velocity. The rate at which the angle described by the radius vector of a moving body changes. See Radius Vector.

Annual Equation. An inequality in the moon's motion, due to the varying distance of the earth from the sun.

Annular Eclipse. A solar eclipse in which the sun is only partly covered by the moon, a ring or annulus of sunlight being left uncovered round the moon's disc.

Annular Nebulæ. Nebulæ of a ring-shaped form. They are among the rarest of celestial objects. The most remarkable object of this class is that situated between the stars β and γ Lyræ, and known to astronomers as 57 Messier.

Annular Variation. The correction to be applied per annum to the right ascension and declination of a star, due to the effects of precession and the star's proper motion.

Anomalistic Month. See Month, Anomalistic.

Anomalistic Year. The time which elapses between two successive passages of the Sun (in its apparent revolution among the stars) through the perigee of the earth's orbit. The length of the anomalistic year is 365 days 6 hrs. 13 mins. 49 secs.

Anomaly of a Planet. The angle between the place of a planet and the major axis of its orbit is called its anomaly. This angle is measured in three ways, which are known as the eccentric, mean, and true anomalies.

Anomaly, Eccentric. An auxiliary angle used in the calculation of the orbits of planets and binary stars. If a circle be described on the major axis of the elliptic orbit, and a perpendicular be drawn to the major axis through the true place of the moving body; then, if the point where this perpendicular meets the auxiliary circle be joined with the centre, the eccentric anomaly is the angle between this line and the major axis.

Anomaly, Mean. The angle between the perihelion and the mean place of a planet, comet, or the component of a binary star. The "mean place" at any given time is the place which the body would occupy if it revolved round its primary in a circular orbit with a uniform velocity, and with a period of the same length as that in the real orbit.

Anomaly, True. The angle between the perihelion of a planet and its true place in the orbits of planets and comets, or the angle between the periastron and the true place of the companion in the real orbit of a binary star, is termed the *true anomaly*.

Ansæ (Handles). A term applied to the portions of Saturn's rings which appear to project on each side (due to perspective) of the planet's globe. To the old astronomers, with their imperfect telescopes, these appeared like handles to the ball : hence the name.

Ant-apex. The point in the celestial sphere *from* which the sun is moving in space.

Antarctic Circle. The circle on the earth's surface ni the southern hemisphere, which lies 23½° from the south pole, or of which the latitude is 66½° south.

Antares. A name applied to the red star α Scorpii.

Antlia. One of the southern constellations. It lies south of Hydra and north of Vela (Argo).

Aperture. The diameter of the object-glass of a refracting telescope, or of the mirror in a reflecting telescope.

Apex. A term usually applied to denote the point in the sky towards which the sun is moving in space. This point is called the "Solar Apex." Various determinations of its position have been made; but most of the points found lie in Hercules and Lyra. The term "apex" is also sometimes applied to the point on the ecliptic towards which the earth's orbital motion round the sun is directed at any instant. This point lies 90° from the sun towards the west, and is called "the apex of the earth's way."

Aphelion. The point in the orbit of a planet or comet which is most remote from the sun. This point lies at the extremity of the major axis of the ellipse, and nearest the focus which is sometimes called "the empty focus."

Aplanatic. A term applied to a telescope or other optical instrument in which the chromatic and spherical aberrations have been satisfactorily corrected by a combination of suitable lenses. The construction of an *absolutely* aplanatic instrument is probably impossible.

Apoastron or **Aphastron.** The point in the *real* orbit of a binary star at which the components are farthest from each other. This point does not always coincide with the point of maximum distance as measured in the *apparent* orbit. The apoastron point may be found by drawing a line from the primary star to the centre of the apparent ellipse, and producing it to meet the ellipse. The opposite intersection of this line with the apparent ellipse is the periastron point.

Apogee. The point in the moon's orbit which is farthest from the earth.

Apparent Ellipse. The ellipse described by one component of a double star round the other *as seen from the earth.* The apparent ellipse is the orthogonal projection of the real ellipse on the background of the sky.

Apparent Motion. The motion of a celestial body as seen from the earth. The term is sometimes applied to the apparent diurnal motion of the heavenly bodies, due to the earth's rotation on its axis, and sometimes to the motions of the sun, moon, and planets among the fixed stars on the celestial sphere.

Apparent Sun. A term applied to the sun itself, or "true sun," to distinguish it from the imaginary, or "mean sun."

Apparition, Circle of Perpetual. See CIRCLE OF PERPETUAL APPARITION.

Appulse. The apparently close approach of two celestial bodies.

Apse, or **Apsis.** A term applied to the "perigee" and "apogee" of the orbit of the earth and moon, or the "perihelion" and "aphelion" of a planet's orbit.

Apsides, Line of. The line joining the "perigee" and "apogee" of the earth's orbit round the sun, of the moon's orbit round the earth, or the "perihelion" and "aphelion" of a planet's orbit.

Apus (the Bird of Paradise). A southern constellation. It lies between Triangulum Australis and the southern celestial pole.

Aquarids. Meteor showers visible about May 1st and July 27th to 29th in each year. They seem to radiate from points in the constellation Aquarius (326° — 2° and 341° — 2°). In both showers the meteors have long paths, but those in May are swift and those in July are slow.

Aquarius (the Water Bearer). One of the zodiacal constellations.

Aquila (the Eagle). One of the constellations. The celestial equator passes through it. Its brightest star is Altair (Aquilæ).

Ara (the Altar). One of the southern constellations.

Arc. A portion of any curve.

Arc, Diurnal. The portion of a circle parallel to the equator which is described by a celestial body between its rising and its setting.

Arc of Progression. The arc in the sky described by a planet when in direct motion—that is, from west to east, or in the order of the signs of the zodiac.

Arc of Retrogradation. The arc described by a planet when apparently retrograding—that is, moving from east to west, or contrary to its real motion in space. This apparent retrograde motion is due to the earth's motion round the sun combined with the motion of the planet.

Arctic Circle. The circle on the earth's surface in the northern hemisphere which lies 23½° from the north pole, or of which the latitude is 66½° north.

Arcturus. A name applied to the bright star α Boötis.

Areal Velocity. The area of the sector traced out by the "radius vector" of a moving body in the unit of time. This area is equal to half the linear velocity multiplied by the perpendicular from the centre of force, or the tangent at the given point.

Areas, Kepler's Law of. When one body revolves round another as a centre of force, the radius vector, or line joining the two bodies, traces out equal areas in equal times. This law applies to the motion of the earth and planets round the sun, the satellites round the planets, the components of binary stars round each other: in fact, it holds true in the case of any body moving round a centre of force under *any* law of force.

Argo (the Ship Argo). A large constellation in the southern hemisphere. It is usually subdivided into four divisions: Puppis, Malus, Vela, and Carina. Its brightest star is Canopus, which ranks only second to Sirius in brilliancy.

Arided. A name sometimes applied to the star α Cygni.

Ariel. The inner satellite of Uranus, or that nearest to the planet. Its mean distance from the planet's centre is about 127,000 miles, and its period of revolution 2 days 12 hrs. 29 mins. It can be well seen only with a large telescope, and its diameter is uncertain. Ariel was discovered by Lassell on Sept. 14th, 1847.

Aries. One of the zodiacal constellations. When the signs of the zodiac were established, the *vernal* equinox was situated at the beginning of this constellation, but owing to the precession of the equinoxes, the point of intersection of the ecliptic and equator has now retrograded into Pisces. The point is, however, still termed *the first point of Aries.*

Armillary Sphere. An ancient instrument constructed with metallic circles representing the astronomical circles of the celestial sphere.

Arnab. A name sometimes applied to the star α Leporis.

Artificial Horizon. A box containing mercury, which forms an horizon when observing altitudes of the celestial bodies. With an artificial horizon there is no *dip* to be taken into account (see DIP OF HORIZON), and the observed angle is double of the real angle of elevation or altitude.

Ascension, Right. The angular distance of a celestial body, measured from the "First Point of Aries" eastwards on the equator. This, combined with the declination, which is measured north and south from the equator on a great circle passing through the celestial poles and the body, determines the position of the object on the celestial sphere.

Asell Australis. A name applied by the ancient Romans to the star δ Cancri.

Asterism. A constellation or group of stars.

Asteroids, or **Minor Planets,** which see.

Asterope. One of the stars in the Pleiades.

Astræa. One of the minor planets which revolve round the sun in orbits lying between those of Mars and Jupiter. It was discovered by Hencke on Dec. 8th, 1845. It revolves round the sun in about 4·14 years, at a mean distance of 2·578 times the earth's mean distance from the sun. Even when favourably situated, its magnitude does not exceed the ninth, and its real diameter does not probably exceed sixty miles.

Astral. Having relation to the stars.

Astrolabe. An instrument invented by Hippardeus to show the circles of the celestial sphere.

Astrology. The so-called science of predicting future events by the positions and aspects of the sun, moon, and planets.

Astrometer. An instrument for measuring the relative brightness of the stars. The term *photometer* is now generally used.

Astrometry. The measurement of the relative brightness of the stars. Now called *photometry*.

Astronomical Clock. A clock used in astronomical observations and regulated to show sidereal time. It therefore gains nearly four minutes a day on an ordinary clock, or 24 hours in the year. The dial is divided from 0 hrs. to 24 hrs., and the hands should point to 0 hr. 0 min. 0 sec. when the "First Point of Aries" transits the meridian.

Astronomy. The science which deals with the heavenly bodies, their distances, magnitudes, and motions, and the laws which govern them. It is derived from two Greek words—*ἀστήρ*, a star, and *νόμος*, a law—the law of the stars.

Atlas. One of the stars in the Pleiades. Otherwise known as 27 Tauri. The term is also applied to a set of star maps.

Atmosphere. The gaseous envelope surrounding the earth and some, at least, of the planets of the solar system. The earth's atmosphere consists of a mechanical mixture of oxygen and nitrogen gases, the proportions by volume being 79 parts nitrogen and 21 parts oxygen, with a very small quantity of carbonic acid gas. It probably extends to a height of 100 miles or more above the earth's surface, with a constantly diminishing density; but the pressure is equivalent to that of a homogeneous atmosphere of about $5\frac{1}{4}$ miles in height and of a density equal to that at the earth's surface.

Attraction of a Sphere. The attraction of a sphere on a body outside it is the same as if the whole mass were collected at the centre of the sphere.

Augmentation of Moon's Apparent Diameter. The increase in the moon's apparent diameter due to an observer on the surface of the earth being nearer to the moon than the earth's centre, to which mathematical calculations are referred.

Auriga (the Waggoner or Charioteer). One of the northern constellations. Its principal star, Capella, is one of the brightest stars in the northern hemisphere, and is about twice as bright as an average star of the first magnitude.

Aurora Borealis, or **Northern Lights.** A luminous phenomenon visible in the atmosphere in the arctic regions, and occasionally, to some extent, in more southern latitudes. A similar phenomenon occurs near the south pole. Auroræ are supposed to be caused by electrical discharges in the upper regions of the earth's atmosphere.

Australis, Asad. A name sometimes applied to the star ϵ Leonis.

Autumnal Equinox. The equinox at which the sun passes from the north to the south side of the equator. This takes place on September 23rd. See EQUINOXES.

Axis of an Orbit. This term is applied to the major axis of the ellipse in elliptical orbits. It is also the line of apsides.

Axis of a Planet. An imaginary line through the planet, round which it rotates.

Axis of Figure. The solids formed by the revolution of a given surface round a fixed line. This line is called the axis of figure. Thus, an oblate spheroid may be supposed to be generated by the rotation of an ellipse round its minor axis. In this case the minor axis is the axis of figure.

Axis of Rotation. The axis round which a body rotates. In the case of the earth recent researches seem to show that the axis of rotation does not coincide *exactly* with the axis of figure. The difference is, however, very small.

Azelfafage. A name sometimes applied to the star π' Cygni.

Azha. A name sometimes applied to the star η Eridani. The Arabic word is *Udh-ha.*

Azimech. The star Spica (α Virginis) is sometimes called *Spica Azimech.*

Azimuth. The angle between the meridian and the great circle passing through the zenith and any given celestial body is called the *azimuth* of the body.

B.

Barlow Lens. A miniature achromatic object-glass with a negative focus, sometimes used in telescopes to increase the power of the eyepiece. It is placed between the object-glass and eyepiece, a few inches behind the eyepiece.

Base-line. A carefully measured line used in trigonometrical surveying, and also in the calculation of the distances of the heavenly bodies. In finding the sun's distance the base line is the earth's semi-diameter or radius, and in the determination of stellar distances the base line is the radius of the earth's orbit, or the mean distance of the earth from the sun.

Baten Kaitos. A name applied by the Arabian antronomers to the star ζ Ceti.

Beads, Baily's. A broken line of light seen on the sun's limb immediately before the totality of a solar eclipse. They are so called after the astronomer Francis Baily, who described them in 1836, but they were first seen by Halley during the total eclipse of 1715. A similar appearance has also been seen at the end of the total phase, and also in annular eclipses.

Beïd. A name applied by the Arabian astronomers to the star ο Eridani. The word signifies an egg, and is supposed to have been given to the star on account of its white colour.

Bellatrix. A name applied to the star γ Orionis.

Belts. A term applied to the dark-coloured bands visible with a telescope on the discs of Jupiter and Saturn.

Benetnasch. A name sometimes applied to the star η Ursæ Majoris. From the Arabic *sarîr banâtnasch.*

Berthon's Dynamometer. An instrument for measuring the power of the eyepiece of an astronomical telescope, invented by the Rev. E. L. Berthon.

Bessel's Day Numbers. See Day Numbers.

Bestiary. A name formerly applied to the zodiac.

Betelgeuse. A name applied to the red and variable star α Orionis. From the Arabic *ibit-al-djauzâ.*

Bifid. A term applied to comets' tails when they appear divided into two portions along their length.

Binary Stars. Double stars in which the components revolve round each other, or rather round their common centre of gravity. The number of known binary stars is now very considerable—probably not far short of a thousand. But, owing to the small arc of the orbit described by most of them since their discovery, it has been found possible to compute the orbit only in a limited number of cases. The orbits of about seventy binary stars have now been fairly well determined, some with considerable accuracy (one or more complete revolutions having been described). The periods of revolution vary in length from about 11½ years to over 1600 years. (For List, see Appendix.)

Binocular. A form of telescope or large opera-glass having two tubes, used with both eyes at the same time.

Binuclear. A term applied to nebulæ which have two *nuclei* or condensations of light.

Bissextile. A term sometimes applied to Leap Year, in which a day is added to the month of February every four years.

Black Drop. An optical effect sometimes noticed in transits of Venus. Just after internal contact at ingress, and just before internal contact at egress, the planet has been seen in some transits apparently attached to the sun's limb by a dark ligament, probably the effect of irradiation and imperfect telescopes.

Bode's Law.* An empirical law connecting the distance of the planets from the sun. The law is as follows:—To each of the series of numbers 0, 3, 6, 12, 24, 48, 96, 192, 384 (in which each number—after the second—is double the preceding number) add 4, and we obtain the series 4, 7, 10, 16, 28, 52, 100, 196, 388, which represent approximately the distances of the planets from the sun, with the exception of Neptune, for which the distance indicated is considerably too large. The Earth's distance being taken as 10, that of Neptune is about 300.

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* Bode's Law was really discovered by Titius.

Bolides. A name applied to the large meteors; also known as fireballs.

Boötes (the Herdsman). One of the northern constellations. Its brightest star is Arcturus, one of the brightest stars in the heavens.

Borda's Principle of Repetition. A method of obtaining a more accurate measure of an angle by repeating the measure several times, and taking a mean of the measures. This is supposed to eliminate the errors due to imperfect graduation of the measuring circles, but in practice is not found very satisfactory, owing probably to imperfect clamping.

Box Sextant. A miniature form of sextant, chiefly used in surveying.

C.

Cælum (the Sculptor's Tool). One of the southern constellations.

Calendar (Gregorian). The omission of three leap years in every four hundred years was proposed by Pope Gregory XIII., and is called the *Gregorian correction.* According to this calendar, every year which is a multiple of 100 and is divisible by 400 is a leap year, and those not divisible by 400 are not leap years. Thus 1700, 1800, and 1900, are not leap years; but 2000 will be a leap year. The correction proposed by Pope Gregory leaves a small difference between the tropical year and the average civil year of about 1·23 day in 4000 years; but this may be safely neglected.

Calendar (Julian). The introduction of a leap year (a year with an additional day) every four years was due to Julius Cæsar, B.C. 44, and the calendar so constructed is called the Julian Calendar.

Calendar Month. The month used for the ordinary purposes of life. April, June, September and November have thirty days each, February has twenty-eight (and in leap year twenty-nine), "and all the rest have thirty-one."

Camelopardalis (the Giraffe). One of the northern constellations.

Cancer (the Crab). One of the zodiacal constellations.

Canes Venatici (the Hunting Dogs). One of the northern constellations.

Canis Major (the Great Dog). One of the southern constellations. Its principal star is Sirius, the brightest star in the heavens.

Canis Minor (the Little Dog). One of the constellations. Its principal star is Procyon, one of the brightest stars in the sky.

Canopus. A name applied to the bright southern star α Argûs. It ranks only second to Sirius in brilliancy. Derived from the Arabic word *Kânupus.*

Capella. A name applied to the bright star α Aurigæ.

Caph. A name sometimes applied to the star β Cassiopeiæ.

Capricornus (the Goat). One of the zodiacal constellations.

Cardinal Points. The cardinal points are north, south, east, and west. The north and south points are where the meridian meets the horizon. The east and west points are the intersections of the celestial equator with the horizon.

Carina (the Keel). A name applied to a part of the southern constellation Argo.

Cassegrainian Telescope. A form of reflecting telescope in which the smaller mirror is *convex*, and the reflected rays pass through a circular aperture in the large mirror.

Cassiopeia. One of the northern constellations. Popularly spoken of as "Cassiopeia's Chair."

Castor. A name applied to the star α Geminorum. It is a remarkable double and binary star.

Catoptrics. A division of the science of optics which deals with images formed by reflection from mirrors.

Cavendish Experiment. An experiment devised by Michell, and carried out by Cavendish in 1798, for the purpose of determining the density of the earth. The apparatus consists of two small equal balls placed at the extremities of a wooden rod, and suspended from the centre by a thin wire. The attraction of two heavy spheres placed alternately on opposite sides of the small balls produces a torsion in the suspending wire, the amount of which can be calculated. By observing the time of a small oscillation of the rod when acted on by gravity alone, and comparing this with the former result, the earth's density can be computed. See DENSITY OF EARTH.

Cebalrai. A name sometimes applied to the star β Ophiuchi.

Celæno. One of the stars in the Pleiades.

Celestial Equator. The great circle in which the plane of the terrestial equator meets the star sphere.

Celestial Globe. A globe on which the stars and constellations are depicted. In examining such a globe it should be remembered that the stars are drawn as supposed to be seen by an eye placed at the centre of the globe. The constellations are therefore reversed, and cannot be compared directly with the sky unless the inversion is mentally corrected.

Celestial Horizon. See Horizon, Celestial.

Celestial Latitude. The angular distance of a celestial body from the ecliptic, measured on a great circle at right angles to the ecliptic.

Celestial Longitude. The angular distance from the "First Point of Aries" to a "secondary" to the ecliptic passing through a given star. Celestial longitude is measured eastwards from the ecliptic.

Celestial Meridian. The great circle of the celestial sphere which passes through the zenith, nadir, and celestial poles.

Celestial Poles. The points in the celestial sphere towards which the earth's axis of rotation points. They are, in fact, the extremities of an imaginary axis round which the star sphere *apparently* rotates.

Celestial Sphere. The hollow sphere on the surface of which the heavenly bodies seem to be placed. The observer's eye is practically situated at the centre of the sphere, and consequently a complete hemisphere is always visible to the observer at any point on the earth's surface.

Centaurus (the Centaur). One of the southern constellations.

Centre of Ellipse. The middle point of the major axis of an ellipse, or the point where the major and minor axis intersect at right angles.

Centre of Figure. The centre of a regular solid, such as the sphere, ellipsoid, etc., is called the *centre of figure.*

Centre of Mass. The "centre of gravity" of a body is sometimes called the centre of mass. In a homogeneous sphere this will coincide with the centre of the sphere or the centre of figure; but, if the sphere is not of the same density throughout, the centre of mass will not coincide with the centre of figure.

Centrifugal Force. If a body of mass, m, revolves in a circle of radius, r, with a velocity, v, the centrifugal force is $\frac{mv^2}{r}$, and acts outwards from the centre.

Centripetal Force. The force acting *towards* the centre which balances the centrifugal force.

Cepheus (the Monarch). One of the northern constellations.

Ceres. One of the minor planets revolving round the Sun in orbits lying between those of Mars and Jupiter. It was discovered by Piazzi at Palermo on January 1st, 1801 (the first day of the nineteenth century). It revolves round the Sun in a period of 4·60 years, at a mean distance of 2·767 times the Earth's mean distance from the Sun. The eccentricity of the orbit is small—only 0·076. Its opposition magnitude is about 7·7, and its real diameter perhaps about two hundred miles.

Cetus (the Whale). One of the constellations.

Chamæleon (the Chamelion). One of the southern constellations.

Chaph. A name sometimes applied to the star β Cassiopeiæ.

Cheliab. A name given in the Arabo-Latin Almagest to the constellation Perseus.

Chimah. An ancient name for the constellation Taurus.

Chinese Annals. Records of astronomical phenomena have been kept in China for many hundreds of years. These are generally referred to in books on astronomy as "the Chinese Annals of Ma-tuoan-lin."

Chronograph. An instrument devised for recording the times of star transits across the wires of a transit instrument. It was designed to supersede the old "eye and ear method." The instrument consists of a cylinder covered with paper, which is made to revolve steadily by clockwork and pushed forward by a screw on the axle. The record is made by means of a pen electrically connected with a button under the control of the observer.

Chronometer. A timepiece carefully constructed so as to keep accurate time.

Circinus (the Compass). One of the southern constellations.

Circle, Great. A circle on a sphere, the plane of which passes through the centre of the sphere.

Circle of Perpetual Apparition. A "small circle" of the celestial sphere, within which the stars do not pass below the horizon at any time. The radius of this circle is equal to the latitude of the place of observation. At the terrestrial poles, therefore, all the visible stars are within the circle of perpetual apparition, which is evidently bounded by the horizon. At the terrestrial equator there is no circle of perpetual apparition.

Circle of Position. A small circle on the earth's surface, the angular radius of which is equal to the sun's zenith distance at any given time. It is used in determining a ship's position at sea by Captain Sumner's method.

Circle, Small. Circles on a sphere, the plane of which does not pass through the centre of the sphere.

Circle, Transit. See TRANSIT INSTRUMENT.

Circles of the Celestial Sphere. Imaginary circles drawn on the celestial sphere, and used for purposes of astronomical measurement.

Circumpolar Stars. Stars which never set at the place of observation. The polar distance of such stars must, therefore, be less than tho latitude of the place. It follows that at the terrestrial poles all the visible stars are circumpolar, and at the terrestrial equator there are no "circumpolar stars."

Civil Year. Usually 365 days, but once in every four years 366 days long (leap year). The average length of the civil year is nearly the same as that of the "tropical year," but 11¼ minutes longer. See Leap Year and Tropical Year.

Clamp. A screw for temporarily tightening portions of astronomical instruments.

Clepsydra. An instrument for measuring time, used by ancient Greeks and Romans, and other nations. It consisted of a vessel filled with water, having a small hole in the bottom. The quantity of water discharged measured the lapse of time. Clepsydræ seem to have been invented by Ctesibius, of Alexandria, about 250 B.C.

Clock, Astronomical. See Astronomical Clock.

Clock Stars. Stars used for finding the error of an astronomical clock.

Clusters, Star. Groups of small stars very close together. These are usually divided into (1) large and scattered clusters, (2) small compressed clusters, and (3) globular clusters.

Co-latitude. The trigonometrical complement of the latitude, or the difference between the latitude and 90°.

Collimating Eyepiece. An eyepicce used in the adjustments of a transit instrument.

Collimation, Error of. The line of collimation (which see) should bo at right angles to the axis round which the telescope turns. If this be not so, the error is called the *error of collimation.*

Collimation, Line of. The line joining the optical centre of the object-glass of an astronomical telescope with the intersection of the middle wires in the eyepiece.

Collimators. Small telescopes placed due north and south of a transit instrument, and used for adjusting the line of collimation in the larger instrument.

Coloured Stars. Most of the stars are of different colours. Some are white or bluish-white, some yellow, others orange, and various shades of red (for list of remarkably red stars see Appendix). The components of many double stars show beautifully contrasted colours.

Columba (the Dove). One of the southern constellations. It lies south of Lepus, and south-west of Canis Major.

Colure, Equinoctial. The great circle, or circle of declination, which passes through the equinoctial points and the celestial poles.

Colure, Solstitial. The great circle which passes through the solstitial points and the celestial poles. This circle also passes through the pole of the ecliptic.

Comes. The fainter of the two components of a double star. Plural, *comites.*

Cometography. The department of astronomy which deals with comets.

Comets. "The word 'comet' is derived through the Latin *cometa* and the French *comète* from the Greek κομήτης. In that language κόμη signifies the hair of the head; and the first idea of comets was that they were bodies with hair-like appendages, appearing to stream from them like the hair from a person's head" (Lynn, *Remarkable Comets*). Some telescopic comets however, have no tails. Comets usually move round the sun in very elongated orbits. Some of them are periodical and therefore regular members of the solar system; others are seen only once, and never return to the sun's vicinity.

Commensurability. A term applied to the equality between a certain number of periods of revolution of a planet or satellite with some other number of periods of another planet or satellite. Thus, two periods of revolution of Saturn round the sun are nearly equal to five of Jupiter. An example of commensurability is also found in the satellites of Saturn, the period of Tethys being double that of Mimas, and the period of Dione double that of Enceladus.

Commutation, Angle of. The angular distance between the sun's place, as seen from the earth, and that of a planet reduced to the ecliptic.

Compass, Points of. See POINTS OF COMPASS.

Complement of an Angle. The difference between the angle and 90°.

Compression of a Planet. The amount by which a planet is flattened—like the earth—at the poles. This is usually expressed as follows: If e be the equatorial diameter, and p the polar, then the compression $= \frac{e-p}{e}$. For the earth the compression is about $\frac{1}{300}$; but for Jupiter, Saturn, and probably Uranus, the compression is considerably greater. The compression is also termed the *ellipticity* of the planet.

Cone. A solid which may be supposed to be generated by the revolution of a right-angled triangle round the perpendicular or vertical side of the triangle. The solid thus formed is termed a *right cone*, and the perpendicular of the generating triangle is called the axis. If the axis is not at right angles to the base, it is called an *oblique cone.*

Configuration. A term applied to the particular arrangement of the stars in a constellation or cluster, or the relative positions of the moon, planets, or other celestial bodies.

Conic Sections. These curves are known as the parabola, ellipse, and hyperbola. They are called conic sections because they may be supposed to be formed by the intersection of a plane and a cone. If the cutting plane intersects both sides of the cone, but is inclined to the axis of the cone, the section will be an ellipse; if it cuts obliquely parallel to the side of the cone, the boundary of the section will be a parabola; and if it be perpendicular to the base of the cone, the section will be an hyperbola. If the plane be perpendicular to the axis, the section will be a circle; so that the circle is merely a special form of the ellipse.

Conjunction. When two celestial bodies have the same longitude they are said to be in *conjunction.* The inferior planets Mercury and Venus are said to be in *inferior conjunction* with the sun when they pass between (or nearly between) the earth and sun. When in that part of their orbit which lies beyond the sun they are said to be in *superior conjunction.*

Co-ordinates. In analytical geometry the position of a point on a plane is determined by means of two co-ordinates. These may be either measured along two axes at right angles, when they are termed *rectangular co-ordinates*, or by an angle and distance, when they are called *polar co-ordinates.* The position of a point on the earth's surface is fixed by two co-ordinates, latitude and longitude. The position of objects on the celestial sphere are determined by the following systems: (1) Altitude and Azimuth; (2) North Polar distance and Hour Angle; (3) Right Ascension and Declination; (4) Latitude and Longitude (with reference to the ecliptic). (1) and (2) are affected by the earth's rotation; (3) and (4) are unaffected.

Constant. In astronomical and mathematical calculations a quantity which has always the same value.

Constellations. The groups or divisions into which the stars are divided for purposes of identification.

Copernican Theory. The theory that the sun forms the centre of the solar system. First advanced by Copernicus in the sixteenth century, and now universally accepted.

Cor Caroli. A name sometimes applied to the star α in Canes Venatici.

Cor Hydræ. A name sometimes applied to the star α Hydræ, otherwise known as Alphard.

Cor Leonis. A name sometimes applied to the star α Leonis or Regulus.

Corona Australis. One of the southern constellations.

Corona Borealis. One of the northern constellations.

Cor Serpentis. A name sometimes applied to the star α Serpentis.

Corvus (the Crow). One of the southern constellations.

Cosmical. A term applied to any fact or phenomenon connected with the heavenly bodies.

Co-tidal Lines. Imaginary lines on the earth's surface, passing through places where the tidal conditions are the same at the same time.

Crater (the Cup). One of the southern constellations.

Craters, Lunar. The ring-shaped formations on the moon's surface, visible with a telescope.

Crepuscular. A term applied to the twilight illumination of the sky.

Crux (the Cross). One of the southern constellations, containing the famous Southern Cross.

Culmination. The transit of a celestial body across the meridian of the place of observation. It then attains its highest altitude above the horizon ; hence the name.

Cursa. A name sometimes applied to the star β Eridani. Derived from the Arabic *kursi al-djauzâ al-mukaddam*, "the front throne of the giant," a term given by the Arabian astronomers to the stars λ, β, ψ Eridani and τ Orionis, which form a small quadrilateral figure close to Rigel.

Curtate Distance. The distance of a celestial body belonging to the solar system from the earth or sun when its place is projected on the plane of the ecliptic.

Cusps. The points of the "horns" of the crescent moon, or of the illuminated portion of the discs of Mercury and Venus when in the crescent phase.

Cycle. A period of time in which a series of celestial phenomena occur over again.

Cycle of Eclipses. A period during which eclipses of the sun and moon occur in nearly the same order. See SAROS and METONIC CYCLE.

Cygnus (the Swan). One of the northern constellations. Marked by the long cross formed by the stars α, δ, γ, ϵ, and β Cygni.

Cynosura. A name sometimes applied to the pole star (Polaris).

D.

Dark Glasses are used in telescopes when observing the sun. They are placed over the eyepiece to moderato the excessive glare and heat.

Day, Apparent Solar. The interval of time between one apparent noon and the next, or between two successive midnights.

Day, Lunar. The time which elapses between two successive passages of the moon across the meridian. The mean length of the lunar day is about 24 hrs. 50 mins. 32 secs.

Day Numbers, Bessel's. Small corrections to be added to the right ascensions and declinations of stars given for any certain epoch to reduce them to another epoch. These corrections are necessary to allow for the effects of precession, nutation, and aberration.

Day, Sidereal. The period of the apparent revolution of the stars round the celestial pole with reference to the meridian. The sidereal day is counted from *sidereal noon*, or the time of transit of the "First Point of Aries" across the meridian.

Declination denotes the angular distance of a celestial body north or south of the celestial equator. It is measured on a great circle passing through the body and the celestial pole. When the body is north of the equator, the declination is usually designated +, and when south of the equator, —.

Declination Circle. A great circle of the sphere passing through the celestial pole. On these circles the declinations of celestial bodies are measured. The term is also applied to the graduated circle of an equatorial telescope on which the declination of celestial objects is measured.

Declination Parallel. A small circle of the celestial sphere, every point on which has the same declination. The planes of these circles are consequently parallel to the plane of the equator.

Degree. In measuring angles the circle is divided into 360 equal parts. Each of these divisions is called a *degree*. The degree is subdivided into 60 minutes, and each minute into 60 seconds.

Deimos. The outer satellite of Mars, or that farthest from the planet. Its distance from the centre of Mars is about 14,500 miles, and it revolves round the planet in about 30 hrs. 18 mins. Its diameter is probably not more than 7 miles. Deimos was discovered by Professor Asaph Hall on Aug. 11th, 1877.

Delisle's Method of determining the Solar Parallax. In this method of observing transits of Venus, the sun's parallax is obtained by noting the difference between the times of beginning or ending of the transit from stations widely separated on the earth's surface. The places of observations must be near the earth's equator. Delisle's method succeeds best when the transit is nearly central—that is, when Venus passes nearly along a diameter of the sun's disc.

Delphinus (the Dolphin). One of the northern constellations, marked by a small rhomb of stars of fourth to fifth magnitude.

Deneb. A name sometimes applied to the star β Leonis.

Deneb Adige. A name applied to the star α Cygni. From the Arabic *dzanab al-dadjâdja*, "the tail of the hen" (or swan).

Deneb Algiedi. A name sometimes applied to the star δ Capricorni.

Denebola. A name sometimes applied to the star β Leonis. It is also called Deneb and Deneb Alcat.

Densities of Sun and Planets. From the principles of mathematical astronomy, the mass of the sun and planets can be found in terms of the mass of the earth. Then the density of the earth being known, and the relative volumes of the sun and earth, we can find the sun's density, or its specific gravity, with reference to an equal volume of water. In the same way the densities of the planets can be determined.

Density of the Earth. The relation between the weight of the earth as a whole and that of an equal volume of water. Taking water as 1, experiments made to determine the earth's density vary from 4·71 to 6·56. The result found by Francis Baily, by means of the "Cavendish Experiment"—namely, 5·66—is probably the best.

Descending Node of a planet's orbit (or comet's orbit) is the point where the planet's orbit cuts the ecliptic, when the planet is descending from the northern to the southern side of the ecliptic.

Diagonal Eyepiece. An eyepiece used in refracting telescopes for observing objects near the zenith. The rays from the object are reflected at right angles to the tube of the telescope by means of a prism or plane mirror.

Diameter, Apparent. The angle which the diameter of a celestial body subtends as viewed from the earth.

Dichotomy. A cutting in two. A term applied to the moon, Mercury, and Venus, when the illuminated portion is an exact semicircle.

Differentiation. The determination of the place of a celestial body by measurements from another the position of which is accurately known.

Digit (or Finger). A term used with reference to eclipses of the sun and moon. It denotes the $\frac{1}{12}$th of the diameter, and the number of digits indicates the magnitude of the eclipse.

Diminution of Gravity. The diminution in the weight of a body on the surface of the earth, or on the planets, due to the centrifugal force produced by the rotation of the earth or planet on its axis. This diminution attains its maximum at the equator.

Dione. One of the satellites of Saturn, the fourth in order counting from the planet, round which it revolves at a mean distance of about 239,000 miles in a period of 2 days 17 hrs. 41 mins. Its diameter is uncertain; but its stellar magnitude is, according to Professor Pickering, 11·5. It was discovered by J. D. Cassini in March 1684.

Dionysian Period. A period of 532 years, formed by multiplying together the lunar and solar cycles (19 × 28 = 532). At the end of this period the moon's changes "take place on the same days of tho week and month as before" (Chambers' *Descriptive Astronomy*).

Dioptrics. A division of the science of optics which deals with images formed by refraction through lenses.

Diphda. A name sometimes applied to the star β Ceti. From the Arabic *al-dhifda*, "the frog" (!).

Dip of Horizon. The angle between the horizontal line through the eye of an observer, and the line from his eye to the *offing*, or visible horizon, is called the *dip of the horizon.* This "dip" is due to tho earth's rotundity, and increases with the height of the eye above the sea-level. The dip is diminished by refraction, which apparently increases the distance of the visible horizon.

Dip Sector. An instrument on the principle of double reflection, devised by Troughton for the determination of refraction, but subsequently used by Dr. Wollaston for measuring the dip of the horizon ; hence its name.

Direct Motion. The motion of a planet when it is moving from west to east among the stars. The term is also applied to the motions of comets when they move in the same direction as the planets, or contrary to the hands of a clock. It is also applied to the angular motion of the components of a binary star when the position angle is increasing.

Disc. The visible surface of the sun, moon, planets, and satellites.

Dispersion of Light. When a beam of white light is passed through a prism it is lengthened out into a rainbow-tinted band. This is due to the different rays being refracted in different degrees, and is called *dispersion.*

Disturbing Forces. Forces which tend to disturb the exact elliptical motion of a body round a centre of force. Thus, the moon's motion round the earth is disturbed by the attraction of the sun and planets, and the motion of the earth and planets is disturbed by the attraction of each other.

Diurnal Aberration. See ABERRATION.

Diurnal Libration. A small libration of the moon, due to the earth's rotation on its axis. When the moon is rising we see a little more of its western side than when it is near the zenith, and when it is setting a little more of the eastern side. The effect is really due to parallax, caused by the earth's rotation on its axis. Its maximum amount is equal to the moon's horizontal parallax, or about 57′.

Diurnal Motion. The apparent motion of the celestial bodies from east to west, due to the rotation of the earth on its axis from west to east.

Dorado (the Sword-Fish). One of the southern constellations.

Double Stars. Stars which appear as single stars to the naked eye, but are seen to consist of two stars when viewed with a telescope. Some of these objects are visible with small telescopes, while others have their components so close that they require the largest instruments to divide them. If the components revolve round each other the double star is called a *binary star*. If there is no relative orbital motion the object is called an *optical double,* as one component may possibly be far out in space beyond the other, and only accidentally placed nearly in the same direction.

Draco (the Dragon). One of the northern constellations.

Draconids. A meteor shower visible about August 21st to 23rd in each year. The meteors seem to radiate from a point in the constellation Draco (291° + 60°). They are slow, with trains.

Dubhe. A name sometimes applied to the star α Ursæ Majoris, the northern of the two "pointers."

Dynamical Mean Sun. An imaginary sun, or rather point, which is supposed to coincide with the true sun at perigee and to move along the ecliptic at a mean rate in a period of one year.

Dynamometer. An instrument for measuring the magnifying power of the eyepieces of telescopes.

E.

Earth. The planet which we inhabit. The earth is an oblate spheroid—that is, it is slightly flattened at the north and south poles. For data respecting the earth, see Appendix.

Earth Shine. The dark part of the moon visible a little before and a little after "new moon." It is due to reflected light from the earth; hence the term. It is called by the French *Lumière cendrée.*

Earth's Way. The angle between the direction in which a star is seen and the direction of the earth's orbital motion at the time. It is used in calculating the *coefficient of aberration.* See Aberration.

Eccentricity of an Orbit. In an elliptic orbit the distance of each of the foci from the centre of the ellipse. The eccentricity is usually expressed as a decimal fraction of the semi-axis major of the ellipse. Thus, if the eccentricity of an orbit be 0·20, it means that each of the foci lie at a distance from the centre equal to $\frac{1}{5}$th of the semi-axis major.

Eccentricity of the Earth's Orbit. The eccentricity is at present about 0·01677, or nearly $\frac{1}{60}$. According to Le Verrier, the eccentricity varies between the limits 0·0747 and 0·0047. At present the eccentricity is diminishing, but will not reach its minimum value for many thousand years. Harkness gives the formula

$$e = 0{\cdot}016771049 - 0{\cdot}000{,}0004245\,(t - 1850) - 0{\cdot}000{,}000{,}001367\left(\frac{t - 1850}{100}\right)^2$$

for the eccentricity at any future epoch, *t.*

Eclipse. The passing of one celestial body through the shadow of another, as the passage of the moon through the earth's shadow, the disappearance of the satellites of Jupiter in the shadow of the planet, etc.

The term is also usually applied to eclipses of the sun; but these are more correctly *occultations* by the moon (see OCCULTATION). A true eclipse is one in which the surface of the body is actually darkened; but in the case of solar eclipses the sun's surface is evidently not darkened.

Ecliptic. The great circle of the celestial sphere along which the sun apparently travels during the year.

Ecliptic, Obliquity of. See OBLIQUITY.

Egress. The end of a transit of Mercury or Venus, when the planet passes off the sun's disc, or of a satellite off the disc of its primary.

Electra. One of the stars in the Pleiades.

Elements of a Binary Star Orbit. Quantities which define the position of the stellar orbit in space with reference to a tangent plane to the celestial sphere (or the background of the sky) at the place of the primary star. Also the time of revolution of one component round the other, or rather of both round the common centre of gravity, the epoch of the periastron passage, and the eccentricity of the real orbit. These elements are: P, the period in years; T, the time of periastron passage; e, the eccentricity of the real orbit; Ω, the position angle of the line of nodes; i or γ, the inclination of the orbit to the plane of projection; λ, the position of the periastron measured from the node on the real orbit; and a, the semi-axis major of the real orbit in seconds of arc.

Elements of a Comet's Orbit. Quantities which define the position of a comet's orbit in space with reference to the plane of the ecliptic. These are: π, the longitude of the perihelion, or the comet's longitude when it passes through that point; Ω, the longitude of the ascending node as seen from the sun; q, the perihelion distance from the sun, expressed in terms of the earth's mean distance from the sun; i, the inclination of the orbit to the plane of the ecliptic. Other elements are: the time of perihelion passage, and—if the orbit is elliptic—the period of revolution round the sun in years, and the eccentricity of the orbit.

Elements of a Planet's Orbit. Quantities which determine the position of a planet's orbit in space with reference to the plane of the ecliptic. These are: a, the mean distance from the sun (that of the earth $= 1$); P, the mean sidereal period in mean solar days; e, the eccentricity; i, the inclination of the orbit plane to the plane of the ecliptic; Ω, the longitude of the ascending node; π, the longitude of the perihelion measured from the node on the orbit; L, the mean longitude of the planet at a certain time; and E, the epoch for which L is given.

Elements of a Variable Star. These are: (1) epoch of maximum or minimum light; (2) the mean length of the period from maximum to maximum, or from minimum to minimum; (3) the variation of light, or the stellar magnitude at maximum and the magnitude at minimum. In some cases more elaborate formulæ are given.

Elevation. A term sometimes applied to the altitude of a celestial body above the horizon. See ALTITUDE.

Ellipse. One of the conic sections. An ellipse may be supposed to be formed by the intersection of a plane with a cone, the cutting plane being inclined to the axis of the cone, and cutting both sides of the cone. In the ellipse, the distance of every point on the curve from a fixed point within it is proportional to its perpendicular distance from a fixed line outside the curve. The fixed point is called the *focus*, and the fixed line the *directrix*. There are two *foci*, both situated on the longer axis of the ellipse. Another property of the ellipse is that the sum of the distances of any point on the curve from the foci is constant and equal to the major axis of the ellipse.

Elliptic Motion. When one body revolves in an elliptic orbit round another situated in one of the foci of the ellipse the motion is called *elliptic motion.*

Ellipticity of the Earth and Planets. Same as Compression, which see.

Elongation. The difference between the celestial longitude of a planet and that of the sun. The elongation of a satellite is the angular distance of the satellite from its primary.

Emersion. The reappearance of a star or planet after occultation by the moon, or the reappearance of a satellite after being eclipsed in the shadow of its primary.

Enceladus. One of the satellites of Saturn, the second in order counting from the planet, round which it revolves in a period of 1 day 8 hrs. 53 mins. at a mean distance of about 151,000 miles. Its diameter is uncertain. It was discovered by Sir William Herschel on August 28th, 1789. According to Professor Pickering, the stellar magnitude of Enceladus at mean opposition is 12·3.

Enib. A name sometimes applied to the star ϵ Pegasi.

Epact. A number employed in the construction of the calendar.

Ephemeris. A table showing the predicted positions of a moving celestial body.

Epicycle. A small circle the centre of which lies on the circumference of a larger circle. It was a device used by the ancient astronomers to explain the apparent motions of the planets, when the earth was supposed to be the centre of the planetary system.

Epoch. A date of reference used in astronomical calculations.

Equation, Annual. An inequality in the moon's motion due to the varying distance of the sun from the earth.

Equation of Equinoxes. Owing to nutation there is a periodical oscillation of the "First Point of Aries," the period being about $18\frac{2}{3}$ years. The angular distance between the mean and true position is called the *Equation of the Equinoxes,* and is about $15'\ 37''$.

Equation of Light. The time taken by light to pass from the sun to the earth. This is about 8 mins. 18 secs.

Equation of the Centre. The angle by which the true longitude of the earth differs from its mean longitude. Its maximum value is $1^\circ\ 55'\ 33{\cdot}3''$. The term is also applied in the same sense to the orbits of the planets.

Equation of Time. The amount which it is necessary to add to or subtract from the apparent time in order to obtain the mean time.

Equation, Personal. The error in the time of transit of a celestial body by a particular observer is called his "personal equation." The term might also be applied to other observations, such as the relative brightness of white and coloured stars, etc.

Equations of Condition. Equations which express the relations existing between the coefficients of another equation. These equations are employed to determine from observations the values of the coefficients in a general equation. They are usually solved by a method known as the Method of Least Squares, which see.

Equator, Celestial. The great circle in which the plane of the terrestrial equator (produced) intersects the star sphere. Every point on the celestial equator is 90° distant from either celestial pole.

Equator of a Planet. The great circle on the surface of the planet the plane of which is at right angles to the planet's axis of rotation.

Equator, Terrestrial. The great circle on the earth's surface every point on which is equidistant from either pole. The plane of the equator is perpendicular to the earth's axis.

Equatorial Horizontal Parallax. The geocentric parallax of a celestial body, as viewed from a place on the earth's equator. It is therefore the angle whose sine is the equatorial radius of the earth divided by the distance of the body from the earth's centre.

Equatorial Telescope. A telescope mounted with its principal axis pointing to the celestial pole. This axis is therefore parallel to the earth's axis of rotation. Perpendicular to the polar axis is a secondary one, which carries the telescope at right angles to it. The secondary axis is movable on the primary so that the telescope may be pointed to any star. A star may thus be kept in view by one motion. An equatorial telescope is usually fitted with graduated circles, and the motion necessary to follow a star is communicated by clockwork.

Equinoctial Points. The points at which the equator and the ecliptic intersect each other. One of these is called the "First Point of Aries," and is denoted by the symbol ♈. The opposite point is called the "First Point of Libra," and is denoted by ♎. Owing to the "precession of the equinoxes" the former has now retrograded into Pisces, and the latter into Virgo. See PRECESSION OF EQUINOXES.

Equinoxes. The points at which the ecliptic intersects the plane of the celestial equator. The point at which the sun, moving in the ecliptic, passes from the south to the north of the equator is called the *Vernal Equinox*, and the point at which the sun passes from the north to the south of the equator the *Autumnal Equinox*. This of course applies only to the earth's northern hemisphere; for in the southern hemisphere the above terms would be reversed.

Equinoxes, Precession of. See PRECESSION OF EQUINOXES.

Equuleus (the Little Horse). One of the northern constellations.

Eridanus (the River). One of the southern constellations.

Errai. A name sometimes applied to the star γ Cephii.

Error, Probable. A term used with reference to a series of observations, each of which is subject to a small error. "In any series of errors the probable error has such a value that the number of errors greater than it is the same as the number less than it; or it is an even wager that an error taken at random will be greater or less than the probable error" (Professor Merriman, *Method of Least Squares*, p. 66).

Establishment of the Port. The time which elapses after the moon's transit across the meridian before high water occurs at the given port. This is for the "lunar tide." A similar correction must be made for the "solar tide."

Etanin. A name sometimes applied to the star γ Draconis. From the Arabic *ras al-tannin*, "the dragon's head."

Ether. The supposed medium which pervades all space, and through which, by means of wave motion, light and heat, and perhaps electricity, are transmitted from the sun and stars to the earth.

Evection of Moon. An inequality in the moon's motion, due to the elliptical shape of its orbit. The sun's disturbing force produces periodical changes in the eccentricity depending on the position of the line of apsides, and these changes are termed the *evection*. The inequality was discovered by Ptolemy, but was previously suspected by Hipparchus.

Exterior Planets. The planets which revolve round the sun at a greater distance than the earth. These are Mars, the Minor Planets or Asteroids, Jupiter, Saturn, Uranus, and Neptune.

Extinction of Light. A supposed diminution in the brightness of the stars as seen from the earth, due to an absorption of light in the luminiferous ether of space. That such an absorption of light does take place in the ether has not, however, been well established.

Eyepiece. The lens or combination of lenses placed at the eye end of a telescope. Its object is to magnify he image formed by the object-glass.

F.

Faculæ of the Sun. Brighter portions of the sun's surface, usually seen near sun-spots, or in places where spots have disappeared or are about to appear.

Falcated. A term applied to the Moon, Mercury, and Venus when they are in the crescent phase.

Field of View. The portion of the sky visible in a telescope. With high magnifying powers the "field of view" is much smaller than with low powers.

Filar Micrometer. A form of micrometer in which fine wires are used.

First Quarter. See Quarter.

Flat. The small plane mirror used in the Newtonian form of reflecting telescope to reflect the rays from the large mirror into the eyepiece.

Flora. One of the minor planets revolving round the sun in orbits lying between those of Mars and Jupiter. It was discovered by Hind on Oct. 18th, 1847. It revolves round the sun in a period of 3·266 years at a mean distance of 2·20 times the sun's mean distance from the earth. Its opposition magnitude is about 9, and its real diameter perhaps about 60 miles.

Foca. A name sometimes applied to the star α Coronæ Borealis.

Foci of an Ellipse. Two points on the longer axis of an ellipse equidistant from the centre. The distance of each focus from the centre depends upon the "eccentricity" of the ellipse. The distance of each focus from either extremity of the minor axis is equal to the semi-axis major; and the sum of the distances of any point on the curve from the foci is constant, and equal to the major axis.

Focus. The point in which rays of light unite after undergoing refraction through lenses or reflection from a mirror.

Fomalhaut. A name applied to the bright southern star α Piscis Australis. From the Arabic *fum al-hût al-djanûbi*, "the mouth of the southern fish."

Forces, Disturbing. See DISTURBING FORCES.

Fornax (the Furnace). One of the southern constellations.

Foucault's Experiment. An experiment devised by Foucault to render the earth's rotation on its axis visible to the eye. A heavy metal ball suspended by a long and fine wire is set vibrating like a pendulum. It will be found that the plane of vibration apparently rotates from east to west, or contrary to that of the earth's rotation. At the poles the plane of vibration would make one rotation in a sidereal day. At places between the poles and the equator the time of rotation depends on the latitude of the place of observation. At the equator there would be no rotation.

Fraunhofer's Lines. The dark lines seen in the spectra of the sun, moon, planets, and fixed stars. They were discovered by the famous German optician Fraunhofer; hence their name.

Front View. A form of reflecting telescope devised by Sir William Herschel. There was no small mirror, but the image formed by the large mirror was (by slightly shifting the position of the large mirror) thrown to the side of the tube, where it was examined directly by the eyepiece. See HERSCHELIAN TELESCOPE.

Full Moon. When the moon is in opposition to the sun, or distant from it by 180° of celestial longitude, it is said to be "full." Accurately speaking, however, the moon is not truly "full" except during the totality of a lunar eclipse.

G.

Galactic Circle. A term applied to the mean or centre line of the Galaxy, or Milky Way zone.

Galaxy. Another name for the Milky Way, which see.

Gauges, Star. A term applied by Sir William Herschel to his counts of stars visible in the field of his telescope in various parts of the sky.

Gegenschein. A phenomenon connected with the zodiacal light. It is a small spot of faint light seen in the sky opposite to the sun's place—that is, 180° from the sun. Keen eyesight is necessary for its detection, as it is always very faint.

Gemini (the Twins). One of the zodiacal constellations. Its brightest stars are Castor and Pollux.

Geminids. A meteor shower visible about December 9th to 12th in each year. The meteors seem to radiate from a point near Castor (107° + 33°). They are swift, with short paths.

Gemma. A name sometimes applied to the star α Coronæ Borealis.

Geocentric Latitude. The latitude of a celestial body as supposed to be seen from the centre of the earth.

Geocentric Longitude. The longitude of a celestial body as supposed to be seen from the earth's centre.

Geocentric Lunar Distances. The angle subtended between the centre of the moon's disc and a given star as seen from the earth's centre. It was formerly used in the determination of terrestrial longitude at sea; but chronometers are now more generally relied on for this purpose.

Geocentric Parallax. The angle subtended at a celestial body by the earth's radius at the point of observation. Hence, to find the geocentric place of the body, or its position as seen from the earth's centre, the amount of the geocentric parallax must be deducted from the apparent zenith distance. The "fixed stars" have no geocentric parallax.

Geocentric Place. The position of a celestial body as supposed to be seen from the earth's centre.

Geodesy. The science which treats of the figure and dimensions of the earth.

Giauzar. A name sometimes applied to the star λ Draconis.

Gibbosity of Mars. When Mars is between "opposition" and "quadrature" (or 90° from the sun) it is slightly gibbous, like the moon a little before and a little after "full moon." At quadrature about one-eighth of the planet's disc is in shadow. For Jupiter and the other planets exterior to Mars the gibbosity is not perceptible.

Gibbous Moon. The moon's phase when more than half the disc is illuminated. This occurs between "first quarter" and "full moon" and again between "full moon" and "last quarter."

Giedi, Prima and Secunda. Names sometimes applied to the stars α^2 and α^1 Capricorni, which form a double star to the naked eye.

Gjenula. A name sometimes applied to the star γ Aquarii.

Globe, Celestial. A globe showing the positions of the stars on the celestial sphere. The observer's eye is supposed to be placed at the *centre of the globe.* It follows therefore that the constellations as marked on a celestial globe are inverted, and are not in their true configurations as seen in the sky.

Globular Clusters. A name applied to close star clusters of a spherical or nearly spherical form.

Gnomon. Another name for a sun-dial. Derived from the Greek γνώμων, an index.

Golden Number. The remainder when the number of the year increased by one is divided by 19. Thus the golden number for 1893 is the remainder when 1894 is divided by 19—that is, 13. If exactly divisible by 19, then 19 is the golden number. Thus the golden number for 1899 will be 19.

Gomeisa. A name sometimes applied to the star β Canis Minoris.

Granulation. A term applied to the mottled appearance visible through a telescope on the sun's surface. The granulations have also been called "willow leaves" and "rice grains."

Gravitation. The tendency of all bodies in the universe to attract each other. The phenomenon of terrestrial gravity has, of course, been known for ages, but the laws of universal gravitation were discovered by Sir Isaac Newton.

Great Circle. The circle on a sphere, the plane of which passes through the centre of the sphere.

Gregorian Reform of Calendar. See CALENDAR, GREGORIAN.

Gregorian Telescope. A form of reflecting telescope in which the smaller mirror is concave, and the reflected rays from the object pass through a circular opening in the large mirror.

Grummium. A name sometimes applied to the star ξ Draconis.

Grus (the Crane). One of the southern constellations.

Gyroscope. A spinning top, or heavy rotating wheel, with its axis of rotation supported in a ring, which is again supported in another ring. This second ring rotates in a fixed frame. By this arrangement the axis of the wheel can be made to point in any direction. The instrument is used to illustrate the earth's rotation on its axis, and the precession of the equinoxes.

H.

Hadley's Sextant. A form of the sextant invented by John Hadley in 1730. An instrument of almost the same form was invented by Thomas Godfrey in the same year. An improved form of the instrument, very similar to that now in use, was devised by Hadley shortly after his first invention. Hadley and Godfrey each received £200 from the Royal Society for their invention. A similar instrument is said to have been invented by Sir Isaac Newton. See SEXTANT.

Halley's Comet. One of the periodical comets, or comets which revolve round the sun and regularly return. The period of Halley's comet is about seventy-six years. Various apparitions of this comet have been traced back, the earliest recorded being in the year B.C. 44. It appeared last in 1835, and its next return will be due about 1910.

Halley's Method of Determining the Solar Parallax. This method of finding the sun's parallax from observations of transits of Venus was devised by Halley in 1716. Two stations are selected—one in high northern latitudes, and the other in high southern latitudes, and both lying as nearly as practicable in a plane at right angles to the orbit plane of Venus. The times of duration of the transit are observed from the two stations, and from these durations the solar parallax is computed.

Hamal. A name sometimes applied to the star α Arietis.

Harmonic Circle. If chords be drawn through the focus of an ellipse, and harmonic means be taken between the intercepts from the focus to the curve, these harmonic means, when laid off from the focus on the chord, will give a number of points which all lie on a circle of which the focus is the centre and the diameter the *latus rectum* of the ellipse (see LATUS RECTUM). This circle is called the "harmonic circle," and is used in the calculation of the orbit of a binary star by the graphical method.

Harmonic Ellipse. The ellipse into which the harmonic circle is projected in the apparent orbit of a binary star.

Harvest Moon. The full moon which falls nearest to the autumnal equinox, or Sept. 23rd, in each year. At this time the interval of time between moonrise on successive nights is much smaller than usual, owing to the fact that the ecliptic then makes the smallest angle with the horizon.

Hebe. One of the group of minor planets which revolve round the sun in orbits lying between those of Mars and Jupiter. It was discovered by M. Hencke at Driesen on July 1st, 1847. When in opposition its stellar magnitude is about 8½. Its period of revolution round the sun is about 3·776 years, and the eccentricity of its orbit about the same as that of Mercury (0·20).

Heliacal. A term applied to the rising or setting of a celestial body at the same time as the sun.

Heliocentric Place. The position of a celestial body as supposed to be seen from the centre of the sun.

Heliometer. An astronomical telescope in which the object-glass is cut in two along a diameter. One half is made to move along the other by a graduated screw. Each half, when separated, forms a distinct image of the object viewed. The instrument may be used for finding the diameters of the sun, moon, and planets, or the angular distance between the components of a double star.

Helioscope. A little instrument devised by Dawes for facilitating the telescopic observation of the sun's surface. It consists of a metallic plate, pierced with a minute hole, and placed in the focus of a telescope. By this means the eye is protected from the glare.

Heliostat. An instrument devised to reflect a ray of sunlight in a fixed direction. When used for astronomical purposes it is sometimes called a *siderostat.*

Hemisphere. The half of a sphere. A plane passing through the centre of a sphere divides it into two hemispheres.

Hercules. One of the northern constellations.

Herschelian Telescope, or "**Front View.**" A form of reflecting telescope, devised by Sir William Herschel, in which the second mirror is dispensed with. The large mirror is inclined slightly to the axis of the tube, and the image formed is viewed directly by the eyepiece placed at the edge of the tube.

Homam. A name sometimes applied to the star ζ Pegasi.

Horary. A term applied to phenomena connected with an hour.

Horizon, Celestial. The tangent plane to the surface of the earth at the place of observation, and produced to meet the star sphere. In other words, it is a plane perpendicular to the diameter of the earth at the observer's standpoint. The poles of this plane are the zenith and nadir.

Horizon, Rational. A plane through the earth's centre parallel to the celestial or sensible horizon. It is sometimes termed "the true horizon."

Horizon, Sensible. Same as Celestial Horizon, which see.

Horizontal Parallax. The geocentric parallax of a celestial body when the body is on the horizon of the plane from which it is observed. It varies inversely as the distance of the body from the earth. The stars are at such a vast distance that their geocentric parallax is inappreciable. See GEOCENTRIC PARALLAX.

Horologium (the Clock). One of the southern constellations.

Hour Angle. The angle between a star's declination circle and the meridian of the place of observation.

Hour Circle. The graduated circle of an equatorial telescope on which the right ascensions of celestial bodies are measured.

Hunter's Moon. The full moon which falls nearest to Oct. 21st in each year. The phenomenon somewhat resembles the harvest moon, but is less marked.

Hyades. A remarkable group of stars shaped like a V in the constellation Taurus.

Hydra (the Sea Serpent). One of the constellations. It is of great length, extending over seven hours of right ascension.

Hydrus (the Water Snake). One of the southern constellations.

Hyperbola. One of the conic sections, which may be supposed to be formed by the intersection of a plane with a cône, the plane being perpendicular to the base of the cone.

Hyperion. One of the satellites of Saturn—the seventh in order counting from the planet. It was discovered by Messrs. Bond and Lassell, on Sept. 19th, 1848. Its mean distance from Saturn is about 951,000 miles, and its period of revolution round the planet 21 days 6 hrs. 39 min. According to Professor Pickering, the stellar magnitude of Hyperion at mean opposition is 13·7. Its real diameter is doubtful.

I.

Iklil, or **Iklil-al-Jebhah.** An Arabic name for the star β Scorpii.

Illumination of the Field of View. For the purpose of measuring celestial bodies, very fine wires are fitted in the eyepiece of a telescope. To render these visible on a dark sky it is necessary to use a small lamp, the light of which is thrown in through a hole in the tube. There are two methods of illumination used: (1) dark wires in a bright field, and (2) bright wires in a dark field.

Immersion. The disappearance of a star or planet when occulted by the moon, or the disappearance of a satellite in the shadow of its primary.

Inclination of Orbit. The angle between the plane of an orbit and a given plane of reference. The orbits of the planets and comets are referred to the plane of the ecliptic; the orbits of the binary stars to a tangent plane to the star sphere at the plane of the star, or in other words, to the background of the sky.

Indiction. A period of fifteen years, fixed by the Roman emperor Constantine as a conventional division of time.

Indus (the Indian). One of the southern constellations.

Inequality, Moon's Parallactic. An inequality in the moon's motion due to the varying amount of the sun's disturbing force at "new moon" and "full moon." It tends to accelerate the time of "first quarter" and to retard that of "last quarter."

Inequality of Jupiter and Saturn. An inequality in the orbital motion of these large planets due to their attractions on each other. It depends upon the near commensurability of the periods of revolution of Jupiter and Saturn round the sun, two periods of Saturn being nearly equal to five of Jupiter.

Inferior Conjunction. See CONJUNCTION.

Inferior Planet. A planet which revolves round the sun at a distance less than that of the earth. There are only two inferior planets—Mercury and Venus.

Ingress. The beginning of a transit of Mercury or Venus, when the planet passes on to the sun's disc. The term is also used with reference to the transits of the satellites of Jupiter and Saturn across the disc of their primary.

Instruments, Meridian. Instruments used in observations for observing the stars when crossing the meridian.

Intercalation. A term applied to the addition of one day to each leap year, or every fourth year. These added days are termed *intercalary* or *leap days.*

Interior Planets. Same as Inferior Planets, which see.

Interpolating Curve. A term applied to a curve drawn through a number of observations (such as the measures of a binary star) plotted on square ruled paper.

This curve should be a "smooth" one—that is, without sudden changes of curvature—and should leave as many observations on one side of the curve as on the other, or as nearly so as possible.

Interstellar. The portion of space which contains the fixed stars, or those parts which lie outside the solar system.

Izar. A name sometimes applied to the star ε Boötis.

J.

Japetus. The outer satellite of Saturn, or that farthest from the planet. It was discovered by J. D. Cassini, on Oct. 25th, 1671. Its mean distance from Saturn is about 2,261,000 miles, and its period of revolution 79 days 7 hrs. 54 mins. According to Professor Pickering, its stellar magnitude at mean opposition is 11·8.

Jovicentric. The place of a celestial body with reference to the centre of the planet Jupiter.

Julian Calendar. The introduction of a leap year every four years, due to Julius Cæsar, B.C. 44.

Julian Period. "A period useful in chronology is obtained by multiplying together the lunar cycle, the solar cycle, and the indiction, forming a period of 7980 years (19 × 28 × 15 = 7980)" (Chambers' *Handbook of Descriptive Astronomy*).

Juno. One of the minor planets revolving round the sun in orbits lying between those of Mars and Jupiter. It was discovered by Harding Sept. 1st, 1804. It revolves round the sun in a period of 4·358 years, at a mean distance of 2·668 times the earth's mean distance from the sun. When in opposition its magnitude is about 8·5, and its real diameter is perhaps about 120 miles.

Jupiter. The largest of all the planets of the solar system, its mean diameter being about 87,000 miles or about eleven times that of the earth. Its volume, therefore, exceeds that of the earth over 1300 times; but in density it is light, its mass being only 312 times the mass of the earth. Its mean distance from the sun is about 483,000,000 miles; and it revolves round the sun in a period of 11 years, 314·8 days. Jupiter has five satellites, the nearest and smallest having been discovered by Barnard in September 1892. For further details, see Appendix.

K.

Kaffaljidhma. A name applied by the Arabian astronomers to the star γ Ceti.

Kaitain. A name sometimes applied to the star α Piscium.

Kaus Australis. A name sometimes applied to the star ϵ Sagittarii.

Keid, or **Al-kaid.** A name applied by the Arabian astronomers to the star 40 (o^2) Eridani.

Kepler's Laws. Laws of planetary motion discovered by the famous Danish astronomer Kepler. These laws are as follows:—

I. The planets revolve round the sun in elliptic orbits, with the sun in one of the foci of the ellipse.

II. The radius vector, or straight line joining the centres of the sun and planet, sweeps over equal areas in equal times.

III. The squares of the periodical times of the different planets are proportional to the cubes of their mean distances from the sun.

Kepler's Laws also apply to the motions of the satellites round the planets, and, with suitable modifications, to the revolution of the components of binary stars round their common centre of gravity.

Kiffa Australis. A name sometimes applied to the stars α^1 and α^2 Libræ.

Kiffa Borealis. A name sometimes applied to the star β Libræ.

Known Stars. Stars whose position on the celestial sphere have been accurately determined by meridianal observations.

Kocab. A name sometimes applied to the star β Ursæ Minoris.

Korneforos. A name sometimes applied to the star β Herculis.

L.

Lacerta (the Lizard). One of the northern constellations. It lies between Cepheus and Cygnus.

Lady's Way. A name formerly applied to the zodiac.

Lagging of Tides. A delay in the time of high water which occurs between the "first quarter" and "full moon," and between the "last quarter" and "new moon," due to the combined action of the sun and moon.

Last Quarter of Moon. See QUARTERS.

Latitude, Celestial. The angular distance of a celestial body from the ecliptic, measured on a great circle at right angles to the ecliptic.

Latitude, Geocentric. The angular distance of a celestial body, north or south of the ecliptic, as supposed to be seen from the centre of the earth.

Latitude, Heliocentric. The angular distance of a celestial body, north or south of the ecliptic, as supposed to be seen from the centre of the sun.

Latitude, Parallel of. A "small circle" on the earth's surface parallel to the equator.

Latitude, Terrestrial. The angular distance of a place on the earth's surface, north or south of the terrestrial equator.

Latus Rectum, or **Parameter.** The chord drawn through the focus of a conic section at right angles to the major axis. If semi-axis major of an ellipse = a, eccentricity $= e$; then length of latus rectum $= 2a\,(1-e^2)$.

Leap Year. The ordinary civil year consists of 365 days; but as the real period of the earth's revolution round the sun is about $365\frac{1}{4}$ days, a day is added to every fourth year, which has therefore 366 days, and is called Leap Year. As this correction is not exactly accurate, the leap year is omitted every hundred years, when the last year of the century is not divisible by 400. Thus, 1700 and 1800 were not leap years, and 1900 will not be a leap year; but the year 2000 will be a leap year.

Least Squares, Method of. A method of solving a number of equations of condition invented by Gauss. The method is as follows: Multiply each equation by the coefficient of the first term, and add. Multiply each equation by the coefficient of the second term, and add; and so on. We thus obtain as many equations as there are unknown quantities, and these can be solved by one of the usual methods of solving simultaneous equations.

Lemniscate. A term applied to the dark opening in the great nebula in Argo, which is sometimes spoken of as the "key-hole nebula."

Lens. "A portion of a refracting medium bounded by two spherical surfaces; the straight line joining their centres being called the *axis* of the lens" (Osmund Airy, *Geometrical Optics*). Lenses are usually formed of glass.

Leo (the Lion). One of the constellations of the zodiac. It contains the well-known "Sickle." Its brightest star is Regulus (α Leonis).

Leo Minor (the Lesser Lion). One of the northern constellations. It lies between Ursa Major and Leo.

Leonids. A meteor shower visible about Nov. 13th to 14th in each year. The meteors seem to radiate from a point near ζ Leonis ($149° + 33°$). They are very swift, with streaks. They are especially numerous once every thirty-three years, when a magnificent shower is usually visible. The last great shower of Leonids occurred in November 1866, and the next will be due in November 1899.

Lepus (the Hare). One of the southern constellations. It lies between Orion and Columba.

Libra (the Balance). One of the constellations of the zodiac.

Libration. The rotation of the moon on its axis is uniform, but its orbital motion round the earth is not so, owing to the elliptical shape of the orbit. This inequality between the velocities of rotation and revolution gives rise to an apparent oscillation of the moon's disc, which brings alternately into view small portions of the opposite hemisphere near the east and west limbs. This is called the *libration in longitude.* Another libration, called the *libration in latitude*, is due to the fact that tho moon's axis of rotation is not exactly perpendicular to the plane of her orbit.

Libration, Diurnal. See Diurnal Libration.

Light Year. The distance which light travels in one year. The distance of stars from the earth is sometimes expressed by stating the number of years which light would take in passing from the star to the earth. When the "parallax" is known, the number of years' travel for light may be found by dividing the number 3·258 by the parallax expressed as a fraction of a second of arc.

Limb. The edge of the disc of the sun, moon, or planets.

Limits, Ecliptic. The angular distance from the node of the moon's orbit on the ecliptic within which an eclipse is possible. For solar eclipses the moon must be within 16° 58′ of the node. For lunar eclipses the sun must be within 11° 21′ of the moon's node in order that there may be any contact of the moon with the *umbra* of the earth's shadow.

Local Time. The mean time at any given place on the earth's surface.

Longitude, Celestial. The angular distance of a celestial body from the "First Point of Aries" *measured on the ecliptic.* This, combined with the latitude, fixes the position of a body on the celestial sphere. See Latitude.

Longitude, Geocentric. The longitude of a celestial body as supposed to be seen from the centre of the earth.

Longitude, Heliocentric. The longitude of a celestial body as supposed to be seen from the centre of the sun.

Longitude, Terrestrial. The angular distance of a place on the earth's surface east or west of a fixed meridian such as the meridian of Greenwich.

Longitude of Perihelion. The longitude of the perihelion of the orbit of a planet or comet as supposed to be seen from the centre of the sun. It is usually measured on the ecliptic to the node of the orbit, and from the node along the orbit to the perihelion point. A more satisfactory method, however, would be to state the heliocentric longitude of the perihelion point.

Loop of Retrogression. The loop in a planet's apparent path in the sky described when the planet's motion is changing from direct to retrograde and *vice versâ*.

Lucida. A term sometimes applied to the brightest object in a group of stars. Thus Alcyone may be called the *lucida* of the Pleiades.

Luculi. A term sometimes applied to the small bright spots visible on the sun's surface.

Lumière Cendrée. A term applied to the "earth-shine" visible on the moon when in the crescent phase.

Lunar Cycle. Same as Meteoric Cycle, which see.

Lunar Distances. The angular distance of the moon's centre from the sun or from bright stars and planets which lie near its path in the sky. Tables of these computed distances are given in the Nautical Almanack for every third hour of Greenwich mean time.

Lunar Inequalities. Inequalities or deviations from a regular elliptic orbit produced in the moon's motion round the earth by the attraction of the sun and planets.

Lunation. Same as a Synodic Month, which see.

Lune. The crescent-shaped space contained between two intersecting circles.

Lupus (the Wolf). One of the southern constellations.

Lynx (the Lynx). One of the northern constellations.

Lyra (the Lyre). One of the northern constellations. Its brightest star is the brilliant Vega (α Lyræ).

Lyrids. A shower of meteors visible about April 19th to 30th in each year. They seem to radiate from a point near the constellation Lyra (271° + 33°).

M.

Maculæ. A term sometimes applied to the darker portions of sun spots.

Magellanic Clouds. Two spots of nebulous light visible to the naked eye in the southern hemisphere, and distinct from the Milky Way. The larger is known to astronomers as the *Nubecula Major*, and the smaller as the *Nubecula Minor*. Both consist of a collection of small stars, star clusters, and nebulæ.

Magnetic Storm. A disturbance in the magnetic conditions of the earth, probably due to a disturbance in the sun. A magnetic storm is indicated by large and sudden variations in the magnetic needle, by auroras, etc.

Maia. One of the stars in the Pleiades.

Major Axis of Orbit. In an elliptical orbit, the longer axis, or that passing through the two foci, is called the major axis.

Malus. A name applied to a portion of the constellation Argo.

Marfik. A name given by the Arabian astronomers to the star λ Ophiuchi.

Markab. A name sometimes applied to the star α Pegasi.

Mars. One of the primary planets. It revolves round the sun at a mean distance of 141,000,000 miles in a period of 687 of our days. Its diameter is about 4200 miles, and markings on its surface are supposed to indicate the existence of land and water. It possesses an atmosphere, and may possibly be inhabited by some forms of life. It has two very small satellites, discovered by Professor Asaph Hall in August 1877. For further details, see Appendix.

Marsic. A name sometimes applied to the star κ Herculis.

Mass. The quantity of matter contained in a body. The weight of the same body would vary if placed on different planets and—very slightly—at different parts of the earth's surface, but the mass remains constant wherever the body is situated.

Mass of Binary Stars. The mass or quantity of matter contained in the components of a binary star is usually expressed in terms of the sun's mass taken as unity. If the distance of a binary star can be determined, we can find from its parallax and the elements of the computed orbit the mean distance between the components in terms of the sun's mean distance from the earth, and then, by an extension of Kepler's third law, the mass of the system in terms of the sun's mass may be found (or, more correctly, in terms of the combined mass of the sun and earth; but the earth's mass being relatively very small it may be neglected). The method of calculation is very simple, and is as follows: Divide the computed semi-axis major by the parallax (both expressed in seconds of arc). The quotient will express the mean distance between the components in terms of the sun's mean distance from the earth. Now cube this quotient and divide the result by the square of the period expressed in years, and the result will be the combined mass of the components of the binary star in terms of the sun's mass.

Mass of Sun and Planet. The mass of a planet is usually expressed as a fraction of the sun's mass taken as unity. Sometimes the sun's mass is stated in terms of the earth's mass taken as unity.

Masym. A name sometimes applied to the star λ Herculis.

Maxima and Minima of Variable Stars. The *maximum* of a variable star is the brightest phase of its varying light, and the *minimum* the faintest.

Mazzaroth. An ancient name for the star Sirius.

Mean Distance. The mean or average distance of a body moving in an elliptic orbit from the focus of the ellipse in which the central body lies. It is therefore equal to the semi-axis major of the ellipse, which is a mean between the greatest and least distances of the revolving body from the focus.

Mean Motion. The velocity with which a moving body would describe a circular orbit having a radius equal to the "mean distance," and in the same period as in the real orbit. In the case of a binary star the mean angular motion is 360° divided by the period in years.

Mean Noon. The time of transit of the "mean sun" across the meridian.

Mean Solar Day. The interval of time which elapses between two successive "mean noons," or transits of the imaginary "mean sun" across the meridian.

Mean Solar Time is the hour angle of the "mean sun" converted into time at the rate of 1 hour to 15° or 4 minutes to 1°.

Mean Sun. The imaginary sun or point used in the regulation of "Mean Time," which see.

Mean Time. The time shown by ordinary clocks and watches. It is regulated by the motion of the "Mean Sun"—an imaginary sun, or rather point, which moves uniformly round the celestial equator.

Mebsuta. A name sometimes applied to the star ε Geminorum.

Medium, Resisting. See ETHER.

Megrez. A name sometimes applied to the star δ Ursæ Majoris.

Mekbuda. A name sometimes applied to the star ζ Geminorum.

Menkab. A name sometimes applied to the star α Ceti.

Menkalinan. A name sometimes applied to the star β Aurigæ. From the Arabic *Menkib dhi-l'inân.*

Menstrual Equation. An apparent monthly displacement of the sun in longitude, due to the fact that the moon revolves round the centre of gravity of the earth and moon, and not round the earth's centre.

Merak. A name sometimes applied to the star β Ursæ Majoris.

Mercator's Projection. A projection of the sphere sometimes used in map drawing. It represents the sphere "as it might be seen by an eye carried successively over every part of it" (Sir John Herschel).

Mercury. The nearest of the planets to the sun. It revolves round the sun in a period of about 88 days, at a mean distance of about 36,000,000 miles. Its orbit has the greatest eccentricity (0·205) of all the primary planets. Its diameter is about 3000 miles. For further details, see Appendix.

Meridian, Celestial. The great circle of the celestial sphere which passes through the poles and the zenith of the place of observation.

Meridian, Prime. The meridian on the earth's surface from which longitudes east and west are reckoned. The meridian of Greenwich Observatory is usually taken as the prime meridian.

Meridian, Terrestrial. A "great circle" on the earth's surface which passes through the terrestrial poles.

Merope. One of the stars in the Pleiades; otherwise known as 23 Tauri.

Mesartim. A name sometimes applied to the star γ Arietis.

Meteoric Stones. Stones which occasionally fall from the sky. Of these there are many well-authenticated cases. They have been classed as follows: "Siderites are those in which iron predominates; Siderolites represent those which are formed of iron and stone in large degree; Ærolites are applied to those which are nearly all stone" (Denning).

Meteors. Luminous bodies which suddenly appear in the atmosphere and move with great rapidity. They are also known as "falling stars" or "shooting stars." They are usually very small bodies, which become incandescent by friction with the air, but are occasionally of considerable size, when they are called fireballs. The mean velocity of meteors is about thirty-four miles a second. The ordinary shooting stars usually become visible at a height of seventy or eighty miles, and disappear at a height of about fifty or fifty-five miles above the earth's surface. Fireballs, however, sometimes approach within five to ten miles.

Method of Least Squares. See LEAST SQUARES.

Metonic Cycle. A lunar cycle discovered by Meton and Euctemon, B.C. 432. They found that after a period of nineteen years "new moons" and "full moons" recurred on the same days of the year. The Metonic Cycle is 235 synodic months = 6939·69 days, or almost exactly nineteen tropical years.

Metre. A French unit of measure, originally fixed at one ten-millionth of the length of a quadrant of the earth's meridian. The length of the motre is 39·37079 English inches, or 3·28089 feet.

Micrometer. An instrument for measuring accurately small angles. There are various forms of micrometer, such as the filar micrometer, the parallel wire micrometer, the position micrometer, heliometer, etc.

Microscopes. Used for reading the graduation on the circles of astronomical instruments.

Microscopium (the Microscope). One of the southern constellations.

Midnight. The time of the sun's transit below the pole. This usually occurs when the sun is below tho horizon.

Milky Way. The nebulous band or zone of light which encircles the heavens. It consists of myriads of small stars, probably mixed up with nebulous matter. It is also called the Galaxy.

Mimas. The inner satellite of Saturn, that nearest to the planet, round which it revolves in a period of 22 hrs. 37 mins., at a mean distance of about 117,000 miles. It was discovered by Sir William Herschel on Sept. 17th, 1789. Its diameter may be about 1000 miles, but this is uncertain. Its stellar magnitude is, according to Pickering, only 12·8, and as it is so near Saturn it can only be seen with telescopes of considerable power.

Minor Axis of Orbit. In an elliptic orbit the axis which passes through the centre of the ellipse at right angles to the major axis.

Mintaka. A name sometimes applied to the star δ Orionis. From the Arabic *mintakat al-djauzâ*, "the belt of the giant."

Mira. A name applied to the wonderful variable star ο Ceti. At the maximum the magnitude varies from 1·7 to 5 at different maxima. At minimum, the star is $8\frac{1}{2}$ or 9 mag. The mean period is about $331\frac{1}{3}$ days, but is subject to irregularities. The star has a remarkable spectrum of the third type, in which bright lines have been seen by several observers.

Mirach. A name sometimes applied to the star β Andromedæ, and also ϵ Boötis.

Mirfak. A name sometimes applied to the star α Persei. From the Arabic *al-marfik*, "the elbow."

Mirzum. A name sometimes applied to the star β Canis Majoris.

Mizar. A name applied to the star ζ Ursæ Majoris; sometimes also to ϵ Boötis.

Monoceros (the Unicorn). One of the constellations. It lies to the east of Orion, and the equator passes through it.

Month, Anomalistic. The period of revolution of the moon round the earth, with reference to the line of apsides of the lunar orbit. This period is 27 days 13 hrs. 18 mins. 37·4 secs.

Month, Nodical. The period which elapses between the passage of the moon through one of its nodes, and its passage through the same node again. This period is 27 days 5 hrs. 5 mins. 35·8 secs.

Month, Sidereal. The period of the moon's rotation round the earth, with reference to the stars; its length is 27 days 7 hrs. 43 mins. 11·4 secs.

Month, Synodical. The period which elapses between two successive conjunctions of the moon with the sun. This period is 29 days 12 hrs. 44 mins. 2·7 secs.

Moon. The Earth's satellite. Its mean distance from the earth is 60·27 times the earth's equatorial radius, or about 238,854 miles; but owing to the eccentricity of the moon's orbit round the earth, this varies from 225,742 miles, when the moon is in *perigee*, to 251,968 miles when it is in *apogee*. The eccentricity of the orbit is about $\frac{1}{18}$, and its inclination to the plane of the ecliptic about 5° 8″. The moon's diameter is 2163 miles. Its mass is $\frac{1}{81}$ of the Earth's mass, and its density (that of water $= 1$) is 3·40.

Moon-culminating Stars. Stars lying near the moon's apparent path in the sky, used for determining the longitude of the place of observation by measurement of their angular distance from the moon's centre.

Moon's Parallactic Inequality. See INEQUALITY.

Mothallath, or **Rás-al-Mothallath.** An Arabic name for the star α Trianguli.

Motion, Accelerated. Motion in which the velocity is constantly increasing. A body falling to the earth is an example of accelerated motion.

Motion, Apparent and Real. The *Apparent* motion of a planet is its motion as seen from the earth. The *Real* motion is its actual motion in space round the sun. Thus, when a planet is "retrograding," its apparent motion is from east to west among the stars, whereas its real motion is from west to east.

Motion, Direct. The motion of a planet when it is moving from west to east among the stars.

Motion, Proper. The motion of a star on the celestial sphere, due to the real motion of the star in space. See PROPER MOTION.

Motion, Relative. The motion of one moving body relative to another. Thus, if two bodies are moving on parallel lines in the same direction, but with different velocities, their relative motion is the difference between the two velocities; but if in opposite directions, the relative motion is the sum of the velocities.

Motion, Retrograde. The motion of the planets in the sky when they *apparently* move from east to west among the stars, or contrary to that of their real motion, which is from west to east. This apparent retrograde motion is due to the earth's orbital motion round the sun combined with that of the planet. The term is also sometimes applied to the apparent diurnal motion of the sun, moon, planets, and stars from east to west, due to the earth's rotation on its axis.

Mountains, Lunar. In addition to the numerous "craters" visible on the moon's surface, there are also lofty ranges of mountains. Some of the most important of these are the Alps, the Caucasus, the Apennines, the Carpathians, the Pyrenees, the Rock Mountains (highest 25,000 feet), the Leibnitz Mountains (highest 26,000 feet, or more), etc. Compared to the moon's diameter, the lunar mountains are much higher than ours.

Mukdim. An Arabic name for the star ϵ Virginis, otherwise known as Vindemiatrix.

Muphrid. A name sometimes applied to the star η Boötis.

Mural Circle. An astronomical instrument used in observatories. It consists of a large, graduated circle, firmly fixed in the plane of the meridian. To this circle a telescope is attached, with which the observations are made. The circle is mounted on the face of a wall; hence its name.

Musca (the Fly). One of the southern constellations. It lies south of the Southern Cross.

N.

Nadir. The point in the celestial sphere vertically below an observer at any point on the earth's surface. Its direction is pointed to by the plumb line, and it corresponds to the *zenith* of a place at the antipodes. See ZENITH.

Nath. A name sometimes applied to the star β Tauri. Derived from the Arabic *al-nátih*, "the butting," referring to its position on the tip of the Bull's Horn.

Neap Tides. The tides which occur at the moon's "quadratures"—that is, at "first quarter" and "last quarter." The heights of "neap" and "spring tides" are about in the ratio of 4 to 10. See SPRING TIDES.

Nebulæ. The hazy spots of light visible in the sky with a telescope. They have been classed as follows: Annular nebulæ, elliptic nebulæ, spiral nebulæ, planetary nebulæ, and nebulous stars. To these may be added irregular nebulæ, like the great nebulæ in Orion and Argo. Clusters of stars are sometimes, but incorrectly, spoken of as nebulæ. True nebulæ are, for the most part, gaseous.

Nebular Hypothesis. A theory proposed by Laplace to explain the origin of the solar system. He supposed the sun and planetary system to have been formed by the cooling and condensation of a rotating nebulous mass, which originally extended beyond the orbit of Neptune. During the process of contraction he supposed that rings were detached from the parent mass, and that these rings afterwards consolidated into planets and satellites. Numerous arguments have been advanced for and against this hypothesis. A full discussion of the question will be found in the present writer's *Visible Universe.*

Nebulosity. Hazy light visible in telescopes which cannot be resolved into stars.

Nebulous Stars. Stars surrounded with nebulosity. These are very rare objects: ε and ι Orionis are examples.

Nekkar. A name sometimes applied to the star β Boötis.

Neptune. The outermost planet of the solar system (so far as is known at present). The telescopic discovery of Neptune was made by Galle at Berlin, on Sept. 23rd, 1846; but its probable existence had been previously predicted by Adams and Le Verrier, from a consideration of irregularities in the motion of Uranus. The mean distance of Neptune from the sun is about 2,789,000,000 miles, and its period of revolution $164\frac{3}{4}$ years. The diameter of Neptune is about 36,000 miles. It is not visible to the naked eye, its stellar magnitude being about the eighth; but it may be seen with any small telescope if its position is accurately known. Neptune is attended by one satellite, which revolves round its primary in 5 days 21 hrs. 2 mins., at a mean distance of about 262,000 miles. It is a very faint object, and can only be well seen in large telescopes; but it is probably of considerable size.

New Moon. When the moon is in conjunction with the sun, or has the same celestial longitude, it is called "new moon." The term is popularly applied to the phase of the moon when it first appears, as a thin crescent, to the east of the sun after sunset; but this application of the term is incorrect.

Newtonian Telescope. A form of reflecting telescope, in which the rays reflected from the large mirror are again reflected at right angles into the eyepiece by means of a small plane mirror.

Nihal, or **Al-nihál.** A name given by the Arabian astronomers to the star β Leporis.

Nodes. The points in which the orbit of a planet or comet cuts the plane of the ecliptic. The node at which the planet or comet is rising from the southern to the northern side of the ecliptic is called the *ascending node*, and that at which the moving body is passing from the northern to the southern side of the ecliptic, the *descending node.* The line joining these points is called *the line of nodes*, and is therefore the line of intersection of the two planes. In the orbits of binary stars, the "position angle" of the line of nodes can be found from the observations, but it is impossible to determine which of the nodes is the *ascending*, and which the *descending node.* In other words, we cannot say from the measures at which node the companion star is approaching the eye, and at which it is receding. It would be possible—at least, theoretically—to determine this by observation with the spectroscope.

Nodical Month. See MONTH, NODICAL.

Nonagesimal Point. The altitude of the highest point of the ecliptic in the sky at any given instant.

Noon, Mean, and **Apparent.** Mean Noon is the time of transit of the "mean sun" across the meridian, and Apparent Noon, the time of transit of the apparent or true sun.

Norma (the Rule). One of the southern constellations.

Normal Disturbing Force. In the theory of perturbations, the component of the disturbing force, which acts along a normal to the curve—that is, at right angles to the tangent at the place of the body.

North Polar Distance. The angular distance of a celestial body from the north pole of the celestial sphere. It is equal to the complement of the declination, or 90 minus the declination.

Nova. A term applied to temporary stars, which see.

Nubecula Major. The larger of the two nebulous spots in the southern hemisphere, popularly known as the "Magellanic Clouds." It consists of a collection of small stars of various magnitudes, apparently associated with star clusters and nebulæ of various forms.

Nubecula Minor. The smaller of the two nebulous spots in the southern hemisphere, popularly known as the "Magellanic Clouds." It consists of a collection of small stars, star clusters, and nebulæ.

Nucleus. The central portion of the head of a comet. The term is also applied to the most condensed portion of the light of a nebula.

Number, Golden. See GOLDEN NUMBER.

Number of Eclipses. The number of eclipses of the sun and moon in the year may amount to seven, and must be at least two. If only two, they are both of the sun. If there are seven, five must be of the sun and two of the moon. There cannot be more than three eclipses of the moon in a year, and in some years there are none. In a period of eighteen years—the length of the Saros (which see)—there are usually about seventy eclipses, twenty-nine of the moon and forty-one of the sun.

Number of Fixed Stars. The number visible to very good eyesight does not much exceed 7000 for the whole sky. The total number visible in the largest telescopes does not probably exceed 100 millions. Owing to the possible extinction of light at great distances, or for some other reasons, the number of the *visible* stars is, and must necessarily be, strictly limited.

Nutation, Lunar. A variation or perturbation in the revolution of the celestial poles round the pole of the ecliptic, due to the action of the moon. Its period is the same as that of a sidereal revolution of the moon's nodes, or about 18 years 220 days.

Nutation, Monthly. A variation in the revolution of the celestial poles round the pole of the ecliptic, due to the changes in the moon's declination. Its period is half a month.

Nutation, Solar. A variation in the revolution of the celestial poles round the pole of the ecliptic, due to the changes in the sun's declination. Its period is half a tropical year.

O.

Oberon. The outermost satellite of Uranus, or that farthest from the planet. Its mean distance from the centre of the planet is about 389,000 miles, and its period of revolution 13 days 11 hrs. 7 mins. It can be well seen only with large telescopes, and its diameter is uncertain. Oberon was discovered by Sir W. Herschel on Jan. 11th, 1787.

Object Glass. The large glass of an astronomical telescope, or that nearest the object. It usually consists of two lenses either cemented together, merely touching each other, or—in large telescopes—separated by several inches. The outer lens is of a double convex shape, and of crown glass; the inner is usually double concave, and made of flint glass. In some binocular field-glasses the object glass consists of three lenses cemented together.

Objects, Test. Celestial objects, such as faint stars, close double stars, etc., which form tests for the "light grasping" power and definition of telescopes.

Oblate Spheroid. A solid formed by the rotation of an ellipse round its minor, or shorter, axis. The figure of the earth is that of an oblate spheroid, its shorter axis being the axis of rotation.

Obliquity of the Ecliptic. The angle between the plane of the equator and the plane of the ecliptic. The present inclination is about 23° $27\frac{1}{2}'$, but it is subject to a cyclical change between the limits—according to Stockwell—of 21° 58′ 36″ and 24° 35′ 58″. That the seasons are due to the obliquity of the ecliptic was taught by Diogenes of Apollonia, about 450 B.C.

Observatory. A building erected for the purpose of observing the heavenly bodies. The name is also applied to buildings constructed for making meteorological and magnetical observations.

Occultation. When one celestial body passes in front of another so as to hide it from view of the observer, the body so hidden is said to be occulted. The moon occasionally occults the planets, and, more frequently, the stars. There are also occultations by the sun, but these are invisible owing to the intense brilliancy of that body. Occultations of stars by the planets have also been observed, but these are of rare occurrence.

Octans (the Octant). One of the southern constellations. The south celestial pole is situated in this constellation.

Offing. The bounding line of the horizon as seen from any point on the earth's surface. The term is applied particularly to the sea horizon.

Okda. A name sometimes applied to the star α Piscium.

Opaque. A substance through which light cannot pass is said to be opaque.

Opera Glass. A small binocular telescope of low power used in theatres. A good opera glass is useful in astronomy for observing the brighter phases of variable stars.

Ophiuchus (the Serpent-Bearer). One of the constellations. It stretches from Hercules to Scorpio. The celestial equator passes through it.

Opposition. When the angular distance between the celestial bodies is 180° (measured on a great circle passing through the two bodies) they are said to be in *opposition.* At "full moon," the moon is in opposition to the sun, or, more correctly speaking, nearly in opposition, as it can be *exactly* in opposition only during the totality of a lunar eclipse.

Orbit. The imaginary curve in space which a body describes when revolving round another. Thus, the path of a planet or comet round the sun, of a satellite round its primary, or of one component of a binary star round the other (or round the centre of gravity of both), is called the *orbit* of the moving body.

Orientation. The direction of a map: a system of triangles, buildings, etc., with reference to the east point.

Orion (the Hunter). One of the finest of the constellations As the celestial equator passes through the centre of the constellation it is visible from nearly all parts of the earth's surface.

Orionids. A meteor shower, visible about Oct. 18th to 20th in each year. The meteors seem to radiate from a point in Orion (90° + 15°). They are swift, with streaks.

Orrery. An instrument for representing the planets and their motions round the sun. Called after the Earl of Orrery.

Orthogonal Disturbing Force. In the theory of perturbations, the component of the disturbing force resolved at right angles to the plane in which the disturbed body is at the instant moving round the centre of force.

Orthographic Projection. A method of mapping the surface of a sphere, in which every point on the hemisphere is projected on its base by a perpendicular let fall on it. In this projection the central portions of the hemisphere are well shown, but those towards the base are much crowded and distorted.

P.

Pallas. One of the minor planets or asteroids revolving round the sun in orbits lying between those of Mars and Jupiter. It was discovered by Olbers on March 28th, 1802. It revolves round the sun in a period of 4·605 years at a mean distance of 2·768 times the earth's mean distance from the sun. When in opposition its magnitude is about the eighth. The orbit of Pallas is remarkable for its high inclination, which amounts to 34° 44′.

Parabola. One of the conic sections, which may be supposed formed by a plane cutting a cone obliquely parallel to the side of the cone. The parabola is therefore not a closed curve, but has two branches which extend out to infinity. Some comets have been found to move in a parabola.

Parallactic Angle. See ANGLE OF SITUATION.

Parallactic Inequality of the Moon. See INEQUALITY.

Parallactic Instrument. An old name for the equatorial telescope. See EQUATORIAL TELESCOPE.

Parallax. An *apparent* change in the position of a celestial object due to a *real* change in the observer's position.

Parallel. A small circle of a sphere. See SMALL CIRCLE.

Parallel Wire Micrometer. A form of micrometer having two parallel wires which can be made to approach each other by means of screws.

Parameter. Same as "Latus Rectum," which see.

Partial Eclipse. An eclipse of the sun or moon in which only a portion of the disc is hidden or darkened.

Pavo (the Peacock). One of the southern constellations. It lies between Octans and Telescopium.

Pegasus (the Winged Horse). One of the northern constellations. The so-called "Square of Pegasus" is formed by β, α, and γ Pegasi, and α Andromedæ.

Penumbra. In an eclipse of the moon, the partial shadow which borders the dark shadow of the earth. At the points of the moon's surface covered by the penumbra the sun is seen partially eclipsed. The lighter shade surrounding the darker portion or *umbra* of a sun-spot is also called the *penumbra*.

Periastron. The point in the *real* orbit of a binary star at which the component stars are at their closest. This point does not always coincide with the point of nearest approach in the *apparent* orbit as seen from the earth. The periastron point may be found by joining the centre of the apparent ellipse with the principal star and producing it to meet the apparent ellipse. If this line is produced in the opposite direction it will meet the ellipse at the point of apoastron, which see.

Perigee. The point in the moon's orbit which is nearest to the earth.

Perihelion. The point in a planet's or comet's orbit at which it is nearest to the sun. This point lies at the extremity of the major axis.

Period, or Periodic Time. The time taken by a planet or comet to revolve round the sun, or by a satellite to revolve round its primary. The term is also applied to the time in which the components of a binary star revolve round their common centre of gravity, and also to the time which elapses between two maxima and two minima of a variable star.

Period, Julian. See JULIAN PERIOD.

Periodical Stars. Another name for Variable Stars, which see.

Perpetual Day. The period in the Arctic zone when the sun does not set.

Perpetual Night. The period in the Arctic regions when the sun does not rise.

Perseids. A meteoric shower, which seems to radiate from the constellation Perseus (44° + 56°). The meteors appear about August 9th to 11th in each year. They are swift, and leave streaks.

Perseus. One of the northern constellations.

Personal Equation. The error in the observations of the time of transit of a celestial body by a particular observer is called his "personal equation." The term might also be applied to other observations, such as the relative brightnesses of white and coloured stars, etc.

Perturbations. Inequalities produced in the orbital motion of the moon, planets, satellites, and comets by the attraction of the sun and the mutual attraction of each other.

Phact. A name sometimes applied to the star α Columbæ.

Phase. The particular aspect of a celestial body, the appearance of which is subject to periodical changes. Thus, we speak of the phases of the moon, the phases of the inferior planets, the phase of a lunar eclipse, etc.

Phecda. A name sometimes applied to the star γ Ursæ Majoris.

Phobos. The inner satellite of Mars. It revolves round the planet in about 7 hrs. 39 mins. Its distance from the centre of Mars is about 5,819 miles, and its diameter probably not more than 7 miles. It was discovered by Professor Asaph Hall on August 17th, 1877. For further details, see Appendix.

Phœnix (the Phœnix). One of the southern constellations.

Photography, Stellar. The art of photography applied to the mapping of the stars. Owing to the introduction of the "dry plate process," and the manufacture of very sensitive plates, it is now possible to obtain photographs of stars, nebulæ, etc. Most beautiful photographs of stars, star clusters, and nebulæ have been obtained by the brothers Henry at the Paris Observatory, and by Dr. Common and Dr. Roberts in England. Photographs are now being taken at several observatories on an organised plan for the construction of a photographic chart of the whole heavens.

Photometer. An instrument for measuring the relative brightness of the stars. These are of various forms, but those now most generally used are the "wedge photometer," used at the Oxford Observatory, and the so-called "meridian photometer," used at the Harvard Observatory (U.S.A.). Catalogues of the magnitudes of the brighter stars, as measured with the photometer, have been published by these observatories. That constructed at Oxford is called the *Uranometria Nova Oxoniensis*, and that found at Harvard the *Harvard Photometry*.

Photometric Scale. The scale in which the brightness of the stars is represented according to a fixed standard. The number which expresses the number of times which the light of a given star exceeds that of another one magnitude fainter is termed the "light ratio." The number now universally adopted by astronomers is 2·5119, of which the logarithm is 0·4.

Photometry of the Stars. The measurement of the relative brightness of the stars, by means of instruments specially designed for the purpose. See PHOTOMETER.

Phurud. A name sometimes applied to the star ζ Canis Majoris.

Pictor (the Painter's Easel). One of the southern constellations.

Pisces (the Fishes). One of the zodiacal constellations. Owing to the precession of the equinoxes, the "First Point of Aries" now lies in the constellation Pisces.

Piscis Australis (the Southern Fish). One of the southern constellations. Its brightest star is Fomalhaut.

Places, Geocentric and Heliocentric. The geocentric place of a celestial body is its position on the star sphere as supposed to be seen from the centre of the earth, and its heliocentric place its position as seen from the centre of the sun.

Places, Star. The correct position of the stars on the surface of the celestial sphere. These are usually defined by stating their right ascensions and declinations for a given epoch. See RIGHT ASCENSION and DECLINATION.

Planetary Motion. The motion of the planets from west to east, or contrary to the diurnal motion. The reality of this motion was taught by Alcmæon of Croton, in the fifth century B.C.

Planetary Nebulæ. Nebulæ of a uniform, or nearly uniform, brightness—at least when viewed with telescopes of moderate power—and usually of a circular or elliptical shape, with discs resembling those of the planets, but of course very much fainter. Some are of a pale blue colour.

Planets, Minor, or Asteroids. The group of small planets which revolve round the sun in orbits lying between those of Mars and Jupiter. They are very small bodies. The diameter of the largest, Vesta, probably does not exceed 200 miles. The number now known (1893) amounts to over 300.

Planets, Primary. The planets which revolve round the sun as a centre. These are in order of distance from the sun: (1) Mercury, (2) Venus, (3) the Earth, (4) Mars, (5) the Group of Minor Planets, (6) Jupiter, (7) Saturn, (8) Uranus, (9) Neptune.

Planets, Secondary. The satellites which revolve round the primary planets as a centre. Our moon is a secondary planet, or satellite of the earth, but from its relatively large size and other reasons, it may be almost considered as a primary planet. Mars has 2 satellites, Jupiter 5, Saturn 8, Uranus 4, and Neptune 2: a total of 22 secondary planets.

Platonic Period. The period of revolution of the equinoxes: about 25,695 years.

Pleiades. The well-known group or naked-eye cluster of stars surrounding the third-magnitude star Alcyone or η Tauri. To ordinary vision, perhaps, only six stars can be seen distinctly with the naked eye; but to keener eyesight more are visible. With a good opera-glass over thirty may be seen. Powerful telescopes show several hundred, and on a photograph taken at the Paris Observatory no less than 2326 may be counted. A quantity of nebulous light is also visible on the photograph, surrounding the brighter stars of the group.

Plumb-line. A weight suspended by a cord. It hangs exactly perpendicular to the surface of smooth water, and therefore perpendicular to a tangent to the earth's surface at the place of observation.

Pointers. A term applied to the stars α and β Ursæ Majoris (or "the Plough") because they nearly point to the Pole Star.

Points of Compass. The principal points of the compass are North, South, East, and West. These are called the Cardinal Points. Each quadrant of 90° is, however, further subdivided into 8 divisions, or $11\frac{1}{4}$° to each division, making 32 points in all. These are designated as follows, beginning at the north, and going round the circle by east, south, and west, back to north again: N., N. by E., N.N.E., N.E. by N., N.E., N.E. by

E., E.N.E., E. by N., E., E. by S., E.S.E., S.E. by E., S.E., S.E. by S., S.S.E., S. by E., S., S. by W., S.S.W., S.W. by S., S.W., S.W. by W., W.S.W., W. by S., W., W. by N., W.N.W., N.W. by W., N.W., N.W. by N., N.N.W., N. by W., N.

Polar Distance. The angular distance of a celestial body from one of the poles of the celestial sphere. The distance from the north pole is called the north polar distance, and that from the south pole the south polar distance.

Polaris, or **Pole Star.** The nearest bright star at present to the north celestial pole. It is otherwise known as α Ursæ Minoris. Its present distance from the pole is about $1\frac{1}{2}°$, and the distance is diminishing.

Poles, Celestial. The poles of the celestial sphere are the points towards which the earth's axis of rotation points. They are, in fact, the extremities of an imaginary axis round which the star sphere *apparently* rotates.

Pole Star, or **Polaris,** which see.

Poles, Terrestrial. The extremities of the earth's axis of rotation, or the points at which the axis meets the surface.

Pollux. A name applied to the bright star β Geminorum.

Pores of Sun's Surface. The minute dark spots visible on the sun's surface with a telescope.

Porrima. A name sometimes applied to the star γ Virginis.

Position Angle. The angle between the line joining the components of a double star, and the "declination circle" passing through the primary star of the pair. This angle is measured from 0° to 360°, beginning at the north point (or bottom of the field in an inverting telescope) and going round by east, south, and west. In a binary star the motion is said to be *direct* when the position angle is increasing numerically, and retrograde when diminishing.

Position Micrometer. A form of parallel-wire micrometer used in measuring double stars.

Postvarta. A name sometimes applied to the star γ Virginis.

Præsepe (the Bee-hive). The star cluster or group of small stars in the constellation Cancer (the Crab).

Precession of the Equinoxes. A slow change in the position of the celestial equator, which causes the equinoctial points to retrograde along the ecliptic. This is due to the pole of the equator revolving round the pole of the ecliptic in a period of about 25,695 years (Stockwell). This motion of the plane of the equator is due to the disturbing effect of the attractions of the sun and moon on the protuberant matter at the earth's equator. It was discovered by Hipparchus in the second century B.C.

Primary Planets. The planets which revolve round the sun as a centre. See PLANETS, PRIMARY.

Prime Meridian. The meridian on the earth's surface from which longitudes east and west are reckoned. The meridian of Greenwich Observatory is usually taken as the prime meridian, but the French reckon from the meridian of Paris.

Prime Vertical. The "great circle" of the celestial sphere which passes through the zenith, nadir, and west points of the horizon.

Priming of the Tides. An acceleration in the time of high water which occurs between "new moon" and "first quarter," and between "full moon" and "last quarter," due to the combined action of the sun and moon.

Problem of Three Bodies. When a large central body has two smaller bodies revolving round it, the investigation of the perturbations of the system thus formed is called the "problem of three bodies." Its *exact* solution is beyond the present powers of mathematical analysis; but when the central body is very large in comparison with the others, as in the case of the sun and planets, a sufficiently close approximation can be made.

Procyon. A name applied to the bright star α Canis Minoris. Derived from the Greek *προκύων*, "the advanced dog," or the dog which goes before Sirius "the great dog."

Projections of the Sphere. Methods of mapping the surface of a sphere on a plane (or flat) surface.

Prolate Spheroid. A solid formed by the rotation of an ellipse round its major or longer axis.

Proper Motions. Many of the so-called "fixed stars" are not really fixed, but have a small motion across the face of the sky. This is called the star's "proper motion." The motion is in many cases very small, but becomes perceptible with accurate astronomical instruments, after the lapse of a number of years. Proper motion is due to a real motion of the star, combined with an apparent motion due to the sun's motion through space.

Pulcherrima. A name sometimes applied to the beautiful double star ε Boötis.

Puppis. A name applied to a portion of the constellation Argo.

Q.

Quadrant. The fourth part of a circle, or a quarter circle.

Quadrantids. A shower of meteors visible about Jan. 2nd in each year. They seem to radiate from a point north of Corona Borealis. They are swift, with long paths.

Quadrature. A term applied to the position of two celestial bodies when the difference of their longitudes is 90°. The moon is in quadrature at "first quarter" and "last quarter."

Quarter, First, and **Last.** Terms applied to the phases of the moon when the disc is half illuminated. This occurs when the moon's angular distance from the sun is 90°. These phases are also called "half moon."

R.

Radial Disturbing Force. In the theory of perturbations, the component of the disturbing force which acts along the radius vector.

Radiant. The point in the celestial sphere from which a shower of meteors seems to radiate.

Radiation, Solar. The amount of heat received from the sun by any particular planet.

Radius Vector. A line supposed to be drawn from a moving body to the centre round which it moves. In a circular orbit the radius vector is constant and equal to the radius of the circle, but in an elliptic orbit it varies in length with the position of the moving body.

Rasalas. A name sometimes applied to the star μ Leonis. From the Arabic *Rás-al-Asad.*

Ras Algethi. A name sometimes applied to the star α Ophiuchi.

Ras Alhague. A name sometimes applied to the star α Ophiuchi.

Rate of Clock. The amount by which an astronomical clock gains or loses in twenty-four hours. If the clock loses tho rate is positive; if it gains it is negative.

Reading Microscopes. Small microscopes used for reading the graduated circles of astronomical and other instruments.

Real Ellipse. The actual ellipse in space described by one of the components of a double star round the other, supposed to be at rest. The orthogonal projection of this ellipse on the background of the sky is the "apparent ellipse," as seen from the earth. The real ellipse is only seen by a terrestrial observer when the plane of the orbit lies at right angles to the line of sight, and such cases are very rare.

Red Stars. Stars of a very reddish colour. For list of the most remarkable red stars, see Appendix.

Reflecting Circle. An instrument invented in 1770 by Tobias Mayers (Prof. Johann T. Mayer), and afterwards improved by the Chevalier de Borda in France and Mr. Edward Troughton in England. The principle of its construction is that of the sextant, but the graduated arc is a complete circle.

Reflecting Telescope. A form of telescope in which the image is formed by reflection from a concave mirror, and again reflected into the eyepiece by means of a smaller mirror. There are four forms of reflecting telescope: viz., the Newtonian, the Gregorian, the Cassegrainian, and the Herschelian, or "front view," which see.

Reformation of Calendar. An improvement in the method of reckoning time, first introduced by Julius Cæsar, B.C. 44, and in later times further corrected by

Pope Gregory XIII. See CALENDAR, GREGORIAN, and JULIAN.

Refraction. The bending or change of direction which a ray of light suffers when passing through a transparent medium, like the earth's atmosphere, or the object-glass of a refracting telescope.

Refracting Telescope. A form of telescope in which an image formed by refraction through the object glass is viewed by an eyepiece placed at the other end of the tube. The largest refracting telescope yet made (1893) is that at the Lick Observatory, California. The object-glass is 36 inches in diameter.

Regulus. A name applied to the bright star α Leonis.

Repetition. A method of measuring an angle on a graduated circle, invented by Borda. The method consists in repeating the measure several times along the graduation, and dividing the final reading by the number of observations. Thus, supposing the angle to be measured is approximately say 15°, then we measure from zero to 15°, then from 15° to about 30°, from 30° to 45°, and so on continuously without changing the index. Suppose the final reading to be 121° 20′ and the number of observations 8, then the correct angle will be $\frac{121^\circ\ 20'}{8} = 15^\circ\ 10'$.

Reticulated Micrometer. A form of micrometer having a series of wires crossing each other at right angles.

Reticulum (the Net). One of the southern constellations.

Retrograde Motion. See MOTION, RETROGRADE.

Reversal. A method of testing the adjustment of the collimation in a transit instrument by reversing the telescope in its supports, so that the eastern end of the axis shall lie in the western support, and *vice versâ.*

Revolution. The motion of one body round another, or round the common centre of gravity of both bodies. Revolution should be carefully distinguished from *Rotation*, which means the motion of a body round a fixed axis contained within the body itself.

Rhea. One of the satellites of Saturn, the fifth in order counting from the planet, round which it revolves at a mean distance of about 336,000 miles, in a period of 4 days 12 hrs. 25 mins. Its diameter is somewhat doubtful, but its stellar magnitude is, according to Professor Pickering, 10·8. Rhea was discovered by J. D. Cassini on Dec. 23rd, 1672.

Rigel. A name applied to the bright star β Orionis. Derived from the Arabic *Ridjl-al-djauzâ*, "the giant's leg."

Right Ascension. The angular distance of a fixed star or other celestial body measured from the "First Point of Aries" eastward *on the equator*. This, combined with the declination, which is measured north and south from the equator, on a great circle passing through the celestial poles and the body, fixes the position of the body on the star sphere.

Rings of Saturn. A marvellous system of flat rings surrounding the planet Saturn, poised in space, and nowhere touching the planet. Various theories of their constitution have been advanced, but the most probable one is that they consist of a multitude of small satellites, too small to be individually visible, even with the most powerful telescopes. The rings are comparatively very thin, possibly not more than fifty miles in thickness.

For dimensions of the ring system, see Appendix ; and for fuller details, see popular works on Astronomy.

Rising of Celestial Objects. The appearance of a celestial body above the horizon of the place of observation. The time of rising is accelerated by refraction, which causes the object to appear above the horizon when it is actually below it. See REFRACTION.

Rotanev. A name sometimes applied to the star β Dolphini. Webb supposes it to be the name " Venator " reversed.

Rotation. The motion of a body round a fixed axis contained within the body itself. Rotation should be carefully distinguished from *revolution,* which means the motion of one body round another or round the common centre of gravity of both bodies.

S.

Sadachbia. A name sometimes applied to the star γ Aquarii.

Sadalmelik. A name sometimes applied to the star α Aquarii. From the Arabic *sad-al-malik,* " the good fortune of the king " (!).

Sadalsund. A name sometimes applied to the star β Aquarii. From the Arabic *sad-al-suûd,* " the fortune of fortunes " ; a term given to the stars β and ξ Aquarii by the old Arabian astronomers.

Sagitta (the Arrow). One of the northern constellations. It lies between Vulpecula and Aquila.

Sagittarius (tho Archer). One of the zodiacal constellations.

Saros. A lunar cycle discovered by the Chaldæan astronomers. It is the period of revolution of the nodes of the moon's orbit with reference to the sun, called the synodic revolution of the nodes. This period is 346·644 days. Now, nineteen synodic revolutions = 6,586·236 days, and is nearly equal to 223 lunar months, which amount to 6,585·29 days, or 18 years and 11 days. Hence, in this period the solar eclipses will be nearly the same. During the period of the Saros the total number of eclipses is about seventy—twenty-nine of the moon and forty-one of the sun.

Satellites. The smaller bodies which revolve round the planets of the solar system. The moon is a satellite of the Earth. Mars has 2 satellites, Jupiter 5, Saturn 8, Uranus 4, and Neptune 2—a total of 22.

Saturn. Next to Jupiter, the largest planet of the solar system. It revolves round the sun in a period of 29 years 167 days, at a mean distance of about 885,000,000 miles. Its mean diameter is about 72,000 miles, or about nine times that of the Earth. It therefore exceeds the Earth in volume over 700 times; but in density it is very light, its mass being only 94 times the mass of the Earth. It is surrounded by a wonderful system of thin rings, which forms the most unique and interesting phenomenon in the solar system. For further details see Appendix.

Scheat. A name sometimes applied to the star β Pegasi.

Schedir. A name sometimes applied to the star α Cassiopeiæ. Probably a corruption of the Arabic *al-sadr*, "the beast." The star is slightly variable in light.

Scintillation. A term sometimes applied to the twinkling of the stars.

Scorpio (the Scorpion). One of the southern zodiacal constellations.

Sculptor (the Sculptor's Workshop). One of the southern constellations.

Seasons. The variation in the relative length of the day and night, due to the inclination of the earth's axis of rotation to the plane of its orbit round the sun. That the seasons are caused by the inclination of the earth's axis was taught by Diogenes of Apollonia about 450 B.C.

Secondary. A term applied to the satellites which revolve round the planets of the solar system. The term is also applied to the great circles on a sphere which pass through the poles of another circle.

Sections, Conic. See CONIC SECTIONS.

Sector, Dip. See DIP SECTOR.

Sector, Zenith. An instrument for measuring the zenith distance of stars. Invented by Hooke in 1669.

Secular Acceleration of the Moon's Mean Motion. An acceleration in the moon's motion, or shortening in its period of revolution round the earth. The moon's mean motion increases at the rate of about eleven seconds in a century. The acceleration is due partly to the variation in the eccentricity of the earth's orbit, and partly to a slight increase in the length of the sidereal day.

Secular Variations. Inequalities in the motions of the planets which do not depend on the configurations of the planets with reference to each other. The effect of secular variations is only perceptible after long periods of time. One of the most important of the secular variations is the slow increase and decrease in the eccentricity of the earth's orbit.

Secunda Giedi. A name sometimes applied to the star α^2 Capricorni.

Selenography. The study of the moon's surface.

Serpens (the Serpent). One of the constellations.

Sexagesimal. The division of the circumference of a circle into 360 degrees. Each degree is subdivided into 60 minutes, and each minute into 60 seconds.

Sextans (the Sextant). One of the constellations. It lies between Leo and Hydra.

Sextant. A mathematical instrument used for measuring angles. It consists of a graduated arc of a circle, fitted with two mirrors and a small telescope. The principle of the instrument depends upon the following optical property :—" The angle between the first and last directions of a ray which has suffered two reflections in one plane is equal to twice the inclination of the reflecting surfaces to each other." The instrument is chiefly used in navigation, but also occasionally for astronomical purposes.

Shadow. The shade cast by an opaque body.

Sháulah. A name sometimes applied to the star λ Scorpii. Derived from the Arabic *al-schaulat*, and *schaulat al-akrab*, " the tail of the scorpion." The stars λ and υ Scorpii were also called *al-ibrat*, " the sting."

Sheliak. A name sometimes applied to the star β Lyræ.

Sheratan. A name sometimes applied to the star β Arietis.

Shooting Stars. A term applied to meteors or " falling stars," which are occasionally seen to shoot across the sky. " Shooting stars " are usually very small bodies, and have no connection with the fixed stars.

Sidereal. Relating to the stars.

Sidereal Month. The period of the moon's revolution round the earth, with reference to the stars. Its length is 27 days 7 hrs. 43 mins. 11·4 secs.

Sidereal Noon. The time of transit of the "First Point of Aries" across the meridian.

Sidereal Period. The period of revolution of a planet round the sun, with reference to the stars.

Sidereal Time. The time measured by the apparent rotation of the star sphere, or transit of the "First Point of Aries" across the meridian.

Sidereal Year. The time which elapses between two successive returns of the sun to the same position among the fixed stars. The length of the sidereal year is 365 days 6 hrs. 9 mins. 8·97 secs. It is therefore about twenty minutes longer than the tropical year, and about 4½ minutes shorter than the anomalistic.

Siderites. Meteoric stones which are chiefly composed of iron.

Siderolites. Meteoric stones containing a mixture of iron and stone.

Signs of Zodiac. The twelve constellations through which the ecliptic passes. These are:—1. Aries (the Ram); 2. Taurus (the Bull); 3. Gemini (the Twins); 4. Cancer (the Crab); 5. Leo (the Lion); 6. Virgo (the Virgin); 7. Libra (the Balance); 8. Scorpio (the Scorpion); 9. Sagittarius (the Archer); 10. Capricornus (the Goat); 11. Aquarius (the Water-bearer); and 12. Pisces (the Fishes).

Sirius. The star α Canis Majoris, the "dog star." It is the brightest star in the sky, being about two magnitudes brighter than an average star of the first magnitude, like Altair or Spica.

Sirrah. A name formerly applied to the star α Andromedæ.

Situation, Angle. The angle between the circles of declination and of latitude passing through a given star.

Skat. A name sometimes applied to the star δ Aquarii.

Small Circle. A circle on a sphere of which the plane does not pass through the centre of the sphere. Small circles are also called *parallels.*

Solar. Relating to the sun.

Solar Cycle. A cycle consisting of twenty-eight Julian years, at the end of which period the days of the week return to the same days of each month throughout the year.

Solar Day. The interval of time between two successive noons, or two successive midnights.

Solar System. The system of planets with their satellites, and comets, which revolve round the sun as a centre.

Solar Time. The time measured by the passage of the sun across the meridian. The time of transit is called *Apparent Noon.*

Solar Year. Same as Tropical Year, which see.

Solstice. Points on the ecliptic which lie at the maximum distance north and south of the celestial equator. The northern point is called the summer solstice, and the southern the winter solstice. The summer solstice is situated in Gemini, and the southern solstice in Sagittarius.

Southing. A term applied to the transit of a celestial body across the meridian of the place of observation, and to the south of the zenith.

South Polar Distance. The angular distance of a celestial body from the south pole of the celestial sphere.

Specific Gravity. The ratio of the weight of a substance to that of an equal volume of water. Thus the earth's specific gravity is about $5\frac{1}{2}$, which implies that its weight is five and a half times that of a globe of water of the same size.

Spectrum Analysis. "The determination of the constituent elements of a luminous body by the examination of its light after its passage through one or more prisms" (Chambers' *Descriptive Astronomy*). Dark lines are visible in the spectra of the sun and stars; and from a comparison of these lines with the bright lines in the spectra of incandescent terrestrial substances, it is possible to determine the chemical elements present in the sun and stars. The *dark* lines in the solar spectrum and in stellar spectra are due to the absorption of the light of the incandescent element when shining through its own vapour. Spectrum analysis is now much used in astronomical researches for the purpose of dividing the stars into classes, and also for determining their motion in the line of sight. This research is much aided by photography.

Speculum. A term applied to the large mirror of a reflecting telescope. The speculum may be formed either of polished metal, or of a glass disc ground to the proper curve, and then silvered over and polished. The latter form of speculum is the one now generally used, and is called "silver on glass."

Sphere. A solid which may be supposed formed by the rotation of a circle round one of its diameter. Every point on the surface of a sphere is equidistant from the centre.

Spheroid. A solid formed by the rotation of an ellipse round one of its axes. If the rotation takes place round the minor axis, the solid is called an *oblate spheroid;* if round the major (or longer) axis, a *prolate spheroid.*

Spica. A named applied to the bright star α Virginis.

Spring Tides. The high tides which occur at new and full moon. The heights of spring and neap tides aro about in the ratio of 10 to 4.

Spots on Sun. See SUN SPOTS.

Stars. The brilliant points of light visible in the sky at night. The stars are of all degrees of brilliancy, from Sirius, the brightest star in the heavens, down to the faintest point visible in the largest telescopes on the clearest nights. They have been divided into magnitudes, the first magnitude including tho brightest stars, the second those decidedly fainter, and so on, down to the seventeenth magnitude, which is, perhaps, the faintest which has yet been *seen* with any telescope. Possibly, however, fainter stars have been photographed. Each magnitude is further subdivided decimally. Thus we have stars of magnitude 2·1, 2·2, 2·3, etc.

Stars, Binary. See BINARY STARS.

Stars, Double. Stars so close that they appear as singlo stars to the naked eye. Some of theso are so excessively close that it requires the largest telescopes to divide them. On the other hand, some may be seen with an opera glass, or even with the naked eye; but these cannot properly be called double stars. Some real double stars—that is, binary or revolving double stars—may, however, be seen with small telescopes, when tho components are at their greatest distance apart. Of these, α Centauri and γ Virginis are examples.

Stars, Variable. See Variable Stars.

Stationary Points. The points in a planet's orbit at which the planet appears stationary among the stars as seen from the earth. In some books on astronomy it is stated that a planet is stationary when it is moving directly towards or away from the earth; but this is quite incorrect.

Stereograms. Photographic views of the moon taken at different phases of libration. These combined in a stereoscope give the effect of a spherical body.

Stereographic Projection. A method of mapping the surface of a sphere, in which the eye is supposed placed at the extremity of a diameter of the sphere, and objects on the opposite hemisphere are projected on a plane passing through the centre of the sphere, and at right angles to the diameter passing through the eye.

Stones, Meteoric. See Meteoric Stones.

Style, Old and New. Prior to 1582 the year commenced on March 25th. The new style, in which the year commences on Jan. 1st, was not introduced into Great Britain till 1752, and as 170 years had elapsed since the new style was established by Pope Gregory, it was necessary to get rid of 11 days; and this was done by calling Sept. 3rd Sept. 14th. In Russia the old style is still retained.

Sub-Polo. A term applied to the passage of a celestial body across the meridian below the pole—that is, between the pole and the north point of the horizon.

Sub-solar Point. The point on the earth's surface at which the sun is in the observer's zenith on any given day at any given moment of Greenwich time.

Suhà. A name applied by the ancients to the star Alcor, near Mizar (ζ Ursæ Majoris).

Sulaphat. A name sometimes applied to the star γ Lyræ.

Summer Solstice. The point on the ecliptic at which the sun attains its maximum distance north of the celestial equator. This point is reached by the sun on June 21st, which is popularly known as the "longest day."

Sun. The centre of the planetary system. Its mean distance from the earth is about 92,796,950 miles (Harkness), and its diameter about 866,000 miles. Its density or specific gravity is 1·40 (that of the earth being 5·6, and water equal to 1). The sun revolves on its axis in a period of about 25¼ days. The axis is inclined to the plane of the ecliptic at an angle of about 83°, and points nearly to the fifth-magnitude star π Draconis. For further particulars see Appendix.

Sun-dial. An instrument for showing the time by means of a shadow cast by the sun on a dial plate. The rod or plate which casts the shadow is called the *gnomon* or *style*. It is placed parallel to the Earth's axis, and therefore points to the celestial pole. There are several forms of sun-dial. The sun-dial is a very ancient form of time-piece, and is mentioned in the Bible (with reference to the sickness of Hezekiah). A sun-dial was erected by Anaximander at Sparta, B.C. 545; one by Meton at Athens, B.C. 433; and one at Rome by Papirius Cursor, B.C. 306. The sun-dial shows apparent time, and to obtain mean time the time indicated by the sun-dial must be corrected by the Equation of Time, which see.

Sun Spots. Dark spots visible at times on the sun's surface. They usually consist of a dark central portion, called the *umbra*, surrounded by a lighter shade, called the *penumbra*. Several instances of spots large enough to be visible to the naked eye have been recorded. The display of sun spots is subject to a periodical variation, the maxima occurring at intervals of about eleven years, with intermediate minima. A maximum occurred in 1882, and another in 1893.

Superior Conjunction. When Mercury and Venus are in that part of their orbit beyond the Sun, as seen from the Earth, they are said to be in superior conjunction.

Superior Planets. The planets of the solar system which are farther from the Sun than the Earth. With the exception of Mercury and Venus, all the planets are superior.

Svalocin. A name sometimes applied to the star α Delphini. Webb supposed it to be the name "Nicolaus" spelt backwards.

Sweeps. A term employed by Sir William Herschel to denote his observations of the number of stars visible in various parts of the sky when the telescope was clamped, and the stars were allowed to pass through the field of view by the effects of the diurnal motion.

Synodical Month. The period which elapses between two successive conjunctions of the moon with the sun. Same as a *lunation*. Its length is 29 days 12 hrs. 44 mins. 2·7 secs.

Synodic Period. The period which elapses between two successive conjunctions or oppositions of a planet with the Sun.

Synodic Revolution. Same as Synodic Period, which see.

Synodic Rotation of the Sun. The *apparent* period of the sun's rotation on its axis. Owing to the revolution of the earth in its orbit in the same direction as the sun's rotation, the apparent period is about two days longer than the real period. The synodical period of rotation is about 27 days 6 hrs. 40 mins.

Synodic Year. Twelve lunar months, or about 355 days. It is a term not often used.

System. Two or more celestial bodies revolving according to the laws of gravitation are said to form a "system." Thus, we have the solar system, Saturn's system, binary star systems, etc.

Syzygy. The moon is said to be in syzygy when it is in conjunction with the sun or "new moon," or when it is in opposition to the sun at "full moon."

T.

Talita. A name sometimes applied to the star ι Ursæ Majoris.

Tangential Force. In the theory of perturbations the component of the disturbing force which acts along the tangent to the orbit of the disturbed body, drawn in the plane of the orbit at the place of the body.

Tangent Screw. A screw used for giving a slow motion to a graduated arc after it has been clamped to the vernier. It was invented by Helvetius about the year 1650. See VERNIER.

Tarazed. Another name for γ Aquilæ. Derived from the Arabic *shâhin târâzed*, "the soaring falcon."

Taurids. A meteor shower visible about November 1st to 8th in each year. The meteors seem to radiate from a point in Taurus (58° + 20°). They are slow and brilliant. Another shower from the same region (62° + 22°) appears about November 20th and 27th.

Taurus (the Bull). One of the zodiacal constellations. Its brightest star is Aldebaran (α Tauri). The Pleiades and Hyades are in this constellation.

Taygeta. One of the stars (19 Tauri) in the Pleiades.

Tegmine. A name sometimes applied to the star ζ Cancri.

Tejat Post. A name sometimes applied to the star μ Geminorum. It comes from the Arabic *tahyáh.*

Telescope. An astronomical instrument for observing the heavenly bodies. It magnifies the image of the object observed, and thus brings it apparently nearer the eye. There are two forms of telescope—the Refracting Telescope and the Reflecting Telescope, which see.

Telescopic Objects. Celestial objects which cannot be seen with the naked eye, but require a telescope or opera-glass to render them visible.

Telescopium (the Telescope). One of the southern constellations.

Temporary Stars. Stars which blaze out suddenly, and after remaining visible for a short time fade away and become very faint stars, or planetary nebulæ, or totally disappear. They are also called *novæ.* Temporary stars are exceedingly rare objects. The recorded instances in modern times are those of 1572 in Cassiopeia (Tycho Brahé's "Pilgrim Star"); 1604 in Ophiuchus ("Kepler's nova"); 1670 in Cygnus (Anthelm's); 1848 in Ophiuchus (Hind's); 1866 in Corona Borealis (Birmingham's); 1876 in Cygnus Schmidt's); 1885 in the great nebula in Andromeda; and 1892 in Auriga (Anderson's). All these, with the exception of the "Blaze Star" of 1866, appeared in or near the Milky Way.

Terminator. A term applied to the line—usually irregular—which divides the bright or illuminated part of the moon from the dark part. At new and full moon the terminator coincides with the limb or circumference of the disc.

Terrestrial Equator. The great circle on the earth's surface, every point on which is equidistant from either pole. The plane of the equator is at right angles to the earth's axis of rotation.

Terrestrial Latitude. The angular distance of a place on the earth's surface north or south of the terrestrial equator. This is measured from 0° to 90°. Thus, the latitude of the equator is 0°, and that of the poles 90°. The altitude of the celestial pole is equal to the latitude of the place of observation.

Terrestrial Longitude. The angular distance of a place on the earth's surface east or west of a fixed meridian called the first or prime meridian. The meridian of Greenwich is usually taken as the prime meridian. Longitudes are measured east and west from 0° to 180°.

Terrestrial Meridian. The meridian of any place on the earth's surface is the great circle passing through the place, and the terrestrial poles. It therefore passes through the earth's axis.

Terrestrial Poles. The extremities of the earth's axis of rotation, or the points at which this axis meets the surface. That situated in the hemisphere containing Europe is called the north pole and the opposite the south pole.

Tethys. One of the satellites of Saturn, the third in order counting from the planet, round which it revolves in a period of 1 day 21 hrs. 18 mins., at a mean distance of about 187,000 miles. It was discovered by J. D. Cassini in March 1684. Its stellar magnitude is, according to Pickering, 11·4, but its real diameter is uncertain.

Thuban. A name sometimes applied to the star α Draconis.

Tides. The daily rise and fall of the waters of the ocean caused by the attraction of the sun and moon. The tide-raising power of the sun is about three-sevenths of that of the moon.

Tidal Friction. The friction caused by the motion of the tides. It has a tendency to check the speed of the the earth's rotation, but the effect is very small and only appreciable—if at all—after the lapse of ages.

Titan. The largest of Saturn's satellites, and sixth in order counting from the planet. It was discovered by C. Huygens on March 25th, 1655. Its mean distance from Saturn is about 777,000 miles, and it revolves round the planet in 15 days 22 hrs. 41 mins. It is visible in small telescopes, its stellar magnitude being, according to Pickering, 9·4. Its real diameter is somewhat doubtful, but is probably between 3,000 and 4,000 miles. It is therefore greater in volume than the planet Mercury.

Titania. One of the satellites of Uranus, the third in order of distance counting from the planet. Its mean distance from the planet's centre is about 291,000 miles, and its period of revolution 8 days 16 hrs. 56 mins. It can be well seen only in large telescopes, and its diameter is uncertain. Titania was discovered by Sir W. Herschel on Jan. 11th, 1787.

Total Eclipse. An eclipse of the sun in which the whole of the disc is covered by the moon; and an eclipse of the moon in which the moon is wholly immersed in the earth's shadow.

Toucan (the Toucan). One of the southern constellations. It lies south of Phœnix and Grus.

Trade Winds. These winds blow from the north-east in the northern hemisphere, and from the south-east in the southern hemisphere. They are due to air-currents flowing from the north and south towards the heated parts of the earth at the equator. They are deflected from their original course by the effect of the earth's rotation on its axis.

Transit. The passage of a celestial body across the meridian of the place of observation.

Transit Instrument. An instrument used for observing the passage of celestial bodies across the meridian. It consists of a telescope attached at right angles to a horizontal axis and fitted with vertical graduated circles. In the focus of the object-glass is a framework of cross wires.

Transit of a Satellite. The passage of a satellite across the disc of its primary planet.

Transit of a Shadow. The passage of the shadow of a satellite across the disc of a planet.

Transits of Mercury. The passage of the planet Mercury across the sun's disc. They occur more frequently than transits of Venus, but are not so useful for determining the sun's distance from the earth, owing to the proximity of Mercury to the sun, which renders the parallaxes of Mercury and the Sun more nearly equal than in the case of Venus and the Sun. Transits of Mercury at the same node occur at intervals of 7, 13, 33, or 46 years. The next transit will occur on Nov. 10th, 1894—the last of the present century.

Transits of Venus. The passage of the planet Venus across the sun's disc. They have been used to determine the sun's distance from the earth, but the results are not so satisfactory as might be expected. Transits of Venus occur at the following intervals in years: 8, 105½; 8, 121½; 8, 105½; 8, 121½. Transits took place in 1761, 1769, 1874, and 1882, and the next will occur in the years 2004 and 2012.

Transversal Disturbing Force. In the theory of perturbations, the component of the disturbing force, which acts at right angles to the radius vector, and in the same plane with the radius vector and the tangent to the orbit of the disturbed body.

Triangulum (the Triangle). One of the northern constellations.

Triangulum Australe. One of the southern constellations.

Tropical Revolution. The period of revolution of a planet, with reference to the nodes of its equator on the plane of its orbit.

Tropical Year. The time which elapses between two successive passages of the sun through the vernal equinox, or "First Point of Aries." The length of the tropical year is 365 days 5 hrs. 48 mins. 45·51 secs., or approximately 365¼ days.

Tropics. The two parallels or "small circles" on the earth's surface, which have a latitude north and south equal to the "obliquity of the ecliptic," or about 23° 27½′. The northern parallel is called the Tropic of Cancer, and the southern the Tropic of Capricorn. The region lying between these parallels is popularly spoken of as "the tropics."

True Sun. A term applied to the sun itself, to distinguish it from the imaginary or "mean sun."

Tureïs. A name sometimes applied to the star ι Argûs.

Twilight. The refracted sunlight visible after the sun has set, or before it rises. Twilight begins and ends when the sun is about 18° below the horizon. On the "longest day" the sun is about $23\frac{1}{2}°$ north of the celestial equator. Its zenith distance is therefore $66\frac{1}{2}°$; and if l be the latitude of the place, the sun's distance below the horizon at midnight will be $66\frac{1}{2}°-l$. Making this equal to 18°, we have $l= 66\frac{1}{2}° - 18 = 48\frac{1}{2}°$. Hence for all places on the earth's surface north of $48\frac{1}{2}°$ there is twilight all night on June 21st. North of latitude $66\frac{1}{2}°$ the sun does not set at all on the "longest day." This produces the phenomenon of "the midnight sun."

U.

Umbra. The dark shadow of the earth seen on the moon during a lunar eclipse. The umbra is bordered by a lighter shade called the *penumbra.* At points covered by the *umbra* a lunar spectator would see a total eclipse of the sun; but in the *penumbra* only a partial eclipse. The darker portion of a sun spot is called the *umbra.*

Umbriel. One of the satellites of Uranus, the second in order of distance counting from the planet. Its mean distance from the planet's centre is about 177,500 miles, and its period of revolution 4 days 3 hrs. 27 mins. It can be well seen only in large telescopes, and its diameter is uncertain. Umbriel was discovered by O. Struve on Oct. 8th, 1847.

Unukalhay. A name sometimes applied to the star α Serpentis. From the Arabic *nuk-al-hayyah,* "the serpent's neck."

Uranography. The department of astronomy which deals with the mapping of the stars.

Uranometry. The measurements of the heavens and of the positions of the fixed stars. The Latin term *Uranometria* has been applied to several star atlases. Thus, we have the *Uranometria Nova* of Argelander, Gould's *Uranometria Argentina*, etc.

Uranus. One of the superior planets. Discovered by Sir W. Herschel on March 13th, 1781. Its mean distance from the sun is about 1,780,000,000 miles, and its period of revolution about 84 years. Its diameter is about 33,000 miles. It may sometimes be seen with the naked eye, its stellar magnitude at opposition being about 5½. Uranus is attended by four satellites—Ariel, Umbriel, Titania, and Oberon, which see.

Ursa Major (the Great Bear or "Plough"). One of the northern constellations.

Ursa Minor (the Little Bear). One of the northern constellations. Its principal star is Polaris, or the Pole star (α Ursæ Minoris).

V.

Variable Stars. Stars which are not constant in their light, but vary in brightness. Some of these curious and interesting objects vary to a great extent, but others only slightly. Over two hundred variable stars are now known. They have been arranged in the following classes: (1) temporary, or new stars, or *novæ* as they are also called; (2) variable stars, with long and tolerably regular periods; (3) irregular variables, or those which have no regular period, but fluctuate irregularly; (4) variables of short period; and (5) variables of the Algol, which at regular intervals undergo sudden diminutions of light, lasting for a few hours only. Of these classes, the following are examples: Class I. (temporary stars).—Tycho Brahé's star of 1572 in Cassiopeia, Kepler's Nova of 1604 in Ophiuchus, Schmidt's Nova Cygni in 1876, and Anderson's New Star in Auriga 1892, and some others (see TEMPORARY STARS). CLASS II.—Mira (ο Ceti), χ Cygni, R. Leonis, etc. CLASS III.—*α* Herculis, *α* Orionis (Betelgeuse), *μ* Cephei, etc. CLASS IV.—*β* Lyræ, ζ Geminorum, η Aquilæ, δ Cephei, S. (10) Sagittæ, etc. CLASS V.—Algol, λ Tauri, δ Libræ. There are only ten known stars in this class.

Variation. An inequality in the moon's motion, due to the varying amount of the sun's disturbing force. This causes a maximum velocity of motion at "new moon" and "full moon," and a minimum velocity at the quadratures ("first" and "last quarter").

Vega. The bright star *α* Lyræ. It is sometimes spelt Wega. The name is derived from the Arabic *vaki*.

Vela. A name applied to a portion of the constellation Argo.

Velocity. The rate at which a body moves. This is usually expressed as so many feet per second; but in the case of very fast moving bodies, like the earth and planets, as so many miles per second.

Venus. One of the inferior planets, or those revolving round the sun inside the earth's orbit. Its mean distance from the sun is about 67,000,000 miles, and its orbit is more nearly circular than that of any of the other large planets. It revolves round the sun in a period of 224·7 days. Its diameter is about 7,918 miles, or nearly equal to that of the earth. As seen from the earth, Venus is the brightest of all the planets, and forms a brilliant object as a "morning" or "evening star." For further details see Appendix.

Vernal Equinox. The equinox at which the sun passes from the south to the north side of the ecliptic. This takes place about March 21st.

Vernier. "A short scale movable by the side of a longer scale, by which subdivisions of the longer scale may be measured." The longer scale is called the limb of the instrument. If the divisions on the vernier are shorter than those on the limb, the divisions on the vernier are numbered and read in the same direction as those on the limb, and the vernier is called a *direct vernier.* If the divisions on the vernier are longer than those on the limb, they are read in the opposite direction to those on the limb, and the vernier is called a *retrograde vernier.* (See *Engineers' Surveying Instruments*, by Professor Ira O. Baker, C.E.)

Vertex. The top of the disc of the sun, moon, or planets, or the point at which a great circle, passing through the zenith and the centre of the disc, intersects the limb.

Vertical Circles. Circles on the celestial sphere which pass through the zenith and nadir of the place of observation.

Vertical, Prime. The "great circle" on the celestial sphere, which passes through the zenith, nadir, and the east and west points of the horizon.

Vesta. One of the minor planets which revolve round the sun in orbits lying between those of Mars and Jupiter. It was discovered by Olbers on March 29th, 1807. It revolves round the sun in a period of 3·629 years, at a mean distance of 2·36 times the earth's mean distance from the sun. Vesta is the brightest of the group of minor planets, its magnitude at mean opposition being about $6\frac{1}{2}$, and it has been occasionally seen with the naked eye. Its real diameter is probably about two hundred miles.

Via Lactea, or **Milky Way,** which see.

Vindemiatrix. A name sometimes applied to the star ε Virginis.

Virgo (the Virgin). One of the zodiacal constellations. Its brightest star is Spica (α Virginis).

Vis Viva. The mass of a moving body multiplied by the square of its velocity is called the *vis viva.*

Volans (the Flying Fish). One of the southern constellations.

Vulpecula (the Fox). One of the northern constellations.

W.

Waning Moon. The moon is said to be "waning" when its light is apparently decreasing between "full moon" and "new moon."

Wasat. A name sometimes applied to the star δ Geminorum.

Waxing Moon. The moon is said to be "waxing" between "new moon" and "full moon," when its light is apparently increasing.

Wedge Photometer. A form of photometer in which a wedge of tinted glass is used to extinguish the light of a star.

Wezen. A name sometimes applied to the star δ Canis Majoris.

Willow Leaves. A term applied by Nasmyth to the markings on the sun's surface, which he thought resembled in shape the leaves of the willow tree. They have also been termed "rice grains" and "granules."

Winter Solstice. The point on the ecliptic which is at the maximum distance south of the equator. This point is reached by the sun about Dec. 22nd, which is popularly known as the "shortest day."

Y.

Year, Anomalistic. The time which elapses between two successive passages of the sun (in its apparent revolution among the stars) through the perigee of the earth's orbit. The length of the anomalistic year is 365 days 6 hrs. 13 mins. 48·09 secs.

Year, Civil. The year used for the ordinary affairs of life. It usually consists of 365 days, but as the real length of the year is about 365¼ days, a day is added every four years. This fourth year is called Leap Year, and contains 366 days.

Year, Leap. See preceding paragraph.

Year, Sidereal. The time which elapses between two successive returns of the sun to the same position among the fixed stars. The length of the sidereal year is 365 days 6 hrs. 9 mins. 9·314 secs. It is therefore about twenty minutes longer than the tropical year, and about four and a half minutes shorter than the anomalistic year.

Year, Synodic. A year of twelve lunar months, or about 355 days. It is a term not often used.

Year, Tropical. The time which elapses between two successive passages of the sun through the vernal equinox, or "First Point of Aries." The length of the tropical year is 365 days 5 hrs. 48 mins. 45·51 secs., or approximately 365¼ days.

Z.

Zaurac. A name sometimes applied to the star γ' Eridani.

Zavijava. A name sometimes applied to the star β Virginis.

Zenith. The point in the celestial sphere vertically overhead. Its direction is indicated by the plumb line.

Zenith Distance. The angular distance of a celestial body from the observer's zenith. It is the complement of the altitude, or the difference between 90° and the altitude.

Zenith Sector. An instrument for measuring the zenith distances of stars, invented by Hooke in 1669.

Zodiac. A belt of the sky extending along the ecliptic, in which the sun, moon, and most of the planets apparently perform their revolutions. The zodiacal zone is about 18° in width, 9° on each side of the ecliptic.

Zodiacal Light. "A cone-shaped or lenticular beam of light, which makes its appearance at certain times of the year above the eastern horizon in the mornings before dawn has commenced, and above the western horizon after sunset in the evening, remaining visible long after twilight has ceased" (*Astronomy for Amateurs*, p. 280). It is best seen after sunset in tho spring months and before sunrise in the autumn. In the tropics it is visible nearly every evening, and may occasionally be well seen in more northern latitudes. "The phenomenon is generally supposed to be due to a sort of nebulous envelope surrounding the sun, and densest in or near the ecliptic: hence the name of Zodiacal Light."

Zones. Spaces included between parallels of declination on the celestial sphere. The term is also applied to spaces on the earth's surface included between parallels of latitude, such as the "Torrid Zone," the "Temperate Zones," and "Frigid Zones."

Zosma. A name sometimes applied to the star δ Leonis. Derived from the Greek ζῶσμα, a tunic or girdle.

Zuben el Chameli. A name sometimes applied to the star β Libræ.

Zuben el Genubi. A name sometimes applied to the star α Libræ.

Zuben Hakrabi. A name sometimes applied to the star γ Libræ.

APPENDIX.

ASTRONOMICAL DATA.

Coefficient of Refraction	57·5″.
Horizontal Refraction	33′.
Constant of Precession	50·1882″ (Nyrén, 1869). 50·438239″ (Stockwell, 1873). 50·3514″ (L. Struve, 1888).

The limits of variation of this constant are, according to Stockwell, 48·212398″ and 52·664080″.

Constant of Nutation	9·23″ (Le Verrier, 1856). 9·134″ (E. J. Stone, 1869). 9·236″ (Nyrén, 1872). 9·22″ (Harkness, 1891).
Period of Nutation	18·66 years.
Equation of Equinoxes	15′ 37″.
Constant of Aberration	20·4451″ (W. Struve, 1843). 20·492″ ± 0·006″ (Nyrén, 1883). 20·45451″ ± 0·01258″ (Harkness, 1891). 20·447″ ± 0·024″ (Lœwy and Puiseux, 1891). 20·494″ ± 0·017″ (Comstock, 1892). 20·510″ (Chandler, 1893).
Velocity of Light	186,337·0 ± 49·722 miles per sec. (Harkness).
Equation of Light	8 mins. 18 secs.

THE EARTH.

Equatorial Diameter	7926·59 miles (Clarke, 1880). 7926·248 ± 0·156 miles (Harkness, 1891).
Polar Diameter .	7899·58 miles (Clarke, 1880). 7899·844 ± 0·124 miles (Harkness, 1891).
Ellipticity or Compression . .	$\frac{1}{293{\cdot}47}$ (Clarke, 1878). $\frac{1}{300{\cdot}205 \pm 2{\cdot}964}$ (Harkness, 1891).
Mean Density (water = 1) . .	5·66 (Francis Baily). 5·576 ± 0·016 (Harkness, 1891).
Mass in Terms of Sun's Mass . .	$\frac{1}{327{,}214 \pm 624}$ (Harkness, 1891).

	hrs.	mins.	secs.
Sidereal Day . .	23	56	4·1.
Mean Solar Day .	24	3	56·55.

	days	hrs.	mins.	secs.
Year, Tropical . .	365	5	48	46.
,, Sidereal . .	365	6	9	9·314 (Harkness, 1891).
,, Anomalistic .	365	6	13	48·09.

Eccentricity of the Earth's Orbit .	0·01677, or $\frac{1}{60}$ nearly.
Obliquity of the Ecliptic . .	23° 27′ 31·83″ (Le Verrier, 1850). 23° 27′ 22·3″ (Airy, 1868).
Annual Motion of Line of Apsides .	11·77″.
Acceleration of Gravity . .	32·086 feet per second (Harkness, 1891).
Length of seconds Pendulum . .	39·012 inches.

THE MOON.

Mean Parallax . . .	57′ 2·542″ (Harkness, 1891).
Mean Distance from the Earth	238,854·75 ± 9·916 miles (Harkness).
Minimum Distance (perigee)	225.741·69 ± 5·44 miles.
Maximum Distance (apogee)	251,967·81 ± 5·44 miles.
Eccentricity of Orbit . .	0·05489972 (Harkness, 1891).
Inclination of Orbit . .	5° 8′ 43·3546″ (Harkness).

Mean Angular Apparent Diameter	31′ 5″.
Diameter in Miles	2163.
Mass in Terms of Earth's Mass	$\frac{1}{81}$.
Density (water = 1)	3·40.
Force of Gravity (Earth's Gravity = 1)	0·165.
Albedo	0·174 (Zöllner).

	days	hrs.	mins.	secs.
Sidereal Month	27	7	43	11·4.
Synodical Month	29	12	44	2·7.
Anomalistic Month	27	13	18	37·4.
Nodical Month	27	5	5	35·8.

Period of Revolution of Moon's Nodes (sidereal)	6793·39 days.
Period of Revolution of Moon's Nodes (synodic)	346·644 days.
Period of Revolution of Moon's Apsides (sidereal)	3232·575 days = 8·85 years.
Period of Revolution of Moon's Apsides (synodic)	411·74 days.
Saros	223 Synodic Months = 6585·29 days = 18·09 years.
Metonic Cycle	235 Synodic Months = 6939·69 days = 19 Tropical Years (very nearly).
Lunar Inequality of the Earth	6·52294″ ± 0·01854″ (Harkness).

THE SUN.

Solar Parallax	8·798″ (Cornu). 8·79″ ± 0·034″ (Newcomb, 1890). 8·800″ ± 0·03″ (Auwers, 1891). 8·80905″ ± 0·00567″ (Harkness, 1891). 8·809 ± 0·0066 (Gill).
Sun's Mean Distance from the Earth	92,796,950 ± 59,715 miles (Harkness, 1891).

Sun's Mean Angular Apparent Diameter . .	32′ 3·6″ (*Nautical Almanack*). 31′ 59·3″ (Auwers).
Sun's Diameter in Miles . .	866,000.
Mass in Terms of Earth's Mass .	327,214 ± 624 (Harkness).
Density (water = 1)	1·40.
Force of Gravity at Sun's Equator (Earth's Gravity = 1) . . .	27·41.
Inclination of Sun's Equator to the Plane of the Ecliptic (1866·5)	6° 58′.
Longitude of Ascending Node of Sun's Equator (1866·5) . .	74° 36′.

MERCURY.

Mean Distance from the Sun (Earth's Distance = 1)	0·3870987.
Mean Distance from the Sun in Miles .	35,921,579.
Eccentricity of Orbit	0·2056048.
Maximum Distance (aphelion) . .	43,308,000.
Minimum Distance (perihelion) . .	28,536,000.
Inclination of Orbit to Plane of Ecliptic	7° 0′ 8″.
Sidereal Period of Revolution . . .	87·969258 days.
Diameter in Miles	3000.
Polar Compression	$\frac{1}{25}$ (?).
Period of Rotation on Axis . . .	88 days (?).
Mass (Sun's Mass = 1)	$\frac{1}{8,374,672 \pm 1,765,762}$ (Harkness).
Mean Density (water = 1) . . .	4·00.
Force of Gravity at Equator (Earth's Gravity = 1)	0·272.
Albedo	0·13 (Zöllner).

VENUS.

Mean Distance from the Sun (Earth's distance = 1)	0·7233322.
Mean Distance in Miles	67,123,022.
Eccentricity of Orbit	0·0068433.
Maximum Distance (aphelion)	67,582,364.
Minimum Distance (perihelion)	66,663,680.
Inclination of Orbit to Plane of Ecliptic	3° 23′ 35″.
Sidereal Period of Revolution	224·700787 days.
Diameter in Miles (0·999 of Earth)	7918 (Hartwig).
Polar Compression	Very small.
Period of Rotation on Axis	225 days (?).
Mass (Sun's Mass = 1)	$\frac{1}{408,968 \pm 1874}$ (Harkness).
Mean Density (water = 1)	4·46.
Force of Gravity at Equator (Earth's gravity = 1)	0·80.
Albedo	0·50 (Zöllner).

MARS.

Mean Distance from the Sun (Earth's distance = 1)	1·5236913.
Mean Distance from the Sun in Miles	141,393,905.
Eccentricity of Orbit	0·0932611.
Maximum Distance (aphelion)	154,580,456.
Minimum Distance (perihelion)	128,207,354.
Inclination of Orbit to Plane of Ecliptic	1° 51′ 2″.
Sidereal Period of Revolution	1·880832 year. 686·98 days.
Diameter in Miles	4200. 4700 (Niesten).
Polar Compression	About $\frac{1}{50}$, but uncertain.
Period of Rotation on Axis	24 hrs. 37 mins. 22·66 secs.
Mass (Sun's mass = 1)	$\frac{1}{3,093,500 \pm 3295}$ (Asaph Hall).
Mean Density (water = 1)	3·95.
Force of Gravity at Equator (Earth's gravity = 1)	0·376 (for diameter = 4200).
Albedo	0·2672 (Zöllner).

MINOR PLANETS.

No. 1. Ceres.

Mean Distance from the Sun (Earth's distance = 1)	2·767265.
Eccentricity of Orbit	0·0763067.
Inclination of Orbit to Ecliptic	10° 37′ 10″.
Sidereal Period of Revolution	4·603 years.
Diameter in Miles	196 (?).

No. 2. Pallas.

Mean Distance from the Sun	2·767972.
Eccentricity of Orbit	0·2408186.
Inclination of Orbit to Ecliptic	34° 43′ 55″ Maximum Inclination of Group.
Sidereal Period of Revolution	4·605 years.
Diameter in Miles	171 (?).

No. 3. Juno.

Mean Distance from the Sun	2·668256.
Eccentricity of Orbit	0·2578570.
Inclination of Orbit to Ecliptic	13° 1′ 23″.
Sidereal Period of Revolution	4·358 years.
Diameter in Miles	124 (?).

No. 4. Vesta.

Mean Distance from the Sun	2·361618.
Eccentricity of Orbit	0·0884191.
Inclination of Orbit to Ecliptic	7° 7′ 54″.
Sidereal Period of Revolution	3·629 years.
Diameter in Miles	214 (?).

No. 5. Astræa.

Mean Distance from the Sun	2·578581.
Eccentricity of Orbit	0·1863016.
Inclination of Orbit	5° 19′ 7″.
Sidereal Period of Revolution	4·141 years.
Diameter in Miles	57 (?).

No. 6. Hebe.

Mean Distance from the Sun	2·424993.
Eccentricity of Orbit	0·2034395.
Inclination of Orbit	14° 47′ 15″.
Sidereal Period of Revolution	3·776 years.
Diameter in Miles	92 (?).

No. 164. Eva.

Mean Distance from the Sun	2·631434.	
Eccentricity of Orbit	0·3471007	Maximum Eccentricity of Group.
Inclination of Orbit	24° 24′ 50″.	
Sidereal Period of Revolution	4·268 years.	

No. 279. Thule.

Mean Distance from the Sun	4·262060	Maximum Distance of Group.
Eccentricity of Orbit	0·0803782.	
Inclination of Orbit	2° 22′ 37″.	
Sidereal Period of Revolution	8·826 years.	

No. 149. Medusa.

Mean Distance from the Sun	2·174715	Minimum Distance of Group.
Eccentricity of Orbit	0·0707682.	
Inclination of Orbit	0° 55′ 12″.	
Sidereal Period of Revolution	3·207 years.	

No. 298. Baptistine.

Mean Distance from the Sun	2·2198.
Eccentricity of Orbit	0·0000.
Inclination of Orbit	5° 0′.
Sidereal Period of Revolution	3·307 years.

JUPITER.

Mean Distance from the Sun (Earth's distance = 1)	5·202800.
Mean Distance from the Sun in Miles	482,803,970.
Eccentricity of Orbit	0·0482519.
Maximum Distance (aphelion)	506,100,180 miles.
Minimum Distance (perihelion)	459,507,760 miles.
Inclination of Orbit to Plane of Ecliptic	1° 18′ 41″.
Sidereal Period of Revolution	11 years 314·838171 days.
Diameter in Miles	Equatorial, 89,790 Polar, 84,300 (Barnard).
Polar Compression	$\frac{1}{17{\cdot}11}$ (Kaiser). $\frac{1}{15\frac{1}{2}}$ (Schur).
Period of Rotation on Axis	9 hrs. 55 mins. 37 secs.
Mass (Sun's Mass = 1)	$\frac{1}{1047{\cdot}55 \pm 0{\cdot}20}$ (Harkness).
Mean Density (water = 1)	1·30.
Force of Gravity at Equator (Earth's gravity = 1)	2·434.
Albedo	0·62 (Zöllner).

SATURN.

Mean Distance from the Sun (Earth's distance = 1)	9·538861.
Mean Distance in Miles	885,177,200.
Eccentricity of Orbit	0·0560713.
Maximum Distance (aphelion)	934,810,240.
Minimum Distance (perihelion)	835,544,170.
Inclination of Orbit to Plane of Ecliptic	2° 29′ 40″.
Sidereal Period of Revolution	29 years 166·98636 days.
Diameter in Miles	Equatorial, 75,900 Polar, 67,600 (Asaph Hall).
Polar Compression	$\frac{1}{9{\cdot}18}$ (Kaiser).

Period of Rotation on Axis . .	10 hrs. 14 mins. 24 secs. (Asaph Hall).
Mass (Sun's Mass = 1) . . .	$\frac{1}{3501{\cdot}6 \pm 0{\cdot}78}$ (Harkness).
Mean Density (water = 1) . .	0·66.
Force of Gravity at Equator (Earth's Gravity = 1)	1·02.
Albedo	0·52 (Zöllner).

SATURN'S RINGS.

Exterior Diameter of Outer Ring .	173,500 miles.
Diameter of Ring in Middle of Cassini's Division	148,000 „
Interior Diameter of Middle Ring .	112,400 „
Interior Diameter of Dusky Ring .	90,800 „
Width of Bright Rings . . .	30,500 „
Width between Dark Ring and Ball .	7600 „
Distance from Planet to Outside of Rings on the West	49,200 „
Distance from Planet to Outside of Rings on the East	48,800 „
Width of Cassini's Division about .	1700 „
Inclination of Rings to the Ecliptic .	28° 7′ 40″ (Asaph Hall).
Period of Rotation of Ring System .	10 hrs. 32 mins. 15 secs. (Sir W. Herschel).

[Mass of ring system $\frac{1}{620}$ of mass of Saturn according to Tisserand, but probably much less.]

URANUS.

Mean Distance from the Sun (Earth's distance = 1)	19·18329.
Mean Distance from the Sun in Miles .	1,780,150,800
Eccentricity of Orbit	0·0463402.
Maximum Distance (aphelion) . .	1,862,643,000.
Minimum Distance (perihelion) . .	1,697,658,600.
Inclination of Orbit to Plane of Ecliptic	0° 46′ 20″.
Sidereal Period of Revolution . .	84 years 7·39036 days.

Diameter in Miles	33,000.
Polar Compression	$\frac{1}{11}$ (Schiaparelli).
Period of Rotation on Axis	Unknown.
Mass (Sun's mass = 1)	$\frac{1}{22600 \pm 36}$ (Harkness).
Mean Density (water = 1)	1·11.
Force of Gravity at Equator (Earth's gravity = 1)	0·835.
Albedo	0·64 (Zöllner).

NEPTUNE.

Mean Distance from the Sun (Earth's distance = 1)	30·05508.
Mean Distance from the Sun in Miles	2,789,019,700.
Eccentricity of Orbit	0·0089646.
Maximum Distance (aphelion)	2,814,022,000.
Minimum Distance (perihelion)	2,764,017,000.
Inclination of Orbit to Plane of Ecliptic	1° 47′ 2″.
Sidereal Period of Revolution	164 years 280·11316 days.
Diameter in Miles	36,000.
Polar Compression	Unknown.
Period of Rotation on Axis	Unknown.
Mass (Sun's Mass = 1)	$\frac{1}{18780 \pm 300}$ (Harkness).
Mean Density (water = 1)	1·03.
Force of Gravity at Equator (Earth's Gravity = 1)	0·844.
Albedo	0·46 (Zöllner).

THE SATELLITES.

SATELLITES OF MARS.

PHOBOS.

Mean Distance from Centre of Mars (Radius of Mars = 1)	2·771.
Mean Distance in Miles (Diameter of Mars = 4200 miles)	5819 miles.
Eccentricity of Orbit	0·03208.
Inclination of Orbit	26° 17·2′.
Sidereal Period of Revolution round Mars	7 hrs. 39 mins. 15·1 secs.
Diameter	About 7 miles.

DEIMOS.

Mean Distance from Centre of Mars (Radius of Mars = 1)	6·921.
Mean Distance in Miles (Diameter of Mars = 4200)	14,534 miles.
Eccentricity of Orbit	0·00574.
Inclination of Orbit	25° 47·2′.
Sidereal Period of Revolution round Mars	1 day 6 hrs. 17 mins. 54 secs.
Diameter	About 6 miles.

SATELLITES OF JUPITER.

	Barnard's Satellite.	I.	II.	III.	IV.
Mean Distance from Centre of Jupiter (Jupiter's radius = 1)	2·50	5·933	9·439	15·057	26·486
Mean Distance in miles from Centre of Jupiter (Jupiter's radius = 44,900 miles) . .	112,500	266,390	423,800	676,000	1,189,200
Eccentricity of Orbit . .	(?)	0·00	0·00	0·001316	0·007243
Inclination of Orbit . . .	(?)	2° 8′ 3″	1° 38′ 57″	1° 59′ 53″	1° 57′ 0″
Sidereal Period of Revolution .	h m s 11 57 23·06	d h m s 1 18 27 33·1	d h m s 3 13 13 42	d h m s 7 3 42 33·39	d h m s 16 15 32 11·2
Diameter in miles . . .	100 ±	2400	2100	3430	2930
Mass (Jupiter's mass = 1) . .	(?)	0·000016877	0·000023227	0·000088437	0·000042475
Density (Water = 1) . .	(?)	1·12	2·14	1·87	1·47

SATELLITES OF SATURN.

	MIMAS.	ENCELADUS.	TETHYS.	DIONE.	RHEA.	TITAN.	HYPERION.	JAPETUS.
Mean Distance from Centre of Saturn (Saturn's equatorial radius = 1) . .	3·10	3·98	4·9	6·31	8·86	20·48	25·07	59·58
Mean Distance in Miles (Saturn's equatorial radius = 37,950) . . .	117,645	151, 40	187,690	239,460	336,240	777,200	951,400	2,261,000
Eccentricity of Orbit . .	0·016	0·0047	—	0·00396	0·00364	0·029869	·11885	0·02957
Inclination of Orbit . .	27° 36′	28° 7′ 0″	28° 40′ 12″	27° 58′ 36″	27° 54′ 27″	27° 38′ 49″	27° 4′ 8″	18° 31′ 5″
Sidereal Period of Revolution	d h m s 0 22 37 5·1	d h m s 1 8 53 7	d h m s 1 21 18 26	d h m s 2 17 41 9·4	d h m s 4 12 25 11·6	d h m s 15 22 41 23	d h m s 21 6 39 27	d h m s 79 7 54 17
Diameter in Miles . .	—	—	—	—	1200?	3200?	—	1800 ?
Mass (Saturn's mass = 1) all uncertain . . .	0·000,000,09	0·000,000,25	0·000,001,30	0·000,001,89	—	387 × Mass of Hyperion (Asaph Hall).		0·000,010

SATELLITES OF URANUS.

	ARIEL.	UMBRIEL.	TITANIA.	OBERON.
Mean Distance from Centre of Uranus (Equatorial radius of Uranus = 1)	7·72	10·76	17·65	23·60
Mean Distance in Miles (Radius of Uranus = 16,500)	127,380	177,540	291,225	389,400
Eccentricity of Orbit	0·020	0·010	0·00106	0·00383
Inclination of Orbit	97° 58′	98° 21′	97° 47′	97° 54′
Sidereal Period of Revolution	$2^{d}\ 12^{h}\ 29^{m}\ 21^{s}$	$4^{d}\ 3^{h}\ 27^{m}\ 37^{s}$	$8^{d}\ 16^{h}\ 56^{m}\ 29{\cdot}5^{s}$	$13^{d}\ 11^{h}\ 7^{m}\ 6{\cdot}4^{s}$

SATELLITE OF NEPTUNE.

Mean Distance from Centre of Neptune (Radius of Neptune = 1)	14·54.
Mean Distance in Miles (Radius of Neptune = 18,000)	261,700.
Eccentricity of Orbit	0·0088.
Inclination of Orbit	145°.
Sidereal Period of Revolution	$5^{d}\ 21^{h}\ 2^{m}\ 44^{s}$.

LIST OF REMARKABLE RED STARS.

(Only the very reddest stars and those brighter than the ninth magnitude are included.)

STAR.	R. A. 1890.			DECL. 1890.		MAG.	REMARKS.
	hrs.	mins.	secs.	degrees	mins.		
Birmingham 4 .	0	14	5	+ 44	5·9	8·2	"Almost vermilion" (Franks); "Intense red colour, most wonderful" (Espin).
D.M. + 34°, 56 .	0	21	43	+ 34	59·6	8·1	"Presque rouge absolu" (Dunér).
R Sculptoris . .	1	21	54	− 33	7·0	Var.	"Intense scarlet" (Gould).
"Mira (ο) Ceti" .	2	13	47	− 3	28·6	Var.	Very red at minimum.
Birm. 65 . .	3	32	21	+ 62	17·5	7·3	"Fiery red" (Dreyer).
R Doradûs . .	4	35	29	− 62	17·6	Var.	"Very red" (Thome).
Birm. 85 . .	4	44	37	+ 28	20·3	8	"Extraordinary ruby colour" (Sir J. Herschel); "Very red" (Espin).
D.M + 38°, 955 .	4	45	6	+ 38	18·9	8·8	"Very red" (Espin).
R Leporis . .	4	54	36	− 14	58·3	Var.	"Most intense crimson" (Hind).
Birm. 96 . .	4	59	43	+ 1	1·5	6·6	"Fiery red" (Doberck); "Fine ruby" (Webb).
D.M. + 7°, 929 .	5	27	17	+ 7	3·8	8·2	"Very red" (Espin).
Birm. 120 . .	5	38	29	+ 24	22·3	8·5	"Presque rouge absolu" (Dunér).
Birm. 121 . .	5	39	6	+ 20	38·9	7·7	"Splendid crimson" (Birmingham); "Full red" (Copeland); "Orange red" (Espin).
Birm. 135 . .	6	4	3	+ 26	2·1	7·4	"Fine ruby colour" (Webb); "Deep red orange" (Gemmill).
Birm. 148 . .	6	28	59	+ 38	32·0	6·3	"Splendid red" (Dreyer); "Colour wonderful" (Espin).
Birm. 165 . .	7	1	47	− 7	23·3	8·3	"Remarkably fine red" (Espin).
S Canis Minoris .	7	26	45	+ 8	33·0	Var.	"Fiery red" (Hind).

STAR.	R. A. 1890.			DECL. 1890.		MAG.	REMARKS.
	hrs.	mins.	secs.	degrees	mins.		
R Leonis . .	9	41	39	+ 11	56·3	Var.	"Blood red" (Criswick); "Presque rouge absolu" (Dunér).
Birm. 232 . .	9	57	34	− 59	45·8	7¾	"Scarlet" (Sir J. Herschel); "Very red" (Thome).
V Hydræ . .	10	46	17	− 20	40·0	Var.	"Copper red, most magnificent" (Dreyer).
R Crateris . .	10	55	9	− 17	44·1	Var.	"Scarlet" (Winnecke); "Very intense ruby" (Webb).
Birm. 225 . .	11	5	30	− 81	11·9	8¾	"Ruby" (Sir J. Herschel).
D.M. + 56°, 1615 .	12	35	21	+ 56	26·7	8·2	"Very red" (Espin).
Birm. 291 . .	12	40	59	− 59	5·6	9·0	"Most intense blood red" (Sir J. Herschel). In field with β Crucis.
Birm. 313 . .	13	42	49	− 27	49	7·0	"Deep red or crimson" (Burnham); "Very red" (Espin).
D.M. + 33°, 2482 .	14	34	39	+ 33	0·5	8·2	"Fine red" (Espin).
Birm. 347 . .	15	14	58	− 75	32·3	8¾	"Very high red" (Sir J. Herschel).
V Ophiuchi . .	16	20	36	− 12	10·6	Var.	"Genuine ruby" (Birmingham); "Presque rouge absolu" (Dunér).
Birm. 385 . .	16	33	34	− 32	9·8	9	"Deep red, like a drop of blood" (Sir J. Herschel).
Birm. 396 . .	16	53	33	− 54	54·4	8½	"Intense ruby red" (Sir J. Herschel).
Birm. 410 . .	17	23	14	− 19	23·0	7·8	"Fine ruby" (Birmingham); "Intense red" (Copeland); "Very red" (Espin).
Birm. 418 . .	17	38	29	− 18	36·5	8·5	"Remarkable red" (Sir J. Herschel); "Very intense red" (Burton).
Birm. 448 . .	18	28	32	+ 36	54·6	8·5	"Intense" (Secchi); "Fiery red, superb" (Franks); "Crimson, magnificent" (Espin); "Presque rouge absolu" (Dunér).
D.M. + 8°, 3780 .	18	33	6	+ 8	44·0	Var.	"Fine red" (Espin).

Star.	R. A. 1890.			Decl. 1890.		Mag.	Remarks.
	hrs.	mins.	secs.	degrees	mins.		
Birm. 464	18	43	57	− 8	1·8	7·1	"Most remarkable red" (Sir J. Herschel); "Very fine red" (Birmingham); "Very red" (Espin).
Birm. 475	18	53	31	+ 14	2·9	9·0	"Fine red" (Birmingham); "Fiery red" (Copeland); "Very red" (Espin); "Presque rouge absolu" (Dunér).
Birm. 483	18	58	32	− 5	50·8	7·0 Var. ?	"Truly striking and wonderful" (Webb); "Very red" (Espin); "Presque rouge absolu" (Dunér).
Birm. 521	19	53	38	+ 43	57·7	8·2	"Splendid, like a drop of blood" (Franks).
Birm. 545	20	10	40	− 21	38·3	7·7	"Pure red—perhaps the finest of my ruby stars" (Sir J. Herschel); "Very red" (Dreyer).
U Cygni	20	16	12	+ 47	32·8	Var.	"One of the loveliest hues in the sky" (Webb); "Very red" (Espin).
D.M. + 39°, 4152	20	17	40	+ 40	5·7	8·0	"Very red" (Espin). In field with γ Cygni.
V Cygni	20	37	46	+ 47	44·9	Var.	"Very red" (Birmingham); "Presque rouge absolu" (Dunér).
D.M. + 45°, 3349	20	54	11	+ 46	2·7	8·1	"Very red" (Espin).
S Cephei	21	36	35	+ 78	7·7	Var.	"Very deep red" (Copeland); "Presque rouge absolu" (Dunér).
Birm. 592	21	38	43	+ 37	30·8	Var.	"Splendid red" (Birmingham); "Very fine colour" (Webb); "Orange vermilion" (Franks); "Presque rouge absolu" (Dunér).
μ Cephei	21	40	8	+ 58	16·5	Var.	Herschel's "garnet star." Probably the reddest star visible to the naked eye.
Birm. 658	23	55	39	+ 59	44·6	7·8	"A very fine ruby, intense and beautiful, pure red" (Webb); "Presque rouge absolu" (Dunér).

LIST OF REMARKABLE VARIABLE STARS.

(*Only those visible, or sometimes visible, to the naked eye are given.*)

Star.	R.A. 1890.		Decl. 1890.		Variation.		Remarks.
	hrs.	mins.	degrees	mins.	Maximum	Minimum	
T Ceti	0	16·2	– 20	40	5·1 – 5·3	6·4 – 7·0	Irregular.
B Cassiopeiæ	0	18·7	+ 63	32	> 1	(?)	Nova, 1572.
O (" Mira ") Ceti	2	13·8	– 3	28·6	1·7 – 5·0	8 – 9·5	Mean period 331·33 days.
ρ Persei	2	58·1	+ 38	25	3·4	4·2	Irregular.
β Persei (Algol)	3	1·0	+ 40	32	2·3	3·5	Type of Algol variables. Period 2 days 20 hrs. 48 mins. 51 secs., from minimum to minimum.
λ Tauri	3	54·6	+ 12	11	3·4	4·2	Algol type. Period 3 days 22 hrs. 52 mins. 12 secs.
Nova Aurigae	5	25·0	+ 30	21·8	4·5	> 15	Nova, 1892.
α Orionis	5	49·2	+ 7	23	1	1·4	Irregular.
U Orionis	5	49·3	+ 20	9·3	6 – 7·5	> 12	"Nova," 1885. Period 373½ days.
η Geminorum	6	8·2	+ 22	32	3·2	3·7 – 4·2	Period 229 days.
T Monocerotis	6	19·3	+ 7	8·7	5·8 – 6·4	7·4 – 8·2	„ 27 days.
ζ Geminorum	6	57·6	+ 20	44	3·7	4·5	„ 10 days 3 hrs. 41·5 mins.
L_2 Puppis	7	10·2	– 44	28	3·5	6·3	„ 137 days.
R Canis Majoris	7	14·5	– 16	11	5·9	6·7	Algol type. Period 1 day 3 hrs. 15 mins. 46 secs.
R Carinæ	9	29·5	– 62	18	4·3 – 5·7	9·3 – 10·0	Period 312 days.

STAR.	R.A. 1890.		DECL. 1890.		VARIATION.		REMARKS.
	hrs.	mins.	degrees	mins.	Maximum	Minimum	
R Leonis	9	41·6	+ 11	56·3	5·2 – 6·7	9·4 – 10·0	Period 313 days.
l Carinæ	9	42·2	– 62	0	3·7	5·2	„ 31 days.
R Ursæ Majoris	10	36·9	+ 69	21	6·0 – 8·2	13	Mean period 302 days.
η Argûs	10	40·8	– 59	6	> 1	7·6	Irregular.
R Hydræ	13	23·7	– 22	43	3·5 – 5·5	9·7	Period 437 days, decreasing.
S Virginis	13	27·3	– 6	38	5·7 – 7·8	12·5	Period 376 days.
R Centauri	14	8·7	– 59	24	5·6 – 6·3	8·7 – 9·8	„ about 530 days.
R Boötis	14	32·4	+ 27	13	5·9 – 7·8	11·3 – 12·2	„ 223·9 days.
W (34) Boötis	14	38·6	+ 27	0	5·2	6·1	Long and irregular.
δ Libræ	14	55·1	– 8	5	5·0	6·2	Algol type. Period 2 days 7 hrs. 51 mins. 23 secs.
R Coronæ	15	44·1	+ 28	30	5·8	13·0	Irregular.
R Serpentis	15	45·6	+ 15	28	5·6 – 7·6	13	Period 357·6 days.
T Coronæ	15	54·9	+ 26	14	2·0	9·5	Nova, 1866. "The Blaze Star."
g (30) Herculis	16	25·0	+ 42	8	4·7 – 5·5	5·4 – 6·0	Irregular.
S Herculis	16	46·9	+ 15	8	5·9 – 7·5	11·5 – 13	Period 309·2 days.
Ophiuchi	16	53·3	– 12	43·5	5·5	12·5	Nova, 1848.
α Herculis	17	9 6	+ 14	31	3·1	3·9	Irregular.
U Ophiuchi	17	10·9	+ 1	20	6·0	6·7	Algol type. Period 20 hrs. 7 mins. 41 secs.

Star.	R.A. 1890.		Decl. 1890.		Variation.		Remarks.
	hrs.	mins.	degrees	mins.	Maximum.	Minimum.	
u (68) Herculis .	17	13·3	+ 33	13	4·6	5·4	
——Serpentarii .	17	24·1	− 21	23·3	> 1	(?)	Kepler's nova, 1604.
X Sagittarii . .	17	40·6	− 27	47	4	6	Period 7·011 days.
W Sagittarii . .	17	58·0	− 29	35	5	6·5	„ 7·593 days.
Y Sagittarii . .	18	14·9	− 18	54	5·8	6·6	„ 5·769 days.
R Scuti . . .	18	41·6	− 5	50	4·7 − 5·7	6·0 − 9·0	Mean period 71·1 days.
κ Pavonis . . .	18	45·6	− 67	22	4·0	5·5	Period 9·1014 days.
β Lyræ . . .	18	46·1	+ 33	14	3·4	4·5	„ 12 days 21 hrs. 46 mins. 58·3 secs.
Nova Vulpeculæ .	19	43·1	+ 27	2·6	3	(?)	Nova, 1670.
χ Cygni . . .	19	46·3	+ 32	38	4·0 − 6·5	13·5	Period 406 days.
η Aquilæ . . .	19	46·9	+ 0	43	3·5	4·7	„ 7 days 4 hrs. 14 mins.
S (10) Sagittæ . .	19	51·0	+ 16	21	5·6	6·4	„ 8 days 9 hrs. 11 mins.
P (34) Cygni . .	20	13·7	+ 37	41	3 − 5	> 6	Nova, 1600.
T Vulpeculæ . .	20	46·6	+ 27	49	5·5	6·5	Period 4 days 10 hrs. 29 mins.
T Cephei . . .	21	8·0	+ 68	2·6	5·6 − 6·8	9·5 − 9·9	„ 383·2 days.
Cygni . . .	21	37·4	+ 42	20·4	3	13·5	Nova, 1876.
δ Cephei . . .	22	25·1	+ 57	51	3·7	4·9	Period 5 days 8 hrs. 47 mins. 40 secs.
β Pegasi . . .	22	58·4	+ 27	29	2·2	2·7	Irregular.
R Aquarii . . .	23	38·1	− 15	53	5·8 − 8·5	11 (?)	Period 387 days.
R Cassiopeiæ . .	23	52·8	+ 50	46·5	4·8 − 7·0	9·8 − 12	„ 429 days.

LIST OF BINARY STARS FOR WHICH ORBITS HAVE BEEN COMPUTED.

Star.	R. A. 1890.			Decl. 1890.		Period Years.	Remarks.
	hrs.	mins.	secs.	degrees	mins.		
Struve 3062	0	0	30	+ 57	49·4	102·9	Orbit by Doberck, 1879.
O. Struve 4	0	11	0	+ 35	52·2	135·2	„ „ Glasenapp, 1889.
η Cassiopeiæ	0	42	27	+ 57	13·9	167·4	„ „ Coit, 1882.
66 Piscium	0	48	50	+ 18	35·5	136·2	„ „ Glasenapp, 1889.
36 Andromedæ	0	49	5	+ 23	1·9	316·0	„ „ Doberck, 1875.
p Eridani	1	35	36	− 56	45	302·37	„ computed, 1887.
Struve 186	1	50	18	+ 1	19	150·80	„ by Glasenapp, 1891.
Struve 228	2	7	0	+ 46	59	88·73	„ computed, 1889.
40 (o^2) Eridani (BC)	4	10	13	− 7	49·5	139·0	„ requires revision
Burnham 883	4	45	6	+ 10	53	16·35	„ by Glasenapp, 1892.
14 (*i*) Orionis	5	1	54	+ 8	21	190·48	„ computed, 1887.
O. Struve 149	6	29	34	+ 29	22	85·9	„ by Glasenapp, 1889.
12 Lyncis (AB)	6	36	31	+ 59	33	485·8	„ computed, 1887.
Sirius	6	40	18	− 16	34·0	49·4	„ by Auwers, 1892.
Castor	7	27	35	+ 32	7·7	1001·21	„ „ Doberck.
9 Argûs	7	46	12	− 13	36	40·54	„ „ Glasenapp, 1892.
ζ Cancri (AB)	8	5	54	+ 17	58·7	59·11	„ „ Seeliger, 1888.
Struve 3121	9	11	21	+ 29	2·4	34·64	„ „ Celoria, 1887.
ω Leonis	9	22	34	+ 9	32·1	115·30	„ „ Doberck, 1876.
φ Ursæ Majoris	9	44	37	+ 54	35·6	115·4	„ „ Casey, 1882.
8 Sextantis	9	47	6	− 7	35	93·92	„ „ Glasenapp, 1892.
O. Struve 215	10	10	14	+ 18	18	107·94	„ computed, 1890.
γ Leonis	10	13	54	+ 20	23·8	407·0	„ by Doberck, 1879.

Star.	R. A. 1890.			Decl. 1890.		Period Years.	Remarks.
	hrs.	mins.	secs.	degrees	mins.		
ξ Ursæ Majoris . .	11	12	19	+ 32	8·9	60·8	Orbit by Pritchard, 1878.
ι Leonis	11	18	12	+ 12	8	116·27	,, computed, 1891.
O. Struve 234 . . .	11	24	53	+ 41	54·9	63·45	,, ,, 1886.
O. Struve 235 . . .	11	26	6	+ 61	40·5	94·4	,, by Doberek, 1879.
γ Centauri . . .	12	35	27	− 48	21·3	61·88	,, computed, 1892.
γ Virginis . . .	12	36	5	− 0	50·8	180·54	,, well determined, Doberek, 1881.
35 Comæ . . .	12	47	54	+ 21	51	228·42	,, computed, 1891.
42 Comæ . . .	13	4	38	+ 18	6·7	25·71	,, by O. Struve.
O. Struve 269 . . .	13	27	53	+ 35	28	47·70	,, computed, 1892.
Struve 1757 . . .	13	28	41	+ 0	14·9	276·92	,, ,, 1892.
25 Can. Venat. . .	13	32	34	+ 36	51·3	119·92	,, by Doberek, 1880.
Burnham 612 . . .	13	34	12	+ 11	18	30·00	,, ,, Glasenapp, 1892.
Struve 1785 . . .	13	44	6	+ 27	32	125·52	,, computed, 1893.
Struve 1819 . . .	14	9	48	+ 3	38·2	340·1	,, by Casey, 1882.
α Centauri . . .	14	32	10	− 60	22·8	88·5	,, provisional.
ξ Boötis	14	16	19	+ 19	33·5	127·35	,, by Doberek, 1877.
44 (*i*) Boötis . . .	15	0	10	+ 48	5	261·12	,, ,, ,, 1875.
η Coronæ Bor. . .	15	18	40	+ 30	41·2	41·56	,, ,, ,, 1880.
μ^2 Boötis . . .	15	20	20	+ 37	44·0	280·29	,, ,, ,, 1878.
O. Struve 298 . . .	15	32	3	+ 40	11·6	56·65	,, by Celoria, 1888.
γ Coronæ Bor. . .	15	38	7	+ 26	38·8	95·5	,, ,, Doberek, 1877.
ξ Scorpii	15	58	19	− 11	4·1	105·19	,, ,, Schorr, 1889.
σ Coronæ Bor. . .	16	10	33	+ 34	8·3	845·86	,, ,, Doberek, 1876.
λ Ophiuchi . . .	16	25	22	+ 2	13·6	373.5	,, ,, Glasenapp, 1888.
ζ Herculis . . .	16	37	8	+ 31	48·2	34·411	,, ,, Doberek, 1880.

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μ Draconis	17	3	3	+ 54	37·0	618·0	,, ,, ,, 1884.
Burnham 416	17	10	47	− 34	51·2	34·48	,, computed, 1893.
Struve 2173	17	24	44	− 0	58·2	45·43	,, by Dunér, 1876.
μ′ Herculis	17	42	7	+ 27	47·2	45·39	,, ,, Leuschner, 1889.
τ Ophiuchi	17	57	6	− 8	10·7	217·87	,, ,, Doberck, 1875.
70 Ophiuchi	17	59	54	+ 2	31·6	87·84	,, ,, Gore, 1888.
99 Herculis	18	2	51	+ 30	33	53·55	,, ,, ,, 1890.
ζ Sagittarii	18	55	37	− 30	2·2	18·69	,, ,, ,, 1886.
γ Coronæ Aust. . . .	18	58	59	− 37	13·2	154·41	,, ,, ,, 1892.
Struve 2525	19	22	8	+ 27	9	138·54	,, ,, ,, 1892.
δ Cygni	19	41	32	+ 44	51·8	376·66	,, ,, ,, 1890.
O. Struve 387	19	44	38	+ 35	2	110·1	,, ,, Glasenapp, 1889.
O. Struve 400	20	6	35	+ 43	37	170·37	,, ,, Gore, 1887.
β Delphini	20	32	33	+ 11	12·8	30·9	,, ,, ,, 1885.
λ Cygni	20	43	6	+ 36	6	93·4	,, ,, Glasenapp, 1889.
4 Aquarii	20	45	26	− 6	2·3	129·84	,, ,, Doberck, 1880.
61 Cygni	21	1	58	+ 38	12·5	462·0	Binary character doubtful.
δ Equuleii	21	9	6	+ 9	34	11·478	Shortest period known.
κ Pegasi	21	39	42	+ 25	8	11·54	Orbit by Glasenapp.
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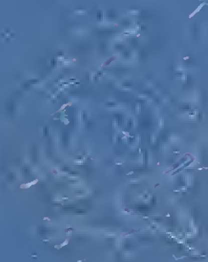43. **Demosthenes.** The Oration on the Crown and the Philippics. With English Notes. By Rev. T. H. L. Leary, D.C.L., formerly Scholar of Brasenose College, Oxford. 1s. 6d.