Description of the Hubble Space Telescope *(cont.)*

HST instrument capabilities (cont.)

Slit spectroscopy

Instrument	Projected aperture size	Resolving power ($\lambda/\Delta\lambda$)	Time resolution	Wavelength range (Å)	Magnitude limit[2]
FOC $f/48$[10]	0.″1 × 20″	2000		1150–1325	18
		2000		1167–1767	18
		2000		1750–2650	20
		2000		3500–5300	21
FOS[11]	0.″1–4.″3	1300	20 ms	1150–8500	18–22–22
		250	20 ms	1150–8500	21–26–23
HRS	0.″25, 2.″0	100 000	50 ms	1150–3200	11–14
		20 000	50 ms	1150–3200	13–16
		2000	50 ms	1150–1800	17

Notes to tables:

[1] The cameras also have coronagraphic and polarimetric imaging capabilities.

[2] Predicted limiting V magnitude for an unreddened A0 V star in order to achieve a S/N ratio of 5 in an exposure time of 1 hour. Single entries refer to wavelengths near the center of the indicated wavelength range. For FOC direct imaging, the F342W filter was assumed. When two values are given, the first refers to wavelengths near the short-wavelength limit, and the second to those near the long-wavelength limit. For FOS spectroscopy, three values are given, corresponding to 1300, 3200, and 6000 Å, respectively.

[3] For $S/N = 1$ in fine lock.

[4] Within the central area of 4′ × 5′. In-orbit performance for astrometry is very uncertain; figure quoted is design goal.

[5] Predicted limiting V magnitude for a 1-hour exposure (half on star, half on sky) on an A0 V star at $S/N = 5$ with the F450W filter.

[6] The HSP can also perform polarimetry.

[7] Using 'objective' gratings or prisms.

[8] Predicted limiting V magnitude for an unreddened B0 V star in order to achieve a S/N ratio of 5 in an exposure time of 1 hour.

[9] Predicted limiting V magnitude for a QSO with a ν^{-2} spectrum in order to achieve a S/N ratio of 10 in an exposure time of 1 hour with the far-UV objective prism (PRISM2).

[10] Two-dimensional spectroscopy with the long slit and grating.

[11] The FOS can also perform spectropolarimetry.

Glossary of astronomical terms

aberration: the apparent angular displacement of the observed position of a celestial object from its *geometric position*, caused by the finite velocity of light in combination with the motions of the observer and of the observed object. (See *aberration, planetary.*)

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aberration, annual: the component of stellar aberration (see *aberration, stellar*) resulting from the motion of the Earth about the Sun.

aberration, diurnal: the component of stellar aberration (see *aberration, stellar*) resulting from the observer's diurnal motion about the center of the Earth.

aberration, E-terms of: terms of annual aberration (*see aberration, annual*) depending on the *eccentricity* and longitude of *perihelion* of the Earth.

aberration, elliptic: see *aberration, E-terms of.*

aberration, planetary: the apparent angular displacement of the observed position of a celestial body produced by motion of the observer (see *aberration, stellar*) and the actual motion of the observed object (see *correction for light-time*).

aberration, secular: the component of stellar aberration (see *aberration, stellar*) resulting from the essentially uniform and rectilinear motion of the entire solar system in space. Secular aberration is usually disregarded.

aberration, stellar: the apparent angular displacement of the observed position of a celestial body resulting from the motion of the observer. Stellar aberration is divided into diurnal, annual and secular components (see *aberration, diurnal; aberration, annual; aberration, secular*).

altitude: the angular distance of a celestial body above or below the *horizon*, measured along the great circle passing through the body and the *zenith*. Altitude is 90° minus *zenith distance*.

aphelion: the point in a planetary *orbit* that is at the greatest distance from the Sun.

apparent place: the position on a *celestial sphere*, centered at the Earth, determined by removing from the directly observed position of a celestial body the effects that depend on the *topocentric* location of the observer; i.e., *refraction*, diurnal aberration (see *aberration, diurnal*) and geocentric (diurnal) *parallax*. Thus the position at which the object would actually be seen from the center of the Earth, displaced by planetary aberration (except the diurnal part – see *aberration, planetary* and *aberration, diurnal*) and referred to the *true equator and equinox*.

apparent solar time: the measure of time based on the diurnal motion of the true Sun. The rate of diurnal motion undergoes seasonal variation because of the *obliquity* of the *ecliptic* and because of the *eccentricity* of the Earth's *orbit*. Additional small variations result from irregularities in the rotation of the Earth on its axis.

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astrometric ephemeris: an ephemeris of a solar system body in which the tabulated positions are essentially comparable to catalog *mean places* of stars at a *standard epoch*. An astrometric position is obtained by adding to the *geometric position*, computed from gravitational theory, the correction for *light-time*. Prior to 1984, the E-terms of annual aberration (see *aberration, annual* and *aberration, E-terms of*) were also added to the geometric position.

astronomical coordinates: the longitude and latitude of a point on the Earth relative to the *geoid*. These coordinates are influenced by local gravity anomalies (see *zenith*.)

astronomical unit (AU): the radius of a circular orbit in which a body of negligible mass, and free of perturbations, would revolve around the Sun in $2\pi/k$ days, where k is the *Gaussian gravitational constant*. This is slightly less than the *semimajor axis* of the Earth's *orbit*.

atomic second: see *second, Système International*.

augmentation: the amount by which the apparent *semidiameter* of a celestial body, as observed from the surface of the Earth, is greater than the semidiameter that would be observed from the center of the Earth.

azimuth: the angular distance measured clockwise along the *horizon* from a specified reference point (usually north) to the intersection with the great circle drawn from the *zenith* through a body on the *celestial sphere*.

barycenter: the center of mass of a system of bodies; e.g., the center of mass of the solar system or the Earth–Moon system.

barycentric dynamical time (TDB): the independent argument of ephemerides and equations of motion that are referred to the *barycenter* of the solar system. A family of time scales results from the transformation by various theories and metrics of relativistic theories of *terrestrial dynamical time* (TDT). TDB differs from TDT only by periodic variations. In the terminology of the general theory of relativity, TDB may be considered to be a coordinate time. (See *dynamical time*.)

catalog equinox: the intersection of the *hour circle* of zero *right ascension* of a star catalog with the *celestial equator*. (See *dynamical equinox* and *equator*.)

celestial ephemeris pole: the reference pole for *nutation* and *polar motion*; the axis of figure for the mean surface of a model Earth in which the free motion has zero amplitude. This pole has no nearly-diurnal nutation with respect to a space-fixed or Earth-fixed coordinate system.

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celestial equator: the projection onto the *celestial sphere* of the Earth's *equator*. (See *mean equator and equinox* and *true equator and equinox*.)

celestial pole: either of the two points projected onto the *celestial sphere* by the extension of the Earth's axis of rotation to infinity.

celestial sphere: an imaginary sphere of arbitrary radius upon which celestial bodies may be considered to be located. As circumstances require, the celestial sphere may be centered at the observer, at the Earth's center, or at any other location.

conjunction: the phenomenon in which two bodies have the same apparent celestial longitude (see *longitude, celestial*) or *right ascension* as viewed from a third body. Conjunctions are usually tabulated as *geocentric* phenomena, however. For Mercury and Venus, geocentric inferior conjunction occurs when the planet is between the Earth and Sun, and superior conjunction occurs when the Sun is between the planet and Earth.

constellation: a grouping of stars, usually with pictorial or mythical associations, that serves to identify an area of the *celestial sphere*. Also one of the precisely defined areas of the celestial sphere, associated with a grouping of stars, that the International Astronomical Union has designated as a constellation.

coordinated universal time (UTC): the time scale available from broadcast time signals. UTC differs from TAI (*see international atomic time*) by an integral number of seconds; it is maintained within ± 0.90 seconds of UT1 (*see universal time*) by the introduction of one second steps (leap seconds).

culmination: passage of a celestial object across the observer's *meridian*; also called 'meridian passage'. More precisely, culmination is the passage through the point of greatest *altitude* in the diurnal path. Upper culmination (also called 'culmination above pole' for circumpolar stars and the Moon) or transit is the crossing closer to the observer's *zenith*. Lower culmination (also called 'culmination below pole' for circumpolar stars and the Moon) is the crossing farther from the zenith.

day: an interval of 86 400 SI seconds (*see second, Système International*), unless otherwise indicated.

day numbers: quantities that facilitate hand calculations of the reduction of *mean place* to *apparent place*. Besselian day numbers depend solely on the Earth's position and motion; second-order day numbers, used in high precision reductions, depend on the positions of both the Earth and the star.

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declination: angular distance on the *celestial sphere* north or south of the *celestial equator*. It is measured along the *hour circle* passing through the celestial object. Declination is usually given in combination with *right ascension* or *hour angle*.

defect of illumination: the angular amount of the observed lunar or planetary disk that is not illuminated to an observer on the Earth.

deflection of light: the angle by which the apparent path of a photon is altered from a straight line by the gravitational field of the Sun. The path is deflected radially away from the Sun by up to 1.″75 at the Sun's limb. Correction for this effect, which is independent of wavelength, is included in the reduction from *mean place* to *apparent place*.

deflection of the vertical: the angle between the astronomical vertical and the geodetic vertical (see *zenith; astronomical coordinates; geodetic coordinates*.)

Delta T (ΔT): the difference between *dynamical time* and *universal time*; specifically the difference between *terrestrial dynamical time* (TDT) and UT1: $\Delta T = TDT - UT1$.

direct motion: for orbital motion in the solar system, motion that is counterclockwise in the orbit as seen from the north pole of the *ecliptic*; for an object observed on the celestial sphere, motion that is from west to east, resulting from the relative motion of the object and the Earth.

DUT1: the predicted value of the difference between UT1 and UTC, transmitted in code on broadcast time signals: DUT1 = UT1 − UTC. (See *universal time* and *coordinated universal time*.)

dynamical equinox: the ascending *node* of the Earth's mean *orbit* on the Earth's *equator*; i.e., the intersection of the *ecliptic* with the *celestial equator* at which the Sun's *declination* is changing from south to north. (See *catalog equinox* and *equinox*.)

dynamical time: the family of time scales introduced in 1984 to replace *ephemeris time* as the independent argument of dynamical theories and ephemerides. (See *barycentric dynamical time* and *terrestrial dynamical time*.)

eccentric anomaly: in undisturbed elliptic motion, the angle measured at the center of the ellipse from *pericenter* to the point on the circumscribing auxiliary circle from which a perpendicular to the major axis would intersect the orbiting body. (See *mean anomaly* and *true anomaly*.)

eccentricity: a parameter that specifies the shape of a conic section; one

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of the standard elements used to describe an elliptic *orbit* (see *elements, orbital*).

eclipse: the obscuration of a celestial body caused by its passage through the shadow cast by another body.

eclipse, annular: a solar *eclipse* (see *eclipse, solar*) in which the solar disk is never completely covered but is seen as an annulus or ring at maximum eclipse. An annular eclipse occurs when the apparent disk of the Moon is smaller than that of the Sun.

eclipse, lunar: an *eclipse* in which the Moon passes through the shadow cast by the Earth. The eclipse may be total (the Moon passing completely through the Earth's *umbra*), partial (the Moon passing partially through the Earth's umbra at maximum eclipse), or penumbral (the Moon passing only through the Earth's *penumbra*).

eclipse, solar: an *eclipse* in which the Earth passes through the shadow cast by the Moon. It may be total (observer in the Moon's *umbra*), partial (observer in the Moon's *penumbra*), or annular (see *eclipse, annular*).

ecliptic: the mean plane of the Earth's *orbit* around the Sun.

elements, Besselian: quantities tabulated for the calculation of accurate predictions of an *eclipse* or *occultation* for any point on or above the surface of the Earth.

elements, orbital: parameters that specify the position and motion of a body in *orbit* (see *osculating elements* and *mean elements.*)

elongation, greatest: the instants when the *geocentric* angular distances of Mercury and Venus are at a maximum from the Sun.

elongation (planetary): the *geocentric* angle between a planet and the Sun, measured in the plane of the planet, Earth and Sun. Planetary elongations are measured from 0° to 180°, east or west of the Sun.

elongation (satellite): the *geocentric* angle between a satellite and its primary, measured in the plane of the satellite, planet and Earth. Satellite elongations are measured from 0° east or west of the planet.

ephemeris hour angle: an *hour angle* referred to the *ephemeris meridian.*

ephemeris longitude: longitude (see *longitude, terrestrial*) measured eastward from the *ephemeris meridian.*

ephemeris meridian: a fictitious *meridian* that rotates independently of the Earth at the uniform rate implicitly defined by *terrestrial dynamical time* (TDT). The ephemeris meridian is $1.002\,738\Delta T$ east of the Greenwich meridian, where $\Delta T = TDT - UT1$.

ephemeris time (ET): the time scale used prior to 1984 as the independent variable in gravitational theories of the solar system. In 1984, ET was replaced by *dynamical time.*

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ephemeris transit: the passage of a celestial body or point across the *ephemeris meridian.*

equation of center: in elliptic motion the *true anomaly* minus the *mean anomaly*. It is the difference between the actual angular position in the elliptic *orbit* and the position the body would have if its angular motion were uniform.

equation of the equinoxes: the *right ascension* of the mean *equinox* (see *mean equator and equinox*) referred to the *true equator and equinox*; apparent *sidereal time* minus mean sidereal time. (See *apparent place* and *mean place.*)

equation of time: the *hour angle* of the true Sun minus the hour angle of the *fictitious mean sun*; alternatively, *apparent solar time* minus *mean solar time.*

equator: the great circle on the surface of a body formed by the intersection of the surface with the plane passing through the center of the body perpendicular to the axis of rotation. (See *celestial equator.*)

equinox: either of the two points on the *celestial sphere* at which the *ecliptic* intersects the *celestial equator*; also the time at which the Sun passes through either of these intersection points; i.e., when the apparent longitude (see *apparent place* and *longitude, celestial*) of the Sun is 0° or 180°. (See *catalog equinox* and *dynamical equinox* for precise usage.)

fictitious mean sun: an imaginary body introduced to define *mean solar time*; essentially the name of a mathematical formula that defined mean solar time. This concept is no longer used in high precision work.

flattening: a parameter that specifies the degree by which a planet's figure differs from that of a sphere,; the ratio $f = (a - b)/a$, where a is the equatorial radius and b is the polar radius.

Gaussian gravitational constant ($k = 0.017\,202\,098\,95$): the constant defining the astronomical system of units of length (*astronomical unit*), mass (solar mass) and time (*day*), by means of Kepler's third law. The dimensions of k^2 are those of Newton's constant of gravitation: $L^3M^{-1}T^{-2}$.

geocentric: with reference to, or pertaining to, the center of the Earth.

geocentric coordinates: the latitude and longitude of a point on the Earth's surface relative to the center of the Earth; also celestial coordinates given with respect to the center of the Earth. (See *zenith; latitude, terrestrial; longitude, terrestrial.*)

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geodetic coordinates: the latitude and longitude of a point on the Earth's surface determined from the geodetic vertical (normal to the specified spheroid). (See *zenith; latitude, terrestrial; longitude, terrestrial.*)

geoid: an equipotential surface that coincides with mean sea level in the open ocean. On land it is the level surface that would be assumed by water in an imaginary network of frictionless channels connected to the ocean.

geometric position: the *geocentric* position of an object on the *celestial sphere* referred to the *true equator and equinox*, but without the displacement due to planetary aberration. (See *apparent place; mean place; aberration, planetary.*)

Greenwich sidereal date (GSD): the number of *sidereal days* elapsed at Greenwich since the beginning of the Greenwich sidereal day that was in progress at *Julian date* 0.0.

Greenwich sidereal day number: the integral part of the *Greenwich sidereal date.*

Gregorian calendar: the calendar introduced by Pope Gregory XIII in 1582 to replace the *Julian calendar*; the calendar now used as the civil calendar in most countries. Every year that is exactly divisible by four is a leap year, except for centurial years, which must be exactly divisible by 400 to be leap years. Thus 2000 is a leap year, but 1900 and 2100 are not leap years.

heliocentric: with reference to, or pertaining to, the center of the Sun.

horizon: a plane perpendicular to the line from an observer to the *zenith.* The great circle formed by the intersection of the *celestial sphere* with a plane perpendicular to the line from an observer to the zenith is called the astronomical horizon.

horizontal parallax: the difference between the *topocentric* and *geocentric* positions of an object, when the object is on the astronomical *horizon.*

hour angle: angular distance on the *celestial sphere* measured westward along the *celestial equator* from the *meridian* to the *hour circle* that passes through a celestial object.

hour circle: a great circle on the *celestial sphere* that passes through the *celestial poles* and is therefore perpendicular to the *celestial equator.*

inclination: the angle between two planes or their poles; usually the angle between an orbital plane and a reference plane; one of the standard orbital elements (see *elements, orbital*) that specifies the orientation of an *orbit.*

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international atomic time (TAI): the continuous scale resulting from analyses by the Bureau International des Poids et Mésures of atomic time standards in many countries. The fundamental unit of TAI is the SI second (see *second, Système International*), and the epoch is 1958 January 1.

invariable plane: the plane through the center of mass of the solar system perpendicular to the angular momentum vector of the solar system.

irradiation: an optical effect of contrast that makes bright objects viewed against a dark background appear to be larger than they really are.

Julian calendar: the calendar introduced by Julius Caesar in 46 BC to replace the Roman calendar. In the Julian calendar a common year is defined to comprise 365 days, and every fourth year is a leap year comprising 366 days. The Julian calendar was superseded by the *Gregorian calendar.*

Julian date (JD): the interval of time in days and fraction of a day since 1 January 4713 BC, Greenwich noon, *Julian proleptic calendar.* In precise work the time scale, e.g., *dynamical time* or *universal time,* should be specified.

Julian date, modified (MJD): the Julian date minus 240 0000.5.

Julian day number (JD): the integral part of the *Julian date.*

Julian proleptic calendar: the calendric system employing the rules of the *Julian calendar,* but extended and applied to dates preceding the introduction of the Julian calendar.

Julian year: a period of 365.25 days. This period served as the basis for the *Julian calendar.*

Laplacian plane: for planets *see invariable plane*; for a system of satellites, the fixed plane relative to which the vector sum of the disturbing forces has no orthogonal component.

latitude, celestial: angular distance on the *celestial sphere* measured north or south of the *ecliptic* along the great circle passing through the poles of the ecliptic and the celestial object.

latitude, terrestrial: angular distance on the Earth measured north or south of the *equator* along the *meridian* of a geographic location.

librations: variations in the orientation of the Moon's surface with respect to an observer on the Earth. Physical librations are due to variations in the rate at which the Moon rotates on its axis. The much larger optical librations are due to variations in the rate of the Moon's orbital motion, the *obliquity* of the Moon's *equator* to its

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orbital plane, and the diurnal changes of geometric perspective of an observer on the Earth's surface.

light-time: the interval of time required for light to travel from a celestial body to the Earth. During this interval the motion of the body in space causes an angular displacement of its *apparent place* from its *geometric position* (see *aberration, planetary*).

light year: the distance that light traverses in a vacuum during one year.

local sidereal time: the local *hour angle* of a *catalog equinox.*

longitude, celestial: angular distance on the *celestial sphere* measured eastward along the *ecliptic* from the *dynamical equinox* to the great circle passing through the poles of the ecliptic and the celestial object.

longitude, terrestrial: angular distance measured along the Earth's *equator* from the Greenwich *meridian* to the meridian of a geographic location.

lunar phases: cyclically recurring apparent forms of the Moon. New Moon, First Quarter, Full Moon and Last Quarter are defined as the times at which the excess of the apparent celestial longitude (see *longitude, celestial*) of the Moon over that of the Sun is 0°, 90°, 180° and 270°, respectively.

lunation: the period of time between two consecutive New Moons.

magnitude, stellar: a measure on a logarithmic scale of the brightness of a celestial object considered as a point source.

magnitude of a lunar eclipse: the fraction of the lunar diameter obscured by the shadow of the Earth at the greatest phase of a lunar eclipse (see *eclipse, lunar*), measured along the common diameter.

magnitude of a solar eclipse: the fraction of the solar diameter obscured by the Moon at the greatest phase of a solar eclipse (*see eclipse, solar*), measured along the common diameter.

mean anomaly: in undisturbed elliptic motion, the product of the *mean motion* of an orbiting body and the interval of time since the body passed *pericenter.* Thus the mean anomaly is the angle from pericenter of a hypothetical body moving with a constant angular speed that is equal to the mean motion. (See *true anomaly* and *eccentric anomaly.*)

mean distance: the *semimajor axis* of an elliptic *orbit.*

mean elements: elements of an adopted reference *orbit* (see *elements, orbital*) that approximates the actual, perturbed orbit. Mean elements may serve as the basis for calculating *perturbations.*

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mean equator and equinox: the celestial reference system determined by ignoring small variations of short period in the motions of the *celestial equator*. Thus the mean equator and equinox are affected only by *precession*. Positions in star catalogs are normally referred to the mean catalog equator and equinox (see *catalog equinox*) of a *standard epoch*.

mean motion: in undisturbed elliptic motion, the constant angular speed required for a body to complete one revolution in an *orbit* of a specified *semimajor axis*.

mean place: the coordinates, referred to the *mean equator and equinox* of a *standard epoch*, of an object on the *celestial sphere* centered at the Sun. A mean place is determined by removing from the directly observed position the effects of *refraction*, geocentric and stellar *parallax*, and stellar aberration (see *aberration, stellar*), and by referring the coordinates to the mean equator and equinox of a standard epoch. In compiling star catalogs it has been the practice not to remove the secular part of stellar aberration (see *aberration, secular*). Prior to 1984, it was additionally the practice not to remove the elliptic part of annual aberration (see *aberration, annual* and *aberration, E-terms of*).

mean solar time: a measure of time based conceptually on the diurnal motion of the *fictitious mean sun*, under the assumption that the Earth's rate of rotation is constant.

meridian: a great circle passing through the *celestial poles* and through the *zenith* of any location on Earth. For planetary observations a meridian is half the great circle passing through the planet's poles and through any location on the planet.

moonrise, moonset: the times at which the apparent upper limb of the Moon is on the astronomical *horizon*; i.e., when the true *zenith distance*, referred to the center of the Earth, of the central point of the disk is $90^\circ\ 34' + s - \pi$, where s is the Moon's semidiameter, π is the *horizontal parallax*, and $34'$ is the adopted value of horizontal *refraction*.

nadir: the point on the *celestial sphere* diametrically opposite to the *zenith*.

node: either of the points on the *celestial sphere* at which the plane of an *orbit* intersects a reference plane. The position of a node is one of the standard orbital elements (see *elements, orbital*) used to specify the orientation of an orbit.

nutation: the short-period oscillations in the motion of the pole of rotation of a freely rotating body that is undergoing torque from

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external gravitational forces. Nutation of the Earth's pole is discussed in terms of components in *obliquity* and longitude (see *longitude, celestial*).

obliquity: in general the angle between the equatorial and orbital planes of a body or, equivalently, between the rotational and orbital poles. For the Earth the obliquity of the *ecliptic* is the angle between the planes of the *equator* and the ecliptic.

occultation: the obscuration of one celestial body by another of greater apparent diameter; especially the passage of the Moon in front of a star or planet, or the disappearance of a satellite behind the disk of its primary. If the primary source of illumination of a reflecting body is cut off by the occultation, the phenomenon is also called an *eclipse*. The occultation of the Sun by the Moon is a solar eclipse (see *eclipse, solar*).

opposition: a configuration of the Sun, Earth and a planet in which the apparent *geocentric* longitude (see *longitude, celestial*) of the planet differs by 180° from the apparent geocentric longitude of the Sun.

orbit: the path in space followed by a celestial body.

osculating elements: a set of parameters (see *elements, orbital*) that specifies the instantaneous position and velocity of a celestial body in its perturbed *orbit*. Osculating elements describe the unperturbed (two-body) orbit that the body would follow if *perturbations* were to cease instantaneously.

parallax: the difference in apparent direction of an object as seen from two different locations; conversely the angle at the object that is subtended by the line joining two designated points. Geocentric (diurnal) parallax is the difference in direction between a *topocentric* observation and a hypothetical *geocentric* observation. Heliocentric or annual parallax is the difference between hypothetical geocentric and *heliocentric* observations; it is the angle subtended at the observed object by the *semimajor axis* of the Earth's *orbit*. (See also *horizontal parallax*.)

parsec: the distance at which one *astronomical unit* subtends an angle of one second of arc; equivalently the distance to an object having an annual *parallax* of one second of arc.

penumbra: the portion of a shadow in which light from an extended source is partially but not completely cut off by an intervening body; the area of partial shadow surrounding the *umbra*.

pericenter: the point in an *orbit* that is nearest to the center of force. (See *perigee* and *perihelion*.)

perigee: the point at which a body in *orbit* around the Earth most

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closely approaches the Earth. Perigee is sometimes used with reference to the apparent orbit of the Sun around the Earth.

perihelion: the point at which a body in *orbit* around the Sun most closely approaches the Sun.

period: the interval of time required to complete one revolution in an *orbit* or one cycle of a periodic phenomenon, such as a cycle of *phases.*

perturbations: deviations between the actual *orbit* of a celestial body and an assumed reference orbit; also the forces that cause deviations between the actual and reference orbits. Perturbations, according to the first meaning, are usually calculated as quantities to be added to the coordinates of the reference orbit to obtain the precise coordinates.

phase: the ratio of the illuminated area of the apparent disk of a celestial body to the area of the entire apparent disk taken as a circle. For the Moon, phase designations (see *lunar phases*) are defined by specific configurations of the Sun, Earth and Moon. For eclipses phase designations (total, partial, penumbral, etc.) provide general descriptions of the phenomena (see *eclipse, solar; eclipse, annular; eclipse, lunar.*)

phase angle: the angle measured at the center of an illuminated body between the light source and the observer.

polar motion: the irregularly varying motion of the Earth's pole of rotation with respect to the Earth's crust. (See *celestial ephemeris pole.*)

precession: the uniformly progressing motion of the pole of rotation of a freely rotating body undergoing torque from external gravitational forces. In the case of the Earth, the component of precession caused by the Sun and Moon acting on the Earth's equatorial bulge is called lunisolar precession; the component caused by the action of the planets is called planetary precession. The sum of lunisolar and planetary precession is called general precession. (See *nutation.*)

proper motion: the projection onto the *celestial sphere* of the space motion of a star relative to the solar system; thus the transverse component of the space motion of a star with respect to the solar system. Proper motion is usually tabulated in star catalogs as changes in *right ascension* and *declination* per year or century.

quadrature: a configuration in which two celestial bodies have apparent longitudes (see *longitude, celestial*) that differ by 90° as viewed from a third body. Quadratures are usually tabulated with respect to the Sun as viewed from the center of the Earth.

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radial velocity: the rate of change of the distance to an object.

refraction, astronomical: the change in direction of travel (bending) of a light ray as it passes obliquely through the atmosphere. As a result of refraction the observed *altitude* of a celestial object is greater than its geometric altitude. The amount of refraction depends on the altitude of the object and on atmospheric conditions.

retrograde motion: for orbital motion in the solar system, motion that is clockwise in the *orbit* as seen from the north pole of the *ecliptic*; for an object observed on the *celestial sphere*, motion that is from east to west, resulting from the relative motion of the object and the Earth. (See *direct motion.*)

right ascension: angular distance on the *celestial sphere* measured eastward along the *celestial equator* from the *equinox* to the *hour circle* passing through the celestial object. Right ascension is usually given in combination with *declination.*

second, Système International (SI): the duration of 9 192 631 770 cycles of radiation corresponding to the transition between two hyperfine levels of the ground state of cesium 133.

selenocentric: with reference to, or pertaining to, the center of the Moon.

semidiameter: the angle at the observer subtended by the equatorial radius of the Sun, Moon or a planet.

semimajor axis: half the length of the major axis of an ellipse; a standard element used to describe an elliptical *orbit* (see *elements, orbital*).

sidereal day: the interval of time between two consecutive *transits* of the *catalog equinox.* (See *sidereal time.*)

sidereal hour angle: angular distance on the *celestial sphere* measured westward along the *celestial equator* from the *catalog equinox* to the *hour circle* passing through the celestial object. It is equal to 360° minus *right ascension* in degrees.

sidereal time: the measure of time defined by the apparent diurnal motion of the *catalog equinox*; hence a measure of the rotation of the Earth with respect to the stars rather than the Sun.

solstice: either of the two points on the *ecliptic* at which the apparent longitude (see *longitude, celestial*) of the Sun is 90° or 270°; also the time at which the Sun is at either point.

standard epoch: a date and time that specifies the reference system to which celestial coordinates are referred. Prior to 1984 coordinates of star catalogs were commonly referred to the *mean equator and equinox* of the beginning of a Besselian year (see *year, Besselian*).

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Beginning with 1984 the *Julian year* has been used, as denoted by the prefix J, e.g., J2000.0.

stationary point (of a planet)*:* the position at which the rate of change of the apparent *right ascension* (see *apparent place*) of a planet is momentarily zero.

sunrise, *sunset:* the times at which the apparent upper limb of the Sun is on the astronomical *horizon*; i.e., when the true *zenith distance*, referred to the center of the Earth, of the central point of the disk is 90° 50′, based on adopted values of 34′ for horizontal *refraction* and 16′ for the Sun's *semidiameter*.

surface brightness (of a planet)*:* the visual magnitude of an average square arc-second area of the illuminated portion of the apparent disk.

synodic period: for planets, the mean interval of time between successive *conjunctions* of a pair of planets, as observed from the Sun; for satellites, the mean interval between successive conjunctions of a satellite with the Sun, as observed from the satellite's primary.

terrestrial dynamical time (TDT): the independent argument for apparent *geocentric* ephemerides. At 1977 January $1^{d}\,00^{h}\,00^{m}\,00^{s}$ TAI, the value of TDT was exactly 1977 January $1^{d}.000\,3725$. The unit of TDT is 86 400 SI seconds at mean sea level. For practical purposes TDT = TAI + $32^{s}.184$. (See *barycentric dynamical time; dynamical time; international atomic time.*)

terminator: the boundary between the illuminated and dark areas of the apparent disk of the Moon, a planet or a planetary satellite.

topocentric: with reference to, or pertaining to, a point on the surface of the Earth, usually with reference to a coordinate system.

transit: the passage of a celestial object across a *meridian*; also the passage of one celestial body in front of another of greater apparent diameter (e.g., the passage of Mercury or Venus across the Sun or Jupiter's satellites across its disk); however, the passage of the Moon in front of the larger apparent Sun is called an annular eclipse (see *eclipse, annular*). The passage of a body's shadow across another body is called a shadow transit; however, the passage of the Moon's shadow across the Earth is called a solar eclipse (see *eclipse, solar*).

true anomaly: the angle, measured at the focus nearest the *pericenter* of an elliptical *orbit*, between the pericenter and the radius vector from the focus to the orbiting body; one of the standard orbital elements (see *elements, orbital*). (See also *eccentric anomaly, mean anomaly.*)

true equator and equinox: the celestial coordinate system determined by the instantaneous positions of the *celestial equator* and *ecliptic*. The

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motion of this system is due to the progressive effect of *precession* and the short-term, periodic variations of *nutation*. (See *mean equator and equinox*.)

twilight: the interval of time preceding sunrise and following sunset (*see sunrise, sunset*) during which the sky is partially illuminated. Civil twilight comprises the interval when the *zenith distance*, referred to the center of the Earth, of the central point of the Sun's disk is between 90° 50′ and 96°, nautical twilight comprises the interval from 96° to 102°, astronomical twilight comprises the interval from 102° to 108°.

umbra: the portion of a shadow cone in which none of the light from an extended light source (ignoring *refraction*) can be observed.

universal time (UT): a measure of time that conforms, within a close approximation, to the mean diurnal motion of the Sun and serves as the basis of all civil timekeeping. UT is formally defined by a mathematical formula as a function of *sidereal time*. Thus UT is determined from observations of the diurnal motions of the stars. The time scale determined directly from such observations is designated UT0; it is slightly dependent on the place of observation. When UT0 is corrected for the shift in longitude of the observing station caused by *polar motion*, the time scale UT1 is obtained.

vernal equinox: the ascending *node* of the *ecliptic* on the *celestial equator*; also the time at which the apparent longitude (*see apparent place* and *longitude, celestial*) of the Sun is 0°. (See *equinox*.)

vertical: apparent direction of gravity at the point of observation (normal to the plane of a free level surface).

year: a period of time based on the revolution of the Earth around the Sun. The calendar year (*see Gregorian calendar*) is an approximation to the tropical year (*see year, tropical*). The anomalistic year is the mean interval between successive passages of the Earth through *perihelion*. The sidereal year is the mean period of revolution with respect to the background stars. (See *Julian year* and *year, Besselian*.)

year, Besselian: the period of one complete revolution in *right ascension* of the *fictitious mean sun*, as defined by Newcomb. The beginning of a Besselian year, traditionally used as a *standard epoch*, is denoted by the suffix '.0'. Since 1984 standard epochs have been defined by the *Julian year* rather than the Besselian year. For distinction, the beginning of a Besselian year is now identified by the prefix B (e.g., B1950.0).

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year, tropical: the period of one complete revolution of the mean longitude of the Sun with respect to the *dynamical equinox*. The tropical year is longer than the Besselian year (see *year, Besselian*) by $0^{s}.148T$, where T is centuries from B1900.0.

zenith: in general, the point directly overhead on the *celestial sphere*. The astronomical zenith is the extension to infinity of a plumb line. The geocentric zenith is defined by the line from the center of the Earth through the observer. The geodetic zenith is the normal to the geodetic ellipsoid or spheroid at the observer's location. (See *deflection of the vertical.*)

zenith distance: angular distance on the *celestial sphere* measured along the great circle from the *zenith* to the celestial object. Zenith distance is 90° minus *altitude*.

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Bibliography

Astrophysical Quantities, Allen, C. W., The Athlone Press, University of London, 1973.

Astrophysical Formulae, Lang, K. R., Springer-Verlag, 1974.

Astronomy Handbook, Roth, G. D., ed., Springer-Verlag, 1975.

An Introduction to Astronomical Photometry, Golay, M., D. Reidel Publishing Company, 1974.

The Astronomical Almanac, US Government Printing Office.

Astronomy and Astrophysics, Landolt–Börnstein, Springer-Verlag, 1981.

Computational Spherical Astronomy, Taff, L. G., John Wiley and Sons, 1981.

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