C Tables

Table C.1 SI basic units

Quantity	Symbol	Unit	Abbr.	Definition
Length	$l, s, \ldots$	Metre	m	The length of the path travelled by light in vacuum during a time interval of $1/299{,}792{,}458$ of a second.
Mass	m, M	Kilogram	kg	Equal to the mass of the international prototype of the kilogram.
Time	t	Second	s	The duration of 9,192,631,770 periods of the radiation corresponding to the transition between two hyperfine levels of the ground state of the caesium 133-atom.
Electric current	I	Ampere	A	That constant current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross section and placed 1 metre apart in a vacuum, would produce a force equal to 2×10^{-7} Newton per metre of length between these conductors.
Temperature	T	Kelvin	K	The fraction $1/273.16$ of the thermodynamic temperature of the triple point of water.
Amount of substance	n	Mole	mol	The amount of substance of a system which contains as many elementary entities as there. are atoms in 0.012 kg of ^{12}C.
Luminous intensity	I	Candela	cd	The luminous intensity in a given direction of a source which emits monochromatic radiation of frequency 540×10^{12} Hz and of which the radiant intensity in that direction is $1/683$ Watt per steradian.

Table C.2 Prefixes for orders of ten

Prefix	Symbol	Multiple	Prefix	Symbol	Multiple
yocto	y	10^{-24}	deca	da	10^{1}
zepto	z	10^{-21}	hecto	h	10^{2}
atto	a	10^{-18}	kilo	k	10^{3}
femto	f	10^{-15}	Mega	M	10^{6}
pico	p	10^{-12}	Giga	G	10^{9}
nano	n	10^{-9}	Tera	T	10^{12}
micro	μ	10^{-6}	Peta	P	10^{15}
milli	m	10^{-3}	Exa	E	10^{18}
centi	c	10^{-2}	Zetta	Z	10^{21}
deci	d	10^{-1}	Yotta	Y	10^{24}

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Table C.3 Constants and units

Radian	1 rad	$= 180°/\pi = 57.2957795° = 206{,}264.8''$
Degree	$1°$	$= 0.01745329$ rad
Arc second	$1''$	$= 0.000004848$ rad

Velocity of light	c	$= 299{,}792{,}458\ \mathrm{m\,s^{-1}}$
Gravitational constant	G	$= 6.673 \times 10^{-11}\ \mathrm{m^3\,kg^{-1}\,s^{-2}}$ $= 4\pi^2\ \mathrm{AU^3}\ M_\odot^{-1}\ \mathrm{a^{-2}}$ $= 3{,}986{,}005 \times 10^8\ \mathrm{m^3}\ M_\oplus^{-1}\ \mathrm{s^{-2}}$
Planck constant	h	$= 6.6261 \times 10^{-34}\ \mathrm{J\,s}$
	$\hbar$	$= h/2\pi = 1.0546 \times 10^{-34}\ \mathrm{J\,s}$
Boltzmann constant	k	$= 1.3807 \times 10^{-23}\ \mathrm{J\,K^{-1}}$
Radiation density constant	a	$= 7.5659 \times 10^{-16}\ \mathrm{J\,m^{-3}\,K^{-4}}$
Stefan-Boltzmann constant	σ	$= ac/4 = 5.6705 \times 10^{-8}\ \mathrm{W\,m^{-2}\,K^{-4}}$
Atomic mass unit	amu	$= 1.6605 \times 10^{-27}$ kg
Electron volt	eV	$= 1.6022 \times 10^{-19}$ J
Electron charge	e	$= 1.6022 \times 10^{-19}$ C
Mass of electron	m_e	$= 9.1094 \times 10^{-31}$ kg $= 0.511$ MeV
Mass of proton	m_p	$= 1.6726 \times 10^{-27}$ kg $= 938.3$ MeV
Mass of neutron	m_n	$= 1.6749 \times 10^{-27}$ kg $= 939.6$ MeV
Mass of ^{1}H atom	m_H	$= 1.6735 \times 10^{-27}$ kg $= 1.0078$ amu
Mass of $^4_2$He atom	m_He	$= 6.6465 \times 10^{-27}$ kg $= 4.0026$ amu
Rydberg constant for ^{1}H	R_H	$= 1.0968 \times 10^7\ \mathrm{m^{-1}}$
Rydberg constant for ∞ mass	R_∞	$= 1.0974 \times 10^7\ \mathrm{m^{-1}}$
Gas constant	R	$= 8.3145\ \mathrm{J\,K^{-1}\,mol^{-1}}$
Normal atmospheric pressure	atm	$= 101{,}325$ Pa $= 1013$ mbar $= 760$ mmHg

Astronomical unit	AU	$= 1.49597870 \times 10^{11}$ m
Parsec	pc	$= 3.0857 \times 10^{16}$ m $= 206{,}265$ AU $= 3.26$ ly
Light-year	ly	$= 0.9461 \times 10^{16}$ m $= 0.3066$ pc

Table C.4 Units of time

Unit	Equivalent to
Sidereal year	365.2564 d (with respect to fixed stars)
Tropical year	365.2422 d (equinox to equinox)
Anomalistic year	365.2596 d (perihelion to perihelion)
Gregorian calendar year	365.2425 d
Julian year	365.25 d
Julian century	36,525 d
Eclipse year	346.6200 d (with respect to the ascending node of the Moon)
Lunar year	354.367 d = 12 synodical months
Synodical month	29.5306 d (newmoon to newmoon)
Sidereal month	27.3217 d (with respect to fixed stars)
Tropical month	27.3216 d (with respect to the vernal equinox)
Anomalistic month	27.5546 d (perigee to perigee)
Draconic month	27.2122 d (node to node)
Mean solar day	24 h mean solar time = 24 h 03 min 56.56 s sidereal time = 1.00273791 sidereal days
Sidereal day	24 h sidereal time = 23 h 56 min 04.09 s mean solar time = 0.99726957 mean solar days
Rotation period of the Earth (referred to fixed stars)	1.000000097 sidereal days = 23 h 56 min 04.10 s mean solar time

Table C.5 The Greek alphabet

A, α	B, β	Γ, γ	Δ, δ	E, ϵ, ε	Z, ζ	H, η	$\Theta, \theta, \vartheta$
alpha	beta	gamma	delta	epsilon	zeta	eta	theta
I, ι	K, κ	Λ, λ	M, μ	N, ν	Ξ, ξ	O, o	Π, π, ϖ
iota	kappa	lambda	mu	nu	xi	omicron	pi
P, ρ	$\Sigma, \sigma, \varsigma$	T, τ	Υ, υ	Φ, ϕ, φ	X, χ	Ψ, ψ	Ω, ω
rho	sigma	tau	upsilon	phi	chi	psi	omega

Table C.6 The Sun

Property	Symbol	Numerical value
Mass	$M_\odot$	1.989×10^{30} kg
Radius	$R_\odot$	6.960×10^8 m $= 0.00465$ AU
Effective temperature	T_e	5785 K
Luminosity	$L_\odot$	3.9×10^{26} W
Apparent visual magnitude	V	-26.78
Colour indices	$B - V$	0.62
	$U - B$	0.10
Absolute visual magnitude	M_V	4.79
Absolute bolometric magnitude	M_{bol}	4.72
Inclination of equator to ecliptic		$7°15'$
Equatorial horizontal parallax	$\pi_\odot$	$8.794''$
Motion: direction of apex		$\alpha = 270°$
		$\delta = 30°$
velocity in LSR		$19.7\ \mathrm{km\,s^{-1}}$
Distance from galactic centre		8.5 kpc

Table C.7 The Earth

Property	Symbol	Numerical value
Mass	$M_\oplus$	$= M_\odot/332{,}946 = 5.974 \times 10^{24}$ kg
Mass, Earth + Moon	$M_\oplus + M_☾$	$= M_\odot/328{,}900.5 = 6.048 \times 10^{24}$ kg
Equatorial radius	R_e	$= 6{,}378{,}137$ m
Polar radius	R_p	$= 6{,}356{,}752$ m
Flattening	f	$= (R_e - R_p)/R_e = 1/298.257$
Surface gravity	g	$= 9.81\ \mathrm{m\,s^{-2}}$

Table C.8 The Moon

Property	Symbol	Numerical value
Mass	$M_☾$	$= M_\oplus/81.30 = 7.348 \times 10^{22}$ kg
Radius	$R_☾$	$= 1738$ km
Surface gravity	$g_☾$	$= 1.62\ \mathrm{m\,s^{-2}} = 0.17g$
Mean equatorial horizontal parallax	$\pi_☾$	$= 57'$
Semimajor axis of the orbit	a	$= 384{,}400$ km
Smallest distance from Earth	r_{min}	$= 356{,}400$ km
Greatest distance from Earth	r_{max}	$= 406{,}700$ km
Mean inclination of orbit to ecliptic	ι	$= 5.145°$

Table C.9 Planets. R_e = equatorial radius, ρ = mean density, τ_{sid} = sidereal rotation period (R indicates retrograde rotation), ε = inclination of the equator with respect to the ecliptic (at the beginning of 2000), f = flattening, T = surface temperature, p = geometric albedo, V_0 = mean opposition magnitude. The data are based mostly on the *Astronomical Almanac*

Name	R_e [km]	Mass			ρ [g/cm^3]	Number of known satellites
		Planet [kg]	Planet + Satellites			
			[$M_\oplus$]	[$M_\odot$]		
Mercury	2440	3.30×10^{23}	0.0553	1/6,023,600	5.4	–
Venus	6052	4.87×10^{24}	0.8150	1/408,523.5	5.2	–
Earth	6378	5.97×10^{24}	1.0123	1/328,900.5	5.5	1
Mars	3397	6.42×10^{23}	0.1074	1/3,098,710	3.9	2
Jupiter	71,492	1.90×10^{27}	317.89	1/1047.355	1.3	67
Saturn	60,268	5.69×10^{26}	95.17	1/3498.5	0.7	62
Uranus	25,559	8.66×10^{25}	14.56	1/22,869	1.3	27
Neptune	24,764	1.03×10^{26}	17.24	1/19,314	1.8	14

Name	τ_{sid}	ε [°]	f	T [K]	p	V_0
Mercury	58.646 d	0.0	0	130–615	0.106	–
Venus	243.019 d R	177.4	0	750	0.65	–
Earth	23 h 56 min 04.1 s	23.4	0.003353	300	0.367	–
Mars	24 h 37 min 22.6 s	25.2	0.006476	220	0.150	−2.01
Jupiter	9 h 55 min 30 s	3.1	0.06487	140	0.52	−2.70
Saturn	10 h 39 min 22 s	26.7	0.09796	100	0.47	+0.67
Uranus	17 h 14 min 24 s R	97.8	0.02293	65	0.51	+5.52
Neptune	16 h 06 min 36 s	28.3	0.01708	55	0.41	+7.84

Table C.10 Magnitudes of the planets. The table gives the expressions used in the *Astronomical Almanac*. They give the magnitudes as functions of the phase angle α. Interior planets can be observed at relatively large phase angles, and thus several terms are needed to describe their phase curves. Phase angles of the exterior planets are always small, and thus very simple expressions are sufficient. The magnitude of Saturn means the magnitude of the planet only; the total magnitude also depends on the orientation of the rings

	$V(1,0)$	$V(1,\alpha)$
Mercury	−0.36	$V(1,0) + 3.80(\alpha/100°) - 2.73(\alpha/100°)^2 + 2.00(\alpha/100°)^3$
Venus	−4.29	$V(1,0) + 0.09(\alpha/100°) + 2.39(\alpha/100°)^2 - 0.65(\alpha/100°)^3$
Mars	−1.52	$V(1,0) + 1.60(\alpha/100°)$
Jupiter	−9.25	$V(1,0) + 0.5(\alpha/100°)$
Saturn	−8.88	
Uranus	−7.19	$V(1,0) + 0.28(\alpha/100°)$
Neptune	−6.87	$V(1,0)$

Table C.11 Osculating elements of planetary orbits on JD 2,451,600.5 (Feb 24, 2000). a = semimajor axis, e = eccentricity, i = inclination, Ω = longitude of ascending node, ϖ = longitude of perihelion, L = men longitude, P_{sid} = mean sidereal orbital period (here 1 a means a Julian year, or 365.25 days), P_{syn} = mean synodic period

	a		e	i [°]	Ω [°]	ϖ [°]	L [°]	P_{sid}		P_{syn} [d]
	[AU]	[10^6 km]						[a]	[d]	
Mercury	0.387	57.9	0.2056	7.01	48.3	77.5	119.4	0.2408	87.97	115.9
Venus	0.723	108.2	0.0068	3.39	76.7	131.9	270.9	0.6152	224.7	583.9
Earth	1.000	149.6	0.0167	0.00	143.9	102.9	155.2	1.0000	365.3	–
Mars	1.524	228.0	0.0934	1.85	49.6	336.1	24.5	1.8807	686.9	779.9
Jupiter	5.204	778.6	0.0488	1.30	100.5	15.5	39.0	11.8565	4330.6	398.9
Saturn	9.582	1433.4	0.0558	2.49	113.6	89.9	51.9	29.4235	10,747	378.1
Uranus	19.224	2875.8	0.0447	0.77	74.0	170.3	314.1	83.747	30,589	369.7
Neptune	30.092	4501.7	0.0112	1.77	131.8	39.5	305.5	163.723	59,800	367.5

Table C.12 Mean elements of planets with respect to the equator and equinox of J2000.0. The variable t is the time in days since J2000.0 and T is the same time in Julian centuries: $t = J - 2{,}451{,}545.0$, $T = t/36{,}525$. L is the mean longitude, $L = M + \varpi$. The elements do not contain periodic terms, and the accuracy of the positions computed from them is of the order of a few minutes of arc. The values are from the *Explanatory Supplement to the Astronomical Almanac*. The elements of the Earth describe the orbit of the barycentre of the Earth–Moon system

Mercury	$a = 0.38709893 + 0.00000066T$	$e = 0.20563069 + 0.00002527T$
	$i = 7.00487° - 23.51''T$	$\Omega = 48.33167° - 446.30''T$
	$\varpi = 77.45645° + 573.57''T$	$L = 252.25084° + 4.09233880°t$
Venus	$a = 0.72333199 + 0.00000092T$	$e = 0.00677323 - 0.00004938T$
	$i = 3.39471° - 2.86''T$	$\Omega = 76.68069° - 996.89''T$
	$\varpi = 131.53298° - 108.80''T$	$L = 181.97973° + 1.60213047°t$
Earth + Moon	$a = 1.00000011 - 0.00000005T$	$e = 0.01671022 - 0.00003804T$
	$i = 0.00005° - 46.94''T$	$\Omega = -11.26064° - 18{,}228.25''T$
	$\varpi = 102.94719° + 1198.28''T$	$L = 100.46435° + 0.98560910°t$
Mars	$a = 1.52366231 - 0.00007221T$	$e = 0.09341233 + 0.00011902T$
	$i = 1.85061° - 25.47''T$	$\Omega = 49.57854° - 1020.19''T$
	$\varpi = 336.04084° + 1560.78''T$	$L = 355.45332° + 0.52403304°t$
Jupiter	$a = 5.20336301 + 0.00060737T$	$e = 0.04839266 - 0.00012880T$
	$i = 1.30530° - 4.15''T$	$\Omega = 100.55615° + 1217.17''T$
	$\varpi = 14.75385° + 839.93''T$	$L = 34.40438° + 0.08308676°t$
Saturn	$a = 9.53707032 - 0.00301530T$	$e = 0.05415060 - 0.00036762T$
	$i = 2.48446° + 6.11''T$	$\Omega = 113.71504° - 1591.05''T$
	$\varpi = 92.43194° - 1948.89''T$	$L = 49.94432° + 0.03346063°t$
Uranus	$a = 19.19126393 + 0.00152025T$	$e = 0.04716771 - 0.00019150T$
	$i = 0.76986° - 2.09''T$	$\Omega = 74.22988° + 1681.40''T$
	$\varpi = 170.96424° + 1312.56''T$	$L = 313.23218° + 0.01173129°t$
Neptune	$a = 30.06896348 - 0.00125196T$	$e = 0.00858587 + 0.00002514T$
	$i = 1.76917° - 3.64''T$	$\Omega = 131.72169° - 151.25''T$
	$\varpi = 44.97135° - 844.43''T$	$L = 304.88003° + 0.00598106°t$

Table C.13 Largest satellites of the planets. The giant planets have a large number of satellites, and new ones are found frequently. Also the distinction between a large ring particle and a small satellite is somewhat arbitrary. Therefore this table is not complete. a = semimajor axis, P_{sid} = sidereal period (tropical for Saturn's moons), R means that the motion is retrograde, e = eccentricity, i = inclination with respect to the equator (E = ecliptic), r = radius, M = mass in planetary masses, ρ = density (calculated), p = geometric albedo and V_0 mean opposition magnitude

		Discoverer	Year of discovery	a [10^3 km]	a [R_p]	P_{sid} [d]	e	i [°]	r [km]	M [M_{plan}]	ρ [g/cm^3]	p	V_0
Earth													
	Moon			384.4	60.27	27.3217	0.055	18.28–28.58	1737	0.0123	3.34	0.12	−12.74
Mars													
	Phobos	Hall	1877	9.38	2.76	0.3189	0.015	1.0	13 × 11 × 9	1.7×10^{-8}	2.0	0.07	11.3
	Deimos	Hall	1877	23.46	6.91	1.2624	0.0005	0.9–2.7	7 × 6 × 5	3.7×10^{-9}	2.7	0.08	12.4
Jupiter													
XVI	Metis	Synnott	1979	128	1.79	0.295			20	5×10^{-11}	2.8	0.05	17.5
XV	Adrastea	Jewitt	1979	129	1.80	0.298			13 × 10 × 8	1×10^{-11}	4.4	0.05	19.1
		Danielson											
		Synnott											
V	Amalthea	Barnard	1892	181	2.53	0.498	0.003	0.40	131 × 73 × 67	3.8×10^{-9}	2.7	0.07	14.1
XIV	Thebe	Synnott	1979	222	3.11	0.674	0.015	0.8	55 × 45	4×10^{-10}	1.3	0.04	15.7
I	Io	Galilei	1610	422	5.90	1.769	0.004	0.04	1830 × 1819 × 1815	4.7×10^{-5}	3.5	0.63	5.0
II	Europa	Galilei	1610	671	9.39	3.551	0.009	0.47	1565	2.5×10^{-5}	3.0	0.67	5.3
III	Ganymedes	Galilei	1610	1070	15.0	7.155	0.002	0.21	2634	7.8×10^{-5}	1.9	0.44	4.6
IV	Callisto	Galilei	1610	1883	26.3	16.689	0.007	0.51	2403	5.7×10^{-5}	1.9	0.20	5.6
XIII	Leda	Kowal	1974	11,094	155.2	238.72	0.148	26.07	5	3×10^{-12}		0.07	20.2
VI	Himalia	Perrine	1905	11,480	160.6	250.566	0.158	27.63	85	5×10^{-9}		0.03	14.8
X	Lysithea	Nicholson	1938	11,720	163.9	259.22	0.107	29.02	12	4×10^{-11}		0.06	18.4
VII	Elara	Perrine	1905	11,737	164.2	259.653	0.207	24.77	40	4×10^{-10}		0.03	16.8
XII	Ananke	Nicholson	1951	21,200	297	631 R	0.169	147	10	2×10^{-11}		0.06	18.9
XI	Carme	Nicholson	1938	22,600	316	692 R	0.207	164	15	5×10^{-11}		0.06	18.0
VIII	Pasiphae	Melotte	1908	23,500	329	735 R	0.378	145	18	1×10^{-10}		0.10	17.0
IX	Sinope	Nicholson	1914	23,700	332	758 R	0.275	153	14	4×10^{-11}		0.05	18.3

Table C.13 (Continued)

		Discoverer	Year of discovery	a [10^3 km]	a [R_p]	P_{sid} [d]	e	i [°]	r [km]	M [M_{plan}]	ρ [g/cm^3]	p	V_0
Saturn													
XVIII	Pan	Showalter	1990	133.58	2.22	0.575			10			0.5	
XV	Atlas	Terrile	1980	137.67	2.28	0.602	0.000	0.3	$18 \times 17 \times 13$			0.8	18
XVI	Prometheus	Collins	1980	139.35	2.31	0.613	0.003	0.0	$74 \times 50 \times 34$			0.5	16
		Carlson											
XVII	Pandora	Collins	1980	141.70	2.35	0.629	0.004	0	$55 \times 44 \times 31$			0.7	16
		Carlson											
XI	Epimetheus	Cruikshank	1980	151.42	2.51	0.694	0.009	0.34	$69 \times 55 \times 55$	9.5×10^{-10}	0.6	0.8	15
X	Janus	Pascu	1980	151.47	2.51	0.695	0.007	0.14	$97 \times 95 \times 77$	3.4×10^{-9}	0.7	0.9	14
I	Mimas	W. Herschel	1789	185.52	3.08	0.942	0.020	1.53	$209 \times 196 \times 191$	6.6×10^{-8}	1.1	0.5	12.9
II	Enceladus	W. Herschel	1789	238.02	3.95	1.370	0.005	0.00	$256 \times 247 \times 245$	1×10^{-7}	0.9	1.0	11.7
XIII	Telesto	Smith	1980	294.66	4.89	1.888			$15 \times 12 \times 7$			1.0	18.5
		Larson											
		Reitsema											
III	Tethys	Cassini	1684	294.66	4.89	1.888	0.000	1.86	$536 \times 528 \times 526$	1.1×10^{-6}	1.0	0.9	10.2
XIV	Calypso	Pascu	1980	294.66	4.89	1.888			$15 \times 8 \times 8$			1.0	18.7
		Seidelmann											
		Baum											
		Currie											
IV	Dione	Cassini	1684	377.40	6.26	2.737	0.002	0.02	560	1.9×10^{-6}	1.5	0.7	10.4
XII	Helene	Laques	1980	377.40	6.26	2.737	0.005	0.0	$18 \times 16 \times 15$			0.7	18
		Lecacheux											
V	Rhea	Cassini	1672	527.04	8.74	4.517	0.001	0.35	764	4.1×10^{-6}	1.2	0.7	9.7
VI	Titan	Huygens	1665	1221.83	20.3	15.945	0.03	0.33	2575	2.4×10^{-4}	1.9	0.22	8.3
VII	Hyperion	Bond	1848	1481.1	24.6	21.277	0.10	0.43	$180 \times 140 \times 113$	4×10^{-8}	1.4	0.3	14.2
VIII	Iapetus	Cassini	1671	3561.3	59.1	79.330	0.028	14.72	718	2.8×10^{-6}	1.0	0.5/0.05	11.1
IX	Phoebe	Pickering	1898	12,952	215	550.48 R	0.163	177 E	110	7×10^{-10}?		0.06	16.4

Table C.13 (Continued)

		Discoverer	Year of discovery	a [10^3 km]	a [R_p]	P_{sid} [d]	e	i [°]	r [km]	M [M_{plan}]	ρ [g/cm^3]	p	V_0
Uranus													
VI	Cordelia	Voyager 2	1986	49.77	1.95	0.335	0.00	0.08	13			0.07	24.1
VII	Ophelia	Voyager 2	1986	53.79	2.10	0.376	0.01	0.10	15			0.07	23.8
VIII	Bianca	Voyager 2	1986	59.17	2.32	0.435	0.00	0.19	21			0.07	23.0
IX	Cressida	Voyager 2	1986	61.78	2.42	0.464	0.00	0.01	31			0.07	22.2
X	Desdemona	Voyager 2	1986	62.68	2.45	0.474	0.00	0.11	27			0.07	22.5
XI	Juliet	Voyager 2	1986	64.35	2.52	0.493	0.00	0.07	42			0.07	21.5
XII	Portia	Voyager 2	1986	66.09	2.59	0.513	0.00	0.06	54			0.07	21.0
XIII	Rosalind	Voyager 2	1986	69.94	2.74	0.558	0.00	0.28	27			0.07	22.5
XIV	Belinda	Voyager 2	1986	75.26	2.94	0.624	0.00	0.03	33			0.07	22.1
XVIII	S/1986U10	Karkoschka	1999	77.30	3.0	0.637			20			0.07	
XV	Puck	Voyager 2	1985	86.01	3.37	0.762	0.00	0.32	77			0.07	20.2
V	Miranda	Kuiper	1948	129.39	5.06	1.413	0.003	4.2	240 × 234 × 233	8×10^{-7}	1.3	0.27	16.3
I	Ariel	Lassell	1851	191.02	7.47	2.520	0.003	0.3	581 × 578 × 578	1.6×10^{-5}	1.7	0.35	14.2
II	Umbriel	Lassell	1851	266.30	10.42	4.144	0.005	0.36	585	1.4×10^{-5}	1.4	0.19	14.8
III	Titania	W. Herschel	1787	435.91	17.06	8.706	0.002	0.14	789	4.1×10^{-5}	1.7	0.28	13.7
IV	Oberon	W. Herschel	1787	583.52	22.83	13.463	0.001	0.10	761	3.5×10^{-5}	1.6	0.25	13.9
XVI	Caliban	Nicholson	1997	7169	281	579 R	0.08	140 E	30			0.07	22.4
XVII	Sycorax	Nicholson	1997	12,214	477	1289 R	0.5	153 E	60			0.07	20.9
Neptune													
III	Naiad	Voyager 2	1989	48.23	1.95	0.294	0.000	4.74	29			0.06	24.7
IV	Thalassa	Voyager 2	1989	50.07	2.02	0.311	0.000	0.21	40			0.06	23.8
V	Despina	Voyager 2	1989	52.53	2.12	0.335	0.000	0.07	74			0.06	22.6
VI	Galatea	Voyager 2	1989	61.95	2.50	0.429	0.000	0.05	79			0.06	22.3
VII	Larissa	Voyager 2	1989	73.55	2.97	0.555	0.001	0.20	104 × 89			0.06	22.0
VIII	Proteus	Voyager 2	1989	117.65	4.75	1.122	0.000	0.55	218 × 208 × 201			0.06	20.3
I	Triton	Lassell	1846	354.76	14.33	5.877R	0.000	157.35	1353	2.1×10^{-4}	2.1	0.77	13.5
II	Nereid	Kuiper	1949	5513.4	222.6	360.136	0.751	27.6	170	2×10^{-7}	1.0	0.4	18.7

Table C.14 Some well-known asteroids. a = semimajor axis, e = eccentricity, i = inclination, d = diameter, τ_{sid} = sidereal period of rotation, p = geometric albedo, V_0 = mean opposition magnitude

	Asteroidi	Discoverer	Year of discovery	a [AU]	e	i [°]	d [km]	τ_{sid} [h]	p	V_0	Type
1	Ceres	Piazzi	1801	2.77	0.08	10.6	946	9.08	0.07	7.9	C
2	Pallas	Olbers	1802	2.77	0.23	34.8	583	7.88	0.09	8.5	U
3	Juno	Harding	1804	2.67	0.26	13.0	249	7.21	0.16	9.8	S
4	Vesta	Olbers	1807	2.36	0.09	7.1	555	5.34	0.26	6.8	U
5	Astraea	Hencke	1845	2.58	0.19	5.3	116	16.81	0.13	11.2	S
6	Hebe	Hencke	1847	2.42	0.20	14.8	206	7.27	0.16	9.7	S
7	Iris	Hind	1847	2.39	0.23	5.5	222	7.14	0.20	9.4	S
8	Flora	Hind	1847	2.20	0.16	5.9	160	13.60	0.13	9.8	S
9	Metis	Graham	1848	2.39	0.12	5.6	168	5.06	0.12	10.4	S
10	Hygiea	DeGasparis	1849	3.14	0.12	3.8	443	18.00	0.05	10.6	C
243	Ida	Palisa	1884	2.86	0.04	1.1	32	4.63	0.16		
433	Eros	Witt	1898	1.46	0.22	10.8	20	5.27	0.18	11.5	S
588	Achilles	Wolf	1906	5.18	0.15	10.3	70	?	?	16.4	U
624	Hektor	Kopff	1907	5.16	0.03	18.3	230	6.92	0.03	15.3	U
944	Hidalgo	Baade	1920	5.85	0.66	42.4	30	10.06	?	19.2	MEU
951	Gaspra	Neujmin	1916	2.21	0.17	4.1	19	7.04	0.15		
1221	Amor	Delporte	1932	1.92	0.43	11.9	5	?	?	20.4	?
1566	Icarus	Baade	1949	1.08	0.83	22.9	2	2.27	?	12.3	U
1862	Apollo	Reinmuth	1932	1.47	0.56	6.4	2	?	?	16.3	?
2060	Chiron	Kowal	1977	13.64	0.38	6.9	320	?	?	17.3	?
5145	Pholus	Rabinowitz	1992	20.46	0.58	24.7	190				

Table C.15 Principal meteor showers

Shower	Period of visibility	Maximum	Radiant		Meteors per hour	Comet
			α	δ		
Quadrantids	Jan. 1–5	Jan. 3–4	15.5 h	+50°	30–40	
Lyrids	Apr. 19–25	Apr. 22	18.2 h	+34°	10	Thatcher
η Aquarids	May 1–12	May 5	22.4 h	−1°	5–10	Halley
Perseids	Jul. 20–Aug. 18	Aug. 12	3.1 h	+58°	40–50	Swift-Tuttle
κ Cygnids	Aug. 17–24	Aug. 20	19.1 h	+59°	5	
Orionids	Oct. 17–26	Oct. 21	6.3 h	+16°	10–15	Halley
Taurids	Oct. 10–Dec. 5	Nov. 1	3.8 h	+14°, +22°	5	Encke
Leonids	Nov. 14–20	Nov. 17	10.2 h	+22°	10	Tempel-Tuttle
Geminids	Dec. 7–15	Dec. 13–14	7.5 h	+33°	40–50	
Ursids	Dec. 17–24	Dec. 22	13.5 h	+78°	5	

Table C.16 Periodic comets with several perihelion passages observed. N = number of passages observed, τ = time of perihelion passage, P = sidereal period, q = perihelion distance, e = eccentricity, ω = argument of perihelion (1950.0), Ω = longitude of ascending node (1950.0), i = inclination, l = longitude of perihelion, defined here as $l = \Omega + \arctan(\tan\omega\cos i)$, b = latitude of perihelion ($\sin b = \sin\omega\sin i$), Q = aphelion distance. The elements are affected by planetary perturbations as well as reaction forces due to evaporating material the amount of which is difficult to predict

Comet	N	τ	P [a]	q [AU]	e	ω [°]	Ω [°]	i [°]	l [°]	b [°]	Q [AU]
Encke	56	Feb. 9, 1994	3.28	0.331	0.850	186.3	334.0	11.9	160.2	−1.3	4.09
Grigg-Skjellerup	16	Jul. 24, 1992	5.10	0.995	0.664	359.3	212.6	21.1	212.0	−0.3	4.93
Honda-Mrkos-Pajdušáková	8	Sep. 12, 1990	5.30	0.541	0.822	325.8	88.6	4.2	54.5	−2.4	5.54
Tuttle-Giacobini-Kresák	8	Feb. 8, 1990	5.46	1.068	0.656	61.6	140.9	9.2	202.1	8.1	5.14
Tempel 2	19	Mar. 16, 1994	5.48	1.484	0.522	194.9	117.6	12.0	312.1	−3.1	4.73
Wirtanen	8	Sep. 21, 1991	5.50	1.083	0.652	356.2	81.6	11.7	77.9	−0.8	5.15
Clark	8	Nov. 28, 1989	5.51	1.556	0.501	208.9	59.1	9.5	267.7	−4.6	4.68
Forbes	8	Mar. 15, 1993	6.14	1.450	0.568	310.6	333.6	7.2	284.5	−5.4	5.25
Pons-Winnecke	20	Aug. 19, 1989	6.38	1.261	0.634	172.3	92.8	22.3	265.6	2.9	5.62
d'Arrest	15	Feb. 4, 1989	6.39	1.292	0.625	177.1	138.8	19.4	316.0	1.0	5.59
Schwassmann-Wachmann 2	11	Jan. 24, 1994	6.39	2.070	0.399	358.2	125.6	3.8	123.8	−0.1	4.82
Wolf-Harrington	8	Apr. 4, 1991	6.51	1.608	0.539	187.0	254.2	18.5	80.8	−2.2	5.37
Ciacobini-Zinner	12	Apr. 14, 1992	6.61	1.034	0.707	172.5	194.7	31.8	8.3	3.9	6.01
Reinmuth 2	8	Jun. 29, 1994	6.64	1.893	0.464	45.9	295.4	7.0	341.1	5.0	5.17
Perrine-Mrkos	8	Mar. 1, 1989	6.78	1.298	0.638	166.6	239.4	17.8	46.6	4.1	5.87
Arend-Rigaux	7	Oct. 3, 1991	6.82	1.438	0.600	329.1	121.4	17.9	91.7	−9.1	5.75
Borrelly	11	Dec. 18, 1987	6.86	1.357	0.624	353.3	74.8	30.3	69.0	−3.4	5.86
Brooks 2	14	Sep. 1, 1994	6.89	1.843	0.491	198.0	176.2	5.5	14.1	−1.7	5.40
Finlay	11	Jun. 5, 1988	6.95	1.094	0.700	322.2	41.7	3.6	4.0	−2.2	6.19
Johnson	7	Nov. 19, 1990	6.97	2.313	0.366	208.3	116.7	13.7	324.3	−6.4	4.98
Daniel	8	Aug. 31, 1992	7.06	1.650	0.552	11.0	68.4	20.1	78.7	3.8	5.71
Holmes	8	Apr. 10, 1993	7.09	2.177	0.410	23.2	327.3	19.2	349.4	7.4	5.21
Reinmuth 1	8	May 10, 1988	7.29	1.869	0.503	13.0	119.2	8.1	132.0	1.8	5.65
Faye	19	Nov. 15, 1991	7.34	1.593	0.578	204.0	198.9	9.1	42.6	−3.7	5.96
Ashbrook-Jackson	7	Jul. 13, 1993	7.49	2.316	0.395	348.7	2.0	12.5	350.9	−2.4	5.34
Schaumasse	10	Mar. 5, 1993	8.22	1.202	0.705	57.5	80.4	11.8	137.3	10.0	6.94
Wolf	14	Aug. 28, 1992	8.25	2.428	0.406	162.3	203.4	27.5	7.6	8.1	5.74
Whipple	9	Dec. 22, 1994	8.53	3.094	0.259	201.9	181.8	9.9	23.4	−3.7	5.25
Comas Solá	8	Aug. 18, 1987	8.78	1.830	0.570	45.5	60.4	13.0	105.2	9.2	6.68
Väisälä 1	6	Apr. 29, 1993	10.8	1.783	0.635	47.4	134.4	11.6	181.2	8.5	7.98
Tuttle	11	Jun. 27, 1994	13.5	0.998	0.824	206.7	269.8	54.7	106.1	−21.5	10.3
Halley	30	Feb. 9, 1986	76.0	0.587	0.967	111.8	58.1	162.2	305.3	16.4	35.3

Table C.17 Nearest stars. V = apparent visual magnitude, $B - V$ = colour index, r = distance, μ = proper motion, v_r = radial velocity (positive for receding objects)

Name	α_{2000}		δ_{2000}		V	$B - V$	Spectrum	r [pc]	μ [″/a]	v_r [km/s]
	[h]	[min]	[°]	[′]						
Sun					−26.8	0.6	G2V			
α Cen C (Proxima)	14	29.7	−62	41	11.0	2.0	M5eV	1.30	3.9	−16
α Cen A	14	39.6	−60	50	−0.0	0.7	G2V	1.33	3.7	−22
α Cen B	14	39.6	−60	50	1.3	0.9	K1V	1.33	3.7	−22
Barnard's star	17	57.8	4	42	9.5	1.7	M5V	1.83	10.3	−108
Wolf 359	10	56.5	7	01	13.5	2.0	M6eV	2.39	4.7	+13
BD+36°2147	11	03.3	35	58	7.5	1.5	M2V	2.54	4.8	−86
α CMa (Sirius) A	6	45.1	−16	43	−1.5	0.0	A1V	2.66	1.3	−8
α CMa (Sirius) B	6	45.1	−16	43	8.4		wdA	2.66	1.3	−8
Luyten 726–8 A	1	39.0	−17	57	12.5		M6eV	2.66	3.3	+29
Luyten 726–8 B (UV Cet)	1	39.0	−17	57	13.0		M6eV	2.66	3.3	+32
Ross 154	18	49.8	−23	50	10.4		M4eV	2.92	0.7	−4
Ross 248	23	41.9	44	11	12.2	1.9	M5eV	3.13	1.6	−81
ε Eri	3	32.9	−9	27	3.7	0.9	K2V	3.26	1.0	+16
Ross 128	11	47.7	0	48	11.1	1.8	M5V	3.31	1.4	−13
Luyten 789–6 A	22	38.6	−15	17	12.8	2.0	M5eV	3.40	3.3	−60
Luyten 789–6 B	22	38.6	−15	17	13.3			3.40	3.3	−60
BD+43°44 A	0	18.4	44	01	8.1	1.6	M3V	3.44	2.9	+13
BD+43°44 B	0	18.4	44	01	11.0	1.8	M6V	3.44	2.9	+20
ε Ind	22	03.4	−56	47	4.7	1.1	K5V	3.45	4.7	−40
BD+59°1915 A	18	42.8	59	38	8.9	1.5	M4V	3.45	2.3	0
BD+59°1915 B	18	42.8	59	38	9.7	1.6	M4V	3.45	2.3	+10
61 Cyg A	21	06.9	38	45	5.2	1.2	K5V	3.46	5.2	−64
61 Cyg B	21	06.9	38	45	6.0	1.4	K7V	3.46	5.2	−64
τ Cet	1	43.1	−15	56	3.5	0.7	G8V	3.48	1.9	−16
CD−36°15693	23	05.9	−35	51	7.4	1.5	M2V	3.51	6.9	+10
α CMi (Procyon) A	7	39.3	5	14	0.4	0.4	F5IV	3.51	1.3	−3
α CMi (Procyon) B	7	39.3	5	14	10.7		wdF	3.51	1.3	
G 51–15	8	29.8	26	47	14.8		M7V	3.62	1.3	
BD+5°1668	7	27.4	5	13	9.8	1.6	M4V	3.76	3.8	+26
Luyten 725–32	1	12.6	−17	00	11.8		M6eV	3.77	1.4	
Kapteyn's star	5	11.7	−45	01	8.8	1.6	M1VI	3.85	8.8	+245
CD−39°14192	21	17.2	−38	52	6.7	1.4	M0eV	3.85	3.5	+21
Krüger 60 A	22	28.0	57	42	9.9	1.6	M3V	3.95	0.9	−26
Krüger 60 B	22	28.0	57	42	11.5	1.8	M4eV	3.95	0.9	−26
Ross 614 A	6	29.4	−2	49	11.2	1.7	M4eV	4.13	1.0	+24
Ross 614 B	6	29.4	−2	49	14.8			4.13	1.0	+24
BD−12°4523	16	30.3	−12	40	10.2	1.6	M5V	4.15	1.2	−13
Wolf 424 A	12	33.3	9	01	13.2	1.8	M6V	4.29	1.8	−5
Wolf 424 B	12	33.3	9	01	13.2			4.29	1.8	−5

Table C.17 (Continued)

Name	α_{2000}		δ_{2000}		V	$B-V$	Spectrum	r [pc]	μ [″/a]	v_r [km/s]
	[h]	[min]	[°]	[′]						
van Maanen's star	0	49.2	5	23	12.4	0.6	wdG	4.33	3.0	+54
Luyten 1159–16	2	00.2	13	03	12.2		M5eV	4.48	2.1	
CD−37°15492	0	05.4	−37	21	8.6	1.5	M3V	4.48	6.1	+23
Luyten 143–23	10	44.5	−61	12	13.9		dM	4.48	1.7	
CD−46°11540	17	28.7	−46	54	9.4	1.5	M3	4.52	1.1	
LP 731–58	10	48.2	−11	20	15.6		M7V	4.55	1.6	
Luyten 145–141	11	45.7	−64	50	11.4	0.2	wdA	4.57	2.7	
BD+68°946	17	36.4	68	20	9.1	1.5	M3V	4.63	1.3	−22
CD−49°13515	21	33.6	−49	01	8.7	1.5	M2V	4.63	0.8	+8
BD+50°1725	10	11.3	49	27	6.6	1.4	K2V	4.67	1.5	−26
G 158–27	0	06.7	−07	32	13.7		M5V	4.67	2.1	
BD−15°6290	22	53.3	−14	18	10.2	1.6	M4V	4.69	1.1	+9
CD−44°11909	17	37.1	−44	19	11.0		M5V	4.72	1.1	
G 208–44/45 A	19	53.9	44	25	13.4		M6eV	4.72	0.7	
G 208–44/45 B	19	53.9	44	25	14.3		dM	4.72	0.7	
G 208–44/45 C	19	53.9	44	25	15.5		dM	4.72	0.7	
o^2 Eri A	4	15.3	−7	39	4.4	0.8	K0V	4.76	4.0	−43
o^2 Eri B	4	15.3	−7	39	9.5	0.0	wdA	4.76	4.0	−21
o^2 Eri C	4	15.3	−7	39	11.2	1.7	M4eV	4.76	4.0	−45
BD+20°2465	10	19.6	19	52	9.4	1.5	M4V	4.88	0.5	+11
70 Oph A	18	05.5	2	30	4.2	0.9	K0V	4.98	1.1	−7
70 Oph B	18	05.5	2	30	6.0		K5V	4.98	1.1	−10
BD+44°2051 A	11	05.5	43	32	8.7		M2V	5.00	4.5	+65
BD+44°2051 B	11	05.5	43	32	14.4		M5eV	5.00	4.5	+65
α Aql (Altair)	19	50.8	8	52	0.8	0.2	A7V	5.08	0.7	−26

Table C.18 Brightest stars ($V \leq 2$). V = apparent visual magnitude, $B-V$ = colour index, r = distance. Remarks: b = binary, sb = spectroscopic binary, v = variable

Name		α_{2000}		δ_{2000}		V	$B-V$	Spectrum	r [pc]	Remarks
		[h]	[min]	[°]	[′]					
α CMa	Sirius	6	45.2	−16	43	−1.5	0.0	A1V,wdA	2.7	b
α Car	Canopus	6	24.0	−52	42	−0.7	0.2	A9II	60	
α Cen	Rigil	14	39.6	−60	50	−0.3	0.7	G2V,K1V	1.3	b, Proxima
	Kentaurus									2.2° apart
α Boo	Arcturus	14	15.7	19	11	−0.0	1.2	K2IIIp	11	
α Lyr	Vega	18	36.9	38	47	0.0	0.0	A0V	8	
α Aur	Capella	5	16.7	46	00	0.1	0.8	G2III,G6III	14	b
β Ori	Rigel	5	14.5	−8	12	0.1	−0.0	B8Ia	90	b
α CMi	Procyon	7	39.3	5	14	0.4	0.4	F5IV,wdF	3.5	b
α Eri	Achernar	1	37.7	−57	14	0.5	−0.2	B3Vp	40	

Table C.18 (Continued)

Name		α_{2000}		δ_{2000}		V	$B-V$	Spectrum	r [pc]	Remarks
		[h]	[min]	[°]	[′]					
α Ori	Betelgeuze	5	55.2	7	24	0.5	1.9	M2I	200	v $0.4-1.3$, sb
β Cen	Hadar	14	03.8	−60	22	0.6	−0.2	B1III	60	b
α Aql	Altair	19	50.8	8	52	0.8	0.2	A7V	5.1	
α Cru	Acrux	12	26.6	−63	06	0.8	−0.3	B0.5IV,B1V	120	b $1.6+2.1$
α Tau	Aldebaran	4	35.9	16	31	0.9	1.5	K5III	20	b, v
α Vir	Spica	13	25.2	−11	10	1.0	−0.2	B1IV	50	sb, several comp.
α Sco	Antares	16	29.4	−26	26	1.0	1.8	M1.5I,B2.5V	50	v $0.9-1.8$
β Gem	Pollux	7	45.3	28	02	1.2	1.1	K0III	11	
α PsA	Fomalhaut	22	57.6	−29	37	1.2	0.1	A3V	7.0	
α Cyg	Deneb	20	41.4	45	17	1.3	0.1	A2Ia	500	
β Cru	Mimosa	12	47.7	−59	41	1.3	−0.2	B0.5III	150	v, sb
α Leo	Regulus	10	08.4	11	58	1.4	−0.1	B7V	26	b
ϵ CMa	Adhara	6	58.6	−28	58	1.5	−0.2	B2II	170	b
α Gem	Castor	7	34.6	31	53	1.6	0.0	A1V,A2V	14	b
γ Cru	Gacrux	12	31.2	−57	07	1.6	1.6	M3.5III	40	v
λ Sco	Shaula	17	33.6	−37	06	1.6	−0.2	B1.5IV		v
γ Ori	Bellatrix	5	25.1	6	21	1.6	−0.2	B2III	40	
β Tau	Elnath	5	26.3	28	36	1.7	−0.1	B7III	55	
β Car	Miaplacidus	9	13.2	−69	43	1.7	0.0	A1III	30	
ϵ Ori	Alnilam	5	36.2	−1	12	1.7	−0.2	B0Ia		
α Gru	Al Na'ir	22	08.2	−46	58	1.7	−0.1	B7IV	20	
ϵ UMa	Alioth	12	54.0	55	58	1.8	−0.0	A0IVp	120	v
γ Vel	Regor	8	09.5	−47	20	1.8	−0.2	WC8,B1IV		b $1.8+4.3$, each sb
α Per	Mirfak	3	24.3	49	52	1.8	0.5	F5Ib	35	
α UMa	Dubhe	11	03.7	61	45	1.8	1.1	K0III	30	b
ϵ Sgr	Kaus Australis	18	24.2	−34	23	1.9	−0.0	A0II	70	
δ CMa	Wezen	7	08.4	−26	23	1.9	0.7	F8Ia		
ϵ Car	Avior	8	22.5	−59	31	1.9	1.3	K3III,B2V	25	sb
η UMa	Alkaid	13	47.5	49	19	1.9	−0.2	B3V		
θ Sco	Girtab	17	37.3	−43	00	1.9	0.4	F0II	50	
β Aur	Menkalinan	5	59.6	44	57	1.9	0.0	A1IV	30	
ζ Ori	Alnitak	5	40.8	−1	57	1.9	−0.2	O9.5Ib,B0III	45	b $2.1+4.2$
α TrA	Atria	16	48.7	−69	02	1.9	1.4	K2II–III	40	
γ Gem	Alhena	6	37.7	16	24	1.9	0.0	A1IV	30	
α Pav	Peacock	20	25.7	−56	44	1.9	−0.2	B3V		
δ Vel		8	44.7	−54	43	2.0	0.0	A1V	20	
β CMa	Mirzam	6	22.7	−17	57	2.0	−0.2	B1II–III	70	v
α Hya	Alphard	9	27.6	−8	40	2.0	1.4	K3II–III	60	
α Ari	Hamal	2	07.2	23	28	2.0	1.2	K2III	25	

Table C.19 Some double stars. Magnitudes of the components are m_1 and m_2, and the angular separation d; r is the distance of the star

Name		α_{2000}		δ_{2000}		m_1	m_2	Spectrum		d	r
		[h]	[min]	[°]	[′]					[″]	[pc]
η Cas	Achird	0	49.1	57	49	3.7	7.5	G0V	M0	12	6
γ Ari	Mesarthim	1	53.5	19	18	4.8	4.9	A1p	B9V	8	40
α Psc	Alrescha	2	02.0	2	46	4.3	5.3	A0p	A3m	2	60
γ And	Alamak	2	03.9	42	20	2.4	5.1	K3IIb	B8V,A0V	10	100
δ Ori	Mintaka	5	32.0	−0	18	2.5	7.0	B0III,O9V	B2V	52	70
λ Ori	Meissa	5	35.1	9	56	3.7	5.7	O8e	B0.5V	4	140
ζ Ori	Alnitak	5	40.8	−1	56	2.1	4.2	O9.51be	B0III	2	40
α Gem	Castor	7	34.6	31	53	2.0	3.0	A1V	A5Vm	3	15
γ Leo	Algieba	10	20.0	19	50	2.6	3.8	K1III	G7III	4	80
ξ UMa	Alula Australis	11	18.2	31	32	4.4	4.9	G0V	G0V	1	7
α Cru	Acrux	12	26.6	−63	06	1.6	2.1	B0.5IV	B1V	4	120
γ Vir	Porrima	12	41.7	−1	27	3.7	3.7	F0V	F0V	3	10
α CVn	Cor Caroli	12	56.1	38	18	2.9	5.5	A0p	F0V	20	40
ζ UMa	Mizar	13	23.9	54	56	2.4	4.1	A1Vp	A1m	14	21
α Cen	Rigil Kentaurus	14	39.6	−60	50	0.0	1.3	G2V	K1V	21	1.3
ϵ Boo	Izar	14	45.0	27	04	2.7	5.3	K0II-III	A2V	3	60
δ Ser		15	34.8	10	32	4.2	5.3	F0IV	F0IV	4	50
β Sco	Graffias	16	05.4	−19	48	2.6	4.9	B1V	B2V	14	110
α Her	Rasalgethi	17	14.6	14	23	3.0–4.0	5.7	M5Ib-II	G5III,F2V	5	120
ρ Her		17	23.7	37	08	4.5	5.5	B9.5III	A0V	4	
70 Oph		18	05.5	2	30	4.3	6.1	K0V	K5V	2	5
ϵ Lyr		18	44.3	39	40	4.8	4.4	A4V,F1V	A8V,F0V	208	50
ϵ^1 Lyr		18	44.3	39	40	5.1	6.2	A4V	F1V	3	50
ϵ^2 Lyr		18	44.4	39	37	5.1	5.3	A8V	F0V	2	50
ζ Lyr		18	44.8	37	36	4.3	5.7	Am	F0IV	44	30
θ Ser	Alya	18	56.2	4	12	4.5	4.9	A5V	A5V	22	30
γ Del		20	46.7	16	07	4.5	5.4	K1IV	F7V	10	40
ζ Aqr		22	28.8	−0	01	4.4	4.6	F3V	F6IV	2	30
δ Cep		22	29.1	58	24	3.5–4.3	7.5	F5Ib–G2Ib	B7IV	41	90

Table C.20 Milky Way Galaxy

Property	Value
Mass	$> 2 \times 10^{11}\ M_{\odot}$
Disc diameter	30 kpc
Disc thickness (stars)	1 kpc
Disc thickness (gas and dust)	200 pc
Halo diameter	50 kpc
Sun's distance from the centre	8.5 kpc
Sun's orbital velocity	$220\ \mathrm{km\,s^{-1}}$
Sun's period	240×10^6 a
Direction of the centre (2000.0)	$\alpha = 17$ h 45.7 min
	$\delta = -29°00'$
Direction of the north pole (2000.0)	$\alpha = 12$ h 51.4 min
	$\delta = +27°08'$
Galactic coordinates of the	$l = 123°00'$
celestial north pole	$b = +27°08'$

Table C.21 Members of the Local Group of Galaxies. V = apparent visual magnitude, M_V = absolute visual magnitude, r = distance

	α_{2000}		δ_{2000}		Type	V	M_V	r
	[h]	[min]	[°]	[′]				[kpc]
Milky Way	17	45.7	−29	00	Sbc		−20.9	8
NGC 224 = M31	00	42.7	41	16	Sb	3.2	−21.2	760
NGC 598 = M33	01	33.8	30	30	Sc	5.6	−18.9	790
Large Magellanic Cloud	05	19.6	−69	27	Irr	0.0	−18.5	50
Small Magellanic Cloud	00	52.6	−72	48	Irr	1.8	−17.1	60
NGC 221 = M32	00	42.7	40	52	E2	7.9	−16.5	760
NGC 205	00	40.4	41	41	dE5	8.0	−16.4	760
IC 10	00	20.4	59	17	Irr	7.8	−16.3	660
NGC 6822	19	44.9	−14	48	Irr	7.5	−16.0	500
NGC 185	00	39.0	48	20	dE3	8.5	−15.6	660
IC 1613	01	04.8	02	08	Irr	9.0	−15.3	720
NGC 147	00	33.2	48	30	dE4	9.0	−15.1	660
WLM	00	02.0	−15	28	Irr	10.4	−14.4	930
Sagittarius	18	55.1	−30	29	dE7	3.1	−13.8	24
Fornax	02	39.9	−34	30	dE3	7.6	−13.1	140
Pegasus	23	28.6	14	45	Irr	12.1	−12.3	760
Leo I	10	08.4	12	18	dE3	10.1	−11.9	250
And II	01	16.5	33	26	dE3	12.4	−11.8	700
And I	00	45.7	38	00	dE0	12.7	−11.8	810
Leo A	09	59.4	30	45	Irr	12.7	−11.5	690
Aquarius	20	46.9	−12	51	Irr	13.7	−11.3	1020
SagDIG	19	30.0	−17	41	Irr	15.0	−10.7	1400
Pegasus II = And VI	23	51.7	24	36	dE	14.0	−10.6	830
Pisces = LGS 3	01	03.9	21	54	Irr	14.1	−10.4	810
And III	00	35.3	36	30	dE6	14.2	−10.2	760
And V	01	10.3	47	38	dE	14.3	−10.2	810
Leo II	11	13.5	22	10	dE0	11.5	−10.1	210
Cetus	00	26.1	−11	02	dE	14.3	−10.1	780
Sculptor	01	00.1	−33	43	dE3	10.0	−9.8	90
Phoenix	01	51.1	−44	27	Irr	13.2	−9.8	400
Tucana	22	41.8	−64	25	dE5	15.1	−9.6	870
Sextans	10	13.0	−01	37	dE4	10.3	−9.5	90
Cassiopeia = And VII	23	26.5	50	42	dE	14.7	−9.5	690
Carina	06	41.6	−50	58	dE4	10.6	−9.4	100
Ursa Minor	15	08.8	67	07	dE5	10.0	−8.9	60
Draco	17	20.3	57	55	dE3	10.9	−8.6	80
Ursa Major	158	43.2	51	55	dE	13.2	−6.8	100
Canes Venatici	13	28.0	33	33	dE	13.9	−7.9	220
Boötes	14	00.0	14	30	dE	13.3	−5.7	60
Ursa Major II	08	51.5	63	08	dE	14.3	−3.8	30

Table C.21 (Continued)

	α_{2000}		δ_{2000}		Type	V	M_V	r [kpc]
	[h]	[min]	[°]	[′]				
Coma Berenices	12	27.0	23	54	dE	14.5	−3.7	44
Canes Venatici II	12	57.2	34	19	dE	15.1	−4.8	150
Hercules	16	31.0	12	47.5	dE	14.7	−6.0	140
Leo IV	11	33.0	−0	32	dE	15.9	−5.1	160
And IX	00	52.9	43	12	dE	16.2	−8.3	760
And X	01	06.5	44	48	dE	16.1	−8.1	710
And XI	00	46.3	33	48	dE	17.2	−7.3	760
And XII	00	47.5	34	22	dE	18.1	−6.4	760
And XIII	00	51.8	33	00	dE	17.6	−6.9	760

Table C.22 Optically brightest galaxies. B = apparent blue magnitude, d = apparent diameter, r = distance

Name	α_{2000}		δ_{2000}		Type	B	d [″]	r [Mpc]
	[h]	[min]	[°]	[′]				
NGC 55	0	15.1	−39	13	Sc/Irr	7.9	30 × 5	2.3
NGC 205	0	40.4	41	41	E6	8.9	12 × 6	0.7
NGC 221 = M32	0	42.7	40	52	E2	9.1	3.4 × 2.9	0.7
NGC 224 = M31	0	42.8	41	16	Sb	4.3	163 × 42	0.7
NGC 247	0	47.2	−20	46	S	9.5	21 × 8	2.3
NGC 253	0	47.6	−25	17	Sc	7.0	22 × 5	2.3
Small Magellanic Cloud	0	52.6	−72	48	Irr	2.9	216 × 216	0.06
NGC 300	0	54.9	−37	41	Sc	8.7	22 × 16	2.3
NGC 598 = M33	1	33.9	30	39	Sc	6.2	61 × 42	0.7
Fornax	2	39.9	−34	32	dE	9.1	50 × 35	0.2
Large Magellanic Cloud	5	23.6	−69	45	Irr/Sc	0.9	432 × 432	0.05
NGC 2403	7	36.9	65	36	Sc	8.8	22 × 12	2.0
NGC 2903	9	32.1	21	30	Sb	9.5	16 × 7	5.8
NGC 3031 = M81	9	55.6	69	04	Sb	7.8	25 × 12	2.0
NGC 3034 = M82	9	55.9	69	41	Sc	9.2	10 × 1.5	2.0
NGC 4258 = M106	12	19.0	47	18	Sb	8.9	19 × 7	4.3
NGC 4472 = M49	12	29.8	8	00	E4	9.3	10 × 7	11
NGC 4594 = M104	12	40.0	−11	37	Sb	9.2	8 × 5	11
NGC 4736 = M94	12	50.9	41	07	Sb	8.9	13 × 12	4.3
NGC 4826 = M64	12	56.8	21	41		9.3	10 × 4	3.7
NGC 4945	13	05.4	−49	28	Sb	8.0	20 × 4	3.9
NGC 5055 = M63	13	15.8	42	02	Sb	9.3	8 × 3	4.3
NGC 5128 = Cen A	13	25.5	−43	01	E0	7.9	23 × 20	3.9
NGC 5194 = M51	13	29.9	47	12	Sc	8.9	11 × 6	4.3
NGC 5236 = M83	13	37.0	−29	52	Sc	7.0	13 × 12	2.4
NGC 5457 = M101	14	03.2	54	21	Sc	8.2	23 × 21	4.3
NGC 6822	19	45.0	−14	48	Irr	9.2	20 × 10	0.7

Table C.23
Constellations. The first column gives the abbreviation of the Latin name used to form star names

Abbreviation	Latin name	Genitive	English name
And	Andromeda	Andromedae	Andromeda
Ant	Antlia	Antliae	Air Pump
Aps	Apus	Apodis	Bird of Paradise
Aql	Aquila	Aquilae	Eagle
Aqr	Aquarius	Aquarii	Water-bearer
Ara	Ara	Arae	Altar
Ari	Aries	Arietis	Ram
Aur	Auriga	Aurigae	Charioteer
Boo	Boötes	Boötis	Herdsman
Cae	Caelum	Caeli	Chisel
Cam	Camelopardalis	Camelopardalis	Giraffe
Cnc	Cancer	Cancri	Crab
CMa	Canis Major	Canis Majoris	Great Dog
CMi	Canis Minor	Canis Minoris	Little Dog
Cap	Capricornus	Capricorni	Sea-goat
Car	Carina	Carinae	Keel
Cas	Cassiopeia	Cassiopeiae	Cassiopeia
Cen	Centaurus	Centauri	Centaurus
Cep	Cepheus	Cephei	Cepheus
Cet	Cetus	Ceti	Whale
Cha	Chamaeleon	Chamaeleontis	Chameleon
Cir	Circinus	Circini	Compasses
Col	Columba	Columbae	Dove
Com	Coma Berenices	Comae Berenices	Berenice's Hair
CrA	Corona Austrina	Coronae Austrinae	Southern Crown
CrB	Corona Borealis	Coronae Borealis	Northern Crown
Crv	Corvus	Corvi	Crow
Crt	Crater	Crateris	Cup
Cru	Crux	Crucis	Southern Cross
CVn	Canes Venatici	Canum Venaticorum	Hunting Dogs
Cyg	Cygnus	Cygni	Swan
Del	Delphinus	Delphini	Dolphin
Dor	Dorado	Doradus	Swordfish
Dra	Draco	Draconis	Dragon
Equ	Equuleus	Equulei	Little Horse
Eri	Eridanus	Eridani	Eridanus
For	Fornax	Fornacis	Furnace
Gem	Gemini	Geminorum	Twins
Gru	Grus	Gruis	Crane
Her	Hercules	Herculis	Hercules
Hor	Horologium	Horologii	Clock
Hya	Hydra	Hydrae	Water Serpent
Hyi	Hydrus	Hydri	Water Snake
Ind	Indus	Indi	Indian

Table C.23 (Continued)

Abbreviation	Latin name	Genitive	English name
Lac	Lacerta	Lacertae	Lizard
Leo	Leo	Leonis	Lion
Lep	Lepus	Leporis	Hare
Lib	Libra	Librae	Scales
LMi	Leo Minor	Leonis Minoris	Little Lion
Lup	Lupus	Lupi	Wolf
Lyn	Lynx	Lyncis	Lynx
Lyr	Lyra	Lyrae	Lyre
Men	Mensa	Mensae	Table Mountain
Mic	Microscopium	Microscopii	Microscpe
Mon	Monoceros	Monocerotis	Unicorn
Mus	Musca	Muscae	Fly
Nor	Norma	Normae	Square
Per	Perseus	Persei	Perseus
Phe	Phoenix	Phoenicis	Phoenix
Pic	Pictor	Pictoris	Painter
PsA	Piscis Austrinus	Piscis Austrini	Southern Fish
Psc	Pisces	Piscium	Fishes
Pup	Puppis	Puppis	Poop
Pyx	Pyxis	Pyxidis	Compass
Ret	Reticulum	Reticuli	Net
Scl	Sculptor	Sculptoris	Sculptor
Sco	Scorpius	Scorpii	Scorpion
Sct	Scutum	Scuti	Sobieski's Shield
Ser	Serpens	Serpentis	Serpent
Sex	Sextans	Sextantis	Sextant
Sge	Sagitta	Sagittae	Arrow
Sgr	Sagittarius	Sagittarii	Archer
Tau	Taurus	Tauri	Bull
Tel	Telescopium	Telescopii	Telescope
TrA	Triangulum Australe	Trianguli Australis	Southern Triangle
Tri	Triangulum	Trianguli	Triangle
Tuc	Tucana	Tucanae	Toucan
UMa	Ursa Major	Ursae Majoris	Great Bear
UMi	Ursa Minor	Ursae Minoris	Little Bear
Vel	Vela	Velorum	Sails
Vir	Virgo	Virginis	Virgin
Vol	Volans	Volantis	Flying Fish
Vul	Vulpecula	Vulpeculae	Fox
Oct	Octans	Octantis	Octant
Oph	Ophiuchus	Ophiuchi	Serpent-bearer
Ori	Orion	Orionis	Orion
Pav	Pavo	Pavonis	Peacock
Peg	Pegasus	Pegasi	Pegasus

Table C.24 Largest optical telescopes. D = diameter of the mirror

Telescope	Location	Completion year	D [m]
GranTeCan	La Palma	2009	10.4
William M. Keck Telescope I	Mauna Kea, Hawaii	1992	10
William M. Keck Telescope II	Mauna Kea, Hawaii	1996	10
Southern African Large Telescope	Sutherland, South Africa	2005	10
Subaru Telescope	Mauna Kea, Hawaii	1999	8.3
Large Binocular Telescope 1	Mt. Graham, Arizona	2005	8.4
Kueyen Telescope (VLT 2)	Cerro Paranal, Chile	1999	8.2
Melipal Telescope (VLT 3)	Cerro Paranal, Chile	2000	8.2
Yepun Telescope (VLT 4)	Cerro Paranal, Chile	2000	8.2
Gemini North Telescope	Mauna Kea, Hawaii	1999	8.1
Gemini South Telescope	Cerro Pachon, Chile	2000	8.1
Multi-Mirror Telescope	Mt. Hopkins, Arizona	1999	6.5
Walter Baade (Magellan 1 Telescope)	Las Campanas, Chile	2000	6.5
Landon Clay (Magellan 2 Telescope)	Las Campanas, Chile	2002	6.5

Table C.25 Largest parabolic radio telescopes. D = diameter of the antenna, λ_{min} = shortest wavelength

		Completion year	D [m]	λ_{min} [cm]	Remarks
Arecibo	Puerto Rico, USA	1963	305	5	Fixed disk; limited tracking
Green Bank	West Virginia, USA	2001	100×110	0.3	The largest fully steerable telescope
Effelsberg	Bonn, Germany	1973	100	0.8	
Jodrell Bank	Macclesfield, Great Britain	1957	76.2	10–20	First large paraboloid antenna
Jevpatoria	Crimea	1979	70	1.5	
Parkes	Australia	1961	64	2.5	Innermost 17 m of dish can be used down to 3 mm wavelengths
Goldstone	California, USA		64	1.5	Belongs to NASA deep space network
Tidbinbilla	Australia		64	1.3	NASA
Madrid	Spain		64	1.3	NASA

Table C.26 Millimetre and submillimetre telescopes and interferometers. h = altitude above sea level, D = diameter of the antenna, λ_{min} = shortest wavelength

Institute	Location	h [m]	D [m]	λ_{min} [mm]	Remarks; operational since
NRAO, VLA	New Mexico, USA	2124	25	7	27 antennas $d_{max} = 36.6$ km 1976
NRAO, VLBA	USA	16–3720	25	13	10 antennas 1988–1993
Max-Planck-Institut für Radioastronomie & University of Arizona	Mt. Graham, USA	3250	10	0.3	1994
California Institute of Technology	Mauna Kea, Hawaii	4100	10.4	0.3	1986
Science Research Council England & Holland	Mauna Kea, Hawaii	4100	15.0	0.5	The James Clerk Maxwell Telescope 1986
California Institute of Technology	Owens Valley, USA	1220	10.4	0.5	3 antenna interferometer 1980
Sweden-ESO Southern Hemisphere Millimeter Antenna (SEST)	La Silla, Chile	2400	15.0	0.6	1987
Institut de Radioastronomie Millimetrique (IRAM), France & Germany	Plateau de Bure, France	2550	15.0	0.6	3 antenna interferometer 1990; fourth antenna 1993
IRAM	Pico Veleta, Spain	2850	30.0	0.9	1984
National Radio Astronomy Observatory (NRAO)	Kitt Peak, USA	1940	12.0	0.9	1983 (1969)
University of Massachusetts	New Salem, USA	300	13.7	1.9	radom 1978
University of California, Berkeley	Hat Creek Observatory	1040	6.1	2	3 antenna interferometer 1968
Purple Mountain Observatory	Nanjing, China	3000	13.7	2	radom 1987
Daeduk Radio Astronomy Observatory	Söul, South-Korea	300	13.7	2	radom 1987
University of Tokyo	Nobeyama, Japan	1350	45.0	2.6	1982
University of Tokyo	Nobeyama, Japan	1350	10.0	2.6	5 antenna interferometer 1984
Chalmers University of Technology	Onsala, Sweden	10	20.0	2.6	radom 1976

Table C.27 Some important astronomical satellites and space probes 1980–2002

Satellite		Launch date	Target
Solar Max	USA	Feb. 14, 1980	Sun
Venera 13	SU	Oct. 30, 1981	Venus
Venera 14	SU	Nov. 4, 1981	Venus
IRAS	USA	Jan. 25, 1983	infrared
Astron	SU	Mar. 23, 1983	ultraviolet
Venera 15	SU	Jun. 2, 1983	Venus
Venera 16	SU	Jun. 7, 1983	Venus
Exosat	ESA/USA	May 26, 1983	X-ray
Vega 1	SU	Dec. 15 1984	Venus/Halley
Vega 2	SU	Dec. 21, 1984	Venus/Halley
Giotto	ESA	Jul. 2, 1985	Halley
Suisei	Japan	Aug. 18, 1985	Halley
Ginga	Japan	Feb. 5, 1987	X-ray
Magellan	USA	May 4, 1989	Venus
Hipparcos	ESA	Aug. 8, 1989	astrometry
COBE	USA	Nov. 18, 1989	cosmic background radiation
Galileo	USA	Oct. 18, 1989	Jupiter etc.
Granat	SU	Dec. 1, 1989	gamma ray
Hubble	USA/ESA	Apr. 24, 1990	UV, visible
Rosat	Germany	Jun. 1, 1990	X-ray
Gamma	SU	Jul. 11, 1990	gamma ray
Ulysses	ESA	Oct. 6, 1990	Sun
Compton	USA	Apr. 5, 1991	gamma ray
EUVE	USA	Jun. 7, 1992	extreme UV
Asuka	Japan	Feb. 20, 1993	X-ray
Clementine	USA	Jan. 25, 1994	Moon
ISO	ESA	Nov. 17, 1995	infrared
SOHO	ESA	Dec. 2, 1995	Sun
Near-Shoemaker	USA	Feb. 17, 1996	Mathilde, Eros
BeppoSAX	Italy	Apr. 30, 1996	X-ray
Mars Global Surveyor	USA	Nov. 7, 1996	Mars
Cassini/Huygens	USA/ESA	Oct. 15, 1997	Saturn, Titan
Mars Pathfinder/Sojourner	USA	Dec. 4, 1996	Mars
Lunar Prospector	USA	Jan. 6, 1998	Moon
Nozomi	Japan	Jul. 4, 1998	Mars
Deep Space 1	USA	Oct. 24, 1998	Braille, Borrelly
Stardust	USA	Feb. 7, 1999	Wild 2
Chandra	USA	Jul. 23, 1999	X-ray
XMM-Newton	ESA	Dec. 10, 1999	X-ray
Hete 2	USA	Oct. 9, 2000	gamma ray
Mars Odyssey	USA	Apr. 7, 2001	Mars
MAP	USA	Jun. 30, 2001	cosmic background radiation

Table C.27 (Continued)

Satellite		Launch date	Target
Genesis	USA	Aug. 8, 2001	solar particles
RHESSI	USA	Feb. 5, 2002	Sun
Grace	Gemany-USA	Mar. 17, 2002	Earth's gravity
Integral	ESA	Oct. 17, 2002	gamma ray
Galex	USA	Apr. 28, 2003	galaxies
Hayabusa	Japan	May 9, 2003	Itokawa
Mars Express	ESA	Jun. 2, 2003	Mars
Spirit	USA	Jun. 10, 2003	Mars
Opportunity	USA	Jul. 8, 2003	Mars
Spitzer	USA	Jun. 10, 2003	infrared
Smart-1	ESA	Sep. 28, 2003	Moon
Rosetta	ESA	Mar. 2, 2004	Churyumov-Gerasimenko
Gravity Probe B	USA	Apr. 20, 2004	relativity
Messenger	USA	Aug. 3, 2004	Mercury
Swift	USA	Nov. 20, 2004	gamma ray bursts
Deep Impact	USA	Jan. 12, 2005	Tempel 1
Mars Recon Orbiter	USA	Aug. 12, 2005	Mars
Venus Express	ESA	Nov. 9, 2005	Venus
New Horizons	USA	Jan. 19, 2006	Pluto
Akari	Japan	Feb. 22, 2006	infrared