THE OBSERVER'S HANDBOOK 1965

Fifty-seventh Year of Publication
THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

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THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

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J. Low
Ottawa Copy

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EDITOR
RUTH J. NORTHCOTT

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252 COLLEGE STREET, TORONTO 2B, ONTARIO

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THE OBSERVER'S HANDBOOK for 1965 is the 57th issue. The astronomical phenomena month by month are now described in words instead of by the symbols traditionally appearing in all editions since the first one in 1907. Information on the satellites of Saturn has been included, and the order of material has been slightly re-arranged. Two new features of this issue are a table giving the central meridian and terminator longitude of Mercury, prepared by Geoffrey Gaherty, Jr., and a table of the strongest radio sources, prepared by John Galt, Officer-in-charge at the Dominion Radio Astrophysical Observatory, Penticton, B.C.

Cordial thanks are offered to all individuals who assisted in the preparation of this edition, to those whose names appear in the various sections and, in addition to those mentioned above, to David Crampton, Barbara Gaizauskas, Douglas Hube, Ian McLennan, Maude Towne, Isabel Williamson and Dorothy Yane. Special thanks are extended to Margaret W. Mayall, Director of the A.A.V.S.O., for the predictions of Algol and the variable stars and to Gordon E. Taylor and the British Astronomical Association for the prediction of planetary appulses and occultations.

My deep indebtedness to the British Nautical Almanac Office and to the *American Ephemeris* is gratefully acknowledged.

RUTH J. NORTHCOTT

ANNIVERSARIES AND FESTIVALS, 1965

New Year's Day	Fri.	Jan.	1	Pentecost (Whit Sunday)		June	6
Epiphany	Wed.	Jan.	6	Trinity Sunday		June	13
Accession of Queen Elizabeth (1952)	Sat.	Feb.	6	Corpus Christi	Thu.	June	17
Septuagesima Sunday		Feb.	14	St. John Baptist (Mid-summer Day)	Thu.	June	24
Quinquagesima (Shrove Sunday)		Feb.	28	Dominion Day	Thu.	July	1
St. David	Mon.	Mar.	1	Birthday of Queen Mother Elizabeth (1900)	Wed.	Aug.	4
Ash Wednesday		Mar.	3	Labour Day	Mon.	Sept.	6
St. Patrick	Wed.	Mar.	17	Hebrew New Year (Rosh Hashanah)	Mon.	Sept.	27
Palm Sunday		Apr.	11	St. Michael (Michaelmas Day)	Wed.	Sept.	29
Good Friday		Apr.	16	Thanksgiving	Mon.	Oct.	11
Easter Sunday		Apr.	18	All Saints' Day	Mon.	Nov.	1
Birthday of Queen Elizabeth (1926)	Wed.	Apr.	21	Remembrance Day	Thu.	Nov.	11
St. George	Fri.	Apr.	23	First Sunday in Advent		Nov.	28
Rogation Sunday		May	23	St. Andrew	Tue.	Nov.	30
Victoria Day	Mon.	May	24	Christmas Day	Sat.	Dec.	25
Ascension Day	Thu.	May	27				

JULIAN DAY CALENDAR, 1965

J.D. 2,430,000 plus the following:

Jan. 1	8,762	May 1	8,882	Sept. 1	9,005
Feb. 1	8,793	June 1	8,913	Oct. 1	9,035
Mar. 1	8,821	July 1	8,943	Nov. 1	9,066
Apr. 1	8,852	Aug. 1	8,974	Dec. 1	9,096

The Julian Day commences at noon. Thus J.D. 2,438,762.0 = Jan. 1.5 U.T.

SYMBOLS AND ABBREVIATIONS

SUN, MOON AND PLANETS

☉ The Sun	☾ The Moon generally	♃ Jupiter
● New Moon	☿ Mercury	♄ Saturn
○ Full Moon	♀ Venus	♅ Uranus
☽ First Quarter	⊕ Earth	♆ Neptune
☾ Last Quarter	♂ Mars	♇ Pluto

ASPECTS AND ABBREVIATIONS

☌ Conjunction, or having the same Longitude or Right Ascension.
☍ Opposition, or differing 180° in Longitude or Right Ascension.
□ Quadrature, or differing 90° in Longitude or Right Ascension.
☊ Ascending Node; ☋ Descending Node.
α or R.A., Right Ascension; δ or Dec., Declination.
h, m, s, Hours, Minutes, Seconds of Time.
° ′ ″, Degrees, Minutes, Seconds of Arc.

SIGNS OF THE ZODIAC

♈ Aries..... 0°	♌ Leo.....120°	♐ Sagittarius ...240°
♉ Taurus.....30°	♍ Virgo.....150°	♑ Capricornus ..270°
♊ Gemini.....60°	♎ Libra.....180°	♒ Aquarius.....300°
♋ Cancer.....90°	♏ Scorpius.....210°	♓ Pisces.....330°

THE GREEK ALPHABET

A, α Alpha	I, ι Iota	P, ρ Rho
B, β Beta	K, κ Kappa	Σ, σ Sigma
Γ, γ Gamma	Λ, λ Lambda	T, τ Tau
Δ, δ Delta	M, μ Mu	Υ, υ Upsilon
E, ϵ Epsilon	N, ν Nu	Φ, ϕ Phi
Z, ζ Zeta	Ξ, ξ Xi	X, χ Chi
H, η Eta	O, o Omicron	Ψ, ψ Psi
Θ, θ, ϑ Theta	Π, π Pi	Ω, ω Omega

THE CONFIGURATIONS OF JUPITER'S SATELLITES

In the Configurations of Jupiter's Satellites (pages 33, 35, etc.), O represents the disk of the planet, d signifies that the satellite is on the disk, * signifies that the satellite is behind the disk or in the shadow. Configurations are for an inverting telescope.

CALCULATIONS FOR ALGOL

The calculations for the minima of Algol are based on the epoch J.D. 2437965.6985 and period 2.8673285 days as published in *Sky and Telescope*, 1963.

CELESTIAL DISTANCES

Celestial distances given herein are based on the standard value of 8.80″ for the sun's parallax, and the astronomical unit of 92.9 million miles.

THE CONSTELLATIONS

LATIN AND ENGLISH NAMES WITH ABBREVIATIONS

Andromeda, (*Chained Maiden*)	And	Andr
Antlia, *Air Pump*	Ant	Antl
Apus, *Bird of Paradise*	Aps	Apus
Aquarius, *Water-bearer*	Aqr	Aqar
Aquila, *Eagle*	Aql	Aquil
Ara, *Altar*	Ara	Arae
Aries, *Ram*	Ari	Arie
Auriga, (*Charioteer*)	Aur	Auri
Bootes, (*Herdsman*)	Boo	Boot
Caelum, *Chisel*	Cae	Cael
Camelopardalis, *Giraffe*	Cam	Caml
Cancer, *Crab*	Cnc	Canc
Canes Venatici, *Hunting Dogs*	CVn	CVen
Canis Major, *Greater Dog*	CMa	CMaj
Canis Minor, *Lesser Dog*	CMi	CMin
Capricornus, *Sea-goat*	Cap	Capr
Carina, *Keel*	Car	Cari
Cassiopeia, (*Lady in Chair*)	Cas	Cass
Centaurus, *Centaur*	Cen	Cent
Cepheus, (*King*)	Cep	Ceph
Cetus, *Whale*	Cet	Ceti
Chamaeleon, *Chamaeleon*	Cha	Cham
Circinus, *Compasses*	Cir	Circ
Columba, *Dove*	Col	Colm
Coma Berenices, *Berenice's Hair*	Com	Coma
Corona Austrina, *Southern Crown*	CrA	CorA
Corona Borealis, *Northern Crown*	CrB	CorB
Corvus, *Crow*	Crv	Corv
Crater, *Cup*	Crt	Crat
Crux, (*Southern*) *Cross*	Cru	Cruc
Cygnus, *Swan*	Cyg	Cygn
Delphinus, *Dolphin*	Del	Dlph
Dorado, *Swordfish*	Dor	Dora
Draco, *Dragon*	Dra	Drac
Equuleus, *Little Horse*	Equ	Equl
Eridanus, *River Eridanus*	Eri	Erid
Fornax, *Furnace*	For	Forn
Gemini, *Twins*	Gem	Gemi
Grus, *Crane*	Gru	Grus
Hercules, (*Kneeling Giant*)	Her	Herc
Horologium, *Clock*	Hor	Horo
Hydra, *Water-snake*	Hya	Hyda
Hydrus, *Sea-serpent*	Hyi	Hydi
Indus, *Indian*	Ind	Indi
Lacerta, *Lizard*	Lac	Lacr
Leo, *Lion*	Leo	Leon
Leo Minor, *Lesser Lion*	LMi	LMin
Lepus, *Hare*	Lep	Leps
Libra, *Scales*	Lib	Libr
Lupus, *Wolf*	Lup	Lupi
Lynx, *Lynx*	Lyn	Lync
Lyra, *Lyre*	Lyr	Lyra
Mensa, *Table* (*Mountain*)	Men	Mens
Microscopium, *Microscope*	Mic	Micr
Monoceros, *Unicorn*	Mon	Mono
Musca, *Fly*	Mus	Musc
Norma, *Square*	Nor	Norm
Octans, *Octant*	Oct	Octn
Ophiuchus, *Serpent-bearer*	Oph	Ophi
Orion, (*Hunter*)	Ori	Orio
Pavo, *Peacock*	Pav	Pavo
Pegasus, (*Winged Horse*)	Peg	Pegs
Perseus, (*Champion*)	Per	Pers
Phoenix, *Phoenix*	Phe	Phoe
Pictor, *Painter*	Pic	Pict
Pisces, *Fishes*	Psc	Pisc
Piscis Austrinus, *Southern Fish*	PsA	PscA
Puppis, *Poop*	Pup	Pupp
Pyxis, *Compass*	Pyx	Pyxi
Reticulum, *Net*	Ret	Reti
Sagitta, *Arrow*	Sge	Sgte
Sagittarius, *Archer*	Sgr	Sgtr
Scorpius, *Scorpion*	Sco	Scor
Sculptor, *Sculptor*	Scl	Scul
Scutum, *Shield*	Sct	Scut
Serpens, *Serpent*	Ser	Serp
Sextans, *Sextant*	Sex	Sext
Taurus, *Bull*	Tau	Taur
Telescopium, *Telescope*	Tel	Tele
Triangulum, *Triangle*	Tri	Tria
Triangulum Australe, *Southern Triangle*	TrA	TrAu
Tucana, *Toucan*	Tuc	Tucn
Ursa Major, *Greater Bear*	UMa	UMaj
Ursa Minor, *Lesser Bear*	UMi	UMin
Vela, *Sails*	Vel	Velr
Virgo, *Virgin*	Vir	Virg
Volans, *Flying Fish*	Vol	Voln
Vulpecula, *Fox*	Vul	Vulp

The 4-letter abbreviations are intended to be used in cases where a maximum saving of space is not necessary.

MISCELLANEOUS ASTRONOMICAL DATA

Units of Length

1 Angstrom unit	$= 10^{-8}$ cm.	1 micron, μ	$= 10^{-4}$ cm. $= 10^{4}$A.
1 inch	= exactly 2.54 centimetres	1 cm.	= 0.39370... in.
1 yard	= exactly 0.9144 metre	1 m.	$= 10^{2}$ cm. = 1.0936... yd.
1 mile	= exactly 1.609344 kilometres	1 km.	$= 10^{5}$ cm. = 0.62137... mi.

1 astronomical unit $= 1.495\times10^{13}$ cm. $= 1.495\times10^{8}$ km. $= 9.29\times10^{7}$ mi.
1 light-year $= 9.460\times10^{17}$ cm. $= 5.88\times10^{12}$ mi. $= 0.3068$ parsecs
1 parsec $= 3.084\times10^{18}$ cm. $= 1.916\times10^{13}$ mi. $= 3.260$ l.y.
1 megaparsec $= 10^{6}$ parsecs

Units of Time

Sidereal day = $23^h\ 56^m\ 04.09^s$ of mean solar time
Mean solar day = $24^h\ 03^m\ 56.56^s$ of mean sidereal time
Synodic month = $29^d\ 12^h\ 44^m\ 03^s$ Sidereal month = $27^d\ 07^h\ 43^m\ 12^s$
Tropical year (ordinary) = $365^d\ 05^h\ 48^m\ 46^s$
Sidereal year = $365^d\ 06^h\ 09^m\ 10^s$
Eclipse year = $346^d\ 14^h\ 52^m\ 52^s$

The Earth

Equatorial radius, a = 6378.39 km. = 3963.35 mi.; flattening, $c = (a-b)/a = 1/297$
Polar radius, b = 6356.91 km. = 3950.01 mi.
1° of latitude $= 111.137-0.562\cos 2\phi$ km. $= 69.057-0.349\cos 2\phi$ mi. (at lat. ϕ)
1° of longitude $= 111.418\cos\phi-0.094\cos 3\phi$ km. $= 69.232\cos\phi-0.0584\cos 3\phi$ mi.
Mass of earth $= 5.98\times10^{24}$ kgm. $= 13.2\times10^{24}$ lb.
Velocity of escape from ⊕ = 11.2 km./sec. = 6.94 mi./sec.

Earth's Orbital Motion

Solar parallax = 8″.80 (adopted); recent determination = 8″.794 (radar, ♀, 1962)
Constant of aberration = 20″.47 (adopted)
Annual general precession = 50″.26; obliquity of ecliptic = 23° 26′ 40″ (1960)
Orbital velocity = 29.8 km./sec. = 18.5 mi./sec.
Parabolic velocity at ⊕ = 42.3 km./sec. = 26.2 mi./sec.

Solar Motion

Solar apex, R.A. $18^h\ 04^m$, Dec. + 30°; solar velocity = 19.4 km./sec. = 12.1 mi./sec.

The Galactic System

North pole of galactic plane R.A. $12^h\ 49^m$, Dec. + 27.°4 (1950)
Centre of galaxy R.A. $17^h\ 42.4^m$, Dec. − 28° 55′ (1950) (zero pt. for new gal. coord.)
Distance to centre ~ 10,000 parsecs; diameter ~ 30,000 parsecs
Rotational velocity (at sun) ~ 262 km./sec.
Rotational period (at sun) $\sim 2.2\times10^{8}$ years
Mass $\sim 2\times10^{11}$ solar masses

External Galaxies

Red Shift ~ + 100 km./sec./megaparsec ~ 19 miles/sec./million l.y.

Radiation Constants

Velocity of light, c = 299,860 km./sec. = 186,324 mi./sec. (adopted);
recent value, 299,792.50 ± 0.10 km./sec. (Froome, *Nature*, 1958)
Solar constant = 1.93 gram calories/square cm./minute
Light ratio for one magnitude = 2.512 . . . ; log ratio = exactly 0.4
Stefan's constant $= 5.6694\times10^{-5}$ c.g.s. units

Miscellaneous

Constant of gravitation, $G = 6.670\times10^{-8}$ c.g.s. units
Mass of the electron, $m = 9.1083\times10^{-28}$ gm.; mass of the proton $= 1.6724\times10^{-24}$ gm
Planck's constant, $h = 6.625\times10^{-27}$ erg. sec.
Loschmidt's number $= 2.6872\times10^{19}$ molecules/cu. cm. of gas at S.T.P.
Absolute temperature = T° K = T° C + 273° = 5/9 (T° F + 459°)

1 radian = 57°.2958 = 3437′.75 = 206,265″

π = 3.141,592,653.6
No. of square degrees in the sky = 41,253
1 gram = 0.03527 oz.

1965 EPHEMERIS OF THE SUN AND CORRECTION TO SUN-DIAL

Date	Apparent R.A. 0h E.T.	Corr. to Sun-dial 12h E.T.	Apparent Dec. 0h E.T.	Date	Apparent R.A. 0h E.T.	Corr. to Sun-dial 12h E.T.	Apparent Dec. 0h E.T.
	h m s	m s	° ′		h m s	m s	° ′
Jan. 1	18 45 06	+ 3 37	−23 02.3	July 3	6 47 13	+ 4 05	+23 00.0
4	18 58 20	+ 5 00	−22 46.0	6	6 59 35	+ 4 37	+22 44.3
7	19 11 31	+ 6 20	−22 25.6	9	7 11 54	+ 5 05	+22 25.0
10	19 24 36	+ 7 36	−22 01.2	12	7 24 08	+ 5 30	+22 02.2
13	19 37 37	+ 8 46	−21 33.0	15	7 36 19	+ 5 50	+21 36.0
16	19 50 32	+ 9 50	−21 01.0	18	7 48 26	+ 6 06	+21 06.5
19	20 03 20	+10 47	−20 25.4	21	8 00 27	+ 6 17	+20 33.7
22	20 16 02	+11 39	−19 46.3	24	8 12 24	+ 6 23	+19 57.9
25	20 28 37	+12 23	−19 04.0	27	8 24 16	+ 6 25	+19 19.1
28	20 41 06	+13 01	−18.18 4	30	8 36 02	+ 6 20	+18 37.4
31	20 53 27	+13 31	−17 29.9				
				Aug. 2	8 47 43	+ 6 11	+17 52.9
Feb. 3	21 05 41	+13 54	−16 38.6	5	8 59 18	+ 5 55	+17 05.8
6	21 17 47	+14 09	−15 44.7	8	9 10 48	+ 5 35	+16 16.2
9	21 29 46	+14 17	−14 48.4	11	9 22 12	+ 5 08	+15 24.3
12	21 41 38	+14 18	−13 49.8	14	9 33 32	+ 4 37	+14 30.2
15	21 53 23	+14 12	−12 49.3	17	9 44 46	+ 4 01	+13 34.0
18	22 05 01	+14 00	−11 46.8	20	9 55 56	+ 3 20	+12 35.8
21	22 16 33	+13 41	−10 42.7	23	10 07 01	+ 2 36	+11 35.9
24	22 27 59	+13 17	− 9 37.1	26	10 18 03	+ 1 47	+10 34.2
27	22 39 21	+12 48	− 8 30.1	29	10 29 01	+ 0 55	+ 9 31.1
Mar. 2	22 50 37	+12 13	− 7 22.0	Sept. 1	10 39 56	− 0 00	+ 8 26.6
5	23 01 49	+11 35	− 6 13.0	4	10 50 48	− 0 58	+ 7 20.9
8	23 12 56	+10 52	− 5 03.2	7	11 01 38	− 1 59	+ 6 14.1
11	23 24 00	+10 06	− 3 52.8	10	11 12 26	− 3 01	+ 5 06.4
14	23 35 02	+ 9 17	− 2 42.0	13	11 23 12	− 4 04	+ 3 58.0
17	23 46 00	+ 8 26	− 1 31.0	16	11 33 58	− 5 08	+ 2 48.9
20	23 56 57	+ 7 33	− 0 19.8	19	11 44 43	− 6 12	+ 1 39.3
23	0 07 53	+ 6 38	+ 0 51.2	22	11 55 30	− 7 16	+ 0 29.3
26	0 18 48	+ 5 44	+ 2 02.1	25	12 06 17	− 8 18	− 0 40.8
29	0 29 43	+ 4 49	+ 3 12.5	28	12 17 05	− 9 19	− 1 51.0
Apr. 1	0 40 38	+ 3 55	+ 4 22.4	Oct. 1	12 27 55	−10 18	− 3 01.0
4	0 51 34	+ 3 02	+ 5 31.6	4	12 38 48	−11 14	− 4 10.8
7	1 02 32	+ 2 10	+ 6 40.0	7	12 49 44	−12 08	− 5 20.0
10	1 13 32	+ 1 21	+ 7 47.2	10	13 00 43	−12 58	− 6 28.7
13	1 24 33	+ 0 33	+ 8 53.3	13	13 11 46	−13 43	− 7 36.6
16	1 35 38	− 0 12	+ 9 58.1	16	13 22 54	−14 24	− 8 43.5
19	1 46 46	− 0 53	+11 01.3	19	13 34 07	−15 00	− 9 49.4
22	1 57 57	− 1 31	+12 03.0	22	13 45 26	−15 29	−10 53.9
25	2 09 13	− 2 04	+13 02.8	25	13 56 51	−15 53	−11 57.1
28	2 20 33	− 2 33	+14 00.8	28	14 08 23	−16 10	−12 58.5
				31	14 20 01	−16 20	−13 58.2
May 1	2 31 57	− 2 57	+14 56.7				
4	2 43 27	− 3 16	+15 50.4	Nov. 3	14 31 46	−16 24	−14 55.8
7	2 55 01	− 3 31	+16 41.7	6	14 43 38	−16 20	−15 51.3
10	3 06 40	− 3 40	+17 30.5	9	14 55 38	−16 09	−16 44.3
13	3 18 25	− 3 45	+18 16.6	12	15 07 45	−15 50	−17 34.8
16	3 30 14	− 3 44	+19 00.0	15	15 20 00	−15 24	−18 22.6
19	3 42 09	− 3 39	+19 40.4	18	15 32 23	−14 49	−19 07.5
22	3 54 08	− 3 28	+20 17.9	21	15 44 53	−14 08	−19 49.3
25	4 06 13	− 3 12	+20 52.3	24	15 57 31	−13 18	−20 27.9
28	4 18 22	− 2 52	+21 23.4	27	16 10 15	−12 22	−21 03.1
31	4 30 35	− 2 28	+21 51.3	30	16 23 06	−11 20	−21 34.7
June 3	4 42 52	− 2 00	+22 15.7	Dec. 3	16 36 03	−10 12	−22 02.6
6	4 55 13	− 1 28	+22 36.6	6	16 49 06	− 8 58	−22 26.7
9	5 07 36	− 0 55	+22 53.9	9	17 02 13	− 7 40	−22 46.8
12	5 20 01	− 0 19	+23 07.6	12	17 15 24	− 6 18	−23 02.9
15	5 32 28	+ 0 19	+23 17.6	15	17 28 39	− 4 52	−23 14.9
18	5 44 56	+ 0 57	+23 23.9	18	17 41 56	− 3 24	−23 22.8
21	5 57 25	+ 1 36	+23 26.6	21	17 55 15	− 1 55	−23 26.4
24	6 09 58	+ 2 15	+23 25.5	24	18 08 34	− 0 25	−23 25.8
27	6 22 21	+ 2 53	+23 20.7	27	18 21 54	+ 1 05	−23 21.0
30	6 34 48	+ 3 30	+23 12.2	30	18 35 12	+ 2 33	−23 11.9

PRINCIPAL ELEMENTS OF THE SOLAR SYSTEM

MEAN ORBITAL ELEMENTS (for epoch 1960 Jan. 1.5 E.T.)

Planet	Mean Distance from Sun (a)		Period of Revolution		Eccentricity (e)	Inclination (i)	Long. of Node (☊)	Long. of Perihelion (π)	Mean Long. at Epoch (L)
	A. U.	millions of miles	Sidereal (P)	Synodic					
				days		°	°	°	°
Mercury	0.387	36.0	88.0d.	116	.206	7.0	47.9	76.8	222.6
Venus	0.723	67.2	224.7	584	.007	3.4	76.3	131.0	174.3
Earth	1.000	92.9	365.26	.....	.017	0.0	0 0	102.3	100.2
Mars	1.524	141.5	687.0	780	.093	1.8	49.2	335.3	258.8
Jupiter	5.203	483.4	11.86y.	399	.048	1.3	100.0	13.7	259.8
Saturn	9.539	886.	29.46	378	.056	2.5	113.3	92.3	280.7
Uranus	19.18	1782.	84.01	370	.047	0.8	73.8	170.0	141.3
Neptune	30.06	2792.	164.8	367	.009	1.8	131.3	44.3	216.9
Pluto	39.44	3664.	247.7	367	.250	17.2	109.9	224.2	181.6

PHYSICAL ELEMENTS

Object	Equatorial Diameter miles	Oblateness	Mass ⊕ = 1	Mean Density water = 1	Surface Gravity ⊕ = 1	Rotation Period	Inclination of Equator to Orbit °	Albedo*
☉ Sun	864,000	0	333,000	1.41	27.9	25d–35d†		
‡☾ Moon	2,160	0	0.0123	3.34	0.16	27d 07h 43m	6.7	0.067
☿ Mercury	3,100	0	0.056	5.13	0.36	88d	?	0.056
♀ Venus	7,700	0	0.817	4.97	0.87	225d‡	32	0.76
⊕ Earth	7,927	1/297	1.000	5.52	1.00	23h 56m 04s	23.4	0.36
♂ Mars	4,200	1/192	0.108	3.94	0.38	24 37 23	24.0	0.16
♃ Jupiter	88,700	1/16	318.0	1.33	2.64	9 50 30	3.1	0.73
♄ Saturn	75,100	1/10	95.2	0.69	1.13	10 14	26.7	0.76
♅ Uranus	29,200	1/16	14.6	1.56	1.07	10 49	97.9	0.93
♆ Neptune	27,700	1/50	17.3	2.27	1.41	14 ?	28.8	0.84
♇ Pluto	8,700?	?	0.9?	4?	?	6.39d ?	?	0.14

Source of data is "Explanatory Supplement to the Ephemeris", 1961, except those marked * which are from L. C. Harris in "Planets and Satellites", *The Solar System*, vol. 3, 1961.

†Depending on latitude. For the physical observations of the sun, p. 60, the sidereal period of rotation is 25.38 m.s.d.

‡Mariner II, Dec. 14, 1962.

SATELLITES OF THE SOLAR SYSTEM

Name	Mag. * †	Diam. miles †	Mean Distance from Planet miles	Mean Distance from Planet " *	Revolution Period d	Revolution Period h	Revolution Period m	Orbit Incl. ° ‡	Discovery
SATELLITE OF THE EARTH									
Moon	−12.7	2160	238,900	...	27	07	43	Var.§	
SATELLITES OF MARS									
Phobos	11.6	(10)	5,800	25	0	07	39	1.0	Hall, 1877
Deimos	12.8	(<10)	14,600	62	1	06	18	1.3	Hall, 1877
SATELLITES OF JUPITER									
V	13.0	(100)	112,000	59	0	11	57	0.4	Barnard, 1892
Io	4.8	2020	262,000	138	1	18	28	0	Galileo, 1610
Europa	5.2	1790	417,000	220	3	13	14	0	Galileo, 1610
Ganymede	4.5	3120	665,000	351	7	03	43	0	Galileo, 1610
Callisto	5.5	2770	1,171,000	618	16	16	32	0	Galileo, 1610
VI	13.7	(50)	7,133,000	3765	250	14		27.6	Perrine, 1904
VII	16	(20)	7,295,000	3850	259	16		24.8	Perrine, 1905
X	18.6	(<10)	7,369,000	3888	263	13		29.0	Nicholson, 1938
XII	18.8	(<10)	13,200,000	6958	631	02		147	Nicholson, 1951
XI	18.1	(<10)	14,000,000	7404	692	12		164	Nicholson, 1938
VIII	18.8	(<10)	14,600,000	7715	738	22		145	Melotte, 1908
IX	18.3	(<10)	14,700,000	7779	758			153	Nicholson, 1914
SATELLITES OF SATURN									
Mimas	12.1	300:	116,000	30	0	22	37	1.5	W. Herschel, 1789
Enceladus	11.8	400:	148,000	38	1	08	53	0.0	W. Herschel, 1789
Tethys	10.3	600	183,000	48	1	21	18	1.1	G. Cassini, 1684
Dione	10.4	600:	235,000	61	2	17	41	0.0	G. Cassini, 1684
Rhea	9.8	810	327,000	85	4	12	25	0.4	G. Cassini, 1672
Titan	8.4	2980	759,000	197	15	22	41	0.3	Huygens, 1655
Hyperion	14.2	(100)	920,000	239	21	06	38	0.4	G. Bond, 1848
Iapetus	11.0	(500)	2,213,000	575	79	07	56	14.7	G. Cassini, 1671
Phoebe	(14)	(100)	8,053,000	2096	550	11		150	W. Pickering, 1898
SATELLITES OF URANUS									
Miranda	16.5	(200)	77,000	9	1	09	56	0	Kuiper, 1948
Ariel	14.4	(500)	119,000	14	2	12	29	0	Lassell, 1851
Umbriel	15.3	(300)	166,000	20	4	03	38	0	Lassell, 1851
Titania	14.0	(600)	272,000	33	8	16	56	0	W. Herschel, 1787
Oberon	14.2	(500)	365,000	44	13	11	07	0	W. Herschel, 1787
SATELLITES OF NEPTUNE									
Triton	13.6	2300	220,000	17	5	21	03	160.0	Lassell, 1846
Nereid	18.7	(200)	3,461,000	264	359	10		27.4	Kuiper, 1949

*At mean opposition distance.

†From D. L. Harris in "Planets and Satellites", *The Solar System*, vol. 3, 1961, *except* numbers in brackets which are rough estimates.

‡Inclination of orbit referred to planet's equator; a value greater than 90° indicates retrograde motion.

§Varies 18° to 29°. The eccentricity of the mean orbit of the moon is 0.05490.

Satellites Io, Europa, Ganymede, Callisto are usually denoted I, II, III, IV respectively, in order of distance from the planet.

SOLAR, SIDEREAL AND EPHEMERIS TIME

Any recurring event may be used to measure time. The various times commonly used are defined by the daily passages of the sun or stars caused by the rotation of the earth on its axis. The more uniform revolution of the earth about the sun, causing the return of the seasons, defines ephemeris time.

A sun-dial indicates *apparent solar time*, but this is far from uniform because of the earth's elliptical orbit and the inclination of the ecliptic. If the real sun is replaced by a fictitious mean sun moving uniformly in the equator, we have *mean* (solar) *time*. *Apparent time − mean time = equation of time.* This is the same as *correction to sun-dial* on page 7, with reversed sign.

If instead of the sun we use stars, we have *sidereal time.* The sidereal time is zero when the vernal equinox or first of Aries is on the meridian. As the earth makes one more revolution with respect to the stars than it does with respect to the sun, sidereal time gains on mean time 3^m56^s per day or 2 hours per month. Right Ascension (R.A.) is measured east from the vernal equinox, so that the R.A. of a body on the meridian is equal to the sidereal time.

Sidereal time is equal to mean time plus 12 hours plus the R.A. of the fictitious mean sun, so that by observation of one kind of time we can calculate the other. Sidereal time = Standard time (0h at midnight) − correction for longtitude (p. 12) + 12 h + R. A. sun (p. 7) − correction to sun-dial (p. 7). (Note that it is necessary to obtain R. A. of the sun at the standard time involved.)

The foregoing refers to *local* time, in general different in different places on the earth. The local mean time of Greenwich, now known as *Universal Time* (UT) is used as a common basis for timekeeping. Navigation and surveying tables are generally prepared in terms of UT. When great precision is required, UT 1 and UT 2 are used differing from UT by polar variation and by the combined effects of polar variation and annual fluctuation respectively.

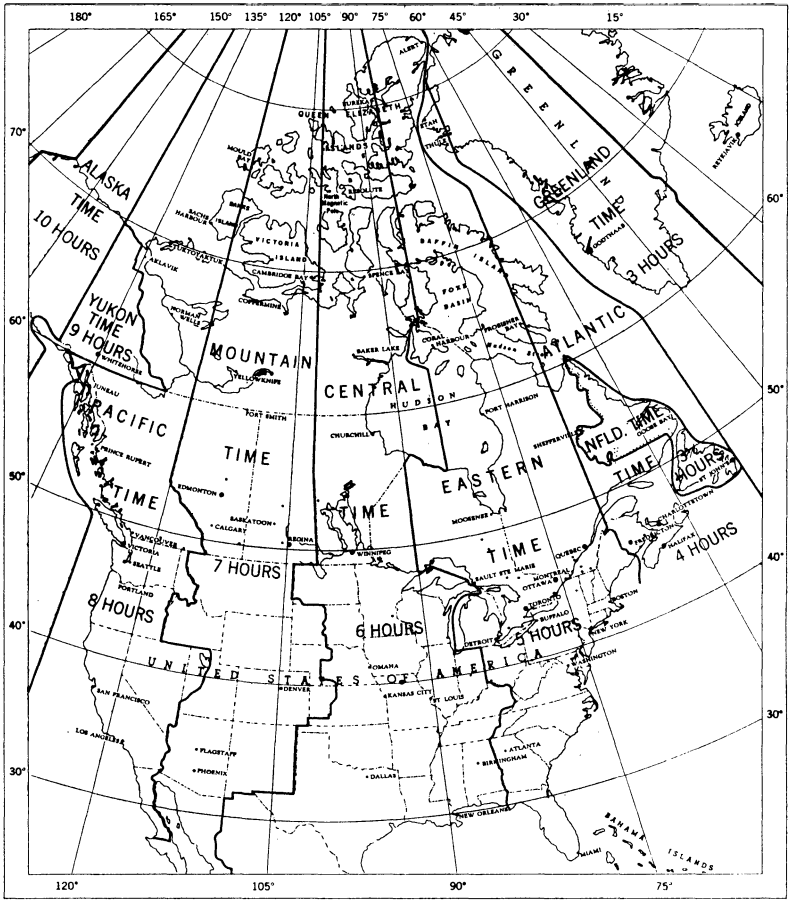
To avoid the inconveniences to travellers of a changing, local time, *standard time* is used. The earth is divided into 24 zones, each ideally 15 degrees wide, the zero zone being centered on the Greenwich meridian. All clocks within the same zone will read the same time.

In Canada and the United States there are 8 standard time zones as follows: Newfoundland (N), 3^h30^m slower than Greenwich; 60th meridian or Atlantic (A), 4 hours; 75th meridian or Eastern (E), 5 hours; 90th meridian or Central (C), 6 hours; 105th meridian or Mountain (M), 7 hours; 120th meridian or Pacific (P), 8 hours; 135th meridian or Yukon (Y), 9 hours; and 150th meridian or Alaska (AL), 10 hours slower than Greenwich.*

Universal time, even after the corrections mentioned have been applied, is still somewhat variable, as shown by atomic clocks or the orbital motion of the moon. *Ephemeris Time* (ET) is used when these irregularities must be avoided. The second, formerly defined as 1/86,400 of the mean solar day, is now defined as 1/31,556,925.9747 of the tropical year for 1900 Jan. 0 at 12 hours E.T. The difference, ΔT, between UT and ET is measured as a small error in the observed longitude of the moon, in the sense ΔT = ET − UT. The moon's position is tabulated in ET, but observed in UT. ΔT was zero near the beginning of the century, but in 1965 will be about 35 seconds.

**Note:* Some Canadian communities near the zone boundaries of south-east Saskatchewan and of eastern Quebec along the St. Lawrence River adopt the time of the adjacent zone.

MAP OF STANDARD TIME ZONES



RADIO TIME SIGNALS

Many national observatories and some standards laboratories transmit time signals. A complete listing of stations emitting time signals may be found in the "List of Radiodetermination and Special Service Stations" prepared by the General Secretariat of the International Telecommunication Union, Geneva. For use in Canada and adjacent areas, the following is a brief list of controlled frequency stations.

CHU Ottawa, Canada—3330, 7335, 14670 kilocycles

WWV Beltsville, Maryland—2.5, 5, 10, 15, 20, 25 megacycles

WWVH Maui, Hawaii—5, 10, 15 megacycles

NBA Balboa, Canal Zone—18 kilocycles.

TIMES OF RISING AND SETTING OF THE SUN AND MOON

The times of sunrise and sunset for places in latitudes ranging from 32° to 54° are given on pages 13 to 18, and of twilight on page 19. The times of moonrise and moonset for the 5 h meridian are given on pages 20 to 25. The times are given in Local Mean Time, and in the table below are given corrections to change from Local Mean Time to Standard Time for the cities and towns named.

The tabulated values are computed for the sea horizon for the rising and setting of the upper limb of the sun and moon, and are corrected for refraction. Because variations from the sea horizon usually exist on land, the tabulated times can rarely be observed.

The sun's declination, apparent diameter and the equation of time do not have precisely the same values on corresponding days from year to year. As the times of sunrise and sunset depend upon these factors, these tables for the solar phenomena can give only average values which may be in error by one or two minutes.

The Standard Times for Any Station

To derive the Standard Time of rising and setting phenomena for the places named, from the list below find the approximate latitude of the place and the correction in minutes which follows the name. Then find in the monthly table the Local Mean Time of the phenomenon for the proper latitude on the desired day. Finally apply the correction to get the Standard Time. The correction is the number of minutes of time that the place is west (plus) or east (minus) of the standard meridian. The corrections for places not listed may be obtained by converting the longitude found from an atlas into time (360° = 24 h).

CANADIAN CITIES AND TOWNS						AMERICAN CITIES		
	Lat.	Corr.		Lat.	Corr.		Lat.	Corr.
Athabaska	55°	+33M	Penticton	49°	−02P	Atlanta	34°	+37E
Baker Lake	64	+24C	Peterborough	44	+13E	Baltimore	39	+06E
Brandon	50	+40C	Port Harrison	59	+13E	Birmingham	33	−13C
Brantford	43	+21E	Port Arthur	48	+57E	Boston	42	−16E
Calgary	51	+36M	Prince Albert	53	+03M	Buffalo	43	+15E
Charlottetown	46	+12A	Prince Rupert	54	+41P	Chicago	42	−10C
Churchill	60	+17C	Quebec	47	−15E	Cincinnati	39	+38E
Cornwall	45	− 1E	Regina	50	−02M	Cleveland	42	+26E
Edmonton	54	+34M	St. Catharines	43	+17E	Dallas	33	+27C
Fort William	48	+57E	St. Hyacinthe	46	−08E	Denver	40	00M
Fredericton	46	+27A	St. John, N.B.	45	+24A	Detroit	42	+32E
Gander	49	+ 8N	St. John's, Nfld.	48	+01N	Fairbanks	65	−10AL
Glace Bay	46	00A	Sarnia	43	+29E	Flagstaff	35	+27M
Goose Bay	53	+ 2A	Saskatoon	52	+07M	Indianapolis	40	−15C
Granby	45	−09E	Sault Ste. Marie	47	+37E	Juneau	58	+58P
Guelph	44	+21E	Shawinigan Falls	47	−09E	Kansas City	39	+18C
Halifax	45	+14A	Sherbrooke	45	−12E	Los Angeles	34	−07P
Hamilton	43	+20E	Stratford	43	+24E	Louisville	38	−17C
Hull	45	+03E	Sudbury	47	+24E	Memphis	35	00C
Kapuskasing	49	+30E	Sydney	46	+01A	Miami	26	+21E
Kingston	44	+06E	The Pas	54	+45C	Milwaukee	43	−09C
Kitchener	43	+22E	Timmins	48	+26E	Minneapolis	45	+13C
London	43	+25E	Toronto	44	+18E	New Orleans	30	00C
Medicine Hat	50	+23M	Three Rivers	46	−10E	New York	41	−04E
Moncton	46	+19A	Trail	49	−09P	Omaha	41	+24C
Montreal	46	−06E	Truro	45	+13A	Philadelphia	40	+01E
Moosonee	51	+23E	Vancouver	49	+12P	Phoenix	33	+28M
Moose Jaw	50	+02M	Victoria	48	+13P	Pittsburgh	40	+20E
Niagara Falls	43	+16E	Whitehorse	61	00Y	St. Louis	39	+01C
North Bay	46	+18E	Windsor	42	+32E	San Francisco	38	+10P
Ottawa	45	+03E	Winnipeg	50	+29C	Seattle	48	+09P
Owen Sound	45	+24E	Yellowknife	62	+38M	Washington	39	+08E

Example—Find the time of sunrise at Owen Sound, on February 12.

In the above list Owen Sound is under "45°", and the correction is + 24 min. On page 13 the time of sunrise on February 12 for latitude 45° is 7.07; add 24 min. and we get 7.31 (Eastern Standard Time).

	DATE	Latitude 32° Sunrise	Latitude 32° Sunset	Latitude 36° Sunrise	Latitude 36° Sunset	Latitude 40° Sunrise	Latitude 40° Sunset	Latitude 44° Sunrise	Latitude 44° Sunset	Latitude 46° Sunrise	Latitude 46° Sunset	Latitude 48° Sunrise	Latitude 48° Sunset	Latitude 50° Sunrise	Latitude 50° Sunset	Latitude 54° Sunrise	Latitude 54° Sunset
		h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
January	1	7 01	5 07	7 11	4 57	7 22	4 45	7 35	4 32	7 42	4 25	7 50	4 17	7 59	4 08	8 19	3 48
	3	7 01	5 08	7 11	4 58	7 23	4 47	7 35	4 34	7 42	4 26	7 50	4 19	7 59	4 10	8 19	3 50
	5	7 01	5 10	7 12	5 00	7 23	4 49	7 35	4 36	7 42	4 29	7 50	4 21	7 58	4 13	8 18	3 53
	7	7 02	5 11	7 11	5 02	7 22	4 50	7 35	4 38	7 42	4 31	7 49	4 23	7 58	4 15	8 18	3 55
	9	7 02	5 13	7 11	5 04	7 22	4 52	7 34	4 40	7 41	4 33	7 49	4 26	7 57	4 18	8 16	3 58
	11	7 02	5 15	7 11	5 06	7 22	4 54	7 34	4 42	7 40	4 36	7 48	4 28	7 56	4 20	8 15	4 01
	13	7 01	5 16	7 11	5 08	7 21	4 56	7 33	4 45	7 39	4 39	7 47	4 31	7 55	4 23	8 14	4 04
	15	7 01	5 18	7 10	5 10	7 20	4 58	7 32	4 48	7 38	4 41	7 45	4 34	7 54	4 26	8 12	4 08
	17	7 01	5 20	7 10	5 12	7 20	5 00	7 30	4 50	7 37	4 44	7 44	4 37	7 52	4 29	8 10	4 11
	19	7 00	5 22	7 09	5 14	7 19	5 02	7 29	4 53	7 35	4 46	7 42	4 39	7 50	4 32	8 07	4 15
	21	6 59	5 24	7 08	5 15	7 18	5 05	7 28	4 55	7 34	4 48	7 40	4 42	7 48	4 35	8 05	4 18
	23	6 59	5 26	7 07	5 17	7 15	5 08	7 26	4 57	7 32	4 51	7 39	4 45	7 46	4 38	8 02	4 22
	25	6 58	5 27	7 06	5 19	7 14	5 10	7 25	5 00	7 31	4 54	7 37	4 48	7 44	4 41	8 00	4 26
	27	6 57	5 29	7 05	5 21	7 12	5 13	7 24	5 02	7 29	4 57	7 35	4 51	7 42	4 45	7 57	4 30
	29	6 56	5 31	7 04	5 23	7 11	5 15	7 22	5 05	7 27	5 00	7 33	4 54	7 39	4 48	7 54	4 34
	31	6 55	5 33	7 02	5 25	7 10	5 17	7 19	5 08	7 24	5 03	7 30	4 57	7 36	4 51	7 50	4 38
February	2	6 53	5 35	7 00	5 27	7 08	5 20	7 17	5 11	7 22	5 06	7 27	5 00	7 33	4 55	7 47	4 42
	4	6 52	5 37	6 59	5 29	7 06	5 22	7 15	5 13	7 20	5 09	7 25	5 04	7 30	4 58	7 44	4 46
	6	6 50	5 38	6 57	5 32	7 04	5 25	7 13	5 16	7 18	5 11	7 22	5 07	7 27	5 02	7 40	4 50
	8	6 49	5 40	6 55	5 34	7 02	5 27	7 10	5 19	7 15	5 14	7 20	5 10	7 24	5 05	7 36	4 54
	10	6 47	5 42	6 53	5 36	7 00	5 29	7 08	5 22	7 13	5 17	7 17	5 13	7 21	5 08	7 32	4 58
	12	6 45	5 44	6 51	5 38	6 59	5 31	7 05	5 24	7 09	5 20	7 14	5 16	7 17	5 12	7 28	5 02
	14	6 44	5 45	6 49	5 40	6 55	5 34	7 03	5 27	7 06	5 23	7 10	5 19	7 14	5 15	7 24	5 06
	16	6 42	5 47	6 47	5 42	6 53	5 36	7 00	5 30	7 02	5 26	7 06	5 23	7 10	5 19	7 20	5 10
	18	6 40	5 49	6 45	5 44	6 50	5 39	6 57	5 33	6 59	5 29	7 03	5 26	7 07	5 22	7 16	5 14
	20	6 38	5 50	6 43	5 46	6 48	5 41	6 54	5 35	6 56	5 32	6 59	5 29	7 03	5 26	7 11	5 18
	22	6 36	5 52	6 40	5 48	6 45	5 43	6 50	5 38	6 53	5 35	6 56	5 32	6 59	5 29	7 07	5 22
	24	6 33	5 54	6 38	5 50	6 42	5 45	6 47	5 40	6 49	5 38	6 52	5 35	6 55	5 32	7 02	5 26
	26	6 31	5 55	6 35	5 52	6 39	5 47	6 44	5 43	6 46	5 41	6 49	5 38	6 51	5 36	6 58	5 30
	28	6 29	5 57	6 33	5 54	6 36	5 49	6 40	5 46	6 43	5 44	6 45	5 41	6 47	5 39	6 53	5 34

	DATE	Latitude 32°		Latitude 36°		Latitude 40°		Latitude 44°		Latitude 46°		Latitude 48°		Latitude 50°		Latitude 54°	
		Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset
		h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
March	2	6 27	5 58	6 30	5 55	6 33	5 52	6 37	5 48	6 39	5 46	6 41	5 44	6 43	5 42	6 48	5 38
	4	6 24	6 00	6 27	5 57	6 30	5 54	6 34	5 51	6 36	5 49	6 37	5 47	6 39	5 46	6 44	5 41
	6	6 22	6 01	6 24	5 59	6 27	5 57	6 30	5 54	6 32	5 52	6 33	5 51	6 35	5 49	6 39	5 45
	8	6 19	6 03	6 22	6 01	6 24	5 59	6 26	5 56	6 28	5 55	6 29	5 54	6 31	5 53	6 34	5 49
	10	6 17	6 04	6 19	6 03	6 21	6 01	6 23	5 59	6 24	5 58	6 25	5 57	6 26	5 56	6 29	5 53
	12	6 14	6 06	6 17	6 04	6 18	6 03	6 19	6 02	6 20	6 01	6 21	6 00	6 22	5 59	6 24	5 57
	14	6 12	6 07	6 14	6 06	6 15	6 05	6 15	6 04	6 16	6 03	6 17	6 03	6 18	6 02	6 20	6 01
	16	6 09	6 09	6 11	6 07	6 12	6 07	6 12	6 07	6 13	6 06	6 13	6 06	6 14	6 05	6 15	6 04
	18	6 07	6 10	6 08	6 10	6 08	6 09	6 08	6 09	6 09	6 09	6 09	6 09	6 10	6 09	6 10	6 08
	20	6 04	6 11	6 06	6 11	6 05	6 11	6 05	6 11	6 05	6 11	6 05	6 12	6 05	6 12	6 05	6 12
	22	6 02	6 13	6 03	6 13	6 02	6 13	6 02	6 14	6 02	6 14	6 01	6 15	6 01	6 15	6 00	6 16
	24	5 59	6 14	6 00	6 15	5 59	6 15	5 58	6 16	5 58	6 16	5 57	6 18	5 57	6 18	5 55	6 19
	26	5 57	6 16	5 57	6 16	5 56	6 17	5 55	6 19	5 54	6 19	5 53	6 20	5 52	6 21	5 50	6 23
	28	5 54	6 17	5 54	6 18	5 52	6 19	5 51	6 21	5 50	6 22	5 49	6 23	5 48	6 24	5 45	6 27
	30	5 51	6 18	5 51	6 19	5 49	6 21	5 48	6 23	5 46	6 24	5 45	6 25	5 43	6 27	5 40	6 31
April	1	5 49	6 20	5 48	6 21	5 46	6 23	5 44	6 25	5 42	6 27	5 41	6 28	5 39	6 30	5 35	6 34
	3	5 46	6 21	5 45	6 22	5 43	6 25	5 40	6 28	5 38	6 29	5 37	6 31	5 35	6 33	5 30	6 38
	5	5 44	6 22	5 42	6 24	5 40	6 27	5 37	6 30	5 35	6 33	5 32	6 34	5 30	6 36	5 25	6 42
	7	5 41	6 24	5 40	6 26	5 36	6 29	5 33	6 33	5 31	6 35	5 28	6 37	5 26	6 40	5 20	6 46
	9	5 39	6 25	5 37	6 28	5 33	6 31	5 29	6 35	5 27	6 38	5 24	6 40	5 21	6 43	5 16	6 49
	11	5 36	6 26	5 34	6 29	5 30	6 33	5 25	6 38	5 23	6 40	5 20	6 43	5 17	6 46	5 11	6 53
	13	5 34	6 28	5 32	6 31	5 27	6 35	5 22	6 40	5 19	6 43	5 16	6 46	5 13	6 49	5 06	6 56
	15	5 32	6 29	5 29	6 32	5 24	6 38	5 19	6 43	5 16	6 46	5 13	6 49	5 09	6 52	5 01	7 00
	17	5 29	6 30	5 26	6 35	5 21	6 40	5 15	6 45	5 12	6 48	5 09	6 52	5 05	6 56	4 57	7 04
	19	5 27	6 32	5 24	6 37	5 18	6 42	5 12	6 48	5 09	6 51	5 05	6 55	5 01	6 59	4 52	7 08
	21	5 25	6 33	5 21	6 38	5 15	6 44	5 09	6 50	5 05	6 54	5 01	6 58	4 57	7 02	4 47	7 11
	23	5 23	6 35	5 18	6 40	5 12	6 46	5 06	6 53	5 02	6 56	4 58	7 01	4 53	7 05	4 43	7 15
	25	5 20	6 36	5 16	6 41	5 09	6 48	5 02	6 55	4 58	6 59	4 54	7 03	4 49	7 08	4 38	7 19
	27	5 18	6 37	5 13	6 43	5 07	6 50	4 59	6 57	4 55	7 01	4 51	7 06	4 45	7 11	4 34	7 23
	29	5 16	6 39	5 11	6 44	5 04	6 52	4 56	7 00	4 52	7 04	4 47	7 08	4 42	7 14	4 30	7 26

	DATE	Latitude 32° Sunrise	Latitude 32° Sunset	Latitude 36° Sunrise	Latitude 36° Sunset	Latitude 40° Sunrise	Latitude 40° Sunset	Latitude 44° Sunrise	Latitude 44° Sunset	Latitude 46° Sunrise	Latitude 46° Sunset	Latitude 48° Sunrise	Latitude 48° Sunset	Latitude 50° Sunrise	Latitude 50° Sunset	Latitude 54° Sunrise	Latitude 54° Sunset
		h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
May	1	5 14	6 40	5 09	6 46	5 02	6 53	4 53	7 02	4 49	7 06	4 44	7 11	4 38	7 17	4 25	7 30
	3	5 13	6 42	5 07	6 48	4 59	6 56	4 50	7 04	4 46	7 09	4 40	7 14	4 34	7 20	4 21	7 34
	5	5 11	6 43	5 05	6 49	4 56	6 58	4 47	7 07	4 43	7 11	4 37	7 17	4 31	7 23	4 17	7 37
	7	5 09	6 46	5 03	6 51	4 54	7 00	4 44	7 09	4 40	7 14	4 34	7 20	4 27	7 26	4 13	7 41
	9	5 07	6 47	5 01	6 52	4 51	7 02	4 42	7 11	4 37	7 16	4 31	7 22	4 24	7 29	4 09	7 44
	11	5 06	6 48	4 59	6 54	4 49	7 04	4 39	7 14	4 34	7 19	4 28	7 25	4 21	7 32	4 06	7 48
	13	5 04	6 49	4 57	6 56	4 47	7 06	4 37	7 16	4 31	7 21	4 25	7 28	4 18	7 35	4 02	7 51
	15	5 03	6 50	4 55	6 57	4 45	7 08	4 35	7 18	4 28	7 24	4 22	7 30	4 15	7 38	3 58	7 55
	17	5 02	6 51	4 53	6 59	4 44	7 10	4 33	7 20	4 26	7 26	4 20	7 33	4 13	7 40	3 55	7 58
	19	5 00	6 53	4 51	7 01	4 42	7 11	4 31	7 22	4 24	7 28	4 17	7 35	4 10	7 43	3 52	8 01
	21	4 59	6 54	4 50	7 03	4 40	7 13	4 29	7 24	4 22	7 31	4 15	7 38	4 07	7 46	3 49	8 05
	23	4 58	6 56	4 49	7 04	4 39	7 15	4 27	7 26	4 20	7 33	4 13	7 40	4 05	7 48	3 46	8 08
	25	4 57	6 57	4 48	7 05	4 37	7 16	4 25	7 28	4 18	7 35	4 11	7 43	4 03	7 51	3 44	8 11
	27	4 56	6 58	4 47	7 07	4 36	7 18	4 24	7 30	4 16	7 37	4 09	7 45	4 01	7 53	3 41	8 14
	29	4 56	6 59	4 46	7 08	4 35	7 20	4 22	7 32	4 15	7 39	4 07	7 47	3 59	7 56	3 39	8 16
June	31	4 55	7 00	4 45	7 10	4 34	7 21	4 21	7 34	4 14	7 41	4 06	7 49	3 57	7 58	3 36	8 19
	2	4 54	7 02	4 45	7 11	4 33	7 23	4 20	7 35	4 13	7 43	4 05	7 51	3 56	8 00	3 34	8 21
	4	4 54	7 03	4 44	7 12	4 33	7 24	4 19	7 37	4 12	7 44	4 04	7 53	3 55	8 02	3 33	8 24
	6	4 54	7 04	4 44	7 13	4 32	7 25	4 18	7 38	4 11	7 46	4 03	7 54	3 53	8 04	3 31	8 26
	8	4 53	7 05	4 43	7 14	4 31	7 26	4 17	7 40	4 10	7 47	4 02	7 56	3 52	8 05	3 30	8 28
	10	4 53	7 05	4 43	7 15	4 31	7 27	4 17	7 41	4 09	7 49	4 01	7 57	3 51	8 07	3 29	8 30
	12	4 53	7 06	4 43	7 16	4 31	7 28	4 17	7 42	4 09	7 50	4 01	7 58	3 51	8 08	3 28	8 31
	14	4 53	7 07	4 43	7 17	4 31	7 29	4 17	7 43	4 08	7 51	4 00	7 59	3 50	8 09	3 27	8 33
	16	4 54	7 08	4 43	7 18	4 31	7 30	4 17	7 44	4 08	7 52	4 00	8 00	3 50	8 10	3 27	8 34
	18	4 54	7 09	4 43	7 19	4 31	7 31	4 17	7 45	4 08	7 53	4 00	8 01	3 50	8 11	3 27	8 35
	20	4 54	7 09	4 43	7 19	4 31	7 31	4 17	7 45	4 08	7 54	4 00	8 02	3 50	8 12	3 27	8 36
	22	4 54	7 09	4 44	7 20	4 31	7 32	4 17	7 46	4 08	7 55	4 01	8 03	3 50	8 12	3 27	8 36
	24	4 55	7 10	4 44	7 20	4 32	7 32	4 18	7 46	4 09	7 55	4 01	8 03	3 51	8 13	3 28	8 36
	26	4 56	7 10	4 44	7 21	4 32	7 33	4 18	7 47	4 10	7 55	4 02	8 03	3 52	8 13	3 28	8 36
	28	4 56	7 10	4 45	7 21	4 33	7 33	4 19	7 47	4 11	7 55	4 03	8 03	3 53	8 13	3 29	8 36
	30	4 57	7 10	4 46	7 21	4 34	7 33	4 20	7 47	4 12	7 55	4 04	8 03	3 54	8 13	3 31	8 36

	DATE	Latitude 32° Sunrise	Latitude 32° Sunset	Latitude 36° Sunrise	Latitude 36° Sunset	Latitude 40° Sunrise	Latitude 40° Sunset	Latitude 44° Sunrise	Latitude 44° Sunset	Latitude 46° Sunrise	Latitude 46° Sunset	Latitude 48° Sunrise	Latitude 48° Sunset	Latitude 50° Sunrise	Latitude 50° Sunset	Latitude 54° Sunrise	Latitude 54° Sunset
		h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
July	2	4 58	7 10	4 47	7 20	4 35	7 33	4 21	7 47	4 13	7 54	4 05	8 03	3 55	8 13	3 32	8 35
	4	4 59	7 10	4 48	7 20	4 36	7 33	4 22	7 46	4 14	7 54	4 06	8 02	3 56	8 12	3 34	8 34
	6	5 00	7 10	4 49	7 19	4 37	7 32	4 23	7 46	4 15	7 53	4 07	8 01	3 58	8 11	3 36	8 33
	8	5 01	7 09	4 50	7 19	4 38	7 31	4 25	7 45	4 17	7 52	4 09	8 00	3 59	8 10	3 38	8 32
	10	5 02	7 09	4 51	7 18	4 39	7 30	4 26	7 44	4 18	7 51	4 10	7 59	4 01	8 08	3 40	8 30
	12	5 03	7 08	4 52	7 18	4 41	7 30	4 28	7 43	4 20	7 50	4 12	7 58	4 03	8 07	3 42	8 28
	14	5 04	7 08	4 53	7 18	4 42	7 29	4 29	7 42	4 22	7 49	4 14	7 57	4 05	8 06	3 44	8 26
	16	5 05	7 07	4 55	7 17	4 44	7 28	4 31	7 40	4 24	7 47	4 16	7 56	4 07	8 04	3 47	8 24
	18	5 06	7 06	4 56	7 16	4 45	7 26	4 32	7 39	4 26	7 46	4 18	7 54	4 10	8 02	3 50	8 22
	20	5 07	7 05	4 57	7 15	4 47	7 25	4 34	7 38	4 28	7 44	4 20	7 52	4 12	8 00	3 53	8 19
	22	5 08	7 04	4 59	7 13	4 48	7 23	4 36	7 36	4 30	7 42	4 22	7 50	4 14	7 58	3 56	8 16
	24	5 10	7 03	5 00	7 12	4 50	7 22	4 38	7 34	4 32	7 40	4 25	7 48	4 17	7 55	3 59	8 13
	26	5 11	7 01	5 02	7 11	4 52	7 20	4 40	7 32	4 34	7 38	4 27	7 45	4 19	7 53	4 02	8 10
	28	5 12	7 00	5 03	7 09	4 53	7 18	4 42	7 30	4 37	7 36	4 30	7 43	4 22	7 50	4 05	8 07
	30	5 14	6 59	5 05	7 07	4 55	7 17	4 44	7 27	4 39	7 33	4 32	7 40	4 25	7 47	4 08	8 03
August	1	5 15	6 57	5 06	7 05	4 57	7 15	4 46	7 25	4 41	7 31	4 35	7 38	4 28	7 44	4 12	8 00
	3	5 16	6 56	5 08	7 04	4 59	7 12	4 48	7 22	4 43	7 28	4 37	7 35	4 31	7 41	4 15	7 56
	5	5 18	6 54	5 09	7 02	5 01	7 11	4 50	7 20	4 45	7 26	4 40	7 31	4 33	7 37	4 18	7 52
	7	5 19	6 52	5 11	7 00	5 02	7 08	4 53	7 17	4 48	7 23	4 42	7 28	4 36	7 34	4 22	7 48
	9	5 20	6 50	5 12	6 58	5 04	7 06	4 55	7 15	4 50	7 20	4 45	7 25	4 39	7 31	4 25	7 44
	11	5 22	6 48	5 14	6 56	5 06	7 03	4 58	7 12	4 53	7 17	4 48	7 22	4 42	7 27	4 29	7 40
	13	5 23	6 46	5 15	6 53	5 08	7 01	5 00	7 09	4 55	7 13	4 50	7 18	4 45	7 24	4 32	7 36
	15	5 24	6 44	5 17	6 51	5 10	6 58	5 02	7 06	4 58	7 10	4 53	7 15	4 48	7 20	4 36	7 32
	17	5 26	6 42	5 19	6 49	5 12	6 55	5 05	7 03	5 00	7 07	4 56	7 11	4 51	7 16	4 40	7 28
	19	5 27	6 39	5 20	6 46	5 14	6 52	5 07	6 59	5 03	7 03	4 59	7 07	4 54	7 12	4 43	7 23
	21	5 28	6 38	5 22	6 43	5 16	6 49	5 09	6 56	5 05	7 00	5 01	7 04	4 57	7 08	4 47	7 18
	23	5 29	6 35	5 23	6 41	5 18	6 46	5 11	6 53	5 08	6 56	5 04	7 00	5 00	7 04	4 50	7 14
	25	5 31	6 33	5 25	6 38	5 20	6 43	5 14	6 50	5 11	6 53	5 07	6 57	5 03	7 00	4 54	7 09
	27	5 31	6 32	5 26	6 35	5 22	6 40	5 16	6 47	5 13	6 49	5 09	6 53	5 06	6 56	4 57	7 05
	29	5 33	6 28	5 28	6 33	5 24	6 37	5 18	6 43	5 15	6 45	5 12	6 49	5 09	6 52	5 01	7 00
	31	5 34	6 26	5 30	6 30	5 25	6 34	5 20	6 40	5 18	6 42	5 15	6 45	5 12	6 48	5 04	6 55

	DATE	Latitude 32°		Latitude 36°		Latitude 40°		Latitude 44°		Latitude 46°		Latitude 48°		Latitude 50°		Latitude 54°	
		Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset
		h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
September	2	5 35	6 23	5 31	6 27	5 27	6 31	5 23	6 36	5 20	6 38	5 18	6 41	5 15	6 44	5 08	6 50
	4	5 36	6 22	5 33	6 24	5 29	6 28	5 25	6 32	5 23	6 34	5 20	6 37	5 18	6 40	5 12	6 46
	6	5 38	6 19	5 34	6 22	5 31	6 25	5 27	6 28	5 25	6 31	5 23	6 33	5 21	6 35	5 15	6 41
	8	5 39	6 17	5 36	6 19	5 33	6 22	5 30	6 25	5 28	6 27	5 26	6 29	5 24	6 31	5 19	6 36
	10	5 41	6 13	5 38	6 16	5 35	6 18	5 32	6 21	5 31	6 23	5 29	6 25	5 27	6 27	5 22	6 31
	12	5 42	6 10	5 39	6 13	5 37	6 15	5 34	6 17	5 33	6 19	5 31	6 21	5 30	6 22	5 26	6 26
	14	5 43	6 09	5 41	6 10	5 39	6 12	5 36	6 14	5 35	6 15	5 34	6 16	5 33	6 18	5 30	6 21
	16	5 44	6 05	5 42	6 07	5 41	6 08	5 39	6 10	5 38	6 11	5 37	6 12	5 36	6 13	5 33	6 16
	18	5 46	6 02	5 44	6 04	5 43	6 05	5 41	6 07	5 41	6 07	5 40	6 08	5 39	6 09	5 37	6 11
	20	5 46	6 01	5 46	6 01	5 45	6 02	5 44	6 03	5 44	6 03	5 43	6 04	5 42	6 05	5 40	6 06
	22	5 48	5 57	5 47	5 58	5 47	5 58	5 46	5 59	5 46	5 59	5 45	6 00	5 45	6 00	5 44	6 01
	24	5 49	5 56	5 49	5 55	5 49	5 55	5 48	5 55	5 48	5 55	5 48	5 56	5 48	5 56	5 47	5 56
	26	5 51	5 52	5 51	5 52	5 51	5 52	5 51	5 52	5 51	5 52	5 51	5 51	5 51	5 51	5 51	5 51
	28	5 52	5 49	5 52	5 49	5 52	5 49	5 53	5 48	5 53	5 48	5 54	5 47	5 54	5 47	5 55	5 46
	30	5 54	5 46	5 53	5 46	5 54	5 46	5 55	5 44	5 56	5 44	5 57	5 43	5 57	5 43	5 58	5 41
October	2	5 54	5 44	5 55	5 44	5 56	5 43	5 57	5 41	5 58	5 40	5 59	5 39	6 00	5 38	6 02	5 36
	4	5 56	5 41	5 56	5 41	5 58	5 40	5 59	5 37	6 01	5 36	6 02	5 35	6 03	5 34	6 06	5 31
	6	5 57	5 39	5 58	5 38	6 00	5 36	6 02	5 34	6 03	5 32	6 04	5 31	6 06	5 29	6 09	5 26
	8	5 58	5 36	5 59	5 35	6 02	5 33	6 04	5 30	6 06	5 28	6 07	5 27	6 09	5 25	6 13	5 21
	10	6 00	5 34	6 01	5 32	6 04	5 30	6 07	5 27	6 08	5 25	6 10	5 23	6 12	5 21	6 17	5 17
	12	6 00	5 33	6 03	5 30	6 06	5 27	6 09	5 24	6 11	5 21	6 13	5 19	6 15	5 17	6 20	5 12
	14	6 03	5 29	6 04	5 27	6 08	5 24	6 11	5 20	6 14	5 18	6 16	5 15	6 19	5 13	6 24	5 07
	16	6 04	5 27	6 06	5 25	6 10	5 21	6 14	5 17	6 17	5 14	6 19	5 11	6 22	5 09	6 28	5 02
	18	6 05	5 25	6 08	5 22	6 12	5 18	6 17	5 13	6 19	5 11	6 22	5 08	6 25	5 05	6 32	4 58
	20	6 07	5 22	6 10	5 19	6 15	5 15	6 20	5 10	6 22	5 07	6 25	5 04	6 28	5 01	6 36	4 53
	22	6 09	5 20	6 12	5 17	6 17	5 12	6 22	5 07	6 25	5 04	6 28	5 00	6 31	4 57	6 39	4 49
	24	6 10	5 18	6 14	5 14	6 19	5 09	6 25	5 04	6 28	5 00	6 31	4 57	6 35	4 53	6 43	4 44
	26	6 12	5 16	6 16	5 12	6 21	5 06	6 27	5 01	6 31	4 57	6 35	4 53	6 38	4 49	6 47	4 40
	28	6 13	5 14	6 18	5 09	6 24	5 03	6 30	4 57	6 34	4 53	6 38	4 49	6 42	4 45	6 51	4 36
	30	6 15	5 12	6 20	5 07	6 26	5 00	6 33	4 55	6 37	4 50	6 41	4 46	6 45	4 42	6 55	4 32

	DATE	Latitude 32°		Latitude 36°		Latitude 40°		Latitude 44°		Latitude 46°		Latitude 48°		Latitude 50°		Latitude 54°	
		Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset
		h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
November	1	6 16	5 10	6 22	5 05	6 28	4 58	6 35	4 52	6 39	4 47	6 44	4 43	6 48	4 39	6 59	4 28
	3	6 18	5 09	6 24	5 03	6 31	4 55	6 38	4 49	6 42	4 44	6 47	4 40	6 52	4 35	7 03	4 24
	5	6 20	5 07	6 26	5 01	6 33	4 53	6 41	4 46	6 45	4 41	6 50	4 37	6 55	4 32	7 07	4 20
	7	6 22	5 06	6 27	4 59	6 35	4 51	6 43	4 43	6 48	4 38	6 53	4 34	6 58	4 28	7 11	4 16
	9	6 23	5 04	6 29	4 57	6 37	4 49	6 46	4 41	6 51	4 36	6 56	4 31	7 01	4 25	7 14	4 12
	11	6 25	5 03	6 31	4 56	6 39	4 47	6 48	4 39	6 53	4 33	6 59	4 29	7 04	4 22	7 18	4 09
	13	6 27	5 02	6 33	4 54	6 42	4 45	6 51	4 37	6 56	4 31	7 02	4 26	7 08	4 20	7 22	4 06
	15	6 29	5 01	6 35	4 52	6 44	4 44	6 54	4 35	6 59	4 29	7 05	4 24	7 11	4 17	7 26	4 02
	17	6 30	4 59	6 37	4 51	6 47	4 42	6 57	4 32	7 02	4 27	7 08	4 21	7 15	4 14	7 30	3 59
	19	6 32	4 59	6 39	4 50	6 49	4 41	6 59	4 31	7 04	4 25	7 10	4 19	7 18	4 12	7 34	3 56
	21	6 34	4 58	6 41	4 49	6 51	4 39	7 01	4 29	7 07	4 23	7 13	4 17	7 21	4 10	7 37	3 54
	23	6 36	4 57	6 43	4 48	6 54	4 38	7 04	4 28	7 10	4 21	7 16	4 15	7 24	4 08	7 41	3 51
	25	6 37	4 57	6 45	4 48	6 56	4 37	7 06	4 27	7 12	4 20	7 19	4 14	7 27	4 06	7 44	3 49
	27	6 39	4 56	6 47	4 47	6 58	4 36	7 09	4 25	7 15	4 19	7 22	4 12	7 30	4 04	7 48	3 47
	29	6 41	4 56	6 48	4 47	6 59	4 36	7 11	4 24	7 18	4 18	7 25	4 11	7 33	4 03	7 51	3 45
December	1	6 43	4 55	6 50	4 47	7 01	4 35	7 13	4 23	7 20	4 17	7 27	4 10	7 36	4 02	7 54	3 43
	3	6 44	4 55	6 52	4 46	7 03	4 35	7 15	4 23	7 22	4 16	7 30	4 09	7 38	4 01	7 57	3 41
	5	6 46	4 55	6 54	4 46	7 05	4 35	7 18	4 23	7 25	4 15	7 32	4 08	7 41	4 00	8 00	3 40
	7	6 47	4 56	6 56	4 46	7 07	4 35	7 20	4 22	7 27	4 15	7 35	4 07	7 43	3 59	8 03	3 39
	9	6 49	4 56	6 57	4 46	7 09	4 35	7 22	4 22	7 29	4 15	7 37	4 07	7 45	3 59	8 06	3 38
	11	6 50	4 56	6 59	4 46	7 10	4 35	7 24	4 22	7 31	4 15	7 39	4 07	7 48	3 58	8 08	3 38
	13	6 52	4 57	7 01	4 47	7 12	4 35	7 25	4 22	7 32	4 15	7 40	4 07	7 50	3 58	8 10	3 38
	15	6 53	4 57	7 02	4 47	7 14	4 36	7 27	4 23	7 34	4 16	7 42	4 07	7 51	3 59	8 12	3 38
	17	6 54	4 58	7 04	4 48	7 16	4 36	7 29	4 23	7 36	4 16	7 44	4 08	7 53	3 59	8 14	3 38
	19	6 55	4 59	7 05	4 49	7 17	4 37	7 30	4 24	7 37	4 17	7 45	4 08	7 54	4 00	8 15	3 38
	21	6 56	4 59	7 06	4 50	7 18	4 38	7 31	4 25	7 38	4 18	7 46	4 09	7 55	4 01	8 17	3 39
	23	6 57	5 01	7 07	4 51	7 19	4 39	7 32	4 26	7 39	4 19	7 47	4 10	7 56	4 02	8 18	3 40
	25	6 58	5 02	7 08	4 52	7 20	4 40	7 33	4 27	7 40	4 20	7 48	4 11	7 57	4 03	8 19	3 41
	27	6 59	5 03	7 09	4 53	7 21	4 41	7 34	4 28	7 41	4 21	7 49	4 13	7 58	4 04	8 19	3 43
	29	7 00	5 04	7 09	4 54	7 21	4 42	7 34	4 30	7 41	4 22	7 50	4 14	7 58	4 06	8 20	3 44
	31	7 00	5 06	7 10	4 56	7 22	4 44	7 35	4 31	7 42	4 24	7 50	4 16	7 59	4 07	8 19	3 46

BEGINNING OF MORNING AND ENDING OF EVENING TWILIGHT

	Latitude 35°		Latitude 40°		Latitude 45°		Latitude 50°		Latitude 54°	
	Morn.	Eve.	Morn.	Eve.	Morn.	Eve.	Morn.	Eve.	Morn.	Eve.
Jan. 1	5 38	6 29	5 45	6 22	5 52	6 15	6 00	6 07	6 07	6 00
11	5 39	6 37	5 45	6 31	5 52	6 24	5 59	6 17	6 05	6 12
21	5 38	6 45	5 43	6 40	5 48	6 35	5 54	6 30	5 58	6 25
31	5 34	6 54	5 38	6 50	5 41	6 47	5 45	6 44	5 47	6 41
Feb. 10	5 27	7 03	5 29	7 01	5 31	7 00	5 32	6 59	5 32	6 58
20	5 17	7 12	5 17	7 12	5 18	7 12	5 15	7 14	5 13	7 17
Mar. 2	5 06	7 20	5 04	7 22	5 02	7 26	4 56	7 30	4 51	7 36
12	4 52	7 29	4 48	7 33	4 43	7 39	4 35	7 47	4 26	7 56
22	4 38	7 38	4 31	7 45	4 23	7 54	4 11	8 06	3 59	8 18
Apr. 1	4 23	7 47	4 13	7 57	4 01	8 09	3 46	8 25	3 29	8 42
11	4 07	7 57	3 55	8 09	3 39	8 25	3 19	8 46	2 56	9 10
21	3 51	8 07	3 36	8 23	3 17	8 43	2 50	9 10	2 20	9 42
May 1	3 37	8 19	3 18	8 37	2 54	9 02	2 20	9 37	1 36	10 22
11	3 23	8 30	3 02	8 52	2 33	9 22	1 48	10 08	0 30	11 37
21	3 12	8 41	2 47	9 07	2 13	9 42	1 13	10 44	——	——
31	3 04	8 51	2 36	9 20	1 56	10 01	0 23	11 42	——	——
June 10	2 59	8 59	2 29	9 30	1 43	10 16	——	——	——	——
20	3 02	9 04	2 27	9 35	1 39	10 23	——	——	——	——
30	3 02	9 04	2 31	9 35	1 44	10 22	——	——	——	——
July 10	3 09	9 01	2 39	9 30	1 56	10 13	——	——	——	——
20	3 18	8 54	2 51	9 20	2 14	9 57	1 04	11 04	——	——
30	3 28	8 43	3 05	9 06	2 33	9 38	1 43	10 26	——	——
Aug. 9	3 39	8 30	3 20	8 50	2 52	9 16	2 15	9 53	1 20	10 45
19	3 50	8 16	3 34	8 32	3 12	8 53	2 42	9 23	2 07	9 57
29	4 00	8 00	3 47	8 14	3 29	8 31	3 06	8 53	2 40	9 19
Sept. 8	4 10	7 44	3 59	7 55	3 46	8 08	3 28	8 26	3 08	8 45
18	4 19	7 28	4 11	7 36	4 01	7 46	3 47	8 00	3 33	8 13
28	4 28	7 13	4 22	7 18	4 15	7 25	4 05	7 35	3 55	7 45
Oct. 8	4 35	6 59	4 32	7 02	4 28	7 06	4 22	7 12	4 15	7 19
18	4 43	6 46	4 42	6 47	4 40	6 49	4 37	6 51	4 34	6 55
28	4 51	6 36	4 52	6 34	4 53	6 34	4 53	6 34	4 52	6 35
Nov. 7	5 00	6 27	5 02	6 24	5 05	6 21	5 07	6 19	5 09	6 17
17	5 08	6 21	5 12	6 17	5 17	6 12	5 21	6 07	5 25	6 04
27	5 16	6 18	5 22	6 13	5 28	6 06	5 34	6 00	5 39	5 55
Dec. 7	5 24	6 18	5 31	6 12	5 38	6 04	5 45	5 57	5 51	5 51
17	5 31	6 21	5 38	6 14	5 45	6 06	5 53	5 58	6 01	5 51
27	5 36	6 26	5 43	6 19	5 51	6 11	5 59	6 03	6 06	5 56
Jan. 1	5 38	6 29	5 45	6 22	5 52	6 15	6 00	6 07	6 07	6 00

The above table gives the local mean time of the beginning of morning twilight, and of the ending of evening twilight, for various latitudes. To obtain the corresponding standard time, the method used is the same as for correcting the sunrise and sunset tables, as described on page 12. The entry —— in the above table indicates that at such dates and latitudes, twilight lasts all night. This table, taken from the American Ephemeris, is computed for *astronomical* twilight, i.e. for the time at which the sun is 108° from the zenith (or 18° below the horizon).

TIME OF MOONRISE AND MOONSET, 1965 (Local Mean Time)

DATE		Latitude 35° Moon Rise	Latitude 35° Moon Set	Latitude 40° Moon Rise	Latitude 40° Moon Set	Latitude 45° Moon Rise	Latitude 45° Moon Set	Latitude 50° Moon Rise	Latitude 50° Moon Set	Latitude 54° Moon Rise	Latitude 54° Moon Set
		h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
Jan.											
1		06 09	16 04	06 24	15 48	06 42	15 29	07 05	15 06	07 28	14 42
2	●	07 01	16 52	07 17	16 36	07 36	16 16	08 00	15 52	08 25	15 27
3		07 50	17 43	08 06	17 28	08 25	17 09	08 49	16 47	09 12	16 22
4		08 34	18 39	08 49	18 24	09 06	18 08	09 28	17 48	09 49	17 26
5		09 13	19 36	09 26	19 24	09 41	19 10	10 00	18 53	10 18	18 35
6		09 49	20 34	09 59	20 25	10 11	20 14	10 26	20 00	10 40	19 47
7		10 20	21 32	10 28	21 26	10 37	21 19	10 47	21 10	10 57	21 01
8		10 50	22 32	10 54	22 28	11 00	22 24	11 06	22 20	11 12	22 16
9		11 18	23 32	11 20	23 31	11 22	23 31	11 24	23 31	11 26	23 31
10	◗	11 47	.. ..	11 46	.. ..	11 44	.. ..	11 42	.. ..	11 40	.. ..
11		12 18	00 33	12 13	00 36	12 07	00 40	12 01	00 45	11 55	00 49
12		12 52	01 38	12 43	01 45	12 34	01 52	12 23	02 01	12 12	02 11
13		13 30	02 46	13 20	02 55	13 07	03 07	12 51	03 21	12 35	03 35
14		14 17	03 56	14 04	04 09	13 47	04 25	13 27	04 44	13 07	05 03
15		15 12	05 08	14 57	05 23	14 38	05 41	14 16	06 04	13 51	06 27
16		16 17	06 17	16 01	06 33	15 42	06 52	15 18	07 16	14 54	07 41
17	○	17 28	07 19	17 13	07 34	16 56	07 53	16 34	08 15	16 12	08 38
18		18 41	08 13	18 29	08 26	18 16	08 41	17 58	09 00	17 40	09 18
19		19 54	08 58	19 45	09 08	19 35	09 20	19 22	09 34	19 10	09 48
20		21 03	09 36	20 58	09 43	20 51	09 51	20 44	10 00	20 37	10 09
21		22 08	10 09	22 07	10 13	22 05	10 17	22 02	10 21	22 00	10 26
22		23 12	10 40	23 12	10 40	23 15	10 41	23 17	10 41	23 19	10 41
23		.. ..	11 10	.. ..	11 06	.. ..	11 03	.. ..	10 59	.. ..	10 55
24	◖	00 12	11 39	00 16	11 33	00 22	11 26	00 29	11 17	00 36	11 09
25		01 11	12 10	01 19	12 01	01 28	11 50	01 39	11 38	01 50	11 26
26		02 09	12 42	02 20	12 31	02 32	12 17	02 48	12 02	03 03	11 45
27		03 07	13 20	03 20	13 06	03 36	12 49	03 55	12 30	04 14	12 09
28		04 03	14 01	04 18	13 45	04 36	13 27	04 58	13 05	05 21	12 41
29		04 57	14 47	05 13	14 31	05 32	14 12	05 56	13 47	06 20	13 23
30		05 47	15 38	06 03	15 22	06 22	15 04	06 46	14 39	07 11	14 16
31		06 33	16 33	06 48	16 18	07 06	16 01	07 27	15 39	07 51	15 17
Feb.											
1	●	07 14	17 30	07 27	17 18	07 43	17 02	08 02	16 44	08 21	16 25
2		07 50	18 28	08 01	18 18	08 14	18 07	08 30	17 52	08 45	17 37
3		08 22	19 27	08 31	19 20	08 41	19 12	08 52	19 02	09 04	18 51
4		08 53	20 26	08 58	20 22	09 05	20 17	09 12	20 12	09 19	20 06
5		09 22	21 26	09 24	21 24	09 27	21 23	09 30	21 22	09 34	21 21
6		09 50	22 26	09 49	22 28	09 49	22 30	09 48	22 33	09 47	22 37
7		10 19	23 28	10 15	23 33	10 11	23 40	10 06	23 48	10 01	23 56
8		10 50	.. ..	10 43	.. ..	10 36	.. ..	10 26	.. ..	10 17	.. ..
9	◗	11 26	00 33	11 16	00 42	11 04	00 52	10 50	01 04	10 36	01 17
10		12 08	01 40	11 54	01 52	11 40	02 05	11 21	02 23	11 03	02 41
11		12 57	02 48	12 42	03 04	12 24	03 20	12 02	03 42	11 30	04 03
12		13 56	03 57	13 40	04 13	13 20	04 32	12 56	04 56	12 32	05 20
13		15 02	05 00	14 46	05 16	14 28	05 35	14 04	05 59	13 40	06 23
14		16 13	05 57	16 00	06 12	15 44	06 28	15 24	06 50	15 04	07 10
15	○	17 27	06 46	17 16	06 58	17 04	07 11	16 49	07 28	16 33	07 44
16		18 39	07 28	18 31	07 36	18 23	07 46	18 13	07 58	18 03	08 09
17		19 48	08 04	19 44	08 09	19 40	08 14	19 35	08 21	19 31	08 28
18		20 53	08 36	20 54	08 38	20 54	08 40	20 54	08 42	20 54	08 44
19		21 57	09 07	22 01	09 06	22 04	09 04	22 09	09 01	22 14	08 59
20		22 59	09 37	23 05	09 33	23 13	09 27	23 23	09 20	23 32	09 13
21		23 59	10 08	.. ..	10 00	.. ..	09 50	.. ..	09 40	.. ..	09 29
22		.. ..	10 40	00 09	10 30	00 21	10 17	00 34	10 02	00 48	09 47
23	◖	00 58	11 17	01 11	11 04	01 25	10 48	01 43	10 29	02 02	10 10
24		01 56	11 57	02 10	11 42	02 27	11 24	02 49	11 02	03 11	10 39
25		02 51	12 41	03 07	12 25	03 25	12 06	03 49	11 42	04 14	11 18
26		03 42	13 31	03 59	13 15	04 18	12 55	04 43	12 31	05 07	12 06
27		04 29	14 25	04 45	14 09	05 04	13 51	05 27	13 28	05 50	13 05
28		05 12	15 21	05 26	15 08	05 43	14 51	06 03	14 32	06 24	14 12

DATE	Latitude 35° Moon Rise	Latitude 35° Moon Set	Latitude 40° Moon Rise	Latitude 40° Moon Set	Latitude 45° Moon Rise	Latitude 45° Moon Set	Latitude 50° Moon Rise	Latitude 50° Moon Set	Latitude 54° Moon Rise	Latitude 54° Moon Set
Mar.	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
1	05 50	16 20	06 02	16 09	06 16	15 56	06 33	15 40	06 49	15 23
2	06 24	17 19	06 33	17 11	06 44	17 01	06 57	16 50	07 10	16 38
3 ♍	06 55	18 19	07 01	18 13	07 09	18 08	07 18	18 00	07 26	17 53
4	07 24	19 19	07 27	19 17	07 32	19 15	07 37	19 12	07 41	19 09
5	07 53	20 20	07 53	20 21	07 54	20 22	07 54	20 24	07 54	20 26
6	08 21	21 22	08 19	21 27	08 16	21 32	08 12	21 39	08 08	21 45
7	08 52	22 26	08 46	22 34	08 39	22 43	08 31	22 55	08 23	23 06
8	09 26	23 32	09 17	23 44	09 06	23 56	08 53	.. ..	08 41	.. ..
9	10 05	.. ..	09 53	.. ..	09 39	.. ..	09 21	00 13	09 04	00 29
10 ♎	10 51	00 40	10 36	00 54	10 19	01 10	09 57	01 31	09 36	01 51
11	11 45	01 46	11 29	02 03	11 09	02 21	10 45	02 44	10 21	03 09
12	12 46	02 49	12 30	03 06	12 10	03 26	11 46	03 50	11 21	04 15
13	13 54	03 47	13 38	04 02	13 21	04 21	13 00	04 43	12 37	05 06
14	15 05	04 37	14 52	04 51	14 37	05 06	14 20	05 25	14 03	05 44
15	16 16	05 21	16 05	05 31	15 56	05 42	15 44	05 57	15 31	06 11
16	17 25	05 58	17 20	06 05	17 14	06 13	17 07	06 22	16 59	06 32
17 ♏	18 33	06 32	18 31	06 35	18 29	06 39	18 26	06 43	18 24	06 48
18	19 38	07 03	19 40	07 03	19 42	07 03	19 45	07 03	19 47	07 03
19	20 42	07 33	20 47	07 30	20 53	07 26	21 01	07 21	21 08	07 17
20	21 44	08 05	21 53	07 58	22 02	07 50	22 15	07 40	22 27	07 32
21	22 46	08 37	22 57	08 27	23 11	08 16	23 27	08 02	23 43	07 49
22	23 45	09 12	23 59	08 59	.. ..	08 45	.. ..	08 27	.. ..	08 10
23	.. ..	09 51	.. ..	09 37	00 15	09 19	00 36	08 57	00 56	08 36
24 ♐	00 42	10 34	00 58	10 19	01 17	09 59	01 39	09 35	02 04	09 11
25	01 35	11 23	01 52	11 06	02 11	10 46	02 36	10 21	03 02	09 56
26	02 25	12 14	02 41	11 59	03 00	11 39	03 25	11 16	03 49	10 51
27	03 09	13 10	03 24	12 56	03 41	12 38	04 04	12 17	04 26	11 55
28	03 48	14 08	04 01	13 56	04 16	13 42	04 36	13 23	04 54	13 05
29	04 24	15 07	04 34	14 58	04 46	14 47	05 02	14 33	05 16	14 20
30	04 55	16 07	05 03	16 00	05 12	15 53	05 23	15 44	05 33	15 35
31	05 25	17 08	05 29	17 04	05 36	17 00	05 42	16 56	05 48	16 51
Apr.										
1 ♑	05 54	18 09	05 55	18 09	05 57	18 10	06 00	18 10	06 01	18 09
2	06 23	19 12	06 21	19 15	06 19	19 20	06 17	19 25	06 15	19 29
3	06 54	20 17	06 48	20 24	06 42	20 32	06 35	20 42	06 28	20 52
4	07 27	21 24	07 18	21 34	07 08	21 47	06 57	22 02	06 45	22 17
5	08 05	22 32	07 53	22 46	07 39	23 01	07 23	23 21	07 07	23 41
6	08 48	23 40	08 34	23 56	08 17	.. ..	07 57	.. ..	07 36	.. ..
7	09 39	.. ..	09 24	.. ..	09 04	00 14	08 40	00 38	08 16	01 01
8 ♒	10 38	00 45	10 22	01 02	10 02	01 21	09 37	01 46	09 11	02 11
9	11 43	01 44	11 28	02 00	11 07	02 18	10 46	02 43	10 22	03 07
10	12 52	02 35	12 38	02 49	12 23	03 06	12 03	03 26	11 43	03 46
11	14 01	03 19	13 51	03 30	13 39	03 44	13 24	04 00	13 09	04 16
12	15 10	03 57	15 03	04 05	14 55	04 15	14 45	04 26	14 36	04 37
13	16 17	04 31	16 13	04 36	16 09	04 41	16 04	04 48	16 00	04 54
14	17 21	05 02	17 21	05 03	17 22	05 05	17 22	05 07	17 23	05 09
15 ♓	18 25	05 32	18 29	05 30	18 33	05 28	18 39	05 25	18 44	05 22
16	19 28	06 02	19 35	05 57	19 43	05 51	19 53	05 43	20 03	05 36
17	20 30	06 33	20 41	06 25	20 52	06 15	21 07	06 04	21 22	05 52
18	21 32	07 07	21 45	06 56	22 00	06 42	22 19	06 27	22 38	06 11
19	22 31	07 45	22 46	07 31	23 04	07 14	23 27	06 55	23 50	06 34
20	23 27	08 27	23 43	08 11	.. ..	07 52	.. ..	07 30	.. ..	07 06
21	.. ..	09 13	.. ..	08 56	00 03	08 36	00 27	08 12	00 53	07 46
22	00 18	10 04	00 35	09 47	00 55	09 28	01 19	09 03	01 46	08 37
23 ♈	01 05	10 59	01 20	10 43	01 39	10 25	02 02	10 02	02 27	09 38
24	01 46	11 55	01 59	11 42	02 17	11 26	02 37	11 06	02 57	10 47
25	02 22	12 53	02 33	12 43	02 48	12 30	03 05	12 15	03 21	11 59
26	02 55	13 53	03 04	13 45	03 14	13 36	03 27	13 25	03 39	13 14
27	03 25	14 53	03 31	14 48	03 38	14 42	03 47	14 36	03 55	14 29
28	03 54	15 54	03 57	15 52	04 00	15 51	04 05	15 48	04 08	15 46
29	04 22	16 56	04 22	16 58	04 22	17 01	04 22	17 03	04 21	17 06
30	04 52	18 01	04 49	18 07	04 44	18 13	04 39	18 21	04 34	18 29

DATE	Latitude 35° Moon Rise		Moon Set		Latitude 40° Moon Rise		Moon Set		Latitude 45° Moon Rise		Moon Set		Latitude 50° Moon Rise		Moon Set		Latitude 54° Moon Rise		Moon Set	
	h	m	h	m	h	m	h	m	h	m	h	m	h	m	h	m	h	m	h	m
May																				
1	05	24	19	09	05	17	19	18	05	09	19	28	05	00	19	41	04	50	19	54
2	06	01	20	19	05	50	20	31	05	38	20	45	05	24	21	04	05	10	21	22
3	06	43	21	29	06	30	21	44	06	14	22	02	05	55	22	24	05	35	22	47
4	07	33	22	37	07	17	22	53	06	59	23	13	06	36	23	38	06	12	..	..
5	08	30	23	40	08	14	23	55	07	54	..	..	07	29	..	..	07	03	00	04
6	09	35	..	..	09	19	..	..	08	59	00	15	08	35	00	40	08	10	01	05
7	10	43	00	34	10	29	00	49	10	12	01	07	09	51	01	28	09	30	01	50
8	11	52	01	20	11	41	01	33	11	28	01	47	11	12	02	05	10	55	02	22
9	13	01	01	59	12	53	02	09	12	43	02	19	12	32	02	32	12	21	02	45
10	14	07	02	34	14	02	02	40	13	57	02	46	13	51	02	55	13	44	03	02
11	15	11	03	05	15	10	03	07	15	09	03	10	15	08	03	14	15	06	03	17
12	16	14	03	34	16	16	03	33	16	19	03	33	16	22	03	32	16	25	03	31
13	17	16	04	03	17	22	03	59	17	28	03	55	17	36	03	49	17	44	03	44
14	18	18	04	33	18	27	04	26	18	37	04	17	18	50	04	07	19	03	03	58
15	19	19	05	05	19	31	04	55	19	45	04	43	20	03	04	29	20	21	04	15
16	20	19	05	41	20	34	05	28	20	51	05	13	21	13	04	54	21	34	04	35
17	21	17	06	21	21	33	06	06	21	52	05	48	22	16	05	26	22	42	05	03
18	22	10	07	06	22	27	06	49	22	47	06	30	23	13	06	06	23	39	05	39
19	22	59	07	55	23	16	07	38	23	36	07	18	..	..	06	53	..	..	06	27
20	23	42	08	48	23	58	08	33	..	..	08	13	00	00	07	49	00	25	07	24
21	..	..	09	44	..	..	09	30	00	15	09	13	00	37	08	52	01	00	08	30
22	00	20	10	42	00	34	10	30	00	48	10	15	01	07	09	58	01	25	09	40
23	00	54	11	40	01	05	11	31	01	16	11	20	01	31	11	07	01	45	10	53
24	01	25	12	38	01	32	12	32	01	41	12	25	01	51	12	17	02	01	12	08
25	01	54	13	38	01	58	13	34	02	03	13	31	02	09	13	27	02	15	13	23
26	02	22	14	38	02	22	14	39	02	24	14	40	02	26	14	40	02	28	14	40
27	02	50	15	42	02	48	15	45	02	46	15	50	02	43	15	55	02	40	16	00
28	03	21	16	47	03	15	16	55	03	09	17	04	03	01	17	14	02	54	17	24
29	03	55	17	57	03	46	18	08	03	35	18	20	03	23	18	37	03	11	18	52
30	04	34	19	09	04	22	19	23	04	08	19	39	03	51	20	00	03	34	20	21
31	05	21	20	20	05	07	20	37	04	49	20	56	04	28	21	20	04	06	21	44
June																				
1	06	17	21	28	06	01	21	45	05	41	22	05	05	17	22	29	04	51	22	55
2	07	21	22	27	07	05	22	43	06	45	23	02	06	20	23	24	05	54	23	48
3	08	31	23	18	08	15	23	32	07	58	23	47	07	35	..	..	07	12	..	..
4	09	42	..	..	09	29	..	..	09	15	..	..	08	57	00	06	08	39	00	26
5	10	52	00	01	10	43	00	11	10	33	00	22	10	20	00	37	10	07	00	51
6	12	00	00	37	11	54	00	43	11	47	00	51	11	39	01	01	11	32	01	10
7	13	04	01	08	13	02	01	12	13	00	01	16	12	57	01	21	12	54	01	26
8	14	07	01	38	14	09	01	38	14	10	01	39	14	12	01	39	14	14	01	40
9	15	09	02	07	15	13	02	03	15	18	02	00	15	25	01	56	15	32	01	52
10	16	10	02	35	16	17	02	30	16	27	02	22	16	38	02	14	16	49	02	06
11	17	11	03	07	17	21	02	57	17	34	02	47	17	50	02	34	18	06	02	21
12	18	10	03	41	18	24	03	28	18	40	03	14	19	00	02	58	19	21	02	40
13	19	09	04	19	19	24	04	04	19	43	03	47	20	07	03	26	20	30	03	05
14	20	04	05	01	20	21	04	45	20	41	04	26	21	06	04	02	21	32	03	38
15	20	55	05	49	21	11	05	32	21	31	05	12	21	56	04	47	22	22	04	21
16	21	40	06	40	21	55	06	25	22	14	06	05	22	37	05	40	23	00	05	15
17	22	19	07	36	22	33	07	21	22	49	07	03	23	09	06	41	23	29	06	17
18	22	55	08	33	23	06	08	21	23	18	08	05	23	35	07	46	23	51	07	27
19	23	26	09	30	23	34	09	21	23	44	09	08	23	56	08	53	..	..	08	38
20	23	55	10	28	..	..	10	21	..	..	10	12	..	..	10	01	00	08	09	51
21	..	..	11	26	00	00	11	22	00	05	11	17	00	14	11	11	00	22	11	04
22	00	22	12	25	00	24	12	23	00	27	12	22	00	31	12	21	00	35	12	19
23	00	49	13	25	00	49	13	27	00	48	13	30	00	48	13	33	00	47	13	36
24	01	17	14	28	01	14	14	33	01	10	14	40	01	05	14	48	01	00	14	56
25	01	49	15	34	01	42	15	43	01	34	15	54	01	24	16	07	01	15	16	20
26	02	26	16	44	02	15	16	57	02	03	17	11	01	48	17	30	01	34	17	48
27	03	08	17	56	02	55	18	11	02	39	18	30	02	19	18	52	02	00	19	15
28	04	00	19	07	03	44	19	23	03	26	19	43	03	02	20	08	02	39	20	34
29	05	01	20	12	04	44	20	28	04	24	20	47	03	59	21	12	03	34	21	37
30	06	10	21	08	05	55	21	23	05	35	21	40	05	11	22	01	04	47	22	22

DATE		Latitude 35° Moon Rise	Set	Latitude 40° Moon Rise	Set	Latitude 45° Moon Rise	Set	Latitude 50° Moon Rise	Set	Latitude 54° Moon Rise	Set
July		h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
1		07 23	21 56	07 10	22 07	06 54	22 21	06 34	22 37	06 13	22 53
2		08 37	22 35	08 27	22 44	08 14	22 53	08 00	23 05	07 44	23 16
3		09 48	23 10	09 41	23 15	09 33	23 20	09 23	23 26	09 14	23 33
4		10 56	23 41	10 52	23 42	10 48	23 44	10 44	23 46	10 39	23 47
5	☽	12 00	.. ..	12 00	.. ..	12 01	.. ..	12 01	.. ..	12 02	.. ..
6		13 02	00 10	13 06	00 08	13 10	00 06	13 15	00 03	13 21	00 01
7		14 04	00 39	14 10	00 34	14 19	00 28	14 29	00 21	14 39	00 14
8		15 05	01 09	15 14	01 01	15 26	00 51	15 41	00 40	15 55	00 29
9		16 04	01 41	16 17	01 31	16 32	01 17	16 51	01 02	17 10	00 46
10		17 03	02 18	17 18	02 05	17 36	01 48	17 58	01 29	18 21	01 09
11		17 59	02 59	18 15	02 43	18 34	02 25	18 59	02 02	19 25	01 39
12		18 51	03 45	19 08	03 28	19 28	03 08	19 53	02 43	20 18	02 18
13	♍	19 38	04 35	19 54	04 19	20 12	03 59	20 36	03 34	21 01	03 08
14		20 19	05 30	20 33	05 14	20 50	04 56	21 11	04 32	21 32	04 09
15		20 56	06 26	21 07	06 13	21 22	05 56	21 39	05 36	21 56	05 16
16		21 27	07 24	21 37	07 13	21 48	06 59	22 01	06 43	22 14	06 27
17		21 57	08 21	22 03	08 13	22 11	08 03	22 20	07 51	22 29	07 39
18		22 24	09 19	22 28	09 14	22 32	09 07	22 36	08 59	22 42	08 52
19		22 51	10 16	22 51	10 14	22 52	10 12	22 52	10 08	22 54	10 05
20		23 18	11 15	23 15	11 15	23 13	11 17	23 09	11 18	23 06	11 20
21	☾	23 47	12 15	23 42	12 19	23 35	12 24	23 27	12 30	23 19	12 36
22		.. ..	13 18	.. ..	13 25	.. ..	13 34	23 48	13 45	23 35	13 56
23		00 20	14 23	00 11	14 35	00 00	14 48	.. ..	15 04	23 58	15 20
24		00 58	15 33	00 47	15 47	00 32	16 04	00 15	16 25	.. ..	16 46
25		01 44	16 43	01 30	17 00	01 12	17 19	00 51	17 43	00 29	18 07
26		02 40	17 51	02 23	18 08	02 04	18 28	01 40	18 52	01 15	19 18
27		03 45	18 51	03 28	19 08	03 09	19 26	02 44	19 48	02 18	20 12
28	♎	04 58	19 44	04 42	19 57	04 25	20 13	04 02	20 31	03 40	20 50
29		06 13	20 28	06 00	20 38	05 46	20 49	05 29	21 03	05 12	21 17
30		07 27	21 06	07 19	21 12	07 09	21 19	06 57	21 28	06 45	21 36
31		08 38	21 39	08 34	21 42	08 28	21 45	08 22	21 49	08 15	21 52
Aug.											
1		09 47	22 10	09 45	22 09	09 44	22 09	09 43	22 08	09 42	22 06
2		10 52	22 40	10 54	22 36	10 58	22 31	11 01	22 25	11 05	22 20
3		11 55	23 10	12 01	23 03	12 08	22 54	12 16	22 44	12 25	22 34
4	☽	12 57	23 42	13 06	23 33	13 17	23 20	13 30	23 06	13 44	22 51
5		13 58	.. ..	14 10	.. ..	14 25	23 50	14 42	23 31	15 00	23 12
6		14 57	00 18	15 12	00 05	15 29	.. ..	15 51	.. ..	16 13	23 39
7		15 54	00 58	16 10	00 43	16 30	00 24	16 54	00 02	17 19	.. ..
8		16 47	01 42	17 04	01 26	17 24	01 06	17 50	00 41	18 16	00 15
9		17 35	02 31	17 52	02 14	18 12	01 54	18 36	01 28	19 01	01 03
10		18 19	03 25	18 34	03 09	18 51	02 49	19 13	02 25	19 36	02 01
11		18 56	04 21	19 09	04 06	19 24	03 49	19 43	03 28	20 01	03 07
12	♏	19 30	05 18	19 40	05 06	19 52	04 51	20 06	04 34	20 20	04 17
13		20 00	06 16	20 07	06 07	20 16	05 55	20 26	05 42	20 36	05 29
14		20 28	07 13	20 32	07 07	20 37	07 00	20 43	06 51	20 50	06 42
15		20 54	08 11	20 56	08 08	20 57	08 04	20 59	07 59	21 01	07 55
16		21 21	09 08	21 19	09 09	21 17	09 09	21 15	09 09	21 13	09 09
17		21 49	10 08	21 44	10 11	21 39	10 15	21 32	10 19	21 25	10 24
18		22 19	11 08	22 11	11 15	22 02	11 23	21 51	11 33	21 40	11 42
19	☾	22 54	12 12	22 43	12 21	22 30	12 33	22 14	12 48	21 59	13 02
20		23 36	13 18	23 22	13 31	23 05	13 46	22 45	14 05	22 25	14 25
21		.. ..	14 26	.. ..	14 41	23 50	15 00	23 26	15 22	23 02	15 46
22		00 25	15 32	00 10	15 49	.. ..	16 09	.. ..	16 34	23 55	17 01
23		01 25	16 35	01 08	16 51	00 47	17 11	00 22	17 35	.. ..	18 01
24		02 32	17 30	02 16	17 45	01 57	18 02	01 33	18 23	01 08	18 45
25		03 46	18 18	03 31	18 30	03 **15**	18 43	02 55	19 00	02 35	19 16
26	♐	05 01	18 59	04 50	19 07	04 38	19 16	04 23	19 27	04 09	19 38
27		06 15	19 35	06 08	19 39	06 01	19 44	05 51	19 50	05 42	19 56
28		07 25	20 06	07 23	20 08	07 20	20 09	07 16	20 10	07 12	20 11
29		08 34	20 37	08 35	20 35	08 36	20 32	08 38	20 28	08 40	20 24
30		09 40	21 09	09 45	21 03	09 50	20 55	09 57	20 47	10 03	20 38
31		10 44	21 41	10 53	21 31	11 03	21 21	11 15	21 08	11 26	20 55

DATE		Latitude 35° Moon Rise	Moon Set	Latitude 40° Moon Rise	Moon Set	Latitude 45° Moon Rise	Moon Set	Latitude 50° Moon Rise	Moon Set	Latitude 54° Moon Rise	Moon Set
		h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
Sept.											
1		11 48	22 16	11 59	22 03	12 12	21 49	12 29	21 32	12 45	21 14
2	☽	12 49	22 55	13 03	22 40	13 20	22 22	13 40	22 01	14 01	21 39
3		13 48	23 38	14 04	23 22	14 23	23 02	14 47	22 37	15 11	22 13
4		14 43	.. ..	15 00	.. ..	15 20	23 48	15 46	23 23	16 12	22 56
5		15 33	00 26	15 49	00 09	16 10	.. ..	16 35	.. ..	17 01	23 51
6		16 18	01 17	16 33	01 02	16 51	00 41	17 15	00 17	17 38	.. ..
7		16 57	02 13	17 11	01 58	17 26	01 40	17 46	01 18	18 07	00 54
8		17 32	03 11	17 43	02 58	17 56	02 42	18 12	02 23	18 28	02 04
9		18 03	04 09	18 11	03 59	18 21	03 47	18 33	03 31	18 44	03 17
10	♍	18 31	05 07	18 36	05 00	18 42	04 51	18 50	04 41	18 58	04 31
11		18 58	06 05	19 01	06 01	19 03	05 56	19 06	05 50	19 09	05 44
12		19 25	07 03	19 24	07 02	19 23	07 01	19 21	07 00	19 21	06 59
13		19 52	08 02	19 48	08 04	19 44	08 07	19 38	08 11	19 33	08 14
14		20 22	09 03	20 14	09 09	20 06	09 15	19 56	09 23	19 46	09 31
15		20 55	10 05	20 44	10 14	20 32	10 25	20 17	10 38	20 03	10 51
16		21 33	11 10	21 20	11 22	21 04	11 37	20 45	11 55	20 26	12 13
17		22 19	12 17	22 03	12 31	21 44	12 49	21 21	13 11	20 58	13 34
18	☾	23 13	13 22	22 56	13 38	22 36	13 59	22 10	14 24	21 44	14 50
19		.. ..	14 24	23 59	14 41	23 38	15 02	23 13	15 27	22 47	15 54
20		00 15	15 21	.. ..	15 36	.. ..	15 55	.. ..	16 19	.. ..	16 42
21		01 24	16 10	01 10	16 23	00 51	16 38	00 29	16 57	00 06	17 16
22		02 37	16 52	02 25	17 02	02 11	17 13	01 53	17 27	01 35	17 41
23		03 50	17 29	03 42	17 35	03 32	17 42	03 20	17 51	03 07	17 59
24	●	05 02	18 02	04 57	18 05	04 51	18 08	04 46	18 11	04 39	18 15
25		06 11	18 33	06 11	18 33	06 10	18 32	06 09	18 30	06 08	18 29
26		07 20	19 05	07 23	19 00	07 26	18 55	07 31	18 48	07 35	18 42
27		08 27	19 37	08 33	19 28	08 40	19 19	08 50	19 08	09 00	18 58
28		09 32	20 11	09 42	20 00	09 54	19 46	10 08	19 30	10 23	19 15
29		10 36	20 49	10 49	20 35	11 04	20 18	11 24	19 58	11 43	19 38
30		11 37	21 31	11 53	21 15	12 11	20 56	12 35	20 32	12 58	20 08
Oct.											
1		12 35	22 18	12 51	22 01	13 12	21 40	13 38	21 14	14 04	20 47
2	☽	13 28	23 09	13 45	22 52	14 05	22 32	14 32	22 06	14 58	21 39
3		14 15	.. ..	14 31	23 48	14 51	23 29	15 15	23 05	15 40	22 40
4		14 56	00 04	15 10	.. ..	15 28	.. ..	15 50	.. ..	16 11	23 49
5		15 32	01 01	15 44	00 47	15 59	00 30	16 17	00 10	16 34	.. ..
6		16 04	01 59	16 14	01 48	16 25	01 34	16 38	01 17	16 51	01 01
7		16 34	02 57	16 40	02 49	16 47	02 39	16 57	02 27	17 06	02 15
8		17 01	03 55	17 04	03 50	17 08	03 44	17 13	03 37	17 17	03 29
9		17 28	04 54	17 28	04 52	17 28	04 50	17 28	04 47	17 29	04 44
10	♍	17 55	05 54	17 51	05 54	17 48	05 56	17 45	05 58	17 41	06 00
11		18 23	06 54	18 17	06 59	18 10	07 05	18 02	07 12	17 53	07 18
12		18 55	07 58	18 46	08 05	18 35	08 15	18 22	08 27	18 09	08 38
13		19 33	09 03	19 20	09 15	19 05	09 27	18 47	09 44	18 29	10 01
14		20 15	10 10	20 01	10 24	19 42	10 41	19 21	11 03	18 58	11 24
15		21 07	11 16	20 50	11 33	20 30	11 52	20 04	12 17	19 38	12 43
16		22 07	12 19	21 49	12 36	21 29	12 57	21 02	13 23	20 36	13 50
17	☾	23 13	13 17	22 56	13 33	22 38	13 53	22 13	14 17	21 49	14 42
18		.. ..	14 07	.. ..	14 21	23 53	14 38	23 33	14 59	23 14	15 20
19		00 23	14 50	00 09	15 01	.. ..	15 14	.. ..	15 30	.. ..	15 46
20		01 34	15 27	01 23	15 35	01 11	15 44	00 57	15 55	00 43	16 05
21		02 43	16 00	02 37	16 05	02 30	16 10	02 21	16 15	02 12	16 21
22		03 52	16 31	03 50	16 32	03 47	16 33	03 43	16 34	03 40	16 35
23		05 00	17 01	05 01	16 59	05 03	16 56	05 05	16 52	05 06	16 48
24	●	06 07	17 33	06 12	17 26	06 17	17 19	06 24	17 10	06 31	17 01
25		07 13	18 05	07 21	17 56	07 31	17 45	07 43	17 31	07 56	17 17
26		08 18	18 42	08 30	18 30	08 44	18 14	09 01	17 56	09 19	17 37
27		09 22	19 23	09 36	19 08	09 54	18 49	10 16	18 27	10 38	18 04
28		10 23	20 08	10 39	19 51	10 59	19 31	11 24	19 06	11 50	18 39
29		11 19	20 59	11 36	20 41	11 57	20 20	12 24	19 54	12 51	19 27
30		12 09	21 53	12 26	21 36	12 46	21 16	13 12	20 51	13 39	20 25
31		12 53	22 49	13 09	22 35	13 27	22 16	13 50	21 54	14 14	21 31

DATE		Latitude 35° Moon Rise	Set	Latitude 40° Moon Rise	Set	Latitude 45° Moon Rise	Set	Latitude 50° Moon Rise	Set	Latitude 54° Moon Rise	Set
Nov.		h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
1	☽	13 31	23 47	13 44	23 35	14 00	23 19	14 19	23 01	14 39	22 42
2		14 04	.. ..	14 15	.. ..	14 28	.. ..	14 43	.. ..	14 58	23 55
3		14 34	00 45	14 42	00 35	14 51	00 24	15 03	00 09	15 13	.. ..
4		15 02	01 43	15 07	01 36	15 12	01 29	15 19	01 19	15 25	01 09
5		15 28	02 41	15 30	02 37	15 32	02 34	15 34	02 29	15 36	02 24
6		15 55	03 40	15 54	03 39	15 52	03 39	15 50	03 39	15 48	03 39
7		16 23	04 40	16 19	04 44	16 13	04 48	16 07	04 52	16 00	04 57
8	♍	16 54	05 44	16 46	05 50	16 37	05 58	16 26	06 07	16 15	06 17
9		17 30	06 49	17 19	07 00	17 05	07 12	16 49	07 27	16 33	07 41
10		18 12	07 57	17 57	08 11	17 40	08 27	17 19	08 47	16 58	09 07
11		19 01	09 06	18 44	09 22	18 25	09 41	18 01	10 05	17 35	10 30
12		19 59	10 13	19 42	10 30	19 22	10 51	18 55	11 17	18 28	11 44
13		21 04	11 13	20 48	11 30	20 28	11 50	20 03	12 16	19 37	12 42
14		22 14	12 06	21 59	12 21	21 42	12 39	21 21	13 01	20 59	13 23
15	☾	23 24	12 51	23 13	13 03	22 59	13 18	22 43	13 35	22 27	13 53
16		.. ..	13 29	.. ..	13 38	.. ..	13 49	.. ..	14 01	23 55	14 13
17		00 33	14 02	00 26	14 08	00 17	14 15	00 06	14 22	.. ..	14 29
18		01 41	14 33	01 37	14 35	01 32	14 38	01 27	14 40	01 22	14 43
19		02 47	15 03	02 46	15 01	02 46	15 00	02 46	14 58	02 46	14 56
20		03 52	15 32	03 55	15 27	03 59	15 22	04 04	15 15	04 09	15 08
21		04 57	16 04	05 04	15 55	05 12	15 45	05 22	15 34	05 32	15 22
22	♎	06 02	16 38	06 12	16 26	06 25	16 12	06 40	15 56	06 55	15 40
23		07 06	17 16	07 20	17 02	07 35	16 45	07 55	16 24	08 16	16 03
24		08 09	18 00	08 25	17 44	08 43	17 23	09 08	17 00	09 32	16 34
25		09 07	18 48	09 24	18 31	09 45	18 10	10 12	17 44	10 39	17 17
26		10 01	19 41	10 18	19 24	10 39	19 03	11 05	18 38	11 33	18 10
27		10 48	20 37	11 04	20 22	11 24	20 03	11 48	19 39	12 12	19 14
28		11 28	21 35	11 43	21 22	11 59	21 05	12 21	20 45	12 42	20 24
29		12 03	22 33	12 15	22 22	12 29	22 09	12 46	21 53	13 04	21 37
30		12 34	23 30	12 43	23 23	12 55	23 12	13 07	23 01	13 20	22 50
Dec.											
1	☽	13 02	.. ..	13 09	.. ..	13 16	.. ..	13 24	.. ..	13 33	.. ..
2		13 28	00 27	13 32	00 23	13 36	00 17	13 40	00 10	13 44	00 03
3		13 55	01 25	13 55	01 23	13 55	01 22	13 55	01 19	13 55	01 17
4		14 22	02 24	14 18	02 25	14 15	02 27	14 11	02 29	14 07	02 32
5		14 51	03 25	14 44	03 30	14 37	03 36	14 28	03 43	14 19	03 50
6		15 24	04 29	15 14	04 38	15 02	04 48	14 49	05 00	14 35	05 12
7		16 03	05 37	15 50	05 49	15 35	06 03	15 16	06 21	14 57	06 38
8	♍	16 50	06 47	16 35	07 02	16 15	07 20	15 53	07 42	15 29	08 05
9		17 46	07 57	17 29	08 13	17 08	08 33	16 43	08 59	16 16	09 26
10		18 51	09 02	18 34	09 19	18 13	09 40	17 48	10 06	17 20	10 33
11		20 01	10 00	19 46	10 16	19 27	10 34	19 05	10 59	18 42	11 22
12		21 14	10 49	21 02	11 02	20 47	11 17	20 29	11 37	20 11	11 56
13		22 25	11 30	22 16	11 40	22 06	11 52	21 53	12 06	21 41	12 20
14		23 34	12 06	23 29	12 16	23 23	12 19	23 16	12 28	23 09	12 37
15	☾	.. ..	12 37	.. ..	12 39	.. ..	12 44	.. ..	12 48	.. ..	12 52
16		00 40	13 06	00 38	13 05	00 37	13 05	00 35	13 05	00 33	13 04
17		01 44	13 35	01 46	13 31	01 49	13 27	01 53	13 22	01 56	13 16
18		02 48	14 05	02 54	13 58	03 01	13 49	03 09	13 39	03 17	13 29
19		03 51	14 37	04 01	14 27	04 12	14 15	04 25	14 00	04 38	13 46
20		04 55	15 13	05 08	15 01	05 22	14 44	05 40	14 25	05 58	14 06
21		05 58	15 54	06 12	15 39	06 31	15 21	06 52	14 57	07 16	14 33
22	♎	06 57	16 41	07 14	16 23	07 34	16 03	08 00	15 37	08 26	15 11
23		07 53	17 32	08 10	17 15	08 30	16 54	08 57	16 28	09 25	16 00
24		08 42	18 28	08 59	18 11	09 19	17 52	09 44	17 26	10 10	17 01
25		09 25	19 25	09 40	19 11	09 58	18 53	10 20	18 31	10 43	18 09
26		10 02	20 23	10 15	20 11	10 31	19 56	10 49	19 38	11 08	19 21
27		10 34	21 20	10 45	21 11	10 57	21 00	11 11	20 47	11 25	20 34
28		11 04	22 17	11 11	22 11	11 19	22 03	11 29	21 55	11 40	21 46
29		11 30	23 13	11 35	23 10	11 39	23 06	11 45	23 02	11 51	22 58
30	☽	11 55	.. ..	11 57	.. ..	11 58	.. ..	12 00	.. ..	12 02	.. ..
31		12 21	00 10	12 19	00 10	12 17	00 11	12 14	00 11	12 12	00 11

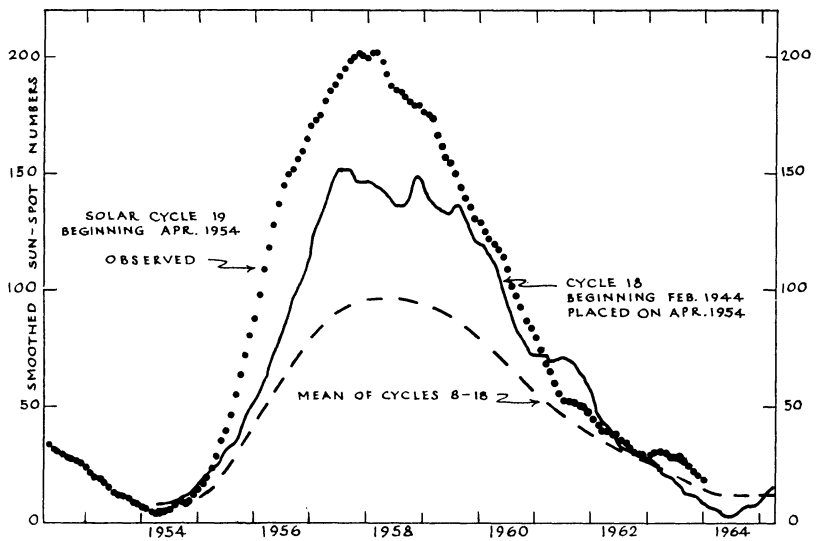
THE SUN AND PLANETS FOR 1965

THE SUN

The diagram represents the sun-spot activity of the current 19th cycle, as far as the final numbers are available. The present cycle began at the minimum in April 1954. For comparison, cycle 18 which began February 1944 (solid curve), and the mean of cycles 8 to 18 (dashed curve), are placed with their minima on April 1954.

The present cycle reached its maximum in January 1958 and since then has been declining slowly.

The observations for sun-spot numbers may be performed by devoted amateur astronomers with small-sized telescopes (suitably protected). Here is a field for amateurs who wish to make a valuable contribution to solar astronomy.



MERCURY

Mercury is exceptional in many ways. It is the planet nearest the sun and travels fastest in its orbit, its speed varying from 23 mi. per sec. at aphelion to 35 mi. per sec. at perihelion. The amount of heat and light from the sun received by it per square mile is, on the average, 6.7 times the amount received by the earth. Its period of rotation on its axis is believed to be the same as its period of revolution about the sun, which is 88 days.

Mercury's orbit is well within that of the earth, and the planet, as seen from

the earth, appears to move quickly from one side of the sun to the other several times in the year. Its quick motion earned for it the name it bears. Its greatest elongation (i.e., its maximum angular distance from the sun) varies between 18° and 28°, and on such occasions it is visible to the naked eye for about two weeks.

When the elongation of Mercury is east of the sun it is an evening star, setting soon after the sun. When the elongation is west, it is a morning star and rises shortly before the sun. Its brightness when it is treated as a star is considerable but it is always viewed in the twilight sky and one must look sharply to see it.

The most suitable times to observe Mercury are at an eastern elongation in the spring and at a western elongation in the autumn. The dates of greatest elongation this year, together with the planet's separation from the sun and its stellar magnitude, are given in the following table:

MAXIMUM ELONGATIONS OF MERCURY DURING 1965

Elong. East—Evening Sky			Elong. West—Morning Sky		
Date	Dist.	Mag.	Date	Dist.	Mag.
Mar. 21	19°	−0.1	Jan. 8	23°	−0.1
July 18	27°	+0.7	May 6	27°	+0.7
Nov. 12	23°	−0.1	Sept. 1	18°	0.0
			Dec. 21	22°	−0.1

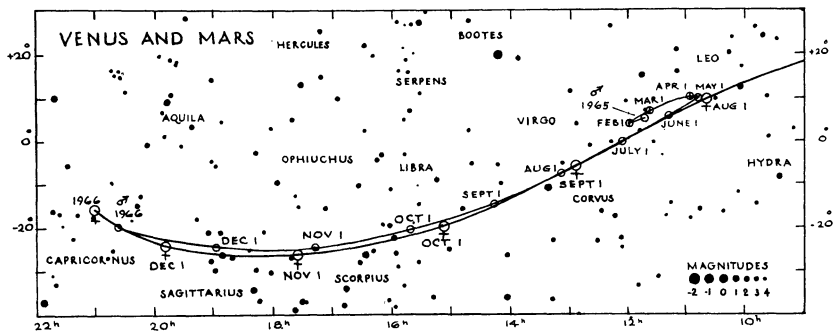
The most favourable elongations to observe are: in the evening, Mar. 21 (not since 1919 has greatest eastern elongation occurred so close to the equinox); in the morning, Sept. 1.

VENUS

Venus is the next planet in order from the sun. In size and mass it is almost a twin of the earth. Venus being within the earth's orbit, its apparent motion is similar to Mercury's but much slower and more stately. The orbit of Venus is almost circular with radius of 67 million miles, and its orbital speed is 22 miles per sec.

On Jan. 1, 1965, Venus is low in the south-eastern sky at dawn, and crosses the meridian almost 2 hours before the sun; its declination is −22° and its stellar magnitude is −3.4. The planet reaches superior conjunction on Apr. 11, and is in the evening sky for the rest of the year. It is at greatest elongation east, 47°, on Nov. 15, when it crosses the meridian about 3 hours after the sun at declination −26°. Greatest brilliancy, −4.4, occurs on Dec. 21. At the end of the year it is low in the south-western sky at sunset. For its positions near elongation, see the map.

Its brilliance is largely due to dense clouds enshrouding the planet. On Dec. 14, 1962, the American spacecraft, Mariner II, passed within 21,700 mi. of Venus, sending back over 90 million bits of information. Among its notable discoveries were: surface temperatures up to 800° F.; an atmosphere 10 to 20 times denser than earth's; no magnetic field or radiation belt; and a rotation period of 225 days (equal to its period of revolution).



MARS

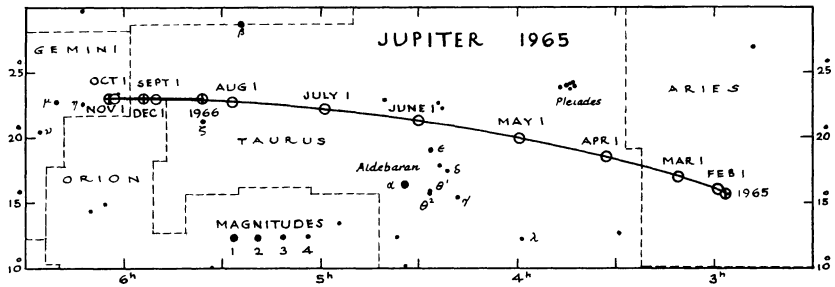
The orbit of Mars is outside that of the earth and consequently its planetary phenomena are quite different from those of the two inferior planets discussed above. Its mean distance from the sun is 141 million miles and the eccentricity of its orbit is 0.093, and a simple computation shows that its distance from the sun ranges between 128 and 154 million miles. Its distance from the earth varies from 35 to 235 million miles and its brightness changes accordingly. When Mars is nearest it is conspicuous in its fiery red, but when farthest away it is no brighter than Polaris. Unlike Venus, its atmosphere is very thin, and features on the solid surface are distinctly visible. Utilizing them its rotation period of 24h. 37m. 22.6689s. has been accurately determined.

The sidereal, or true mechanical, period of revolution of Mars is 687 days; and the synodic period (for example, the interval from one opposition to the next one) is 780 days. This is the average value; it may vary from 764 to 810 days. At the opposition on Sept. 10, 1956, the planet was closer to the earth than it will be for some years. In contrast, the opposition distance on Mar. 9, 1965, is almost a maximum.

On Jan. 1, 1965, Mars is in Virgo, and rises about an hour before midnight; its declination is +5°, and stellar magnitude is +0.5. It retrogrades from Jan. 29 to Apr. 21, with opposition occurring on Mar. 9. It is closest to the earth on Mar. 11, when its magnitude has brightened to −1.0. It is in the evening sky for the rest of the year. On Dec. 31 it is in Capricornus, and is low in the south-western sky at sunset; its stellar magnitude has faded to +1.4.

JUPITER

Jupiter is the giant of the family of the sun. Its mean diameter is 87,000 miles and its mass is 2½ times that of all the rest of the planets combined! Its mean distance is 483 million miles and the revolution period is 11.9 years. This planet is known to possess 12 satellites, the last discovered in 1951 (see p. 9). Bands of clouds may be observed on Jupiter, interrupted by irregular spots which may be short-lived or persist for weeks. The atmosphere contains ammonia and methane at a temperature of about −200°F. Intense radiation belts (like terrestrial Van Allen belts) have been disclosed by observations at radio wave-lengths.

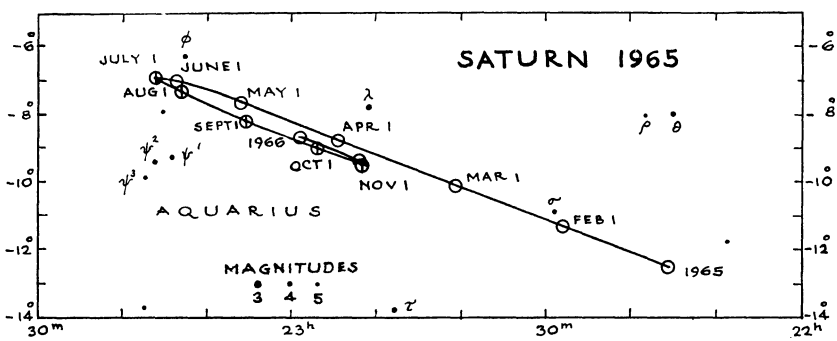


Jupiter is a fine object for the telescope. Many details of the cloud belts as well as the flattening of the planet, due to its short rotation period, are visible, and the phenomena of its satellites provide a continual interest.

On Jan. 1, 1965, Jupiter is retrograding in Aries and is fairly high in the eastern sky at sunset (direct motion resumes on Jan. 10); its stellar magnitude is −2.2. On May 30 it is in conjunction with the sun and moves into the morning sky. Retrograde motion commences on Oct. 19 and continues for the rest of the year. (See map; circles with vertical lines denote retrograde motion). Opposition occurs on Dec. 18 when it is visible all night in Taurus near Gemini; its stellar magnitude is −2.3. On Dec. 31 it is low in the eastern sky at sunset.

SATURN

Saturn was the outermost planet known until modern times. In size it is a good second to Jupiter. In addition to its family of nine satellites, this planet has a unique system of rings, and it is one of the finest of celestial objects in a good telescope. The plane of the rings makes an angle of 27° with the plane of the planet's orbit, and twice during the planet's revolution period of 29½ years the rings appear to open out widest; then they slowly close in until, midway between the maxima, the rings are presented edgewise to the sun or the earth, at which times they are invisible. The rings were edgewise in 1950, and will be again in 1966; the northern face of the rings was at maximum in 1958 and the southern will be in 1973. Thus during 1965 the northern face of the rings is

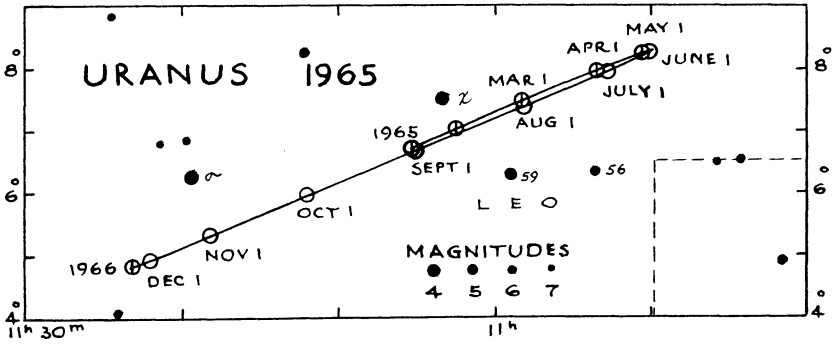


visible, with a tilt fluctuating between 10° and 2½°; the ellipse of the outer edge of the rings has an apparent major axis of about 39″ and a minor axis of about 3″.

During 1965 Saturn is in Aquarius and on Jan. 1 it is just past the meridian at sunset; its stellar magnitude is +1.1. On Feb. 26 it is in conjunction with the sun and moves into the morning sky. It reaches opposition on Sept. 6 when its stellar magnitude has brightened to +0.8 and it is visible all night. It retrogrades from June 29 to Nov. 14 (see map; circles with vertical lines denote retrograde motion). On Dec. 31 it is in the south at sunset; stellar magnitude is +1.3.

URANUS

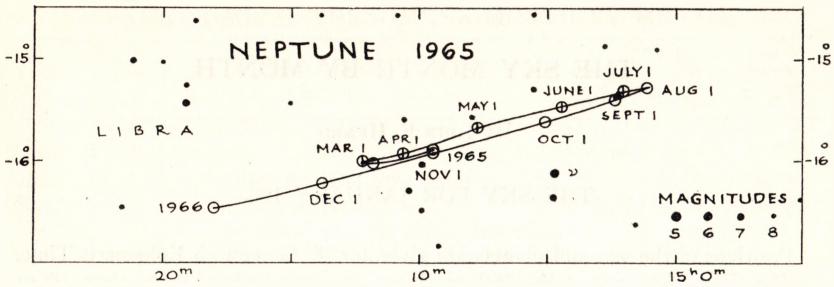
Uranus was discovered in 1781 by Sir William Herschel by means of a 6¼-in. mirror-telescope made by himself. The object did not look just like a star and he observed it again four days later. It had moved amongst the stars, and he assumed it to be a comet. He could not believe that it was a new planet. However, computation later showed that it was a planet nearly twice as far from the sun as Saturn. Its period of revolution is 84 years and it rotates on its axis in about 11 hours. Its five satellites are visible only in a large telescope.



During 1965 Uranus is in Leo (see map). At the beginning of the year it rises before midnight and is retrograding (direct motion resumes on May 18). It is in opposition on Mar. 3 and is above the horizon all night; its apparent diameter is 4.0″; its stellar magnitude is +5.7. When conjunction occurs on Sept. 7 its magnitude has faded to +5.9. It is in the morning sky the rest of the year, retrograde motion commences on Dec. 25. It is overtaken by Venus on Aug. 5, while Mars is close to it during April and May with conjunctions occurring on Apr. 2 and May 6.

NEPTUNE

Neptune was discovered in 1846 after its existence in the sky had been predicted from independent calculations by Leverrier in France and Adams in England. It caused a sensation at the time. Its distance from the sun is 2791



million miles and its period of revolution is 165 years. A satellite was discovered in 1846 soon after the planet. A second satellite was discovered by G. P. Kuiper at the McDonald Observatory on May 1, 1949. Its magnitude is about 19.5, its period about a year, and diameter about 200 miles. It is named Nereid.

During 1965 Neptune is in Libra (see map). It is in opposition on May 9, when it is above the horizon all night. Its stellar magnitude is then +7.7 and during the year fades slightly to +7.8. Thus it is too faint to be seen with the naked eye. In the telescope it shows a greenish tint and an apparent diameter 2.5″ to 2.3″. It is in conjunction with the sun on Nov. 12 and moves into the morning sky for the rest of the year. It retrogrades from Feb. 20 to July 30.

PLUTO

Pluto, the most distant known planet, was discovered at the Lowell Observatory in 1930 as a result of an extended search started two decades earlier by Percival Lowell. The faint star-like image was first detected by Clyde Tombaugh by comparing photographs taken on different dates. Further observations confirmed that the object was a distant planet. Its mean distance from the sun is 3671 million miles and its revolution period is 248 years. It appears as a 15th mag. star in the constellation Leo. It is in opposition to the sun on Mar. 5, at which time its astrometric position is R.A. 11h 28m, Dec. +19° 26′.

THE SKY MONTH BY MONTH

By John F. Heard

THE SKY FOR JANUARY 1965

Positions of the sun and planets are given for 0h Greenwich Ephemeris Time. The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

The Sun—During January the sun's R.A. increases from 18h 45m to 20h 58m and its Decl. changes from 23° 02′ S. to 17° 13′ S. The equation of time changes from −3m 43s to −13m 33s. (These values of the equation of time are for noon E.S.T. on the first and last days of the month in this and in following months.) For changes in the length of the day, see p. 13.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 20.

Mercury on the 15th is in R.A. 18h 10m, Decl. 22° 44′ S., and transits at 10h 34m. Greatest elongation west is on the 8th, and at that time it is a morning star standing in the south-east about 16 degrees above the horizon at sunrise. For about a week before and after this date it will be easily seen.

Venus on the 15th is in R.A. 18h 14m, Decl. 23° 03′ S., mag. −3.3, and transits at 10h 38m. It is a morning star, rising in the south-east between one and two hours before sunrise.

Mars on the 15th is in R.A. 11h 54m, Decl. 4° 09′ N., mag. +0.2, and transits at 4h 15m. In Virgo, it rises about two hours before midnight and is well down in the west at sunrise. Notice that it is brightening rapidly during the first few months of the year. On the 29th it is stationary in right ascension and begins to retrograde.

Jupiter on the 15th is in R.A. 2h 56m, Decl. 15° 44′ N., mag. −2.1, and transits at 19h 14m. In Aries, it is well up in the east at sunset and well down in the west at sunrise. On the 10th it is stationary in right ascension and resumes direct (or eastward) motion among the stars. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 22h 21m, Decl. 12° 00′ S., mag. +1.1, and transits at 14h 40m. In Aquarius, it is well down in the south-west at sunset.

Uranus on the 15th is in R.A. 11h 04m, Decl. 6° 49′ N. and transits at 3h 25m. It rises a few hours after sunset.

Neptune on the 15th is in R.A. 15h 11m, Decl. 15° 58′ S. and transits at 7h 31m. It rises about two hours after midnight.

Pluto—For information in regard to this planet, see p. 31.

JANUARY E.S.T.				Min. of Algol	Config. of Jupiter's Sat. 20h 35m	Sun's Selen. Colong. 0h U.T.
	d	h	m	h m		°
Fri.	1		Mars greatest hel. lat. N.....		3120 4	247.44
Sat.	2		Earth at perihelion.....	2 30	0124*	259.62
			Dist. from ☉, 91,350,000 mi.			
		0	Pallas in conjunction with sun..			
		9	Moon at apogee, 252,600 mi.....			
		16	07 ● New Moon.....			
Sun.	3		Quadrantid meteors.....		1203 4	271.81
Mon.	4			23 20	2013 4	284.00
Tue.	5				1023 4	296.19
Wed.	6	17	Saturn 4° N. of moon.....		d3042	308.37
Thu.	7	2	Mercury 1.2° N. of Venus.....	20 10	3240 1	320.55
Fri.	8	4	Mercury greatest elong. W., 23°		4321 0	332.73
Sat.	9				4301 2	344.90[b]
Sun.	10	15	Jupiter stationary.....	17 00	d4103	357.06
		16	00 ☽ First Quarter.....			
Mon.	11				4201 3	9.22[l]
Tue.	12	12	Jupiter 2° N. of moon.....		4102 3	21.37
Wed.	13			13 50	4301 2	33.52
Thu.	14				3420*	45.65
Fri.	15				3210 4	57.79
Sat.	16	20	Moon at perigee, 221,900 mi....	10 40	3012 4	69.91
Sun.	17	8	38 ○ Full Moon.....		1023 4	82.04
Mon.	18				2013 4	94.16
Tue.	19		Mercury at descending node....	7 30	1034*	106.29
Wed.	20	10	Uranus 5° S. of moon.....		3012 4	118.42
Thu.	21	10	Mars 2° S. of moon.....		3204*	130.55[b]
Fri.	22		Venus at descending node.....	4 10	3210 4	142.69
Sat.	23				3041 2	154.83[l]
Sun.	24	3	Mercury 0.5° S. of Venus.....		4102 3	166.98
		6	07 ☾ Last Quarter.....			
Mon.	25	12	Neptune 1° S. of moon.....	1 00	4201 3	179.14
Tue.	26		.....		4103*	191.31
Wed.	27		.....	21 50	d4012	203.48
Thu.	28		.....		4321 0	215.65
Fri.	29	13	Moon at apogee, 252,400 mi.....		d432 0	227.83
		15	Mars stationary.....			
Sat.	30		Mercury at aphelion.....	18 40	4301 2	240.02
		20	Venus 2° N. of moon.....			
Sun.	31	0	Mercury 2° N. of moon.....		4102 3	252.21

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]Jan. 11, −7.46°; Jan. 23, +7.77°. [b]Jan. 9, +6.77°; Jan. 21, −6.69°.

THE SKY FOR FEBRUARY 1965

Positions of the sun and planets are given for 0h Greenwich Ephemeris Time. The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

The Sun—During February the sun's R.A. increases from 20h 58m to 22h 47m and its Decl. changes from 17° 13′ S. to 7° 45′ S. The equation of time changes from −13m 41s to a maximum of −14m 19s on the 10th and then to −12m 34s at the end of the month. For changes in the length of the day, see p. 13.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 20.

Mercury on the 15th is in R.A. 21h 28m, Decl. 17° 07′ S., and transits at 11h 51m. It is too close to the sun for observation, being in superior conjunction on the 23rd.

Venus on the 15th is in R.A. 20h 59m, Decl. 18° 02′ S., mag. −3.3, and transits at 11h 20m. It is a morning star but too close to the sun for easy observation.

Mars on the 15th is in R.A. 11h 52m, Decl. 5° 09′ N., mag. −0.6, and transits at 2h 11m. In Virgo it rises three hours after sunset and approaches the western horizon at sunrise.

Jupiter on the 15th is in R.A. 3h 04m, Decl. 16° 26′ N., mag. −1.9, and transits at 17h 21m. In Aries, it is about on the meridian at sunset and sets soon after midnight. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 22h 34m, Decl. 10° 42′ S., and transits at 12h 52m. It is too close to the sun for observation, conjunction being on the 26th.

Uranus on the 15th is in R.A. 11h 01m, Decl. 7° 14′ N., and transits at 1h 20m. It rises about at sunset.

Neptune on the 15th is in R.A. 15h 12m, Decl. 16° 03′ S., and transits at 5h 31m. It rises about at midnight.

Pluto—For information in regard to this planet, see p. 31.

FEBRUARY E.S.T.				Min. of Algol	Config. of Jupiter's Sat. 20h 25m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Mon. 1	11	36	● New Moon		20413	264.40
	17		Ceres in conjunction with sun			
Tue. 2				15 30	12034	276.59
Wed. 3	5		Saturn 4° N. of moon		03124	288.79
Thu. 4					31204	300.98
Fri. 5				12 20	32014	313.16[b]
Sat. 6			Mars at aphelion		3024*	325.35
			Jupiter in quadrature E.			
Sun. 7					1024*	337.53
Mon. 8			Neptune in quadrature W.	9 10	20143	349.70[l]
	22		Jupiter 2° N. of moon			
Tue. 9	3	53	◑ First Quarter		12403	1.87
Wed. 10					40312	14.03
Thu. 11				6 00	d4310	26.19
Fri. 12					43201	38.33
Sat. 13					43102	50.47
Sun. 14	6		Moon at perigee, 224,200 mi.	2 50	4102*	62.61
Mon. 15	19	27	○ Full Moon		42013	74.75
Tue. 16	19		Uranus 5° S. of moon	23 40	41203	86.88
Wed. 17	17		Mars 1° S. of moon		40132	99.01
Thu. 18					31024	111.15[b]
Fri. 19			Mercury greatest hel. lat. S.	20 30	32014	123.29
Sat. 20	8		Neptune stationary		3104*	135.43[l]
Sun. 21	20		Neptune 0.8° S. of moon		d3024	147.58
Mon. 22				17 20	2034*	159.74
Tue. 23	0	40	◐ Last Quarter		21034	171.90
	22		Mercury in superior conjunction			
Wed. 24					01234	184.07
Thu. 25				14 10	13024	196.25
Fri. 26			Venus at aphelion			
	5		Saturn in conjunction with sun		32401	208.43
	5		Moon at apogee, 251,800 mi.			
Sat. 27					3410*	220.62
Sun. 28				11 00	43012	232.82

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]Feb. 8, −6.50°; Feb. 20, +6.94°. [b]Feb. 5, +6.64°; Feb. 18, −6.53°.

THE SKY FOR MARCH 1965

Positions of the sun and planets are given for 0h Greenwich Ephemeris Time. The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

The Sun—During March the sun's R.A. increases from 22h 47m to 0h 41m and its Decl. changes from 7° 45′ S. to 4° 22′ N. The equation of time changes from −12m 23s to −4m 09s. For changes in the length of the day, see p. 14.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 21.

Mercury on the 15th is in R.A. 0h 37m, Decl. 4° 59′ N., and transits at 13h 08m. On the 21st it is in greatest eastern elongation, this is a favourable elongation, the planet standing about 18 degrees above the western horizon at sunset. Between the 14th and the end of the month it should be easy to find Mercury low on the western horizon just before sunset.

Venus on the 15th is in R.A. 23h 15m, Decl. 6° 26′ S., mag. −3.4, and transits at 11h 45m. It is a morning star but too close to the sun for easy observation.

Mars on the 15th is in R.A. 11h 17m, Decl. 8° 53′ N., mag. −1.0, and transits at 23h 40m. Moving into Leo, it rises at about sunset and sets at about sunrise. On the 9th it is in opposition, on the 11th nearest the earth (at 62,102,000 mi.); it is now at its greatest brilliancy.

Jupiter on the 15th is in R.A. 3h 20m, Decl. 17° 37′ N., mag. −1.7, and transits at 15h 47m. Moving into Taurus, it is well past the meridian at sunset and sets before midnight. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 22h 47m, Decl. 9° 27′ S., and transits at 11h 15m. It is too close to the sun for easy observation.

Uranus on the 15th is in R.A. 10h 56m, Decl. 7° 42′ N., and transits at 23h 21m. It rises after sunset. Opposition is on the 3rd, at which time its distance from the earth is 1,607,000,000 miles.

Neptune on the 15th is in R.A. 15h 12m, Decl. 15° 59′ S., and transits at 3h 40m. It rises in the late evening.

Pluto—For information in regard to this planet, see p. 31.

MARCH E.S.T.				Min. of Algol	Config. of Jupiter's Sat. 20h 15m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Mon. 1			.....		42O3*	245.02
Tue. 2	5		Venus 4° N. of moon.....	.....	421O3	257.22
Wed 3	4	56	● New Moon.....	7 50	4O123	269.42
	9		Uranus at opposition.....			
Thu. 4			.....		413O2	281.63[b]
Fri. 5	15		Pluto at opposition.....		342O1	293.83
Sat. 6			.....	4 30	3124O	306.03[l]
Sun. 7			.....		3O142	318.23
Mon. 8	10		Jupiter 2° N. of moon.....		12O34	330.43
Tue. 9	7		Mars at opposition.....	1 20	d2O34	342.62
Wed. 10			Mercury at ascending node.....		O1234	354.80
	12	53	◑ First Quarter.....			
Thu. 11	20		Mars nearest to earth.....	22 10	1O324	6.98
Fri. 12			.....		32O14	19.15
Sat. 13			.....		312O4	31.31
Sun. 14	4		Moon at perigee, 227,500 mi....	19 00	3O142	43.47
Mon. 15			Mercury at perihelion.....		d41O3	55.63
Tue. 16	3		Uranus 4° S. of moon.....		42O13	67.78
	12		Mars 1° S. of moon.....			
Wed. 17	6	24	○ Full Moon.....	15 50	4O23*	79.93[b]
Thu. 18			.....		41O32	92.07
Fri. 19			.....		432O1	104.22
Sat. 20			Venus greatest hel. lat. S.....	12 40	4312O	116.38[l]
	15	05	Equinox; spring begins.....			
Sun. 21	5		Neptune 0.5° S. of moon.....		43O12	128.53
	15		Mercury greatest elong. E., 19°			
Mon. 22			.....		41O2*	140.70
Tue. 23			.....	9 30	2O413	152.87
Wed. 24	20	37	◐ Last Quarter.....		O43**	165.04
Thu. 25			Mercury greatest hel. lat. N.		1O324	177.22
Fri. 26	1		Moon at apogee, 251,300 mi.	6 20	32O14	189.41
Sat. 27			.....		321O4	201.61
Sun. 28			.....		3O124	213.81
Mon. 29	6		Mercury stationary.....	3 10	1O24*	226.01
Tue. 30	8		Saturn 4° N. of moon.....		2O134	238.23
Wed. 31			.....		1O43*	250.44[b]

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]Mar. 6, −5.28°; Mar. 20, +5.82°. [b]Mar. 4, +6.55°; Mar. 17, −6.52°; Mar. 31, +6.60°.

THE SKY FOR APRIL 1965

Positions of the sun and planets are given for 0h Greenwich Ephemeris Time. The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

The Sun—During April the sun's R.A. increases from 0h 41m to 2h 32m and its Decl. changes from 4° 22′ N. to 14° 57′ N. The equation of time changes from −3m 52s to +2m 51s. For changes in the length of the day, see p. 14.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 21.

Mercury on the 15th is in R.A. 0h 50m, Decl. 6° 13′ N., and transits at 11h 14m. It may be seen with difficulty at the first of the month as an evening star, but by the 8th it is in inferior conjunction and for the rest of the month it is too close to the sun for easy observation.

Venus on the 15th is in R.A. 1h 36m, Decl. 8° 52′ N., mag. −3.5, and transits at 12h 04m. Superior conjunction is on the 11th and, though it then becomes an evening star it is not easily seen during the month.

Mars on the 15th is in R.A. 10h 46m, Decl. 10° 46′ N., mag. −0.4, and transits at 21h 09m. In Leo, it is well up at sunset and sets well before sunrise. It is declining rapidly in brilliancy during the next few months. On the 21st it is stationary in right ascension and resumes direct (or eastward) motion among the stars.

Jupiter on the 15th is in R.A. 3h 45m, Decl. 19° 10′ N., mag. −1.6, and transits at 14h 10m. In Taurus, it is well down in the west at sunset and sets within three hours. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 23h 00m, Decl. 8° 11′ S., mag. +1.3, and transits at 9h 26m. In Aquarius, it is a morning star rising about an hour before the sun.

Uranus on the 15th is in R.A. 10h 52m, Decl. 8° 07′ N., and transits at 21h 15m. It is well up in the east at sunset.

Neptune on the 15th is in R.A. 15h 09m, Decl. 15° 48′ S., and transits at 1h 36m. It rises soon after sunset.

Pluto—For information in regard to this planet, see p. 31.

APRIL E.S.T.				Min. of Algol	Config. of Jupiter's Sat. 20h05m	Sun's Selen. Colong. 0h U.T.
	d	h	m	h m		°
Thu.	1	19	21	● New Moon	0 00	d4O32	262.66
Fri.	2	19		Mars 3° N. of Uranus		432O1	274.88[l]
Sat.	3				20 50	4321O	287.10
Sun.	4					43O12	299.32
Mon.	5	1		Jupiter 1° N. of moon		413O2	311.54
Tue.	6				17 40	42O13	323.75
Wed.	7					412O3	335.96
Thu.	8	8		Mercury in inferior conjunction.		4O123	348.17
		19	40	☽ First Quarter			
Fri.	9	6		Moon at perigee, 229,900 mi.	14 30	32O4*	0.36
Sat.	10					321O4	12.55
Sun.	11	23		Venus in superior conjunction		3O124	24.74
Mon.	12	7		Mars 2° S. of moon	11 10	31O24	36.91
		9		Uranus 5° S. of moon			
Tue.	13					2O134	49.09[b]
Wed.	14					12O34	61.26
Thu.	15	18	03	○ Full Moon	8 00	O1234	73.42
Fri.	16					dd1O4	85.59
Sat.	17			Mercury at descending node		321O4	97.76[l]
		13		Neptune 0.4° S. of moon			
Sun.	18				4 50	34O12	109.93
Mon.	19					431O2	122.10
Tue.	20	18		Mercury stationary		42O13	134.28
Wed.	21	3		Mars stationary	1 40	412O3	146.46
Thu.	22			Lyrid meteors		4O123	158.65
		20		Moon at apogee, 251,200 mi.			
Fri.	23	16	07	☾ Last Quarter	22 30	41O32	170.84
Sat.	24					d432O	183.04
Sun.	25					34O1*	195.25
Mon.	26	22		Saturn 4° N. of moon	19 20	31O42	207.47
Tue.	27					2O314	219.69[b]
Wed.	28			Mercury at aphelion		21O34	231.91
Thu.	29	6		Mercury 2° N. of moon	16 10		244.14[l]
Fri.	30						256.38

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]Apr. 2, −5.00°; Apr. 17, +4.99°; Apr. 29, −5.66°.
[b]Apr. 13, −6.62°; Apr. 27, +6.73°.

THE SKY FOR MAY 1965

Positions of the sun and planets are given for 0h Greenwich Ephemeris Time. The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

The Sun—During May the sun's R.A. increases from 2h 32m to 4h 35m and its Decl. changes from 14° 57′ N. to 22° 00′ N. The equation of time changes from +2m 58s to a maximum of +3m 45s on the 14th and then to +2m 26s at the end of the month. There is a total eclipse of the sun on the 30th visible in the Pacific Ocean. For changes in the length of the day, see p. 15.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 22.

Mercury on the 15th is in R.A. 1h 53m, Decl. 8° 23′ N., and transits at 10h 23m. On the 6th it is at greatest western elongation and so might be seen as a morning star. However, this is an unfavourable elongation, the altitude of Mercury being less than 10 degrees at sunrise.

Venus on the 15th is in R.A. 4h 02m, Decl. 20° 38′ N., mag. −3.4, and transits at 12h 32m. It is an evening star to be seen briefly very low on the north-western horizon just after sunset.

Mars on the 15th is in R.A. 10h 57m, Decl. 8° 25′ N., mag. +0.2, and transits at 19h 23m. In Leo, it is about on the meridian at sunset and is approaching the horizon at midnight.

Jupiter on the 15th is in R.A. 4h 13m, Decl. 20° 34′ N., mag. −1.5, and transits at 12h 40m. In Taurus, nearing the western horizon at sunset it is still visible early in the month, but by the 30th it is in conjunction with the sun.

Saturn on the 15th is in R.A. 23h 10m, Decl. 7° 16′ S., mag. +1.3, and transits at 7h 37m. In Aquarius, it is visible low in the south-east for a few hours before sunrise.

Uranus on the 15th is in R.A. 10h 50m, Decl. 8° 17′ N., and transits at 19h 15m. It is near the meridian at sunset.

Neptune on the 15th is in R.A. 15h 06m, Decl. 15° 35′ S., and transits at 23h 31m. It rises about at sunset. Opposition is on the 9th, at which time its distance from the earth is 2,723,000,000 miles.

Pluto—For information in regard to this planet, see p. 31.

			MAY E.S.T.	Min. of Algol		Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Sat. 1	6	56	● New Moon			268.61
	14		Vesta in conjunction with sun			
Sun. 2	19		Jupiter 0.5° N. of moon	13 00		280.85
Mon. 3						293.09
Tue. 4	20		Moon at perigee, 228,100 mi.			305.32
Wed. 5			η Aquarid meteors	9 50		317.55
Thu. 6	8		Mercury greatest elong. W., 27°.			329.78
	10		Mars 1.1° N. of Uranus			
Fri. 7						342.00
Sat. 8	1	20	☽ First Quarter	6 40		354.21
Sun. 9	7		Neptune at opposition			6.42
	14		Uranus 5° S. of moon			
	15		Mars 4° S. of moon			
Mon. 10						18.62[b]
Tue. 11				3 30		30.82
Wed. 12						43.01
Thu. 13						55.20[l]
Fri. 14	19		Neptune 0.5° S. of moon	0 10		67.38
Sat. 15	6	53	○ Full Moon			79.56
Sun. 16			Venus at ascending node	21 00		91.75
Mon. 17						103.93
Tue. 18			Mercury greatest hel. lat. S.			116.12
	17		Uranus stationary			
Wed. 19				17 50		128.31
Thu. 20	15		Moon at apogee, 251,500 mi.			140.50
	23		Venus 6° N. of Aldebaran			
Fri. 21						152.70
Sat. 22				14 40		164.90
Sun. 23	9	41	☾ Last Quarter			177.11
Mon. 24	10		Saturn 4° N. of moon			189.33
Tue. 25			Uranus greatest hel. lat. N.	11 30		201.56[b]
Wed. 26						213.78
Thu. 27						226.02[l]
Fri. 28				8 20		238.26
Sat. 29	14		Mercury 0.5° N. of moon			250.50
Sun. 30	2		Jupiter in conjunction with sun			262.75
	13		Pluto stationary			
	16	13	● New Moon. Eclipse of ☉, see p. 64			
Mon. 31				5 10		275.00

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.

[l]May 13, +5.19°; May 27, −6.56°. [b]May 10, −6.74°; May 25, +6.81°.

Jupiter being near the sun, configurations of the satellites are not given between April 28 and July 1.

THE SKY FOR JUNE 1965

Positions of the sun and planets are given for 0h Greenwich Ephemeris Time. The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

The Sun—During June the sun's R.A. increases from 4h 35m to 6h 39m and its Decl. changes from 22° 00′ N. to 23° 09′ N. The equation of time changes from +2m 17s to −3m 33s. For changes in the length of the day, see p. 15.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 22. There is a partial eclipse of the moon on the night of the 13th, visible on the east coast of North America.

Mercury on the 15th is in R.A. 5h 50m, Decl. 24° 45′ N., and transits at 12h 21m. It is too close to the sun for observation, being in superior conjunction on the 11th.

Venus on the 15th is in R.A. 6h 46m, Decl. 24° 09′ N., mag. −3.3, and transits at 13h 15m. It is an evening star visible briefly just after sunset low on the north-western horizon.

Mars on the 15th is in R.A. 11h 37m, Decl. 3° 15′ N., mag. +0.7, and transits at 18h 02m. In Leo, it is well past the meridian at sunset and sets before midnight.

Jupiter on the 15th is in R.A. 4h 44m, Decl. 21° 44′ N., mag. −1.5, and transits at 11h 09m. It is too close to the sun for observation until late in the month when it begins to appear as a morning star near the eastern horizon just before sunrise.

Saturn on the 15th is in R.A. 23h 15m, Decl. 6° 50′ S., mag. +1.3, and transits at 5h 41m. In Aquarius, it rises at about midnight and reaches the meridian at about sunrise. On the 29th it is stationary in right ascension and begins to retrograde, i.e., move westward among the stars.

Uranus on the 15th is in R.A. 10h 51m, Decl. 8° 08′ N. and transits at 17h 15m. It is well past the meridian at sunset.

Neptune on the 15th is in R.A. 15h 03m, Decl. 15° 23′ S., and transits at 21h 26m. It is well up in the south-east at sunset.

Pluto—For information in regard to this planet, see p. 31.

			JUNE E.S.T.	Min. of Algol		Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Tue. 1			Uranus in quadrature E.			287.25
	13		Moon at perigee, 225,000 mi. .			
Wed. 2	8		Pallas stationary			299.50
Thu. 3			. . . . .	2 00		311.74
Fri. 4			. . . . .			323.98
Sat. 5	20		Uranus 5° S. of moon	22 50		336.22
Sun. 6			Mercury at ascending node			348.44[b]
	7	12	☽ First Quarter			
	11		Mars 5° S. of moon			
Mon. 7			Saturn in quadrature W			0.66
Tue. 8			. . . . .	19 30		12.88
Wed. 9			. . . . .			25.09[l]
Thu. 10	13		Juno stationary			37.29
Fri. 11			Mercury at perihelion	16 20		49.49
	0		Neptune 0.5° S. of moon			
	14		Mercury in superior conjunction			
Sat. 12			. . . . .			61.68
Sun. 13	21	00	☽ Full Moon. Eclipse of ☾, see p. 64			73.88
Mon. 14			Mars in quadrature E.	13 10		86.07
Tue. 15			. . . . .			98.26
Wed. 16			. . . . .			110.46
Thu. 17	5		Moon at apogee, 252,100 mi. . . .	10 00		122.66
Fri. 18			Venus at perihelion			134.86
Sat. 19			. . . . .			147.06
Sun. 20	20		Saturn 4° N. of moon	6 50		159.27
Mon. 21			Mercury greatest hel. lat. N. . . .			171.48[b]
	9	56	Solstice. Summer begins			
Tue. 22	0	37	☾ Last Quarter			183.70
Wed. 23			. . . . .	3 40		195.93
Thu. 24			. . . . .			208.16[l]
Fri. 25	12		Venus 5° S. of Pollux			220.40
Sat. 26			. . . . .	0 30		232.64
Sun. 27	13		Jupiter 0.7° S. of moon			244.89
	17		Mercury 5° S. of Pollux			
Mon. 28	23	53	● New Moon	21 20		257.14
Tue. 29	2		Saturn stationary			269.40
	19		Moon at perigee, 222,700 mi. . . .			
Wed. 30	8		Mercury 2° S. of moon			281.65
	11		Venus 2° S. of moon			

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.

[l]June 9, +6.32°; June 24, −7.25°. [b]June 6, −6.77°; June 21, +6.83°.

Jupiter being near the sun, configurations of the satellites are not given between April 28 and July 1.

THE SKY FOR JULY 1965

Positions of the sun and planets are given for 0h Greenwich Ephemeris Time. The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

The Sun—During July the sun's R.A. increases from 6h 39m to 8h 44m and its Decl. changes from 23° 09′ N. to 18° 08′ N. The equation of time changes from −3m 45s to a maximum of −6m 25s on the 26th and then to −6m 17s at the end of the month. For changes in the length of the day, see p. 16.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 23.

Mercury on the 15th is in R.A. 9h 25m, Decl. 15° 12′ N., and transits at 13h 54m. Greatest eastern elongation is on the 18th, Mercury then standing about 14 degrees above the western horizon at sunset—a little below and "to the right" of Regulus. Indeed, for most of the month it is possible to find Mercury low on the western horizon after sunset.

Venus on the 15th is in R.A. 9h 20m, Decl. 17° 15′ N., mag. −3.3, and transits at 13h 50m. It is an evening star visible for an hour or more near the western horizon after sunset.

Mars on the 15th is in R.A. 12h 31m, Decl. 3° 16′ S., mag. +1.0, and transits at 16h 58m. In Virgo, it is well down in the west at sunset and sets before midnight.

Jupiter on the 15th is in R.A. 5h 12m, Decl. 22° 28′ N., mag. −1.6, and transits at 9h 39m. In Taurus it rises about two hours before the sun. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 23h 15m, Decl. 6° 59′ S., mag. +1.1, and transits at 3h 43m. In Aquarius, it rises several hours before midnight and crosses the meridian before sunrise.

Uranus on the 15th is in R.A. 10h 55m, Decl. 7° 43′ N., and transits at 15h 21m. It is well down in the west at sunset.

Neptune on the 15th is in R.A. 15h 01m, Decl. 15° 17′ S., and transits at 19h 26m. It is about on the meridian at sunset.

Pluto—For information in regard to this planet, see p. 31.

JULY E.S.T.				Min. of Algol	Config. of Jupiter's Sat. 3h 20m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Thu. 1			.....	18 00	d423O	293.91
Fri. 2			.....		42O13	306.16
Sat. 3			Earth at aphelion.....		1O423	318.40
			Dist. from ⊙, 94,454,000 mi.			
	4		Uranus 5° S. of moon.....			
	19		Mercury 0.04° S. of Venus.....			
Sun. 4	16		Mars 5° S. of moon.....	14 50	dO134	330.64[b]
Mon. 5	14	37	☽ First Quarter.....		213O4	342.87
Tue. 6			.....		3O214	355.10[l]
Wed. 7			.....	11 40	31O24	7.32
Thu. 8	5		Neptune 0.6° S. of moon.....		32O14	19.54
Fri. 9			.....		2O34*	31.75
Sat. 10			Venus greatest hel. lat. N.....	8 30	1O243	43.95
Sun. 11			.....		O4123	56.15
Mon. 12			.....		d241O	68.35
Tue. 13	12	02	☽ Full Moon.....	5 20	43O21	80.54
Wed. 14			Mercury at descending node....		431O2	92.74
	12		Moon at apogee, 252,500 mi. ...			
Thu. 15			.....		432O1	104.93
Fri. 16			.....	2 10	42O3*	117.13
Sat. 17			.....		d4O23	129.33
Sun. 18			Mars at descending node.....	23 00	4O123	141.53[b]
	2		Saturn 3° N. of moon.....			
	18		Mercury greatest elong. E., 27°.			
Mon. 19	1		Mercury 3° S. of Venus.....		241O3	153.73
Tue. 20			.....		3O41*	165.94
Wed. 21	12	54	☾ Last Quarter.....	19 50	31O24	178.16
Thu. 22			.....		32O14	190.38[l]
Fri. 23			.....		21O34	202.61
Sat. 24	13		Venus 1.2° N. of Regulus.....	16 30	O1234	214.84
Sun. 25			Mercury at aphelion.....		O1234	227.08
	9		Jupiter 1° S. of moon.....			
Mon. 26			.....		21O34	239.33
Tue. 27			.....	13 20	32O14	251.58
Wed. 28	4		Moon at perigee, 222,000 mi. ...		31O42	263.83
	6	45	● New Moon.....			
Thu. 29			δ Aquarid meteors.....		432O1	276.08
	17		Mercury 9° S. of moon.....			
Fri. 30	2		Neptune stationary.....	10 10	421O3	288.33
	5		Venus 4° S. of moon.....			
	16		Uranus 5° S. of moon.....			
Sat. 31	20		Mercury stationary.....		4O123	300.58[b]

[l] July 6, +7.41°; July 22, −7.36°.

[b] July 4, −6.70°; July 18, +6.71°; July 31, −6.60°.

THE SKY FOR AUGUST 1965

Positions of the sun and planets are given for 0h Greenwich Ephemeris Time. The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

The Sun—During August the sun's R.A. increases from 8h 44m to 10h 40m and its Decl. changes from 18° 08′ N. to 8° 27′ N. The equation of time changes from −6m 14s to −0m 15s. For changes in the length of the day, see p. 16.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 23.

Mercury on the 15th is in R.A. 9h 37m, Decl. 9° 17′ N., and transits at 11h 58m. For most of the month it is poorly placed for observation, being in inferior conjunction on the 15th. However, during the last few days of the month Mercury can be seen as a morning star low on the eastern horizon just before sunrise.

Venus on the 15th is in R.A. 11h 42m, Decl. 3° 05′ N., mag. −3.4, and transits at 14h 09m. It is an evening star visible near the western horizon for about two hours after sunset.

Mars on the 15th is in R.A. 13h 38m, Decl. 10° 38′ S., mag. +1.2, and transits at 16h 03m. In Virgo (passing within 2 degrees of Spica on the 8th) it is well down in the west at sunset and sets within about two hours.

Jupiter on the 15th is in R.A. 5h 38m, Decl. 22° 51′ N., mag. −1.7, and transits at 8h 03m. In Taurus, it rises soon after midnight and is well up before sunrise. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 23h 10m, Decl. 7° 40′ S., mag. +0.9, and transits at 1h 35m. In Aquarius, it rises shortly after sunset and is visible during the rest of the night.

Uranus on the 15th is in R.A. 11h 01m, Decl. 7° 04′ N., and transits at 13h 25m. It is too close to the sun for observation.

Neptune on the 15th is in R.A. 15h 01m, Decl. 15° 19′ S., and transits at 17h 24m. It is well down in the south-west at sunset.

Pluto—For information in regard to this planet, see p. 31.

AUGUST E.S.T.				Min. of Algol	Config. of Jupiter's Sat. 3h 10m	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Sun.	1	10		Juno at opposition		4023*	312.83
Mon.	2	4		Mars 5° S. of moon	7 00	42103	325.06
		20		Ceres stationary			
Tue.	3					43201	337.30[l]
Wed.	4	0	48	◑ First Quarter		34102	349.52
		11		Neptune 0.4° S. of moon			
Thu.	5	3		Venus 0.6° N. of Uranus	3 50	34021	1.74
Fri.	6	12		Pallas at opposition		21304	13.95
Sat.	7					02134	26.16
Sun.	8	11		Mars 1.8° N. of Spica	0 40	10234	38.36
Mon.	9			Neptune in quadrature E.		d2034	50.56
Tue.	10	15		Moon at apogee, 252,400 mi.	21 30	23014	62.75
Wed.	11					31024	74.94
Thu.	12			Perseid meteors		30124	87.13
		3	23	○ Full Moon			
Fri.	13				18 10	21304	99.32
Sat.	14			Mercury greatest hel. lat. S.		4013*	111.51[b]
		5		Saturn 3° N. of moon			
Sun.	15	14		Mercury in inferior conjunction		41023	123.70
Mon.	16				15 00	42013	135.89
Tue.	17					42301	148.08
Wed.	18					43102	160.28
Thu.	19	22	51	◐ Last Quarter	11 50	43012	172.49
Fri.	20					42130	184.70[l]
Sat.	21					4013*	196.92
Sun.	22	2		Jupiter 2° S. of moon	8 40	14023	209.14
Mon.	23					20143	221.37
Tue.	24	18		Mercury stationary		d204*	233.60
Wed.	25	10		Mercury 7° S. of moon	5 30	31024	245.84
		14		Moon at perigee, 223,100 mi.			
Thu.	26	13	51	● New Moon		30124	258.08
Fri.	27					32104	270.33[b]
Sat.	28				2 20	20314	282.57
Sun.	29	1		Venus 4° S. of moon		10234	294.81
Mon.	30	22		Mars 4° S. of moon	23 10	d0143	307.04
Tue.	31	20		Neptune 0.1° S. of moon		24103	319.27

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]Aug. 3, +7.87°; Aug. 20, −6.78°. [b]Aug. 14, +6.59°; Aug. 27, −6.50°.

THE SKY FOR SEPTEMBER 1965

Positions of the sun and planets are given for 0h Greenwich Ephemeris Time. The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

The Sun—During September the sun's R.A. increases from 10h 40m to 12h 28m and its Decl. changes from 8° 27′ N. to 3° 01′ S. The equation of time changes from +0m 04s to +10m 02s. For changes in the length of the day, see p. 17.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 24.

Mercury on the 15th is in R.A. 10h 52m, Decl. 9° 06′ N., and transits at 11h 19m. Greatest western elongation is on the 1st when the planet stands 14 degrees above the eastern horizon at sunrise just above Regulus. During the following week Mercury may be seen as a morning star nearing Regulus and passing within a degree of it on the 7th. By the 27th it is in superior conjunction.

Venus on the 15th is in R.A. 13h 56m, Decl. 12° 32′ S., mag. −3.5, and transits at 14h 21m. It is an evening star visible near the south-western horizon for two hours or more after sunset.

Mars on the 15th is in R.A. 14h 56m, Decl. 17° 35′ S., mag. +1.3, and transits at 15h 19m. In Libra, it is well down in the south-west at sunset and sets about two hours later.

Jupiter on the 15th is in R.A. 5h 57m, Decl. 22° 57′ N., mag. −1.9, and transits at 6h 20m. Moving into Gemini, it rises before midnight and is visible for the rest of the night. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 23h 01m, Decl. 8° 35′ S., mag. +0.8, and transits at 23h 21m. In Aquarius, it rises at about sunset and sets before sunrise. On the 6th it is in opposition, its distance from the earth then being 805,400,000 miles.

Uranus on the 15th is in R.A. 11h 08m, Decl. 6° 20′ N., and transits at 11h 30m. It is too close to the sun for observation. Conjunction is on the 7th.

Neptune on the 15th is in R.A. 15h 03m, Decl. 15° 29′ S., and transits at 15h 25m. It is low in the south-west at sunset.

Pluto—For information in regard to this planet, see p. 31.

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.

[a]Sept. 1, +7.57°; Sept. 16, −5.64°; Sept. 29, +6.70°.

[b]Sept. 10, +6.56°; Sept. 23, −6.50°.

SEPTEMBER E.S.T.				Min. of Algol	Config. of Jupiter's Sat. 2h 55m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Wed. 1	20		Mercury greatest elong. W., 18°.		d43O2	331.50[l]
Thu. 2			Mercury at ascending node.....	19 50	43O12	343.72
	14	28	☽ First Quarter.....			
Fri. 3			.....		4321O	355.93
Sat. 4			Venus at descending node.....		42O31	8.13
Sun. 5			.....	16 40	41O23	20.33
Mon. 6	11		Saturn at opposition.....		4O213	32.52
	23		Moon at apogee, 252,000 mi. ...			
Tue. 7			Mercury at perihelion.....			
	8		Venus 2° N. of Spica.....		421O3	44.71
	22		Uranus in conjunction with sun.			
	22		Mercury 0.7° N. of Regulus.....			
Wed. 8	19		Pluto in conjunction with sun ..	13 30	34O12	56.89
Thu. 9			.....		3O42*	69.07
Fri. 10	7		Saturn 3° N. of moon.....		321O4	81.25[b]
	18	32	♋ Full Moon, Harvest Moon...			
Sat. 11			.....	10 20	2O14*	93.43
Sun. 12			.....		1O234	105.60
Mon. 13			.....		O1234	117.78
Tue. 14			.....	7 10	21O34	129.95
Wed. 15			.....		3O14*	142.13
Thu. 16			.....		3O42*	154.32[l]
Fri. 17			Mercury greatest hel. lat. N. ...	4 00	3421O	166.50
	16		Mars 3° S. of Neptune.....			
Sat. 18	6	59	☾ Last Quarter.....		423O1	178.70
	13		Juno stationary.....			
	13		Ceres at opposition.....			
	15		Jupiter 2° S. of moon.....			
Sun. 19			.....		41O23	190.90
Mon. 20			.....	0 50	4O213	203.11
Tue. 21			.....		421O3	215.32
Wed. 22	18		Moon at perigee, 225,600 mi....	21 30	43O1*	227.54
Thu. 23			Jupiter in quadrature W.....			
	1	06	Equinox. Autumn begins.....		431O2	239.76[b]
	18		Uranus 5° S. of moon.....			
Fri. 24	9		Pallas stationary.....		d342O	251.99
	22	18	♍ New Moon.....			
Sat. 25			.....	18 20	23O41	264.21
Sun. 26			.....		1O234	276.44
Mon. 27	10		Mercury in superior conjunction		O1234	288.67
Tue. 28	2		Venus 3° S. of moon.....	15 10	21O34	300.89
	6		Neptune 0.1° N. of moon.....			
	20		Mars 2° S. of moon.....			
Wed. 29			.....		23O14	313.11[l]
Thu. 30	1		Venus 3° S. of Neptune.....		31O24	325.32

THE SKY FOR OCTOBER 1965

Positions of the sun and planets are given for 0h Greenwich Ephemeris Time. The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

The Sun—During October the sun's R.A. increases from 12h 28m to 14h 24m and its Decl. changes from 3° 01′ S. to 14° 18′ S. The equation of time changes from +10m 22s to 16m 21s. For changes in the length of the day, see p. 17.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 24.

Mercury on the 15th is in R.A. 14h 04m, Decl. 13° 05′ S., and transits at 12h 31m. It is too close to the sun for observation.

Venus on the 15th is in R.A. 16h 15m, Decl. 23° 43′ S., mag. −3.8, and transits at 14h 42m. It is an evening star seen low in the south-west at sunset, setting about two hours later.

Mars on the 15th is in R.A. 16h 23m, Decl. 22° 36′ S., mag. +1.4, and transits at 14h 48m. In Scorpius (passing 4 degrees north of Antares on the 16th) it is well down in the south-west at sunset and sets within about two hours.

Jupiter on the 15th is in R.A. 6h 06m, Decl. 22° 58′ N., mag. −2.0, and transits at 4h 30m. In Gemini, it rises about three hours before midnight and is visible until sunrise. On the 19th it is stationary in right ascension and begins to retrograde, i.e., move westward among the stars. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 22h 54m, Decl. 9° 19′ S., mag. +0.9, and transits at 21h 16m. In Aquarius, it is risen at sunset and sets about two hours before sunrise.

Uranus on the 15th is in R.A. 11h 15m, Decl. 5° 38′ N., and transits at 9h 39m. It is well up in the east at sunrise.

Neptune on the 15th is in R.A. 15h 07m, Decl. 15° 45′ S., and transits at 13h 30m. It is too close to the sun for observation.

Pluto—For information in regard to this planet, see p. 31.

OCTOBER E.S.T.				Min. of Algol	Config. of Jupiter's Sat. 2h 45m	Sun's Selen. Colong. 0h U.T.
	d	h	m	h m		°
Fri.	1		.....	12 00	d3O14	337.53
Sat.	2	7	38 ☽ First Quarter.....		23O4*	349.73
Sun.	3		.....		1O423	1.92
Mon.	4	15	Moon at apogee, 251,500 mi.....	8 50	4O123	14.11
Tue.	5		.....		421O3	26.29
Wed.	6		.....		42O31	38.47
Thu.	7	11	Saturn 3° N. of moon.....	5 40	431O2	50.64[b]
Fri.	8		.....		43O21	62.80
Sat.	9		Venus at aphelion		423O*	74.96
Sun.	10		Mercury at descending node....	2 30	41O23	87.12
		9	14 ☺ Full Moon, Hunter's Moon..			
Mon.	11		.....		4O123	99.28
Tue.	12		.....	23 10	21O43	111.44[l]
Wed.	13		.....		2O314	123.60[l]
Thu.	14		.....		31O24	135.76
Fri.	15	23	Jupiter 3° S. of moon.....	20 00	3O124	147.92
Sat.	16	7	Mars 4° N. of Antares.....		231O4	160.09
Sun.	17	10	Venus 2° N. of Antares.....		dO34*	172.27
		14	00 ☾ Last Quarter.....			
Mon.	18		.....	16 50	O1234	184.45
Tue.	19	10	Venus 1.6° S. of Mars.....		21O43	196.64
		15	Jupiter stationary.....			
Wed.	20		Orionid meteors.....		24O31	208.83
		6	Moon at perigee, 228,800 mi.....			
Thu.	21		Mercury at aphelion.....	13 40	431O2	221.03[b]
		5	Uranus 5° S. of moon.....			
Fri.	22		.....		43O21	233.24
Sat.	23		.....		4321O	245.45
Sun.	24	9	12 ● New Moon.....	10 30	4O1**	257.66
Mon.	25	17	Mercury 3° S. of moon.....		4O23*	269.87
		17	Neptune 0.3° N. of moon.....			
		22	Mercury 4° S. of Neptune.....			
Tue.	26		.....		421O3	282.08[l]
Wed.	27	21	Mars 0.01° N. of moon.....	7 20	42O13	294.29
Thu.	28	4	Venus 2° S. of moon.....		314O2	306.49
Fri.	29		.....		3O412	318.69
Sat.	30		.....	4 10	321O4	330.89
Sun.	31		Venus greatest hel. lat. S.....		23O14	343.07

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]Oct. 12, 13, −4.58°; Oct. 26, +5.68°. [b]Oct. 7, +6.65°; Oct. 21, −6.65°.

THE SKY FOR NOVEMBER 1965

Positions of the sun and planets are given for 0h Greenwich Ephemeris Time. The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

The Sun—During November the sun's R.A. increases from 14h 24m to 16h 27m and its Decl. changes from 14° 18′ S. to 21° 44′ S. The equation of time changes from +16m 23s to a maximum of +16m 24s on the 3rd and then to +11m 15s at the end of the month. There is an annular eclipse of the sun on the 22nd, visible in Asia. For changes in the length of the day, see p. 18.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 25.

Mercury on the 15th is in R.A. 16h 53m, Decl. 25° 13′ S., and transits at 13h 17m. Greatest eastern elongation is on the 12th, but this is an exceedingly unfavourable elongation, the planet being only about 8 degrees above the south-western horizon at sunset.

Venus on the 15th is in R.A. 18h 43m, Decl. 26° 27′ S., mag. −4.1, and transits at 15h 07m. Although it is at greatest eastern elongation on the 15th it is only about 19 degrees above the south-western horizon at sunset and sets about three hours later.

Mars on the 15th is in R.A. 18h 02m, Decl. 24° 37′ S., mag. +1.4, and transits at 14h 26m. Moving into Sagittarius, it is now very low in the south-west at sunset.

Jupiter on the 15th is in R.A. 6h 01m, Decl. 23° 00′ N., mag. −2.2, and transits at 2h 23m. In Gemini it rises soon after sunset and is visible all the rest of the night. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 57.

Saturn on the 15th is in R.A. 22h 51m, Decl. 9° 32′ S., mag. +1.1, and transits at 19h 11m. In Aquarius, it is well up in the south-east at sunset and sets soon after midnight. It is stationary in right ascension on the 14th and resumes direct, i.e., eastward, motion among the stars.

Uranus on the 15th is in R.A. 11h 20m, Decl. 5° 06′ N., and transits at 7h 42m. It rises a few hours after midnight.

Neptune on the 15th is in R.A. 15h 11m, Decl. 16° 04′ S., and transits at 11h 33m. It is too close to the sun for observation. Conjunction is on the 12th.

Pluto—For information in regard to this planet, see p. 31.

			NOVEMBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 2h 30m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Mon. 1	3	26	☽ First Quarter		0234*	355.26
	10		Moon at apogee, 251,200 mi.			
Tue. 2				1 00	d2034	7.43
Wed. 3	17		Saturn 3° N. of moon		20134	19.60
Thu. 4				21 50	13024	31.76[b]
Fri. 5			Taurid meteors		30412	43.92
Sat. 6					32140	56.07
Sun. 7				18 30	42301	68.22
Mon. 8	23	16	☺ Full Moon		41032	80.36[l]
Tue. 9	3		Mercury 1.9° N. of Antares		dd403	92.51
Wed. 10			Mercury greatest hel. lat. S.	15 20	42013	104.65
	3		Vesta stationary			
Thu. 11					41302	116.79
Fri. 12	3		Jupiter 3° S. of moon		43012	128.93
	3		Neptune in conjunction with sun			
	22		Mercury greatest elong. E., 23°			
Sat. 13				12 10	34120	141.08
Sun. 14	3		Moon at perigee, 229,600 mi.		23401	153.23
	4		Ceres stationary			
	13		Saturn stationary			
Mon. 15	15		Venus greatest elong. E., 47°		10324	165.39
	20	54	☾ Last Quarter			
Tue. 16			Leonid meteors	9 00	01234	177.55
Wed. 17	13		Uranus 5° S. of moon		2034*	189.72[b]
Thu. 18					d1024	201.90
Fri. 19				5 50	30124	214.08
Sat. 20					31204	226.27
Sun. 21					32014	238.46
Mon. 22	23	10	● New Moon. Eclipse of ☉, see p. 64	2 40	10432	250.66[l]
Tue. 23	0		Mercury stationary		40123	262.86
Wed. 24	9		Mercury 0.1° S. of moon	23 30	4203*	275.05
Thu. 25					4103*	287.25
Fri. 26	0		Mars 2° N. of moon		43012	299.44
Sat. 27	1		Venus 0.7° N. of moon	20 20	43120	311.63
Sun. 28					43201	323.82
Mon. 29			Mercury at ascending node		41032	336.00
	7		Moon at apogee, 251,500 mi.			
Tue. 30				17 10	40123	348.17

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]Nov. 8, −4.80°; Nov. 22, +5.16°. [b]Nov. 4, +6.78°; Nov. 17, −6.77°.

THE SKY FOR DECEMBER 1965

Positions of the sun and planets are given for 0h Greenwich Ephemeris Time. The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

The Sun—During December the sun's R.A. increases from 16h 27m to 18h 44m and its Decl. changes from 21° 44′ S. to 23° 04′ S. The equation of time changes from +10m 53s to −3m 07s. For changes in the length of the day, see p. 18.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 25. There is a penumbral eclipse of the moon on the 8th, not visible in North America.

Mercury on the 15th is in R.A. 16h 07m, Decl. 18° 05′ S., and transits at 10h 31m. Inferior conjunction is on the 2nd so that the planet is not well placed for observation early in the month. During the latter half of the month, however, it may be seen as a morning star low on the south-eastern horizon just before sunrise. At greatest western elongation on the 21st Mercury is about 16 degrees above the horizon at sunrise.

Venus on the 15th is in R.A. 20h 34m, Decl. 20° 32′ S., mag. −4.4, and transits at 14h 59m. It is an evening star about 17 degrees above the south-western horizon at sunset, setting about two hours later. Greatest brilliancy is on the 21st.

Mars on the 15th is in R.A. 19h 43m, Decl. 22° 34′ S., mag. +1.4, and transits at 14h 08m. It is too low in the south-west at sunset for easy observation.

Jupiter on the 15th is in R.A. 5h 46m, Decl. 23° 01′ N., mag. −2.3, and transits at 0h 10m. Moving back into Taurus, it rises at about sunset and sets at about sunrise. Opposition is on the 18th, the distance from the earth then being 384,000,000 miles. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 57.

Saturn on the 15th is in R.A. 22h 54m, Decl. 9° 09′ S., mag. +1.2, and transits at 17h 16m. In Aquarius, it is nearing the meridian at sunset and sets before midnight.

Uranus on the 15th is in R.A. 11h 23m, Decl. 4° 50′ N., and transits at 5h 47m. It rises before midnight.

Neptune on the 15th is in R.A. 15h 16m, Decl. 16° 20′ S., and transits at 9h 39m. It is too close to the sun for observation.

Pluto–For information in regard to this planet, see p. 31.

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.

[t]Dec. 6, −5.87°; Dec. 18, +5.84°.

[b]Dec. 1, +6.86°; Dec. 14, −6.76°; Dec. 28, +6.77°.

DECEMBER E.S.T.				Min. of Algol	Config. of Jupiter's Sat. 0h 25m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Wed. 1	0	25	☽ First Quarter		21043	0.34[b]
	2		Saturn 4° N. of moon			
Thu. 2			Saturn in quadrature E.		20134	12.50
	23		Mercury in inferior conjunction.			
Fri. 3				14 00	3024*	24.65
Sat. 4			Mercury at perihelion		d3104	36.80
Sun. 5					32014	48.94
Mon. 6				10 40	10324	61.08[l]
Tue. 7					01234	73.21
Wed. 8	12	22	☽ Full Moon. Penumbral eclipse of ☾, see p. 64		21043	85.34
Thu. 9	7		Jupiter 2° S. of moon	7 30	20413	97.47
Fri. 10					43102	109.60
Sat. 11			Uranus in quadrature W.		43102	121.73
	1		Moon at perigee, 226,500 mi.			
Sun. 12	16		Mercury stationary	4 20	43201	133.86
Mon. 13			Geminid meteors		4102*	146.00
Tue. 14			Mercury greatest hel. lat. N.		40123	158.15[b]
	19		Uranus 5° S. of moon			
Wed. 15	4	52	☾ Last Quarter	1 10	41203	170.30
Thu. 16					42013	182.45
Fri. 17				22 00	34102	194.62
Sat. 18	4		Jupiter at opposition		d3024	206.79[l]
Sun. 19	13		Neptune 0.5° N. of moon		32014	218.97
Mon. 20	20		Mercury 3° N. of moon	18 50	13024	231.15
Tue. 21	12		Venus at greatest brilliancy		01234	243.34
	17		Mercury greatest elong. W., 22°.			
	19		Mercury 7° N. of Antares			
	20	41	Solstice. Winter begins			
Wed. 22			Ursid meteors		12034	255.52
			Mars greatest hel. lat. S.			
	16	03	● New Moon			
Thu. 23				15 40	20134	267.71
Fri. 24					13024	279.90
Sat. 25	4		Mars 3° N. of moon		30124	292.09
	9		Uranus stationary			
	23		Venus 5° N. of moon			
Sun. 26			Venus at ascending node	12 30	3240*	304.27
Mon. 27	2		Moon at apogee, 252,100 mi.		4310*	316.45
Tue. 28	1		Pluto stationary		40132	328.63[b]
	4		Vesta at opposition			
	12		Saturn 3° N. of moon			
Wed. 29				9 20	41203	340.80
Thu. 30	20	47	☽ First Quarter		42013	352.97
Fri. 31					41302	5.13

JANUARY

d	h	m	Sat.	Phen.
1	22	02	II	OD
2	19	09	III	OD
	21	20	III	OR
	23	37	III	ED
3	1	51	III	ER
	19	22	II	SI
	19	34	II	Te
	21	49	II	Se
5	1	03	I	TI
	22	23	I	OD
6	1	42	I	ER
	19	31	I	TI
	20	40	I	SI
	21	40	I	Te
	22	49	I	Se
7	20	11	I	ER
9	0	28	II	OD
	22	48	III	OD
10	1	02	III	OR
	19	36	II	TI
	21	59	II	SI
	22	01	II	Te
11	0	25	II	Se
12	18	37	II	ER
13	0	14	I	OD
	19	42	III	Se
	21	22	I	TI
	22	35	I	SI
	23	31	I	Te
14	0	44	I	Se
	18	42	I	OD
	22	06	I	ER
15	17	59	I	Te
	19	13	I	Se
17	22	06	II	TI
18	0	31	II	Te
	0	36	II	SI
19	18	40	II	OR
	18	47	II	ED
	21	15	II	ER
20	18	34	III	Te
	21	32	III	SI
	23	15	I	TI
	23	44	III	Se
21	0	31	I	SI
	20	34	I	OD
22	0	02	I	ER
	19	00	I	SI
	19	52	I	Te
	21	09	I	Se
23	18	31	I	ER
25	0	37	II	TI
26	18	44	II	OD
	21	13	II	OR
	21	24	II	ED
	23	53	II	ER
27	20	11	III	TI
	22	29	III	Te
28	18	57	II	Se
	22	28	I	OD
29	19	37	I	TI
	20	56	I	SI
	21	46	I	Te
	23	05	I	Se
30	20	26	I	ER

FEBRUARY

d	h	m	Sat.	Phen.
2	21	20	II	OD
	23	49	II	OR
3	0	02	II	ED
4	0	08	III	TI
	18	56	II	Te
	19	07	II	SI
4	21	34	II	Se
5	21	32	I	TI
	22	51	I	SI
	23	41	I	Te
6	18	51	I	OD
	22	22	I	ER
7	19	30	I	Se
	19	44	III	ED
	22	00	III	ER
9	23	58	II	OD
11	19	06	II	TI
	21	33	II	Te
	21	44	II	SI
12	23	28	I	TI
13	18	30	II	ER
	20	47	I	OD
14	19	16	I	SI
	20	07	I	Te
	20	44	III	OR
	21	26	I	Se
15	18	46	I	ER
18	21	45	II	TI
20	18	38	II	ED
	21	08	II	ER
	22	44	I	OD
21	19	55	I	TI
	21	12	I	SI
	22	05	I	Te
	22	28	III	OD
	23	22	I	Se
22	20	41	I	ER
25	19	55	III	Se
27	18	42	II	OD
	21	13	II	OR
	21	17	II	ED
28	21	53	I	TI

MARCH

d	h	m	Sat.	Phen.
1	19	12	I	OD
	22	37	I	ER
2	19	46	I	Se
4	19	04	III	Te
	21	41	III	SI
6	21	26	II	OD
8	18	57	II	Te
	21	10	I	OD
	21	17	II	Se
9	19	33	I	SI
	20	32	I	Te
	21	42	I	Se
10	19	01	I	ER
11	20	55	III	TI
15	19	12	II	TI
	21	25	II	SI
	21	41	II	Te
16	20	21	I	TI
	21	28	I	SI
17	20	56	I	ER
22	19	52	III	ED
	21	57	II	TI
24	19	39	I	OD
	21	02	II	ER
25	20	03	I	Se
29	19	53	III	OD

APRIL

d	h	m	Sat.	Phen.
1	19	49	I	SI
	21	04	I	Te
8	20	54	I	TI
9	20	09	III	Se
	20	59	II	Se
16	20	12	I	OD
17	20	20	I	Se
24	20	04	I	SI

Jupiter being near the sun, phenomena of the satellites are not given between Apr. 28 and July 10.

JULY

d	h	m	Sat.	Phen.
12	3	21	III	Te
13	3	17	II	OR
16	3	13	I	ED
24	3	20	I	TI
25	2	41	I	OR
29	3	03	II	Te
30	2	25	III	OR

AUGUST

d	h	m	Sat.	Phen.
2	2	01	I	Te
5	3	12	II	TI
	3	44	II	Se
6	2	29	III	ER
8	3	23	I	ED
9	1	48	I	TI
	2	55	I	Se
12	3	45	II	SI
13	3	53	III	ED
14	3	47	II	OR
16	2	39	I	SI
	3	46	I	TI
17	1	11	III	Te
	3	07	I	OR
21	1	28	II	ED
24	1	39	I	ED
	2	45	III	TI
25	1	11	I	Se
	2	24	I	Te
28	4	03	II	ED
30	0	46	II	TI
	0	51	II	Se
	3	25	II	Te
31	1	52	III	SI
	3	33	I	ED

SEPTEMBER

d	h	m	Sat.	Phen.
1	0	55	I	SI
	2	09	I	TI
	3	05	I	Se
	4	20	I	Te
2	1	31	I	OR
6	0	51	II	SI
	3	27	II	TI
	3	27	II	Se
8	1	10	II	OR
	2	48	I	SI
	4	05	I	TI
	23	55	I	ED
9	3	27	I	OR
10	0	45	I	Te
11	1	10	III	OD
	3	55	III	OR
13	3	27	II	SI
15	1	07	II	ER
	1	07	II	OD
	3	47	II	OR
16	1	49	I	ED
17	0	28	I	TI
	1	20	I	Se
	2	39	I	Te
	23	50	III	ED
	23	51	I	OR
18	2	30	III	ER
22	1	03	II	ED
	3	41	II	ER
	3	42	II	OD
23	3	43	I	ED
24	0	42	II	Te
	1	04	I	SI
	2	22	I	TI
	3	14	I	Se
	4	33	I	Te
25	1	45	I	OR
	3	48	III	ED
	23	01	I	Te
28	23	07	III	TI
29	1	52	III	Te
	3	37	II	ED

OCTOBER

d	h	m	Sat.	Phen.
1	0	35	II	Se
	0	36	II	TI
	2	57	I	SI
	3	17	II	Te
	4	15	I	TI
2	0	05	I	ED
	3	38	I	OR
	22	43	I	TI
	23	36	I	Se
3	0	53	I	Te
6	0	27	III	Se
	3	00	III	TI
8	0	33	II	SI
	3	09	II	TI
	3	11	II	Se
	4	50	I	SI
9	1	59	I	ED
	23	19	I	SI
10	0	34	I	TI
	0	40	II	OR
	1	29	I	Se
	2	45	I	Te
	23	58	I	OR
13	1	45	III	SI
	4	27	III	Se
15	3	09	II	SI
16	3	53	I	ED
	22	02	II	ED
	23	31	III	OR
17	1	12	I	SI
	2	24	I	TI
	3	07	II	OR
	3	23	I	Se
	4	35	I	Te
	22	22	I	ED
18	1	49	I	OR
	21	35	II	Te
	21	51	I	Se
	23	02	I	Te
23	22	31	III	ER
24	0	25	III	OD
	0	36	II	ED
	3	05	I	SI
	3	13	III	OR
	4	13	I	TI
	5	16	I	Se
25	0	16	I	ED
	3	38	I	OR
	21	21	II	TI
	21	34	I	SI
	21	44	II	Se
	22	40	I	TI
	23	45	I	Se
26	0	03	II	Te
	0	51	I	Te
	22	05	I	OR
30	23	45	III	ED

d	h	m	Sat.	Phen.
31	2	31	III	ER
	3	09	II	ED
	4	02	III	OD
	4	59	I	SI

NOVEMBER

d	h	m	Sat.	Phen.
1	2	10	I	ED
	5	26	I	OR
	21	41	II	SI
	23	27	I	SI
	23	46	II	TI
2	0	21	II	Se
	0	28	I	TI
	1	38	I	Se
	2	27	II	Te
	2	39	I	Te
	20	38	I	ED
	23	58	I	OR
3	20	29	III	Te
	21	05	II	OR
	21	06	I	Te
7	3	44	III	ED
	5	43	II	ED
8	4	04	I	ED
9	0	18	II	SI
	1	20	I	SI
	2	08	II	TI
	2	14	I	TI
	2	58	II	Se
	3	32	I	Se
	4	25	I	Te
	4	50	II	Te
	22	33	I	ED
10	1	40	I	OR
	19	49	I	SI
	20	25	III	Se
	20	40	I	TI
	21	12	III	TI
	22	00	I	Se
	22	52	I	Te
	23	24	II	OR
	23	58	III	Te
11	20	07	I	OR
15	5	58	I	ED
16	2	54	II	SI
	3	14	I	SI
16	3	59	I	TI
	4	29	II	TI
	5	25	I	Se
	5	36	II	Se
17	0	27	I	ED
	3	26	I	OR
	21	34	II	ED
	21	38	III	SI
	21	42	I	SI
	22	26	I	TI
	23	54	I	Se
18	0	25	III	Se
	0	37	I	Te
	0	37	III	TI
	1	41	II	OR
	3	23	III	Te
	21	52	I	OR
19	20	19	II	Te
23	5	07	I	SI
	5	31	II	SI
	5	44	I	TI
24	2	21	I	ED
	5	11	I	OR
	23	36	I	SI
25	0	08	II	ED
	0	10	I	TI
	1	37	III	SI
	1	48	I	Se
	2	22	I	Te
	3	57	II	OR
	3	58	III	TI
	4	26	III	Se
	20	50	I	ED
	23	37	I	OR
26	18	49	II	SI
	19	55	II	TI
	20	16	I	Se
	20	48	I	Te
	21	31	II	Se
	22	37	II	Te
28	20	30	III	OR

DECEMBER

d	h	m	Sat.	Phen.
1	4	16	I	ED
2	1	29	I	SI
	1	54	I	TI
2	2	42	II	ED
	3	42	I	Se
	4	06	I	Te
	5	37	III	SI
	6	11	II	OR
	22	44	I	ED
3	1	22	I	OR
	19	58	I	SI
	20	20	I	TI
	21	26	II	SI
	22	10	I	Se
	22	11	II	TI
	22	32	I	Te
4	0	09	II	Se
	0	53	II	Te
	19	48	I	OR
5	19	17	II	OR
	19	41	III	ED
	23	48	III	OR
9	3	23	I	SI
	3	37	I	TI
	5	16	II	ED
	5	36	I	Se
	5	50	I	Te
10	0	39	I	ED
	3	05	I	OR
	21	52	I	SI
	22	03	I	TI
11	0	03	II	SI
	0	04	I	Se
	0	15	I	Te
	0	27	II	TI
	2	46	II	Se
	3	08	II	Te
	19	08	I	ED
	21	31	I	OR
12	18	33	I	Se
	18	33	II	ED
	18	41	I	Te
	21	30	II	OR
	23	41	III	ED
13	3	04	III	OR
16	5	17	I	SI
	5	20	I	TI
17	2	34	I	ED
	4	49	I	OR
	23	46	I	TI
17	23	46	I	SI
18	1	58	I	Te
	1	58	I	Se
	2	41	II	SI
	2	41	II	TI
	5	23	II	Te
	5	24	II	Se
	21	02	I	OD
	23	16	I	ER
19	18	12	I	TI
	18	14	I	SI
	20	24	I	Te
	20	27	I	Se
	21	03	II	OD
	23	49	II	ER
20	3	31	III	OD
	6	34	III	ER
	17	45	I	ER
21	18	31	II	Te
	18	43	II	Se
23	17	34	III	SI
	19	49	III	Te
	20	27	III	Se
24	4	19	I	OD
25	1	30	I	TI
	1	40	I	SI
	3	42	I	Te
	3	53	I	Se
	4	56	II	TI
	5	18	II	SI
	22	46	I	OD
26	1	11	I	ER
	19	55	I	TI
	20	09	I	SI
	22	08	I	Te
	22	21	I	Se
	23	16	II	OD
27	2	24	II	ER
	19	40	I	ER
28	18	04	II	TI
	18	37	II	SI
	20	46	II	Te
	21	21	II	Se
30	20	16	III	TI
	21	34	III	SI
	23	04	III	Te
31	0	27	III	Se

E—eclipse, O—occultation, T—transit, S—shadow, D—disappearance, R—reappearance, I—ingress, e—egress; E.S.T. (For other times see p. 10.)
The phenomena are given for latitude 45° N., for Jupiter at least one hour above the horizon, and the sun at least one hour below the horizon.

Note: Satellites move from east to west across the face of the planet, and from west to east behind it. Before opposition shadows fall to the west, and after opposition to the east. Thus eclipse phenomena occur on the east side from January to April, and on the west side from July to December. No eclipses of satellite IV are visible this year.

SATURN'S SATELLITES, 1965

Name	Greatest E. Elongation E.S.T.*		Mean Synodic Period	
	d	h	d	h
Mimes	Sept. 6	15.4	0	22.6
Enceladus	Sept. 7	1.4	1	8.9
Tethys	Sept. 6	22.7	1	21.3
Dione	Sept. 7	6.0	2	17.7
Rhea	Sept. 8	11.0	4	12.5
Titan	Sept. 5	9.2†	15	23.3
Hyperion	Sept. 10	8.6†	21	7.6
Iapetus	Oct. 23	11.3†	79	22.1
Phoebe			523	15.6

*Near opposition of Saturn, 1965 Sept. 6.
†See p. 58 for more information.

SATURN'S SATELLITES, TITAN, HYPERION AND IAPETUS

ELONGATIONS AND CONJUNCTIONS, E.S.T. 1965

TITAN

Elong. E.		Inf. Conj.		Elong. W.		Sup. Conj.	
d	h	d	h	d	h	d	h
						Jan. 4	19.4
Jan. 8	17.2	Jan. 12	21.9	Jan. 17	0.0	20	19.6
..	....	..	....	..	....	..	....
..	....	Apr. 3	0.7	Apr. 7	2.2	Apr. 10	21.5
Apr. 14	20.1	19	1.1	23	2.4	26	21.6
30	20.3	May 5	1.2	May 9	2.3	May 12	21.5
May 16	20.1	21	1.0	25	1.9	28	21.0
June 1	19.7	June 6	0.4	June 10	1.2	June 13	20.2
17	18.8	21	23.5	26	0.2	29	19.0
July 3	17.6	July 7	22.1	July 11	22.7	July 15	17.5
19	15.9	23	20.4	27	20.9	31	15.6
Aug. 4	13.9	Aug. 8	18.2	Aug. 12	18.8	Aug. 16	13.4
20	11.6	24	15.9	28	16.4	Sept. 1	11.1
Sept. 5	9.2	Sept. 9	13.4	Sept. 13	14.0	17	8.7
21	6.7	25	10.9	29	11.7	Oct. 3	6.4
Oct. 7	4.4	Oct. 11	8.6	Oct. 15	9.5	19	4.4
23	2.3	27	6.7	31	7.7	Nov. 4	2.7
Nov. 8	0.7	Nov. 12	5.1	Nov. 16	6.3	20	1.3
23	23.4	28	4.0	Dec. 2	5.2	Dec. 6	0.4
Dec. 9	22.6	Dec. 14	3.3	18	4.6	21	23.8
25	22.2	30	3.0				

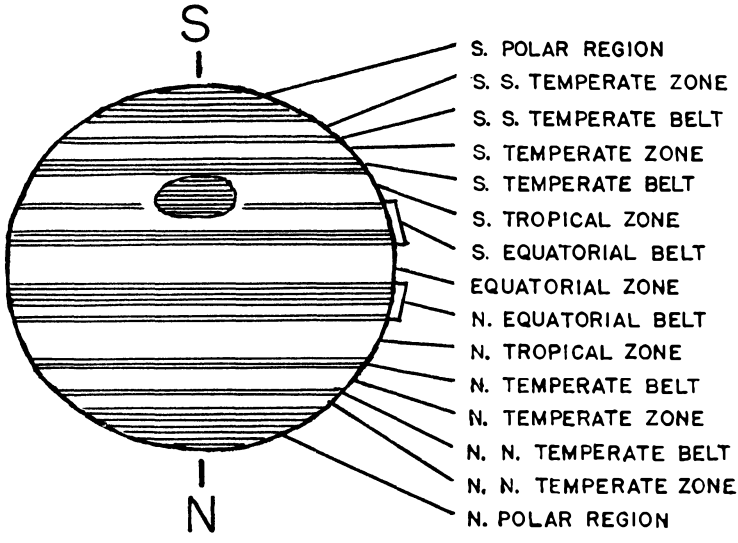
HYPERION

Elong. E.		Inf. Conj.		Elong. W.		Sup. Conj.	
d	h	d	h	d	h	d	h
		Jan. 2	18.4	Jan. 8	7.0	Jan. 12	12.2
Jan. 17	14.0	..	....	..	....	..	....
..	....	..	....	Apr. 4	4.0	Apr. 8	8.9
Apr. 13	17.0	Apr. 20	10.2	25	15.3	29	20.2
May 5	5.5	May 11	22.4	May 17	2.1	May 21	7.0
26	17.3	June 2	9.5	June 7	12.1	June 11	17.0
June 17	3.8	23	19.4	28	21.1	July 3	2.0
July 8	13.0	July 15	3.9	July 20	5.1	24	9.9
29	20.7	Aug. 5	10.9	Aug. 10	11.9	Aug. 14	16.7
Aug. 20	3.1	26	16.8	31	17.8	Sept. 4	22.6
Sept. 10	8.6	Sept. 16	21.9	Sept. 21	23.1	26	4.0
Oct. 1	13.6	Oct. 8	2.6	Oct. 13	4.1	Oct. 17	9.2
22	18.7	29	7.6	Nov. 3	9.1	Nov. 7	14.4
Nov. 13	0.3	Nov. 19	13.1	24	14.4	28	20.0
Dec. 4	6.5	Dec. 10	19.2	Dec. 15	19.9	Dec. 20	1.9
25	13.5						

IAPETUS

Elong. E.		Inf. Conj.		Elong. W.		Sup. Conj.	
d	h	d	h	d	h	d	h
				Jan. 18	9.4	..	....
..	....	..	....	..	....	..	....
..	....	..	....	Apr. 9	18.9	Apr. 29	14.9
May 18	20.2	June 8	7.6	June 29	3.3	July 18	10.7
Aug. 6	4.9	Aug. 26	3.9	Sept. 15	14.2	Oct. 4	18.3
Oct. 23	11.3	Nov. 12	13.3	Dec. 3	10.1	Dec. 23	2.1

JUPITER'S BELTS AND ZONES



Viewed through a telescope of 6-inch aperture or greater, Jupiter exhibits a variety of changing detail and colour in its cloudy atmosphere. Some features are of long duration, others are short-lived. The standard nomenclature of the belts and zones is given in the figure.

DIMENSIONS OF SATURN'S RINGS

Diameter		Miles	At Mean Opposition Distance	Ratio
			"	
Outer Ring, A	— outer	169,100	44.0	2.252
	— inner	148,800	38.7	1.982
Inner Ring, B	— outer	145,400	37.8	1.936
	— inner	112,400	29.2	1.498
Dusky Ring	— inner	92,700	24.1	1.236
Saturn	— equatorial	75,100	19.5	1.000

During 1965 the northern face of Saturn's rings is visible and approaching an edge-on position. The major and minor axes of the outer edge of the outer ring have the following values during the year: Jan. 1, 36.31", 6.08"; May 1, 35.01", 4.02"; June 17, 39.52", 1.76"; Sept. 5, 43.29", 3.23"; Nov. 4, 41.08", 4.16"; Dec. 30, 37.42", 3.19".

LONGITUDE OF JUPITER'S CENTRAL MERIDIAN

By Geoffrey Gaherty, Jr.

The table lists the longitude of the central meridian of the illuminated disk of Jupiter for given times daily during the period when the planet is favourably placed. System I applies to the regions between the middle of the North Equatorial Belt and the middle of the South Equatorial Belt; System II to the rest of the planet. Longitude increases hourly by 36.58° in System I and 36.26° in System II. Detailed ancillary tables may be found in "The Planet Jupiter" by B. M. Peek (Faber & Faber, 1958) on pages 274 and 275.

Month U.T.	SYSTEM I						SYSTEM II					
	Jan. 22^h	Feb. 23^h	Sept. 5^h	Oct. 3^h	Nov. 0^h	Dec. 23^h	Jan. 22^h	Feb. 23^h	Sept. 5^h	Oct. 3^h	Nov. 0^h	Dec. 23^h
Day	°	°	°	°	°	°	°	°	°	°	°	°
1	266.5	154.7	169.0	152.1	258.9	81.0	214.1	225.4	67.9	182.7	54.0	359.8
2	64.3	312.4	326.8	310.0	56.9	239.0	4.3	15.5	218.1	333.0	204.3	150.2
3	222.2	110.1	124.7	107.9	214.9	37.1	154.5	165.6	8.3	123.3	354.7	300.6
4	20.0	267.9	282.5	265.8	12.9	195.1	304.7	315.7	158.5	273.6	145.1	91.0
5	177.8	65.6	80.4	63.7	170.9	353.1	94.9	105.8	308.7	63.9	295.4	241.4
6	335.7	223.3	238.2	221.7	328.9	151.2	245.1	255.9	99.0	214.2	85.8	31.8
7	133.5	21.1	36.1	19.6	126.9	309.2	35.3	46.0	249.2	4.5	236.2	182.2
8	291.3	178.8	193.9	177.5	284.9	107.3	185.5	196.1	39.4	154.8	26.5	332.6
9	89.1	336.5	351.8	335.5	82.9	265.3	335.7	346.2	189.6	305.1	176.9	123.0
10	247.0	134.2	149.6	133.4	240.9	63.3	125.9	136.3	339.9	95.4	327.3	273.5
11	44.8	291.9	307.5	291.3	39.0	221.4	276.1	286.4	130.1	245.7	117.7	63.9
12	202.6	89.7	105.4	89.3	197.0	19.4	66.3	76.5	280.3	36.0	268.1	214.3
13	0.4	247.4	263.2	247.2	355.0	177.5	216.5	226.5	70.6	186.3	58.5	4.7
14	158.2	45.1	61.1	45.2	153.0	335.5	6.6	16.6	220.8	336.6	208.8	155.1
15	316.0	202.8	219.0	203.1	311.0	133.5	156.8	166.7	11.0	127.0	359.2	305.5
16	113.8	0.5	16.8	1.1	109.0	291.6	307.0	316.8	161.3	277.3	149.6	95.9
17	271.6	158.2	174.7	159.0	267.1	89.6	97.1	106.8	311.5	67.6	300.0	246.3
18	69.4	315.9	332.6	317.0	65.1	247.6	247.3	256.9	101.8	217.9	90.4	36.7
19	227.2	113.6	130.5	114.9	223.1	45.7	37.4	47.0	252.0	8.3	240.8	187.1
20	24.9	271.3	288.4	272.9	21.2	203.7	187.6	197.1	42.3	158.6	31.2	337.5
21	182.7	69.0	86.2	70.9	179.2	1.7	337.7	347.1	192.5	308.9	181.6	127.9
22	340.5	226.7	244.1	228.8	337.2	159.8	127.9	137.2	342.8	99.3	332.0	278.3
23	138.3	24.4	42.0	26.8	135.2	317.8	278.0	287.2	133.1	249.6	122.4	68.7
24	296.0	182.1	199.9	184.8	293.3	115.8	68.2	77.3	283.3	39.9	272.8	219.1
25	93.8	339.8	357.8	342.7	91.3	273.8	218.3	227.4	73.6	190.3	63.2	9.5
26	251.6	137.4	155.7	140.7	249.3	71.8	8.4	17.4	223.9	340.6	213.6	159.9
27	49.3	295.1	313.6	298.7	47.4	229.8	158.6	167.5	14.1	131.0	4.0	310.2
28	207.1	92.8	111.5	96.7	205.4	27.8	308.7	317.5	164.4	281.3	154.4	100.6
29	4.8		269.4	254.7	3.5	185.8	98.8		314.7	71.7	304.8	251.0
30	162.6		67.3	52.6	161.5	343.9	248.9		105.0	222.0	95.2	41.4
31	320.3			210.6		141.9	39.1			12.4		191.8

Dec. 1, 0^h U.T.: System I: 319.5°; System II: 245.7°.

CENTRAL MERIDIAN AND TERMINATOR LONGITUDE OF MERCURY

By Geoffrey Gaherty, Jr.

The eccentricity of Mercury's orbit causes libration effects similar to those of the moon. The sub-solar point, i.e. the point on the surface of Mercury at which the sun is overhead, thus varies by 23.7° on either side of its mean position, which is taken as the zero meridian. The apparent shifts in the positions of Mercury's surface markings as a result of this libration must be taken into account in analysing observations of the planet.

The table gives at five-day intervals the central meridian (C.M.) and the longitude of the visible terminator (T.), in terms of the longitude system used in the map by E.-M. Antoniadi. It is based on libration tables by M. B. B. Heath (*J.B.A.A.*, vol. 69, p. 48) and formulae developed by the writer. Note that the central meridian is that of the whole disk, not that of the illuminated portion as in the central meridian tables for Jupiter.

Date	C.M.	T.	Date	C.M.	T.	Date	C.M.	T.	Date	C.M.	T.
	°	°		°	°		°	°		°	°
Jan. 0	−125	−112	Apr. 10	167	−111	July 19	89	82	Oct. 27	50	98
5	−108	−114	15	−170	−105	24	105	89	Nov. 1	63	104
10	−92	−112	20	−149	−101	29	123	96	6	77	109
15	−77	−108	25	−128	−94	Aug. 3	143	102	11	92	113
20	−64	−103	30	−109	−87	8	163	107	16	106	113
25	−51	−97	May 5	−93	−81	13	−176	111	21	125	112
30	−37	−90	10	−77	−75	18	−142	−67	26	145	106
Feb. 4	−24	−83	15	−63	−70	23	−122	−67	Dec. 1	170	97
9	−12	−77	20	−50	−67	28	−102	−71	6	−162	−95
14	0	−72	25	−38	−67	Sept. 2	−92	−86	11	−137	−104
19	11	−68	30	−27	−69	7	−72	−90	16	−118	−111
24	19	−66	Jun. 4	−17	−76	12	−60	−101	21	−100	−113
Mar. 1	35	112	9	−7	−85	17	−48	−109	26	−86	−113
6	45	107	14	3	83	22	−37	−113	31	−72	−110
11	56	99	19	13	74	27	−28	−114	36	−57	−104
16	68	88	24	23	68	Oct. 2	−12	69			
21	81	77	29	34	64	7	−1	73			
26	98	70	Jul. 4	47	68	12	11	78			
31	118	67	9	60	71	17	23	84			
Apr. 5	140	67	14	74	76	22	37	92			

THE OBSERVATION OF THE MOON

During 1965 the ascending node of the moon's orbit moves across the constellation Taurus (☊ from 82° to 63°). See p. 62 for occultations of the planets and stars.

The sun's selenographic colongitude is essentially a convenient way of indicating the position of the sunrise terminator as it moves across the face of the moon. It provides an accurate method of recording the exact conditions of illumination (angle of illumination), and makes it possible to observe the moon under exactly the same lighting conditions at a later date.

The sun's selenographic colongitude is numerically equal to the selenographic longitude of the sunrise terminator reckoned eastward from the mean centre of the disk. Its value increases at the rate of nearly 12.2° per day or about ½° per hour; it is approximately 270°, 0°, 90° and 180° at New Moon, First Quarter, Full Moon and Last Quarter respectively. (See the tabulated values for 0h U.T. starting on p. 33.)

Sunrise will occur at a given point *east* of the central meridian of the moon when the sun's selenographic colongitude is equal to the eastern selenographic

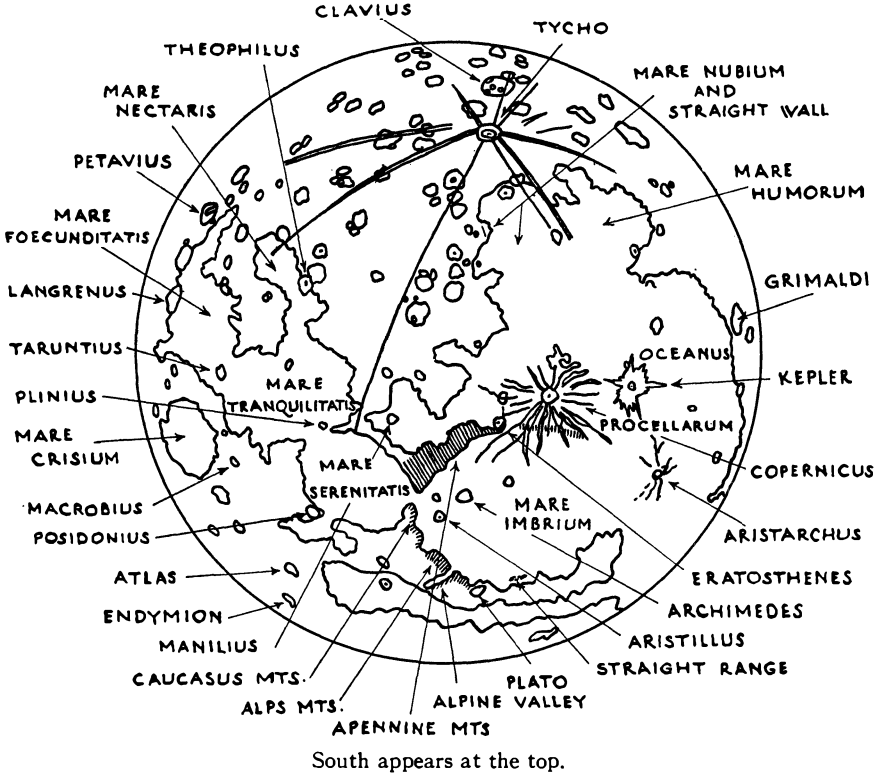
longitude of the point; at a point *west* of the central meridian when the sun's selenographic colongitude is equal to 360° minus the western selenographic longitude of the point. The longitude of the sunset terminator differs by 180° from that of the sunrise terminator.

The sun's selenographic latitude varies between $+1\frac{1}{2}°$ and $-1\frac{1}{2}°$ during the year.

By the moon's libration is meant the shifting, or rather apparent shifting, of the visible disk. Sometimes the observer sees features farther around the eastern or the western limb (libration in longitude), or the northern or southern limb (libration in latitude). The quantities called the earth's selenographic longitude and latitude are a convenient way of indicating the two librations. When the libration in longitude, that is the selenographic longitude of the earth, is positive, the mean central point of the disk of the moon is displaced eastward on the celestial sphere, exposing to view a region on the west limb. When the libration in latitude, or the selenographic latitude of the earth, is positive, the mean central point of the disk of the moon is displaced towards the south, and a region on the north limb is exposed to view.

In the Astronomical Phenomena Month by Month the dates of the greatest positive and negative values of the libration in longitude are indicated by [a] in the column headed "Sun's Selenographic Colongitude," and their values are given in the footnotes. Similarly the extreme values of the libration in latitude are indicated by [b].

MAP OF THE MOON



South appears at the top.

EPHEMERIS FOR THE PHYSICAL OBSERVATIONS OF THE SUN, 1965

For 0h U.T.

Date	P	B_0	L_0	Date	P	B_0	L_0
	°	°	°		°	°	°
Jan. 1	+ 2.11	−3.07	248.18	July 5	− 0.97	+3.34	326.44
6	− 0.32	−3.64	182.33	10	+ 1.30	+3.86	260.27
11	− 2.73	−4.18	116.49	15	+ 3.54	+4.36	194.10
16	− 5.10	−4.69	50.65	20	+ 5.74	+4.82	127.94
21	− 7.40	−5.16	344.81	25	+ 7.89	+5.26	61.79
26	− 9.62	−5.59	278.98	30	+ 9.96	+5.66	355.65
31	−11.75	−5.98	213.15	Aug. 4	+11.95	+6.01	289.53
Feb. 5	−13.76	−6.32	147.32	9	+13.84	+6.33	223.41
10	−15.65	−6.61	81.48	14	+15.63	+6.61	157.31
15	−17.40	−6.85	15.65	19	+17.30	+6.83	91.22
20	−19.02	−7.03	309.80	24	+18.86	+7.01	25.15
25	−20.49	−7.16	243.95	29	+20.28	+7.14	319.09
Mar. 2	−21.80	−7.23	178.09	Sept. 3	+21.57	+7.22	253.04
7	−22.96	−7.25	112.22	8	+22.72	+7.25	187.01
12	−23.95	−7.21	46.33	13	+23.72	+7.23	120.98
17	−24.78	−7.12	340.43	18	+24.57	+7.15	54.97
22	−25.43	−6.97	274.51	23	+25.27	+7.02	348.98
27	−25.92	−6.77	208.58	28	+25.79	+6.84	282.99
Apr. 1	−26.22	−6.53	142.62	Oct. 3	+26.15	+6.61	217.01
6	−26.35	−6.23	76.65	8	+26.33	+6.32	151.04
11	−26.29	−5.89	10.66	13	+26.33	+5.99	85.08
16	−26.05	−5.51	304.64	18	+26.14	+5.62	19.13
21	−25.63	−5.08	238.61	23	+25.76	+5.20	313.18
26	−25.02	−4.63	172.55	28	+25.19	+4.74	247.24
May 1	−24.23	−4.14	106.48	Nov. 2	+24.42	+4.25	181.31
6	−23.26	−3.62	40.39	7	+23.45	+3.72	115.38
11	−22.12	−3.08	334.28	12	+22.29	+3.16	49.46
16	−20.80	−2.52	268.15	17	+20.94	+2.57	343.55
21	−19.32	−1.94	202.01	22	+19.40	+1.97	277.64
26	−17.69	−1.35	135.86	27	+17.69	+1.35	211.74
31	−15.91	−0.75	69.70	Dec. 2	+15.81	+0.72	145.85
June 5	−14.02	−0.15	3.53	7	+13.79	+0.08	79.96
10	−12.01	+0.46	297.35	12	+11.64	−0.56	14.07
15	− 9.91	+1.06	231.17	17	+ 9.39	−1.20	308.20
20	− 7.73	+1.65	164.99	22	+ 7.05	−1.83	242.33
25	− 5.50	+2.23	98.80	27	+ 4.65	−2.44	176.47
30	− 3.24	+2.79	32.62				

P—The position angle of the axis of rotation, measured eastward from the north point of the disk.

B_0—The heliographic latitude of the centre of the disk.

L_0—The heliographic longitude of the centre of the disk, from Carrington's solar meridian.

CARRINGTON'S ROTATION NUMBERS—GREENWICH DATE OF COMMENCEMENT OF SYNODIC ROTATIONS, 1965

No.	Commences	No.	Commences	No.	Commences
1490	Jan. 19.85	1495	June 5.27	1500	Oct. 19.45
1491	Feb. 16.19	1496	July 2.46	1501	Nov. 15.75
1492	Mar. 15.52	1497	July 29.67	1502	Dec. 13.07
1493	Apr. 11.81	1498	Aug. 25.90		
1494	May 9.06	1499	Sept. 22.16		

ECLIPSES DURING 1965

In 1965 there will be four eclipses, two of the sun and two of the moon. Of these, only the partial eclipse of the moon of June 13 will be visible in North America, and that only in the eastern part.

1. *A Total Eclipse of the Sun* on May 30. The eclipse path is almost entirely in the Pacific Ocean, running from the northern tip of New Zealand to the coast of Peru. A partial eclipse will be seen in Mexico and the Carribean islands.

2. *A Partial Eclipse of the Moon* on June 13. The beginning of the eclipse will be visible on the east coast of North America, the end visible over the south-eastern half of North America.

Moon enters umbra.....19h 58m E.S.T.
Middle of eclipse.....20h 49m E.S.T.
Moon leaves umbra.....21h 40m E.S.T.

3. *An Annular Eclipse of the Sun* on November 23. The path runs across the Middle East, South-East Asia, Indonesia, and ends over the Pacific Ocean.

4. *A Penumbral Eclipse of the Moon* on December 8. The eclipse will be visible in Europe, Asia, Africa and Australia, but not in North America.

LUNAR OCCULTATIONS

When the moon passes between the observer and a star that star is said to be occulted by the moon and the phenomenon is known as a lunar occultation. The passage of the star behind the east limb of the moon is called the immersion and its re-appearance from behind the west limb the emersion. As in the case of eclipses, the times of immersion and emersion and the duration of the occultation are different for different places on the earth's surface. The tables given below, are adapted from data supplied by the British Nautical Almanac Office and give the times of immersion or emersion or both for occultations visible from six stations distributed across Canada. Stars of magnitude 7.5 or brighter are included as well as daytime occultations of very bright stars and planets. Since an occultation at the bright limb of the moon is difficult to observe the predictions are limited to phenomena occurring at the dark limb.

The terms a and b are for determining corrections to the times of the phenomena for stations within 300 miles of the standard stations. Thus if λ_0, ϕ_0, be the longitude and latitude of the standard station and λ, ϕ, the longitude and latitude of the neighbouring station then for the neighbouring station we have:

Standard Time of phenomenon = Standard Time of phenomenon at the standard station $+a(\lambda-\lambda_0)+b(\phi-\phi_0)$

where $\lambda-\lambda_0$ and $\phi-\phi_0$ are expressed in degrees. The quantity P is the position angle of the point of contact on the moon's disk reckoned from the north point towards the east.

The co-ordinates of the standard stations are: Halifax, λ_0 63° 36.0′, ϕ_0+44° 38.0′; Montreal, λ_0 73° 34.7′, ϕ_0+45° 30.3′; Toronto, λ_0 79° 23.9′, ϕ_0+43° 39.8′; Winnipeg, λ_0 97° 06.0′, ϕ_0+49° 55.0; Edmonton, λ_0 113° 05′, ϕ_0+53° 32′; Vancouver, λ_0 123° 06′, ϕ_0+49° 30′.

LUNAR OCCULTATIONS VISIBLE AT HALIFAX AND MONTREAL, 1965

Date	Star	Mag.	I or E	Age of Moon	Halifax				Montreal			
					A.S.T.	a	b	P	E.S.T.	a	b	P
				d	h m	m	m	°	h m	m	m	°
Jan. 10	117G. Psc	6.6	I	08.0	17 36.8	−1.4	+1.4	54	Sun	...	...	...
Jan. 11/12	25 (Ari)	6.5	I	09.3	0 09.9	−0.4	−1.3	87	23 03.0	−0.7	−1.2	84
Jan. 14	108 Tau	6.2	I	12.2	20 30.6	−1.5	+0.9	81	19 18.6	−1.1	+1.5	68
Jan. 15	+22° 925	6.5	I	12.4	4 02.8	+1.1	−4.0	156	No Occ.	...	...	...
Jan. 21	ν Vir	4.2	I	18.5	4 53.6	−1.6	−1.0	108	3 37.2	−1.5	−1.0	121
Jan. 21	ν Vir	4.2	E	18.5	6 04.6	−0.9	−2.0	318	4 52.5	−1.2	−1.5	306
Feb. 4	−8°6166	7.1	I	03.2	18 30.8	−0.3	+0.8	28	Sun	...	...	...
Feb. 5	64B. Cet	7.0	I	04.3	Graze	...	...	...	18 32.0	−1.7	−3.0	113
Feb. 7	+7° 324	6.7	I	06.3	20 21.7	−1.1	−0.8	78	19 08.8	−1.3	−0.2	68
Feb. 7	64 Cet	5.7	I	06.4	Low	...	...	...	22 22.3	—	—	145
Feb. 8	+13° 484	7.4	I	07.3	21 20.8	−1.0	0.0	54	20 09.9	−1.2	+0.5	48
Feb. 9/10	163B. Tau	5.8	I	08.5	0 58.9	+0.4	−2.7	128	23 59.9	+0.3	−3.6	137
Feb. 10	+21° 707	6.9	I	09.3	19 15.8	−1.7	+0.7	76	18 01.4	−1.3	+1.5	63
Feb. 11	ι Tau	4.7	I	09.5	Low	...	...	...	1 32.4	—	—	156
Feb. 11	408B. Tau	7.0	I	10.3	19 56.9	—	—	154	18 28.2	−2.1	−1.2	130
Feb. 12	2 Gem	6.9	I	10.6	2 44.1	+0.1	−1.6	108	1 43.2	0.0	−1.9	117
Feb. 12	93B. Gem	6.8	I	11.3	18 27.2	−1.0	+1.2	88	Sun	...	...	...
Feb. 12	ω Gem	5.2	I	11.4	22 21.1	−1.7	−0.9	106	21 03.5	−1.7	−0.4	105
Feb. 13	48 Gem	5.8	I	11.6	3 03.5	−0.8	−0.3	52	1 54.9	−0.9	−0.6	65
Feb. 21	6B. Lib	6.2	E	19.6	1 56.9	−0.3	−1.0	336	0 52.8	−0.4	−0.4	325
Mar. 5	26 Cet	6.2	I	02.5	19 15.2	−0.6	−3.0	116	Sun	...	...	...
Mar. 7	38 Ari	5.2	I	04.6	20 36.9	−0.5	−1.1	80	19 29.0	−0.9	−1.0	78
Mar. 8	+16° 497	7.2	I	05.7	22 45.9	0.0	−1.5	97	21 43.6	−0.2	−1.8	101
Mar. 10	+23° 1007	6.5	I	07.7	23 59.7	+0.2	−2.3	127	22 58.6	+0.1	−3.0	138
Mar. 11	52B. Gem	6.4	I	08.6	20 26.2	−1.8	+0.1	79	19 08.7	−1.8	+0.6	77
Mar. 11	+24° 1332	6.7	I	08.6	20 55.0	−1.6	−1.3	107	19 37.5	−1.7	−0.9	107
Mar. 11	+24° 1343	6.5	I	08.6	21 33.1	−1.6	−0.2	72	20 16.2	−1.7	+0.1	75
Mar. 12	181B. Gem	6.0	I	09.6	19 28.8	−1.7	+3.4	41	Sun	...	...	...
Mar. 13	γ Cnc	4.7	I	10.6	20 23.9	—	—	173	19 05.7	—	—	169
Mar. 19	74 Vir	4.8	E	15.9	Sun	...	...	...	5 02.0	−1.0	−1.5	281
Mar. 19	κ Vir	4.3	I	16.8	22 57.7	−0.6	+0.1	129	Low	...	...	...
Mar. 19/20	κ Vir	4.3	E	16.8	0 06.3	−1.1	+0.3	295	22 56.5	−0.9	+0.8	285
Mar. 22	47 Lib m.	5.9	E	18.8	1 17.0	−0.7	+0.1	310	Low	...	...	...
Apr. 11	167B. Leo	7.1	I	10.1	23 22.8	−1.6	−1.0	91	22 06.1	−1.6	−1.0	105
Apr. 20	39 Oph	5.4	E	18.2	0 54.8	−1.2	+0.9	281	Low	...	...	...
May 4	5 Gem	5.9	I	03.6	Low	...	...	...	21 53.2	+0.1	−1.0	81
May 5	+24° 1576	6.7	I	04.6	22 49.9	−1.0	+0.8	31	21 41.9	−0.7	−0.3	50
May 6	35B. Cnc	6.4	I	05.5	21 08.4	−0.7	−1.6	107	19 59.6	−0.8	−1.8	117
May 10	+6° 2529	7.5	I	09.6	21 24.9	−1.9	−0.6	100	20 06.9	−1.6	−0.6	114
May 22	33 Cap	5.5	E	20.8	2 52.3	—	—	315	Low	...	...	...
May 24	257B. Aqr	6.3	E	22.8	3 01.9	−0.9	+1.8	252	Low	...	...	...
June 2	+24° 1806	6.7	I	03.2	21 38.6	+0.1	−1.3	97	20 38.0	0.0	−1.5	106
June 3	+21° 1952	7.5	I	04.2	21 49.0	−0.8	−0.4	52	20 40.5	−0.8	−0.8	67
June 6	ν Vir	4.2	I	07.2	22 23.6	−1.4	−1.0	75	21 08.0	−1.5	−1.1	89
June 8	65 Vir	5.9	I	09.2	22 17.5	−1.8	−1.0	92	20 58.5	−1.8	−0.9	105
June 8	66 Vir	5.8	I	09.2	23 11.0	−1.4	−1.4	101	21 55.3	−1.5	−1.3	110
June 9	96 Vir	6.5	I	10.2	21 11.4	−0.5	−2.1	169	Sun	...	...	...
July 10	39 Oph	5.4	I	11.9	21 46.0	—	—	41	20 18.9	−2.5	+1.9	57
July 16	143B. Oph	6.2	E	17.1	2 54.5	−1.6	+0.5	235	1 37.8	−1.8	+0.6	248
July 19	30 Psc	4.7	E	20.1	3 05.4	−1.7	+1.3	246	1 50.2	−1.6	+1.4	260
July 24	43 Tau	5.7	E	25.1	3 12.4	−1.1	+0.3	308	No. occ.	...	...	...
Aug. 5	83B. Sco	6.7	I	08.6	22 30.6	−1.3	−1.4	97	21 14.8	−1.6	−1.1	96
Aug. 8	σ Sgr	2.1	I	11.7	Low	...	...	...	23 52.0	−1.9	−1.6	114
Aug. 24	5B. Cnc	6.4	E	26.9	4 19.1	+0.2	+1.8	245	3 22.3	+0.2	+1.4	258
Sept. 1	λ Lib	5.1	I	06.2	20 03.5	−1.5	−0.8	69	18 46.0	−1.9	−0.5	70
Sept. 5	−25° 14115	7.4	I	10.4	Low	...	...	...	22 54.6	−0.8	−0.2	47
Sept. 12	26 Cet	6.2	E	17.4	22 58.2	+0.1	+3.2	178	21 59.2	−0.3	+2.6	195
Sept. 16	224B. Tau m.	6.1	E	21.4	22 41.7	−0.1	+1.0	288	Low	...	...	...
Sept. 16	227B. Tau	5.9	E	21.4	23 07.3	−0.6	+0.5	307	No Occ.	...	...	...
Sept. 20	176B. Gem	6.3	E	24.6	No Occ.	...	...	...	2 50.3	+0.7	+4.2	205
Sept. 20	κ Gem	3.7	I	24.7	Sun	...	...	...	5.04.0	−1.6	−1.1	137

Date	Star	Mag.	I or E	Age of Moon	Halifax				Montreal			
					A.S.T.	a	b	P	E.S.T.	a	b	P
				d	h m	m	m	°	h m	m	m	°
Oct. 5	143B. Cap	6.2	I	10.9	21 33 5	−1.6	+0.4	56	20 19.1	−1.5	+1.0	43
Oct. 8	30 Psc	4.7	I	13.9	20 44.9	−2.2	+0.7	109	19 29.1	−1.3	+1.4	96
Oct. 14	53 Tau	5.4	E	19.2	4 45.4	−1.6	+0.2	246	3 29.0	−1.7	+0.3	254
Oct. 17	57 Gem	5.1	E	22.2	4 50.6	—	—	209	3 41.2	−1.1	+3.4	221
Oct. 29	φ Sgr	3.3	I	05.3	18 34.4	−2.1	−1.8	124	17 12.7	−2.0	−1.0	114
Oct. 29	φ Sgr	3.3	E	05.3	Low	...	...	...	18 25.6	−1.1	−0.4	235
Nov. 3	257B. Aqr	6.3	I	10.5	No Occ.	...	...	...	19 30.8	−2.8	−0.3	107
Nov. 5	−2° 69	6.8	I	12.5	22 34.2	+0.1	+3.0	358	No Occ.	...	...	...
Nov. 6	89 Psc	5.3	I	13.5	21 47.5	−1.1	+1.7	39	20 40.4	−0.6	+2.3	20
Nov. 11	132 Tau	5.0	E	18.5	21 29.6	+0.5	+2.7	206	20 35.8	+0.4	+2.0	223
Nov. 12	37 Gem	5.8	E	19.6	22 59.3	−0.1	+2.2	234	22 00.6	0.0	+1.7	248
Nov. 16	η Leo	3.6	I	21.8	2 49.2	−0.9	+0.2	121	1 41.8	−0.6	+0.6	115
Nov. 16	η Leo	3.6	E	21.8	3 57.8	−1.3	+0.8	279	2 47.0	−1.0	+0.9	281
Nov. 17	+12° 2284	6.4	E	23.7	2 48.9	−0.5	+1.1	279	1 45.7	−0.3	+1.0	285
Dec. 1	336B. Aqr	6.5	I	08.9	22 14.6	−0.5	+0.4	37	21 10.7	−0.4	+1.2	20
Dec. 2	−4° 12	7.5	I	09.9	22 39.5	−0.5	+1.1	26	21 37.2	−0.1	+2.2	6
Dec. 5	+6° 275	7.3	I	12.0	0 44.0	−0.4	+3.0	4	Graze	...	...	...
Dec. 5	31 Ari	5.7	I	13.0	22 55.3	−2.2	−0.9	97	21 34.9	−1.9	+0.4	79
Dec. 15	ν Vir	4.2	I	22.3	5 34.1	−2.0	+0.3	94	4 17.0	−1.5	+0.3	105
Dec. 15	ν Vir	4.2	E	22.3	6 38.8	−0.8	−2.1	337	5 27.8	−1.1	−1.4	323
Dec. 17	66 Vir	5.8	E	24.3	No Occ.	...	...	...	4 14.6	—	—	8
Dec. 19	ν Lib	5.3	E	26.3	No Occ.	...	...	...	5 53.2	—	—	14
Dec. 26	38 Cap	7.0	I	04.0	17 41.2	−0.9	0.0	50	Sun	...	...	...
Dec. 26	37 Cap	5.8	I	04.0	18 07.9	+0.5	+1.9	5	No Occ.	...	...	...

LUNAR OCCULTATIONS VISIBLE AT TORONTO AND WINNIPEG, 1965

Date	Star	Mag.	I or E	Age of Moon	Toronto				Winnipeg			
					E.S.T.	a	b	P	C.S.T.	a	b	P
				d	h m	m	m	°	h m	m	m	°
Jan. 8	30 Psc	4.7	I	06.2	Low	...	...	...	21 31.6	−0.5	−1.1	75
Jan. 11	25 (Ari)	6.5	I	09.3	23 00.3	−1.0	−1.3	89	21 36.4	−1.2	+0.1	59
Jan. 14	108 Tau	6.2	I	12.2	19 09.8	−0.9	+1.7	65	18 16.1	+0.1	+2.7	26
Jan. 14	109 Tau	5.1	I	12.2	No Occ.	...	...	...	19 49.9	−1.9	−0.6	128
Jan. 21	ν Vir	4.2	I	18.5	3 31.2	−1.3	−1.2	134	2 05.0	−1.0	−0.6	137
Jan. 21	ν Vir	4.2	E	18.5	4 46.7	−1.6	−1.1	294	3 14.8	−1.5	0.0	284
Jan. 28	51 Oph	4.9	E	25.6	6 31.1	−1.0	+0.5	298	Low	...	...	...
Feb. 4	64B. Cet	7.0	I	04.3	18 26.1	−2.1	−2.8	112	Sun	...	...	...
Feb. 7	+7° 324	6.7	I	06.3	19 00.7	−1.5	0.0	68	Sun	...	...	...
Feb. 7	64 Cet	5.7	I	06.4	No Occ.	...	...	...	20 49.1	−1.1	−2.5	110
Feb. 7	ξ¹ Cet	4.5	I	06.4	Low	...	...	...	21 44.2	−0.6	−1.5	89
Feb. 8	+13° 484	7.4	I	07.3	20 01.4	−1.4	+0.7	51	18 53.4	−0.5	+3.3	8
Feb. 9	163B. Tau	5.8	I	08.5	No Occ.	...	...	...	22 39.2	−0.7	−3.8	132
Feb. 11	408B. Tau	7.0	I	10.3	18 17.8	−2.1	−0.9	129	Sun	...	...	...
Feb. 12	2 Gem	6.9	I	10.6	1 47.1	0.0	−2.3	130	0 27.5	−0.5	−2.5	129
Feb. 12	ω Gem	5.2	I	11.4	20 54.1	−1.8	−0.5	110	19 31.3	−1.1	+1.3	81
Feb. 13	48 Gem	5.8	I	11.6	1 51.1	−0.9	−0.9	78	0 26.5	−1.3	−0.6	79
Feb. 20	598B. Vir p.	6.5	E	18.7	No Occ.	...	...	...	3 29.7	+0.1	−2.4	0
Feb. 21	6B. Lib	6.2	E	19.6	0 50.8	−0.4	0.0	312	Low	...	...	...
Mar. 5	29 Cet	6.7	I	02.6	Low	...	...	...	19 13.3	−0.4	−0.6	61
Mar. 7	38 Ari	5.2	I	04.6	19 25.2	−1.1	−1.1	84	Sun	...	...	...
Mar. 8	+16° 497	7.2	I	05.7	21 45.8	−0.3	−2.2	112	20 22.2	−1.0	−1.5	95
Mar. 10	+21° 707	6.9	I	06.8	Low	...	...	...	0 33.8	+0.2	−1.4	94
Mar. 10	+23° 1007	6.5	I	07.7	23 07.4	—	—	158	21 37.9	−0.6	−4.2	146
Mar. 11	408B. Tau	7.0	I	07.9	Low	...	...	...	1 47.5	+0.6	−2.1	135
Mar. 11	52B. Gem	6.4	I	08.6	18 57.3	−1.8	+0.6	82	Sun	...	...	...
Mar. 11	+24° 1332	6.7	I	08.6	19 28.7	−1.9	−1.0	114	Sun	...	...	...
Mar. 11	+24° 1343	6.5	I	08.6	20 05.5	−1.8	+0.1	83	Sun	...	...	...
Mar. 12	93B. Gem	6.8	I	08.9	Low	...	...	...	1 48.2	−0.1	−1.2	83
Mar. 13	+23° 1863	6.9	I	09.9	Low	...	...	...	2 34.4	−0.3	−1.0	70
Mar. 15	107B. Leo	6.3	I	12.0	Low	...	...	...	4 45.9	+0.1	−1.6	115
Mar. 19	74 Vir	4.8	E	15.9	4 57.9	−1.3	−1.3	274	3 22 9	−1.9	−0.5	262
Mar. 19	κ Vir	4.3	E	16.8	22 49.0	−0.9	+1.3	272	Low	...	...	...
Mar. 20	2 Lib	6.3	E	17.0	Sun	...	...	...	4 31.9	−1.4	−1.2	296
Mar. 20	4G. Lib m.	6.5	E	17.0	Sun	...	...	...	4 58.6	−0.8	−1.9	340

Date	Star	Mag.	I or E	Age of Moon	Toronto				Winnipeg			
					E.S.T.	a	b	P	C.S.T.	a	b	P
				d	h m	m	m	°	h m	m	m	°
Mar. 22	ω^1 Sco	4.1	I	19.1	Sun	...	...	...	5 13.5	−1.4	−0.9	131
Mar. 23	24 Oph m.	5.6	E	20.0	Sun	...	...	...	5 02.7	−1.1	−0.9	332
Apr. 4	+16° 450	7.0	I	03.1	Low	...	...	...	21 14.3	−0.7	+1.5	14
Apr. 8	52B. Gem	6.4	I	06.2	Low	...	...	...	0 44.6	−0.2	−0.4	46
Apr. 10	γ Cnc	4.7	I	08.3	Low	...	...	...	1 37.4	0.0	−1.6	107
Apr. 11	167B. Leo	7.1	I	10.1	21 59.1	−1.5	−1.2	118	20 28.0	−1.3	−0.5	120
Apr. 11/12	46 Leo	5.7	I	10.2	0 10.7	—	—	52	22 30.5	−2.1	+0.2	73
May 4	5 Gem	5.9	I	03.6	21 55.9	+0.1	−1.2	91	20 46.2	−0.3	−1.5	96
May 5	+24° 1576	6.7	I	04.6	21 38.9	−0.7	−0.6	64	Sun	...	...	...
May 6	35B. Cnc	6.4	I	05.5	19 58.4	−0.8	−2.2	130	Sun	...	...	...
May 9	42 Leo	6.1	I	07.7	1 29.1	−0.2	−0.9	65	0 13.9	−0.7	−1.3	74
May 19	σ Sgr	2.1	I	17.9	4 13.6	−2.2	−1.0	117	2 37.5	−1.6	+0.3	109
June 2	+24° 1806	6.7	I	03.2	20 40.9	0.0	−1.7	116	Sun	...	...	...
June 2	5B. Cnc	6.4	I	03.2	Low	...	...	...	21 23.1	−0.3	−1.1	72
June 3	+21° 1952	7.5	I	04.2	20 37.4	−0.8	−1.1	80	Sun	...	...	...
June 6	ν Vir	4.2	I	07.2	21 01.3	−1.5	−1.3	101	Sun	...	...	...
June 8	65 Vir	5.9	I	09.2	20 50.0	−1.7	−0.9	117	Sun	...	...	...
June 8	66 Vir	5.8	I	09.2	21 48.9	−1.5	−1.4	121	Sun	...	...	...
June 8/9	519B. Vir	7.0	I	09.3	1 03.5	−0.5	−2.2	145	19 38.6	−0.7	−2.0	147
June 11	ν Lib	5.3	I	11.4	Low	...	...	...	0 30.4	−0.9	−2.1	163
June 27	JUPITER	−1.5	I	27.8	No Occ.	...	...	...	11 18.0	−2.0	−2.6	130
June 27	JUPITER	−1.5	E	27.8	No Occ.	...	...	...	12 01.0	−1.2	+3.2	200
July 16	143B. Cap	6.2	E	17.1	1 25.4	−1.9	+0.9	251	0 02.3	−1.4	+1.3	265
July 19	30 Psc	4.7	E	20.1	1 38.8	−1.4	+1.5	263	0 28.5	−0.8	+1.5	282
July 19	33 Psc	4.7	E	20.2	Sun	...	...	...	2 45.5	−1.3	+1.5	244
July 22	ξ Ari	5.5	E	23.2	3 44.7	−1.8	+0.8	287	No Occ.	...	...	...
Aug. 5	83B. Sco	6.7	I	08.6	21 06.5	−1.9	−1.0	100	Sun	...	...	...
Aug. 8	σ Sgr	2.1	I	11.7	23 43.2	−2.1	−1.3	111	22 05.1	−1.8	0.0	96
Aug. 8	σ Sgr	2.1	E	11.7	Low	...	...	...	23 29.5	−1.6	−0.5	258
Aug. 31	22 Lib	6.6	I	05.3	Low	...	...	...	20 07.7	−1.1	−1.4	85
Sept. 5	−25° 14115	7.4	I	10.4	22 49.4	−1.0	+0.1	44	Graze	...	...	...
Sept. 12	26 Cet	6.2	E	17.4	21 52.7	−0.3	+2.5	198	21 02.2	−0.2	+2.1	217
Sept. 13	33 Cet	6.2	E	17.5	2 34.2	—	—	164	1 40.6	−1.0	+1.5	219
Sept. 18	121 Tau	5.3	E	22.6	No Occ.	...	...	...	3 03.9	−0.5	+2.3	228
Sept. 19	ϵ Gem	3.2	I	23.7	No Occ.	...	...	...	5 10.6	−1.6	−0.6	127
Sept. 20	176B. Gem	6.3	E	24.6	2 47.2	+0.7	+3.6	208	2 06.5	+0.2	+1.7	251
Sept. 20	181B. Gem	6.0	E	24.6	No Occ.	...	...	...	2 18.0	+0.6	+2.8	214
Sept. 20	κ Gem	3.7	I	24.7	4 56.4	−1.7	−1.1	140	3 39.8	−0.6	+1.1	101
Sept. 20	κ Gem	3.7	E	24.7	Sun	...	...	...	4 42.1	−0.7	+1.6	260
Oct. 5	143B. Cap	6.2	I	10.9	20 08.0	−1.5	+1.4	39	18 55.6	−1.2	+2.1	18
Oct. 8	30 Psc	4.7	I	13.9	19 19.6	−1.0	+1.4	94	Low	...	...	...
Oct. 8	33 Psc	4.7	I	14.0	No Occ.	...	...	...	20 32.7	—	—	121
Oct. 11	ξ Ari	5.5	E	17.0	No Occ.	...	...	...	20 29.0	+0.4	+2.7	181
Oct. 14	ω Tau	4.8	E	19.1	No Occ.	...	...	...	0 22.8	−0.5	+2.3	220
Oct. 14	53 Tau	5.4	E	19.2	3 17.9	−1.8	+0.6	252	1 46.2	−2.0	−0.3	294
Oct. 16	52 Gem	6.0	E	22.1	23 26.6	—	—	193	Low	...	...	...
Oct. 17	57 Gem	5.1	E	22.2	3 29.0	−0.8	+3.8	217	2 30.3	−0.7	+1.7	256
Oct. 29	φ Sgr	3.3	E	05.3	18 19.0	−1.4	−0.2	238	Sun	...	...	...
Oct. 31	52B. Cap	6.7	I	07.5	No Occ.	...	...	...	19 58.6	—	—	141
Nov. 1	35 Cap	6.0	I	08.5	No Occ.	...	...	...	19 14.3	−2.0	−0.1	93
Nov. 2	−17° 6491	7.4	I	09.6	Low	...	...	...	22 32.1	−1.1	−0.9	75
Nov. 3	257B. Aqr.	6.3	I	10.5	19 15.4	−2.5	+0.4	100	17 51.0	−1.3	+1.5	76
Nov. 5	64B. Cet	7.0	I	12.5	18 42.6	—	—	125	Sun	...	...	...
Nov. 6	89 Psc	5.3	I	13.5	20 32.9	−0.4	+2.6	13	No Occ.	...	...	...
Nov. 11	132 Tau	5.0	E	18.5	20 34.5	+0.4	+1.9	227	Low	...	...	...
Nov. 12	37 Gem	5.8	E	19.6	21 57.8	+0.1	+1.6	251	21 07.8	+0.1	+1.1	282
Nov. 16	η Leo	3.6	I	21.8	1 37.5	−0.5	+0.5	119	0 40.3	+0.1	+1.5	88
Nov. 16	η Leo	3.6	E	21.8	2 39.9	−0.8	+1.1	275	1 34.9	−0.4	+0.5	303
Nov. 17	+12° 2284	6.4	E	23.7	1 42.7	−0.1	+1.0	281	Low	...	...	...
Nov. 30	−15° 6265	7.2	I	07.9	No Occ.	...	...	...	19 20.7	—	—	120
Nov. 30	69 Aqr	5.8	I	08.0	No Occ.	...	...	...	21 43.1	−1.2	−1.5	90
Dec. 1	336B. Aqr	6.5	I	08.9	21 06.1	−0.3	+1.6	15	No Occ.	...	...	...
Dec. 2	−4° 12	7.5	I	09.9	21 32.4	0.0	+2.7	1	No Occ.	...	...	...
Dec. 4	+6° 275	7.3	I	12.0	23 37.8	—	—	345	No Occ.	...	...	...
Dec. 5	31 Ari	5.7	I	13.0	21 23.1	−1.8	+0.8	75	20 11.0	−0.7	+2.1	36
Dec. 15	ν Vir	4.2	I	22.3	4 08.6	−1.3	0.0	118	2 52.8	−0.8	+0.8	109
Dec. 15	ν Vir	4.2	E	22.3	5 22.8	−1.3	−0.9	310	3 59.2	−0.9	−0.2	309
Dec. 17	65 Vir	5.9	E	24.2	3 25.3	+0.3	−3.3	4	No Occ.	...	...	...
Dec. 17	66 Vir	5.8	E	24.3	4 19.8	−0.1	−1.7	348	Low	...	...	...
Dec. 19	ν Lib	5.3	E	26.3	6 02.0	+0.2	−1.4	348	Low	...	...	...
Dec. 28	290B. Aqr	6.4	I	06.2	Low	...	...	...	20 46.6	—	—	354
Dec. 29	70B. Psc	6.8	I	07.2	No Occ.	...	...	...	20 44.0	−1.3	−1.3	87

LUNAR OCCULTATIONS VISIBLE AT EDMONTON AND VANCOUVER, 1965

Date	Star	Mag.	I or E	Age of Moon	Edmonton				Vancouver			
					M.S.T.	a	b	P	P.S.T.	a	b	P
				d	h m	m	m	°	h m	m	m	°
Jan. 5	ϵ Cap	4.7	I	03.2	Low	...	...	...	17 25.2	−0.8	−0.4	54
Jan. 8	30 Psc	4.7	I	06.2	20 19.0	−0.7	−0.2	51	19 11.3	−1.0	+0.1	51
Jan. 8	33 Psc	4.7	I	06.3	Low	...	...	...	21 15.9	−0.7	−1.7	92
Jan. 10	ν Psc	4.7	I	08.3	23 20.6	−0.3	+1.1	17	22 12.6	−0.6	+0.7	30
Jan. 11	25 (Ari)	6.5	I	09.3	20 21.9	−0.9	+1.3	33	19 06.4	−0.9	+1.8	32
Jan. 14	109 Tau	5.1	I	12.2	18 32.4	−0.8	+1.2	96	17 20.9	−0.5	+1.3	93
Jan. 15	175H^1. Tau	6.5	I	12.6	5 00.5	+0.9	−3.1	152	No Occ.	...	...	...
Jan. 15	394B. Tau	6.1	I	12.6	No Occ.	...	...	...	4 28.6	−0.4	−0.2	41
Jan. 20/21	ν Vir	4.2	I	18.5	0 50.7	−0.7	−0.1	136	23 46.6	−0.5	−0.9	155
Jan. 21	ν Vir	4.2	E	18.5	1 54.8	−1.2	+0.8	279	0 37.6	−1.1	+2.0	257
Feb. 7	64 Cet	5.7	I	06.4	19 22.9	−1.3	−0.8	84	18 09.9	−1.7	−0.4	86
Feb. 7	ξ^1 Cet	4.5	I	06.4	20 26.9	−1.0	−0.7	71	19 17.9	−1.4	−0.6	77
Feb. 9	163B. Tau	5.8	I	08.5	21 11.2	−1.3	−2.1	113	20 04.7	−2.0	−3.0	126
Feb. 11	2 Gem	6.9	I	10.6	23 06.4	−1.0	−2.3	127	22 08.6	—	—	152
Feb. 12	8 Gem	6.1	I	10.7	3 13.5	−0.5	−0.3	41	2 11.0	−0.5	−0.8	64
Feb. 12	9 Gem	6.3	I	10.7	3 19.2	0.0	−1.4	94	2 25.8	0.0	−1.8	112
Feb. 12	10 Gem	6.6	I	10.7	4 04.7	+0.4	−1.7	119	3 17.1	+0.6	−2.3	140
Feb. 12	ω Gem	5.2	I	11.4	18 25.6	−0.4	+2.2	57	Sun	...	...	...
Feb. 12	48 Gem	5.8	I	11.6	23 03.8	−1.4	0.0	78	21 49.4	−1.5	−0.1	93
Feb. 20	598B. Vir p.	6.5	E	18.7	2 20.4	−0.4	−1.0	342	1 17.3	−0.7	−0.2	317
Feb. 21	μ Lib f.	5.8	E	19.8	Sun	...	...	...	5 24.0	−2.3	+0.1	253
Mar. 5	33 Cet	6.2	I	02.7	19 48.8	−0.2	+1.3	13	18 42.4	−0.4	+0.7	27
Mar. 5	35 Cet	6.8	I	02.7	Low	...	...	...	19 31.3	−0.3	−1.0	73
Mar. 6	136G. Psc	7.2	I	03.7	20 54.0	−0.2	−1.5	86	19 57.7	−0.5	−2.1	102
Mar. 8	+16° 497	7.2	I	05.7	19 00.0	−1.3	−0.5	79	Sun	...	...	...
Mar. 9	+21° 707	6.9	I	06.8	23 28.6	−0.1	−1.7	98	22 34.8	−0.2	−2.3	118
Mar. 10	+23° 1007	6.5	I	07.7	20 08.6	−1.3	−2.8	133	Graze	...	...	...
Mar. 11	408B. Tau	7.0	I	07.9	0 47.6	+0.5	−3.0	146	No Occ.	...	...	...
Mar. 11/12	93B. Gem	6.8	I	08.9	0 39.0	−0.4	−1.5	92	23 41.0	−0.5	−1.8	110
Mar. 12	ω Gem	5.2	I	09.0	Low	...	...	...	2 45.2	0.0	−0.9	65
Mar. 12	+24° 1806	6.7	I	09.9	No Occ.	...	...	...	22 48.0	−2.2	+1.6	43
Mar. 13	+23° 1863	6.9	I	09.9	1 22.5	−0.6	−1.3	81	0 21.5	−0.7	−1.5	100
Mar. 13	9 Cnc	6.2	I	10.0	4 02.0	+0.4	−1.5	118	3 12.4	+0.4	−1.8	132
Mar. 15	107B. Leo	6.3	I	12.0	3 38.5	−0.2	−1.8	123	2 44.1	−0.2	−2.0	138
Mar. 19	74 Vir	4.8	E	15.9	1 48.8	—	—	239	No Occ.	...	...	...
Mar. 20	2 Lib	6.3	E	17.0	3 06.4	−1.5	−0.3	283	1 48.6	−2.0	+0.8	262
Mar. 20	4 G. Lib m.	6.5	E	17.0	3 39.2	−0.9	−1.1	327	2 32.2	−1.2	−0.7	309
Mar. 22	ω^1 Sco	4.1	I	19.1	3 52.1	−0.9	−0.3	142	2 47.4	−0.3	−1.0	163
Mar. 22	ω^1 Sco	4.1	E	19.1	5 01.2	−1.7	−0.1	263	3 40.0	−2.3	+1.0	246
Mar. 23	24 Oph m.	5.6	E	20.0	3 46.3	−0.8	0.0	319	2 36.6	−0.9	+0.5	301
Apr. 4	+16° 450	7.0	I	03.1	20 08.7	−0.8	+2.1	10	Sun	...	...	...
Apr. 7	52B. Gem	6.4	I	06.2	23 37.1	−0.4	−0.8	58	22 36.7	−0.5	−1.1	78
Apr. 7	+24° 1332	6.7	I	06.3	23 53.2	−0.1	−1.4	86	22 58.3	−0.1	−1.6	104
Apr. 7/8	+24° 1343	6.5	I	06.3	0 29.5	−0.4	−0.5	42	23 29.0	−0.3	−0.9	65
Apr. 8	181B. Gem	6.0	I	07.2	No Occ.	...	...	...	22 24.0	—	—	38
Apr. 9/10	γ Cnc	4.7	I	08.3	0 29.7	−0.2	−1.8	117	23 35.5	−0.2	−2.2	135
Apr. 11	46 Leo	5.7	I	10.2	21 02.7	−1.6	+0.6	84	19 46.0	−1.4	+0.2	105
May 8	42 Leo	6.1	I	07.7	22 55.6	−1.0	−1.3	88	21 51.2	−1.1	−1.5	107
May 9	167B. Leo	7.1	I	07.9	No Occ.	...	...	...	1 30.3	−0.4	−0.8	53
June 8	519B. Vir	7.0	I	09.3	22 20.4	−0.6	−1.8	160	21 25.3	—	—	185
June 8/9	74 Vir	4.8	I	09.4	0 00.4	−0.8	−1.8	133	22 59.5	−0.9	−1.9	143
June 10	2 Lib	6.3	I	10.5	Low	...	...	...	1 01.4	−0.9	−1.5	84
June 10	ν Lib	5.3	I	11.4	23 12.1	—	—	176	No Occ.	...	...	...
June 27	JUPITER	−1.5	I	27.8	9 46.8	−1.4	+0.3	100	8 30.3	−1.4	+0.7	100
June 27	JUPITER	−1.5	E	27.8	10 50.7	−1.1	+1.6	227	9 32.6	−1.0	+2.1	223
July 19	33 Psc	4.7	E	20.2	1 32.9	−1.0	+1.7	260	0 17.5	−0.7	+1.7	261
July 21	ν Psc	4.7	E	22.3	Sun	...	...	...	3 09.7	−0.7	+2.0	222
Aug. 5	−21° 4341	7.1	I	08.7	Low	...	...	...	21 28.5	−1.5	−1.0	92
Aug. 8	σ Sgr	2.1	E	11.7	22 02.9	−1.6	+0.2	265	20 44.3	−1.7	+0.8	259
Aug. 22	412B. Tau	6.0	E	25.0	3 34.1	−0.1	+1.8	248	2 26.7	+0.1	+1.6	251
Sept. 1	−20° 4380	7.2	I	06.4	Low	...	...	...	20 03.8	—	—	180
Sept. 6	−24° 16056	6.9	I	11.5	23 01.9	−1.6	−0.6	91	21 46.4	−1.8	−0.1	87
Sept. 6	30B. Cap	6.9	I	11.5	23 19.3	−1.1	−0.3	55	22 07.0	−1.4	+0.3	50
Sept. 12/13	33 Cet	6.2	E	17.5	0 27.6	−1.1	+1.4	245	23 10.1	−1.1	+1.6	252
Sept. 13	89 Psc	5.3	E	17.7	Sun	...	...	...	4 31.6	−1.1	−0.1	238
Sept. 18	121 Tau	5.3	E	22.6	2 04.0	−0.4	+1.7	254	0 54.4	−0.2	+1.6	257
Sept. 19	ϵ Gem	3.2	I	23.7	3 52.4	−0.9	+1.1	100	2 40.3	−0.6	+1.1	100
Sept. 19	ϵ Gem	3.2	E	23.7	4 56.9	−0.9	+1.7	249	3 41.6	−0.7	+1.9	246
Sept. 20	176B. Gem	6.3	E	24.6	1 14.8	+0.2	+1.2	273	Low	...	...	...
Sept. 20	181B. Gem	6.0	E	24.6	1 32.9	+0.4	+1.7	243	Low	...	...	...
Sept. 20	κ Gem	3.7	I	24.7	2 40.7	0.0	+1.7	78	1 35.4	+0.2	+1.5	77

Date	Star	Mag.	I or E	Age of Moon	Edmonton				Vancouver			
					M.S.T.	a	b	P	P.S.T.	a	b	P
				d	h m	m	m	°	h m	m	m	°
Sept. 20	κ Gem	3.7	E	24.7	3 37.2	−0.5	+1.1	283	2 28.8	−0.3	+1.1	283
Sept. 28	41 Lib	5.5	I	03.9	Low	...	...	...	18 20.5	−1.1	−0.5	48
Oct. 3	−25° 14589	7.2	I	09.1	No Occ.	...	...	...	20 48.8	—	—	146
Oct. 8	336B. Aqr	6.5	I	13.2	2 01.6	−0.6	−0.2	47	0 55.0	−0.8	+0.1	46
Oct. 9	33 Psc	4.7	I	14.0	19 18.1	−0.7	+1.6	104	Low	...	...	...
Oct. 13	26B. Tau	6.4	E	18.4	Sun	...	...	...	5 16.5	−1.1	−0.3	243
Oct. 13	ω Tau	4.8	E	19.1	23 22.8	−0.4	+1.8	245	22 12.3	−0.2	+1.7	250
Oct. 14	224B. Tau m.	6.1	E	19.2	1 33.5	—	—	182	0 20.8	+0.3	+3.6	189
Oct. 14	227B. Tau	5.9	E	19.3	2 25.5	−0.6	+2.9	202	1 08.8	−0.4	+2.9	203
Oct. 14	247B. Tau	5.7	E	19.3	5 22.8	−1.3	−0.9	268	4 10.4	−1.6	0.0	258
Oct. 17	57 Gem	5.1	E	22.2	1 26.6	−0.5	+1.3	280	0 18.2	−0.2	+1.2	281
Oct. 20	46 Leo	5.7	E	25.4	Sun	...	...	...	4 55.4	−0.8	+2.6	247
Oct. 29	−26° 13562	6.3	I	05.5	Low	...	...	...	17 29.9	—	—	16
Oct. 31	52B. Cap	6.7	I	07.5	18 17.0	−1.8	−0.1	110	Sun	...	...	...
Oct. 31	56B. Cap	6.3	I	07.5	19 52.3	−0.9	0.0	41	18 41.0	−1.2	+0.6	36
Nov. 1	35 Cap	6.0	I	08.5	17 48.6	−1.5	+0.9	78	Sun	...	...	...
Nov. 2	−17° 6491	7.4	I	09.6	21 13.9	−1.0	+0.1	48	20 01.5	−1.2	+0.7	41
Nov. 30	−15° 6265	7.2	I	07.9	17 44 4	−1.7	+0.6	87	Sun	...	...	...
Nov. 30	69 Aqr	5.8	I	08.0	20 21.9	−1.1	−0.3	61	19 10.0	−1.3	+0.3	55
Nov. 30	τ Aqr	4.2	I	08.0	22 02.1	−0.1	+0.6	21	20 57.6	−0.2	+0.9	19
Dec. 1	352B. Aqr	7.3	I	09.0	22 39.1	−0.9	−1.1	77	21 32.6	−1.2	−0.8	76
Dec. 5	31 Ari	5.7	I	13.0	19 15.0	+0.2	+2.8	5	18 07.6	—	—	352
Dec. 13	η Leo	3.6	I	20.4	No Occ.	...	...	...	6 03.0	—	—	55
Dec. 13	η Leo	3.6	E	20.4	No Occ.	...	...	...	6 33.9	—	—	3
Dec. 14	+12° 2284	6.4	E	21.4	6 03.3	−0.1	−3.2	358	5 06.6	−0.9	−1.6	329
Dec. 15	ν Vir	4.2	I	22.3	1 47.6	−0.4	+1.3	101	Low	...	...	...
Dec. 15	ν Vir	4.2	E	22.3	2 47.3	−0.6	+0.2	312	1 40.3	−0.5	+0.7	296
Dec. 17	72 Vir	6.1	E	24.4	6 09.3	−1.4	+1.1	270	4 44.0	—	—	235
Dec. 17	74 Vir	4.8	E	24.4	6 20.2	—	—	11	5 26.5	−0.4	−0.9	336
Dec. 26	143B. Cap	6.2	I	04.2	Low	...	...	...	17 52.9	−0.7	0.0	41
Dec. 29	70B. Psc	6.8	I	07.2	19 22.2	−1.1	+0.1	58	18 08.5	−1.3	+0.7	53

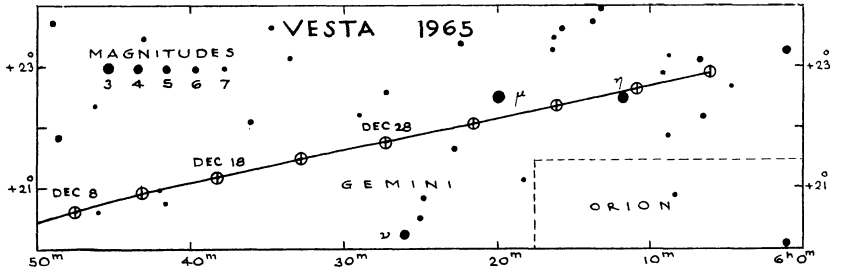
PLANETARY APPULSES AND OCCULTATIONS

A close appulse of the 7.5 mag. star B.D. + 22°1032 with Jupiter's satellite IV will occur on the morning of Aug. 23–24. Observers should watch from 4:30 a.m. to 5:30 a.m. E.S.T. in case an actual occultation occurs, according to Mr. Gordon E. Taylor of the British Astronomical Association. No planetary occultation will be visible from Canada during 1965.

OPPOSITION EPHEMERIDES OF THE BRIGHTEST ASTEROIDS, 1965

The asteroids are many small objects revolving around the sun mainly between the orbits of Mars and Jupiter. The largest, Ceres, is only 480 miles in diameter. Vesta, though half the diameter of Ceres, is brighter. The next brightest asteroids, Juno and Pallas, are 120 and 300 miles in diameter, respectively. Unlike the planets the asteroids move in orbits which are appreciably elongated. Thus the distance of an asteroid from the earth (and consequently its magnitude) varies greatly at different oppositions.

Ephemerides for the four brightest asteroids are given when the asteroids are near opposition, along with maps for Ceres and Vesta. Right ascensions and declinations are for 0h E.T. and equinox of 1950.0.



Opposition Ephemerides of the Brightest Asteroids, 1965

Juno (No. 3)
Opp. Aug. 1 in Aql — Mag. 8.9

July	12	20h	47.4m	−03°11′
	17	20	43.9	−03 27
	22	20	40.0	−03 49
	27	20	35.9	−04 14
Aug.	1	20	31.6	−04 44
	6	20	27.2	−05 17
	11	20	23.0	−05 54
	16	20	19.0	−06 32
	21	20	15.2	−07 12

Pallas (No. 2)
Opp. Aug. 6 in Del — Mag. 9.2

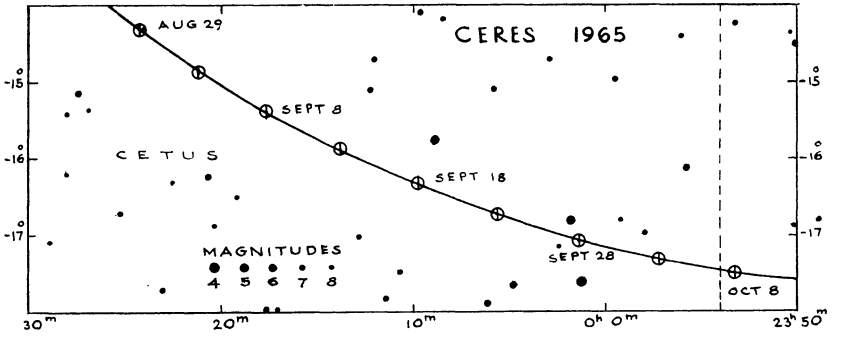
July	17	20h	43.7m	+17°02′
	22	20	40.0	+16 42
	27	20	36.1	+16 15
Aug.	1	20	32.1	+15 42
	6	20	28.2	+15 03
	11	20	24.4	+14 19
	16	20	20.8	+13 30
	21	20	17.4	+12 37
	26	20	14.4	+11 40

Ceres (No. 1)
Opp. Sept. 18 in Cet — Mag. 7.2

Aug.	29	0h	24.2m	−14°19′
Sept.	3	0	21.1	−14 51
	8	0	17.6	−15 23
	13	0	13.8	−15 52
	18	0	09.8	−16 19
	23	0	05.6	−16 44
	28	0	01.4	−17 04
Oct.	3	23	57.2	−17 19
	8	23	53.3	−17 30

Vesta (No. 4)
Opp. Dec. 28 in Gem — Mag. 6.6

Dec.	8	6h	47.6m	+20°38′
	13	6	43.2	+20 54
	18	6	38.2	+21 11
	23	6	32.8	+21 29
	28	6	27.2	+21 46
Jan.	1	6	22.7	+22 00



METEORS, FIREBALLS AND METEORITES

By Peter M. Millman

Meteoroids are small solid particles moving in orbits about the sun. On entering the earth's atmosphere at velocities ranging from 10 to 45 miles per second they become luminous and appear as meteors or fireballs and, if large enough to avoid complete vapourization, in rare cases they may fall to the earth as meteorites.

Meteors are visible on any night of the year. At certain times of the year the earth encounters large numbers of meteors all moving together along the same orbit. Such a group is known as a meteor shower and the accompanying list gives the more important showers visible in 1965. The Leonid shower is increasing in strength and will be of particular interest. The maximum this year comes at the time of last quarter moon, which will interfere with visual and photographic observations. Unfortunately the Perseids, the best shower for the amateur, comes at the time of full moon.

On the average an observer sees 7 meteors per hour which are not associated with any recognized shower. These have been included in the hourly rates listed in the table. The radiant is the position among the stars from which the meteors of a given shower seem to radiate. The appearance of any very bright fireball should be reported immediately to the nearest astronomical group or other organization concerned with the collection of such information. Where no local organization exists, reports should be sent to Meteor Centre, National Research Council, Ottawa 2, Ontario. Free fireball report forms and instructions for their use, printed in either French or English, may be secured at the above address. If sounds are heard accompanying a bright fireball there is a possibility that a meteorite may have fallen. Astronomers must rely on observations made by the general public to track down such an object.

The velocities of shower meteors in miles per second are: Quadrantids, 25; Lyrids, 30; η Aquarids, 40; δ Aquarids, 25; Perseids, 37; Orionids, 41; Taurids, 17; Leonids, 45; Geminids, 22; Ursids, 21.

Meteor Showers For 1965

Shower	Shower Maximum			Radiant				Single Observer Hourly Rate	Normal Duration to ½ strength of Max.
				Position at Max.		Daily Motion			
	Date	E.S.T.	Moon	R.A.	Dec.	R.A.	Dec.		
				h m	°	m	°		(days)
Quadrantids	Jan. 3	07^h	N.M.	15 28	+50	—	—	40	0.6
Lyrids	Apr. 22	00	L.Q.	18 16	+34	+4.4	0.0	15	2.3
η Aquarids	May 5	00	F.Q.	22 24	00	+3.6	+0.4	20	1.8
δ Aquarids	July 29	08	N.M.	22 36	−17	+3.4	+0.17	20	20
Perseids	Aug. 12	03	F.M.	03 04	+58	+5.4	+0.12	50	5.0
Orionids	Oct. 20	15	L.Q.	06 20	+15	+4.9	+0.13	25	8
Taurids	Nov. 5	15	F.M.	03 32	+14	+2.7	+0.13	15	(30)
Leonids	Nov. 16	14	L.Q.	10 08	+22	+2.8	−0.42	25	4
Geminids	Dec. 13	08	L.Q.	07 32	+32	+4.2	−0.07	50	6.0
Ursids	Dec. 22	13	N.M.	14 28	+76	—	—	15	2.2

TABLE OF PRECESSION FOR 50 YEARS

R.A.	Prec. in Dec.	Precession in Right Ascension														Prec. in Dec.	R.A.
		$\delta = +85°$	$+80°$	$+75°$	$+70°$	$+60°$	$+50°$	$+40°$	$+30°$	$+20°$	$+10°$	$0°$	$-10°$	$-20°$	$-30°$		
h m	′	m	m	m	m	m	m	m	m	m	m	m	m	m	m	′	h m
0 00	+16.7	+ 2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	−16.7	12 00
0 30	+16.6	+ 4.22	3.38	3.10	2.96	2.81	2.73	2.68	2.64	2.61	2.59	2.56	2.53	2.51	2.48	−16.6	11 30
1 00	+16.1	+ 5.85	4.19	3.64	3.36	3.06	2.90	2.80	2.73	2.67	2.61	2.56	2.51	2.45	2.39	−16.1	11 00
1 30	+15.4	+ 7.43	4.98	4.15	3.73	3.30	3.07	2.92	2.81	2.72	2.64	2.56	2.49	2.40	2.31	−15.4	10 30
2 00	+14.5	+ 8.92	5.72	4.64	4.09	3.52	3.22	3.03	2.88	2.76	2.66	2.56	2.46	2.36	2.24	−14.5	10 00
2 30	+13.2	+10.31	6.40	5.09	4.42	3.73	3.37	3.13	2.95	2.81	2.68	2.56	2.44	2.31	2.17	−13.2	9 30
3 00	+11.8	+11.56	7.02	5.50	4.73	3.92	3.50	3.22	3.02	2.85	2.70	2.56	2.42	2.27	2.11	−11.8	9 00
3 30	+10.2	+12.66	7.57	5.86	4.99	4.09	3.61	3.30	3.07	2.88	2.72	2.56	2.40	2.24	2.05	−10.2	8 30
4 00	+ 8.3	+13.58	8.03	6.16	5.21	4.23	3.71	3.37	3.12	2.91	2.73	2.56	2.39	2.21	2.00	− 8.3	8 00
4 30	+ 6.4	+14.32	8.40	6.40	5.39	4.34	3.79	3.42	3.16	2.93	2.74	2.56	2.38	2.19	1.97	− 6.4	7 30
5 00	+ 4.3	+14.85	8.66	6.58	5.52	4.42	3.84	3.46	3.18	2.95	2.75	2.56	2.37	2.17	1.94	− 4.3	7 00
5 30	+ 2.2	+15.18	8.82	6.68	5.60	4.47	3.88	3.49	3.20	2.96	2.75	2.56	2.37	2.16	1.92	− 2.2	6 30
6 00	+ 0.0	+15.29	8.88	6.72	5.62	4.49	3.89	3.50	3.20	2.97	2.76	2.56	2.36	2.16	1.92	0.0	6 00
12 00	−16.7	+ 2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+16.7	24 00
12 30	−16.6	+ 0.90	1.82	2.02	2.16	2.31	2.39	2.44	2.48	2.51	2.53	2.56	2.59	2.61	2.64	+16.6	23 30
13 00	−16.1	− 0.73	+0.93	1.48	1.77	2.06	2.22	2.32	2.39	2.45	2.51	2.56	2.61	2.67	2.73	+16.1	23 00
13 30	−15.4	− 2.31	+0.14	0.97	1.39	1.82	2.05	2.20	2.31	2.40	2.49	2.56	2.64	2.72	2.81	+15.4	22 30
14 00	−14.5	− 3.80	−0.60	+0.46	1.03	1.60	1.90	2.09	2.24	2.36	2.46	2.56	2.66	2.76	2.88	+14.5	22 00
14 30	−13.2	− 5.19	−1.28	+0.03	0.70	1.39	1.75	1.99	2.17	2.31	2.44	2.56	2.68	2.81	2.95	+13.2	21 30
15 00	−11.8	− 6.44	−1.90	−0.38	+0.40	1.20	1.62	1.90	2.11	2.27	2.42	2.56	2.70	2.85	3.02	+11.8	21 00
15 30	−10.2	− 7.54	−2.45	−0.74	+0.13	1.03	1.51	1.81	2.05	2.24	2.40	2.56	2.72	2.88	3.07	+10.2	20 30
16 00	− 8.3	− 8.46	−2.91	−1.04	−0.09	+0.89	1.41	1.75	2.00	2.21	2.39	2.56	2.73	2.91	3.12	+ 8.3	20 00
16 30	− 6.4	− 9.20	−3.27	−1.28	−0.27	+0.78	1.33	1.70	1.97	2.19	2.38	2.56	2.74	2.93	3.16	+ 6.4	19 30
17 00	− 4.3	− 9.73	−3.54	−1.45	−0.40	+0.70	1.28	1.66	1.94	2.17	2.37	2.56	2.75	2.95	3.18	+ 4.3	19 00
17 30	− 2.2	−10.06	−3.70	−1.56	−0.47	+0.65	1.25	1.63	1.92	2.16	2.37	2.56	2.75	2.96	3.20	+ 2.2	18 30
18 00	− 0.0	−10.17	−3.75	−1.60	−0.50	+0.63	1.23	1.62	1.92	2.16	2.36	2.56	2.76	2.97	3.20	+ 0.0	18 00

FINDING LIST OF NAMED STARS

Name		R.A.	Name		R.A.
Acamar	θ Eri	02	Fomalhaut	α PsA	22
Achernar	α Eri	01	Gacrux	γ Cru	12
Acrux	α Cru	12	Gienah	γ Crv	12
Adhara	ϵ CMa	06	Hadar	β Cen	14
Al Na'ir	α Gru	22	Hamal	α Ari	02
Albireo	β Cyg	19	Kaus Australis	ϵ Sgr	18
Alcyone	η Tau	03	Kochab	β UMi	14
Aldebaran	α Tau	04	Markab	α Peg	23
Alderamin	α Cep	21	Megrez	δ UMa	12
Algenib	γ Peg	00	Menkar	α Cet	03
Algol	β Per	03	Menkent	θ Cen	14
Alioth	ϵ UMa	12	Merak	β UMa	10
Alkaid	η UMa	13	Miaplacidus	β Car	09
Almach	γ And	02	Mira	o Cet	02
Alnilam	ϵ Ori	05	Mirach	β And	01
Alphard	α Hya	09	Mirfak	α Per	03
Alphecca	α CrB	15	Mizar	ζ UMa	13
Alpheratz	α And	00	Nunki	σ Sgr	18
Altair	α Aql	19	Peacock	α Pav	20
Ankaa	α Phe	00	Phecda	γ UMa	11
Antares	α Sco	16	Polaris	α UMi	01
Arcturus	α Boo	14	Pollux	β Gem	07
Atria	α TrA	16	Procyon	α CMi	07
Avior	ϵ Car	08	Ras-Algethi	α Her	17
Bellatrix	γ Ori	05	Rasalhague	α Oph	17
Betelgeuse	α Ori	05	Regulus	α Leo	10
Canopus	α Car	06	Rigel	β Ori	05
Capella	α Aur	05	Rigil Kentaurus	α Cen	14
Caph	β Cas	00	Sabik	η Oph	17
Castor	α Gem	07	Scheat	β Peg	23
Deneb	α Cyg	20	Schedar	α Cas	00
Denebola	β Leo	11	Shaula	λ Sco	17
Diphda	β Cet	00	Sirius	α CMa	06
Dubhe	α UMa	11	Spica	α Vir	13
Elnath	β Tau	05	Suhail	λ Vel	09
Eltanin	γ Dra	17	Vega	α Lyr	18
Enif	ϵ Peg	21	Zubenelgenubi	α Lib	14

THE BRIGHTEST STARS

By Donald A. MacRae

The 286 stars brighter than apparent magnitude 3.55.

Star. If the star is a visual double the letter *A* indicates that the data are for the brighter component. The brightness and separation of the second component *B* are given in the last column. Sometimes the double is too close to be conveniently resolved and the data refer to the combined light, *AB*; in interpreting such data the magnitudes of the two components must be considered.

Visual Magnitude (*V*). These magnitudes are based on *photoelectric observations*, with a few exceptions, which have been adjusted to match the yellow colour-sensitivity of the eye. The photometric system is that of Johnson and Morgan in *Ap. J.*, vol. 117, p. 313, 1953. It is as likely as not that the true magnitude is within 0.03 mag. of the quoted figure, on the average. Variable stars are indicated with a "v". The type of variability, range, *R*, in magnitudes, and period in days are given.

Colour index (*B–V*). The blue magnitude, *B*, is the brightness of a star as observed photoelectrically through a blue filter. The difference *B–V* is therefore a measure of the colour of a star. The table reveals a close relaton between *B–V* and spectral type. Some of the stars are slightly reddened by interstellar dust. The probable error of a value of *B–V* is only 0.01 or 0.02 mag.

Type. The customary spectral (temperature) classification is given first. The Roman numerals are indicators of *luminosity class.* They are to be interpreted as follows: Ia—most luminous supergiants; Ib—less luminous supergiants; II—bright giants; III—normal giants; IV—subgiants; V—main sequence stars. Intermediate classes are sometimes used, e.g. Iab. Approximate absolute magnitudes can be assigned to the various spectral and luminosity class combinations. Other symbols used in this column are: p—a peculiarity; e—emission lines; v—the spectrum is variable; m—lines due to metallic elements are abnormally strong; f—the O-type spectrum has several broad emission lines; n or nn—unusually wide or diffuse lines. A composite spectrum, e.g. M1 Ib+B, shows up when a star is composed of two nearly equal but unresolved components. In the far southern sky, spectral types in italics were provided through the kindness of Prof. R. v. d. R. Woolley, Australian Commonwealth Observatory. Types in parentheses are less accurately defined (g—giant, d—dwarf, c–exceptionally high luminosity). All other types were very kindly provided especially for this table by Dr. W. W. Morgan, Yerkes Observatory.

Parallax (π). From "General Catalogue of Trigonometric Stellar Parallaxes" by Louise F. Jenkins, Yale Univ. Obs., 1952.

Absolute visual magnitude (M_V), and *distance in light-years* (D). If π is greater than 0.030″ the distance corresponds to this trigonometric parallax and the absolute magnitude was computed from the formula $M_V = V + 5 + 5 \log \pi$. Otherwise a generally more accurate absolute magnitude was obtained from the luminosity class. In this case the formula was used to *compute* π and the distance corresponds to this "spectroscopic" parallax. The formula is an expression of the inverse square law for decrease in light intensity with increasing distance. The effect of absorption of light by interstellar dust was neglected, except for three stars, ζ Per, σ Sco and ζ Oph, which are significantly reddened and would therefore be about a magnitude brighter if they were in the clear.

Annual proper motion (μ), and *radial velocity* (R). From "General Catalogue of Stellar Radial Velocities" by R. E. Wilson, Carnegie Inst. Pub. 601, 1953. Italics indicate an average value of a variable radial velocity.

The star names are given for all the officially designated navigation stars and a few others. Throughout the table, a *colon* (:) indicates an uncertainty.

We are indebted to Dr. Daniel L. Harris, Yerkes Observatory, particularly for his compilation of the photometric data from numerous sources.

Star	Right Ascension 1960	Declination 1960	Visual Magnitude	Colour Index	Spectral Classification	Parallax	Absolute Magnitude	Distance light-years	Proper Motion	Radial Velocity	
	h m	° ′	V	$B-V$	Type	π	M_V	D	μ	R	
						″		l.y.	″	km./sec.	
SUN			−26.73	+0.63	G2 V		+4.84				***Sun***
α And	00 06.3	+28 52	2.06	−0.08	B9p	0.024	−0.1	90	0.209	*−11.7*	Manganese star ***Alpheratz***
β Cas	07.0	+58 56	2.26	+0.34	F2 IV	0.072	+1.6	45	0.555	+11.8	***Caph***
γ Peg	11.2	+14 58	2.84v	−0.23	B2 IV	−.004	−3.4	570	0.010	+04.1	β CMa type, R in V 2.83–2.85, 0.15^d
β Hyi	23.7	−77 29	2.78	+0.62	*G1 IV*	0.153	+3.7	21	2.255	+22.8	γ Peg = ***Algenib***
α Phe	24.3	−42 31	2.39	+1.08	*K0 III*	0.035	+0.1	93	0.442	*+74.6*	***Ankaa***
δ And *A*	37.2	+30 39	3.25:	+1.26	K3 III	0.024	−0.2	160	0.161	−07.3	*B* 12^m 28″
α Cas	38.2	+56 19	2.16	+1.18	K0 II–III	0.009	−1.1	150	0.058	−03.8	Var.? ***Schedar***
β Cet	41.6	−18 12	2.02	+1.03	K1 III	0.057	+0.8	57	0.234	+13.1	***Diphda***
η Cas *A*	46.7	+57 36	3.47	+0.56	G0 V	0.182	+4.8	18	1.221	+09.4	*B* 7.26^m 9″
γ Cas *A*	54.3	+60 30	2.13v	−0.16v	B0 IV: pe	0.034	−0.3:	96:	0.026	−06.8	Var. *B* 8.18^m 2″
β Phe *AB*	01 04.3	−46 56	3.30	+0.88	*G8 III*	0.017	+0.3	190	0.035	−01.1	*A* 4.1^m *B* 4.1^m 2″
η Cet	06.6	−10 24	3.47	+1.16	K3 III	0.032	+1.0	102	0.250	+11.5	
β And	07.5	+35 25	2.02	+1.57	M0 III	0.043	+0.2	76	0.211	+00.3	***Mirach***
δ Cas	23.2	+60 02	2.67	+0.13	A5 V	0.029	+2.1	43	0.301	+06.7	Ecl.? *R* 0.08:^{m} 759^d
γ Phe	26.6	−43 31	3.44	+1.56	*K5 Ib*	−.003	−4.6	1300	0.209	*+25.7*	
α Eri	36.2	−57 26	0.51	−0.16	*B5 IV:*	0.023	−2.3	118	0.098	+19	***Achernar***
τ Cet	42.2	−16 09	3.50	+0.72	G8 Vp	0.275	+5.70	12	1.921	−16.2	

Star	R.A. 1960 h m	Dec. ° ′	V	$B-V$	Type	π	M_V	D	μ	R	
						″		l.y.	″	km./sec.	
α Tri	01 50.8	+29 23	3.45	+0.46	F6 IV	0.050	+2.0	65	0.230	*−12.6*	
ϵ Cas	51.5	+63 28	3.33	−0.15	B3 IV: p	0.007	−2.7	520	0.038	−08.1	
β Ari	52.4	+20 37	2.68	+0.14	A5 V	0.063	+1.7	52	0.147	*−01.9*	
α UMi *A*	55.5	+89 05	1.99v	+0.60v	F8 Ib	0.003	−4.6	680	0.046	*−17.4*	Cep., *R* 0.11^m 4.0^d, *B* 8.9^m 18″ *Polaris*
α Hyi	57.5	−61 46	2.84	+0.28	*F0 V*		+2.9	31	0.265	+07	
											γ And = *Almach*
γ And *A*	02 01.4	+42 08	2.14:	+1.16:	K3 II	0.005	−2.4	260	0.068	−11.7	*B* 5.4^m *C* 6.2^m *A–BC* 10″ *B–C* 0.7″
α Ari	04.9	+23 16	2.00	+1.15	K2 III	0.043	+0.2	76	0.241	−14.3	*Hamal*
β Tri	07.2	+34 48	3.00	+0.13	A5 III	0.012	−0.1	140	0.156	*+09.9*	
o Cet *A*	17.3	−03 09	2.0v		(gM6e)	0.013	−0.5	103	0.232	+63.8	LP, *R* 2.0–10.1, 332^d, *B* 10^m 1″ *Mira*
γ Cet *AB*	41.2	+03 04	3.48	+0.11	A2 V	0.048	+2.0	68	0.203	−05.1	*A* 3.57^m *B* 6.23^m 3″
θ Eri *AB*	56.7	−40 28	2.92	+0.13	*A3 V*	0.028	+1.7	65	0.061	*+11.9*	*A* 3.25^m *B* 4.36^m 8″ *Acamar*
α Cet	03 00.2	+03 56	2.54	+1.63	M2 III	0.003	−0.5	130	0.075	−25.9	*Menkar*
γ Per	01.9	+53 21	2.91:	+0.72:	G8III: +A3:	0.011	+0.3	113	0.004	*+02.5*	
ρ Per	02.6	+38 41	3.5v		M4 II–III	0.008	−1.0	260	0.172	+28.2	Irr. *R* 3.2–3.8
β Per	05.6	+40 48	2.06v	−0.07	B8 V	0.031	−0.5	105	0.006	*+04.0*	Ecl. *R* 2.06–3.28, 2.87^d *Algol*
α Per	21.5	+49 43	1.80	+0.48	F5 Ib	0.029	−4.4	570	0.035	−02.4	*Mirfak*
δ Per	40.1	+47 40	3.03	−0.14	B5 III	0.007	−3.3	590	0.046	−09	
η Tau	45.1	+23 59	2.86	−0.09	B7 III	0.005	−3.2	541	0.050	+10.1	in Pleiades *Alcyone*
γ Hyi	47.8	−74 22	3.30	+1.61	*M2 II–III*	−.001	−1.5	300	0.125	+16.0	
ζ Per *A*	51.6	+31 46	2.83	+0.13	B1 Ib	0.007	−6.1	1000	0.015	+20.6	*B* 9.36^m 13″
ϵ Per *A*	55.2	+39 54	2.88	−0.17	B0.5 V	−.001	−3.7	680	0.036	−01	*B* 7.99^m 9″
γ Eri	56.2	−13 37	3.01	+1.58	M0 III	0.003	−0.5	160	0.126	+61.7	
α Ret *A*	04 13.9	−62 34	3.33	+0.91	*G6 II*	0.008	−2.1	390	0.064	+35.6	*B* 12^m 49″
ϵ Tau	26.3	+19 06	3.54	+1.02	K0 III	0.018	+0.1	160	0.118	+38.6	
θ^2 Tau	26.4	+15 47	3.42	+0.17	A7 III	0.025	+0.2	140	0.108	*+39.5*	
α Dor	33.1	−55 08	3.28	−0.08	*A0 IIIp*	0.011	−1.2	260	0.051	+25.6	Silicon star
α Tau *A*	33.6	+16 26	0.86v	+1.52	K5 III	0.048	−0.7	68	0.202	+54.1	Irr.? *R* 0.78–0.93, *B* 13^{m}31″ ***Aldebaran***
π^3 Ori	47.7	+06 54	3.17	+0.45	F6 V	0.125	+3.65	26	0.468	+24.3	
ι Aur	54.4	+33 06	2.64:	+1.49	K3 II	0.015	−2.4	330	0.021	+17.5	

α UMi, *Polaris:* R.A. 1 h 59.4 m; Dec. +89° 06′ (1965).

Star	R.A 1960 h m	Dec. ° ′	V	$B-V$	Type	π	M_V	D	μ	R	
						″		l.y.	″	km./sec.	
ϵ Aur	04 59.1	+43 46	3.0v	+0.50:	F0 Iap	0.004	−7.1	3400	0.008	*−02.5*	Ecl. R 0.81^m 9886^d
η Aur	05 03.7	+41 11	3.17	−0.18	B3 V	0.013	−2.1	370	0.077	+07.4	
ϵ Lep	03.8	−22 25	3.21	+1.46	*K5 III*	0.006	−0.4	170	0.077	+01.0	
β Eri	05.9	−05 08	2.79	+0.13	A3 III	0.042	+0.9	78	0.122	−08	
μ Lep	11.1	−16 15	3.29	−0.09	*B9 IIIp*	0.018	−2.1	390	0.049	+27.7	Manganese star
β Ori A	12.6	−08 15	0.14v	−0.04	B8 Ia	−.003	−7.1	900	0.001	*+20.7*	Irr.? R 0.08–0.20, B 6.65^m 9″ ***Rigel***
α Aur	13.7	+45 58	0.05	+0.80	G8III: +F	0.073	−0.6	45	0.435	*+30.2*	***Capella***
η Ori AB	22.5	−02 26	3.32v	−0.18	B0.5 V	0.004	−3.7	940	0.008	*+19.8*	Ecl. R 3.32–3.50, 8.0^d, A 3.59^m B 4.98^m 1″
γ Ori	23.0	+06 19	1.64	−0.23	B2 III	0.026	−4.2	470	0.015	+18.2	*Bellatrix*
β Tau	23.8	+28 35	1.65	−0.13	B7 III	0.018	−3.2	300	0.178	+08.0	*Elnath*
β Lep A	26.5	−20 47	2.81	+0.82	G5 III	0.014	+0.1	113	0.090	−13.5	B 9.4^m 3″
δ Ori A	30.0	−00 20	2.20v	−0.20	O9.5 II	0.004	−6.1	1500	0.002	*+16.0*	Ecl. R 2.20–2.35 5.7^d, B 6.74^m 53″
α Lep	31.0	−17 51	2.58	+0.22	F0 Ib	0.002	−4.6	900	0.006	+24.7	
λ Ori AB	32.9	+09 55	3.40	−0.18	O8	0.006	−5.1	1800	0.006	+33.5	A 3.56^m B 5.54^m 4″ C 10.92^m 29″
ι Ori AB	33.5	−05 56	2.76	−0.24	O9 III	0.021	−6.1	2000	0.005	*+21.5*	A 2.78^m B 7.31^m 11″
ϵ Ori	34.2	−01 14	1.70	−0.19	B0 Ia	−.007	−6.8	1600	0.000	+26.1	*Alnilam*
ζ Tau	35.3	+21 07	3.07:	−0.13:	B2 III: p	−.002	−4.2	940	0.023	*+24.3*	Shell star
α Col A	38.2	−34 06	2.64	−0.11	*B8 Ve*	−.005	−0.6	140	0.026	+35	B 12^m 12″
ζ Ori AB	38.7	−01 58	1.79	−0.22	O9.5 Ib	0.022	−6.6	1600	0.004	+18.1	A 1.91^m B 4.05^m 3″
κ Ori	45.9	−09 41	2.06	−0.17	B0.5 Ia	0.009	−6.9	2100	0.004	+20.6	
β Col	49.5	−35 47	3.12	+1.16	(gK1)	0.023	+0.0	140	0.402	+89.4	
α Ori	53.0	+07 24	0.41v	+1.87:	M2 Iab	0.005	−5.6	520	0.028	*+21.0*	Irr.? R 0.06:–0.75:^{m} ***Betelgeuse***
β Aur	56.6	+44 57	1.86	+0.06	A2 V	0.037	−0.3	88	0.051	*−18.2*	
θ Aur AB	57.0	+37 13	2.65	−0.07	B9.5pv	0.018	+0.1	108	0.097	+29.3	Silicon star A 2.67^m B 7.14^m 3″
η Gem A	06 12.5	+22 31	3.33v	+1.58	M3 III	0.013	−0.6	200	0.066	*+19.0*	R 0.27^m, B 6.70^m 1″
ζ CMa	18.8	−30 03	3.04	−0.18	B2.5 V	−.003	−2.4	390	0.004	*+32.2*	
μ Gem	20.5	+22 32	2.92v	+1.63	M3 III	0.021	−0.6	160	0.129	+54.8	R 0.14^m
β CMa	20.9	−17 56	1.96	−0.24	B1 II–III	0.014	−4.8	750	0.004	*+33.7*	β CMa type variable
α Car	23.1	−52 40	−0.72	+0.16	F0 Ib–II	0.018	−3.1	98	0.025	+20.5	***Canopus***
γ Gem	35.4	+16 26	1.93	0.00	A0 IV	0.031	−0.6	105	0.066	*−12.5*	

Star	R.A. 1960 h m	Dec. ° ′	V	$B-V$	Type	π	M_V	D	μ	R	
						″		l.y.	″	km./sec.	
ν Pup	06 36.5	−43 10	3.19	−0.10	*B7 III*		−3.2	620	0.010	+28.2	
ϵ Gem	41.5	+25 10	3.00	+1.39	G8 Ib	0.009	−4.6	1080	0.016	+09.9	
ξ Gem	43.0	+12 56	3.38	+0.43	F5 IV	0.051	+1.9	64	0.224	+25.3	
α CMa *A*	43.4	−16 40	−1.42	+0.01	A1 V	0.375	+1.45	8.7	1.324	*−07.6*	*B* 8.66^m 1960: 9″, θ = 90° ***Sirius***
α Pic	47.8	−61 54	3.27	+0.21	*A5 V*		+2.1	57	0.272	+20.6	
τ Pup	48.9	−50 34	2.97	+1.17	*K0 III*		+0.1	124	0.079	*+36.4*	
ϵ CMa *A*	57.1	−28 55	1.48:	−0.18:	B2 II		−5.1	680	0.004	+27.4	*B* 7.5^m 8″ ***Adhara***
o^2 CMa	07 01.4	−23 46	3.02	−0.09	B3 Ia		−7.1	3400	0.000	+48.4	
δ CMa	06.8	−26 20	1.85	+0.65	F8 Ia	−.018	−7.1	2100	0.005	+34.3	
L_2 Pup	12.3	−44 34			(gM5e)	0.016	−3.1	650	0.342	+53.0	LP, *R* 3.4–6.2, 141^d
π Pup	15.7	−37 01	2.81	+1.56:	(gK4)	0.023	−0.3	140	0.008	+15.8	
η CMa	22.5	−29 13	2.46	−0.08	B5 Ia		−7.1	2700	0.008	+41.1	
β CMi	25.0	+08 22	2.91	−0.09	B7 V	0.020	−1.1	210	0.065	+22	
σ Pup *A*	28.0	−43 13	3.28	+1.49	(gK5)	0.013	−0.4	180	0.195	*+88.1*	*B* 9.4^m 22″
α Gem *A*	32.0	+31 59	1.97	+0.00:	A1 V	0.072	+1.3	45	0.199	+06.0	} 5″, *B–V*+0.02, *C* 9.08v^m 73″ *Castor*
α Gem *B*	32.0	+31 59	2.95	+0.07:	A5m	0.072	+2.3	45	0.199	−01.2	
α CMi *A*	37.2	+05 20	0.37	+0.41	F5 IV–V	0.288	+2.7	11.3	1.250	−03.2	*B* 10.7^m 5″ ***Procyon***
β Gem	42.9	+28 07	1.16	+1.02	K0 III	0.093	+1.0	35	0.625	+03.3	***Pollux***
ξ Pup	47.6	−24 45	3.34	+1.23	G3 Ib	−.003	−4.6	1240	0.005	*+02.7*	
χ Car	55.8	−52 52	3.48	−0.18	(B3)		−2.1	430	0.039	+19.1	
ζ Pup	08 02.2	−39 53	2.23	−0.26	O5f		−7.1	2400	0.033	−24	
ρ Pup	05.8	−24 11	2.80v	+0.42	F6 IIp	0.031	+0.3:	105:	0.098	+46.6	Var. *R* 2.72–2.87
γ Vel *A*	08.3	−47 14	1.88	−0.26	*WC7*		−4.1	520	0.011	+35	*B* 4.31^m 41″
ϵ Car	21.7	−59 23	1.97	+1.14:	(K0 + B)		−3.1:	340	0.030	+11.5	***Avior***
o UMa *A*	27.0	+60 51	3.37	+0.83	G5 III	0.004	+0.1	150	0.171	+19.8	*B* 15^m 7″
δ Vel *AB*	43.6	−54 34	1.95	+0.05	*A0 V*	0.043	+0.2	76	0.086	+02.2	*A* 2.0^m *B* 5.1^m 3″ *CD* 10^m 69″
ϵ Hya *ABC*	44.7	+06 34	3.39	+0.68	G0 comp.	0.010	+0.6	140	0.198	*+36.4*	*A*3.7^m*B*5.2^{m}0.2″15^y, *C*6.8^{m}3″*D*12^{m}20″
ζ Hya	53.3	+06 06	3.11	+1.00	K0 II–III	0.029	−1.1	220	0.101	+22.8	
ι UMa *A*	56.5	+48 12	3.12	+0.19	A7 V	0.066	+2.2	49	0.505	+12.2	*BC* 10.8^m 7″

Star	R.A. 1960		Dec.	V	$B-V$	Type	π	M_V	D	μ	R	
	h	m	° ′				″		l.y.	″	km./sec.	
λ Vel	09	06.5	−43 16	2.24	+1.64:	*K5 Ib*	0.015	−4.6	750	0.026	+18.4	*Suhail*
a Car		09.9	−58 48	3.43	−0.17	*B3 IV*		−2.9	590	0.028	*+23.3*	
β Car		12.8	−69 33	1.67	+0.01	*A0 III*	0.038	−0.4	86	0.183	−05	*Miaplacidus*
ι Car		16.0	−59 06	2.25	+0.17	*F0 Ib*		−4.6	750	0.019	+13.3	
α Lyn		18.6	+34 34	3.17	+1.54	M0 III	0.021	−0.5	180	0.217	+37.6	
κ Vel		20.9	−54 50	2.45	−0.15	*B2 IV*	0.007	−3.4	470	0.012	*+21.9*	
α Hya		25.6	−08 29	1.98	+1.44	K4 III	0.017	−0.3	94	0.034	−04.3	*Alphard*
N Vel		30.0	−56 51	3.19	+1.56	(gK5)	0.015	−0.4	170	0.036	−13.9	
θ UMa *A*		30.2	+51 52	3.19	+0.46	F6 IV	0.052	+1.8	63	1.094	+15.4	*B* 14^m 5″
ε Leo		43.6	+23 58	2.99	+0.81	G0 II	0.002	−2.1	340	0.048	+05.0	
l Car		44.1	−62 19	4.1		(cG0)	0.019	−5.5	2700	0.016	*+04.0*	Cep. max. 3.4^m min. 4.8^m, 35.52^d
υ Car *AB*		46.1	−64 53	2.95	+0.26	*A7 II*	0.020	−2.1	340	0.012	+13.6	*A* 3.02^m *B* 6.03^m 5″
α Leo *A*	10	06.2	+12 10	1.36	−0.11	B7 V	0.039	−0.7	84	0.248	+03.5	*B* 8.1^m 177″ **Regulus**
ω Car		12.8	−69 50	3.33	−0.08	*B8.5 IV*		−1.5	300	0.029	+04	
ζ Leo		14.5	+23 37	3.46	+0.30	F0 III	0.009	+0.5	130	0.023	−15.0	
λ UMa		14.7	+43 07	3.45	+0.03	A2 IV	−.010	+0.1	150	0.170	+18.3	
q Car		15.8	−61 08	3.41v	+1.55	*K5 Ib*	0.018	−4.6	1300	0.023	+08.6	Var. *R* 3.38–3.44
γ Leo *AB*		17.8	+20 03	1.99	+1.13	K0 IIIp	0.019	+0.1	90	0.350	−36.6	*A* 2.29^m *B* 3.54^m 4″
μ UMa		20.0	+41 42	3.05	+1.55	M0 III	0.031	+0.5	105	0.086	*−20.5*	
p Car		30.6	−61 29	3.30v	−0.11	*B5 IVpe*		−2.3	430	0.021	+26.0	Var. *R* 3.22–3.39
θ Car		41.5	−64 11	2.74	−0.22	*B0 Vp*		−4.0	710	0.018	+24	
μ Vel *AB*		45.0	−49 12	2.67	+0.89	*G5 III*		+0.1	108	0.085	+06.9	*A* 2.7^m *B* 7.2^m 2″
ν Hya		47.6	−15 59	3.12	+1.25	K3 III	0.022	−0.2	150	0.221	−01.0	
β UMa		59.4	+56 36	2.37	−0.03	A1 V	0.042	+0.5	78	0.087	−12.0	*Merak*
α UMa *AB*	11	01.3	+61 58	1.81	+1.06	K0 III	0.031	−0.7	105	0.138	−08.9	*A* 1.88^m *B* 4.82^m 1″ *Dubhe*
ψ UMa		07.4	+44 43	3.00	+1.14	K1 III		+0.0	130	0.072	−03.8	
δ Leo		12.0	+20 45	2.57	+0.13	A4 V	0.040	+0.6	82	0.201	−20.6	
θ Leo		12.1	+15 39	3.34	0.00	A2 V	0.019	+1.1	90	0.104	+07.8	
λ Cen		33.9	−62 48	3.15	−0.05	*B9 III*		−2.1	370	0.039	+07.9	
β Leo		47.0	+14 48	2.14	+0.09	A3 V	0.076	+1.5	43	0.511	−00.1	*Denebola*

Star	R.A. 1960 h m	Dec. ° ′	V	$B-V$	Type	π	M_V	D	μ	R	
						″		l.y.	″	km./sec.	
γ UMa	11 51.7	+53 55	2.44	0.00	A0 V	0.020	+0.2	90	0.094	−12.9	*Phecda*
δ Cen	12 06.3	−50 30	2.59v	−0.15:	*B2 Ve*		−2.7	370	0.042	+09	Var. *R* 2.56–2.62
ϵ Crv	08.1	−22 24	3.04	+1.33	K3 III		−0.2	140	0.069	+04.9	
δ Cru	13.0	−58 32	2.81v	−0.23	*B2 IV*		−3.4	570	0.041	+26.4	Var. *R* 2.78–2.84
δ UMa	13.5	+57 15	3.30	+0.07	A3 V	0.052	+1.9	63	0.106	−12.9	*Megrez*
γ Crv	13.7	−17 19	2.59	−0.10	B8 III		−3.1	450	0.163	−04.2	*Gienah*
α Cru *A*	24.4	−62 53	1.39	−0.25	*B1 IV*		−3.9	370	0.042	*−11.2*	} 5″, *C* 4.90^m 89″ ***Acrux***
α Cru *B*	24.4	−62 53	1.86	−0.25	(B3)		−3.4	370	0.042	*−00.6*	}
δ Crv *A*	27.8	−16 18	2.97	−0.04	B9.5 V: n	0.018	+0.1	124	0.255	+09	*B* 8.26^m 24″
γ Cru	28.9	−56 53	1.69	+1.55	*M3 II*		−2.5	220	0.274	+21.3	*Gacrux*
β Crv	32.3	−23 11	2.66	+0.89	G5 III	0.027	+0.1	108	0.059	−07.7	
α Mus	34.8	−68 55	2.70v	−0.20	*B3 IV*		−2.9	430	0.037	+18	Var. *R* 2.66–2.73
γ Cen *AB*	39.3	−48 44	2.17	+0.00	*A0 IV:*	0.006	−0.5	160	0.197	−07.5	*A* 2.9^m *B* 2.9^m 1″
γ Vir *AB*	39.6	−01 14	2.76	+0.34	F0 V	0.101	+3.5	32	0.567	−19.7	*A* 3.50^m *B* 3.52^m 4″
β Mus *AB*	43.8	−67 53	3.06	−0.17:	*B3 V*		−2.1	470	0.041	+42	*A* 3.7^m *B* 4.0^m 1″
β Cru	45.4	−59 28	1.28	−0.25	*B0 III*		−4.6	490	0.049	+20.0	***Beta Crucis***
ϵ UMa	52.3	+56 11	1.79	−0.03	A0pv	0.008	+0.2	68	0.113	−09.3	Chromium-europium star *Alioth*
α CVn *A*	54.2	+38 32	2.90	−0.10	B9.5pv	0.023	+0.1	118	0.238	*−03.3*	Silicon-europium star. *B* 5.61^m 20″
ϵ Vir	13 00.2	+11 10	2.86	+0.93	G9 II–III	0.036	+0.6	90	0.274	−14.0	
γ Hya	16.7	−22 58	2.98	+0.92	G8 III	0.021	+0.3	113	0.086	−05.4	
ι Cen	18.3	−36 30	2.76	+0.05	*A2 V*	0.046	+1.1	71	0.351	+00.1	
ζ UMa *A*	22.3	+55 08	2.26	+0.02	A2 V	0.037	+0.1	88	0.127	*−09.0*	*B* 3.94^m 14″ *Mizar*
α Vir	23.1	−10 57	0.91v	−0.24	B1 V	0.021	−3.3	220	0.054	*+01.0*	Ecl. *R* 0.91–1.01, 4.0^d ***Spica***
ζ Vir	32.7	−00 24	3.40	+0.10	A3 Vn	0.035	+1.1	93	0.287	−13.2	
ϵ Cen	37.3	−53 16	2.33	−0.23	*B1 IV*		−3.9	570	0.033	+05.6	
η UMa	46.0	+49 31	1.87	−0.20	B3 V	0.004	−2.1	210	0.123	−10.9	*Alkaid*
ν Cen	47.1	−41 29	3.42	−0.22	B2 IV		−3.4	750	0.037	*+09.0*	
μ Cen	47.2	−42 17	3.12v	−0.13:	B2 V: pne		−2.7	470	0.032	+12.6	Var. *R* 3.08–3.17
η Boo	52.8	+18 36	2.69	+0.59	G0 IV	0.102	+2.7	32	0.370	*−00.1*	
ζ Cen	53.0	−47 06	2.56	−0.23:	*B2 IV*		−3.4	520	0.076	*+06.5*	

Star	R.A. 1960	Dec.	V	$B-V$	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
β Cen *AB*	14 01.0	−60 11	0.63	−0.23:	*B1 II:*	0.016	−5.2	490	0.035	*−12*	*A* 0.7^m *B* 3.9^m 1″	***Hadar***
π Hya	04.1	−26 29	3.25	+1.13	K2 III	0.039	+1.2	84	0.156	+27.2		
θ Cen	04.3	−36 10	2.04	+1.03	K0 III–IV	0.059	+0.9	55	0.738	+01.3		*Menkent*
α Boo	13.8	+19 23	−0.06	+1.23	K2 IIIp	0.090	−0.3	36	2.284	−05.2		***Arcturus***
γ Boo	30.5	+38 29	3.05	+0.19	A7 III	0.016	+0.2	118	0.186	−35.5		
η Cen	33.0	−41 59	2.39v	−0.21	B1.5 V:ne		−3.0	390	0.049	−00.2	Var. *R* 2.33–2.45	
α Cen *A*	36.9	−60 40	0.01	+0.68	*G2 V*	.751	+4.39	4.3	3.676	−24.6	18″	***Rigil Kentaurus***
α Cen *B*	36.9	−60 40	1.40:	+0.73:	(dK1)		+5.8	4.3		−20.7		
α Cir *AB*	39.2	−64 48	3.18	+0.25	*F0 Vp*	0.049	+1.6	66	0.308	+07.4	Strontium star.	*A* 3.19^m *B* 8.61^m 16″
α Lup	39.3	−47 13	2.32	−0.22	B1 V		−3.3	430	0.033	+07.3		
ϵ Boo *AB*	43.2	+27 14	2.37	+0.96	K1: III: + A	0.013	+0.0	103	0.051	−16.5	*A* 2.47^m *B* 5.04^m 3″	
α Lib *A*	48.5	−15 50	2.76	+0.15	A3m	0.049	+1.2	66	0.130	−10	*B* 5.15^m 231″	*Zubenelgenubi*
β UMi	50.8	+74 19	2.04	+1.47	K4 III	0.031	−0.5	105	0.033	+16.9		*Kochab*
β Lup	55.9	−42 58	2.69	−0.23	B2 IV		−3.4	540	0.066	−00.3		
κ Cen	56.5	−41 57	3.15	−0.21	B2 V		−2.7	470	0.033	+09.1		
β Boo	15 00.4	+40 33	3.48	+0.95	G8 III	0.022	+0.3	140	0.059	−19.9		
σ Lib	01.7	−25 08	3.31	+1.65	M4 III	0.056	+2.0:	58:	0.089	−04.3		
ζ Lup *A*	09.4	−51 57	3.42	+0.90:	*K0 III*	0.036	+1.2	90	0.135	−09.7	*B* 7.8^m 71″	
δ Boo *A*	13.9	+33 28	3.47	+0.95	G8 III	0.028	+0.3	140	0.148	−12.2	*B* 7.84^m 105″	
β Lib	14.8	−09 14	2.61	−0.11	B8 V	−.012	−0.6	140	0.101	−35.2		
γ TrA	15.1	−68 32	2.94	−0.01	*A0 Vp*	0.005	+0.2	113	0.067	00	Europium star	
δ Lup	18.7	−40 30	3.24	−0.23	B2 IV		−3.4	680	0.032	+02		
γ UMi	20.8	+71 59	3.08	+0.06	A3 II-III	−.005	−1.5	270	0.026	*−03.9*		
ι Dra	24.0	+59 06	3.28	+1.18	K2 III	0.032	+0.8	102	0.012	−11.0		
γ Lup *AB*	32.5	−41 02	2.80	−0.22	B2 Vn		−2.7	570	0.037	+06	*A* 3.5^m *B* 3.7^m 1″	
α CrB	33.0	+26 51	2.23v	−0.02	A0 V	0.043	+0.4	76	0.154	*+01.7*	Ecl. *R* 0.11^m, 17.4^d	*Alphecca*
α Ser	42.3	+06 33	2.65	+1.17	K2 III	0.046	+1.0	71	0.139	+02.9		
β TrA	51.6	−63 19	2.87	+0.28:	*F2 V*	0.078	+2.3	42	0.448	−00.3		
π Sco	56.4	−26 00	2.92	−0.19	B1 V	0.005	−3.3	570	0.034	*−03*		
η Lup *AB*	57.5	−38 17	3.45	−0.23	B2 V		−2.7	570	0.042	+07	*A* 3.47^m *B* 7.70^m 15″	
δ Sco	58.0	−22 51	2.34	−0.13	B0 V		−4.0	590	0.032	−14		

Star	R.A. 1960	Dec.	V	$B-V$	Type	π	M_V	D	μ	R	
	h m	° ′				″		l.y.	″	km./sec.	
β Sco *AB*	16 03.1	−19 42	2.65	−0.09	B0.5 V	0.004	−3.7	650	0.027	*−06.6*	*A* 2.78^m *B* 5.04^m 1″, *C* 4.93^m 14″
δ Oph	12.2	−03 36	2.72	+1.59	M1 III	0.029	−0.5	140	0.156	−19.9	
ϵ Oph	16.2	−04 36	3.22	+0.97	G9 III	0.036	+1.0	90	0.089	−10.3	
σ Sco *A*	18.8	−25 30	2.86v	+0.14	B1 III		−4.4	570	0.030	*−00.4*	β CMa *R* 2.82–2.90, 0.25^d, *B* 8.49^m 20″
η Dra *A*	23.4	+61 36	2.71	+0.92	G8 III	0.043	+0.9	76	0.062	−14.3	*B* 8.7^m 6″
α Sco *A*	26.9	−26 21	0.92v	+1.84	M1 Ib+B	0.019	−5.1	520	0.029	−03.2	*A* 0.86^m–1.02^m *B* 5.07^m 3″ ***Antares***
β Her	28.5	+21 35	2.78	+0.92	G8 III	0.017	+0.3	103	0.105	*−25.5*	
τ Sco	33.4	−28 08	2.85	−0.25	B0 V		−4.0	750	0.030	−00.7	
ζ Oph	35.0	−10 29	2.57	+0.00	O9.5 V	−.007	−4.3	520	0.022	−19	
ζ Her *AB*	39.8	+31 40	2.81	+0.64	G0 IV	0.110	+3.1	30	0.608	*−69.9*	*A* 2.91^m *B* 5.46^m 1″
η Her	41.5	+39 00	3.46	+0.92	G7 III–IV	0.053	+2.1	62	0.097	+08.3	
α TrA	44.4	−68 57	1.93	+1.43	*K2 III*	0.024	−0.1	82	0.044	−03.6	*Atria*
ϵ Sco	47.6	−34 13	2.28	+1.16	*K2 III–IV*	0.049	+0.7	66	0.664	−02.5	
μ^1 Sco	49.2	−37 59	2.99v	−0.20	B1.5 V		−3.0	520	0.033	*−25*	Ecl. *R* 2.99–3.09, 1.4^d
ζ Ara	55.3	−55 56	3.16	+1.61	(gK5)	0.036	+0.9	90	0.042	−06.0	
κ Oph	55.8	+09 26	3.18	+1.15	K2 III	0.026	−0.1	150	0.293	−55.6	
η Oph *AB*	17 08.1	−15 41	2.46	+0.06	A2.5 V	0.047	+1.4	69	0.097	−00.9	*A* 3.0^m *B* 3.4^m 1″ *Sabik*
ζ Dra	08.7	+65 46	3.20	−0.12	B6 III	0.017	−3.2	620	0.026	−14.1	
η Sco	09.3	−43 11	3.33	+0.38	*F2 III*	0.063	+2.3	52	0.293	−28.4	
α Her *AB*	12.8	+14 26	3.10v	+1.41	M5 II	−.007	−2.3	410	0.032	−33.1	*A* 3.2^m ± 0.3 *B* 5.4^m 5″ *Ras-Algethi*
δ Her	13.4	+24 53	3.14	+0.09	A3 IV	0.034	+0.8	96	0.164	−41	
π Her	13.7	+36 51	3.13	+1.43	K3 II	0.020	−2.4	410	0.029	−25.7	
θ Oph	19.6	−24 58	3.29	−0.22	B2 IV		−3.4	710	0.025	−03.6	
β Ara	22.0	−55 30	2.90	+1.45:	*K3 Ib*	0.026	−4.6	1030	0.035	−00.4	
γ Ara *A*	22.0	−56 21	3.32	−0.16	*B1 V*		−3.3	680	0.017	−04	*B* 10^m 18″
υ Sco	28.0	−37 16	2.71	−0.22	*B2 IV*		−3.4	540	0.039	*+18*	
α Ara	28.7	−49 51	2.95	−0.18:	B2.5 V		−2.4	390	0.083	*−02*	
β Dra *A*	29.5	+52 20	2.77	+0.96	G2 II	0.009	−2.1	310	0.019	−20.0	*B* 11.49^m 4″
λ Sco	30.9	−37 05	1.60	−0.24	B1 V		−3.3	310	0.031	00	*Shaula*
α Oph	33.1	+12 35	2.09	+0.16	A5 III	0.056	+0.8	58	0.260	+12.7	*Rasalhague*
θ Sco	34.4	−42 58	1.86	+0.39	*F0 Ib*	0.020	−4.6	650	0.012	+01.4	

Star	R.A. 1960 h m	Dec. ° ′	V	$B-V$	Type	π	M_V	D	μ	R	
						″		l.y.	″	km./sec.	
κ Sco	17 39.7	−39 01	2.39	−0.21	*B2 IV*		−3.4	470	0.031	−10	
β Oph	41.5	+04 35	2.77	+1.16	K2 III	0.023	−0.1	124	0.160	−12.0	
ι^1 Sco	44.8	−40 07	2.99	+0.49	F2 Ia	0.013	−7.1	3400	0.004	*−27.6*	
μ Her *A*	44.9	+27 45	3.42	+0.75	G5 IV	0.108	+3.6	30	0.811	−15.6	*BC* 9.78^m 33″
G Sco	47.1	−37 02	3.21	+1.18	(gK1)	0.032	+0.7	102	0.064	+24.7	
γ Dra	55.7	+51 30	2.21	+1.52	K5 III	0.017	−0.4	108	0.026	−27.6	***Eltanin***
ν Oph	56.8	−09 46	3.32	+1.00	G9 III	0.015	+0.2	140	0.118	+12.4	
γ Sgr	18 03.2	−30 26	2.97	+1.00	*K0 III*	0.018	+0.1	124	0.200	*+22.1*	
η Sgr *A*	14.9	−36 47	3.17	+1.55	*M3 II*	0.038	+1.1:	86:	0.218	+00.5	*B* 10^m 4″
δ Sgr	18.4	−29 51	2.71	+1.39	*K2 III*	0.039	+0.7	84	0.050	−20.0	
η Ser	19.2	−02 55	3.23	+0.94	K0 III–IV	0.054	+1.9	60	0.894	+08.9	
ϵ Sgr	21.5	−34 24	1.81	−0.02	*B9 IV*	0.015	−1.1	124	0.135	−11	*Kaus Australis*
λ Sgr	25.5	−25 27	2.80	+1.05	*K2 III*	0.046	+1.1	71	0.194	−43.3	
α Lyr	35.6	+38 45	0.04	0.00	A0 V	0.123	+0.5	26.5	0.345	−13.9	***Vega***
ϕ Sgr	43.2	−27 02	3.20	−0.11	*B8 III*		−3.1	590	0.052	+21.5	
β Lyr *A*	48.6	+33 19	3.38v	−0.05:	Bpe	−.011	−4.6	1300	0.007	*−19.2*	Ecl. *R* 3.38–4.36, 12.9^d, *B* 7.8^m 46″
σ Sgr	52.8	−26 21	2.12	−0.21	B2 V		−2.7	300	0.059	−11	*Nunki*
ξ^2 Sgr	55.3	−21 10	3.51	+1.18:	(gK1)	0.006	+0.0	160	0.035	−19.9	
γ Lyr	57.4	+32 38	3.25	−0.05	B9 III	0.011	−2.1	370	0.007	−21.5	
ζ Sgr *AB*	19 00.1	−29 56	2.61	+0.08	*A2 IV*	0.020	+0.1	140	0.020	+22	*A* 3.3^m *B* 3.5^m 1″
ζ Aql *A*	03.6	+13 48	2.99	+0.01	A0 V: nn	0.036	+0.8	90	0.101	−26.3	*B* 12^m 5″
λ Aql	04.1	−04 57	3.44	−0.07	B9: V: n	0.025	−0.1	160	0.092	−14	
τ Sgr	04.4	−27 44	3.30	+1.18	(gK1)	0.038	+1.2	86	0.261	*+45.4*	
π Sgr *ABC*	07.4	−21 05	2.89	+0.35	F2 II–III	0.016	−0.7	250	0.040	−09.8	*A* 3.7^m *B* 3.8^m *C* 6.0^m < 1″
δ Dra	12.6	+67 35	3.06	+1.00	G9 III	0.028	+0.2	124	0.130	+24.8	
δ Aql	23.5	+03 02	3.38	+0.31	F0 IV	0.062	+2.3	53	0.267	*−29.9*	
β Cyg *A*	29.1	+27 52	3.07	+1.12	K3 II: + B:	0.004	−2.4	410	0.009	−24.0	*B* 5.11^m 35″ ***Albireo***
δ Cyg *AB*	43.7	+45 02	2.87	−0.03	B9.5 III	0.021	−1.7	270	0.060	−21	*A* 2.91^m *B* 6.44^m 2″
γ Aql	44.4	+10 31	2.67	+1.48	K3 II	0.006	−2.4	340	0.012	−02.1	
α Aql	48.8	+08 46	0.77	+0.22	A7 IV, V	0.198	+2.2	16.5	0.658	−26.3	***Altair***

Star	R.A. 1960	Dec.	V	$B-V$	Type	π	M_V	D	μ	R	
	h m	° ′				″		l.y.	″	km./sec.	
θ Aql	20 09.2	−00 56	3.31	−0.07	B9.5 III	0.008	−1.7	330	0.034	*−27.3*	
β Cap *A*	18.8	−14 55	3.06	+0.76	comp.	0.005	+0.1	130	0.039	−18.9	Type gK0: + late B; *B* 5.97^m 205″
γ Cyg	20.8	+40 08	2.22	+0.66	F8 Ib	−.006	−4.6	750	0.001	−07.5	
α Pav	22.5	−56 52	1.95	−0.20	*B3 IV*		−2.9	310	0.087	*+02.0*	*Peacock*
α Ind	34.8	−47 26	3.11	+1.00	*K0 III*	0.039	+1.1	84	0.082	−01.1	
α Cyg	40.1	+45 08	1.26	+0.09	A2 Ia	−.013	−7.1	1600	0.003	−04.6	***Deneb***
β Pav	41.4	−66 21	3.45	+0.16	*A5 III*	0.026	−0.1	160	0.046	+09.8	
η Cep	44.5	+61 41	3.41	+0.92	K0 IV	0.071	+2.7	46	0.825	−87.3	
ϵ Cyg	44.6	+33 49	2.46	+1.03	K0 III	0.044	+0.7	74	0.481	*−10.3*	
ζ Cyg	21 11.2	+30 04	3.25:		G8 II	0.021	−2.2	390	0.056	+17.4	
α Cep	17.6	+62 25	2.44	+0.24	A7 IV, V	0.063	+1.4	52	0.156	−10	*Alderamin*
β Cep	28.2	+70 23	3.15v	−0.22v	B2 III	0.005	−4.2	980	0.014	−08.2	β CMa *R* 3.14–3.16, 0.19^d
β Aqr	29.5	−05 45	2.86	+0.82	G0 Ib	0.000	−4.6	1030	0.017	+06.5	
ϵ Peg *A*	42.2	+09 41	2.31	+1.55	K2 Ib	−.005	−4.6	780	0.025	+04.7	*B* 11^m 82″ *Enif*
δ Cap	44.8	−16 19	2.92v	+0.29	A6m	0.065	+2.0	50	0.392	*−06.3*	Var. *R* 2.88–2.95
γ Gru	51.5	−37 33	3.03	−0.10	*B8 III:*	0.008	−3.1	540	0.102	−02.1	
α Aqr	22 03.7	−00 31	2.96	+0.96	G2 Ib	0.003	−4.6	1080	0.016	+07.5	
α Gru	05.7	−47 09	1.76	−0.14	*B5 V*	0.051	+0.3:	64:	0.194	+11.8	*Al Na'ir*
ζ Cep	09.5	+58 00	3.31	+1.55	K1 Ib	0.019	−4.6	1240	0.015	*−18.4*	
α Tuc	15.8	−60 28	2.87	+1.40	*K3 III–IV*	0.019	+1.5	62	0.079	*+42.2*	
δ Cep *A*	27.7	+58 13	3.96v	+0.66v	F5–G2 Ib	0.005	−4.0	1300	0.012	*−16.8*	Cep. *R* 3.51–4.42, 5.4^d, *B* 6.19^m 41″
ζ Peg	39.5	+10 37	3.40:	−0.08:	B8 V	−.004	−0.6	210	0.077	+07	
β Gru	40.3	−47 06	2.17v	+1.59	*M3 II*	0.003	−2.5	280	0.134	+01.6	Var. *R* 2.11–2.23
η Peg	41.1	+30 01	2.95	+0.85	G8 II: + F?	−.002	−2.2	360	0.027	*+04.3*	
δ Aqr	52.5	−16 02	3.28	+0.08	A3 V	0.039	+1.2	84	0.047	+18.0	
α PsA	55.4	−29 50	1 19	+0.10	A3 V	0.144	+2.0	22.6	0.367	+06.5	***Fomalhaut***
β Peg	23 01.8	+27 52	2.5 v	+1.67	M2 II–III	0.015	−1.5	210	0.234	+08.7	Var. *R* 2.4–2.7 *Scheat*
α Peg	02.8	+14 59	2.50	−0.03	B9.5 III	0.030	−0.1	109	0.071	−03.5	*Markab*
γ Cep	37.7	+77 25	3.20	+1.02	K1 IV	0.064	+2.2	51	0.168	−42.4	

DOUBLE AND MULTIPLE STARS

By Frank Holden

Many stars may be separated into two or more components by the use of a telescope. The greater the aperture of the telescope, the closer the stars which can be separated *in good seeing conditions*. With telescopes of medium size, and for stars which are not unduly bright or faint, the minimum angle of separation—in seconds of arc—is given by $4.6/D$. The symbol D indicates the diameter of the telescope's objective in inches.

The following lists give some interesting examples of double stars. In the first list are pairs suitable for testing the performance of telescopes because the stellar components are relatively fixed over many years; in the second list are pairs of more general interest, including several binaries of shorter period for which the apparent separation or position-angle alters relatively quickly.

In both lists the columns give, successively, the star's designation in two forms; its right ascension and declination for 1960; the visual magnitudes of the combined pair and of each component; the apparent separation in 1964; the approximate position-angle in 1964; and the period, if known.

Star	A.D.S.	R.A. 1960 h m	Dec. 1960 ° ′	Magnitudes comb.	a	b	Sep. 1964.5 ″	P.A. 1964.5 °	P (app.) years
λ Cas	434	00 29.6	+54 18	4.9	5.5	5.8	0.6	180	900
α Psc	1615	01 59.9	+02 34	4.0	4.3	5.3	1.9	291	720
33 Ori	4123	05 29.1	+03 15	5.7	6.0	7.3	1.9	27	—
OΣ 156	5447	06 45.1	+18 14	6.1	6.8	7.0	0.5	255	1,060
Σ 1338	7307	09 18.5	+38 21	5.8	6.5	6.7	1.2	223	390
35 Com	8695	12 51.3	+21 28	5.1	5.3	7.3	0.9	150	675
Σ 2054	10052	16 23.3	+61 48	5.6	6.0	7.2	1.0	353	—
ϵ^1 Lyr	11635	18 43.0	+39 38	4.4	4.6	6.3	2.8	1	—
ϵ^2 Lyr	11635	18 43.0	+39 35	4.2	4.9	5.2	2.4	99	—
π Aql	12962	19 46.9	+11 42	5.6	6.0	6.8	1.4	109	—
σ Cas	17140	23 56.9	+55 32	4.9	5.4	7.5	3.1	330	—
η Cas	671	00 46.7	+57 36	3.4	*3.5	7.3	11.2	298	530
Σ 186	1538	01 53.8	+01 39	6.2	6.9	7.0	1.4	54	160
γ And AB	1630	02 01.4	+42 08	2.1	*2.1	5.4	9.9	63	—
α C Ma	5423	06 43.4	−16 40	−1.4	−1.4	8.7	10.2	79	50
α Gem	6175	07 32.0	+31 59	1.6	2.0	2.9	1.8	147	380
ζ Cnc AB	6650	08 09.9	+17 46	5.0	5.6	5.9	1.1	350	60
ζ Cnc AC	6650	08 09.9	+17 46	5.0	5.6	6.0	5.6	82	1,150
10 U Ma	Kpr	08 58.1	+41 57	4.1	4.3	6.3	0.5	298	20
γ Leo	7724	10 17.8	+20 03	2.0	2.3	3.5	4.3	122	620
ξ U Ma AB	8119	11 16.1	+31 46	3.9	4.4	4.9	2.5	136	60
γ Vir	8630	12 39.6	−01 14	2.8	3.5	3.5	4.9	306	170
Σ 1785	9031	13 47.3	+27 11	6.6	7.2	7.5	3.1	148	155
ζ Boo	9343	14 39.3	+13 54	3.9	4.6	4.6	1.2	308	125
ξ Boo	9413	14 49.6	+19 17	4.7	4.8	6.9	6.9	344	150
ζ Her	10157	16 39.8	+31 40	2.8	2.9	5.5	0.9	28	35
α Her AB	10418	17 12.8	+14 26	3.1	*3.2	5.4	4.6	109	—
Σ 2173	10598	17 28.3	−01 01	5.4	6.1	6.1	0.8	154	45
70 Oph	11046	18 03.4	+02 31	4.1	4.3	6.0	3.5	80	90
β 648	11871	18 55.6	+32 51	5.2	5.3	7.7	0.9	214	60
4 Aqr	14360	20 49.3	−05 47	6.0	6.4	7.2	1.0	5	155
τ Cyg	14787	21 13.2	+37 52	3.8	3.9	6.3	0.8	210	50
Σ 3050	17149	23 57.4	+33 30	5.8	6.5	6.5	1.5	284	320

*The two components have dissimilar colours.

Many of the components themselves are very close visual doubles or spectroscopic binaries. (Other double stars appear in the table of The Brightest Stars, p. 74 and of The Nearest Stars, p. 87.)

THE NEAREST STARS

By R. M. Petrie and Jean K. McDonald

Perhaps the most difficult problem in observational astronomy is the determination of the distances to the stars. The reason, of course, is that the distances are so enormous as to require the measurement of vanishingly small angular displacements. As the earth goes in its orbit around the sun the stars show a small change in their positions and it is this small apparent movement which is called the annual parallax. If we can measure the parallax we can at once calculate the distance to the star concerned.

Astronomers speak of stellar distances in terms of light-years or, alternatively, parsecs. A light-year is the distance light travels in one year with its speed of 186,000 miles per second. If we know the parallax in seconds of arc we obtain the distance in light-years by dividing 3.26 by the parallax. Thus the star Sirius, which has an annual parallax of 0.″375, is 8.7 light-years distant. The reciprocal of the parallax gives the distance in parsecs; Sirius is 2.7 parsecs from the sun.

The apparent motion, per year, of a star across the sky, called proper motion, is a good indication of a star's distance. Obviously, the nearer stars will appear to move more rapidly than their more distant fellows and this fact has many times been instrumental in the discovery of nearby stars.

The table accompanying this note lists, in order of distance, all known stars within sixteen light-years. Including the sun it contains fifty-five stars, but it does not contain the unseen companions of double and multiple stars entered in the table. The table is taken from a paper by Professor van de Kamp, published in 1953. In addition to the name and position for each star, the table gives spectral type, Sp.; parallax, π; distance in light-years, D; proper motion in second of arc per year, μ; total velocity with respect to the sun in km./sec., W; apparent visual magnitude, m; and finally, luminosity in terms of the sun, L. In column four, *wd* indicates a white dwarf, and *e* indicates an emission-line star.

The stars within sixteen light-years form an important astronomical table because the annual parallaxes are large enough to be well determined. This means that we have accurate knowledge of the distances, speeds, and luminosities of these stars. Furthermore this sample is probably quite representative of the stellar population in our part of the galaxy, and as such is well worth our study.

It is interesting to note that most of the stars are cool red dwarfs, of type M. This must be the most populous of all the stellar varieties. Only ten of these nearby stars are bright enough to be seen with the unaided eye (magnitude less than five). Only three stars, Sirius, Altair, and Procyon, are brighter than the sun while the great majority are exceedingly faint. Not one giant star is contained in the list nor is there a B-type star. This is a consequence of the extreme rarity of very hot and very bright stars. One may conclude that stars brighter than the sun are very scarce.

Another striking fact is the prevalence of double and multiple stars, there being sixteen such systems if we count unseen components. Obviously double and multiple stars are quite common in the stellar population, and must be explained by any acceptable theory of stellar formation and evolution.

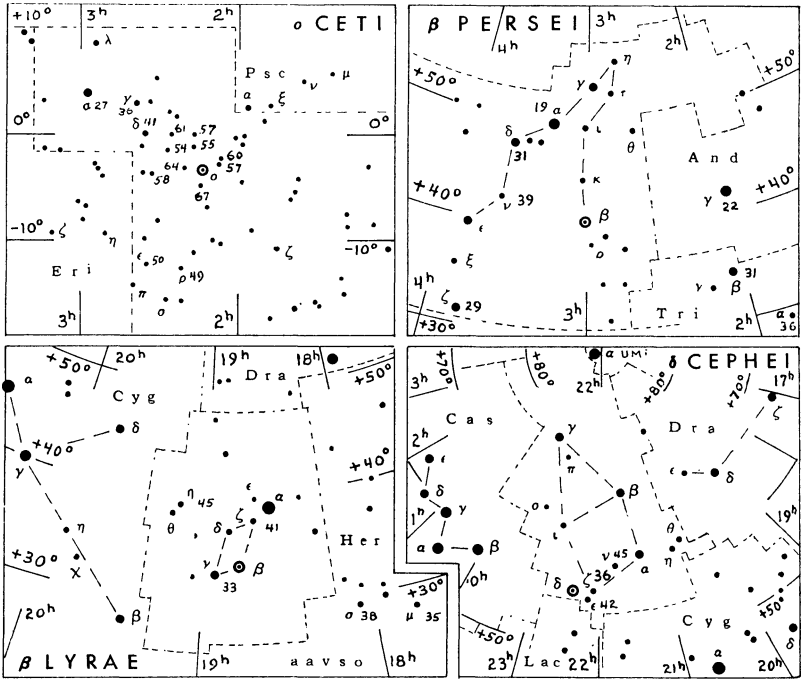
Star	1950 α	1950 δ	Sp.	π	D	μ	W	m	L
	h m	°		"	l.y.	"	km./sec.		
Sun			G2					-26.9	1.0
α Cen A	14 36	−60 38	G2	0.751	4.3	3.68	34	0.0	1.0
B			K1					1.4	0.28
C	14 26	−62 28	M5*e*					11	0.000052
Barnard's *	17 55	+ 4 33	M5	.545	6.0	10.30	141	9.5	0.00040
Wolf 359	10 54	+ 7 20	M6*e*	.421	7.7	4.84	56	13.5	0.000017
Luy. 726-8A	1 36	−18 13	M6*e*	.410	7.9	3.35	48	12.5	0.00004
B			M6*e*					13.0	0.00003
Lal. 21185*	11 01	+36 18	M2	.398	8.2	4.78	103	7.5	0.0048
Sirius A	6 43	−16 39	A1	.375	8.7	1.32	18	−1.4	23.
B			*wd*					7.1	0.008
Ross 154	18 47	−23 53	M5*e*	.351	9.3	0.67	10	10.6	0.00036
Ross 248	23 39	+43 55	M6*e*	.316	10.3	1.58	84	12.2	0.00010
ε Eri	3 31	− 9 38	K2	.303	10.8	0.97	21	3.8	0.25
Ross 128	11 45	+ 1 07	M5	.298	10.9	1.40	26	11.1	0.00030
61 Cyg* A	21 05	+38 30	K6	.293	11.1	5.22	106	5.6	0.052
B			M0					6.3	0.028
Luy. 789-6	22 36	−15 37	M6	.292	11.2	3.27	80	12.2	0.00012
Procyon A	7 37	+ 5 21	F5	.288	11.3	1.25	20	0.4	5.8
B			*wd*					10.8	0.00044
ι Ind	22 00	−57 00	K5	.285	11.4	4.67	87	4.7	0.12
Σ 2398 A	18 42	+59 33	M4	.280	11.6	2.29	38	8.9	0.0028
B			M4					9.7	0.0013
Groom. 34 A	0 16	+43 44	M2*e*	.278	11.7	2.91	51	8.1	0.0058
B			M4*e*					10.9	0.00044
τ Ceti	1 42	−16 12	G8	.275	11.8	1.92	37	3.5	0.36
Lac. 9352	23 03	−36 09	M2	.273	11.9	6.87	118	7.2	0.013
BD +5°1668	7 25	+ 5 29	M4	.263	12.4	3.73	72	10.1	0.0010
Lacaille 8760	21 14	−39 04	M1	.255	12.8	3.46	68	6.6	0.028
Kapteyn's	5 10	−45 00	M0	.251	13.0	8.79	275	9.2	0.0025
Kruger 60 A	22 26	+57 27	M4	.249	13.1	0.87	29	9.9	0.0013
B			M5*e*					11.4	0.00033
Ross 614 A	6 27	− 2 47	M5*e*	.248	13.1	0.97	30	10.9	0.00052
B			?					14.8	0.000016
BD −12°4523	16 28	−12 32	M5	.244	13.4	1.24	27	10.0	0.0013
van Maanen's	0 46	+ 5 10	*wd*F	.236	13.8	2.98	64	12.3	0.00016
Wolf 424 A	12 31	+ 9 18	M6*e*	.223	14.6	1.87	40	12.6	0.00014
B			M6*e*					12.6	0.00014
Groom. 1618	10 08	+49 42	K5	.222	14.7	1.45	41	6.8	0.030
CD −37°15492	0 02	−37 36	M3	.219	14.9	6.09	134	8.6	0.0058
CD −46°11540	17 25	−46 51	M4	.213	15.3	1.15		9.7	0.0023
BD +20°2465*	10 17	+20 07	M4*e*	.211	15.4	0.49	15	9.5	0.0028
CD −44°11909	17 34	−44 16	M5	.209	15.6	1.14		11.2	0.00058
CD −49°13515	21 30	−49 13	M3	.209	15.6	0.78		9	0.0044
AOe 17415-6	17 37	+68 23	M3	.206	15.8	1.31	34	9.1	0.0040
Ross 780	22 50	−14 31	M5	.206	15.8	1.12	28	10.2	0.0014
Lal. 25372	13 43	+15 10	M2	.205	15.9	2.30	55	8.6	0.0063
CC 658	11 43	−64 33	*wd*	.203	16.0	2.69		11	0.0008
o^2 Eri A	4 13	− 7 44	K0	.200	16.3	4.08	105	4.5	0.30
B			*wd*A					9.2	0.0040
C			M5*e*					11.0	0.0008
70 Oph A	18 03	+ 2 31	K1	.199	16.4	1.13	28	4.2	0.40
B			K5					5.9	0.083
Altair	19 48	+ 8 44	A7	.198	16.5	0.66	31	0.8	8.3
BD +43°4305	22 45	+44 05	M5*e*	.198	16.5	0.84	20	10.2	0.0016
AC 79°3888	11 44	+78 57	M4	0.196	16.6	0.87	121	11.0	0.0008

*Star has an unseen component.

VARIABLE STARS

Maps of the fields of four bright variable stars are given below. In each case the magnitudes of several suitable comparison stars are given. Note that the decimal points are omitted: a star 36 is of mag. 3.6. Use two comparison stars, one brighter and one fainter than the variable, and estimate the brightness of the variable in terms of these two stars. Record the date and time of observation. When a number of observations have been made, a graph may be plotted showing the magnitude estimate as ordinates against the date (days and tenths of a day) as abscissae. Each type of variable has a distinctive shape of light curve.

In the tables the first column, the Harvard designation of the star, gives the 1900 position: the first four figures give the hours and minutes of R.A., the last two figures give the Dec. in degrees, italicised for southern declinations. The column headed *Max.* gives the mean maximum magnitude. The *Period* is in days. The *Epoch* gives the predicted date of the *earliest* maximum occurring this year; by adding the period to this epoch other dates of maximum may be found. The list of long-period variables has been prepared by the American Association of Variable Star Observers and includes the variables with maxima brighter than mag. 8.0, and north of Dec. −20°. These variables may reach maximum two or three weeks before or after the listed epoch and may remain at maximum for several weeks. The second table contains stars which are representative of other types of variable. The data are taken from "The General Catalogue of Variable Stars" by Kukarkin and Parenago and for eclipsing binaries from *Rocznik Astronomiczny Obserwatorium Krakowskiego*, 1964, International Supplement.



LONG-PERIOD VARIABLE STARS

Variable	Max. m	Per d	Epoch 1965	Variable	Max. m	Per d	Epoch 1965
001755 T Cas	7.8	445	Jan. 29	143227 R Boo	7.2	223	June 28
001838 R And	7.0	409	Sept. 8	151731 S CrB	7.3	361	Apr. 3
021143 W And	7.4	397	Jan. 29	154639 V CrB	7.5	358	Jan. 12
021403 o Cet	3.4	332	Jan. 27	154615 R Ser	6.9	357	Jan. 19
022813 U Cet	7.5	235	Apr. 9	160625 RU Her	8.0	484	Dec. 4
023133 R Tri	6.2	266	Aug. 20	162119 U Her	7.5	406	Mar. 30
043065 T Cam	8.0	374	Oct. 15	162112 V Oph	7.5	298	Mar. 8
045514 R Lep	6.8	432	Nov. 12	163266 R Dra	7.6	245	Apr. 19
050953 R Aur	7.7	459	Sept. 24	164715 S Her	7.6	307	June 15
054920 U Ori	6.3	372	June 17	170215 R Oph	7.9	302	Mar. 13
061702 V Mon	7.0	335	May 29	171723 RS Her	7.9	219	Jan. 19
065355 R Lyn	7.9	379	Dec. 30	180531 T Her	8.0	165	Apr. 23
070122a R Gem	7.1	370	Apr. 21	181136 W Lyr	7.9	196	June 30
070310 R CMi	8.0	338	July 31	183308 X Oph	6.8	334	Mar. 10
072708 S CMi	7.5	332	Apr. 28	190108 R Aql	6.1	300	May 4
081112 R Cnc	6.2	362	Feb. 25	191017 T Sgr	8.0	392	July 25
081617 V Cnc	7.9	272	Apr. 12	191019 R Sgr	7.3	269	Jan. 20
084803 S Hya	7.8	257	Apr. 14	193449 R Cyg	7.5	426	Oct. 7
085008 T Hya	7.8	288	July 22	194048 RT Cyg	7.3	190	Apr. 28
093934 R LMi	7.1	372	Dec. 31	194632 X Cyg	5.2	407	Apr. 7
094211 R Leo	5.8	313	May 16	200938 RS Cyg	7.2	418	July 17
103769 R UMa	7.5	302	Aug. 10	201647 U Cyg	7.2	465	Oct. 9
121418 R Crv	7.5	317	Aug. 2	204405 T Aqr	7.7	202	June 1
122001 SS Vir	6.8	355	May 9	210868 T Cep	6.0	390	. . .
123160 T UMa	7.7	257	Aug. 5	213753 RU Cyg	8.0	234	Apr. 13
123307 R Vir	6.9	146	Mar. 14	230110 R Peg	7.8	378	Sept. 29
123961 S UMa	7.8	226	Jan. 1	230759 V Cas	7.9	228	Feb. 6
131546 V CVn	6.8	192	June 23	231508 S Peg	8.0	319	May 29
132706 S Vir	7.0	378	Oct. 16	233815 R Aqr	6.5	387	May 18
134440 R CVn	7.7	328	July 31	235350 R Cas	7.0	431	June 1
142584 R Cam	7.9	270	Mar. 18	235715 W Cet	7.6	351	June 18
142539 V Boo	7.9	258	May 1				

OTHER TYPES OF VARIABLE STARS

Variable	Max. m	Min. m	Type	Sp. Cl.	Period d	Epoch 1965 E.S.T.
005381 U Cep	6.7	9.8	Ecl	B8+gG2	2.49295	Jan. 1.92*
025838 ρ Per	3.3	4.0	Semi R	M4	33–55, 1100	
030140 β Per	2.1	3.3	Ecl	B8+G	2.86731	Jan. 1.10*
035512 λ Tau	3.5	4.0	Ecl	B3	3.952952	Jan. 3.84*
060822 η Gem	3.1	3.9	Semi R	M3	233.4	. . .
061907 T Mon	6.4	8.0	δ Cep	F7–K1	27.0205	Jan. 23.61
065820 ζ Gem	4.4	5.2	δ Cep	F7–G3	10.15172	Jan. 10.88
154428 R Cr B	5.8	14.8	R Cr B	cFpep		
171014 α Her	3.0	4.0	Semi R	M5	50–130, 6 yrs.	
184205 R Sct	6.3	8.6	RVTau	G0e-K0p	144	
184633 β Lyr	3.4	4.3	Ecl	B8	12.931163	Jan. 11.19*
192242 RR Lyr	6.9	8.0	RR Lyr	A2–F1	0.5668223	Jan. 1.54
194700 η Aql	4.1	5.2	δ Cep	F6–G4	7.176641	Jan. 7.83
222557 δ Cep	4.1	5.2	δ Cep	F5–G2	5.366341	Jan. 3.21

*Minimum

STAR CLUSTERS

The star clusters for this observing list have been selected to include the more conspicuous members of the two main classes—open clusters and globular clusters. Most of the data are from Shapley's *Star Clusters* and from Trumpler's catalogue in Lick Bulletin No. 420. In the following table *N.G.C.* indicates the serial number of the cluster in the New General Catalogue of Clusters and Nebulae; *M*, its number in Messier's catalogue; *Con.*, the constellation in which it is located; α and δ, its right ascension and declination; *Cl.*, the kind of cluster, *Op* for open or galactic and *Gl* for globular; *Diam.*, the apparent diameter in minutes of arc; *Mag. B.S.*, the magnitude of the fifth brightest star in the case of open clusters, the mean of the 25 brightest for globulars; *No.*, the number of stars in the open clusters down to the limiting magnitudes of the photographs on which the particular clusters were studied; *Int. mag.*, the total apparent magnitude of the globular clusters; and *Dist.*, the distance in light years.

N.G.C.	M	Con.	α 1960 h m	δ ° ′	Cl.	Diam. ′	Mag. B.S.	No.	Int. mag.	Dist l.y.
869		hPer	02 16.2	+56 58	Op	30	7			4,300
884		χPer	02 19.6	+56 56	Op	30	7			4,300
1039	34	Per	02 39.4	+42 37	Op	30	9	80		1,500
Pleiades	45	Tau	03 45.1	+23 59	Op	120	4.2	250		490
Hyades		Tau	04 18	+15 31	Op	400	4.0	100		120
1912	38	Aur	05 26.0	+35 48	Op	18	9.7	100		2,800
2099	37	Aur	05 49.7	+32 33	Op	24	9.7	150		2,700
2168	35	Gem	06 06.4	+24 21	Op	29	9.0	120		2,700
2287	41	C Ma	06 45.3	−20 42	Op	32	9	50		1,300
2632	44	Cnc	08 37.8	+20 07	Op	90	6.5	350		490
5139		ωCen	13 24.3	−47 16	Gl	23	12.9		3	22,000
5272	3	C Vn	13 40.4	+28 35	Gl	10	14.2		4.5	40,000
5904	5	Ser	15 16.5	+02 13	Gl	13	14.0		3.6	35,000
6121	4	Sco	16 21.2	−26 26	Gl	14	13.9		5.2	24,000
6205	13	Her	16 40.2	+36 32	Gl	10	13.8		4.0	34,000
6218	12	Oph	16 45.2	−01 53	Gl	9	14.0		6.0	36,000
6254	10	Oph	16 55.0	−04 03	Gl	8	14.1		5.4	36,000
6341	92	Her	17 15.9	+43 11	Gl	8	13.9		5.1	36,000
6494	23	Sgr	17 54.6	−19 01	Op	27	10.2	120		2,200
6611	16	Ser	18 16.6	−13 48	Op	8	10.6	55		6,700
6656	22	Sgr	18 34.0	−23 57	Gl	17	12.9		3.6	22,000
7078	15	Peg	21 28.0	+11 59	Gl	7	14.3		5.2	43,000
7089	2	Aqr	21 31.4	−01 00	Gl	8	14.6		5.0	45,000
7092	39	Cyg	21 30.8	+48 15	Op	32	6.5	25		1,000
7654	52	Cas	23 22.4	+61 23	Op	13	11.0	120		4,400

GALACTIC NEBULAE

The galactic nebulae here listed have been selected to include the most readily observable representatives of planetary nebulae such as the Ring Nebula in Lyra, diffuse bright nebulae like the Orion nebula and dark absorbing nebulosities such as the Coal Sack. These objects are all located in our own galactic system. The first five columns give the identification and position as in the table of clusters. In the *Cl* column is given the classification of the nebula, planetary nebulae being listed as *Pl*, diffuse nebulae as *Dif*, and dark nebulae as *Drk*. *Size* indicates approximately the greatest apparent diameter in minutes of arc; and *m n* is the magnitude of the planetary nebula and *m ** is the magnitude of its central star. The distance is given in light years, and the name of the nebula is added for the better known objects.

N.G.C.	M	Con	α 1960 h m	δ ° ′	Cl	Size ′	m n	m *	Dist. l.y.	Name
650	76	Per	01 39.7	+51 22	Pl	1.5	11	17	15,000	
1952	1	Tau	05 32.1	+22 00		6	11	16	4,100	Crab
1976	42	Ori	05 33.3	−05 25	Dif	30			1,800	Orion
B33		Ori	05 38.9	−02 29	Drk	4			300	Horsehead
2261		Mon	06 37.0	+08 46	Dif	2				Hubble's var.
2392		Gem	07 26.8	+21 00	Pl	0.3	8	10	2,800	
2440		Pup	07 40.1	−18 07	Pl	0.9	11	16	8,600	
3587	97	UMa	11 12.5	+55 14	Pl	3.3	11	14	12,000	Owl
		Cru	12 49	−63	Drk	300			300	Coalsack
6210		Her	16 42.8	+23 52	Pl	0.3	10	12	5,600	
B72		Oph	17 21.2	−23 35	Drk	20			400	S nebula
6514	20	Sgr	18 00.0	−23 02	Dif	24			3,200	Trifid
B86		Sgr	18 00.5	−27 53	Drk	5				
6523	8	Sgr	18 01.2	−24 23	Dif	50			3,600	Lagoon
6543		Dra	17 58.6	+66 37	Pl	0.4	9	11	3,500	
6572		Oph	18 10.2	+06 50	Pl	0.2	9	12	4,000	
B92		Sgr	18 13.2	−18 15	Drk	15				
6618	17	Sgr	18 18.5	−16 12	Dif	26			3,000	Horseshoe
6720	57	Lyr	18 52.1	+32 59	Pl	1.4	9	14	5,400	Ring
6826		Cyg	19 43.7	+50 26	Pl	0.4	9	11	3,400	
6853	27	Vul	19 57.9	+22 36	Pl	8	8	13	3,400	Dumb-bell
6960		Cyg	20 44.0	+30 34	Dif	60				Network
7000		Cyg	20 57.4	+44 10	Dif	100				N. America
7009		Aqr	21 02.0	−11 32	Pl	0.5	8	12	3,000	
7662		And	23 24.0	+42 19	Pl	0.3	9	13	3,900	

EXTERNAL GALAXIES

Among the hundreds of thousands of systems far beyond our own galaxy relatively few are readily seen in small telescopes. The following list contains a selection of the closer brighter objects of this kind. The first five columns give the catalogue numbers, constellation and position on the celestial sphere. In the column *Cl*, *E* indicates an elliptical nebula, *I* an irregular object, and *Sa*, *Sb*, *Sc* spiral nebulae, in which the spiral arms become increasingly dominant compared with the nucleus as we pass from *a* to *c*. The remaining columns give the apparent magnitude of the nebula, its distance in light years and the radial velocity in kilometers per second. As these objects have been selected on the basis of ease of observation, the faint, very distant objects which have spectacularly large red shifts, corresponding to large velocities of recession, are not included.

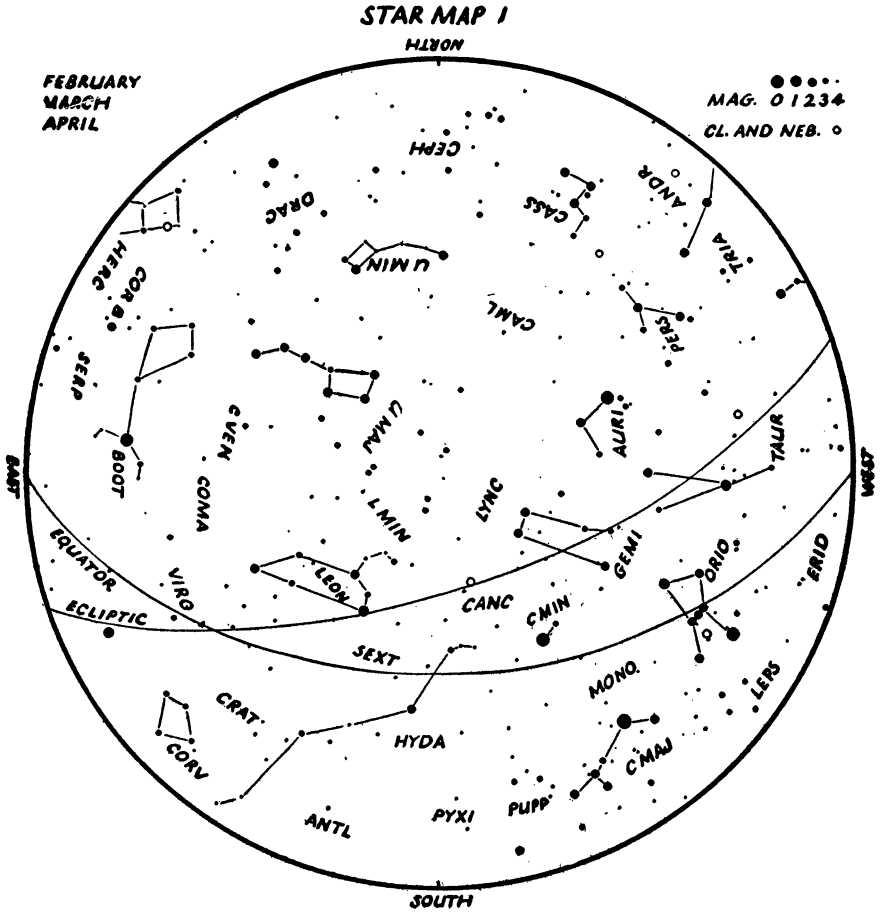
N.G.C.	M	Con	α 1960 h m	δ ° ′	Cl	Dimens. ′ ′	Mag.	Distance millions of l.y.	Vel. km / sec
221	32	And	00 40.5	+40 39	E	3×3	8.8	1.6	− 185
224	31	And	00 40.5	+41 03	Sb	160×40	5.0	1.6	− 220
SMC		Tuc	00 53	−72 35	I	220×220	1.5	0.17	+ 170
598	33	Tri	01 31.6	+30 28	Sc	60×40	7.0	1.4	− 70
LMC		Dor	05 21	−69 26	I	430×530	0.5	0.17	+ 280
3031	81	UMa	09 52.4	+69 16	Sb	16×10	8.3	4.8	− 30
3034	82	UMa	09 52.7	+69 53	I	7× 2	9.0	5.2	+ 290
3368	96	Leo	10 44.6	+12 02	Sa	7× 4	10.0	11.4	+ 940
3623	65	Leo	11 16.8	+13 19	Sb	8× 2	9.9	10.0	+ 800
3627	66	Leo	11 18.2	+13 13	Sb	8× 2	9.1	8.6	+ 650
4258		CVn	12 17.0	+47 32	Sb	20× 6	8.7	9.2	+ 500
4374	84	Vir	12 23.0	+13 06	E	3× 2	9.9	12.0	+1050
4382	85	Com	12 23.4	+18 25	E	4× 2	10.0	7.4	+ 500
4472	49	Vir	12 27.8	+08 13	E	5× 4	10.1	11.4	+ 850
4565		Com	12 34.4	+26 12	Sb	15× 1	11.0	15.2	+1100
4594		Vir	12 37.9	−11 24	Sa	7× 2	9.2	14.4	+1140
4649	60	Vir	12 41.7	+11 46	E	4× 3	9.5	15.0	+1090
4736	94	CVn	12 49.0	+41 20	Sb	5× 4	8.4	6.0	+ 290
4826	64	Com	12 54.8	+21 54	Sb	8× 4	9.2	2.6	+ 150
5005		CVn	13 09.0	+37 16	Sc	5× 2	11.1	13.2	+ 900
5055	63	CVn	13 14.0	+42 14	Sb	8× 3	9.6	7.2	+ 450
5194	51	CVn	13 28.2	+47 24	Sc	12× 6	7.4	6.0	+ 250
5236	83	Hya	13 34.8	−29 40	Sc	10× 8	8	5.8	+ 500
6822		Sgr	19 42.7	−14 52	I	20×10	11	2.0	− 150
7331		Peg	22 35.2	+34 12	Sb	9× 2	10.4	10.4	+ 500

RADIO SOURCES

By John Galt

This table lists most of the strongest sources of radio emission as well as a representative number of sources with interesting properties. Although most of these have been identified with optical objects, it should be remembered that many of the weaker sources remain unidentified. The flux, which is a measure of the intensity of the source, is given in units of 10^{-26} watts/metre^2/cycle per second at a frequency of 960 Mc./sec. or a wave-length of 31 cm. The relative intensities of these sources can be quite different at different frequencies. In particular Jupiter is a very strong emitter at lower frequencies. The distances are derived, in general, from measurements in the optical region. Many extra-galactic sources are double and this is indicated in the column "Approximate Radio Size" by noting the size of each individual emitting region followed by their separation, *s*.

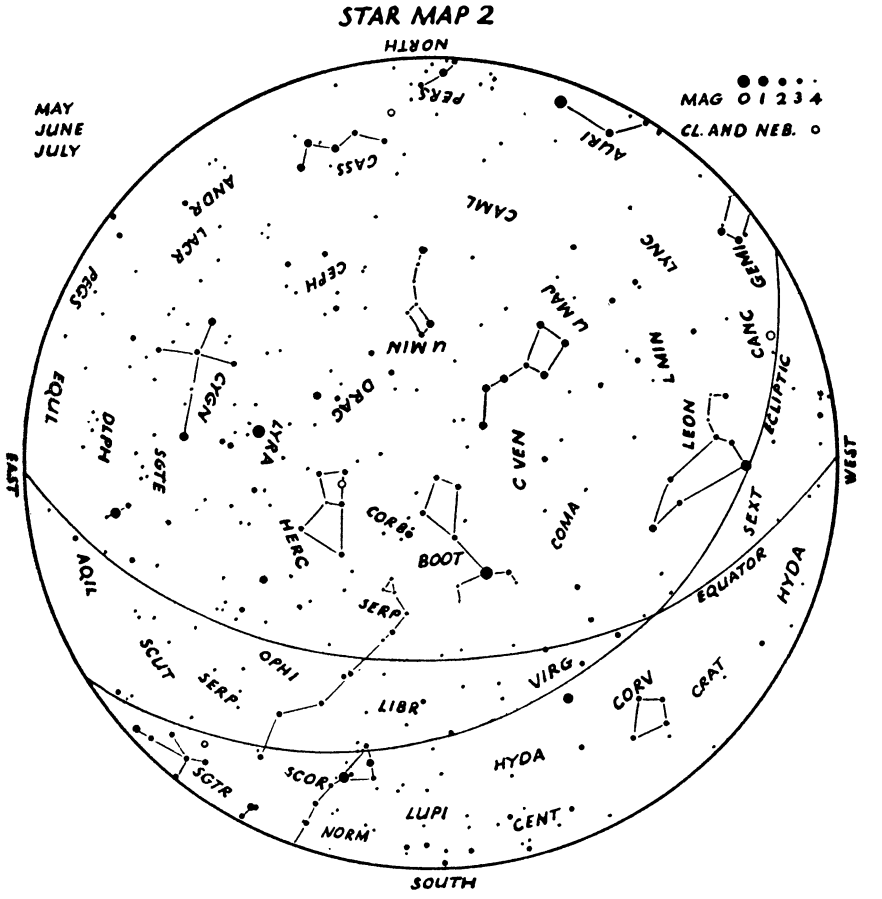
Name	R.A. 1960 h m	Dec. ° ′	Flux	Distance thousands of l.y.	Approximate Radio Size
Tycho's S'nova	00 23.4	+63 54	57	1	6′.6
Andromeda Gal.	00 40.5	+41 03	65	2000	10°
Fornax A	03 20.8	−37 19	150	60000	18′ + 18′, *s*29′
Crab Neb., M1	05 32.0	+22 00	1030	4	5′
Orion Neb., M42	05 33.3	−05 25	360	2	4° × 3°
IC 443	06 14.9	+22 36	195	4	1.5°
Rosette Neb.	06 29.9	+04 53	24	5	1.2°
3C 273	12 27.2	+02 17	50	1500000	< 12″
Virgo A, M 87	12 28.8	+12 37	300	40000	4′.7
Centaurus A	13 23.0	−42 49	2010	10000	3°, complex
3C 295	14 10.0	+52 22	30	4500000	< 12″
3C 353	17 18.5	−00 56	84	800000	4′
Kepler's S'nova	17 28.4	−21 16	20	4	2′
Galactic Nucleus	17 43.5	−28 50	240	26	1° × 1.5°, complex
Omega Neb., M 17	18 18.0	−16 18	500	3	8′
3C 392	18 54.1	+01 16	211	?	15′
Cygnus A	19 58.1	+40 37	2160	500000	51″ + 51″, *s*1′.3
Cygnus X	20 21.1	+40 15	800	5	0°.6 × 1°.8
HB 21	20 45.3	+50 32	180	?6	1°.3
Cygnus loop	20 50.4	+29 32	252	2	2° × 2°.5
N. America Neb.	20 53.6	+43 54	350	3	1°.5 × 2°
Cassiopeia A	23 21.6	+58 35	3120	10	4′
Sun			300000		0°.6
Moon			500		0°.5
Jupiter			5		3.3 × eq. diam. 1 × polar diam.



The above map represents the evening sky at

Midnight	.....	Feb. 6
11 p.m.	.....	" 21
10 "	.....	Mar. 7
9 "	.....	" 22
8 "	.....	Apr. 6
7 "	.....	" 21

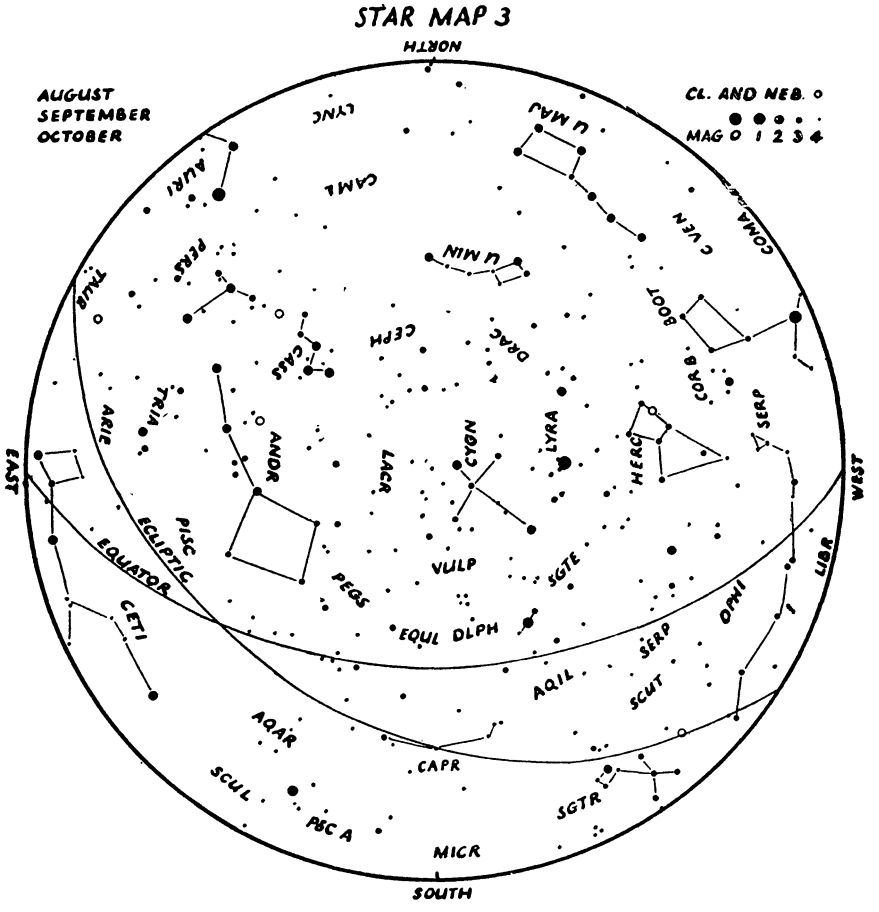
The centre of the map is the zenith, the circumference the horizon. To identify the stars hold the map so that the part of the horizon you are facing is down. A set of four 8-inch horizon maps may be obtained by writing to the National Office.



The above map represents the evening sky at

Midnight.....	May 8
11 p.m.....	" 24
10 "	June 7
9 "	" 22
8 "	July 6

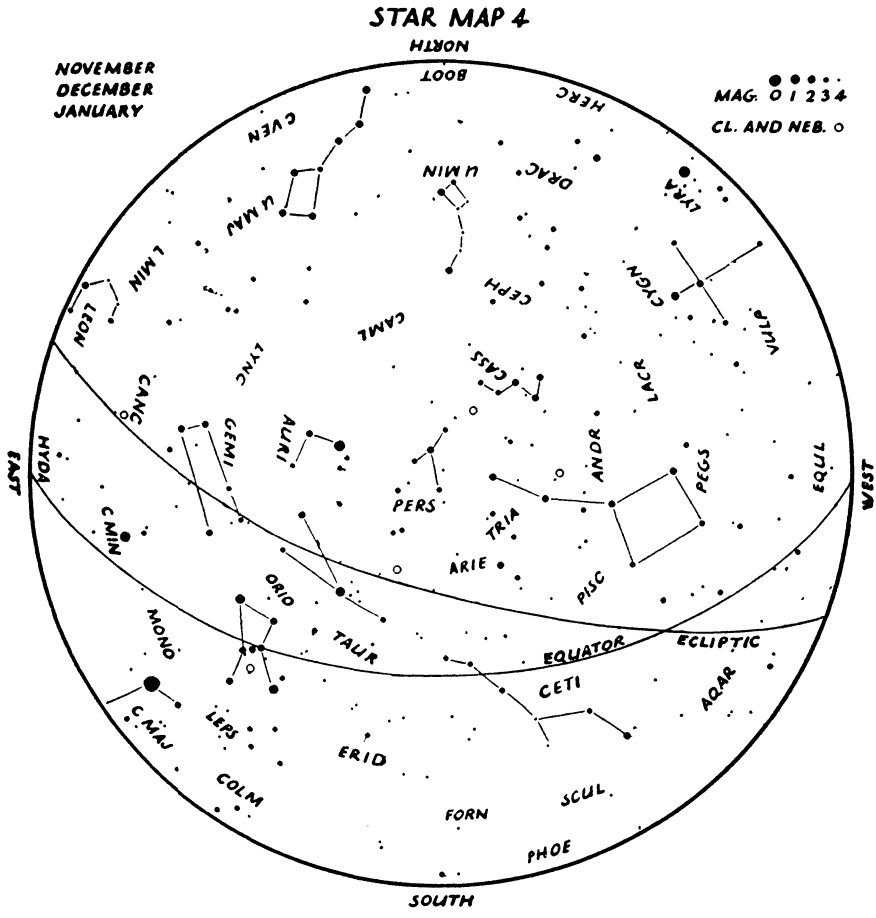
The centre of the map is the zenith, the circumference the horizon. To identify the stars hold the map so that the part of the horizon you are facing is down.



The above map represents the evening sky at

Midnight	.....	Aug. 5
11 p.m.	.....	" 21
10 "	.....	Sept. 7
9 "	.....	" 23
8 "	.....	Oct. 10
7 "	.....	" 26
6 "	.....	Nov. 6
5 "	.....	" 21

The centre of the map is the zenith, the circumference the horizon. To identify the stars hold the map so that the part of the horizon you are facing is down.



The above map represents the evening sky at

Midnight	Nov.	6
11 p.m.	"	21
10 "	Dec.	6
9 "	"	21
8 "	Jan.	5
7 "	"	20
6 "	Feb.	6

The centre of the map is the zenith, the circumference the horizon. To identify the stars hold the map so that the part of the horizon you are facing is down.

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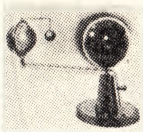

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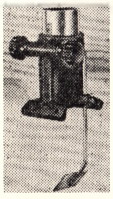

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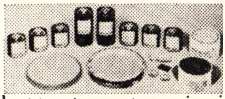

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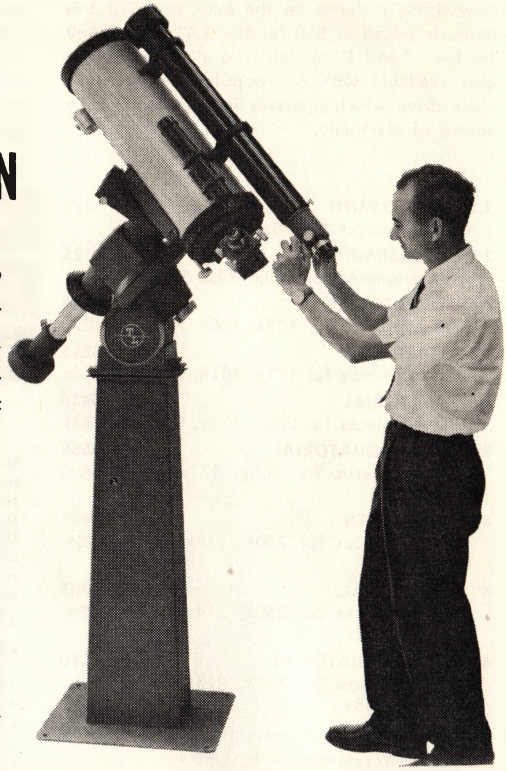

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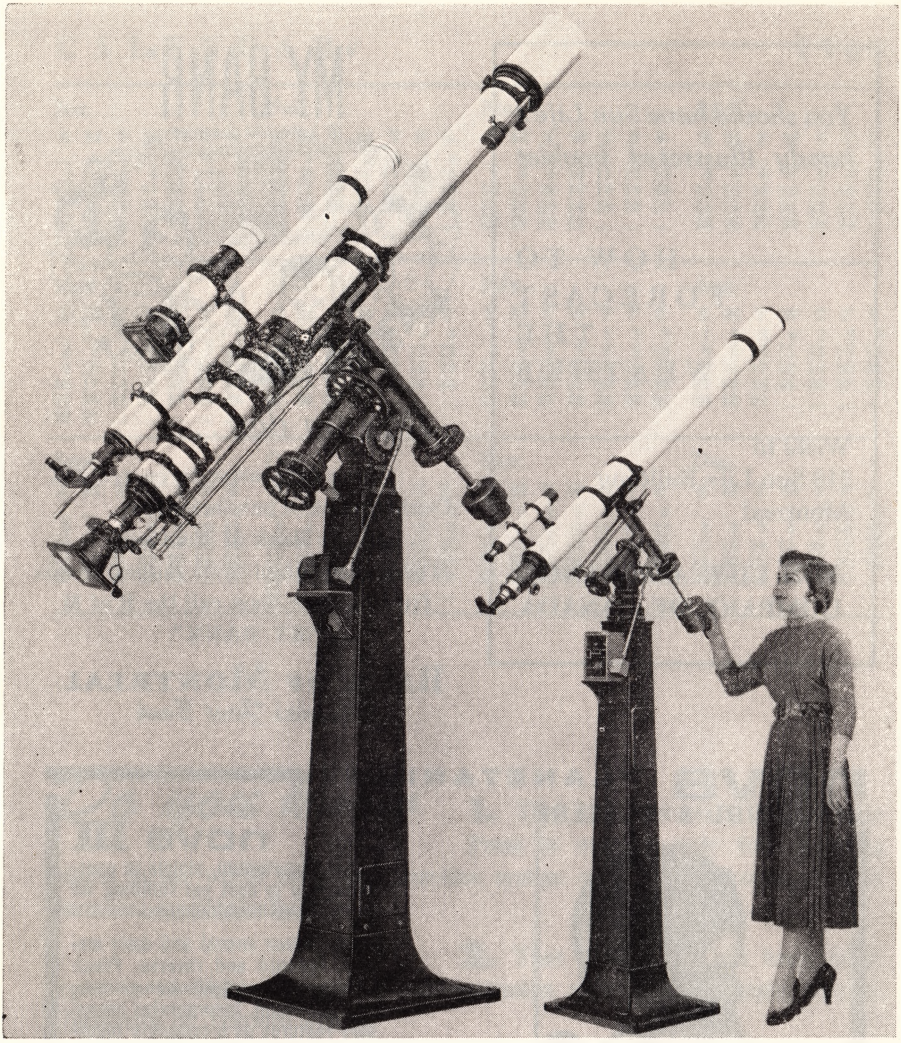

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CALENDAR 1965

Jan.

S	M	T	W	T	F	S
....	....	....	....	....	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31	....	....	....	....	....	....

Feb.

S	M	T	W	T	F	S
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14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	....	....	....	....	....	....

Mar.

S	M	T	W	T	F	S
....	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31	....	....	....

April

S	M	T	W	T	F	S
....	....	....	....	1	2	3
4	5	6	7	8	9	10
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18	19	20	21	22	23	24
25	26	27	28	29	30	....

May

S	M	T	W	T	F	S
....	....	....	....	....	....	1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
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23	24	25	26	27	28	29
30	31	....	....	....	....	....

June

S	M	T	W	T	F	S
....	....	1	2	3	4	5
6	7	8	9	10	11	12
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20	21	22	23	24	25	26
27	28	29	30	....	....	....

July

S	M	T	W	T	F	S
....	....	....	....	1	2	3
4	5	6	7	8	9	10
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18	19	20	21	22	23	24
25	26	27	28	29	30	31

Aug.

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	....	....	....	....

Sept.

S	M	T	W	T	F	S
....	....	....	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	....	....

Oct.

S	M	T	W	T	F	S
....	....	....	....	....	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
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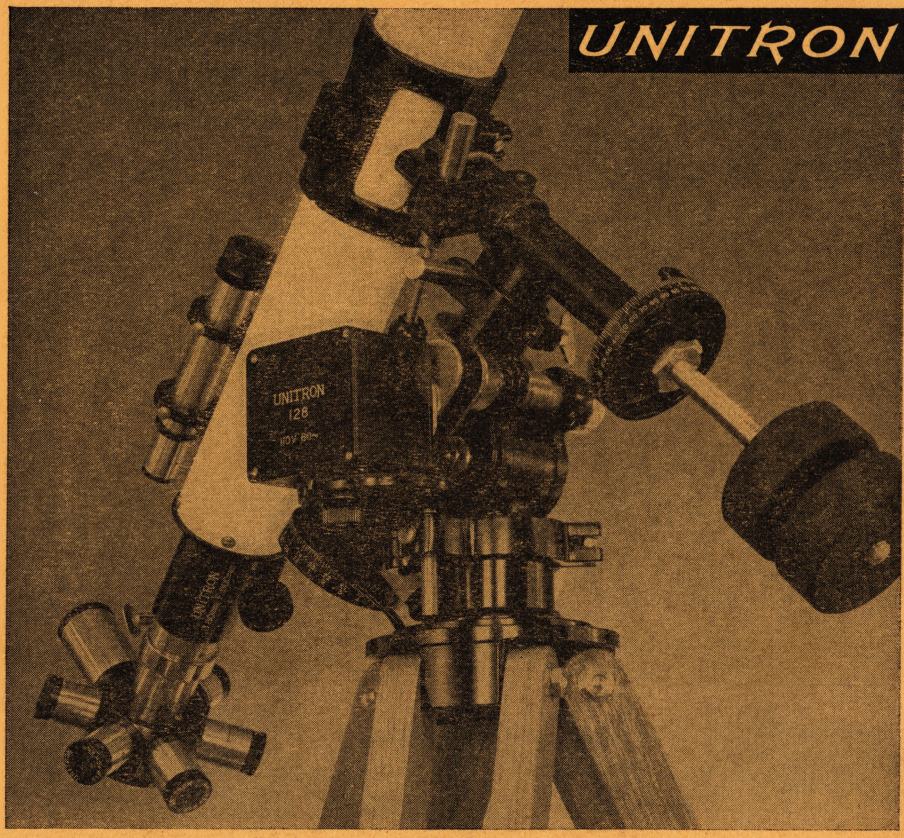
24	25	26	27	28	29	30
31	....	....	....	....	....	....

Nov.

S	M	T	W	T	F	S
....	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	....	....	....	....

Dec.

S	M	T	W	T	F	S
....	....	....	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	....



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