THE OBSERVER'S HANDBOOK 1969

Sixty-first Year of Publication

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

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Incorporated 1890 — Royal Charter 1903

The National Office of the Royal Astronomical Society of Canada is located at 252 College Street, Toronto 2B, Ontario. The business office of the Society, reading rooms and astronomical library, are housed here.

Membership in the Society is open to anyone interested in astronomy. Applicants may affiliate with one of the Society's sixteen centres across Canada, or may join the National Society direct. Centres of the Society are established in St. John's, Quebec, Montreal, Ottawa, Kingston, Hamilton, Niagara Falls, London, Windsor, Winnipeg, Edmonton, Calgary, Vancouver, Victoria, and Toronto. Addresses of the Centres' secretaries may be obtained from the National Office.

Publications of the Society are free to members, and include the JOURNAL (6 issues per year) and the OBSERVER'S HANDBOOK (published annually in November). Annual fees of $7.50 are payable October 1 and include the publications for the following year.

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Saturday evenings, April through October (by reservation).

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Monday to Friday, daytime, no program.
Saturday evenings, April through November.

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Calgary Centennial Planetarium, Calgary, Alta.
Daily (except Tues.), 2, 3:15, 7, 8:15 p.m.

Dow Planetarium, Montreal, P.Q.
In English: Mon. through Sat., 3:30 p.m., also Sat. 1 p.m. and Sun. 2:15 p.m. Evenings (except Mon.), 8:15.
In French: Mon. through Sat., 2:15 p.m., Sun., 1 and 3:30 p.m. Evenings (except Mon.), 9:30.

H.R. MacMillan Planetarium, Vancouver, B.C.
Tues. through Thur., 3, 8 p.m., Fri. 3, 7:30, 9 p.m., Sat. 1:30, 3, 8 p.m., Sun. and holidays, 1:30, 3, 4:30, 8 p.m. (During summer months, Tues. through Sun. at 1:30, 3, 7:30, 9 p.m.)

Manitoba Museum of Man and Nature Planetarium, Winnipeg, Man.
Tues. through Fri., 3, 7:30, 9 p.m., Sat. 11 a.m., 1, 2:30, 4 and 8 p.m., Sun. 1, 2:30 and 4 p.m.

McLaughlin Planetarium, Toronto, Ont.
Tues. through Fri., 3:30, 8 p.m., Sat. 11 a.m., 2, 3:30, 5 and 8 p.m., Sun. 2, 3:30 and 5 p.m.

McMaster University, Hamilton, Ont. (group reservations only).

Nova Scotia Museum, Halifax, N.S. (Tues. only, 8 p.m.).

Queen Elizabeth Planetarium, Edmonton, Alta.
(Winter) Tues. through Fri., 8 p.m., Sat. 3 p.m., Sun. and holidays, 2, 4, 8 p.m. (Summer) Mon. through Sat., 3, 8 p.m., Sun. and holidays, 2, 3, 4, 8 p.m.

University of Manitoba, Winnipeg, Man.
Tues. 8:30 p.m., Thurs. 7:30, 9 p.m. (closed April and May).

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EDITOR
RUTH J. NORTHCOTT

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252 COLLEGE STREET, TORONTO 2B, ONTARIO

OBSERVERS HANDBOOK

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THE OBSERVER'S HANDBOOK for 1969 is the 61st edition. The time zone map has been revised and supplied courtesy of the Department of Energy, Mines and Resources. A table giving the longitude of the central meridian of Mars has been added. Changes have been made in the table of Saturn's satellites, so that it will be more useful to observers. The times of sunrise and sunset, and of twilight, are again for the current year. The magnitudes in the table of Messier's objects have been revised.

During 1969 the range of the moon's declination reaches its greatest value, so that the moon occults stars of the Pleiades. Observers in Montreal, Winnipeg and Vancouver may find that the stars occulted by the moon may not be in strict chronological order (see p. 64).

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 to Barbara Gaizauskas, Helen Sawyer Hogg, Ronald Nikaido, John Percy, Maude Town and Isabel Williamson. 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, 1969

New Year's Day	Wed.	Jan.	1
Epiphany	Mon.	Jan.	6
Septuagesima Sunday		Feb.	2
Accession of Queen Elizabeth (1952)	Thur.	Feb.	6
Quinquagesima (Shrove Sunday)		Feb.	16
Ash Wednesday		Feb.	19
St. David	Sat.	Mar.	1
St. Patrick	Mon.	Mar.	17
Palm Sunday		Mar.	30
Good Friday		Apr.	4
Easter Sunday		Apr.	6
Birthday of Queen Elizabeth (1926)	Mon.	Apr.	21
St. George	Wed.	Apr.	23
Rogation Sunday		May	11
Ascension Day	Thur.	May	15
Victoria Day	Mon.	May	19
Pentecost (Whit Sunday)		May	25
Trinity Sunday		June	1
Corpus Christi	Thur.	June	5
St. John Baptist (Midsummer Day)	Tues.	June	24
Dominion Day	Tues.	July	1
Birthday of Queen Mother Elizabeth (1900)	Mon.	Aug.	4
Labour Day	Mon.	Sept.	1
Hebrew New Year (Rosh Hashanah)	Sat.	Sept.	13
St. Michael (Michaelmas Day)	Mon.	Sept.	29
Thanksgiving	Mon.	Oct.	13
All Saints' Day	Sat.	Nov.	1
Remembrance Day	Tues.	Nov.	11
St. Andrew	Sun.	Nov.	30
First Sunday in Advent		Nov.	30
Christmas Day	Thur.	Dec.	25

JULIAN DAY CALENDAR, 1969

J.D. 2,400,000 plus the following:

Jan. 1	40,223	May 1	40,343	Sept. 1	40,466
Feb. 1	40,254	June 1	40,374	Oct. 1	40,496
Mar. 1	40,282	July 1	40,404	Nov. 1	40,527
Apr. 1	40,313	Aug. 1	40,435	Dec. 1	40,557

The Julian Day commences at noon. Thus J.D. 2,440,223.0 = 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

Α, α	Alpha	Ι, ι	Iota	Ρ, ρ	Rho
Β, β	Beta	Κ, κ	Kappa	Σ, σ	Sigma
Γ, γ	Gamma	Λ, λ	Lambda	Τ, τ	Tau
Δ, δ	Delta	Μ, μ	Mu	Υ, υ	Upsilon
Ε, ε	Epsilon	Ν, ν	Nu	Φ, φ	Phi
Ζ, ζ	Zeta	Ξ, ξ	Xi	Χ, χ	Chi
Η, η	Eta	Ο, ο	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 8.794″ for the sun's parallax, and the astronomical unit of 92.957 million miles.

THE CONSTELLATIONS

LATIN AND FRENCH NAMES WITH ABBREVIATIONS

The approximate position of the centre of each constellation is indicated by the right ascension in hours and the declination as follows: on the zodiac, Z; on the equator, E; northern hemisphere, N; southern hemisphere, S; italics are used for constellations completely within 45° of a pole.

Andromeda, *Andromède*	And	1	N
Antlia, *La Machine Pneumatique*	Ant	10	S
Apus, *L'Oiseau de Paradis*	Aps	16	*S*
Aquarius, *Le Verseau*	Aqr	22	Z
Aquila, *L'Aigle*	Aql	19	E
Ara, *L'Autel*	Ara	17	*S*
Aries, *Le Bélier*	Ari	2	Z
Auriga, *Le Cocher*	Aur	5	N
Boötes, *Le Bouvier*	Boo	14	N
Caelum, *Le Burin du Graveur*	Cae	4	S
Camelopardalis, *La Girafe*	Cam	6	*N*
Cancer, *Le Cancer*	Cnc	8	Z
Canes Venatici, *Les Chiens de Chasse*	CVn	13	N
Canis Major, *Le Grand Chien*	CMa	6	S
Canis Minor, *Le Petit Chien*	CMi	7	N
Capricornus, *Le Capricorne*	Cap	21	Z
Carina, *La Carène du Navire*	Car	8	*S*
Cassiopeia, *Cassiopée*	Cas	1	*N*
Centaurus, *Le Centaure*	Cen	12	S
Cepheus, *Céphée*	Cep	23	*N*
Cetus, *La Baleine*	Cet	1	E
Chamaeleon, *Le Caméléon*	Cha	10	*S*
Circinus, *Le Compas*	Cir	14	*S*
Columba, *La Colombe*	Col	5	S
Coma Berenices, *La Chevelure de Bérénice*	Com	12	N
Corona Australis, *La Couronne Australe*	CrA	18	S
Corona Borealis, *La Couronne Boréale*	CrB	15	N
Corvus, *Le Corbeau*	Crv	12	S
Crater, *La Coupe*	Crt	11	S
Crux, *La Croix du Sud*	Cru	12	*S*
Cygnus, *Le Cygne*	Cyg	20	N
Delphinus, *Le Dauphin*	Del	20	N
Dorado, *La Dorade*	Dor	5	*S*
Draco, *Le Dragon*	Dra	16	*N*
Equuleus, *Le Petit Cheval*	Equ	21	N
Eridanus, *Eridan*	Eri	3	S
Fornax, *Le Fourneau*	For	2	S
Gemini, *Les Gémeaux*	Gem	7	Z
Grus, *La Grue*	Gru	22	S
Hercules, *Hercule*	Her	17	N
Horologium, *L'Horloge*	Hor	3	S
Hydra, *L'Hydre Femelle*	Hya	11	S
Hydrus, *L'Hydre Mâle*	Hyi	2	*S*
Indus, *Indien (l'Oiseau)*	Ind	21	*S*
Lacerta, *Le Lézard*	Lac	22	N
Leo, *Le Lion*	Leo	10	Z
Leo Minor, *Le Petit Lion*	LMi	10	N
Lepus, *Le Lièvre*	Lep	5	S
Libra, *La Balance*	Lib	15	Z
Lupus, *Le Loup*	Lup	15	S
Lynx, *Le Lynx*	Lyn	7	N
Lyra, *La Lyre*	Lyr	18	N
Mensa, *La Table*	Men	5	*S*
Microscopium, *Le Microscope*	Mic	20	S
Monoceros, *La Licorne*	Mon	6	E
Musca, *La Mouche*	Mus	12	*S*
Norma, *La Règle*	Nor	15	S
Octans, *L'Octant*	Oct	—	*S*
Ophiuchus, *Ophiuchus*	Oph	17	E
Orion, *Orion*	Ori	5	E
Pavo, *Le Paon*	Pav	19	*S*
Pegasus, *Pégase*	Peg	22	N
Perseus, *Persée*	Per	3	N
Phoenix, *Le Phénix*	Phe	0	S
Pictor, *Peintre (le Chevalet du)*	Pic	5	S
Pisces, *Les Poissons*	Psc	0	Z
Piscis Austrinus, *Le Poisson Austral*	PsA	22	S
Puppis, *La Poupe du Navire*	Pup	7	S
Pyxis, *La Boussole*	Pyx	8	S
Reticulum, *Le Réticule*	Ret	3	*S*
Sagitta, *La Flèche*	Sge	19	N
Sagittarius, *Le Sagittaire*	Sgr	18	Z
Scorpius, *Le Scorpion*	Sco	16	Z
Sculptor, *Sculpteur (l'Atelier du)*	Scl	0	S
Scutum, *L'Ecu*	Sct	18	S
Serpens, *Le Serpent*	Ser	16	E
Sextans, *Le Sextant*	Sex	10	E
Taurus, *Le Taureau*	Tau	4	Z
Telescopium, *Le Télescope*	Tel	19	*S*
Triangulum, *Le Triangle*	Tri	2	N
Triangulum Australe, *Le Triangle Austral*	TrA	16	*S*
Tucana, *Le Toucan*	Tuc	23	*S*
Ursa Major, *La Grande Ourse*	UMa	11	N
Ursa Minor, *La Petite Ourse*	UMi	—	*N*
Vela, *Les Voiles du Navire*	Vel	9	S
Virgo, *La Vierge*	Vir	13	Z
Volans, *Le Poisson Volant*	Vol	7	*S*
Vulpecula, *Le Renard*	Vul	20	N

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. = 10 mm.	= 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	$= 1.496\times10^{13}$ cm. $= 1.496\times10^8$ km.	$= 9.2957\times10^7$ mi.	
1 light-year	$= 9.461\times10^{17}$ 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 = 6378.160 km. = 3963.20 mi.: flattening, $c = (a-b)/a = 1/298.25$
Polar radius, b = 6356.77 km. = 3949.91 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″.794 (adopted)
Constant of aberration = 20″.496 (adopted)
Annual general precession = 50″.26; obliquity of ecliptic = 23° 26′ 35″ (1970)
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 = 299,792.50 ± 0.10 km./sec. = 186,282.1 mi./sec.;
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	π = 3.141,592,653,6	
= 3437′.75	No. of square degrees in the sky = 41,253	
= 206,265″	1 gram = 0.03527 oz.	

SUN—EPHEMERIS AND CORRECTION TO SUN-DIAL

Date		Apparent R.A. 0h E.T.	Corr. to Sun-dial 12h E.T.	Apparent Dec. 0h E.T.
		h m s	m s	° ′
Jan.	1	18 45 16	+ 3 38	−23 02.3
	4	18 58 29	+ 5 01	−22 45.9
	7	19 11 39	+ 6 20	−22 25.5
	10	19 24 44	+ 7 35	−22 01.1
	13	19 37 45	+ 8 45	−21 32.8
	16	19 50 40	+ 9 50	−21 00.7
	19	20 03 29	+10 48	−20 25.1
	22	20 16 11	+11 40	−19 45.9
	25	20 28 47	+12 24	−19 03.5
	28	20 41 15	+13 01	−18 17.9
	31	20 53 36	+13 31	−17 29.4
Feb.	3	21 05 49	+13 54	−16 38.1
	6	21 17 55	+14 09	−15 44.2
	9	21 29 54	+14 17	−14 47.9
	12	21 41 46	+14 18	−13 49.3
	15	21 53 31	+14 12	−12 48.6
	18	22 05 10	+14 00	−11 46.1
	21	22 16 42	+13 42	−10 41.9
	24	22 28 08	+13 18	− 9 36.2
	27	22 39 29	+12 48	− 8 29.3
Mar.	2	22 50 45	+12 13	− 7 21.2
	5	23 01 56	+11 34	− 6 12.2
	8	23 13 04	+10 51	− 5 02.4
	11	23 24 08	+10 05	− 3 52.1
	14	23 35 09	+ 9 16	− 2 41.2
	17	23 46 08	+ 8 25	− 1 30.1
	20	23 57 05	+ 7 33	− 0 18.9
	23	0 08 01	+ 6 39	+ 0 52.2
	26	0 18 57	+ 5 44	+ 2 03.0
	29	0 29 51	+ 4 50	+ 3 13.5
Apr.	1	0 40 47	+ 3 55	+ 4 23.3
	4	0 51 42	+ 3 02	+ 5 32.5
	7	1 02 40	+ 2 10	+ 6 40.8
	10	1 13 39	+ 1 20	+ 7 48.0
	13	1 24 41	+ 0 33	+ 8 54.1
	16	1 35 46	− 0 12	+ 9 58.9
	19	1 46 54	− 0 52	+11 02.2
	22	1 58 06	− 1 30	+12 03.9
	25	2 09 22	− 2 03	+13 03.7
	28	2 20 42	− 2 32	+14 01.6
May	1	2 32 06	− 2 57	+14 57.5
	4	2 43 35	− 3 16	+15 51.0
	7	2 55 09	− 3 31	+16 42.3
	10	3 06 49	− 3 41	+17 31.1
	13	3 18 33	− 3 45	+18 17.2
	16	3 30 23	− 3 44	+19 00.6
	19	3 42 18	− 3 37	+19 41.0
	22	3 54 18	− 3 26	+20 18.5
	25	4 06 23	− 3 11	+20 52.8
	28	4 18 32	− 2 51	+21 23.9
	31	4 30 45	− 2 27	+21 51.6
June	3	4 43 01	− 1 59	+22 16.0
	6	4 55 21	− 1 28	+22 36.8
	9	5 07 44	− 0 54	+22 54.1
	12	5 20 10	− 0 18	+23 07.8
	15	5 32 38	+ 0 20	+23 17.8
	18	5 45 06	+ 0 59	+23 24.1
	21	5 57 35	+ 1 38	+23 26.7
	24	6 10 04	+ 2 17	+23 25.5
	27	6 22 31	+ 2 55	+23 20.7
	30	6 34 58	+ 3 31	+23 12.1

Date		Apparent R.A. 0h E.T.	Corr. to Sun-dial 12h E.T.	Apparent Dec. 0h E.T.
		h m s	m s	° ′
July	3	6 47 22	+ 4 05	+22 59.9
	6	6 59 44	+ 4 37	+22 44.1
	9	7 12 02	+ 5 05	+22 24.8
	12	7 24 17	+ 5 30	+22 01.9
	15	7 36 29	+ 5 51	+21 35.7
	18	7 48 36	+ 6 07	+21 06.1
	21	8 00 37	+ 6 19	+20 33.3
	24	8 12 34	+ 6 25	+19 57.5
	27	8 24 25	+ 6 25	+19 18.6
	30	8 36 11	+ 6 21	+18 36.9
Aug.	2	8 47 51	+ 6 10	+17 52.4
	5	8 59 26	+ 5 55	+17 05.3
	8	9 10 56	+ 5 34	+16 15.7
	11	9 22 21	+ 5 08	+15 23.7
	14	9 33 40	+ 4 37	+14 29.5
	17	9 44 55	+ 4 02	+13 33.2
	20	9 56 05	+ 3 21	+12 35.0
	23	10 07 10	+ 2 36	+11 35.0
	26	10 18 12	+ 1 47	+10 33.4
	29	10 29 09	+ 0 55	+ 9 30.3
Sept.	1	10 40 04	− 0 01	+ 8 25.8
	4	10 50 56	− 0 59	+ 7 20.1
	7	11 01 46	− 1 59	+ 6 13.3
	10	11 12 34	− 3 01	+ 5 05.6
	13	11 23 21	− 4 04	+ 3 57.1
	16	11 34 07	− 5 08	+ 2 47.9
	19	11 44 53	− 6 11	+ 1 38.3
	22	11 55 38	− 7 15	+ 0 28.3
	25	12 06 25	− 8 18	− 0 41.7
	28	12 17 13	− 9 19	− 1 51.9
Oct.	1	12 28 03	−10 18	− 3 01.9
	4	12 38 56	−11 15	− 4 11.6
	7	12 49 52	−12 08	− 5 20.9
	10	13 00 51	−12 57	− 6 29.6
	13	13 11 55	−13 43	− 7 37.5
	16	13 23 04	−14 23	− 8 44.5
	19	13 34 17	−14 59	− 9 50.3
	22	13 45 36	−15 28	−10 54.8
	25	13 57 00	−15 52	−11 57.9
	28	14 08 32	−16 10	−12 59.3
	31	14 20 09	−16 21	−13 58.9
Nov.	3	14 31 55	−16 24	−14 56.5
	6	14 43 47	−16 20	−15 52.0
	9	14 55 47	−16 08	−16 45.0
	12	15 07 55	−15 49	−17 35.5
	15	15 20 10	−15 22	−18 23.3
	18	15 32 33	−14 47	−19 08.2
	21	15 45 03	−14 06	−19 49.9
	24	15 57 41	−13 17	−20 28.4
	27	16 10 25	−12 21	−21 03.5
	30	16 23 16	−11 19	−21 35.1
Dec.	3	16 36 13	−10 11	−22 02.9
	6	16 49 15	− 8 57	−22 27.0
	9	17 02 23	− 7 38	−22 47.1
	12	17 15 35	− 6 15	−23 03.2
	15	17 28 50	− 4 50	−23 15.1
	18	17 42 07	− 3 22	−23 22.9
	21	17 55 25	− 1 53	−23 26.5
	24	18 08 44	− 0 24	−23 25.8
	27	18 22 03	+ 1 05	−23 20.9
	30	18 35 21	+ 2 33	−23 11.8

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	332,958	1.41	27.9	25^d–35^d†		
☾ Moon	2,160	0	0.0123	3.34	0.16	$27^d\ 07^h\ 43^m$	6.7	0.067
☿ Mercury	3,100	0	0.056	5.13	0.36	58.65^d	?	0.056
♀ Venus	7,700	0	0.817	4.97	0.87	244^d(retro.)	10	0.76
⊕ Earth	7,926	1/298	1.000	5.52	1.00	$23^h\ 56^m\ 04^s$	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	3,500?	?	0.06?	4?	0.3?	6.387^d	?	0.14?

†Depending on latitude. For the physical observations of the sun, p. 63, the sidereal period of rotation is 25.38 m.s.d.

SATELLITES OF THE SOLAR SYSTEM

Name	Mag.	Diam. miles	Mean Distance from Planet		Revolution Period			Orbit Incl.	Discovery
	* †	†	miles	″ *	d	h	m	° ‡	
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									
Janus	(14)	<300	100,000		0	17	59		A. Dollfus, 1966
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.

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 during a year, 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 longitude (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 centred 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.*

The mean solar second, defined as 1/86400 of the mean solar day, has been abandoned as the unit of time because random changes in the earth's rotation make it variable. The unit of time now has two definitions. In terms of Ephemeris Time (ET) it is 1/31, 556, 925.9747 of the tropical year 1900 January 0 at 12 hrs ET. In terms of the caesium beam frequency standard at zero magnetic field, it is defined as 9, 192, 631, 770 cycles. Ephemeris Time is required in celestial mechanics, while the caesium resonator makes the unit readily available. 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

***Note:* According to the Saskatchewan Time Act 1966, the time zone boundary between C.S.T. and M.S.T. is defined by the 106th meridian of west longitude. Communities to the west of this boundary may elect to adopt C.S.T., and except for Lloydminster the cities have done so.**

tabulated in ET, but observed in UT. ΔT was zero near the beginning of the century, but in 1969 will be about 40 seconds.

RADIO TIME SIGNALS

National time services distribute co-ordinated time called UTC, which approximates UT2. It is derived from the atomic standard by offsetting the output frequency. The offset is reviewed annually, and a change, if necessary, is applied at the beginning of the year. A divergence between UTC and UT2 amounting to 0.1s is corrected by a step adjustment at the beginning of the next month. By agreement these changes are co-ordinated through the Bureau International de l'Heure, so that most time services are synchronized to the millisecond.

Radio time signals readily available in Canada include:

CHU Ottawa, Canada	3330, 7335, 14670 kHz
WWV Fort Collins, Colorado	2.5, 5, 10, 15, 20, 25 mHz
WWVH Maui, Hawaii	2.5, 5, 10, 15 mHz

TIMES OF RISING AND SETTING OF THE SUN AND MOON

The times of sunrise and sunset for places in latitudes ranging from 30° 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 Standard Times for Any Station

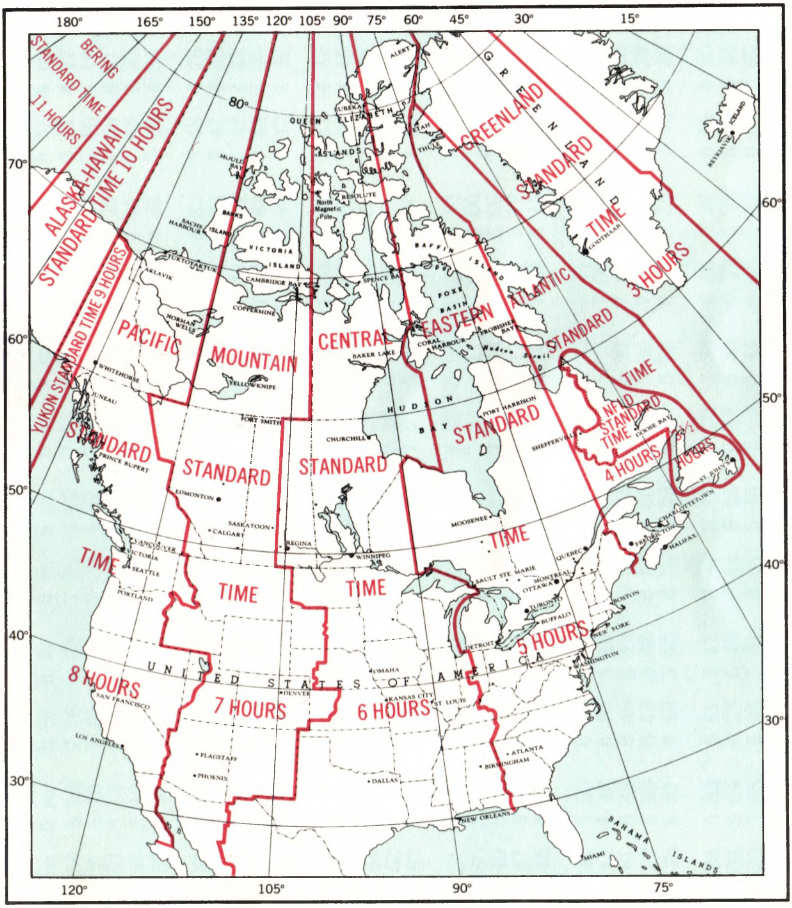
To derive the Standard Time of rising and setting phenomena for the places named, from the list below find the approximate latitude of the place and the correction in minutes which follows the name. Then find in the monthly table the Local Mean Time of the phenomenon for the proper latitude on the desired 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.
Athabasca	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	+63C	Buffalo	43	+15E
Charlottetown	46	+12A	Prince Rupert	54	+41P	Chicago	42	−10C
Churchill	59	+17C	Quebec	47	−15E	Cincinnati	39	+38E
Cornwall	45	− 1E	Regina	50	+58C	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	Saint 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	+67C	Indianapolis	40	−15C
Granby	45	−09E	Sault Ste. Marie	47	+37E	Juneau	58	+58P
Guelph	44	+21E	Shawinigan	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	+62C	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).

MAP OF STANDARD TIME ZONES



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

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

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

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

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

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

BEGINNING OF MORNING AND ENDING OF EVENING TWILIGHT

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

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).

MOONRISE AND MOONSET, 1969 (Local Mean Time)

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

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

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

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

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

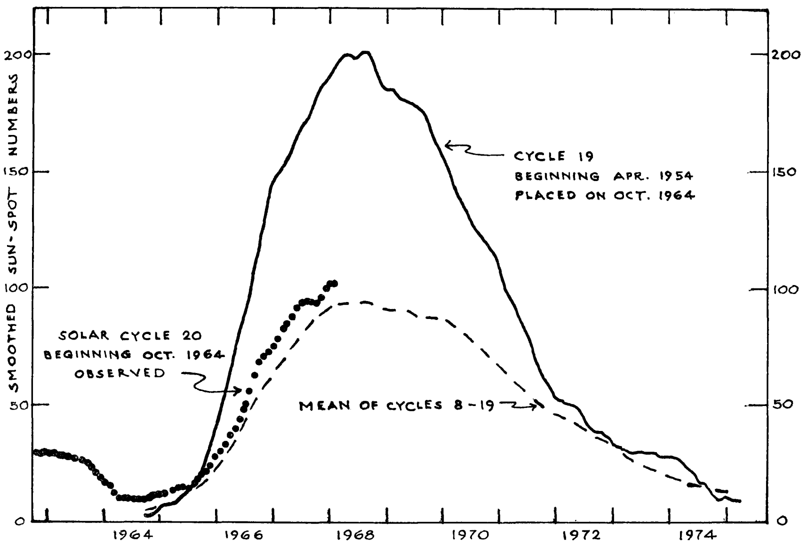
DATE	Latitude 30° Moon Rise	Latitude 30° Moon Set	Latitude 35° Moon Rise	Latitude 35° Moon Set	Latitude 40° Moon Rise	Latitude 40° Moon Set	Latitude 45° Moon Rise	Latitude 45° Moon Set	Latitude 50° Moon Rise	Latitude 50° Moon Set	Latitude 54° Moon Rise	Latitude 54° Moon Set
Nov.	h m	h m	h m	h m	h m	h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

THE SUN AND PLANETS FOR 1969

THE SUN

The diagram represents the sun-spot activity of the current 20th cycle, as far as the final numbers are available. The present cycle began at the minimum in October 1964. For comparison, cycle 19 which began April 1954 (solid curve), and the mean of cycles 8 to 19 (dashed curve), are placed with their minima on October 1964.

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. By a radar technique in 1965, the period of rotation on its axis was found to be 59 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 1969

Elong. East—Evening Sky			Elong. West—Morning Sky		
Date	Dist.	Mag.	Date	Dist.	Mag.
Jan. 13	19°	−0.3	Feb. 23	27°	+0.3
May 5	21°	+0.5	June 23	23°	+0.7
Sept. 2	27°	+0.4	Oct. 14	18°	−0.3
Dec. 27	20°	−0.3			

The most favourable elongations are: in the evening, May 5; in the morning, Oct. 14. The apparent diameter of the planet ranges from about 5″ to 12″.

VENUS

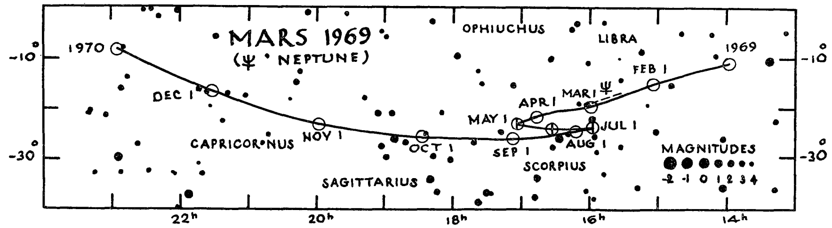
Venus is the next planet in order from the sun. In size and mass it is almost a twin of the earth. Venus being within the earth's orbit, its apparent motion is similar to Mercury's but much slower and more stately. The orbit of Venus is almost circular with radius of 67 million miles, and its orbital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

On Jan. 1, 1969, Venus crosses the meridian about 3 hours after the sun and is in the south-south-west at sunset; its declination is −15° and its stellar magnitude is −3.8. By Jan. 26 it is at greatest eastern elongation, 47°, and is almost 40° above the south-western horizon at sunset. Greatest brilliancy, −4.3, occurs on Mar. 3. Inferior conjunction is reached on Apr. 8, and the planet moves into the morning sky for the rest of the year. Greatest brilliancy, −4.2, occurs on May 14. At greatest western elongation, 46°, on June 17, Venus crosses the meridian about 3 hours before the sun at declination +12°. It overtakes Saturn in early June, and Jupiter in early Nov. By Dec. 31 the planet is approaching superior conjunction. The apparent diameter is 19″ on Jan. 1, increasing to 59″ in early Apr. (inferior conjunction), and decreasing to 10″ on Dec. 31.

Its brilliance is due to its nearness and 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. The rotation period is now quoted as 244 days in a retrograde direction.

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. Perhaps the most surprising result of the space programme so far is the revelation by Mariner IV that the surface of Mars contains craters much like those on the Moon.

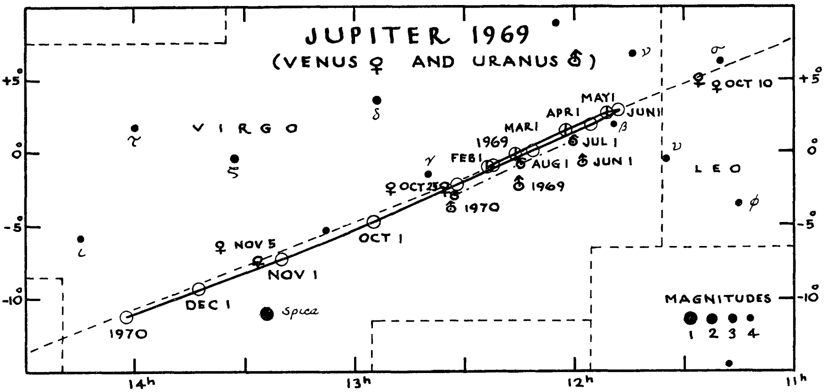
The sidereal, or true mechanical, period of revolution of Mars is 687 days; and the synodic period (for example, the interval from one opposition to the next one) is 780 days. This is the average value; it may vary from 764 to 810 days. At the opposition on Sept. 10, 1956, the planet was closer to the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

1969 is a year when Mars comes to opposition. On Jan. 1, it is in the morning sky in Virgo, moving toward Libra, and is just past the meridian at dawn; its declination is $-11°$ and its stellar magnitude is $+1.5$. It retrogrades from Apr. 26 to July 8, and at opposition on May 31, moves into the evening sky for the rest of the year. It is closest to the earth (44,550,000 mi.) on June 8, when its magnitude brightens to -1.9. From early Mar. to late Aug., Mars is within ten degrees of Antares (see map). On Dec. 31 it is in Aquarius and is just past the meridian at sunset; its magnitude is then $+1.0$. The apparent diameter is 5.4″ on Jan. 1, 11.2″ on Apr. 1, 19.5″ at closest approach in June, 14.5″ on Aug. 1 and 6.0″ on Dec. 31.

JUPITER

Jupiter is the giant of the family of the sun. Its mean diameter is 87,000 miles and its mass is $2\frac{1}{2}$ 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. A correlation of radio bursts with the orbital position of the satellite Io has now been found.

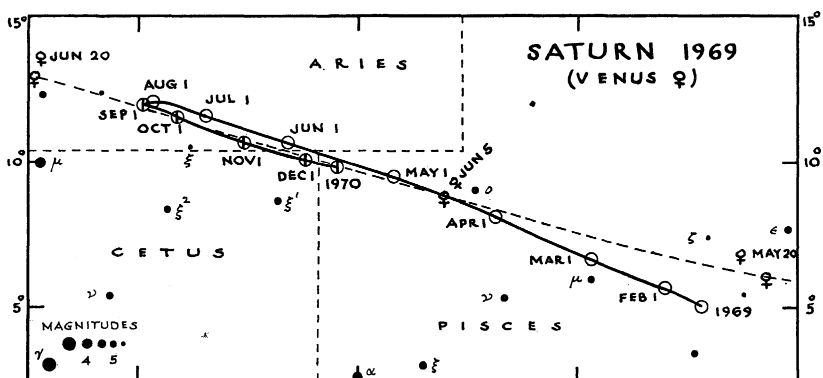
Jupiter is a fine object for the telescope. Many details of the cloud belts as well as the flattening of the planet, due to its short rotation period, are visible, and the phenomena of its satellites provide a continual interest.



On Jan. 1, 1969, Jupiter is in the morning sky in Virgo; it is in the south-southwest at dawn; its stellar magnitude is −1.6 and its declination is −1°. It retrogrades from Jan. 20 to May 23 (see map). Opposition occurs on Mar. 21, when the planet moves into the evening sky and is visible all night; its magnitude is then −2.0. On Oct. 9 it is in conjunction with the sun and moves into the morning sky for the rest of the year. In early Nov. it is near Spica when overtaken by Venus. On Dec. 31, Jupiter is just past the meridian at sunrise; its stellar magnitude is −1.5. The apparent polar diameter ranges from a maximum of 41″ in Mar. to a minimum of 28″ in Oct.

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 ten 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



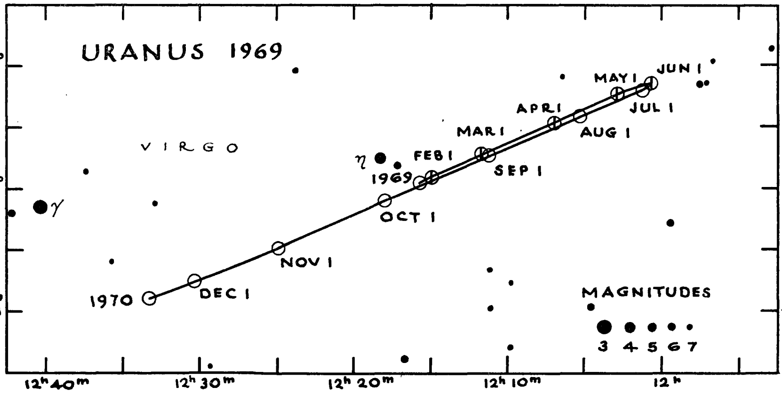
the planet's orbit, and twice during the planet's revolution period of 29½ years the rings appear to open out widest; then they slowly close in until, midway between the maxima, the rings are presented edgewise to the sun or the earth, at which times they are invisible. The rings were edgewise in 1950, and were again in 1966; the northern face of the rings was at maximum in 1958 and the southern will be in 1973. See p. 59. (The tenth satellite was discovered in 1966.)

On Jan. 1, 1969, Saturn is in Pisces, in the south-east at sunset; its declination is +5°, and its stellar magnitude is +0.7. On Apr. 18, it is in conjunction with the sun and moves into the morning sky. Venus retrogrades not far west of Saturn and finally overtakes it on June 11. On Oct. 28 it is in opposition and is visible all night; its magnitude is then +0.1. Beginning to retrograde on Aug. 21 (see map), by Dec. 31 it has moved through Cetus into Pisces and is in the south-east at sunset; its magnitude is then +0.5. The apparent diameter of the ball of the planet ranges from 14″ in Apr. to 18″ in Oct. The rings are open to over half the maximum value, with the southern face visible.

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.

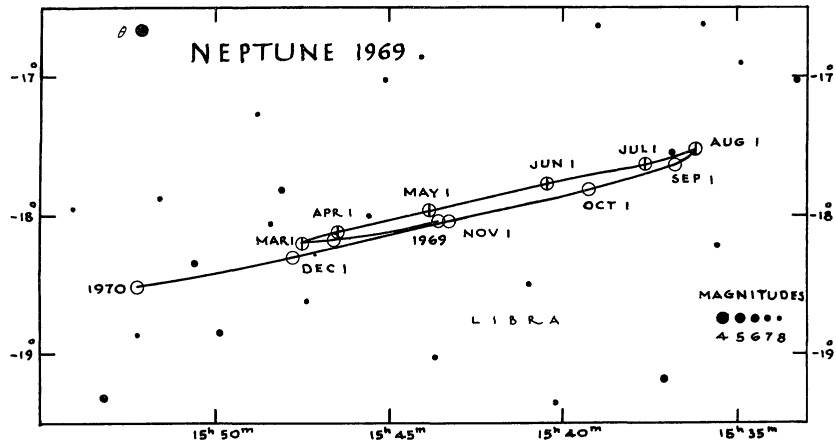
During 1969 Uranus is in Virgo (see map). At the beginning of the year it rises about midnight. It retrogrades from Jan. 8 to June 7, with opposition on Mar. 22 when its stellar magnitude is +5.7 and its apparent diameter is 4.0″. Jupiter retrogrades in Virgo not far from Uranus; the planets are in conjunction on Mar. 15 and July 18. When conjunction occurs on Sept. 27, its magnitude is +5.9; it is in the morning sky for the rest of the year.



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 1969 Neptune is in Libra (see map). It retrogrades from Mar. 1 to Aug. 7. Opposition occurs on May 18 when it is above the horizon all night; its stellar magnitude is then +7.7 and during the year it 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 of 2.3″ to 2.5″. It is in conjunction with the sun on Nov. 20 and moves into the morning sky for the rest of the year.



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. 14 at which time its astrometric position is R.A. 12h 02m, Dec. +17° 12′, and its distance from the earth is 2,870,000,000 mi.

THE SKY MONTH BY MONTH

By John F. Heard

THE SKY FOR JANUARY 1969

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 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 the following months. The earth is in perihelion or nearest the sun on the 3rd at a distance of 91,400,000 mi. 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. 30.

Mercury on the 1st is in R.A. 19h 47m, Decl. 23° 17′ S. and on the 15th is in R.A. 21h 04m, Decl. 17° 02′ S. Greatest eastern elongation is on the 13th, and for a few days before and after this date Mercury is visible as an evening star low in the south-west just after sunset. This is a moderately unfavourable elongation, the altitude of Mercury being about 12° at sunset on the 13th. By the 29th the planet is in inferior conjunction.

Venus on the 1st is in R.A. 21h 54m, Decl. 14° 30′ S. and on the 15th is in R.A. 22h 52m, Decl. 8° 01′ S., mag. −3.9, and transits at 15h 15m. It is in the south-western sky at sunset, setting about four hours later. Greatest eastern elongation is on the 26th, when Venus is almost 40° above the horizon at sunset.

Mars on the 15th is in R.A. 14h 28m, Decl. 13° 12′ S., mag. +1.3, and transits at 6h 50m. Moving into Libra, it is a morning star rising about two hours after midnight.

Jupiter on the 15th is in R.A. 12h 24m, Decl. 1° 08′ S., mag. −1.7, and transits at 4h 46m. In Virgo, it rises about an hour before midnight. On the 20th it is stationary in right ascension and begins to retrograde. 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. 1h 15m, Decl. 5° 15′ N., mag. +0.8, and transits at 17h 34m. In Pisces, it is nearing the meridian at sunset, quadrature east occurring on the 9th, and sets at about midnight.

Uranus on the 15th is in R.A. 12h 16m, Decl. 0° 54′ S. and transits at 4h 37m.

Neptune on the 15th is in R.A. 15h 45m, Decl. 18° 07′ S. and transits at 8h 06m.

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

1969			JANUARY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 3h 00m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Wed. 1	10		Moon at apogee, 252,500 mi.		23104	58.25
Thu. 2					30214	70.37
Fri. 3			Quadrantid meteors	10 40	31024	82.50[b]
			Earth at perihelion			
	13	28	⊕ Full Moon			
Sat. 4	2		Pluto stationary		2014*	94.63
Sun. 5					4203*	106.76
Mon. 6				7 20	d4023	118.89
Tue. 7					40213	131.02
Wed. 8	10		Uranus stationary		42310	143.16
Thu. 9			Saturn in quadrature E.	4 10	43021	155.30
Fri. 10	3		Uranus 1° N. of moon		43102	167.44
	7		Jupiter 2° N. of moon			
Sat. 11	9	01	☾ Last Quarter		4201*	179.59[l]
Sun. 12	17		Mars 5° N. of moon	1 00	42103	191.75
Mon. 13	10		Mercury greatest elong. E., 19°		d0423	203.92
Tue. 14	2		Neptune 6° N. of moon	21 50	02134	216.09
Wed. 15					21304	228.27
Thu. 16			Mercury at ascending node		3014*	240.45
	19		Moon at perigee, 223,200 mi.			
Fri. 17	23	59	● New Moon	18 40	31024	252.64[b]
Sat. 18					23014	264.83
Sun. 19	3		Mercury 5° N. of moon		21034	277.02
	18		Mercury stationary			
Mon. 20			Mercury at perihelion	15 30	01243	289.21
	22		Jupiter stationary			
Tue. 21	11		Venus 1° N. of moon		0423*	301.40
Wed. 22					24130	313.58
Thu. 23			Venus at ascending node	12 20	4301*	325.76[l]
Fri. 24	1		Saturn 4° S. of moon		43102	337.93
Sat. 25	3	24	☽ First Quarter		43201	350.10
Sun. 26	17		Venus greatest elong. E., 47°	9 10	42103	2.26
Mon. 27					40123	14.42
Tue. 28	22		Moon at apogee, 252,000 mi.		4023*	26.57
Wed. 29	4		Mercury in inferior conjunction	6 00	d2403	38.71
Thu. 30			Mercury greatest hel. lat. N.		32014	50.85[b]
Fri. 31					31024	62.99

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]Jan. 11, −7.00°; Jan. 23, +7.16°.
[b]Jan. 3, −6.56°; Jan. 17, +6.49°; Jan. 30, −6.67°.

THE SKY FOR FEBRUARY 1969

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° 44′ S. The equation of time changes from −13m 41s to a maximum of −14m 18s on the 11th and then to −12m 35s 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 1st is in R.A. 20h 30m, Decl. 15° 15′ S. and on the 15th is in R.A. 20h 13m, Decl. 18° 19′ S. Greatest western elongation is on the 23rd, so that Mercury then may be seen as a morning star very low in the south-east just before sunrise. However, this is an unfavourable elongation, the altitude of the planet being only about 9° at sunrise on the 23rd, so that observation will be difficult.

Venus on the 1st is in R.A. 23h 54m; Decl. 0° 23′ N. and on the 15th is in R.A. 0h 38m, Decl. 7° 01′ N., mag. −4.2, and transits at 14h 58m. It is almost 40° above the south-western horizon at sunset and sets about four hours later.

Mars on the 15th is in R.A. 15h 33m, Decl. 17° 52′ S., mag. +0.8, and transits at 5h 52m. In Libra, it is a morning star rising an hour or more after midnight. It is at western quadrature on the 12th.

Jupiter on the 15th is in R.A. 12h 21m, Decl. 0° 38′ S., mag. −1.9, and transits at 2h 40m. In Virgo it rises about three hours after sunset. 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. 1h 23m, Decl. 6° 09′ N., mag. +0.8, and transits at 15h 40m. In Pisces, it is well past the meridian at sunset and sets about two hours before midnight.

Uranus on the 15th is in R.A. 12h 14m, Decl. 0° 38′ S. and transits at 2h 33m.

Neptune on the 15th is in R.A. 15h 47m, Decl. 18° 12′ S. and transits at 6h 06m. It is at western quadrature on the 16th, and on the 22nd is overtaken by Mars.

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

1969			FEBRUARY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 1h 50m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Sat. 1				2 50	d3014	75.12
Sun. 2	7	56	Full Moon		21034	87.26
Mon. 3				23 40	01234	99.39
Tue. 4					10234	111.52
Wed. 5					20134	123.66
Thu. 6	8		Uranus 1° N. of moon	20 30	3204*	135.80
	12		Jupiter 2° N. of moon			
Fri. 7					31042	147.94 [l]
Sat. 8					34021	160.09
Sun. 9	19	09	Last Quarter	17 20	42103	172.24
	21		Mercury stationary			
Mon. 10	1		Mars 6° N. of moon		40213	184.41
	10		Neptune 6° N. of moon			
Tue. 11					41023	196.57
Wed. 12			Mars in quadrature W.	14 10	42013	208.75
Thu. 13	23		Moon at perigee, 226,400 mi.		4320*	220.93 [b]
Fri. 14	13		Mercury 6° N. of moon		34102	233.12
Sat. 15				11 00	34021	245.32
Sun. 16			Neptune in quadrature W.		2104*	257.52
	11	26	New Moon			
Mon. 17					0134*	269.72
Tue. 18	21		Venus 2° N. of moon	7 40	10234	281.92
Wed. 19	14		Saturn 5° S. of moon		20134	294.11
Thu. 20					23104	306.31 [l]
Fri. 21	11		Mars 0.5° S. of Neptune	4 30	d3024	318.50
Sat. 22			Mercury at descending node		30214	330.69
Sun. 23	6		Mercury greatest elong. W., 27°		2104*	342.87
	23	31	First Quarter			
Mon. 24	17		Moon at apogee, 251,500 mi.	1 20	4013*	355.04
Tue. 25			Venus at perihelion		41023	7.21
Wed. 26				22 10	42013	19.38 [b]
Thu. 27					42310	31.54
Fri. 28					43012	43.69

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]Feb. 7, −5.78°; Feb. 20, +5.96°. [b]Feb. 13, +6.66°; Feb. 26, −6.80°.

THE SKY FOR MARCH 1969

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° 44′ S. to 4° 23′ N. The equation of time changes from −12m 23s to −4m 10s. On the 20th at 14h 08m E.S.T. the sun crosses the equator on its way north, enters the sign of Aries and spring commences. This is the vernal equinox. For changes in the length of the day, see p. 14. There is an annular eclipse of the sun, not visible in North America, on the 17–18th.

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 1st is in R.A. 21h 07m, Decl. 17° 25′ S. and on the 15th is in R.A. 22h 25m, Decl. 12° 11′ S. It is too close to the sun for observation.

Venus on the 1st is in R.A. 1h 12m, Decl. 12° 42′ N. and on the 15th is in R.A. 1h 29m, Decl. 16° 30′ N., mag. −4.2, and transits at 13h 56m. It is about 31° above the south-western horizon at sunset on the 15th and sets about three hours later. By the end of the month it is too close to the sun for easy observation. Greatest brilliancy, mag. −4.3, is on the 3rd.

Mars on the 15th is in R.A. 16h 23m, Decl. 20° 37′ S., mag. +0.3, and transits at 4h 52m. Moving through Scorpius it rises about at midnight and is past the meridian at sunrise. On the 17th it passes 6° north of Antares.

Jupiter on the 15th is in R.A. 12h 10m, Decl. 0° 38′ N., mag. −2.0, and transits at 0h 39m. In Virgo, it rises about at sunset, opposition being on the 21st, when its distance from the earth is 413,800,000 mi. 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. 1h 33m, Decl. 7° 18′ N., mag. +0.8, and transits at 14h 01m. In Pisces, moving into Aries, it is well down in the west at sunset and sets about two hours later.

Uranus on the 15th is in R.A. 12h 10m, Decl. 0° 12′ S., mag. +5.7, and transits at 0h 39m. Opposition is on the 22nd, when its distance from the earth is 1609,000,000 mi. It is in conjunction with Jupiter on the 15th.

Neptune on the 15th is in R.A. 15h 47m, Decl. 18° 10′ S. and transits at 4h 16m

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

1969			MARCH E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 0h 40m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Sat. 1	0		Neptune stationary	19 00	4302*	55.84
Sun. 2					42130	67.99
Mon. 3	5		Venus at greatest brilliancy		42013	80.14
Tue. 4	0	18	Full Moon	15 50	10423	92.28
Wed. 5			Mercury at aphelion		d0134	104.43 [l]
	12		Uranus 1° N. of moon			
	14		Jupiter 2° N. of moon			
Thu. 6					21304	116.57
Fri. 7				12 40	30214	128.72
Sat. 8					31024	140.87
Sun. 9	16		Neptune 6° N. of moon		d2304	153.03
Mon. 10	3		Mars 6° N. of moon	9 30	20134	165.20
Tue. 11	2	45	Last Quarter		10243	177.37
Wed. 12	21		Moon at perigee, 229,600 mi.		02413	189.55 [b]
Thu. 13				6 20	d2410	201.74
Fri. 14	8		Pluto at opposition		43021	213.93
Sat. 15	18		Jupiter 0.9° N. of Uranus		43102	226.13
Sun. 16	11		Mercury 0.05° S. of moon	3 10	d4230	238.34
Mon. 17	2		Venus stationary		42013	250.55
	23	52	New Moon			
			Eclipse of ⊙, p. 64			
Tue. 18					41023	262.76
Wed. 19			Venus greatest hel. lat. N.	0 00	40213	274.97 [l]
Thu. 20	1		Venus 6°N. of moon		24103	287.19
	5		Saturn 5° S. of moon			
	14	08	Equinox. Spring begins			
Fri. 21	18		Jupiter at opposition	20 50	3041*	299.40
Sat. 22	14		Uranus at opposition		31024	311.61
Sun. 23					32014	323.81
Mon. 24				17 40	2034*	336.01
Tue. 25			Mercury greatest hel. lat. S.		10234	348.21
	13		Moon at apogee, 251,200 mi.			
	19	49	First Quarter			
Wed. 26					02134	0.40 [b]
Thu. 27				14 30	21034	12.58
Fri. 28					3014*	24.76
Sat. 29					31402	36.94
Sun. 30				11 10	43201	49.11
Mon. 31					42103	61.27

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]Mar. 5, −5.05°; Mar. 19, +4.92°. [b]Mar. 12, +6.77°; Mar. 26, −6.84°.

THE SKY FOR APRIL 1969

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° 23′ N. to 14° 57′ N. The equation of time changes from −3m 52s to +2m 50s, being zero on the 15th. For the 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. There is a penumbral eclipse of the moon, not visible in North America, on the 2nd.

Mercury on the 1st is in R.A. 0h 14m, Decl. 0° 28′ S. and on the 15th is in R.A. 1h 57m, Decl. 12° 11′ N. During the latter half of the month Mercury will be increasingly visible as an evening star low in the west just after sunset. By month's end its altitude will be about 18° at sunset.

Venus on the 1st is in R.A. 1h 13m, Decl. 16° 20′ N. and on the 15th is in R.A. 0h 45m, Decl. 11° 35′ N., mag. −3.3, and transits at 11h 09m. During the first half of the month it is too close to the sun for easy observation, inferior conjunction being on the 8th. By the end of the month it is easily visible as a morning star about 13° above the eastern horizon at sunrise.

Mars on the 15th is in R.A. 16h 59m, Decl. 22° 27′ S., mag. −0.6, and transits at 3h 26m. In Ophiuchus, it rises shortly before midnight and is well past the meridian at sunrise. On the 26th it is stationary in right ascension and begins to retrograde.

Jupiter on the 15th is in R.A. 11h 56m, Decl. 2° 08′ N., mag. −2.0, and transits at 22h 19m. In Virgo, it is well up in the east at sunset. 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. 1h 48m, Decl. 8° 43′ N., and transits at 12h 13m. It is too close to the sun for easy observation, conjunction being on the 18th.

Uranus on the 15th is in R.A. 12h 05m, Decl. 0° 19′ N. and transits at 22h 28m.

Neptune on the 15th is in R.A. 15h 45m, Decl. 18° 03′ S. and transits at 2h 12m.

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

1969			APRIL E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 23h 35m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Tue. 1	16		Jupiter 2° N. of moon		40123	73.43 [l]
	19		Uranus 1° N. of moon			
Wed. 2	13	46	○ Full Moon. Eclipse of ☾, p. 64	8 00	42103	85.59
Thu. 3					43201	97.75
Fri. 4					34102	109.91
Sat. 5	22		Neptune 6° N. of moon	4 50	34201	122.07
Sun. 6	19		Moon at perigee, 228,800 mi.		2104*	134.24
	23		Mars 6° N. of moon			
Mon. 7					01234	146.41
Tue. 8	10		Venus in inferior conjunction	1 40	01234	158.59 [b]
	18		Mercury in superior conjunction			
Wed. 9	8	59	☾ Last Quarter		21034	170.77
Thu. 10				22 30	32014	182.97
Fri. 11					31024	195.17
Sat. 12					d3014	207.37
Sun. 13				19 20	21304	219.59
Mon. 14			Mercury at ascending node		40123	231.81
Tue. 15	11		Venus 5° N. of moon		4023*	244.03 [l]
Wed. 16	13	16	● New Moon	16 10	42103	256.26
Thu. 17					42301	268.49
Fri. 18			Mercury at perihelion		43102	280.72
	15		Saturn in conjunction with sun			
Sat. 19				13 00	43021	292.95
Sun. 20					42310	305.17
Mon. 21			Mars at descending node		4013*	317.39
Tue. 22			Lyrid meteors	9 50	10423	329.61 [b]
	9		Moon at apogee, 251,500 mi.			
Wed. 23					d2034	341.83
Thu. 24	14	45	☽ First Quarter		23014	354.04
Fri. 25				6 40	31024	6.24
Sat. 26	22		Mars stationary		30214	18.44
Sun. 27	2		Venus stationary		21304	30.63
Mon. 28			Mercury greatest hel. lat. N.	3 30	0134*	42.82
	4		Pallas stationary			
	20		Jupiter 1° N. of moon			
Tue. 29	2		Uranus 1° N. of moon		10243	55.00 [l]
Wed. 30					20413	67.18

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

[l]Apr. 1, −5.54°; Apr. 15, +4.79°; Apr. 29, −6.57°.

[b]Apr. 8, +6.74°; Apr. 22, −6.77°.

THE SKY FOR MAY 1969

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 25s at the end of the month. 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 1st is in R.A. 3h 51m, Decl. 22° 42′ N. and on the 15th is in R.A. 4h 40m, Decl. 23° 54′ N. During the first half of the month it will be seen easily as an evening star low in the west just after sunset. Greatest eastern elongation on the 5th is a favourable one, the planet being about 19° above the horizon at sunset. By the 29th Mercury has reached inferior conjunction.

Venus on the 1st is in R.A. 0h 35m, Decl. 6° 34′ N. and on the 15th is in R.A. 0h 54m, Decl. 5° 42′ N., mag. −4.2, and transits at 9h 22m. It rises about two hours before the sun. Greatest brilliancy is on the 14th.

Mars on the 15th is in R.A. 16h 54m, Decl. 23° 40′ S., mag. −1.5, and transits at 1h 22m. In Ophiuchus, it rises about two hours after sunset and dominates the southern sky during the rest of the night. It is in opposition on the 31st, when its distance from the earth is 45,150,000 mi.

Jupiter on the 15th is in R.A. 11h 48m, Decl. 2° 51′ N., mag. −1.8, and transits at 20h 14m. In Virgo, it is nearly at the meridian at sunset and sets more than two hours after midnight. On the 23rd it is stationary in right ascension and resumes direct motion. 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. 2h 02m, Decl. 10° 01′ N., and transits at 10h 30m. Leaving Pisces, it may be seen very low in the east just before sunrise.

Uranus on the 15th is in R.A. 12h 02m, Decl. 0° 39′ N. and transits at 20h 27m.

Neptune on the 15th is in R.A. 15h 42m, Decl. 17° 53′ S., mag. +7.7, and transits at 0h 11m. Opposition is on the 18th, when its distance from the earth is 2725,000,000 mi.

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

1969			MAY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 22h 55m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Thu. 1				0 20	d42O*	79.36
Fri. 2	0	14	Full Moon		431O2	91.53
Sat. 3	5		Neptune 6° N. of moon	21 00	43O12	103.70
Sun. 4	6		Moon at perigee, 225,600 mi.		4231O	115.88
	10		Mars 4° N. of moon			
Mon. 5			η Aquarid meteors		42O31	128.06 [b]
	18		Mercury greatest elong. E., 21°			
Tue. 6	12		Juno stationary	17 50	41O23	140.24
Wed. 7					42O13	152.43
Thu. 8	15	12	Last Quarter		24O3*	164.63
Fri. 9				14 40	31O42	176.83
Sat. 10					3O124	189.04
Sun. 11					321O4	201.26 [l]
Mon. 12	20		Venus 1° S. of moon	11 30	2O14*	213.49
Tue. 13					1O234	225.72
Wed. 14			Venus at descending node		dO134	237.96
	4		Venus at greatest brilliancy			
	10		Saturn 5° S. of moon			
Thu. 15				8 20	21O34	250.20
Fri. 16	3	27	New Moon		d3O24	262.44
Sat. 17	13		Mercury 4° S. of moon		34O12	274.68
Sun. 18	0		Mercury stationary	5 10	3421O	286.92
	7		Neptune at opposition			
Mon. 19					42O31	299.16 [b]
Tue. 20	0		Moon at apogee, 252,100 mi.		41O23	311.40
Wed. 21				2 00	4O213	323.64
Thu. 22			Mercury at descending node		421O3	335.87
Fri. 23	17		Jupiter stationary	22 50	43O1*	348.09
Sat. 24	7	16	First Quarter		34O2*	0.31
Sun. 25					3214O	12.53
Mon. 26	4		Jupiter 1° N. of moon	19 40	23O14	24.73
	11		Uranus 1° N. of moon			
Tue. 27					1O234	36.94 [l]
Wed. 28					O2134	49.13
Thu. 29	5		Mercury in inferior conjunction	16 30	21O34	61.32
Fri. 30	14		Neptune 6° N. of moon		3O14*	73.51
Sat. 31	8	19	Full Moon		3O24*	85.69
	9		Mars 3° N. of moon			
	11		Mars at opposition			

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]May 11, +5.84°; May 27, −7.49°. [b]May 5, +6.59°; May 19, −6.64°.

THE SKY FOR JUNE 1969

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° 08′ N., reaching 23° 27′ N. on the 21st. The equation of time changes from +2m 16s to −3m 34s, being zero on the 13th. The summer solstice is on the 21st at 8h 55m E.S.T. 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 1st is in R.A. 4h 20m, Decl. 18° 43′ N. and on the 15th is in R.A. 4h 12m, Decl. 16° 52′ N. On the 23rd Mercury is at greatest western elongation and for a few days before and after this date the planet may be seen as a morning star low in the east just before sunrise and about 2° north of Aldebaran. However, this is not a very favourable elongation, the altitude of Mercury being only about 11°.

Venus on the 1st is in R.A. 1h 39m, Decl. 8° 07′ N. and on the 15th is in R.A. 2h 26m, Decl. 11° 35′ N., mag. −4.0, and transits at 8h 54m. It rises between two and three hours before the sun. Greatest western elongation is on the 17th, when at sunrise it stands about 22° above the eastern horizon. It overtakes Saturn on the 11th.

Mars on the 15th is in R.A. 16h 11m, Decl. 23° 52′ S., mag. −1.8, and transits at 22h 33m. Moving westward through Scorpius, it is already risen at sunset and sets about an hour before sunrise. It is nearest to the earth, 44,550,000 mi., on the 8th. On the 3rd it passes 2° north of the red star, Antares.

Jupiter on the 15th is in R.A. 11h 51m, Decl. 2° 29′ N., mag. −1.6, and transits at 18h 15m. In Virgo, it is well past the meridian at sunset and sets at about midnight. On the 18th it is at eastern quadrature. 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. 2h 15m, Decl. 11° 07′ N., mag. +0.7, and transits at 8h 41m. In Aries, it rises about two hours before the sun.

Uranus on the 15th is in R.A. 12h 01m, Decl. 0° 43′ N. and transits at 18h 25m. It is at eastern quadrature on the 21st.

Neptune on the 15th is in R.A. 15h 39m, Decl. 17° 42′ S. and transits at 22h 02m.

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

1969			JUNE E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 22h 00m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Sun. 1			Mercury at aphelion	13 10	d3204	97.88
	10		Moon at perigee, 223,000 mi.			
Mon. 2					23014	110.06[b]
Tue. 3					14023	122.25
Wed. 4				10 00	40213	134.44
Thu. 5					42103	146.64
Fri. 6	22	40	☾ Last Quarter		42301	158.84
Sat. 7	10		Uranus stationary	6 50	43102	171.06
Sun. 8	23		Mars nearest to earth		d4320	183.28[l]
Mon. 9	1		Pluto stationary		4230*	195.50
	7		Ceres stationary			
Tue. 10	8		Mercury stationary	3 40	41023	207.73
	21		Venus 6° S. of moon			
	21		Saturn 6° S. of moon			
Wed. 11	9		Venus 0.3° S. of Saturn		0123*	219.97
Thu. 12					21043	232.21
Fri. 13	4		Vesta in conjunction with sun	0 30	d2014	244.46
	5		Mercury 9° S. of moon			
Sat. 14	18	09	● New Moon		31024	256.71
Sun. 15				21 20	d3014	268.96[b]
Mon. 16	10		Moon at apogee, 252,600 mi.		2304*	281.21
Tue. 17	12		Venus greatest elong. W., 46°		10234	293.46
Wed. 18			Venus at aphelion	18 10	01243	305.71
			Jupiter in quadrature E.			
Thu. 19					21043	317.95
Fri. 20					42031	330.19
Sat. 21			Mercury greatest hel. lat. S.	15 00	43102	342.43
			Uranus in quadrature E.			
	8	55	Solstice. Summer begins			
Sun. 22	15		Jupiter 2° N. of moon		43021	354.66
	19		Uranus 1° N. of moon			
	20	45	☽ First Quarter			
Mon. 23	6		Mercury greatest elong. W., 23°		42310	6.88
Tue. 24	22		Pallas at opposition	11 40	d403*	19.10[l]
Wed. 25					40123	31.31
Thu. 26					42103	43.51
Fri. 27	0		Neptune 6° N. of moon	8 30	24031	55.71
	8		Mars 2° N. of moon			
Sat. 28					31042	67.90
Sun. 29	15	04	○ Full Moon		30214	80.09[b]
	19		Moon at perigee, 221,800 mi.			
Mon. 30	15		Juno at opposition	5 20	32104	92.28

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

[l]June 8, +7.03°; June 24, −7.86°.

[b]June 2, +6.50°; June 15, −6.56°; June 29, +6.51°.

THE SKY FOR JULY 1969

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° 08′ N. to 18° 08′ N. The equation of time changes from −3m 45s to −6m 17s. On the 5th the earth is in aphelion, or farthest from the sun, at a distance of 94,510,000 mi. 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 1st is in R.A. 5h 10m, Decl. 20° 53′ N. and on the 15th is in R.A. 6h 59m, Decl. 23° 29′ N. It is too close to the sun for observation all month; superior conjunction is on the 22nd.

Venus on the 1st is in R.A. 3h 29m, Decl. 15° 53′ N. and on the 15th is in R.A. 4h 29m, Decl. 19° 07′ N., mag. −3.7, and transits at 8h 59m. It is just 3° north of Aldebaran on the 15th and rises about three hours before the sun.

Mars on the 15th is in R.A. 15h 57m, Decl. 23° 52′ S., mag. −1.3, and transits at 20h 22m. Moving westward until the 8th, and then eastward again in Scorpius, it is nearing the meridian at sunset and it sets at about midnight.

Jupiter on the 15th is in R.A. 12h 02m, Decl. 1° 10′ N., mag. −1.4, and transits at 16h 28m. In Virgo, it is well down in the south-west at sunset and sets about three hours later. 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. 2h 25m, Decl. 11° 50′ N., mag. +0.6, and transits at 6h 52m. In Aries, it rises at about midnight and is well up in the south-east at sunrise. It is at western quadrature on the 31st.

Uranus on the 15th is in R.A. 12h 03m, Decl. 0° 28′ N. and transits at 16h 29m. It is in conjunction with Jupiter on the 18th.

Neptune on the 15th is in R.A. 15h 37m, Decl. 17° 36′ S. and transits at 20h 02m.

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

1969			JULY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 21h 00m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Tue. 1					2O14*	104.47
Wed. 2					O234*	116.66
Thu. 3				2 10	21O34	128.85
Fri. 4					2O134	141.05
Sat. 5			Earth at aphelion	23 00	13O24	153.26
Sun. 6	8	18	☾ Last Quarter		3O412	165.47 [l]
Mon. 7					3241O	177.69
Tue. 8	5		Mars stationary	19 50	423O1	189.92
	8		Saturn 6° S. of moon			
Wed. 9					41O23	202.15
Thu. 10			Venus greatest hel. lat. S.		d41O3	214.39
	11		Venus 8° S. of moon			
Fri. 11			Mercury at ascending node	16 40	42O13	226.63
Sat. 12					413O2	238.88 [b]
Sun. 13	9		Mercury 4° S. of moon		43O12	251.13
	13		Moon at apogee, 252,600 mi.			
Mon. 14	9	12	● New Moon	13 30	3214O	263.38
Tue. 15			Mercury at perihelion		23O41	275.63
Wed. 16					1O324	287.88
Thu. 17				10 10	dO234	300.13
Fri. 18			Jupiter greatest hel. lat. N.		2O34*	312.38
	1		Jupiter 0.6° N. of Uranus			
Sat. 19					13O24	324.62
Sun. 20	3		Uranus 2° N. of moon	7 00	3O124	336.86
	3		Jupiter 2° N. of moon			
Mon. 21					321O4	349.09
Tue. 22	7	10	☽ First Quarter		32O14	1.32 [l]
	10		Mercury in superior conjunction			
Wed. 23				3 50	14O32	13.54
Thu. 24	8		Neptune 7° N. of moon		4O213	25.75
	19		Mars 2° N. of moon			
Fri. 25			Mercury greatest hel. lat. N.		42O3*	37.95
Sat. 26				0 40	41O3*	50.15 [b]
Sun. 27	15		Ceres at opposition		43O12	62.34
Mon. 28	4		Moon at perigee, 222,400 mi.	21 30	4312O	74.53
	21	46	○ Full Moon			
Tue. 29			δ Aquarid meteors		432O1	86.72
Wed. 30					41O32	98.91
Thu. 31			Saturn in quadrature W.	18 20	4O123	111.09

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

[l]July 6, +7.63°; July 22, −7.47°. [b]July 12, −6.61; July 26, +6.60°.

THE SKY FOR AUGUST 1969

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° 26′ N. The equation of time changes from −6m 14s to −0m 14s. 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. There is a penumbral eclipse of the moon on the night of the 26th-27th; this is "visible" in North America.

Mercury on the 1st is in R.A. 9h 27m, Decl. 16° 52′ N. and on the 15th is in R.A. 10h 58m, Decl. 7° 08′ N. Mercury is too close to the sun for observation this month.

Venus on the 1st is in R.A. 5h 49m, Decl. 21° 28′ N. and on the 15th is in R.A. 6h 58m, Decl. 21° 35′ N., mag. −3.5, and transits at 9h 26m. It rises about three hours before the sun and on the 15th is about 32° above the eastern horizon at sunrise. It passes 7° south of Pollux on the 23rd.

Mars on the 15th is in R.A. 16h 33m, Decl. 25° 15′ S., mag. −0.6, and transits at 18h 58m. Moving through Scorpius, it is about on the meridian at sunset and sets about an hour before midnight. It passes about a degree north of Antares on the 11th.

Jupiter on the 15th is in R.A. 12h 20m, Decl. 0° 54′ S., mag. −1.3, and transits at 14h 44m. In Virgo, it is low in the west at sunset and sets within two hours.

Saturn on the 15th is in R.A. 2h 29m, Decl. 12° 04′ N., mag. +0.5, and transits at 4h 55m. In Aries, it rises about two hours before midnight. On the 21st it is stationary in right ascension and begins to retrograde.

Uranus on the 15th is in R.A. 12h 08m, Decl. 0° 05′ S. and transits at 14h 32m.

Neptune on the 15th is in R.A. 15h 36m, Decl. 17° 36′ S. and transits at 18h 00m. It is at quadrature east on the 18th.

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

1969			AUGUST E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 20h 20m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Fri. 1					21O43	123.28
Sat. 2					d2O34	135.48
Sun. 3				15 10	3O124	147.68 [l]
Mon. 4	18		Saturn 7° S. of moon		312O4	159.89
	20	39	☾ Last Quarter			
Tue. 5					32O14	172.10
Wed. 6				11 50	1O324	184.32
Thu. 7	21		Neptune stationary		O1234	196.55
Fri. 8					21O43	208.78 [b]
Sat. 9	9		Venus 7° S. of moon	8 40	24O13	221.01
	20		Moon at apogee, 252,300 mi.			
Sun. 10					43O2*	233.25
Mon. 11						245.49
Tue. 12			Perseid meteors	5 30		257.74
Wed. 13	0	17	● New Moon			269.99
Thu. 14	21		Mercury 0.3° S. of moon			282.23
Fri. 15				2 20		294.48
Sat. 16	11		Uranus 2° N. of moon			306.72
	18		Jupiter 3° N. of moon			
Sun. 17				23 10		318.95
Mon. 18			Mercury at descending node			331.19
			Neptune in quadrature E.			
	22		Pallas stationary			
Tue. 19						343.42 [l]
Wed. 20	15		Neptune 7° N. of moon	20 00		355.64
	15	04	☽ First Quarter			
Thu. 21	19		Mars 2° N. of moon			7.85
	20		Saturn stationary			
Fri. 22						20.06
Sat. 23				16 50		32.25 [b]
Sun. 24	19		Juno stationary			44.45
Mon. 25	10		Moon at perigee, 224,600 mi.			56.63
Tue. 26				13 30		68.81
Wed. 27	5	33	○ Full Moon			80.99
			Eclipse of ☾, p. 64			
Thu. 28			Mercury at aphelion			93.17
Fri. 29				10 20		105.35
Sat. 30	8		Mercury 3° S. of Uranus			117.53
Sun. 31						129.71 [l]

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

[l]Aug. 3, +7.48°; Aug. 19, −6.41°; Aug. 31, +6.70°.

[b]Aug. 8, −6.73°; Aug. 23, +6.70°.

Jupiter being near the sun, configurations of the satellites are not given from Aug. 11 to Nov. 5.

THE SKY FOR SEPTEMBER 1969

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° 26′ N. to 3° 02′ S. The equation of time changes from +0m 05s to +10m 03s. On the 23rd at 0h 07m E.S.T. the sun crosses the equator moving southward, enters the sign of Libra and autumn commences. For changes in the length of the day, see p. 17. There is an annular eclipse of the sun on the 11th which is visible as a partial eclipse over most of North America.

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. There is a penumbral eclipse of the moon, not visible in North America, on the 25th.

Mercury on the 1st is in R.A. 12h 16m, Decl. 4° 01′ S. and on the 15th is in R.A. 12h 48m, Decl. 9° 21′ S. Greatest eastern elongation is on the 2nd, but this is a most unfavourable one, the planet being only at about 7° altitude at sunset. It will be very difficult to observe. By the 29th Mercury is in inferior conjunction.

Venus on the 1st is in R.A. 8h 23m, Decl. 19° 11′ N. and on the 15th is in R.A. 9h 31m, Decl. 15° 15′ N., mag. −3.4, and transits at 9h 56m. It rises about three hours before the sun and on the 15th stands about 28° above the eastern horizon at sunrise. It passes within a degree of Regulus on the 22nd.

Mars on the 15th is in R.A. 17h 43m, Decl. 26° 16′ S., mag. −0.1, and transits at 18h 07m. Moving into Sagittarius, it is about on the meridian at sunset and sets about four hours later; eastern quadrature is on the 25th.

Jupiter on the 15th is in R.A. 12h 42m, Decl. 3° 22′ S., mag. −1.2, and transits at 13h 05m. In Virgo, it is very low in the west at sunset and can be observed only with difficulty late in the month.

Saturn on the 15th is in R.A. 2h 28m, Decl. 11° 48′ N., mag. +0.3, and transits at 2h 51m. In Aries, it rises about two hours after sunset.

Uranus on the 15th is in R.A. 12h 14m, Decl. 0° 48′ S. and transits at 12h 36m.

Neptune on the 15th is in R.A. 15h 38m, Decl. 17° 43′ S. and transits at 15h 59m.

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

1969			SEPTEMBER E.S.T.	Min. of Algol		Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Mon. 1	2		Saturn 7° S. of moon	7 10		141.90
Tue. 2	23		Mercury greatest elong. E., 27°			154.10
Wed. 3			Jupiter at aphelion			166.30
	11	58	☾ Last Quarter			
Thu. 4			Venus at ascending node	4 00		178.50
Fri. 5						190.71 [b]
Sat. 6	10		Moon at apogee, 251,700 mi.			202.93
Sun. 7	11		Mercury 5° S. of Jupiter	0 50		215.15
Mon. 8	14		Venus 3° S. of moon			227.38
Tue. 9				21 40		239.61
Wed. 10						251.84
Thu. 11	14	56	● New Moon			264.07
			Eclipse of ⊙, p. 64			
Fri. 12	20		Uranus 2° N. of moon	18 30		276.31
Sat. 13	11		Jupiter 3° N. of moon			288.54
	14		Mercury 2° S. of moon			
Sun. 14						300.77
Mon. 15				15 10		313.00 [l]
Tue. 16	3		Mercury stationary			325.22
	21		Neptune 7° N. of moon			
Wed. 17			Mercury greatest hel. lat. S.			337.44
	20		Pluto in conjunction with sun			
Thu. 18	8		Ceres stationary	12 00		349.65
	21	25	☽ First Quarter			
Fri. 19	2		Mars 2° N. of moon			1.85 [b]
	15		Mercury 6° S. of Jupiter			
Sat. 20						14.05
Sun. 21				8 50		26.23
Mon. 22	6		Moon at perigee, 227,800 mi.			38.41
Tue. 23	0	07	Equinox. Autumn commences			50.59
Wed. 24				5 40		62.76
Thu. 25			Mars in quadrature E.			74.92
	15	22	○ Full Moon. Harvest Moon			
			Eclipse of ☾, p. 64			
Fri. 26			Mars greatest hel. lat. S.			87.09
Sat. 27	12		Uranus in conjunction with sun	2 30		99.25
Sun. 28	10		Saturn 7° S. of moon			111.42 [l]
Mon. 29	5		Mercury in inferior conjunction	23 20		123.59
Tue. 30						135.76

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

[l]Sept. 15, −5.20°; Sept. 28, +5.70°. [b]Sept. 5, −6.82°; Sept. 19, +6.77°.

Jupiter being near the sun, configurations of the satellites are not given from Aug. 11 to Nov. 5.

THE SKY FOR OCTOBER 1969

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° 02′ S. to 14° 18′ S. The equation of time changes from +10m 23s 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 1st is in R.A. 12h 13m, Decl. 3° 32′ S. and on the 15th is in R. A. 12h 15m, Decl. 0° 13′ N. For the middle two weeks of the month Mercury will be visible as a morning star low in the east just before sunrise. Greatest western elongation on the 14th is a moderately favourable one, the planet being at about 16° altitude at sunrise.

Venus on the 1st is in R.A. 10h 46m, Decl. 9° 03′ N. and on the 15th is in R.A. 11h 51m, Decl. 2° 38′ N., mag. −3.4, and transits at 10h 18m. It rises about two hours before the sun and on the 15th stands about 21° above the eastern horizon at sunrise.

Mars on the 15th is in R.A. 19h 08m, Decl. 24° 53′ S., mag +0.2, and transits at 17h 34m. In Sagittarius, it is about on the meridian at sunset and sets about four hours later.

Jupiter on the 15th is in R.A. 13h 06m, Decl. 5° 52′ S., mag. −1.2, and transits at 11h 31m. In Virgo, it is too close to the sun for observation early in the month, conjunction being on the 9th. By the end of the month it can be observed as a morning star, being about 13° above the south-eastern horizon at sunrise.

Saturn on the 15th is in R.A. 2h 21m, Decl. 11° 09′ N., mag. +0.1, and transits at 0h 46m. In Aries, it rises at about sunset, opposition being on the 28th, when its distance from the sun is 765,800,000 mi.

Uranus on the 15th is in R.A. 12h 21m, Decl. 1° 33′ S. and transits at 10h 45m. On the 21st it is overtaken by Venus.

Neptune on the 15th is in R.A. 15h 41m, Decl. 17° 55′ S. and transits at 14h 05m.

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

1969			OCTOBER E.S.T.	Min. of Algol		Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Wed. 1						147.94
Thu. 2				20 10		160.12 [b]
Fri. 3	6	06	☾ Last Quarter			172.30
Sat. 4	4		Moon at apogee, 251,300 mi.			184.50
Sun. 5				16 50		196.69
Mon. 6			Mercury at ascending node			208.90
Tue. 7	12		Mercury stationary			221.10
Wed. 8			Venus at perihelion	13 40		233.32
Thu. 9	2		Venus 1° N. of moon			245.53
	17		Jupiter in conjunction with sun			
	21		Mercury 2° N. of moon			
Fri. 10						257.75
Sat. 11			Mercury at perihelion	10 30		269.97 [l]
	4	40	● New Moon			
Sun. 12						282.18
Mon. 13						294.40
Tue. 14	4		Neptune 7° N. of moon	7 20		306.61
	17		Mercury greatest elong. W., 18°			
Wed. 15						318.82
Thu. 16	7		Mercury 1.3° N. of Uranus			331.03 [b]
Fri. 17	14		Mars 2° N. of moon	4 10		343.22
	23		Moon at perigee, 229,900 mi.			
Sat. 18	3	32	☽ First Quarter			355.41
Sun. 19						7.59
Mon. 20				1 00		19.77
Tue. 21			Orionid meteors			31.94
			Mercury greatest hel. lat. N.			
			Mars at perihelion			
	21		Venus 0.9° N. of Uranus			
Wed. 22				21 50		44.10
Thu. 23						56.25
Fri. 24						68.40
Sat. 25	3	45	○ Full Moon. Hunter's Moon	18 40		80.55
	15		Saturn 7° S. of moon			
Sun. 26	6		Mercury 0.8° N. of Jupiter			92.70 [l]
Mon. 27						104.85
Tue. 28	21		Saturn at opposition	15 20		117.00
Wed. 29						129.15 [b]
Thu. 30			Venus greatest hel. lat. N.			141.31
Fri. 31				12 10		153.47

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

[l]Oct. 11, −4.95°; Oct. 26, +4.95°.

[b]Oct. 2, −6.83°; Oct. 16, +6.70°; Oct. 29, −6.70°.

Jupiter being near the sun, configurations of the satellites are not given from Aug. 11 to Nov. 5.

THE SKY FOR NOVEMBER 1969

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 28m and its Decl. changes from 14° 18′ S. to 21° 45′ S. The equation of time changes from +16m 23s to +11m 14s. 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 1st is in R.A. 13h 49m, Decl. 9° 43′ S. and on the 15th is in R.A. 15h 17m, Decl. 18° 16′ S. It is too close to the sun for observation, superior conjunction being on the 16th.

Venus on the 1st is in R.A. 13h 08m, Decl. 5° 34′ S. and on the 15th is in R.A. 14h 14m, Decl. 12° 01′ S., mag. −3.4, and transits at 10h 39m. It rises about an hour before the sun and on the 15th stands about 14° above the south-eastern horizon at sunrise. On the 3rd it overtakes Jupiter and a few hours later passes north of Spica.

Mars on the 15th is in R.A. 20h 41m, Decl. 20° 06′ S., mag. +0.6, and transits at 17h 05m. Moving from Sagittarius into Capricornus, it is close to the meridian at sunset and sets about five hours later.

Jupiter on the 15th is in R.A. 13h 31m, Decl. 8° 19′ S., mag. −1.3, and transits at 9h 53m. In Virgo, it rises more than three hours before sunrise. It passes 3° north of Spica on the 5th. 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. 2h 11m, Decl. 10° 21′ N., mag. +0.1, and transits at 22h 31m. In Aries and Cetus, it is already risen at sunset.

Uranus on the 15th is in R.A. 12h 28m, Decl. 2° 14′ S. and transits at 8h 50m.

Neptune on the 15th is in R.A. 15h 45m, Decl. 18° 10′ S. and transits at 12h 07m.

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

1969			NOVEMBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 5h 30m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Sat. 1	1		Moon at apogee, 251,300 mi.			165.64
Sun. 2	2	14	☾ Last Quarter			177.81
Mon. 3	19		Venus 0.5° N. of Jupiter	9 00		189.99
Tue. 4						202.17
Wed. 5			Taurid meteors			214.36
Thu. 6	19		Uranus 2° N. of moon	5 50	43201	226.55
Fri. 7					43102	238.75 [l]
Sat. 8	1		Jupiter 4° N. of moon		d4032	250.95
	10		Venus 5° N. of moon			
Sun. 9	17	12	● New Moon	2 40	42013	263.15
Mon. 10					21403	275.36
Tue. 11				23 30	01324	287.56
Wed. 12	21		Moon at perigee, 227,600 mi		31024	299.76 [b]
Thu. 13					32014	311.96
Fri. 14			Mercury at descending node	20 20	31024	324.15
Sat. 15	6		Mars 2° N. of moon		0124*	336.33
Sun. 16	3		Mercury in superior conjunction		2034*	348.51
	10	46	☽ First Quarter			
Mon. 17			Leonid meteors	17 10	21043	0.68
Tue. 18					04132	12.84
Wed. 19					14302	25.00
Thu. 20	18		Neptune in conjunction with sun	14 00	43201	37.14
Fri. 21	19		Saturn 7° S. of moon		4310*	49.29 [l]
Sat. 22					43012	61.43
Sun. 23	18	54	○ Full Moon	10 50	4203*	73.57
Mon. 24			Mercury at aphelion		42103	85.70
Tue. 25					40123	97.84 [b]
Wed. 26				7 30	41302	109.97
Thu. 27					32041	122.11
Fri. 28	20		Moon at apogee, 251,800 mi.		31204	134.25
Sat. 29				4 20	30124	146.40
Sun. 30					12034	158.55

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]Nov. 7, −5.74°; Nov. 21, +5.20°. [b]Nov. 12, +6.57°; Nov. 25, −6.56°.

THE SKY FOR DECEMBER 1969

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 28m to 18h 44m and its Decl. changes from 21° 45′ S. to 23° 03′ S., reaching 23° 27′ S. on the 21st. The equation of time changes from +10m 52s to −3m 08s, being zero on the 25th. The winter solstice occurs on the 21st at 19h 44m E.S.T. 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 1st is in R.A. 17h 02m, Decl. 24° 26′ S. and on the 15th is in R.A. 18h 37m, Decl. 25° 27′ S. For about the last ten days of the month Mercury will be visible as an evening star low in the south-west just after sunset. Greatest eastern elongation on the 27th is a relatively unfavourable one, however, the altitude of the planet being only about 12° at sunset.

Venus on the 1st is in R.A. 15h 33m, Decl. 18° 13′ S. and on the 15th is in R.A. 16h 47m, Decl. 21° 57′ S., mag. −3.4, and transits at 11h 14m. It is rapidly approaching the sun and by the 15th it is only about 6° above the south-eastern horizon at sunrise.

Mars on the 15th is in R.A. 22h 08m, Decl. 12° 42′ S., mag. +0.9, and transits at 16h 33m. Moving into Aquarius, it is about on the meridian at sunset and sets over five hours later.

Jupiter on the 15th is in R.A. 13h 52m, Decl. 10° 17′ S., mag. −1.4, and transits at 8h 17m. In Virgo, it rises about three hours after midnight. 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. 2h 05m, Decl. 9° 52′ N., mag. +0.4, and transits at 20h 26m. Moving westward into Pisces, it is well up in the east at sunset.

Uranus on the 15th is in R.A. 12h 32m, Decl. 2° 41′ S. and transits at 6h 56m. It is at western quadrature on the 30th.

Neptune on the 15th is in R.A. 15h 50m, Decl. 18° 24′ S. and transits at 10h 14m.

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

1969			DECEMBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 5h 10m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Mon. 1	22	51	☾ Last Quarter		d2O34	170.70
Tue. 2				1 10	O1234	182.86
Wed. 3	17		Venus 0.8° S. of Neptune		1O324	195.03
Thu. 4	8		Uranus 3° N. of moon	22 00	32O14	207.20
Fri. 5	21		Jupiter 5° N. of moon		312O4	219.38 [l]
Sat. 6					34O12	231.56
Sun. 7				18 50	d41O3	243.75
Mon. 8	2		Neptune 7° N. of moon		42O13	255.94
Tue. 9	4	43	● New Moon		4O23*	268.13 [b]
Wed. 10	19		Moon at perigee, 224,200 mi.	15 40	41O32	280.32
Thu. 11					432O1	292.52
Fri. 12					4312O	304.70
Sat. 13			Geminid meteors	12 30	34O12	316.89
Sun. 14			Mercury greatest hel. lat. S.		1O342	329.07
	1		Mars 0.3° N. of moon			
Mon. 15	20	10	☽ First Quarter		2O143	341.24
Tue. 16				9 20	1O234	353.40
Wed. 17					dO324	5.56 [l]
Thu. 18	22		Saturn 7° S. of moon		32O14	17.71 [l]
Fri. 19				6 10	321O4	29.85
Sat. 20					3O124	41.99
Sun. 21	19	44	Solstice. Winter commences		1O24*	54.12
Mon. 22			Ursid meteors	3 00	2O413	66.26 [b]
Tue. 23	12	36	○ Full Moon		41O3*	78.38
Wed. 24				23 50	4O132	90.51
Thu. 25			Venus at descending node		432O1	102.64
Fri. 26	12		Moon at apogee, 252,300 mi.		4321O	114.77
Sat. 27	6		Vesta stationary	20 30	43O12	126.91
	16		Mercury greatest elong. E., 20°			
Sun. 28					41O2*	139.04
Mon. 29					42O13	151.18
Tue. 30			Uranus in quadrature W.	17 20	412O3	163.33
Wed. 31	17	53	☾ Last Quarter		O1423	175.48
	18		Uranus 3° N. of moon			

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]Dec. 5, −6.94°; Dec. 17, 18, +6.40°. [b]Dec. 9, +6.48°; Dec. 22, −6.55°.

JANUARY

d	h	m	Sat.	Phen.
4	1	56	III	OD
	4	50	III	OR
	5	22	I	SI
	5	44	IV	SI
	6	35	I	TI
5	2	31	I	ED
	5	58	I	OR
6	1	03	I	TI
	2	05	I	Se
	3	16	I	Te
7	0	25	I	OR
	1	24	II	SI
	3	48	II	TI
	4	04	II	Se
	6	24	II	Te
9	1	28	II	OR
11	0	50	III	ED
	3	59	III	ER
	5	46	III	OD
12	4	24	I	ED
13	1	44	I	SI
	2	55	I	TI
	3	58	I	Se
	5	07	I	Te
14	2	16	I	OR
	3	57	II	SI
	6	17	II	TI
16	3	57	II	OR
18	4	48	III	ED
19	6	17	I	ED
20	3	37	I	SI
	4	45	I	TI
	5	52	I	Se
	23	45	IV	SI
21	0	46	I	ED
	1	39	IV	Se
	4	06	I	OR
	6	30	II	SI
	23	12	I	TI
	23	30	III	TI
22	0	19	I	Se
	1	24	I	Te
	2	17	III	Te
23	1	31	II	ED
	6	25	II	OR
25	0	32	II	Te
27	5	31	I	SI
28	2	39	I	ED
	5	54	I	OR
	22	51	III	SI
	23	59	I	SI
29	1	01	I	TI
	1	56	III	Se
	2	13	I	Se
	3	09	III	TI
	3	13	I	Te
	5	55	III	Te
30	0	21	I	OR
	4	06	II	ED

FEBRUARY

d	h	m	Sat.	Phen.
1	0	20	II	TI
	1	00	II	Se
	2	55	II	Te
4	4	32	I	ED
5	1	52	I	SI
	2	48	III	SI
	2	49	I	TI
	4	06	I	Se
	5	01	I	Te
	5	53	III	Se
	23	00	I	ED
6	2	08	I	OR
	22	35	I	Se
6	23	27	I	Te
8	0	53	II	SI
	2	41	II	TI
	3	34	II	Se
	5	16	II	Te
	23	09	III	OR
10	0	22	II	OR
12	3	46	I	SI
	4	35	I	TI
	6	00	I	Se
13	0	53	I	ED
	3	55	I	OR
	22	14	I	SI
	23	02	I	TI
14	0	28	I	Se
	1	14	I	Te
	22	21	I	OR
15	3	27	II	SI
	3	46	IV	ED
	5	01	II	TI
	5	05	IV	ER
	23	44	III	ER
	23	51	III	OD
16	2	36	III	OR
	22	34	II	ED
17	2	41	II	OR
19	5	39	I	SI
20	2	47	I	ED
	5	40	I	OR
21	0	07	I	SI
	0	47	I	TI
	2	22	I	Se
	2	59	I	Te
	21	15	I	ED
22	0	06	I	OR
	21	26	I	Te
23	0	37	III	ED
24	1	09	II	ED
	4	59	II	OR
25	21	59	II	Se
	23	02	II	Te
27	4	40	I	ED
28	2	01	I	SI
	2	32	I	TI
	4	15	I	Se
	4	44	I	Te
	23	09	I	ED

MARCH

d	h	m	Sat.	Phen.
1	1	51	I	OR
	20	29	I	SI
	20	58	I	TI
	22	44	I	Se
	23	10	I	Te
2	4	34	III	ED
3	3	44	II	ED
	22	00	IV	ED
	22	46	IV	ER
4	21	53	II	SI
	22	43	II	TI
5	0	33	II	Se
	1	18	II	Te
	20	21	III	TI
	21	43	III	Se
	23	05	III	Te
6	20	23	II	OR
7	3	55	I	SI
	4	16	I	TI
8	1	02	I	ED
	3	35	I	OR
	22	23	I	SI
	22	42	I	TI
9	0	37	I	Se
	0	55	I	Te
9	22	01	I	OR
12	0	27	II	SI
	0	57	II	TI
	3	08	II	Se
	3	33	II	Te
	22	38	III	SI
	23	37	III	TI
13	1	40	III	Se
	2	22	III	Te
	22	38	II	OR
15	2	56	I	ED
16	0	17	I	SI
	0	26	I	TI
	2	31	I	Se
	2	38	I	Te
	21	25	I	ED
	23	45	I	OR
17	20	59	I	Se
	21	04	I	Te
19	3	02	II	SI
	3	12	II	TI
20	2	36	III	SI
	2	53	III	TI
	22	11	II	ED
21	0	52	II	OR
22	4	50	I	OD
23	2	10	I	TI
	2	11	I	SI
	4	22	I	Te
	4	25	I	Se
	19	31	III	ER
	23	16	I	OD
24	1	33	I	ER
	20	36	I	TI
	20	40	I	SI
	22	48	I	Te
	22	53	I	Se
25	20	01	I	ER
28	0	29	II	OD
	3	26	II	ER
29	21	10	II	Te
	21	36	II	Se
30	3	53	I	TI
	4	05	I	SI
	19	41	III	OD
	23	29	III	ER
31	1	00	I	OD
	3	27	I	ER
	22	19	I	TI
	22	34	I	SI

APRIL

d	h	m	Sat.	Phen.
1	0	32	I	Te
	0	47	I	Se
	21	55	I	ER
4	2	44	II	OD
5	20	49	II	TI
	21	31	II	SI
	23	26	II	Te
6	0	11	II	Se
	22	58	III	OD
7	2	44	I	OD
	3	27	III	ER
8	0	04	I	TI
	0	28	I	SI
	2	16	I	Te
	2	41	I	Se
	21	10	I	OD
	23	50	I	ER
9	20	43	I	Te
	21	10	I	Se
12	23	05	II	TI
13	0	07	II	SI
	1	43	II	Te
13	2	47	II	Se
14	2	16	III	OD
	21	53	II	ER
15	1	49	I	TI
	2	22	I	SI
	22	55	I	OD
16	1	44	I	ER
	20	15	I	TI
	20	51	I	SI
	22	28	I	Te
	23	04	I	Se
17	20	13	I	ER
	21	29	III	Se
20	1	23	II	TI
	2	43	II	SI
21	20	24	II	OD
22	0	27	II	ER
23	0	41	I	OD
	22	01	I	TI
	22	45	I	SI
24	0	14	I	Te
	0	58	I	Se
	22	08	I	ER
	22	22	III	Te
	22	30	III	SI
25	1	27	III	Se
28	22	43	II	OD
30	21	18	II	Se
	23	48	I	TI

MAY

d	h	m	Sat.	Phen.
1	0	40	I	SI
	2	01	I	Te
	20	55	I	OD
	22	54	III	TI
2	0	03	I	ER
	1	50	III	Te
	20	28	I	Te
	21	21	I	Se
6	1	04	II	OD
7	21	13	II	SI
	21	57	II	Te
	23	53	II	Se
8	1	36	I	TI
	22	44	I	OD
9	21	03	I	SI
	22	16	I	Te
	23	15	I	Se
10	20	26	I	ER
12	20	23	III	ED
	23	18	III	ER
14	21	42	II	TI
	23	52	II	SI
15	0	22	II	Te
16	0	33	I	OD
	21	28	II	ER
	21	53	I	TI
	22	57	I	SI
17	0	05	I	Te
	1	09	I	Se
	22	21	I	ER
19	22	48	III	OR
20	0	23	III	ED
22	0	10	II	TI
23	23	43	I	TI
24	0	02	II	ER
	0	52	I	SI
	20	52	I	OD
25	0	16	I	ER
	21	32	I	Se
26	23	30	III	OD
30	21	17	III	Se
	21	34	II	OD
31	22	44	I	OD

JUNE

d	h	m	Sat.	Phen.
1	21	04	II	Se
	21	15	I	SI
	22	16	I	Te
	23	27	I	Se
2	20	41	I	ER
6	22	25	III	SI
8	21	03	II	SI
	21	10	II	Te
	21	56	I	TI
	23	10	I	SI
	23	41	II	Se
9	22	36	I	ER
11	21	34	IV	OD
	22	48	IV	OR
13	21	12	III	TI
15	21	05	II	TI
16	21	00	I	OD
17	21	03	II	ER
17	21	44	I	Se
24	21	28	I	SI
	22	26	I	Te
25	20	55	I	ER

JULY

d	h	m	Sat.	Phen.
1	21	06	II	OD
	22	09	I	TI
	22	16	III	OR
3	20	53	II	Se
9	21	18	I	OD
10	20	47	I	Te
	20	52	II	SI
	21	07	II	Te
12	21	07	III	Se
17	21	08	II	TI
18	21	09	I	ER
19	20	41	III	Te

Jupiter being near the sun, phenomena of the satellites are not given between Aug. 2 and Nov. 8.

NOVEMBER

d	h	m	Sat.	Phen.
23	5	15	I	ED
24	5	18	I	Te
28	5	45	II	ED
30	4	59	II	Te

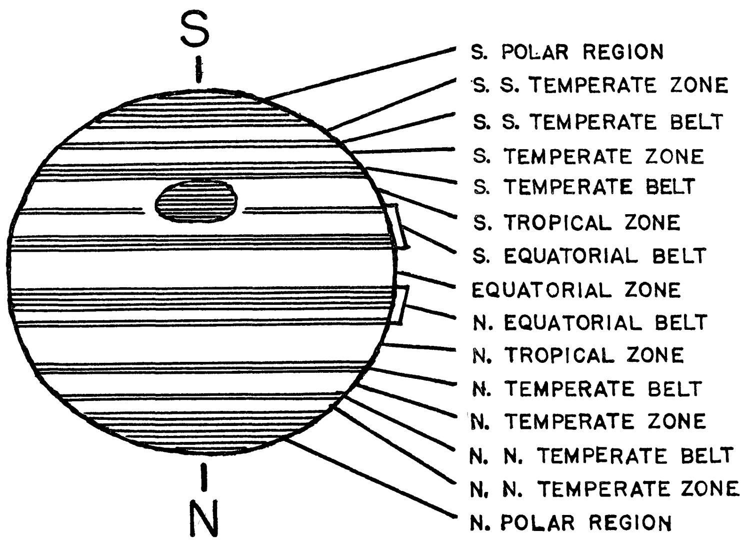
DECEMBER

d	h	m	Sat.	Phen.
1	5	06	I	TI
2	4	37	I	OR
3	5	19	III	TI
7	5	09	II	TI
	5	57	II	Se
8	6	11	I	SI
10	5	51	III	SI
14	5	57	II	SI
16	4	51	II	OR
	5	22	I	ED
17	4	44	I	Se
	5	44	I	Te
21	4	03	III	OD
	6	25	III	OR
24	4	26	I	SI
	5	31	I	TI
	6	37	I	Se
25	4	59	I	OR
28	3	42	III	ED
	6	12	III	ER
30	5	24	II	ED
31	6	20	I	SI

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 April to August, and on the west side during the rest of the year.**

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.

SATURN'S SATELLITES TITAN, RHEA AND IAPETUS (E.S.T.)

By Terence Dickinson

Titan, the largest and brightest of Saturn's moons is seen easily in a 2-inch or larger telescope. At elongation Titan appears about 5 ring-diameters from Saturn. The satellite orbits Saturn in about 16 days and at magnitude 8.4* dominates the field around the ringed planet.

Rhea is considerably fainter than Titan at magnitude 9.8 and a good quality 3-inch telescope may be required to detect it. At elongation Rhea is about 2 ring-diameters from the centre of Saturn.

Iapetus is unique among the satellites of the solar system in that it is five times brighter at western elongation (mag. 10.1) than at eastern elongation (mag. 11.9). When brightest, Iapetus is located about 12 ring-diameters west of its parent planet.

Of the remaining moons only Dione and Tethys are seen in "amateur"-sized telescopes.

*All magnitudes given are at mean opposition.

Titan

Elong. E.			Elong. W.		
	d	h		d	h
Jan.	16	15.6	Jan.	8	19.5
Feb.	1	15.3		24	18.9
	17	15.4	Feb.	9	18.7
Mar.	5	15.8		25	18.8
	..	....	Mar.	13	19.2
May	24	19.8		..	....
June	9	20.4	June	1	22.1
	25	20.8		17	22.4
July	11	20.8	July	3	22.5
	27	20.5		19	22.2
Aug.	12	19.7	Aug.	4	21.6
	28	18.4		20	20.5
Sept.	13	16.6	Sept.	5	18.9
	29	14.3		21	17.0
Oct.	15	11.8	Oct.	7	14.7
	31	9.1		23	12.2
Nov.	16	6.4	Nov.	8	9.6
Dec.	2	3.9		24	7.1
	18	1.9	Dec.	10	5.0
				26	3.2

Iapetus

Elong. E.			Elong. W.		
	d	h		d	h
Feb.	2	23.1	Mar.	16	22.2
	..	....		..	....
July	15	15.1	June	6	10.7
Oct.	2	20.9	Aug.	25	18.2
Dec.	19	23.9	Nov.	12	1.9

Rhea

Elong. E.			Elong. E.		
	d	h		d	h
Jan.	1	13.2	Aug.	2	2.6
	6	1.6		6	15.1
	10	14.1		11	3.5
	15	2.6		15	16.0
	19	15.1		20	4.4
	24	3.6		24	16.8
	28	16.1		29	5.2
Feb.	2	4.6	Sept.	2	17.6
	6	17.1		7	5.9
	11	5.6		11	18.3
	15	18.2		16	6.7
	20	6.7		20	19.0
	24	19.3		25	7.4
Mar.	1	7.8		29	19.7
	5	20.4	Oct.	4	8.0
	10	9.0		8	20.4
	14	21.5		13	8.7
	..	....		17	21.0
May	26	6.8		22	9.3
	30	19.4		26	21.6
June	4	8.0		31	9.9
	8	20.5	Nov.	4	22.2
	13	9.1		9	10.6
	17	21.6		13	22.9
	22	10.1		18	11.2
	26	22.7		22	23.5
July	1	11.2		27	11.9
	5	23.7	Dec.	2	0.2
	10	12.2		6	12.6
	15	0.7		11	0.9
	19	13.2		15	13.3
	24	1.7		20	1.7
	28	14.2		24	14.1
				29	2.5

SATURN'S SATELLITES, 1969

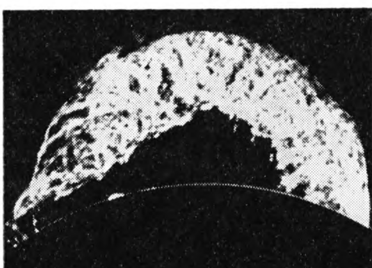
Name	Greatest E. Elongation E.S.T.*			Mean Synodic Period	
		d	h	d	h
Janus (discovered 1966)					
Mimas	Oct.	28	7.5	0	22.6
Enceladu	Oct.	28	23.0	1	08.9
Tethys	Oct.	28	7.8	1	21.3
Dione	Oct.	27	9.3	2	17.7
Rhea	Oct.	26	21.6†	4	12.5
Titan	Oct.	31	9.1†	15	23.3
Hyperion	Nov.	2	4.8	21	07.6
Iapetus	Oct.	2	20.9†	79	22.1
Phoebe				523	15.6

*Near opposition of Saturn, 1969 Oct. 28.
†See p. 58 for more information.

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 1969 Saturn's rings open to over half the maximum value, with the southern face visible. The major and minor axes of the outer ring have the following values during the year: Jan. 3, 41.02″, 7.97″; Apr. 17, 36.50″, 9.61″; Sept. 24, 44.57″, 13.94″; Oct. 30, 45.56″, 13.57″; Dec. 29, 42.86″, 12.06″.



JUPITER—LONGITUDE OF CENTRAL MERIDIAN

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. 8^h	Feb. 7^h	Mar. 6^h	Apr. 5^h	May 3^h	Dec. 10^h	Jan. 8^h	Feb. 7^h	Mar. 6^h	Apr. 5^h	May 3^h	Dec. 10^h
Day	°	°	°	°	°	°	°	°	°	°	°	°
1	263.6	83.7	151.6	334.0	319.5	128.8	228.2	172.0	26.7	332.8	90.1	64.4
2	61.5	241.7	309.7	132.0	117.4	286.6	18.5	322.4	177.1	123.2	240.4	214.5
3	219.4	39.7	107.7	290.0	275.3	84.3	168.7	112.7	327.5	273.6	30.7	4.6
4	17.4	197.7	265.7	88.0	73.2	242.1	319.0	263.1	117.9	63.9	180.9	154.8
5	175.3	355.7	63.8	246.0	231.1	39.9	109.3	53.5	268.3	214.3	331.2	304.9
6	333.2	153.7	221.8	44.0	29.0	197.7	259.6	203.8	58.7	4.7	121.4	95.1
7	131.2	311.7	19.8	202.0	186.8	355.5	49.9	354.2	209.1	155.0	271.7	245.3
8	289.1	109.7	177.9	0.0	344.7	153.2	200.2	144.6	359.5	305.4	62.0	35.4
9	87.0	267.7	335.9	157.9	142.6	311.0	350.6	295.0	149.9	95.7	212.2	185.6
10	245.0	65.7	134.0	315.9	300.5	108.8	140.9	85.4	300.3	246.1	2.4	335.7
11	42.9	223.7	292.0	113.9	98.3	266.6	291.2	235.7	90.8	36.4	152.7	125.9
12	200.9	21.8	90.0	271.9	256.2	64.4	81.5	26.1	241.2	186.8	302.9	276.1
13	358.8	179.8	248.1	69.8	54.1	222.2	231.8	176.5	31.6	337.1	93.1	66.2
14	156.8	337.8	46.1	227.8	211.9	20.0	22.1	326.9	182.0	127.4	243.4	216.4
15	314.7	135.8	204.2	25.8	9.8	177.8	172.4	117.3	332.4	277.8	33.6	6.6
16	112.7	293.8	2.2	183.7	167.6	335.6	322.8	267.7	122.8	68.1	183.8	156.7
17	270.6	91.9	160.2	341.7	325.5	133.4	113.1	58.1	273.2	218.4	334.0	306.9
18	68.6	249.9	318.3	139.6	123.3	291.3	263.4	208.5	63.6	8.8	124.2	97.1
19	226.6	47.9	116.3	297.6	281.1	89.1	53.8	358.9	214.0	159.1	274.4	247.3
20	24.5	205.9	274.3	95.5	79.0	246.9	204.1	149.3	4.4	309.4	64.6	37.5
21	182.5	4.0	72.4	253.5	236.8	44.7	354.4	299.7	154.8	99.7	214.9	187.7
22	340.5	162.0	230.4	51.4	34.6	202.5	144.8	90.1	305.2	250.0	5.0	337.8
23	138.4	320.0	28.4	209.4	192.5	0.3	295.1	240.5	95.6	40.3	155.2	128.0
24	296.4	118.1	186.4	7.3	350.3	158.2	85.5	30.9	246.0	190.6	305.4	278.2
25	94.4	276.1	344.5	165.2	148.1	316.0	235.8	181.3	36.4	340.9	95.6	68.4
26	252.4	74.1	142.5	323.1	305.9	113.8	26.2	331.7	186.8	131.2	245.8	218.6
27	50.4	232.2	300.5	121.1	103.7	271.6	176.5	122.1	337.2	281.5	36.0	8.8
28	208.3	30.2	98.5	279.0	261.5	69.5	326.9	272.5	127.6	71.8	186.2	159.0
29	6.3		256.5	76.9	59.3	227.3	117.2		278.0	222.1	336.3	309.2
30	164.3		54.6	234.8	217.1	25.2	267.6		68.3	12.4	126.5	99.4
31	322.3		212.6		14.9	183.0	57.9		218.7		276.7	249.7

MARS—LONGITUDE OF CENTRAL MERIDIAN

By Terence Dickinson

The table lists the longitude of the central meridian of the geometric disk of Mars at 19 hours E.S.T. To obtain values for other times, the longitude of the central meridian increases by 14.6° an hour. Syrtis Major, a prominent dark feature of the Martian globe, is located around longitude 290°.

Date	Mar.	Apr.	May	June	July	Aug.	Sept.
	°	°	°	°	°	°	°
1	311.6	19.5	103.2	186.8	279.9	353.8	59.3
2	302.1	10.2	94.2	177.9	270.8	344.4	49.7
3	292.6	0.9	85.1	169.1	261.8	335.0	40.1
4	283.1	351.6	76.1	160.3	252.7	325.6	30.5
5	273.6	342.2	67.0	151.5	243.6	316.2	20.9
6	264.2	332.9	58.0	142.7	234.5	306.8	11.3
7	254.7	323.6	49.0	133.8	225.4	297.3	1.7
8	245.2	314.4	40.0	125.0	216.3	287.9	352.0
9	235.8	305.1	31.0	116.2	207.2	278.4	342.4
10	226.3	295.8	22.0	107.3	198.0	269.0	332.8
11	216.9	286.5	13.1	98.5	188.8	259.5	323.2
12	207.4	277.3	4.1	89.7	179.7	250.0	313.5
13	198.0	268.0	355.2	80.8	170.5	240.5	303.9
14	188.5	258.8	346.3	72.0	161.3	231.0	294.3
15	179.1	249.6	337.3	63.1	152.1	221.6	284.6
16	169.7	240.4	328.4	54.2	142.8	212.1	275.0
17	160.2	231.1	319.5	45.3	133.6	202.6	265.3
18	150.8	221.9	310.6	36.4	124.4	193.0	255.7
19	141.4	212.7	301.7	27.5	115.1	183.5	246.0
20	132.0	203.6	292.9	18.6	105.8	174.0	236.3
21	122.6	194.4	284.0	9.7	96.6	164.5	226.7
22	113.2	185.2	275.1	0.8	87.3	154.9	217.0
23	103.8	176.1	266.3	351.8	78.0	145.4	207.3
24	94.4	166.9	257.4	342.9	68.7	135.8	197.7
25	85.0	157.8	248.6	333.9	59.3	126.3	188.0
26	75.6	148.7	239.7	325.0	50.0	116.7	178.3
27	66.3	139.6	230.9	316.0	40.7	107.2	168.6
28	56.9	130.4	222.1	307.0	31.3	97.6	158.9
29	47.6	121.4	213.2	298.0	22.0	88.0	149.2
30	38.2	112.3	204.4	288.9	12.6	78.4	139.6
31	28.9		195.6		3.2	68.9	

THE OBSERVATION OF THE MOON

During 1969 the ascending node of the moon's orbit regresses from Pisces into Aquarius (☊ from 5° to 345°). Thus the range of the moon's declination attains its greatest value. See p. 64 for occultations of 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.

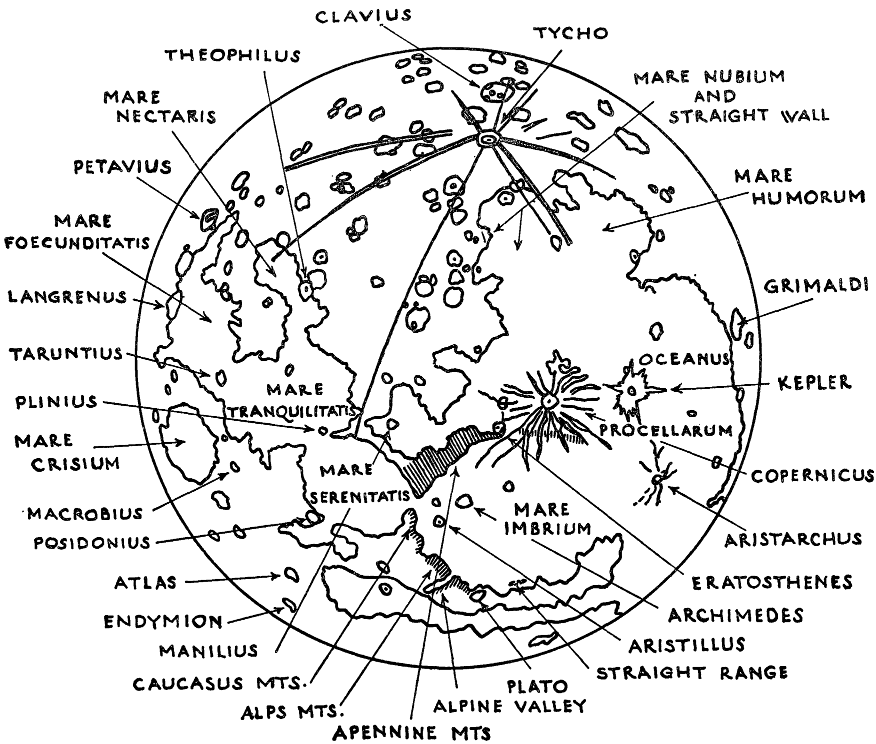
The sun's selenographic latitude varies between $+1\frac{1}{2}°$ and $-1\frac{1}{2}°$ during the year.

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 [l] 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].

Two areas suspected of showing changes are Alphonsus and Aristarchus.

MAP OF THE MOON



South appears at the top.

SUN—EPHEMERIS FOR PHYSICAL OBSERVATIONS, 1969
For 0h U.T.

Date	P	B_0	L_0	Date	P	B_0	L_0
	°	°	°		°	°	°
Jan. 1	+ 2.10	−3.07	44.75	July 5	− 0.95	+3.34	123.01
6	− 0.33	−3.64	338.90	10	+ 1.31	+3.86	56.84
11	− 2.74	−4.18	273.06	15	+ 3.56	+4.36	350.67
16	− 5.11	−4.69	207.22	20	+ 5.76	+4.82	284.51
21	− 7.41	−5.16	141.38	25	+ 7.90	+5.26	218.36
26	− 9.63	−5.59	75.55	30	+ 9.97	+5.65	152.22
31	−11.76	−5.98	9.72	Aug. 4	+11.96	+6.01	86.09
Feb. 5	−13.77	−6.32	303.89	9	+13.85	+6.33	19.98
10	−15.65	−6.61	238.05	14	+15.64	+6.60	313.88
15	−17.41	−6.84	172.22	19	+17.31	+6.83	247.80
20	−19.02	−7.03	106.37	24	+18.86	+7.01	181.72
25	−20.49	−7.16	40.52	29	+20.28	+7.14	115.66
Mar. 2	−21.80	−7.23	334.66	Sept. 3	+21.57	+7.22	49.61
7	−22.96	−7.25	268.79	8	+22.72	+7.25	343.58
12	−23.95	−7.21	202.90	13	+23.73	+7.23	277.56
17	−24.78	−7.12	137.00	18	+24.57	+7.15	211.55
22	−25.43	−6.97	71.09	23	+25.26	+7.02	145.55
27	−25.91	−6.77	5.15	28	+25.79	+6.84	79.56
Apr. 1	−26.22	−6.53	299.20	Oct. 3	+26.14	+6.61	13.58
6	−26.34	−6.23	233.22	8	+26.32	+6.32	307.61
11	−26.29	−5.89	167.23	13	+26.32	+6.00	241.66
16	−26.05	−5.51	101.21	18	+26.13	+5.62	175.70
21	−25.62	−5.09	35.18	23	+25.75	+5.20	109.76
26	−25.01	−4.63	329.13	28	+25.18	+4.74	43.82
May 1	−24.22	−4.14	263.05	Nov. 2	+24.41	+4.25	337.88
6	−23.25	−3.62	196.96	7	+23.44	+3.72	271.96
11	−22.10	−3.08	130.85	12	+22.28	+3.16	206.04
16	−20.79	−2.52	64.73	17	+20.92	+2.58	140.13
21	−19.31	−1.94	358.59	22	+19.39	+1.97	74.22
26	−17.67	−1.35	292.44	27	+17.67	+1.35	8.31
31	−15.90	−0.75	226.27	Dec. 2	+15.80	+0.72	302.42
June 5	−14.00	−0.15	160.10	7	+13.77	+0.08	236.53
10	−11.99	+0.45	93.92	12	+11.62	−0.56	170.65
15	− 9.89	+1.05	27.74	17	+ 9.37	−1.20	104.78
20	− 7.72	+1.65	321.56	22	+ 7.03	−1.83	38.91
25	− 5.49	+2.23	255.38	27	+ 4.64	−2.44	333.04
30	− 3.23	+2.79	189.19				

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, 1969

No.	Commences	No.	Commences	No.	Commences
1543	Jan. 4.40	1548	May 20.89	1553	Oct. 4.03
1544	Jan. 31.74	1549	June 17.10	1554	Oct. 31.32
1545	Feb. 28.08	1550	July 14.29	1555	Nov. 27.63
1546	Mar. 27.39	1551	Aug. 10.51	1556	Dec. 24.95
1547	Apr. 23.66	1552	Sept. 6.76		

ECLIPSES DURING 1969

In 1969 there will be five eclipses, two of the sun and three of the moon. Of these, the eclipse of the sun on September 11 will be visible as a partial eclipse over most of North America, and the penumbral eclipse of the moon on August 27 will also be "visible" over most of North America.

1. An annular eclipse of the sun on March 17–18, not visible in North America, the path crossing the Indian and Pacific Oceans north of Australia.

2. A penumbral eclipse of the moon on April 2, not visible in North America.

3. A penumbral eclipse of the moon on the night of August 26–27, visible in North America except in the extreme north-eastern part. As a penumbral eclipse, the phenomenon will be not easily detectable.

Moon enters penumbra............	August 27, 5h 21m E.S.T.
Middle of eclipse...........................	5h 48m E.S.T.
Moon leaves penumbra.....................	6h 14m E.S.T.

4. An annular eclipse of the sun on September 11. The path of the annular eclipse is mostly in the Pacific Ocean some hundreds of miles off the coast of North America, but the partial eclipse will be visible in North America except for the corner north-east of a line roughly through Churchill, Sault Ste. Marie and Washington, D.C. The time of the eclipse will range from about 13:00 C.S.T. in western Canada to 15:30 E.S.T. in south-eastern U.S.A.

5. A penumbral eclipse of the moon on September 25, not visible in North America except for the extreme north-eastern part and the Arctic regions.

OCCULTATIONS BY THE MOON

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.

Note that stars of the Pleiades are occulted in 1969. The stars are listed according to the first of the two stations in a table. Thus, in a few cases, occultations for the second station are not in strict chronological order.

The co-ordinates of the standard stations are: Halifax, λ_0 63° 36.0′, ϕ_0+44° 38.0′; Montreal, λ_0 73° 34.5′, ϕ_0+45° 30.3′; Toronto, λ_0 79° 24.0′, ϕ_0+43° 39.8′; Winnipeg, λ_0 97° 06.0′, ϕ_0+49° 55.0′; Edmonton, λ_0 113° 04.5′, ϕ_0+53° 32.0′; Vancouver, λ_0 123° 06.0′, ϕ_0+49° 30.0′.

LUNAR OCCULTATIONS VISIBLE AT HALIFAX AND MONTREAL, 1969

Date	Star	Mag.	I or E	Elong. of Moon	Halifax				Montreal			
					A.S.T.	*a*	*b*	*P*	E.S.T.	*a*	*b*	*P*
				°	h m	m	m	°	h m	m	m	°
Jan. 9	89 Leo	5.8	E	243	5 57.6	−1.4	−1.4	298	4 39.7	−1.9	−0.6	282
Jan. 11	−8° 3495	6.4	E	268	6 24.4	−1.1	−1.2	321	5 10.9	−1.3	−0.6	306
Jan. 14	3 Sco	5.9	E	307	5 50.6	−0.1	−0.4	334	Low	...	...	...
Jan. 21	337B. Aqr	6.4	I	49	18 31.5	—	—	330				
Jan. 21	337B. Aqr	6.4	E	49	18 38.8	—	—	317				
Jan. 21	−5° 6011	7.0	I	50	20 01.2	−0.9	−2.3	103	18 49.6	−1.0	−1.3	88
Jan. 22	98B. Psc	6.4	I	62	18 06.0	−1.3	+0.2	59	Sun	...	...	...
Jan. 23	ε Psc	4.4	I	74	17 48.1	−0.4	+2.6	9	16 57.0	—	—	333
Jan. 23	ε Psc	4.4	E	74					17 12.4	—	—	310
Jan. 23	192B. Psc	6.9	I	74	20 09.7	−1.0	+0.3	48	19 00.0	−1.0	+1.0	36
Jan. 25	+18° 337*p*	7.5	I	98	20 45.6	−1.7	−1.2	92	19 26.0	−1.9	−0.2	81
Jan. 25/26	114B. Ari	7.3	I	99	0 35.1	0.0	−1.2	82	23 31.9	−0.3	−1.4	87
Jan. 26	66 Ari	6.1	I	108	19 35.2	−1.8	+0.8	66	18 19.6	−1.4	+1.8	52
Jan. 26/27	9 Tau	6.7	I	110	0 55.0	0.0	−1.7	101	23 51.4	−0.3	−2.1	107
Jan. 28	+27° 734	6.9	I	130	18 00.2	−1.1	+1.5	78	Sun	...	...	...
Jan. 28/29	354B. Tau	6.3	I	132	1 07.9	−1.6	+0.6	41	23 51.9	−1.6	+0.2	53
Feb. 18	71B. Psc	7.0	I	30	Low	...	...	...	18 56.1	−0.1	+0.7	26
Feb. 20	π Psc	5.6	I	55	21 31.4	0.0	−1.5	93	20 27.6	−0.3	−1.7	93
Feb. 20	281B. Psc	6.9	I	55	Low	...	...	...	20 55.3	—	—	131
Feb. 24	+27° 716	6.8	I	101	23 08.4	−0.3	−2.3	117	22 01.3	−0.6	−2.8	126
Feb. 26	25 Gem	6.5	I	122	18 46.0	−1.5	+2.7	54	Sun	...	...	...
Feb. 26	+27° 1219	6.8	I	122	22 00.6	—	—	166				
Feb. 27	+27° 1270	7.0	I	125	3 04.3	+0.2	−1.4	101	2 04.9	+0.1	−1.7	111
Feb. 27/28	76 Gem	5.4	I	135	0 29.1	−1.2	−1.2	89	23 14.6	−1.3	−1.4	102
Mar. 1	γ Cnc	4.7	I	148	Low	...	...	...	3 56.7	+1.1	−2.9	182
Mar. 6	25 Vir	5.9	E	206	2 05.4	−2.2	0.0	270	0 38.4	—	—	244
Mar. 20	+14° 326	6.8	I	34	19 19.5	−0.4	−1.4	88	Sun	...	...	...
Mar. 22	17 Tau	3.8	I	58	21 10.0	−0.4	−0.9	72	20 03.2	−0.7	−0.1	78
Mar. 22	16 Tau	5.4	I	58	21 26.9	−1.2	+1.5	21	20 16.2	−1.1	+0.8	32
Mar. 22	20 Tau	4.0	I	58	No Occ.	...	...	...	20 56.8	—	—	15
Mar. 22	23 Tau	4.2	I	58	21 56.1	+0.4	−2.4	124	20 57.5	+0.3	−3.4	135
Mar. 22	+23° 523	7.0	I	59	22 01.4	−0.4	−0.2	50	20 56.3	−0.5	−0.5	58
Mar. 22	η Tau	3.0	I	59	22 22.7	+0.1	−1.3	92	21 22.4	0.0	−1.7	101
Mar. 22	+23° 540	6.8	I	59	22 29.9	−0.2	−0.2	49	21 26.4	−0.3	−0.5	58
Mar. 22	+23° 538	7.1	I	59	22 35.5	—	—	150	No Occ.	...	...	...
Mar. 22	105B. Tau	6.6	I	59	Low	...	...	...	21 56.6	−0.2	−0.3	51
Mar. 22	28 Tau	5.2	I	59	Low	...	...	...	22 10.0	+0.3	−1.7	106
Mar. 22	27 Tau	3.8	I	59	Low	...	...	...	22 14.8	+0.7	−2.4	129
Mar. 22	η Tau	3.0	E	59	Low	...	...	...	22 18.8	0.0	−0.7	244
Mar. 22	+23° 561	6.6	I	59	Low	...	...	...	22 20.6	−0.2	−0.3	49
Mar. 23	+26° 731*m*	6.5	I	70	21 56.5	−1.0	+0.3	39	20 45.5	−1.1	0.0	50
Mar. 25	228B. Aur	6.8	I	92	No Occ.	...	...	...	22 51.3	−1.7	+0.5	40
Mar. 26	+27° 1362	6.9	I	102	21 19.7	−1.1	−2.0	120	20 05.3	−1.3	−2.2	130
Mar. 27	+26° 1564	7.2	I	104	1 46.6	+0.2	−1.4	103	0 47.2	+0.1	−1.7	112
Mar. 30	+15 2136	7.5	I	138	1 17.8	+0.5	−2.9	178	No Occ.	...	...	...
Apr. 5	43B. Lib	6.1	I	214					0 14.5	—	—	39
Apr. 5	43B. Lib	6.1	E	214					0 25.3	—	—	21
Apr. 6	π Sco	3.0	I	228	2 01.8	−1.5	+0.3	99	0 48.7	−1.1	+0.4	112
Apr. 6	π Sco	3.0	E	228	3 16.1	−1.5	−0.4	304	2 01.2	−1.4	0.0	295
Apr. 20	+27° 734	6.9	I	49	19 57.9	−0.3	−2.0	112	Sun	...	...	...
Apr. 22	+27° 1296	7.2	I	72	21 29.3	−0.1	−2.2	126	20 25.3	−0.1	−2.7	139
Apr. 26	137B. Leo	7.1	I	116	19 52.2	−1.2	−1.6	140	Sun	...	...	...
Apr. 27	162B. Leo	6.6	I	118	1 45.7	−0.2	−1.5	93	0 41.1	−0.4	−1.7	101
Apr. 28	+01° 2624	6.4	I	141	No Occ.	...	...	...	19 44.6	−2.6	+2.1	71
May 7	60 Sgr	5.0	E	251	3 06.0	−1.4	+0.8	274	Low	...	...	...
May 18	406B. Tau	5.6	I	31	Low	...	...	...	20 25.4	0.0	−0.9	72
May 22	+19° 2187	6.9	I	74	21 20.2	−0.7	−1.6	99	20 10.1	−0.9	−1.8	112
May 25	+03° 2519	6.7	I	109	20 48.7	−0.8	−1.9	150	Sun	...	...	...
May 27	50 Vir	6.2	I	134	21 18.1	−1.1	−1.1	138	20 07.2	−0.7	−1.2	153
May 28	474B. Vir	6.9	I	135	1 15.0	−0.5	−2.9	182	0 08.2	—	—	189
June 7	317B. Aqr	6.3	E	272	Sun	...	...	...	2 13.4	−0.8	+1.5	270
June 17	35B. Cnc	6.4	I	33	Low	...	...	...	20 26.9	+0.8	−2.3	164
July 1	27 Cap	6.2	E	213	23 52.9	—	—	314	Low	...	...	...

Date	Star	Mag.	I or E	Elong. of Moon	Halifax				Montreal			
					A.S.T.	*a*	*b*	*P*	E.S.T.	*a*	*b*	*P*
				°	h m	m	m	°	h m	m	m	°
July 3	39 Aqr	6.2	E	228	Sun	...	...	...	2 21.0	−1.6	+0.7	254
July 4	83 Aqr	5.6	E	241	Sun	...	...	...	2 41.5	−1.4	+1.2	243
July 21	497B. Vir	7.1	I	83	20 45.9	−0.9	−2.0	145	Sun	...	...	...
July 22	43H. Vir	5.6	I	96	Low	...	...	...	20 58.7	−1.4	−0.9	70
July 24	−26° 11240	6.7	I	122	21 30.3	−1.7	−0.5	83	20 12.1	−1.8	−0.1	87
July 24	−26° 11247	6.8	I	122	22 16.7	−1.5	−1.2	121	20 59.9	−1.6	−0.8	120
July 25	−29° 13411	6.8	I	137	Low	...	...	...	22 33.3	−1.7	−1.1	124
July 31/1	337B. Aqr	6.4	E	221	0 08.4	−0.6	+2.0	203	23 04.1	−0.5	+2.0	213
Aug. 1	342B. Aqr	6.5	E	221	1 38.4	−0.9	+1.6	216	0 29.5	−1.0	+1.6	231
Aug. 6	17 Tau	3.8	I	284	Sun	...	...	...	3 39.1	−1.3	+1.2	92
Aug. 20	−25° 11098	6.9	I	90	20 10.0	−1.5	−1.1	112	Sun	...	...	...
Aug. 30	60 Psc	6.2	E	214	0 54.8	—	—	293	No Occ.	...	...	...
Sept. 4	38B. (Aur)	6.5	E	274	0 37.2	−0.9	+0.2	314	No Occ.	...	...	...
Sept. 4	47B. (Aur)	6.1	E	275	3 06.4	—	—	325	No Occ.	...	...	...
Sept. 8	γ Cnc	4.7	E	319	4 46.3	0.0	+2.7	241	3 48.0	0.0	+2.0	254
Sept. 21	73B. Cap	7.3	I	127	20 43.3	—	—	125	19 19.7	−1.9	+0.3	108
Sept. 29	47 Ari	5.8	I	219	0 03.2	—	—	140				
Sept. 28/29	47 Ari	5.8	E	219	0 13.7	—	—	157	23 27.0	0.0	+2.9	196
Sept. 29	ϵ Ari	4.6	E	220	1 58.6	−2.5	−0.4	286	No Occ.	...	...	...
Sept. 29	17 Tau	3.8	I	230	20 46.7	+0.4	+1.6	53	Low	...	...	...
Sept. 29	23 Tau	4.2	I	230	21 24.0	−0.4	+0.7	123	Low	...	...	...
Sept. 29	16 Tau	5.4	E	230	21 28.8	—	—	317	No Occ.	...	...	...
Sept. 29	20 Tau	4.0	I	230	21 31.6	+1.0	+2.6	7	No Occ.	...	...	...
Sept. 29	17 Tau	3.8	E	230	21 39.9	0.0	+1.4	263	20 41.4	0.0	+1.2	275
Sept. 29	η Tau	3.0	I	230	21 52.2	−0.4	+1.0	108	20 51.6	0.0	+1.2	94
Sept. 29	23 Tau	4.2	E	230	21 55.8	+0.8	+2.6	192	21 04.6	+0.5	+2.0	209
Sept. 29	20 Tau	4.0	E	230	22 00.4	−0.9	+0.4	308	No Occ.	...	...	...
Sept. 29	η Tau	3.0	E	230	22 36.7	+0.4	+2.4	206	21 42.0	+0.2	+2.0	221
Sept. 29	28 Tau	5.2	E	231	No Occ.	...	...	...	22 10.2	—	—	181
Oct. 17	248B. Sgr	5.6	I	83	20 25.5	0.0	+0.8	17	No Occ.	...	...	...
Oct. 18	−24° 16056	6.9	I	95	18 39.7	—	—	124	Sun	...	...	...
Oct. 18	30B. Cap	6.9	I	95	18 41.3	−1.8	+0.1	85	Sun	...	...	...
Oct. 20	45 Aqr	6.1	I	122	18 07.0	−1.3	+1.4	66	Sun	...	...	...
Oct. 21	ϕ Aqr	4.4	I	136	21 10.7	−1.5	+0.8	61	19 58.2	−1.1	+1.4	44
Oct. 21/22	96 Aqr	5.7	I	137	0 41.9	−1.0	−0.8	78	23 30.5	−1.1	−0.1	62
Oct. 22	319B. Aqr	6.7	I	138	1 57.8	−0.4	−0.3	58	0 52.8	−0.5	0.0	47
Oct. 29	354B. Tau	6.3	E	223	1 19.7	−1.6	+1.1	263	0 05.1	−1.4	+0.9	277
Oct. 31	47 Gem	5.6	E	246	1 41.1	−1.4	+0.4	290	0 28.3	−1.2	+0.2	303
Oct. 31	134B. Gem	6.5	E	247	5 21.1	−1.7	−1.7	303	4 01.8	−1.8	−1.1	299
Nov. 6	31B. Vir	6.4	E	315	5 48.2	—	—	236	No Occ.	...	...	...
Nov. 16	−15° 6143	6.6	I	92	No Occ.	...	...	...	18 08.5	−2.9	−0.7	112
Nov. 17	81 Aqr	6.4	I	106	22 03.2	−0.2	+1.4	13	21 07.0	—	—	347
Nov. 18/19	60B. Psc	6.0	I	120	0 48.3	−0.3	0.0	47	23 43.9	−0.5	+0.4	38
Dec. 12	−21° 5844	7.1	I	47	17 36.4	0.0	+1.1	12	No Occ.	...	...	...
Dec. 12	−21° 5852	7.3	I	47	18 08.8	−0.5	+0.2	37	17 05.2	−0.2	+0.9	17
Dec. 13	δ Cap	3.0	E	60	17 38.9	−1.6	−0.2	257	16 19.8	−2.1	−0.2	277
Dec. 13	156B. Cap	7.0	I	62	Low	...	...	...	19 51.2	−1.2	−1.9	102
Dec. 15	34G. Psc	7.0	I	87	18 07.7	−1.5	+0.7	63	16 54.7	−1.1	+1.3	45
Dec. 16/17	116B. Psc	6.6	I	102	0 15.8	−0.3	−2.7	112	23 08.3	−0.7	−2.3	104
Dec. 17	198B. Psc	6.9	I	112	18 26.5	—	—	347	No Occ.	...	...	...
Dec. 17	210B. Psc	6.6	I	113	20 09.9	−1.1	+1.5	37	19 02.5	−0.6	+2.3	17
Dec. 18	235B. Psc	6.9	I	116	Low	...	...	...	1 08.4	−0.2	−0.5	59
Dec. 20	ϵ Ari	4.6	I	139	1 30.5	−0.8	−0.7	71	0 19.8	−1.1	−0.6	72
Dec. 20	16 Tau	5.4	I	149	20 54.5	−2.0	+0.3	94	19 38.0	−1.4	+1.3	77
Dec. 20	17 Tau	3.8	I	149	No Occ.	...	...	...	19 47.6	—	—	125
Dec. 20	19 Tau	4.4	I	149	21 14.9	−1.6	+1.3	64	20 02.8	−1.0	+2.1	49
Dec. 20	20 Tau	4.0	I	149	21 36.4	−2.2	−0.2	99	20 16.8	−1.7	+0.9	83
Dec. 20	21 Tau	5.8	I	149	21 44.9	−1.6	+1.3	60	20 32.1	−1.1	+2.2	45
Dec. 20	22 Tau	6.5	I	149	21 47.9	−1.7	+1.0	68	20 33.4	−1.3	+1.8	54
Dec. 25	35B. Cnc	6.4	E	205	21 35.4	−0.6	+1.3	274	20 31.3	−0.4	+1.0	285
Dec. 28	α Leo	1.3	I	232	10 24.7	+0.2	−1.5	108	9 24.8	0.0	−1.7	111

LUNAR OCCULTATIONS VISIBLE AT TORONTO AND WINNIPEG, 1969

Date	Star	Mag.	I or E	Elong. of Moon	Toronto				Winnipeg			
					E.S.T.	*a*	*b*	*P*	C.S.T.	*a*	*b*	*P*
				°	h m	m	m	°	h m			°
Jan. 9	89 Leo	5.8	E	243	4 26.8	−2.6	+0.3	265	2 49.8	—	—	246
Jan. 11	439B. Vir	5.7	E	268	3 34.6	—	—	17	2 28.0	+0.6	−3.0	8

Date		Star	Mag.	I or E	Elong. of Moon	Toronto				Winnipeg			
						E.S.T.	*a*	*b*	*P*	C.S.T.	*a*	*b*	*P*
					°	h m	m	m	°	h m	m	m	°
Jan.	11	−8° 3495	6.4	E	268	5 03.0	−1.6	−0.1	292	3 40.1	−1.2	+0.9	279
Jan.	12	214G. Vir	6.4	E	282	Sun	...	...	...	6 59.2	−1.3	−0.4	298
Jan.	13	43B. Lib	6.1	E	294	6 29.4	−1.6	+0.3	281	5 08.6	−1.2	+1.3	265
Jan.	21	−5° 6011	7.0	I	50	18 44.8	−1.3	−1.1	86	Sun	...	...	...
Jan.	23	192B. Psc	6.9	I	74	18 51.7	−1.0	+1.3	34	No Occ.	...	...	...
Jan.	24	+14° 326	6.8	I	88	Low	...	...	...	23 40.9	—	—	2
Jan.	25	+18° 337*p*	7.5	I	98	19 14.3	−2.1	0.0	80	17 54.2	−0.9	+2.0	39
Jan.	25	114B. Ari	7.3	I	99	23 32.6	−0.4	−1.7	97	22 08.9	−1.1	−1.0	80
Jan.	26	66 Ari	6.1	I	108	18 08.0	−1.2	+2.0	49	Sun	...	...	...
Jan.	26	9 Tau	6.7	I	110	23 54.0	−0.3	−2.8	120	22 23.1	−1.2	−2.0	104
Jan.	27	χ Tau	5.5	I	120	No Occ.	...	...	...	18 49.1	—	—	133
Jan.	28	354B. Tau	6.3	I	132	23 41.9	−1.7	−0.1	66	22 12.7	−1.7	+1.3	52
Feb.	5	80 Leo	6.4	E	214	Sun	...	...	...	5 27.9	−1.0	−1.6	296
Feb.	18	71B. Psc	7.0	I	30	18 53.5	−0.2	+0.6	30	No Occ.	...	...	...
Feb.	20	π Psc	5.6	I	55	20 28.3	−0.5	−2.1	102	19 03.2	−1.0	−0.7	73
Feb.	20	281B. Psc	6.9	I	55	No Occ.	...	...	...	19 25.4	−1.1	−2.4	105
Feb.	24	+27° 716	6.8	I	101	22 04.4	−0.4	−4.1	141	20 22.1	−1.6	−2.5	123
Feb.	24/25	38B. (Aur)	6.5	I	102	0 34.6	−1.1	+0.5	36	23 14.4	−1.3	+0.3	42
Feb.	25	+27° 734	6.9	I	103	Low	...	...	...	1 41.6	0.0	−1.1	72
Feb.	26	+27° 1219	6.8	I	122	No Occ.	...	...	...	18 45.3	−1.9	−2.2	145
Feb.	27	+27° 1270	7.0	I	125	2 09.1	+0.1	−1.9	122	0 55.7	−0.1	−2.4	133
Feb.	27	+27° 1296	7.2	I	126	Low	...	...	...	3 12.0	0.0	−1.4	92
Feb.	27	76 Gem	5.4	I	135	23 09.4	−1.4	−1.7	115	21 32.9	−1.6	−0.9	114
Mar.	7	550B. Vir	5.8	E	221	Sun	...	...	...	4 50.1	−1.0	−1.4	319
Mar.	20	+15° 305	7.5	I	36	Low	...	...	...	20 27.3	−0.2	−0.4	52
Mar.	21	+19° 432	7.0	I	47	20 34.5	−1.2	+2.5	12	No Occ.	...	...	...
Mar.	21	47 Ari	5.8	I	48	Low	...	...	...	20 59.9	−0.4	−0.2	45
Mar.	22	17 Tau	3.8	I	58	20 00.8	−0.8	−1.3	88	Sun	...	...	...
Mar.	22	16 Tau	5.4	I	58	20 08.5	−1.1	+0.2	46	Sun	...	...	...
Mar.	22	20 Tau	4.0	I	58	20 47.0	−1.1	+0.7	35	19 31.5	−1.4	+2.1	21
Mar.	22	+23° 523	7.0	I	59	20 54.0	−0.6	−0.8	70	19 33.7	−1.1	−0.3	62
Mar.	22	23 Tau	4.2	I	58	21 14.8	—	—	168	19 39.4	—	—	141
Mar.	22	23 Tau	4.2	E	58	21 19.0	—	—	175				
Mar.	22	+23° 540	6.8	I	59	21 25.3	−0.4	−0.8	70	20 07.9	−0.9	−0.6	65
Mar.	22	η Tau	3.0	I	59	21 26.1	0.0	−2.1	113	20 06.4	−0.6	−2.2	108
Mar.	22	105B. Tau	6.6	I	59	21 55.9	−0.3	−0.6	64	20 41.7	−0.7	−0.6	62
Mar.	22	28 Tau	5.2	I	59	22 15.7	+0.4	−2.1	118	21 03.4	−0.1	−2.6	118
Mar.	22	η Tau	3.0	E	59	22 18.8	−0.3	−0.2	232	21 07.3	−0.7	−0.3	232
Mar.	22	+23° 561	6.6	I	59	22 20.3	−0.1	−0.6	61	21 08.7	−0.6	−0.7	61
Mar.	22	27 Tau	3.8	I	59	22 26.0	+1.3	−4.2	149	21 15.4	—	—	150
Mar.	23	+26° 731*m*	6.5	I	70	20 39.1	−1.2	−0.4	63	Sun	...	...	...
Mar.	25	228B. Aur	6.8	I	92	22 42.7	−1.3	−0.4	60	21 13.3	−1.6	−0.3	68
Mar.	25/26	49 Aur	5.0	I	93	1 10.0	—	—	33	23 52.4	−0.9	−0.6	53
Mar.	26	+27° 1362	6.9	I	102	20 02.3	−1.3	−3.0	143	Sun	...	...	...
Mar.	26/27	+26° 1564	7.2	I	104	0 51.4	+0.1	−1.8	122	23 38.3	−0.1	−2.3	135
Mar.	29	+19° 2187	6.9	I	128	Low	...	...	...	3 02.6	+0.1	−1.8	129
Apr.	5	43B. Lib	6.1	E	214	0 35.8	0.0	−1.4	352	Low	...	...	...
Apr.	6	π Sco	3.0	I	228	0 42.4	−0.7	+0.2	124	Low	...	...	...
Apr.	6	π Sco	3.0	E	228	1 52.4	−1.5	+0.3	285	Low	...	...	...
Apr.	22	+27° 1296	7.2	I	72	20 30.5	+0.1	−3.5	155	Sun	...	...	...
Apr.	23	47 Gem	5.6	I	74	Low	...	...	...	0 08.4	0.0	−1.1	68
Apr.	26/27	162B. Leo	6.6	I	118	0 41.5	−0.5	−1.7	109	23 17.6	−0.8	−1.8	123
May	4	135B. Sco	6.0	E	211	Sun	...	...	...	2 36.2	−1.9	+0.5	223
May	18	406B. Tau	5.6	I	31	20 27.2	0.0	−1.1	83	Sun	...	...	...
May	19	+27° 1236	6.6	I	42	Low	...	...	...	21 20.6	+0.1	−1.7	112
May	27/28	−10° 3644	6.7	I	136	0 59.2	−0.8	−1.9	135	23 31.9	−0.9	−1.5	141
May	28	−10° 3652	7.1	I	136	Low	...	...	...	0 47.3	−0.9	−1.6	111
June	7	317B. Aqr	6.3	E	272	2 06.1	−0.6	+1.5	270	Low	...	...	...
June	17	35B. Cnc	6.4	I	33	20 37.7	+1.3	−3.1	179	No Occ.	...	...	...
June	21	82 Leo	6.7	I	80	Low	...	...	...	22 48.3	−0.4	−1.7	91
June	23	99G. Vir	6.8	I	104	Low	...	...	...	22 56.1	−1.0	−1.3	73
July	3	39 Aqr	6.2	E	228	2 09.6	−1.6	+0.9	259	0 50.4	−1.1	+1.2	281
July	4	83 Aqr	5.6	E	241	2 30.7	−1.4	+1.3	248	1 17.3	−1.0	+1.4	271
July	22	43H. Vir	5.6	I	96	20 51.1	−1.7	−0.8	75	Sun	...	...	...
July	22	231G. Vir	6.4	I	97	21 55.3	−1.1	−1.6	118	Sun	...	...	...
July	22	236G. Vir	5.7	I	97	Low	...	...	...	21 18.8	−1.2	−1.3	108
July	24	−26° 11247	6.8	I	122	20 51.9	−1.6	−0.7	125	Sun	...	...	...
July	24	−26° 11273	7.5	I	123	22 45.7	−1.4	−1.0	98	21 13.9	−1.5	−0.3	93
July	25	−29° 13411	6.8	I	137	22 24.8	−1.8	−0.9	124	Sun	...	...	...
July	31	337B. Aqr	6.4	E	221	22 57.1	−0.5	+2.0	215	Low	...	...	...
July	31/1	342B. Aqr	6.5	E	221	0 20.4	−1.0	+1.7	235	23 15.8	−0.6	+1.6	254
Aug.	6	17 Tau	3.8	I	284	3 29.7	−1.0	+1.4	86	2 32.8	0.0	+2.0	52

Date		Star	Mag.	I or E	Elong. of Moon	Toronto				Winnipeg			
						E.S.T.	*a*	*b*	*P*	C.S.T.	*a*	*b*	*P*
					°	h m	m	m	°	h m	m	m	°
Aug.	6	19 Tau	4.4	I	284	4 10.6	+0.1	+3.3	16	No Occ.	...	...	...
Aug.	6	23 Tau	4.2	I	284	No Occ.	...	...	...	3 21.1	—	—	130
Aug.	6	20 Tau	4.0	I	284	4 11.1	−0.7	+2.0	55	3 24.0	+0.4	+3.1	12
Aug.	6	16 Tau	5.4	E	284	Sun	...	...	...	3 26.7	—	—	309
Aug.	6	17 Tau	3.8	E	284	4 37.5	−0.6	+2.5	221	3 36.8	−0.7	+1.6	259
Aug.	6	23 Tau	4.2	E	284	No Occ.	...	...	...	3 49.8	—	—	181
Aug.	6	η Tau	3.0	I	284	No Occ.	...	...	...	3 55.2	−1.6	+0.6	116
Aug.	6	20 Tau	4.0	E	284	Sun	...	...	...	4 06.0	−1.8	+0.4	298
Aug.	10	134B. Gem	6.5	E	328	3 46.2	−0.7	−0.4	327	No Occ.	...	...	...
Aug.	20	−25° 11125	6.7	I	91	20 30.6	−1.6	−1.9	148	Sun	...	...	...
Sept.	8	γ Cnc	4.7	E	319	3 45.0	+0.1	+1.8	254	Low	...	...	...
Sept.	18	2B. (Sgr)	6.8	I	87	19 53.0	−1.5	−0.7	89	Sun	...	...	...
Sept.	21	73B. Cap	7.3	I	127	19 08.0	−1.7	+0.5	106	Sun	...	...	...
Sept.	22	152B. Cap	6.5	I	141	No Occ.	...	...	...	20 21.9	−1.6	+0.8	98
Sept.	28	47 Ari	5.8	E	219	23 22.1	0.0	+2.6	203	22 32.8	−0.2	+1.9	238
Sept.	29	23 Tau	4.2	E	230	21 04.4	+0.6	+1.9	213	Low	...	...	...
Sept.	29	27 Tau	3.8	I	231	No Occ.	...	...	...	20 47.9	0.0	+1.0	116
Sept.	29	η Tau	3.0	E	230	21 40.3	+0.3	+1.8	226	20 56.8	+0.3	+1.5	249
Sept.	29	27 Tau	3.8	E	231	No Occ.	...	...	...	21 24.6	+0.6	+2.0	203
Sept.	29	28 Tau	5.2	E	231	22 10.8	+0.9	+2.8	190	21 34.3	+0.3	+1.8	224
Oct.	21	ϕ Aqr	4.4	I	136	19 48.9	−1.0	+1.6	38	18 48.4	−0.3	+2.0	9
Oct.	21	96 Aqr	5.7	I	137	23 23.7	−1.2	+0.1	58	22 13.6	−0.4	+1.5	14
Oct.	21/22	319B. Aqr	6.7	I	138	0 49.0	−0.6	+0.2	46	23 48.1	+0.1	+2.2	359
Oct.	27	17 Tau	3.8	I	203	Sun	...	...	...	6 03.7	−0.1	−3.6	133
Oct.	27	19 Tau	4.4	I	203	Sun	...	...	...	6 12.7	−0.9	−0.1	49
Oct.	27	20 Tau	4.0	I	203	Sun	...	...	...	6 23.9	−0.6	−1.1	78
Oct.	28	354B. Tau	6.3	E	223	23 55.2	−1.3	+0.9	280	No Occ.	...	...	...
Oct.	31	47 Gem	5.6	E	246	0 21.1	−1.0	+0.2	304	No Occ.	...	...	...
Oct.	31	134B. Gem	6.5	E	247	3 51.8	−2.0	−0.4	291	2 16.8	−1.6	−1.0	320
Nov.	16	−15° 6143	6.6	I	92	17 53.3	−2.4	0.0	103	Sun	...	...	...
Nov.	16	42 Aqr	5.6	I	94	Low	...	...	...	22 31.2	−0.4	−0.2	49
Nov.	17	81 Aqr	6.4	I	106	21 09.1	—	—	332				
Nov.	17	81 Aqr	6.4	E	106	21 21.8	—	—	311				
Nov.	18	60B. Psc	6.0	I	120	23 39.6	−0.6	+0.5	39	22 44.4	—	—	346
Nov.	20	60 Psc	6.2	I	134	No Occ.	...	...	...	1 03.7	−1.0	−2.8	110
Nov.	20	62 Psc	6.1	I	134	Low	...	...	...	1 58.5	−0.3	+1.1	18
Nov.	25	136 Tau	4.5	I	203	No Occ.	...	...	...	19 51.6	−0.3	+0.8	120
Nov.	25	136 Tau	4.5	E	203	No Occ.	...	...	...	20 38.3	+0.3	+2.4	224
Dec.	2	59 Leo	5.1	E	272	6 22.3	−1.9	−0.6	289	4 50.1	−1.5	+0.7	279
Dec.	13	156B. Cap	7.0	I	62	19 46.6	−1.4	−1.6	98	18 21.5	−0.9	0.0	53
Dec.	13	−15° 6103	7.2	I	63	No Occ.	...	...	...	19 59.7	—	—	124
Dec.	16	116B. Psc	6.6	I	102	23 07.9	−1.0	−2.8	110	21 38.0	−1.1	−0.3	68
Dec.	17	210B. Psc	6.6	I	113	18 55.0	−0.3	+2.7	10	No Occ.	...	...	...
Dec.	17/18	235B. Psc	6.9	I	116	1 07.8	−0.3	−0.6	68	23 55.3	−0.7	0.0	46
Dec.	18	241B. Psc	6.9	I	116	No Occ.	...	...	...	0 51.1	—	—	136
Dec.	19	+19° 432	7.0	I	138	No Occ.	...	...	...	19 21.0	−1.4	+1.1	88
Dec.	19/20	ϵ Ari	4.6	I	139	0 13.7	−1.3	−0.7	79	22 47.7	−1.3	+0.9	51
Dec.	20	134B. Ari	6.7	I	139	0 50.9	—	—	347				
Dec.	20	134B. Ari	6.7	E	139	0 54.4	—	—	341				
Dec.	20	16 Tau	5.4	I	149	19 27.7	−1.1	+1.6	73	18 30.5	0.0	+2.4	34
Dec.	20	17 Tau	3.8	I	149	19 33.4	−2.3	−0.1	117	18 18.7	−0.5	+1.7	74
Dec.	20	19 Tau	4.4	I	149	19 53.1	−0.8	+2.3	45	No Occ.	...	...	...
Dec.	20	20 Tau	4.0	I	149	20 05.2	−1.5	+1.2	79	19 01.7	−0.3	+2.4	40
Dec.	20	21 Tau	5.8	I	149	20 21.6	−0.9	+2.4	42	No Occ.	...	...	...
Dec.	20	22 Tau	6.5	I	149	20 22.5	−1.1	+2.1	51	19 35.9	—	—	359
Dec.	25	κ Gem	3.7	I	199	Sun	...	...	...	7 15.3	+0.2	−2.1	139
Dec.	25	35B. Cnc	6.4	E	205	20 27.5	−0.2	+0.9	285	Low	...	...	...
Dec.	28	α Leo	1.3	I	232	9 28.1	0.0	−1.8	117	8 12.1	−0.3	−2.0	125
Dec.	28	α Leo	1.3	E	232	10 25.9	+0.2	−1.6	302	9 16.0	−0.1	−1.9	298

LUNAR OCCULTATIONS VISIBLE AT EDMONTON AND VANCOUVER, 1969

Date		Star	Mag.	I or E	Elong. of Moon	Edmonton				Vancouver			
						M.S.T.	*a*	*b*	*P*	P.S.T.	*a*	*b*	*P*
						h m	m	m	°	h m	m	m	°
Jan.	9	89 Leo	5.8	E	243	1 30.2	—	—	237	No Occ.	...	...	...
Jan.	11	−08° 3495	6.4	E	268	2 28.9	−0.7	+1.6	271	Low	...	...	...
Jan.	12	214G. Vir	6.4	E	282	5 38.2	−1.2	+0.5	281	4 18.8	−1.8	+1.9	253

Date	Star	Mag.	I or E	Elong. of Moon	Edmonton				Vancouver			
					M.S.T.	*a*	*b*	*P*	P.S.T.	*a*	*b*	*P*
				°	h m	m	m	°	h m	m	m	°
Jan. 20	70 Aqr	6.2	I	38	18 44.7	−1.6	−3.4	118	17 39.0	−2.2	−3.1	117
Jan. 24	+14° 326	6.8	I	88	No Occ.	...	...	...	21 19.7	−0.8	+2.2	12
Jan. 25	114B. Ari	7.3	I	99	20 47.0	−1.3	0.0	63	19 31.5	−1.6	+0.3	69
Jan. 26	9 Tau	6.7	I	110	20 54.7	−1.5	−0.5	87	19 39.0	−1.9	−0.3	94
Jan. 27	23 Tau	4.2	I	112	2 28.6	−0.6	+0.4	23	1 24.3	−0.4	−0.4	50
Jan. 27	+23° 537	6.8	I	112	2 40.0	+0.1	−1.1	74	1 46.5	+0.1	−1.5	93
Jan. 27	+23° 538	7.1	I	113	2 48.2	−0.1	−0.5	47	1 50.3	0.0	−0.9	67
Jan. 27	η Tau	3.0	I	113	No Occ.	...	...	...	2 21.7	—	—	357
Jan. 28	354B. Tau	6.3	I	132	20 56.0	−1.2	+3.2	32	19 32.3	−1.0	+2.8	41
Jan. 29	107B. (Aur)	6.5	I	135	4 33.9	+0.3	−1.4	96	3 43.9	+0.3	−1.7	113
Feb. 5	80 Leo	6.4	E	214	4 02.9	−1.5	−0.8	279	2 42.7	—	—	249
Feb. 24	+27° 716	6.8	I	101	18 48.5	−1.7	−0.4	104	Sun	...	...	...
Feb. 24	38B. (Aur)	6.5	I	102	21 52.8	−1.5	+0.6	45	20 35.4	−1.6	+0.2	66
Feb. 24/25	+27° 734	6.9	I	103	0 34.1	−0.3	−1.4	82	23 37.2	−0.3	−1.8	102
Feb. 26	+27° 1270	7.0	I	125	23 42.2	−0.3	−3.1	146	No Occ.	...	...	...
Feb. 27	+27° 1296	7.2	I	126	2 05.5	−0.1	−1.8	105	1 12.0	−0.1	−2.1	123
Feb. 27	76 Gem	5.4	I	135	20 06.5	−1.4	+0.1	108	18 51.9	−1.4	0.0	120
Mar. 7	550B. Vir	5.8	E	221	3 28.5	−1.1	−0.6	304	2 16.7	−1.5	0.0	285
Mar. 21	47 Ari	5.8	I	48	19 49.1	−0.7	0.0	43	Sun	...	...	...
Mar. 22	105B. Tau	6.6	I	59	19 24.5	−1.1	−0.2	59	Sun	...	...	...
Mar. 22	28 Tau	5.2	I	59	19 46.8	−0.7	−2.7	116	18 54.6	—	—	144
Mar. 22	η Tau	3.0	E	59	19 52.1	−1.0	−0.1	233	18 37.5	−1.4	+1.5	213
Mar. 22	+23° 561	6.6	I	59	19 53.3	−0.9	−0.5	61	Sun	...	...	...
Mar. 22	27 Tau	3.8	I	59	20 00.0	—	—	149	No Occ.	...	...	...
Mar. 22	+24° 599	6.4	I	61	Low	...	...	...	22 59.5	+0.7	−2.4	132
Mar. 25	228B. Aur	6.8	I	92	19 46.3	−1.6	+0.2	70	Sun	...	...	...
Mar. 25	49 Aur	5.0	I	93	22 33.6	−1.0	−0.9	69	21 27.3	−1.1	−1.3	91
Mar. 26	+26° 1564	7.2	I	104	22 25.8	−0.2	−2.9	149	No Occ.	...	...	...
Mar. 29	+19° 2187	6.9	I	128	1 57.0	0.0	−2.1	141	1 06.7	+0.1	−2.4	158
Apr. 20	354B. Tau	6.3	I	51	No Occ.	...	...		20 57.2	−1.0	+0.1	37
Apr. 22	47 Gem	5.6	I	74	23 01.1	−0.2	−1.4	81	22 04.5	−0.3	−1.7	99
Apr. 26	162B. Leo	6.6	I	118	21 57.7	−0.8	−1.7	139	20 59.1	−0.4	−2.4	163
May 22	+18° 2182*m*	7.1	I	76	No Occ.	...	...	...	21 20.9	−1.4	−1.0	66
May 26	162B. Vir	6.6	I	123	21 33.1	−2.1	−0.1	74	Sun	...	...	...
May 27	−10° 3644	6.7	I	136	22 13.4	−0.6	−1.2	156	21 15.1	0.0	−1.9	181
May 27	−10° 3652	7.1	I	136	23 25.7	−1.0	−1.2	119	22 19.3	−1.1	−1.1	133
May 29	43H. Vir	5.6	I	150	Low	...	...	...	0 05.6	−0.8	−1.6	159
June 21	83 Leo	6.2	I	80	22 20.1	−0.3	−1.9	120	21 23.3	−0.5	−1.9	130
June 21	τ Leo	5.2	I	80	23 00.6	−0.2	−1.9	116	22 05.1	−0.4	−1.9	123
June 25	17G. Lib	6.4	I	130	Low	...	...	...	23 08.2	−1.1	−1.3	124
July 3	45 Aqr	6.1	E	230	Sun	...	...	...	2 07.9	−2.1	+0.3	294
July 21	−12° 3830	6.9	I	85	Low	...	...	...	20 58.5	−1.0	−1.5	94
Aug. 6	17 Tau	3.8	I	284	1 43.5	+0.4	+2.1	30	0 40.4	+0.6	+2.1	23
Aug. 6	23 Tau	4.2	I	284	2 10.3	−0.3	+1.5	97	1 02.2	0.0	+1.4	91
Aug. 6	17 Tau	3.8	E	284	2 31.5	−0.6	+1.4	286	1 20.8	−0.4	+1.1	294
Aug. 6	η Tau	3.0	I	284	2 45.4	−0.4	+1.6	86	1 35.8	−0.1	+1.6	79
Aug. 6	23 Tau	4.2	E	284	3 04.7	0.0	+2.3	218	1 56.5	+0.1	+2.1	225
Aug. 6	η Tau	3.0	E	284	3 47.4	−0.3	+2.2	228	2 36.3	−0.1	+2.0	234
Aug. 6	28 Tau	5.2	E	285	Sun	...	...	...	3 15.3	+0.2	+2.9	201
Aug. 8	107B. (Aur)	6.5	I	307					3 02.2	—	—	163
Aug. 8	107B. (Aur)	6.5	E	307					3 08.5	—	—	175
Sept. 20	ω Sgr	4.8	I	115	20 55.5	−1.5	−0.3	103	19 39.4	−1.6	+0.1	98
Sept. 21	−22° 5572	7.5	I	129	21 10.3	−1.7	0.0	106	19 52.0	−1.6	+0.5	99
Sept. 28	47 Ari	5.8	E	219	21 36.7	0.0	+1.7	257	20 30.1	+0.1	+1.5	262
Sept. 29	27 Tau	3.8	E	231	20 40.6	+0.5	+1.6	222	Low	...	...	...
Sept. 29	28 Tau	5.2	E	231	20 46.9	+0.4	+1.5	240	Low	...	...	...
Oct. 2	406B. Tau	5.6	E	256	2 31.3	−0.1	+3.6	212	1 17.4	+0.1	+3.3	213
Oct. 21	φ Aqr	4.4	I	136	17 54.6	—	—	345	Sun	...	...	...
Oct. 27	17 Tau	3.8	I	203	4 41.9	−0.9	−3.2	126	No Occ.	...	...	...
Oct. 27	19 Tau	4.4	I	203	4 56.2	−1.1	+0.3	45	3 42.6	−1.4	+0.1	62
Oct. 27	20 Tau	4.0	I	203	5 07.2	−0.9	−0.9	75	3 59.9	−1.3	−1.2	91
Oct. 27	17 Tau	3.8	E	203	5 29.3	−1.1	+1.1	209	No Occ.	...	...	...
Oct. 27	16 Tau	5.4	E	203	5 44.0	−0.8	−1.0	255	4 36.0	−1.2	0.0	237
Oct. 27	19 Tau	4.4	E	203	5 55.5	−0.5	−2.3	292	4 55.8	−0.9	−1.4	272
Oct. 27	20 Tau	4.0	E	203	6 16.4	−0.5	−1.3	263	5 12.2	−1.0	−0.4	244
Oct. 27	χ Tau	5.5	E	211	20 06.5	+0.7	+2.1	202	Low	...	...	...
Oct. 28	+26° 731*m*	6.5	E	214	5 02.5	−1.1	−1.7	285	3 53.7	−1.5	−0.6	269
Nov. 16	42 Aqr	5.6	I	94	21 25.9	−0.2	+0.6	18	20 19.9	−0.2	+1.1	12
Nov. 17	282B. Aqr	7.0	I	108	23 32.1	−0.2	+0.2	30	22 26.7	−0.4	+0.4	32
Nov. 19	60 Psc	6.2	I	134	23 38.4	−1.2	−0.8	81	22 26.8	−1.6	−0.4	82
Nov. 19/20	62 Psc	6.1	I	134	1 02.6	—	—	346	23 46.9	−0.2	+2.7	1
Nov. 25	136 Tau	4.5	I	203	18 56.0	+0.2	+1.2	96	Low	...	...	...

Date		Star	Mag.	I or E	Elong. of Moon	Edmonton M.S.T.	Edmonton a	Edmonton b	Edmonton P	Vancouver P.S.T.	Vancouver a	Vancouver b	Vancouver P
						h m	m	m	°	h m	m	m	°
Nov.	25	136 Tau	4.5	E	203	19 50.1	+0.2	+1.7	250	18 46.9	+0.4	+1.4	254
Dec.	2	59 Leo	5.1	E	272	3 33.1	−1.0	+1.3	275	2 15.1	−0.8	+2.8	252
Dec.	3	9B. Vir	6.2	E	284	6 30.2	−0.9	−0.7	319	5 20.5	−1.2	0.0	296
Dec.	6	43H. Vir	5.6	E	322	Sun	...	...	...	6 26.8	−0.4	0.0	317
Dec.	13	156B. Cap	7.0	I	62	17 09.9	−0.6	+0.8	25	Sun	...	...	...
Dec.	13	−15° 6103	7.2	I	63	18 28.5	−1.2	−0.5	81	17 15.9	−1.4	0.0	73
Dec.	16	87G. Psc	6.9	I	101	17 20.7	−1.6	+0.9	97	Sun	...	...	...
Dec.	16	116B. Psc	6.6	I	102	20 21.8	−0.9	+0.8	40	19 07.8	−0.9	+1.3	35
Dec.	17	235B. Psc	6.9	I	116	22 45.0	−0.7	+1.1	25	21 31.8	−0.9	+1.3	31
Dec.	17	241B. Psc	6.9	I	116	23 23.9	−1.1	−2.5	107	22 21.6	—	—	120
Dec.	19	+19° 432	7.0	I	138	18 11.3	−0.5	+1.9	61	16 59.3	−0.2	+1.9	54
Dec.	19	ε Ari	4.6	I	139	21 35.4	−0.7	+2.5	24	20 17.4	−0.6	+2.7	23
Dec.	20	17 Tau	3.8	I	149	17 22.0	0.0	+2.0	51	16 15.6	+0.3	+1.9	45
Dec.	20	16 Tau	5.4	I	149	17 48.5	—	—	356	No Occ.	...	...	...
Dec.	20	23 Tau	4.2	I	149	18 03.5	−1.1	+0.8	121	16 50.3	−0.6	+1.1	112
Dec.	20	20 Tau	4.0	I	149	18 14.3	+0.8	+3.4	4	17 14.8	—	—	344
Dec.	20	η Tau	3.0	I	150	18 36.3	−1.0	+1.1	107	17 22.6	−0.6	+1.3	99
Dec.	20	η Tau	3.0	E	150	19 28.6	−0.1	+2.7	208	18 16.9	0.0	+2.5	215
Dec.	25	κ Gem	3.7	I	199	6 10.5	+0.2	−2.7	155	5 36.9	—	—	200
Dec.	25	κ Gem	3.7	E	199	6 56.4	−0.6	−1.2	248	5 40.4	—	—	206
Dec.	28	α Leo	1.3	I	232	6 57.0	−0.5	−2.1	140	6 01.5	−0.3	−2.5	160
Dec.	28	α Leo	1.3	E	232	8 03.4	−0.6	−1.8	287	7 01.7	−1.2	−1.5	271

PLANETARY APPULSES AND OCCULTATIONS

No planetary appulses or occultations are observable from Canada this year.

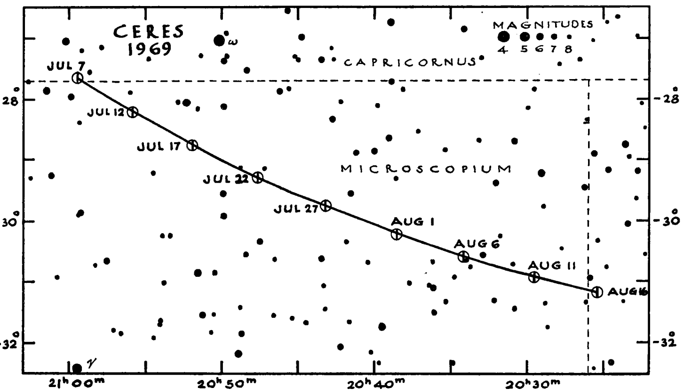
ASTEROIDS—EPHEMERIDES AT OPPOSITION, 1969

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 brighest 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 three brightest asteroids are given when the asteroids are near opposition, along with a map for Ceres. Right ascensions and declinations are for 0h E.T. and equinox of 1950.0.

ASTEROIDS—EPHEMERIDES AT OPPOSITION, 1969

Pallas (No. 2) Opp. June 25 in Her Mag. 9.1			Juno (No. 3) Opp. June 30 in Scu Mag. 9.6			Ceres (No. 1) Opp. July 27 in Mic Mag. 7.2		
	h m	° ′		h m	° ′		h m	° ′
June 5	18 25.6	+23 53	June 10	18 49.6	−4 56	July 7	20 55.9	−27 53
10	18 21.8	+24 10	15	18 45.9	−4 50	12	20 52.4	−28 26
15	18 17.7	+24 19	20	18 41.9	−4 49	17	20 48.4	−28 59
20	18 13.5	+24 22	25	18 37.6	−4 50	22	20 44.1	−29 30
25	18 09.3	+24 17	30	18 33.3	−4 55	27	20 39.5	−29 59
30	18 05.1	+24 04	July 5	18 28.8	−5 04	Aug. 1	20 34.9	−30 26
July 5	18 01.0	+23 44	10	18 24.5	−5 16	6	20 30.3	−30 48
10	17 57.1	+23 18	15	18 20.3	−5 31	11	20 25.9	−31 08
15	17 53.6	+22 45	20	18 16.3	−5 49	16	20 21.7	−31 23



METEORS, FIREBALLS AND METEORITES

By Peter M. Millman

Meteroids are small solid particles moving in orbits about the sun. On entering the earth's atmosphere at velocities ranging from 15 to 75 kilometres per second they become luminous and appear as meteors or fireballs and, if large enough to avoid complete vaporization, 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 1969. Although in 1969 we have passed the current Leonid peak, the shower may still be above average strength. This year the full moon will handicap observations of several major showers.

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 7, 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.

Meteor Showers for 1969

Shower	Shower Maximum			Radiant				Single Observer Hourly Rate	Velocity	Normal Duration to ¼ strength of Max.
	Date	E.S.T.	Moon	Position at Max. R.A.	Dec.	Daily Motion R.A.	Dec.			
				h m	°	m	°		km/sec	days
Quadrantids	Jan. 3	23h	F.M.	15 28	+50	—	—	40	41	1.1
Lyrids	Apr. 22	00	F.Q.	18 16	+34	+4.4	0.0	15	48	2
η Aquarids	May 5	02	F.M.	22 24	00	+3.6	+0.4	20	64	3
δ Aquarids	July 29	—	F.M.	22 36	−17	+3.4	+0.17	20	40	—
Perseids	Aug. 12	02	N.M.	03 04	+58	+5.4	+0.12	50	60	4.6
Orionids	Oct. 21	04	F.Q.	06 20	+15	+4.9	+0.13	25	66	2
Taurids	Nov. 5	—	L.Q.	03 32	+14	+2.7	+0.13	15	28	—
Leonids	Nov. 17	01	F.Q.	10 08	+22	+2.8	−0.42	25	72	—
Geminids	Dec. 13	19	F.Q.	07 32	+32	+4.2	−0.07	50	35	2.6
Ursids	Dec. 22	13	F.M.	14 28	+76	—	—	15	34	2

TABLE OF PRECESSION FOR 50 YEARS

R.A.	Prec. in Dec.	Precession in Right Ascension														Prec. in Dec.	R.A
		δ = +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.

Star	Right Ascension	Declination	Visual Magnitude	Colour Index	Spectral Classification		Parallax	Absolute Magnitude	Distance light-years	Proper Motion	Radial Velocity		
Star	R.A. 1970	Dec.	V	$B-V$	Type		π	M_V	D	μ	R		
	h m	° ′					″		l.y.	″	km./sec.		
SUN			-26.73	+0.63	G2	V		+4.84					***Sun***
α And	00 06.8	+28 55	2.06	−0.08	B9p		0.024	−0.1	90	0.209	*−11.7*	Manganese star	*Alpheratz*
β Cas	07.6	+58 59	2.26	+0.34	F2	IV	0.072	+1.6	45	0.555	+11.8		*Caph*
γ Peg	11.7	+15 01	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	24.2	−77 25	2.78	+0.62	*G1*	*IV*	0.153	+3.7	21	2.255	+22.8		γ Peg = *Algenib*
α Phe	24.8	−42 28	2.39	+1.08	*K0*	*III*	0.035	+0.1	93	0.442	*+74.6*		*Ankaa*
δ And *A*	37.7	+30 42	3.25:	+1.26	K3	III	0.024	−0.2	160	0.161	−07.3	*B* 12^m 28″	
α Cas	38.8	+56 22	2.16	+1.18	K0	II–III	0.009	−1.1	150	0.058	−03.8	Var.?	*Schedar*
β Cet	42.1	−18 09	2.02	+1.03	K1	III	0.057	+0.8	57	0.234	+13.1		*Diphda*
η Cas *A*	47.3	+57 39	3.47	+0.56	G0	V	0.182	+4.8	18	1.221	+09.4	*B* 7.26^m 9″	
γ Cas *A*	54.9	+60 33	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 04.7	−46 53	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	07.1	−10 20	3.47	+1.16	K3	III	0.032	+1.0	102	0.250	+11.5		
β And	08.0	+35 28	2.02	+1.57	M0	III	0.043	+0.2	76	0.211	+00.3		*Mirach*
δ Cas	23.8	+60 05	2.67	+0.13	A5	V	0.029	+2.1	43	0.301	+06.7	Ecl.? *R* 0.08:^{m} 759^d	
γ Phe	27.1	−43 28	3.44	+1.56	*K5*	*Ib*	−.003	−4.6	1300	0.209	*+25.7*		
α Eri	36.6	−57 23	0.51	−0.16	*B5*	*IV:*	0.023	−2.3	118	0.098	+19		***Achernar***
τ Cet	42.7	−16 06	3.50	+0.72	G8	Vp	0.275	+5.70	12	1.921	−16.2		

Star	R.A. 1970	Dec.	*V*	*B−V*	Type	π	M_V	D	μ	R	
	m	° ′				″		l.y.	″	km./sec.	
α Tri	01 51.4	+29 26	3.45	+0.46	F6 IV	0.050	+2.0	65	0.230	*−12.6*	
ε Cas	52.2	+63 31	3.33	−0.15	B3 IV: p	0.007	−2.7	520	0.038	−08.1	
β Ari	53.0	+20 40	2.68	+0.14	A5 V	0.063	+1.7	52	0.147	*−01.9*	
α Hyi	57.8	−61 43	2.84	+0.28	*F0 V*		+2.9	31	0.265	+07	
γ And *A*	02 02.1	+42 11	2.14:	+1.16:	K3 II	0.005	−2.4	260	0.068	−11.7	*B* 5.4$^{\mathrm{m}}$ *C* 6.2$^{\mathrm{m}}$ *A–BC* 10″ *B–C* 0.7″ γ And = *Almach*
α UMi *A*	02.5	+89 08	1.99v	+0.60v	F8 Ib	0.003	−4.6	680	0.046	*−17.4*	Cep., *R* 0.11$^{\mathrm{m}}$ 4.0$^{\mathrm{d}}$, *B* 8.9$^{\mathrm{m}}$ 18″ *Polaris*
α Ari	05.5	+23 19	2.00	+1.15	K2 III	0.043	+0.2	76	0.241	−14.3	*Hamal*
β Tri	07.8	+34 51	3.00	+0.13	A5 III	0.012	−0.1	140	0.156	*+09.9*	
ο Cet *A*	17.8	−03 07	2.0v		(gM6e)	0.013	−0.5	103	0.232	+63.8	LP, *R* 2.0–10.1, 332$^{\mathrm{d}}$, *B* 10$^{\mathrm{m}}$ 1″ *Mira*
γ Cet *AB*	41.7	+03 07	3.48	+0.11	A2 V	0.048	+2.0	68	0.203	−05.1	*A* 3.57$^{\mathrm{m}}$ *B* 6.23$^{\mathrm{m}}$ 3″
θ Eri *AB*	57.1	−40 25	2.92	+0.13	*A3 V*	0.028	+1.7	65	0.061	*+11.9*	*A* 3.25$^{\mathrm{m}}$ *B* 4.36$^{\mathrm{m}}$ 8″ *Acamar*
α Cet	03 00.7	+03 58	2.54	+1.63	M2 III	0.003	−0.5	130	0.075	−25.9	*Menkar*
γ Per	02.6	+53 23	2.91:	+0.72:	G8III: +A3:	0.011	+0.3	113	0.004	*+02.5*	
ρ Per	03.1	+38 43	3.5v		M4 II–III	0.008	−1.0	260	0.172	+28.2	Irr. *R* 3.2–3.8
β Per	06.0	+40 50	2.06v	−0.07	B8 V	0.031	−0.5	105	0.006	*+04.0*	Ecl. *R* 2.06–3.28, 2.87$^{\mathrm{d}}$ *Algol*
α Per	22.2	+49 45	1.80	+0.48	F5 Ib	0.029	−4.4	570	0.035	−02.4	*Mirfak*
δ Per	40.8	+47 42	3.03	−0.14	B5 III	0.007	−3.3	590	0.046	−09	
η Tau	45.7	+24 01	2.86	−0.09	B7 III	0.005	−3.2	541	0.050	+10.1	in Pleiades *Alcyone*
γ Hyi	47.7	−74 20	3.30	+1.61	*M2 II–III*	−.001	−1.5	300	0.125	+16.0	
ζ Per *A*	52.1	+31 48	2.83	+0.13	B1 Ib	0.007	−6.1	1000	0.015	+20.6	*B* 9.36$^{\mathrm{m}}$ 13″
ε Per *A*	55.8	+39 55	2.88	−0.17	B0.5 V	−.001	−3.7	680	0.036	−01	*B* 7.99$^{\mathrm{m}}$ 9″
γ Eri	56.6	−13 36	3.01	+1.58	M0 III	0.003	−0.5	160	0.126	+61.7	
α Ret *A*	04 14.0	−62 33	3.33	+0.91	*G6 II*	0.008	−2.1	390	0.064	+35.6	*B* 12$^{\mathrm{m}}$ 49″
ε Tau	26.9	+19 07	3.54	+1.02	K0 III	0.018	+0.1	160	0.118	+38.6	
θ² Tau	26.9	+15 48	3.42	+0.17	A7 III	0.025	+0.2	140	0.108	*+39.5*	
α Dor	33.3	−55 06	3.28	−0.08	*A0 IIIp*	0.011	−1.2	260	0.051	+25.6	Silicon star
α Tau *A*	34.2	+16 27	0.86v	+1.52	K5 III	0.048	−0.7	68	0.202	+54.1	Irr.? *R*0.78–0.93, *B*13$^{\mathrm{m}}$31″ **Aldebaran**
π³ Ori	48.2	+06 55	3.17	+0.45	F6 V	0.125	+3.65	26	0.468	+24.3	
ι Aur	55.0	+33 07	2.64:	+1.49	K3 II	0.015	−2.4	330	0.021	+17.5	

α UMi, *Polaris:* R.A. 2h 02.5m; Dec. +89° 07′ (1969).

Star	R.A. 1970	Dec.	V	$B-V$	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
ϵ Aur	04 59.8	+43 47	3.0v	+0.50:	F0 Iap	0.004	−7.1	3400	0.008	*−02.5*	Ecl. *R* 0.81^m 9886^d	
ϵ Lep	05 04.2	−22 25	3.21	+1.46	*K5 III*	0.006	−0.4	170	0.077	+01.0		
η Aur	04.4	+41 12	3.17	−0.18	B3 V	0.013	−2.1	370	0.077	+07.4		
β Eri	06.4	−05 07	2.79	+0.13	A3 III	0.042	+0.9	78	0.122	−08		
μ Lep	11.6	−16 14	3.29	−0.09	*B9 IIIp*	0.018	−2.1	390	0.049	+27.7	Manganese star	
β Ori *A*	13.1	−08 14	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	14.5	+45 58	0.05	+0.80	G8III: +F	0.073	−0.6	45	0.435	*+30.2*		***Capella***
η Ori *AB*	23.0	−02 25	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	23.5	+06 19	1.64	−0.23	B2 III	0.026	−4.2	470	0.015	+18.2		*Bellatrix*
β Tau	24.4	+28 35	1.65	−0.13	B7 III	0.018	−3.2	300	0.178	+08.0		*Elnath*
β Lep *A*	27.0	−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*	30.5	−00 19	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	31.4	−17 51	2.58	+0.22	F0 Ib	0.002	−4.6	900	0.006	+24.7		
λ Ori *AB*	33.5	+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*	34.0	−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	34.7	−01 13	1.70	−0.19	B0 Ia	−.007	−6.8	1600	0.000	+26.1		*Alnilam*
ζ Tau	35.9	+21 08	3.07:	−0.13:	B2 III: p	−.002	−4.2	940	0.023	*+24.3*	Shell star	
α Col *A*	38.6	−34 05	2.64	−0.11	*B8 Ve*	−.005	−0.6	140	0.026	+35	*B* 12^m 12″	
ζ Ori *AB*	39.2	−01 57	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	46.3	−09 41	2.06	−0.17	B0.5 Ia	0.009	−6.9	2100	0.004	+20.6		
β Col	49.9	−35 47	3.12	+1.16	(gK1)	0.023	+0.0	140	0.402	+89.4		
α Ori	53.5	+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	57.3	+44 57	1.86	+0.06	A2 V	0.037	−0.3	88	0.051	*−18.2*		
θ Aur *AB*	57.7	+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 13.1	+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	19.2	−30 03	3.04	−0.18	B2.5 V	−.003	−2.4	390	0.004	*+32.2*		
μ Gem	21.1	+22 32	2.92v	+1.63	M3 III	0.021	−0.6	160	0.129	+54.8	*R* 0.14^m	
β CMa	21.4	−17 56	1.96	−0.24	B1 II–III	0.014	−4.8	750	0.004	*+33.7*	β CMa type variable	
α Car	23.3	−52 41	−0.72	+0.16	F0 Ib–II	0.018	−3.1	98	0.025	+20.5		***Canopus***
γ Gem	36.0	+16 26	1.93	0.00	A0 IV	0.031	−0.6	105	0.066	*−12.5*		

Star	R.A. 1970	Dec.	V	$B-V$	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
ν Pup	06 36.8	−43 10	3.19	−0.10	*B7 III*		−3.2	620	0.010	+28.2		
ϵ Gem	42.1	+25 10	3.00	+1.39	G8 Ib	0.009	−4.6	1080	0.016	+09.9		
ξ Gem	43.6	+12 56	3.38	+0.43	F5 IV	0.051	+1.9	64	0.224	+25.3		
α CMa *A*	43.8	−16 41	−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	48.1	−61 54	3.27	+0.21	*A5 V*		+2.1	57	0.272	+20.6		
τ Pup	49.2	−50 35	2.97	+1.17	*K0 III*		+0.1	124	0.079	*+36.4*		
ϵ CMa *A*	57.4	−28 56	1.48:	−0.18:	B2 II		−5.1	680	0.004	+27.4	*B* 7.5^m 8″	***Adhara***
o^2 CMa	07 01.8	−23 47	3.02	−0.09	B3 Ia		−7.1	3400	0.000	+48.4		
δ CMa	07.2	−26 21	1.85	+0.65	F8 Ia	−.018	−7.1	2100	0.005	+34.3		
L_2 Pup	12.6	−44 36			(gM5e)	0.016	−3.1	650	0.342	+53.0	LP, *R* 3.4–6.2, 141^d	
π Pup	16.1	−37 03	2.81	+1.56:	(gK4)	0.023	−0.3	140	0.008	+15.8		
η CMa	22.9	−29 14	2.46	−0.08	B5 Ia		−7.1	2700	0.008	+41.1		
β CMi	25.7	+08 21	2.91	−0.09	B7 V	0.020	−1.1	210	0.065	+22		
σ Pup *A*	28.3	−43 14	3.28	+1.49	(gK5)	0.013	−0.4	180	0.195	*+88.1*	*B* 9.4^m 22″	
α Gem *A*	32.7	+31 57	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*	32.7	+31 57	2.95	+0.07:	A5m	0.072	+2.3	45	0.199	−01.2		
α CMi *A*	37.7	+05 18	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	43.5	+28 06	1.16	+1.02	K0 III	0.093	+1.0	35	0.625	+03.3		***Pollux***
ξ Pup	48.0	−24 48	3.34	+1.23	G3 Ib	−.003	−4.6	1240	0.005	*+02.7*		
χ Car	56.0	−52 54	3.48	−0.18	(B3)		−2.1	430	0.039	+19.1		
ζ Pup	08 02.5	−39 55	2.23	−0.26	O5f		−7.1	2400	0.033	−24		
ρ Pup	06.3	−24 13	2.80v	+0.42	F6 IIp	0.031	+0.3:	105:	0.098	+46.6	Var. *R* 2.72–2.87	
γ Vel *A*	08.6	−47 16	1.88	−0.26	*WC7*		−4.1	520	0.011	+35	*B* 4.31^m 41″	
ϵ Car	21.9	−59 24	1.97	+1.14:	(K0 + B)		−3.1:	340	0.030	+11.5		*Avior*
o UMa *A*	27.8	+60 49	3.37	+0.83	G5 III	0.004	+0.1	150	0.171	+19.8	*B* 15^m 7″	
δ Vel *AB*	43.9	−54 36	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*	45.2	+06 32	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	53.8	+06 04	3.11	+1.00	K0 II–III	0.029	−1.1	220	0.101	+22.8		
ι UMa *A*	57.2	+48 09	3.12	+0.19	A7 V	0.066	+2.2	49	0.505	+12.2	*BC* 10.8^m 7″	

Star	R.A. 1970	Dec.	V	$B-V$	Type		π	M_V	D	μ	R		
	h m	° ′					″		l.y.	″	km./sec.		
λ Vel	09 06.9	−43 19	2.24	+1.64:	*K5*	*Ib*	0.015	−4.6	750	0.026	+18.4		*Suhail*
a Car	10.2	−58 50	3.43	−0.17	*B3*	*IV*		−2.9	590	0.028	+*23.3*		
β Car	12.9	−69 36	1.67	+0.01	*A0*	*III*	0.038	−0.4	86	0.183	−05		*Miaplacidus*
ι Car	16.3	−59 08	2.25	+0.17	*F0*	*Ib*		−4.6	750	0.019	+13.3		
α Lyn	19.3	+34 32	3.17	+1.54	M0	III	0.021	−0.5	180	0.217	+37.6		
κ Vel	21.2	−54 53	2.45	−0.15	*B2*	*IV*	0.007	−3.4	470	0.012	+*21.9*		
α Hya	26.1	−08 32	1.98	+1.44	K4	III	0.017	−0.3	94	0.034	−04.3		*Alphard*
N Vel	30.3	−56 54	3.19	+1.56	(gK5)		0.015	−0.4	170	0.036	−13.9		
θ UMa *A*	30.8	+51 49	3.19	+0.46	F6	IV	0.052	+1.8	63	1.094	+15.4	*B* 14^m 5″	
ε Leo	44.1	+23 54	2.99	+0.81	G0	II	0.002	−2.1	340	0.048	+05.0		
l Car	44.4	−62 23	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*	46.4	−64 56	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 06.8	+12 07	1.36	−0.11	B7	V	0.039	−0.7	84	0.248	+03.5	*B* 8.1^m 177″	***Regulus***
ω Car	13.0	−69 53	3.33	−0.08	*B8.5*	*IV*		−1.5	300	0.029	+04		
ζ Leo	15.1	+23 34	3.46	+0.30	F0	III	0.009	+0.5	130	0.023	−15.0		
λ UMa	15.3	+43 04	3.45	+0.03	A2	IV	−.010	+0.1	150	0.170	+18.3		
q Car	16.1	−61 11	3.41v	+1.55	*K5*	*Ib*	0.018	−4.6	1300	0.023	+08.6	Var. *R* 3.38–3.44	
γ Leo *AB*	18.3	+20 00	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	20.5	+41 39	3.05	+1.55	M0	III	0.031	+0.5	105	0.086	−*20.5*		
p Car	31.0	−61 32	3.30v	−0.11	*B5*	*IVpe*		−2.3	430	0.021	+26.0	Var. *R* 3.22–3.39	
θ Car	41.9	−64 14	2.74	−0.22	*B0*	*Vp*		−4.0	710	0.018	+24		
μ Vel *AB*	45.5	−49 16	2.67	+0.89	*G5*	*III*		+0.1	108	0.085	+06.9	*A* 2.7^m *B* 7.2^m 2″	
ν Hya	48.1	−16 02	3.12	+1.25	K3	III	0.022	−0.2	150	0.221	−01.0		
β UMa	11 00.0	+56 33	2.37	−0.03	A1	V	0.042	+0.5	78	0.087	−12.0		*Merak*
α UMa *AB*	01.9	+61 55	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	08.0	+44 39	3.00	+1.14	K1	III		+0.0	130	0.072	−03.8		
δ Leo	12.5	+20 41	2.57	+0.13	A4	V	0.040	+0.6	82	0.201	−20.6		
θ Leo	12.7	+15 36	3.34	0.00	A2	V	0.019	+1.1	90	0.104	+07.8		
λ Cen	34.4	−62 51	3.15	−0.05	*B9*	*III*		−2.1	370	0.039	+07.9		
β Leo	47.5	+14 44	2.14	+0.09	A3	V	0.076	+1.5	43	0.511	−00.1		*Denebola*

Star	R.A. 1970	Dec.	V	$B-V$	Type		π	M_V	D	μ	R		
	h m	° ′					″		l.y.	″	km./sec.		
γ UMa	11 52.2	+53 52	2.44	0.00	A0	V	0.020	+0.2	90	0.094	−12.9		*Phecda*
δ Cen	12 06.8	−50 33	2.59v	−0.15:	*B2*	*Ve*		−2.7	370	0.042	+09	Var. *R* 2.56–2.62	
ε Crv	08.6	−22 27	3.04	+1.33	K3	III		−0.2	140	0.069	+04.9		
δ Cru	13.5	−58 35	2.81v	−0.23	*B2*	*IV*		−3.4	570	0.041	+26.4	Var. *R* 2.78–2.84	
δ UMa	13.9	+57 12	3.30	+0.07	A3	V	0.052	+1.9	63	0.106	−12.9		*Megrez*
γ Crv	14.3	−17 22	2.59	−0.10	B8	III		−3.1	450	0.163	−04.2		*Gienah*
α Cru *A*	24.9	−62 56	1.39	−0.25	*B1*	*IV*		−3.9	370	0.042	*−11.2*	} 5″, *C* 4.90ᵐ 89″	***Acrux***
α Cru *B*	24.9	−62 56	1.86	−0.25	(B3)			−3.4	370	0.042	*−00.6*		
δ Crv *A*	28.3	−16 21	2.97	−0.04	B9.5	V: n	0.018	+0.1	124	0.255	+09	*B* 8.26ᵐ 24″	
γ Cru	29.5	−56 57	1.69	+1.55	*M3*	*II*		−2.5	220	0.274	+21.3		*Gacrux*
β Crv	32.8	−23 14	2.66	+0.89	G5	III	0.027	+0.1	108	0.059	−07.7		
α Mus	35.4	−68 58	2.70v	−0.20	*B3*	*IV*		−2.9	430	0.037	+18	Var. *R* 2.66–2.73	
γ Cen *AB*	39.9	−48 48	2.17	+0.00	*A0*	*IV:*	0.006	−0.5	160	0.197	−07.5	*A* 2.9ᵐ *B* 2.9ᵐ 1″	
γ Vir *AB*	40.1	−01 17	2.76	+0.34	F0	V	0.101	+3.5	32	0.567	−19.7	*A* 3.50ᵐ *B* 3.52ᵐ 4″	
β Mus *AB*	44.4	−67 57	3.06	−0.17:	*B3*	*V*		−2.1	470	0.041	+42	*A* 3.7ᵐ *B* 4.0ᵐ 1″	
β Cru	46.0	−59 32	1.28	−0.25	*B0*	*III*		−4.6	490	0.049	+20.0		***Beta Crucis***
ε UMa	52.7	+56 07	1.79	−0.03	A0pv		0.008	+0.2	68	0.113	−09.3	Chromium-europium star	*Alioth*
α CVn *A*	54.6	+38 29	2.90	−0.10	B9.5pv		0.023	+0.1	118	0.238	*−03.3*	Silicon-europium star. *B* 5.61ᵐ 20″	
ε Vir	13 00.7	+11 08	2.86	+0.93	G9	II–III	0.036	+0.6	90	0.274	−14.0		
γ Hya	17.3	−23 01	2.98	+0.92	G8	III	0.021	+0.3	113	0.086	−05.4		
ι Cen	18.9	−36 33	2.76	+0.05	*A2*	*V*	0.046	+1.1	71	0.351	+00.1		
ζ UMa *A*	22.7	+55 05	2.26	+0.02	A2	V	0.037	+0.1	88	0.127	*−09.0*	*B* 3.94ᵐ 14″ (Alcor, 224″)	*Mizar*
α Vir	23.6	−11 00	0.91v	−0.24	B1	V	0.021	−3.3	220	0.054	*+01.0*	Ecl. *R* 0.91–1.01, 4.0ᵈ	***Spica***
ζ Vir	33.2	−00 27	3.40	+0.10	A3	Vn	0.035	+1.1	93	0.287	−13.2		
ε Cen	38.0	−53 19	2.33	−0.23	*B1*	*IV*		−3.9	570	0.033	+05.6		
η UMa	46.4	+49 28	1.87	−0.20	B3	V	0.004	−2.1	210	0.123	−10.9		*Alkaid*
ν Cen	47.7	−41 32	3.42	−0.22	B2	IV		−3.4	750	0.037	*+09.0*		
μ Cen	47.8	−42 20	3.12v	−0.13:	B2	V: pne		−2.7	470	0.032	+12.6	Var. *R* 3.08–3.17	
η Boo	53.3	+18 33	2.69	+0.59	G0	IV	0.102	+2.7	32	0.370	*−00.1*		
ζ Cen	53.7	−47 09	2.56	−0.23:	*B2*	*IV*		−3.4	520	0.076	*+06.5*		

Star	R.A. 1970	Dec.	*V*	*B–V*	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
β Cen *AB*	14 01.7	−60 13	0.63	−0.23:	*B1 II:*	0.016	−5.2	490	0.035	*−12*	*A* 0.7ᵐ *B* 3.9ᵐ 1″	***Hadar***
π Hya	04.7	−26 32	3.25	+1.13	K2 III	0.039	+1.2	84	0.156	+27.2		
θ Cen	04.9	−36 14	2.04	+1.03	K0 III–IV	0.059	+0.9	55	0.738	+01.3		*Menkent*
α Boo	14.3	+19 20	−0.06	+1.23	K2 IIIp	0.090	−0.3	36	2.284	−05.2		***Arcturus***
γ Boo	30.9	+38 27	3.05	+0.19	A7 III	0.016	+0.2	118	0.186	−35.5		
η Cen	33.6	−42 01	2.39v	−0.21	B1.5 V:ne		−3.0	390	0.049	−00.2	Var. *R* 2.33–2.45	
α Cen *A*	37.6	−60 43	0.01	+0.68	*G2 V*	.751	+4.39	4.3	3.676	−24.6	18″	***Rigil Kentaurus***
α Cen *B*	37.6	−60 43	1.40:	+0.73:	(dK1)		+5.8	4.3		−20.7		
α Lup	40.0	−47 16	2.32	−0.22	B1 V		−3.3	430	0.033	+07.3		
α Cir *AB*	40.1	−64 50	3.18	+0.25	*F0 Vp*	0.049	+1.6	66	0.308	+07.4	Strontium star. *A* 3.19ᵐ *B* 8.61ᵐ 16″	
ε Boo *AB*	43.7	+27 12	2.37	+0.96	K1: III: + A	0.013	+0.0	103	0.051	−16.5	*A* 2.47ᵐ *B* 5.04ᵐ 3″	
α Lib *A*	49.2	−15 52	2.76	+0.15	A3m	0.049	+1.2	66	0.130	−10	*B* 5.15ᵐ 231″	*Zubenelgenubi*
β UMi	50.8	+74 16	2.04	+1.47	K4 III	0.031	−0.5	105	0.033	+16.9		*Kochab*
β Lup	56.6	−43 01	2.69	−0.23	B2 IV		−3.4	540	0.066	−00.3		
κ Cen	57.1	−41 59	3.15	−0.21	B2 V		−2.7	470	0.033	+09.1		
β Boo	15 00.8	+40 30	3.48	+0.95	G8 III	0.022	+0.3	140	0.059	−19.9		
σ Lib	02.3	−25 10	3.31	+1.65	M4 III	0.056	+2.0:	58:	0.089	−04.3		
ζ Lup *A*	10.1	−51 59	3.42	+0.90:	*K0 III*	0.036	+1.2	90	0.135	−09.7	*B* 7.8ᵐ 71″	
δ Boo *A*	14.3	+33 26	3.47	+0.95	G8 III	0.028	+0.3	140	0.148	−12.2	*B* 7.84ᵐ 105″	
β Lib	15.4	−09 16	2.61	−0.11	B8 V	−.012	−0.6	140	0.101	−35.2		
γ TrA	16.1	−68 34	2.94	−0.01	*A0 Vp*	0.005	+0.2	113	0.067	00	Europium star	
δ Lup	19.4	−40 32	3.24	−0.23	B2 IV		−3.4	680	0.032	+02		
γ UMi	20.8	+71 56	3.08	+0.06	A3 II-III	−.005	−1.5	270	0.026	*−03.9*		
ι Dra	24.3	+59 04	3.28	+1.18	K2 III	0.032	+0.8	102	0.012	−11.0		
γ Lup *AB*	33.1	−41 04	2.80	−0.22	B2 Vn		−2.7	570	0.037	+06	*A* 3.5ᵐ *B* 3.7ᵐ 1″	
α CrB	33.4	+26 49	2.23v	−0.02	A0 V	0.043	+0.4	76	0.154	*+01.7*	Ecl. *R* 0.11ᵐ, 17.4ᵈ	*Alphecca*
α Ser	42.8	+06 31	2.65	+1.17	K2 III	0.046	+1.0	71	0.139	+02.9		
β TrA	52.5	−63 20	2.87	+0.28:	*F2 V*	0.078	+2.3	42	0.448	−00.3		
π Sco	57.0	−26 02	2.92	−0.19	B1 V	0.005	−3.3	570	0.034	*−03*		
η Lup *AB*	58.1	−38 19	3.45	−0.23	B2 V		−2.7	570	0.042	+07	*A* 3.47ᵐ *B* 7.70ᵐ 15″	
δ Sco	58.6	−22 32	2.34	−0.13	B0 V		−4.0	590	0.032	−14		

Star	R.A. 1970	Dec.	V	$B-V$	Type	π	M_V	D	μ	R	
	h m	° ′				″		l.y.	″	km./sec.	
β Sco *AB*	16 03.7	−19 43	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	12.8	−03 36	2.72	+1.59	M1 III	0.029	−0.5	140	0.156	−19.9	
ε Oph	16.7	−04 38	3.22	+0.97	G9 III	0.036	+1.0	90	0.089	−10.3	
σ Sco *A*	19.4	−25 31	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*	23.6	+61 34	2.71	+0.92	G8 III	0.043	+0.9	76	0.062	−14.3	*B* 8.7^m 6″
α Sco *A*	27.6	−26 22	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	28.9	+21 33	2.78	+0.92	G8 III	0.017	+0.3	103	0.105	*−25.5*	
τ Sco	34.0	−28 09	2.85	−0.25	B0 V		−4.0	750	0.030	−00.7	
ζ Oph	35.5	−10 30	2.57	+0.00	O9.5 V	−.007	−4.3	520	0.022	−19	
ζ Her *AB*	40.2	+31 39	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	41.9	+38 59	3.46	+0.92	G7 III–IV	0.053	+2.1	62	0.097	+08.3	
α TrA	45.5	−68 59	1.93	+1.43	*K2 III*	0.024	−0.1	82	0.044	−03.6	*Atria*
ε Sco	48.2	−34 15	2.28	+1.16	*K2 III–IV*	0.049	+0.7	66	0.664	−02.5	
μ¹ Sco	49.8	−38 00	2.99v	−0.20	B1.5 V		−3.0	520	0.033	*−25*	Ecl. *R* 2.99–3.09, 1.4^d
ζ Ara	56.1	−55 56	3.16	+1.61	(gK5)	0.036	+0.9	90	0.042	−06.0	
κ Oph	56.3	+09 26	3.18	+1.15	K2 III	0.026	−0.1	150	0.293	−55.6	
ζ Dra	17 08.7	+65 45	3.20	−0.12	B6 III	0.017	−3.2	620	0.026	−14.1	
η Oph *AB*	08.7	−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*
η Sco	10.0	−43 12	3.33	+0.38	*F2 III*	0.063	+2.3	52	0.293	−28.4	
α Her *AB*	13.3	+14 25	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	13.8	+24 52	3.14	+0.09	A3 IV	0.034	+0.8	96	0.164	−41	
π Her	14.0	+36 50	3.13	+1.43	K3 II	0.020	−2.4	410	0.029	−25.7	
θ Oph	20.2	−24 58	3.29	−0.22	B2 IV		−3.4	710	0.025	−03.6	
β Ara	22.8	−55 30	2.90	+1.45:	*K3 Ib*	0.026	−4.6	1030	0.035	−00.4	
γ Ara *A*	22.9	−56 21	3.32	−0.16	*B1 V*		−3.3	680	0.017	−04	*B* 10^m 18″
υ Sco	28.7	−37 16	2.71	−0.22	*B2 IV*		−3.4	540	0.039	+*18*	
α Ara	29.5	−49 52	2.95	−0.18:	B2.5 V		−2.4	390	0.083	*−02*	
β Dra *A*	29.7	+52 20	2.77	+0.96	G2 II	0.009	−2.1	310	0.019	−20.0	*B* 11.49^m 4″
λ Sco	31.6	−37 05	1.60	−0.24	B1 V		−3.3	310	0.031	00	*Shaula*
α Oph	33.5	+12 35	2.09	+0.16	A5 III	0.056	+0.8	58	0.260	+12.7	*Rasalhague*
θ Sco	35.2	−42 59	1.86	+0.39	*F0 Ib*	0.020	−4.6	650	0.012	+01.4	

Star	R.A. 1970	Dec.	V	$B-V$	Type	π	M_V	D	μ	R	
	h m	° ′				″		l.y.	″	km./sec.	
κ Sco	17 40.4	−39 01	2.39	−0.21	*B2 IV*		−3.4	470	0.031	−10	
β Oph	42.0	+04 35	2.77	+1.16	K2 III	0.023	−0.1	124	0.160	−12.0	
μ Her *A*	45.3	+27 45	3.42	+0.75	G5 IV	0.108	+3.6	30	0.811	−15.6	*BC* 9.78^m 33″
ι^1 Sco	45.5	−40 06	2.99	+0.49	F2 Ia	0.013	−7.1	3400	0.004	*−27.6*	
G Sco	47.7	−37 02	3.21	+1.18	(gK1)	0.032	+0.7	102	0.064	+24.7	
γ Dra	55.9	+51 29	2.21	+1.52	K5 III	0.017	−0.4	108	0.026	−27.6	*Eltanin*
ν Oph	57.4	−09 47	3.32	+1.00	G9 III	0.015	+0.2	140	0.118	+12.4	
γ Sgr	18 03.9	−30 26	2.97	+1.00	*K0 III*	0.018	+0.1	124	0.200	*+22.1*	
η Sgr *A*	15.6	−36 47	3.17	+1.55	*M3 II*	0.038	+1.1:	86:	0.218	+00.5	*B* 10^m 4″
δ Sgr	19.1	−29 50	2.71	+1.39	*K2 III*	0.039	+0.7	84	0.050	−20.0	
η Ser	19.7	−02 54	3.23	+0.94	K0 III–IV	0.054	+1.9	60	0.894	+08.9	
ϵ Sgr	22.2	−34 24	1.81	−0.02	*B9 IV*	0.015	−1.1	124	0.135	−11	*Kaus Australis*
λ Sgr	26.1	−25 27	2.80	+1.05	*K2 III*	0.046	+1.1	71	0.194	−43.3	
α Lyr	35.9	+38 45	0.04	0.00	A0 V	0.123	+0.5	26.5	0.345	−13.9	***Vega***
ϕ Sgr	43.8	−27 02	3.20	−0.11	*B8 III*		−3.1	590	0.052	+21.5	
β Lyr *A*	49.0	+33 20	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	53.4	−26 20	2.12	−0.21	B2 V		−2.7	300	0.059	−11	*Nunki*
ξ^2 Sgr	55.9	−21 08	3.51	+1.18:	(gK1)	0.006	+0.0	160	0.035	−19.9	
γ Lyr	57.8	+32 39	3.25	−0.05	B9 III	0.011	−2.1	370	0.007	−21.5	
ζ Sgr *AB*	19 00.7	−29 55	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*	04.0	+13 49	2.99	+0.01	A0 V:nn	0.036	+0.8	90	0.101	−26.3	*B* 12^m 5″
λ Aql	04.7	−04 56	3.44	−0.07	B9: V:n	0.025	−0.1	160	0.092	−14	
τ Sgr	05.1	−27 43	3.30	+1.18	(gK1)	0.038	+1.2	86	0.261	*+45.4*	
π Sgr *ABC*	08.0	−21 04	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	12.5	+67 37	3.06	+1.00	G9 III	0.028	+0.2	124	0.130	+24.8	
δ Aql	24.0	+03 03	3.38	+0.31	F0 IV	0.062	+2.3	53	0.267	*−29.9*	
β Cyg *A*	29.5	+27 54	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*	44.0	+45 04	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	44.8	+10 32	2.67	+1.48	K3 II	0.006	−2.4	340	0.012	−02.1	
α Aql	49.3	+08 47	0.77	+0.22	A7 IV, V	0.198	+2.2	16.5	0.658	−26.3	***Altair***

Star	R.A. 1970	Dec.	V	$B-V$	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
θ Aql	20 09.8	−00 54	3.31	−0.07	B9.5 III	0.008	−1.7	330	0.034	*−27.3*		
β Cap *A*	19.3	−14 53	3.06	+0.76	comp.	0.005	+0.1	130	0.039	−18.9	Type gK0: + late B; *B* 5.97ᵐ 205″	
γ Cyg	21.1	+40 09	2.22	+0.66	F8 Ib	−.006	−4.6	750	0.001	−07.5		
α Pav	23.3	−56 50	1.95	−0.20	*B3 IV*		−2.9	310	0.087	*+02.0*		*Peacock*
α Ind	35.5	−47 23	3.11	+1.00	*K0 III*	0.039	+1.1	84	0.082	−01.1		
α Cyg	40.4	+45 10	1.26	+0.09	A2 Ia	−.013	−7.1	1600	0.003	−04.6		***Deneb***
β Pav	42.3	−66 19	3.45	+0.16	*A5 III*	0.026	−0.1	160	0.046	+09.8		
η Cep	44.7	+61 43	3.41	+0.92	K0 IV	0.071	+2.7	46	0.825	−87.3		
ε Cyg	45.0	+33 51	2.46	+1.03	K0 III	0.044	+0.7	74	0.481	*−10.3*		
ζ Cyg	21 11.7	+30 06	3.25:		G8 II	0.021	−2.2	390	0.056	+17.4		
α Cep	17.9	+62 28	2.44	+0.24	A7 IV, V	0.063	+1.4	52	0.156	−10		*Alderamin*
β Cep	28.3	+70 25	3.15v	−0.22v	B2 III	0.005	−4.2	980	0.014	−08.2	β CMa *R* 3.14–3.16, 0.19ᵈ	
β Aqr	30.0	−05 43	2.86	+0.82	G0 Ib	0.000	−4.6	1030	0.017	+06.5		
ε Peg *A*	42.7	+09 45	2.31	+1.55	K2 Ib	−.005	−4.6	780	0.025	+04.7	*B* 11ᵐ 82″	*Enif*
δ Cap	45.4	−16 16	2.92v	+0.29	A6m	0.065	+2.0	50	0.392	*−06.3*	Var. *R* 2.88–2.95	
γ Gru	52.1	−37 30	3.03	−0.10	*B8 III:*	0.008	−3.1	540	0.102	−02.1		
α Aqr	22 04.2	−00 28	2.96	+0.96	G2 Ib	0.003	−4.6	1080	0.016	+07.5		
α Gru	06.3	−47 07	1.76	−0.14	*B5 V*	0.051	+0.3:	64:	0.194	+11.8		*Al Na'ir*
ζ Cep	09.8	+58 03	3.31	+1.55	K1 Ib	0.019	−4.6	1240	0.015	*−18.4*		
α Tuc	16.4	−60 24	2.87	+1.40	*K3 III–IV*	0.019	+1.5	62	0.079	*+42.2*		
δ Cep *A*	28.1	+58 16	3.96v	+0.66v	F5–G2 Ib	0.005	−4.0	1300	0.012	*−16.8*	Cep. *R* 3.51–4.42, 5.4ᵈ, *B* 6.19ᵐ 41″	
ζ Peg	40.0	+10 41	3.40:	−0.08:	B8 V	−.004	−0.6	210	0.077	+07		
β Gru	40.9	−47 02	2.17v	+1.59	*M3 II*	0.003	−2.5	280	0.134	+01.6	Var. *R* 2.11–2.23	
η Peg	41.6	+30 04	2.95	+0.85	G8 II: + F?	−.002	−2.2	360	0.027	*+04.3*		
δ Aqr	53.1	−15 59	3.28	+0.08	A3 V	0.039	+1.2	84	0.047	+18.0		
α PsA	56.0	−29 47	1.19	+0.10	A3 V	0.144	+2.0	22.6	0.367	+06.5		***Fomalhaut***
β Peg	23 02.3	+27 55	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	03.3	+15 02	2.50	−0.03	B9.5 III	0.030	−0.1	109	0.071	−03.5		*Markab*
γ Cep	38.1	+77 27	3.20	+1.02	K1 IV	0.064	+2.2	51	0.168	−42.4		

DOUBLE AND MULTIPLE STARS

By Charles E. Worley

Many stars can be separated into two or more components by use of a telescope. The larger the aperture of the telescope, the closer the stars which can be separated under good seeing conditions. With telescopes of moderate size and average optical quality, and for stars which are not unduly faint or of large magnitude difference, the minimum angular separation is given by 4.6/D, where D is the diameter of the telescope's objective in inches.

The following lists contain some interesting examples of double stars. The first list presents pairs whose orbital motions are very slow. Consequently, their angular separations remain relatively fixed and these pairs are suitable for testing the performance of small telescopes. In the second list are pairs of more general interest, including a number of binaries of short period for which the position angles and separations are changing rapidly.

In both lists the columns give, successively; the star designation in two forms; its right ascension and declination for 1970; the combined visual magnitude of the pair and the individual magnitudes; the apparent separation and position angle for 1969. 0; and the period, if known.

Many of the components are themselves very close visual or spectroscopic binaries. (Other double stars appear in the table of The Brightest Stars, p. 74, and of The Nearest Stars, p. 86.)

Star	A.D.S.	R.A. 1970 h	m	Dec. 1970 °	′	Magnitudes comb.	A	B	Sep. 1969.0 ″	P.A. 1969.0 °	P (app.) years
λ Cas	434	00	30.1	+54	22	4.9	5.5	5.8	0.6	178	640
α Psc	1615	02	00.4	+02	37	4.0	4.3	5.3	1.9	290	720
33 Ori	4123	05	29.6	+03	16	5.7	6.0	7.3	1.8	27	—
OΣ 156	5447	06	45.7	+18	14	6.1	6.8	7.0	0.5	252	1,100
Σ 1338	7307	09	19.2	+38	19	5.8	6.5	6.7	1.1	237	390
35 Com	8695	12	51.8	+21	25	5.1*	5.2	7.4	0.9	156	670
Σ 2054	10052	16	23.3	+61	45	5.6	6.0	7.2	1.1	355	—
ϵ^1 Lyr†	11635	18	43.4	+39	39	5.1	5.4	6.5	2.7	358	1,200
ϵ^2 Lyr†	11635	18	43.4	+39	36	4.4	5.1	5.3	2.2	96	600
π Aql	12962	19	47.4	+11	44	5.6	6.0	6.8	1.4	110	—
σ Cas	17140	23	57.4	+55	36	5.2	5.4	7.5	3.0	326	—
η Cas	671	00	47.3	+57	39	3.5*	3.5	7.2	11.4	301	480
Σ 186	1538	01	54.3	+01	42	6.0	6.8	6.8	1.4	50	155
γ And AB	1630	02	02.0	+42	12	2.1*	2.1	5.4	9.8	64	—
α C Ma	5423	06	43.9	−16	41	−1.4	−1.4	8.5	11.0	70	50
α Gem	6175	07	32.7	+31	58	1.6	2.0	2.8	1.8	135	420
ζ Cnc AB	6650	08	10.4	+17	44	5.0	5.6	5.9	1.1	334	60
ζ Cnc AC	6650	08	10.4	+17	44	5.2	5.4	7.3	5.6	82	1150
+42° 1956	KUI	08	58.7	+41	53	3.9	4.1	6.2	0.5	227	22
γ Leo	7724	10	18.3	+20	00	1.8	2.1	3.4	4.4	122	620
ξ U Ma AB	8119	11	16.7	+31	42	3.8	4.3	4.8	2.9	126	60
γ Vir	8630	12	40.1	−01	18	2.8	3.5	3.5	4.6	304	170
Σ 1785	9031	13	47.7	+27	08	7.0	7.6	8.0	3.2	151	155
ζ Boo	9343	14	39.8	+13	52	3.8	4.5	4.5	1.1	307	125
ξ Boo	9413	14	50.0	+19	14	4.5	4.7	6.8	7.1	340	150
ζ Her	10157	16	40.2	+31	39	2.8	2.9	5.5	0.7	248	34
α Her AB	10418	17	13.3	+14	26	3.1*	3.2	5.4	4.6	108	—
Σ 2173	10598	17	28.8	−01	02	5.3	6.0	6.1	0.7	145	46
70 Oph	11046	18	03.9	+02	32	4.0	4.2	6.0	2.6	61	88
β 648	11871	18	56.0	+32	52	5.2	5.4	7.5	0.5	177	61
4 Aqr	14360	20	49.9	−05	45	6.0	6.4	7.2	1.0	7	160
τ Cyg	14787	21	13.6	+37	54	3.7	3.8	6.4	0.9	190	50
Σ 3050	17149	23	57.9	+33	34	5.8	6.5	6.7	1.6	295	320

*There is a marked colour difference between the components.
†The separation of the two pairs of ε Lyr is 208″.

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.

*Deceased

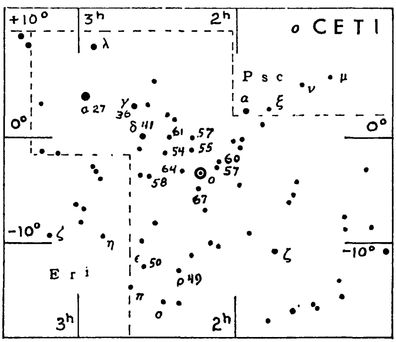
Star	1970 α		1970 δ		Sp.	π	D	μ	W	m	L
	h	m	°	′		″	l.y.	″	km./sec.		
Sun					G2					−26.9	1.0
α Cen A	14	37	−60	43	G2	0.751	4.3	3.68	34	0.0	1.0
B					K1					1.4	0.28
C	14	27	−62	33	M5*e*					11	0.000052
Barnard's *	17	56	+ 4	36	M5	.545	6.0	10.30	141	9.5	0.00040
Wolf 359	10	55	+ 7	13	M6*e*	.421	7.7	4.84	56	13.5	0.000017
Luy. 726–8A	1	37	−18	07	M6*e*	.410	7.9	3.35	48	12.5	0.00004
B					M6*e*					13.0	0.00003
Lal. 21185*	11	02	+36	10	M2	.398	8.2	4.78	103	7.5	0.0048
Sirius A	6	44	−16	41	A1	.375	8.7	1.32	18	−1.4	23.
B					*wd*					7.1	0.008
Ross 154	18	48	−23	51	M5*e*	.351	9.3	0.67	10	10.6	0.00036
Ross 248	23	40	+44	01	M6*e*	.316	10.3	1.58	84	12.2	0.00010
ε Eri	3	32	− 9	34	K2	.303	10.8	0.97	21	3.8	0.25
Ross 128	11	46	+ 1	01	M5	.298	10.9	1.40	26	11.1	0.00030
61 Cyg* A	21	06	+38	36	K6	.293	11.1	5.22	106	5.6	0.052
B					M0					6.3	0.028
Luy. 789–6	22	37	−15	31	M6	.292	11.2	3.27	80	12.2	0.00012
Procyon A	7	38	+ 5	18	F5	.288	11.3	1.25	20	0.4	5.8
B					*wd*					10.8	0.00044
ε Ind	22	02	−56	55	K5	.285	11.4	4.67	87	4.7	0.12
Σ 2398 A	18	42	+59	35	M4	.280	11.6	2.29	38	8.9	0.0028
B					M4					9.7	0.0013
Groom. 34 A	0	17	+43	51	M2*e*	.278	11.7	2.91	51	8.1	0.0058
B					M4*e*					10.9	0.00044
τ Ceti	1	43	−16	06	G8	.275	11.8	1.92	37	3.5	0.36
Lac. 9352	23	04	−36	02	M2	.273	11.9	6.87	118	7.2	0.013
BD +5°1668	7	26	+ 5	28	M4	.263	12.4	3.73	72	10.1	0.0010
Lacaille 8760	21	15	−39	00	M1	.255	12.8	3.46	68	6.6	0.028
Kapteyn's	5	11	−45	00	M0	.251	13.0	8.79	275	9.2	0.0025
Kruger 60 A	22	27	+57	33	M4	.249	13.1	0.87	29	9.9	0.0013
B					M5*e*					11.4	0.00033
Ross 614 A	6	28	− 2	48	M5*e*	.248	13.1	0.97	30	10.9	0.00052
B					?					14.8	0.000016
BD−12°4523	16	29	−12	35	M5	.244	13.4	1.24	27	10.0	0.0013
van Maanen's	0	47	+ 5	16	*wd*F	.236	13.8	2.98	64	12.3	0.00016
Wolf 424 A	12	32	+ 9	12	M6*e*	.223	14.6	1.87	40	12.6	0.00014
B					M6*e*					12.6	0.00014
Groom. 1618	10	09	+49	36	K5	.222	14.7	1.45	41	6.8	0.030
CD−37°15492	0	03	−37	30	M3	.219	14.9	6.09	134	8.6	0.0058
CD−46°11540	17	27	−46	53	M4	.213	15.3	1.15		9.7	0.0023
BD+20°2465*	10	18	+20	01	M4*e*	.211	15.4	0.49	15	9.5	0.0028
CD−44°11909	17	36	−44	17	M5	.209	15.6	1.14		11.2	0.00058
CD−49°13515	21	31	−49	08	M3	.209	15.6	0.78		9	0.0044
AOe 17415–6	17	37	+68	22	M3	.206	15.8	1.31	34	9.1	0.0040
Ross 780	22	51	−14	25	M5	.206	15.8	1.12	28	10.2	0.0014
Lal. 25372	13	44	+15	04	M2	.205	15.9	2.30	55	8.6	0.0063
CC 658	11	44	−64	39	*wd*	.203	16.0	2.69		11	0.0008
o² Eri A	4	14	− 7	42	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	04	+ 2	31	K1	.199	16.4	1.13	28	4.2	0.40
B					K5					5.9	0.083
Altair	19	49	+ 8	47	A7	.198	16.5	0.66	31	0.8	8.3
BD+43°4305	22	46	+44	11	M5*e*	.198	16.5	0.84	20	10.2	0.0016
AC 79°3888	11	45	+78	50	M4	0.196	16.6	0.87	121	11.0	0.0008

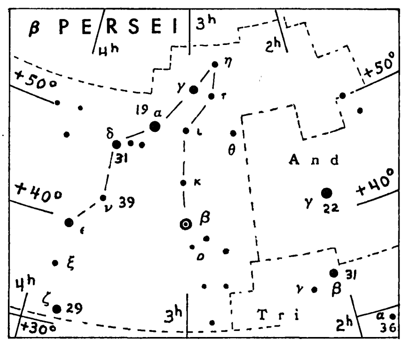
*Star has an unseen component.

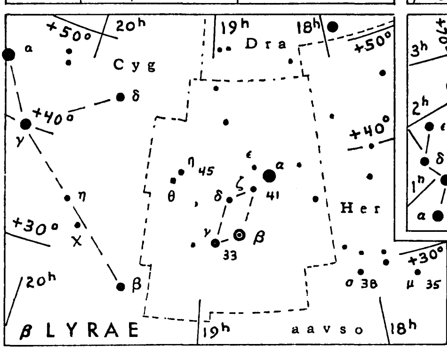
VARIABLE STARS

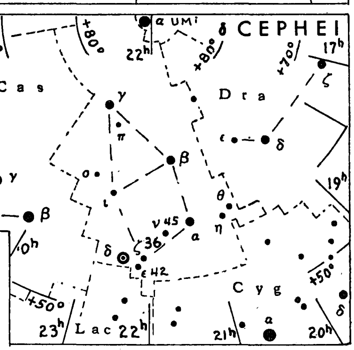
Maps of the fields of four bright variable stars are given below. In each case the magnitudes of several suitable comparison stars are given. Note that the decimal points are omitted: a star 36 is of mag. 3.6. Use two comparison stars, one brighter and one fainter than the variable, and estimate the 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*, 1968, International Supplement.









LONG-PERIOD VARIABLE STARS

Variable	Max. m	Per d	Epoch 1969
001755 T Cas	7.8	445	Dec. 13
001838 R And	7.0	409	. . .
021143 W And	7.4	397	May 13
0214*03* o Cet	3.4	332	Aug. 30
0228*13* U Cet	7.5	235	Feb. 10
023133 R Tri	6.2	266	June 28
043065 T Cam	8.0	374	Nov. 18
0455*14* R Lep	6.8	432	May 30
050953 R Aur	7.7	459	June 7
054920 U Ori	6.3	372	July 9
0617*02* V Mon	7.0	335	Jan. 8
065355 R Lyn	7.9	379	Jan. 14
070122aR Gem	7.1	370	May 8
070310 R CMi	8.0	338	Apr. 8
072708 S CMi	7.5	332	Nov. 19
081112 R Cnc	6.8	362	Jan. 13
081617 V Cnc	7.9	272	Sept. 26
084803 S Hya	7.8	257	June 26
0850*08* T Hya	7.8	288	Aug. 16
093934 R LMi	7.1	372	Jan. 13
094211 R Leo	5.8	313	Aug. 4
103769 R UMa	7.5	302	Sept. 21
1214*18* R Crv	7.5	317	Jan. 18
122001 SS Vir	6.8	355	Feb. 12
123160 T UMa	7.7	257	Jan. 17
123307 R Vir	6.9	146	Mar. 13
123961 S UMa	7.8	226	Apr. 25
131546 V CVn	6.8	192	Feb. 11
1327*06* S Vir	7.0	378	Nov. 10
134440 R CVn	7.7	328	Mar. 18
142584 R Cam	7.9	270	Aug. 26
142539 V Boo	7.9	258	June 25
143227 R Boo	7.2	223	Feb. 26
151731 S CrB	7.3	361	Mar. 5
154639 V CrB	7.5	358	Dec. 9
154615 R Ser	6.9	357	Nov. 28
160625 RU Her	8.0	484	Dec. 12
162119 U Her	7.5	406	Sept. 28
1621*12* V Oph	7.5	298	Apr. 13
163266 R Dra	7.6	245	Apr. 28
164715 S Her	7.6	307	Aug. 20
1702*15* R Oph	7.9	302	Apr. 30
171723 RS Her	7.9	219	Apr. 19
180531 T Her	8.0	165	May 25
181136 W Lyr	7.9	196	Apr. 18
183308 X Oph	6.8	334	Sept. 14
190108 R Aql	6.1	300	May 8
1910*17* T Sgr	8.0	392	Nov. 26
1910*19* R Sgr	7.3	269	June 25
193449 R Cyg	7.5	426	Apr. 13
194048 RT Cyg	7.3	190	June 26
194632 χ Cyg	5.2	407	Sept. 5
200938 RS Cyg	7.2	418	. . .
201647 U Cyg	7.2	465	July 28
2044*05* T Aqr	7.7	202	Apr. 6
210868 T Cep	6.0	390	Feb. 27
213753 RU Cyg	8.0	234	Mar. 3
230110 R Peg	7.8	378	Dec. 10
230759 V Cas	7.9	228	July 21
231508 S Peg	8.0	319	Oct. 13
2338*15* R Aqr	6.5	387	Aug. 31
235350 R Cas	7.0	431	. . .
2357*15* W Cet	7.6	351	Apr. 18

OTHER TYPES OF VARIABLE STARS

Variable	Max. m	Min. m	Type	Sp. Cl.	Period d	Epoch 1969 E.S.T.
005381 U Cep	6.7	9.8	Ecl	B8+gG2	2.49302	Jan. 1.88*
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. 3.44*
035512 λ Tau	3.5	4.0	Ecl	B3	3.952952	Jan. 2.37*
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. 21.72
065820 ζ Gem	4.4	5.2	δ Cep	F7–G3	10.15172	Jan. 1.57
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.	
1842*05* R Sct	6.3	8.6	RVTau	G0e-K0p	144	
184633 β Lyr	3.4	4.3	Ecl	B8	12.931163	Jan. 11.54*
192242 RR Lyr	6.9	8.0	RR Lyr	A2–F1	0.5668223	Jan. 1.31
194700 η Aql	4.1	5.2	δ Cep	F6–G4	7.176641	Jan. 3.68
222557 δ Cep	4.1	5.2	δ Cep	F5–G2	5.366341	Jan. 1.95

*Minimum

STAR CLUSTERS

By T. Schmidt-Kaler

The star clusters for this list have been selected to include those most conspicuous. Two types of clusters can be recognized: open (or galactic), and globular. Globulars appear as highly symmetrical agglomerations of very large numbers of stars, distributed throughout the galactic halo but concentrated toward the centre of the Galaxy. Their colour-magnitude diagrams are typical for the old stellar population II. Open clusters appear usually as irregular aggregates of stars, sometimes barely distinguished from random fluctuations of the general field. They are concentrated to the galactic disk, with colour-magnitude diagrams typical for the stellar population I of the normal stars of the solar neighbourhood.

The first table includes all well-defined open clusters with diameters greater than 40′ or integrated magnitudes brighter than 5.0, as well as the richest clusters and some of special interest. *NGC* indicates the serial number of the cluster in Dreyer's *New General Catalogue of Clusters and Nebulae*, *M*, its number in Messier's catalogue, α and δ denote right ascension and declination, *P*, the apparent integrated photographic magnitude according to Collinder (1931), *D*, the apparent diameter in minutes of arc according to Trumpler (1930) when possible, in one case from Collinder; *m*, the photographic magnitude of the fifth-brightest star according to Shapley (1933) when possible or from new data, in italics; *r*, the distance of the cluster in kpcs (1 kpc = 3263 light-years), as a mean from the values given by Johnson, Hoag *et al.* (1961), and by Becker (1963/64), in a few cases from other sources, with values in italics from Trumpler; *Sp*, the earliest spectral type of cluster stars as determined from three-colour photometry, or from spectral types in italics. The spectral type also indicates the age of the cluster, expressed in millions of years, thus: O5 = 0.5; b0 = 5; b5 = 50; a0 = 300; a5 = 1000; f0 = 3000; f5 = 10,000.

The second table includes all globular clusters with a total apparent photographic magnitude brighter than 7.6. The first three columns are as in the first table, followed by *B*, the total photographic magnitude; *D*, the apparent diameter in minutes of arc containing 90 per cent of the stars, and in italics, total diameters from miscellaneous sources; *Sp*, the integrated spectral type; *m*, the mean blue magnitude of the 25 brightest stars (excluding the five brightest); *N*, the number of known variables; *r*, the distance in kpcs (absolute magnitude of RR Lyrae variables taken as $M_B = +0.5$); *V*, the radial velocity in km/sec. The data are taken from a compilation by Arp (1965); in case no data were available there, various other sources have been used, especially H. S. Hogg's Bibliography (1963).

Open Clusters

NGC	α 1970 h m	δ ° ′	P	D	m	r	Sp	Remarks
188	00 41.0	+85 11	9.3	14	14.6	1.55	f5	oldest known
752	01 56.0	+37 32	6.6	45	9.6	0.38	f0	
869	02 16.9	+57 01	4.3	30	9.5	2.26	b0	h Per
884	02 20.3	+56 59	4.4	30	9.5	2.41	b0	χ Per, M supergiants
Perseus	03 20	+48 30	2.3	240	5	0.17	b3	moving cl., α Per
Pleiades	03 45.3	+24 02	1.6	120	4.2	0.125	b7	M45, best known
Hyades	04 18	+15 34	0.8	400	*1.5*	0.040	a2	moving cl. in Tau*
1912	05 26.6	+35 49	7.0	18	9.7	1.37	b8	
1976/80	05 33.9	−05 24	2.5	50	*5.5*	0.42	O5	Trapezium, very young
2099	05 50.4	+32 32	6.2	24	9.7	1.28	b8	M37
2168	06 07.0	+24 21	5.6	29	9.0	0.87	b5	M35
2232	06 25.0	−04 44	4.1	*20*	*7*	*0.49*	*b3*	
2244	06 30.8	+04 53	5.2	27	*8.0*	1.65	O5	Rosette, very young
2264	06 39.4	+09 55	4.1	30	*8.0*	0.73	O9	S Mon
2287	06 45.8	−20 42	5.0	32	*8.8*	0.67	b3	M41
2362	07 17.6	−24 53	3.8	7	9.4	1.53	b0	τ CMa

***Basic for distance determination.**

NGC	α 1970	δ	P	D	m	r	Sp	Remarks
	h m	° ′						
2422	07 34.2	−14 26	4.3	30	9.8	0.48	b4	
2437	07 40.4	−14 45	6.6	27	10.8	1.66	b3	M46
2451	07 44.3	−37 54	3.7	37	6	*0.29*	*b3*	
2516	07 57.8	−60 49	3.3	50	10.1	0.37	b9	
2546	08 11.4	−37 33	5.0	45	7	0.74	b0	
2632	08 38.4	+20 06	3.9	90	7.5	0.158	a5	Praesepe, M44
IC2391	08 39.4	−52 57	2.6	45	3.5	0.15	b3	
IC2395	08 40.1	−48 05	4.6	20	10.1	0.90	b2	
2682	08 48.8	+11 56	7.4	18	10.8	0.83	f2	M67, old cl.
3114	10 01.7	−59 58	4.5	37	7	0.85	b6	
IC2602	10 42.2	−64 14	1.6	65	6	0.16	b2	θ Car
Tr 16	10 44.0	−59 33	6.7	10	10	1.95	b0	η Car and nebula
3532	11 05.1	−58 30	3.4	55	8.1	0.42	b9	
3766	11 34.7	−61 27	4.4	12	8.1	1.63	b0	
Coma	12 23.6	+26 16	2.9	300	5.5	0.08	a2	Very sparse cl.
4755	12 51.8	−60 10	5.2	12	7	1.34	b3	κ Cru, "jewel box"
6067	16 10.9	−54 08	6.5	16	10.9	2.10	b3	G and K supergiants
6231	16 51.9	−41 45	8.5	16	7.5	1.82	O5	O supergiants, WR-stars
Tr24	16 54.9	−40 37	8.5	60	*7.3*	*0.68*	*O5*	
6405	17 38.1	−32 12	4.6	26	8.3	0.57	b4	M6
IC4665	17 45.2	+05 44	5.4	50	7	0.33	b5	
6475	17 51.9	−34 48	3.3	50	7.4	0.24	b8	M7
6494	17 55.1	−19 01	5.9	27	10.2	0.55	b9	M23
6523	18 01.3	−24 23	5.2	45	*7*	1.47	O5	M8, Lagoon neb. and very young cl. NGC6530
6611	18 17.2	−13 48	6.6	8	10.6	1.90	O5	M16, nebula
IC4725	18 29.9	−19 16	6.2	35	9.3	0.60	b3	M25, Cepheid, U Sgr
IC4756	18 37.8	+05 25	5.4	50	8.5	*0.41*	*b9*	
6705	18 49.5	−06 19	6.8	12.5	12	1.72	b8	M11, very rich cl.
Mel227	20 06.7	−79 25	5.2	60	*9*	*0.24*	*b9*	
IC1396	21 38.0	+57 22	5.1	60	*8.6*	*0.73*	*O6*	Tr 37
7790	23 56.9	+61	7.1	4.5	11.7	3.39	b4	3 Ceph: CEa, CEb, CF Cas

Globular Clusters

NGC	M	α 1970	δ	B	D	Sp	m	N	r	V
		h m	° ′							
104	47 Tuc	00 22.6	−72 14	4.35	*44*	G3	13.54	11	5	−24
1851		05 13.0	−40 03	7.72:	*11.5*	F7		3	14.0	+309
2808		09 11.3	−64 44	7.4	*18.8*	F8	15.09	4	9.1	+101
5139	ω Cen	13 25.0	−47 09	4.5	*65.4*	F7	13.01	165	5.2	+230
5272	3	13 40.8	+28 32	6.86	9.3	F7	14.35	189	10.6	−153
5904	5	15 17.0	+02 12	6.69	10.7	F6	14.07	97	8.1	+49
6121	4	16 21.8	−26 27	7.05	22.6	*G0*	13.21	43	4.3	+65
6205	13	16 40.6	+36 31	6.43	12.9	F6	13.85	10	6.3	−241
6218	12	16 45.6	−01 54	7.58	21.5	F8	14.07	1	7.4	−16
6254	10	16 55.5	−04 04	7.26	16.2	G1	14.17	3	6.2	+71
6341	92	17 16.2	+43 11	6.94	12.3	F1	13.96	16	7.9	−118
6397		17 38.4	−53 40	6.9	*19*	F5	12.71	3	2.9	+11
6541		18 05.8	−43 45	7.5	*23.2*	F6	13.45	1	4.0	−148
6656	22	18 34.5	−23 57	6.15	26.2	F7	13.73	24	3.0	−144
6723		18 57.6	−36 40	7.37	11.7	G4	14.32	19	7.4	−3
6752		19 08.2	−60 02	6.8	*41.9*	F6	13.36	1	5.3	−39
6809	55	19 38.2	−31 00	6.72	21.1	F5	13.68	6	6.0	+170
7078	15	21 28.6	+12 02	6.96	9.4	F2	14.44	103	10.5	−107
7089	2	21 31.9	−00 58	6.94	6.8	F4	14.77	22	12.3	−5

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.

NGC	M	Con	α 1970 h m	δ ° ′	Cl	Size ′	m n	m *	Dist. l.y.	Name
650	76	Per	01 40.3	+51 25	Pl	1.5	11	17	15,000	
1952	1	Tau	05 32.7	+22 00		6	11	16	4,100	Crab
1976	42	Ori	05 33.8	−05 25	Dif	30			1,800	Orion
B33		Ori	05 39.4	−02 29	Drk	4			300	Horsehead
2261		Mon	06 37.5	+08 45	Dif	2				Hubble's var.
2392		Gem	07 27.4	+20 59	Pl	0.3	8	10	2,800	
2440		Pup	07 40.5	−18 08	Pl	0.9	11	16	8,600	
3587	97	UMa	11 13.1	+55 11	Pl	3.3	11	14	12,000	Owl
		Cru	12 50	−63	Drk	300			300	Coalsack
6210		Her	16 43.2	+23 51	Pl	0.3	10	12	5,600	
B72		Oph	17 21.8	−23 36	Drk	20			400	S nebula
6514	20	Sgr	18 00.6	−23 02	Dif	24			3,200	Trifid
B86		Sgr	18 01.1	−27 53	Drk	5				
6523	8	Sgr	18 01.8	−24 23	Dif	50			3,600	Lagoon
6543		Dra	17 58.6	+66 37	Pl	0.4	9	11	3,500	
6572		Oph	18 10.7	+06 50	Pl	0.2	9	12	4,000	
B92		Sgr	18 13.8	−18 15	Drk	15				
6618	17	Sgr	18 19.1	−16 12	Dif	26			3,000	Horseshoe
6720	57	Lyr	18 52.5	+33 00	Pl	1.4	9	14	5,400	Ring
6826		Cyg	19 44.0	+50 27	Pl	0.4	9	11	3,400	
6853	27	Vul	19 58.3	+22 38	Pl	8	8	13	3,400	Dumb-bell
6960		Cyg	20 44.4	+30 36	Dif	60				Network
7000		Cyg	20 57.8	+44 12	Dif	100				N. America
7009		Aqr	21 02.5	−11 30	Pl	0.5	8	12	3,000	
7662		And	23 24.5	+42 22	Pl	0.3	9	13	3,900	

EXTERNAL GALAXIES

By S. van den Bergh

Among the hundreds of thousands of systems far beyond our own Galaxy relatively few are readily seen in small telescopes. The first list contains the brightest galaxies. The first four columns give the catalogue numbers and position. In the column *Type*, *E* indicates elliptical, *I*, irregular, and *Sa*, *Sb*, *Sc*, spiral galaxies, in which the arms are more open going from *a* to *c*. Roman numerals I, II, III, IV, and V refer to supergiant, bright giant, giant, subgiant and dwarf galaxies respectively; *p* means "peculiar". The remaining columns give the apparent photographic magnitude, the angular dimensions and the distance in millions of light-years.

The second list contains the nearest galaxies and includes the photographic distance modulus $(m - M)_{pg}$, and the absolute photographic magnitude, M_{pg}.

THE BRIGHTEST GALAXIES

NGC or name	M	α 1970 (h m)	δ (° ′)	Type	m_{pg}	Dimensions ′ ′	Distance millions of l.y.
55		00 13.5	−39 23	Sc or Ir	7.9	30×5	7.5
205		00 38.7	+41 32	E6p	8.89	12×6	2.1
221	32	00 41.1	+40 43	E2	9.06	3.4×2.9	2.1
224	31	00 41.1	+41 07	Sb I–II	4.33	163×42	2.1
247		00 45.6	−20 54	S IV	9.47	21×8.4	7.5
253		00 46.1	−25 27	Scp	7.0:	22×4.6	7.5
SMC		00 51.7	−72 59	Ir IV or IV–V	2.86	216×216	0.2
300		00 53.5	−37 51	Sc III–IV	8.66	22×16.5	7.5
598	33	01 32.2	+30 30	Sc II–III	6.19	61×42	2.4
Fornax		02 38.3	−34 39	dE	9.1:	50×35	0.4
LMC		05 23.8	−69 47	Ir or Sc III–IV	0.86	432×432	0.2
2403		07 33.9	+65 40	Sc III	8.80	22×12	6.5
2903		09 30.4	+21 39	Sb I–II	9.48	16×6.8	19.0
3031	81	09 53.1	+69 12	Sb I–II	7.85	25×12	6.5
3034	82	09 53.6	+69 50	Scp:	9.20	10×1.5	6.5
4258		12 17.5	+47 28	Sbp	8.90	19×7	14.0
4472	49	12 28.3	+08 09	E4	9.33	9.8×6.6	37.0
4594	104	12 38.3	−11 28	Sb	9.18	7.9×4.7	37.0
4736	94	12 49.5	+41 16	Sbp II:	8.91	13×12	14.0
4826	64	12 55.3	+21 51	?	9.27	10×3.8	12.0:
4945		13 03.5	−49 19	Sb III	8.0	20×4	—
5055	63	13 14.4	+42 11	Sb II	9.26	8.0×3.0	14.0
5128		13 23.6	−42 51	E0p	7.87	23×20	—
5194	51	13 28.6	+47 21	Sc I	8.88	11×6.5	14.0
5236	83	13 35.4	−29 43	Sc I–II	7.0:	13×12	8.0:
5457	101	14 02.1	+54 29	Sc I	8.20	23×21	14.0
6822		19 43.2	−14 50	Ir IV–V	9.21	20×10	1.7

The Nearest Galaxies

Name	NGC	α 1970 (h m)	δ (° ′)	m_{pg}	$(m-M)_{pg}$	M_{pg}	Type	Dist. thous. of l.y.
M31	224	00 41.1	+41 07	4.33	24.65	−20.3	Sb I–II	2,100
Galaxy		—	—	—	—	?	Sb or Sc	—
M33	598	01 32.2	+30 30	6.19	24.70	−18.5	ScII–III	2,400
LMC		05 23.8	−69 47	0.86	18.65	−17.8	Ir or SBc III–IV	160
SMC		00 51.7	−72 59	2.86	19.05	−16.2	Ir IV or IV–V	190
NGC	205	00 38.7	+41 32	8.89	24.65	−15.8	E6p	2,100
M32	221	00 41.1	+40 43	9.06	24.65	−15.6	E2	2,100
NGC	6822	19 43.2	−14 50	9.21	24.55	−15.3	Ir IV-V	1,700
NGC	185	00 37.2	+48 11	10.29	24.65	−14.4	E0	2,100
IC1613		01 03.5	+01 58	10.00	24.40	−14.4	Ir V	2,400
NGC	147	00 31.5	+48 11	10.57	24.65	−14.1	dE4	2,100
Fornax		02 38.3	−34 39	9.1:	20.6:	−12:	dE	430
Leo I		10 06.9	+12 27	11.27	21.8:	−10:	dE	750:
Sculptor		00 58.4	−33 52	10.5	19.70	−9.2	dE	280:
Leo II		11 11.9	+22 19	12.85	21.8:	−9:	dE	750:
Draco		17 19.7	+57 57	—	19.50	?	dE	260
Ursa Minor		15 08.4	+67 13	—	19.40	?	dE	250

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. 1970 h m	Dec. ° ′	Flux	Distance thousands of l.y.	Approximate Radio Size
Tycho's S'nova	00 24.0	+63 57	57	1	6′.6
Andromeda Gal.	00 41.0	+41 06	65	2000	10°
Fornax A	03 21.2	−37 17	150	60000	18′ + 18′, *s*29′
Crab Neb., M1	05 32.6	+22 00	1030	4	5′
Orion Neb., M42	05 33.8	−05 25	360	2	4° × 3°
IC 443	06 15.5	+22 36	195	4	1.5°
Rosette Neb.	06 30.4	+04 53	24	5	1.2°
3C 273	12 27.7	+02 14	50	1500000	< 12″
Virgo A, M 87	12 29.3	+12 34	300	40000	4′.7
Centaurus A	13 23.6	−42 52	2010	10000	3°, complex
3C 295	14 10.4	+52 19	30	4500000	< 12″
3C 353	17 19.0	−00 57	84	800000	4′
Kepler's S'nova	17 29.0	−21 16	20	4	2′
Galactic Nucleus	17 44.1	−28 50	240	26	1° × 1.5°, complex
Omega Neb., M 17	18 18.6	−16 18	500	3	8′
3C 392	18 54.6	+01 17	211	?	15′
Cygnus A	19 58.4	+40 39	2160	500000	51″ + 51″, *s*1′.3
Cygnus X	20 21.5	+40 17	800	5	0°.6 × 1°.8
HB 21	20 45.6	+50 34	180	?6	1°.3
Cygnus loop	20 50.8	+29 34	252	2	2° × 2°.5
N. America Neb.	20 54.0	+43 57	350	3	1°.5 × 2°
Cassiopeia A	23 22.1	+58 38	3120	10	4′
Sun			300000		0°.6
Moon			500		0°.5
Jupiter			5		3.3 × eq. diam. 1 × polar diam.

MESSIER'S CATALOGUE OF DIFFUSE OBJECTS

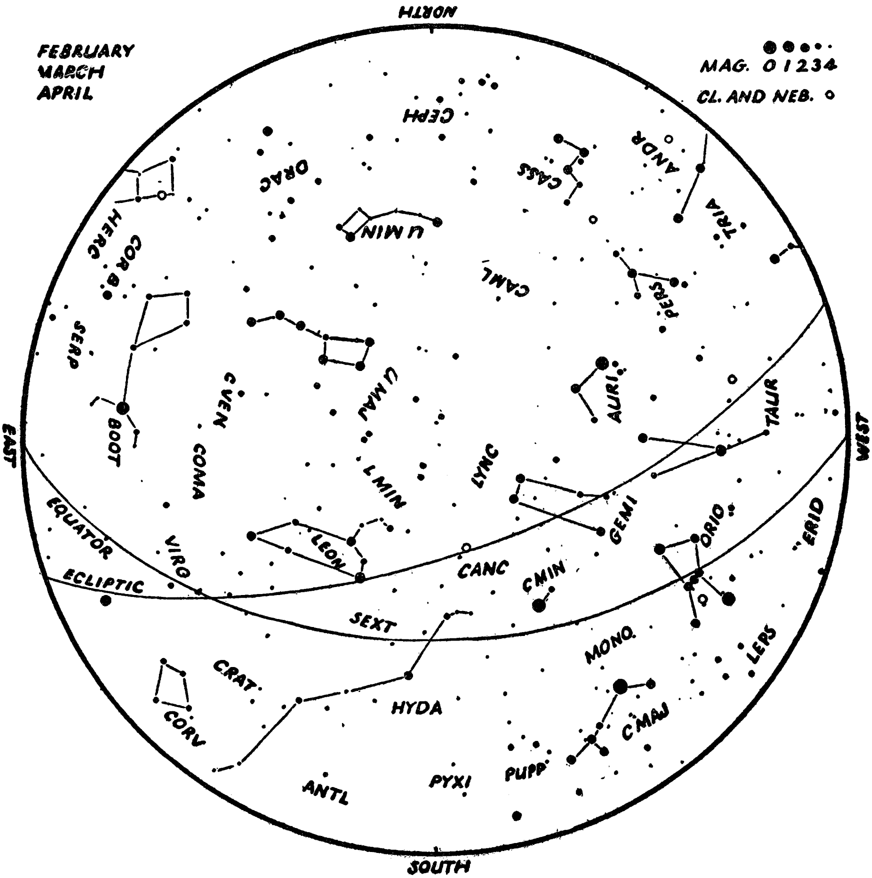
This table lists the 103 objects in Messier's original catalogue. The columns contain: Messier's number (M), the number in Dreyer's New General Catalogue (NGC), the constellation, the 1970 position, the integrated visual magnitude (m_v), and the class of object. OC means open cluster, GC, globular cluster, PN, planetary nebula, DN, diffuse nebula, and G, galaxy. The type of galaxy is also indicated, as explained in the table of external galaxies. An asterisk indicates that additional information about the object may be found elsewhere in the *Handbook*, in the appropriate table.

M	NGC	Con	α 1970	δ 1970	m_v	Type
1	1952	Tau	5 32.7	+22 01	11.3	DN*
2	7089	Aqr	21 31.9	−00 57	6.27	GC*
3	5272	CVn	13 40.8	+28 32	6.22	GC*
4	6121	Sco	16 21.8	−26 26	6.07	GC*
5	5904	Ser	15 17.0	+02 13	5.99	GC*
6	6405	Sco	17 38.1	−32 11	6	OC*
7	6475	Sco	17 51.9	−34 48	5	OC*
8	6523	Sgr	18 01.8	−24 23		DN*
9	6333	Oph	17 17.5	−18 29	7.58	GC
10	6254	Oph	16 55.5	−04 04	6.40	GC*
11	6705	Sct	18 49.5	−06 19	7	OC*
12	6218	Oph	16 45.6	−01 54	6.74	GC*
13	6205	Her	16 40.6	+36 31	5.78	GC*
14	6402	Oph	17 36.0	−03 14	7.82	GC
15	7078	Peg	21 28.6	+12 02	6.29	GC*
16	6611	Ser	18 17.2	−13 48	7	OC*
17	6618	Sgr	18 19.1	−16 12	7	DN*
18	6613	Sgr	18 18.2	−17 09	7	OC
19	6273	Oph	17 00.7	−26 13	6.94	GC
20	6514	Sgr	18 00.6	−23 02		DN*
21	6531	Sgr	18 02.8	−22 30	7	OC
22	6656	Sgr	18 34.6	−23 56	5.22	GC*
23	6494	Sgr	17 55.1	−19 00	6	OC*
24	6603	Sgr	18 16.7	−18 27	6	OC
25	4725†	Sgr	18 29.9	−19 16	6	OC*
26	6694	Sct	18 43.6	−09 26	9	OC
27	6853	Vul	19 58.4	+22 38	8.2	PN*
28	6626	Sgr	18 22.6	−24 52	7.07	GC
29	6913	Cyg	20 22.9	+38 25	8	OC
30	7099	Cap	21 38.6	−23 18	7.63	GC
31	224	And	0 41.1	+41 06	3.7	G-Sb*
32	221	And	0 41.1	+40 42	8.5	G-E*
33	598	Tri	1 32.2	+30 30	5.9	G-Sc*
34	1039	Per	2 40.1	+42 40	6	OC
35	2168	Gem	6 07.0	+24 21	6	OC*
36	1960	Aur	5 34.3	+34 05	6	OC
37	2099	Aur	5 50.4	+32 33	6	OC*
38	1912	Aur	5 26.6	+35 48	6	OC
39	7092	Cyg	21 31.1	+48 18	6	OC
40	—	UMa	—	—		2 stars
41	2287	CMa	6 45.8	−20 42	6	OC*
42	1976	Ori	5 33.9	−05 24		DN*
43	1982	Ori	5 34.1	−05 18		DN
44	2632	Cnc	8 38.2	+20 06	4	OC*
45	—	Tau	3 45.7	+24 01	2	OC*
46	2437	Pup	7 40.4	−14 45	7	OC*
47	2422	Pup	7 35.1	−14 26	5	OC
48	2548	Hya	8 12.0	−05 41	6	OC
49	4472	Vir	12 28.3	+08 10	8.9	G-E*
50	2323	Mon	7 01.5	−08 18	7	OC
51	5194	CVn	13 28.6	+47 21	8.4	G-Sc*
52	7654	Cas	23 22.9	+61 26	7	OC
53	5024	Com	13 11.5	+18 20	7.70	GC
54	6715	Sgr	18 53.2	−30 31	7.7	GC
55	6809	Sgr	19 38.1	−31 01	6.09	GC*

M	NGC	Con	α 1970	δ 1970	m_v	Type
56	6779	Lyr	19 15.4	+30 07	8.33	GC
57	6720	Lyr	18 52.5	+33 00	9.0	PN*
58	4579	Vir	12 36.2	+11 59	9.9	G-SBb
59	4621	Vir	12 40.5	+11 50	10.3	G-E
60	4649	Vir	12 42.1	+11 44	9.3	G-E
61	4303	Vir	12 20.3	+04 39	9.7	G-Sc
62	6266	Sco	16 59.3	−30 04	7.2	GC
63	5055	CVn	13 14.4	+42 11	8.8	G-Sb*
64	4826	Com	12 55.2	+21 51	8.7	G-Sb*
65	3623	Leo	11 17.3	+13 16	9.6	G-Sa
66	3627	Leo	11 18.6	+13 10	9.2	G-Sb
67	2682	Cnc	8 49.5	+11 56	7	OC*
68	4590	Hya	12 37.8	−26 35	8.04	GC
69	6637	Sgr	18 29.4	−32 23	7.7	GC
70	6681	Sgr	18 41.3	−32 19	8.2	GC
71	6838	Sge	19 52.4	+18 42	6.9	GC
72	6981	Aqr	20 51.8	−12 41	9.15	GC
73	6994	Aqr	20 57.3	−12 46		OC
74	628	Psc	1 35.1	+15 38	9.5	G-Sc
75	6864	Sgr	20 04.3	−22 01	8.31	GC
76	650	Per	1 40.3	+51 25	11.4	PN*
77	1068	Cet	2 41.1	−00 07	9.1	G-Sb
78	2068	Ori	5 45.3	+00 02		DN
79	1904	Lep	5 22.9	−24 33	7.3	GC
80	6093	Sco	16 15.2	−22 55	7.17	GC
81	3031	UMa	9 53.4	+69 12	6.9	G-Sb*
82	3034	UMa	9 53.6	+69 50	8.7	G-Irr*
83	5236	Hya	13 35.3	−29 43	7.5	G-Sc*
84	4374	Vir	12 23.6	+13 03	9.8	G-E
85	4382	Com	12 23.8	+18 21	9.5	G-SO
86	4406	Vir	12 24.6	+13 06	9.8	G-E
87	4486	Vir	12 29.2	+12 33	9.3	G-Ep
88	4501	Com	12 30.4	+14 35	9.7	G-Sb
89	4552	Vir	12 34.1	+12 43	10.3	G-E
90	4569	Vir	12 35.3	+13 19	9.7	G-Sb
91	—	—	—	—		M58?
92	6341	Her	17 16.2	+43 11	6.33	GC*
93	2447	Pup	7 43.2	−23 48	6	OC
94	4736	CVn	12 49.6	+41 17	8.1	G-Sb*
95	3351	Leo	10 42.3	+11 52	9.9	G-SBb
96	3368	Leo	10 45.1	+11 59	9.4	G-Sa
97	3587	UMa	11 13.1	+55 11	11.1	PN*
98	4192	Com	12 12.2	+15 04	10.4	G-Sb
99	4254	Com	12 17.3	+14 35	9.9	G-Sc
100	4321	Com	12 21.4	+15 59	9.6	G-Sc
101	5457	UMa	14 02.1	+54 30	8.1	G-Sc*
102	—	—	—	—		M101?
103	581	Cas	1 31.2	+60 32	7	OC

†Index Catalogue Number.

STAR MAP 1

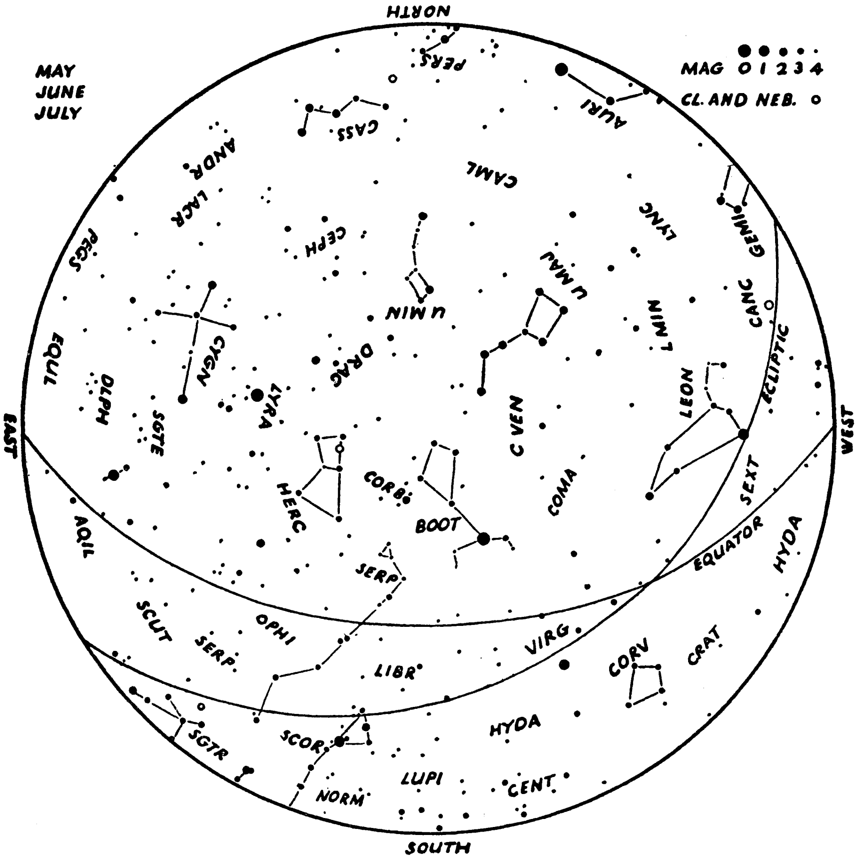


The above map represents the evening sky at

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.

STAR MAP 2

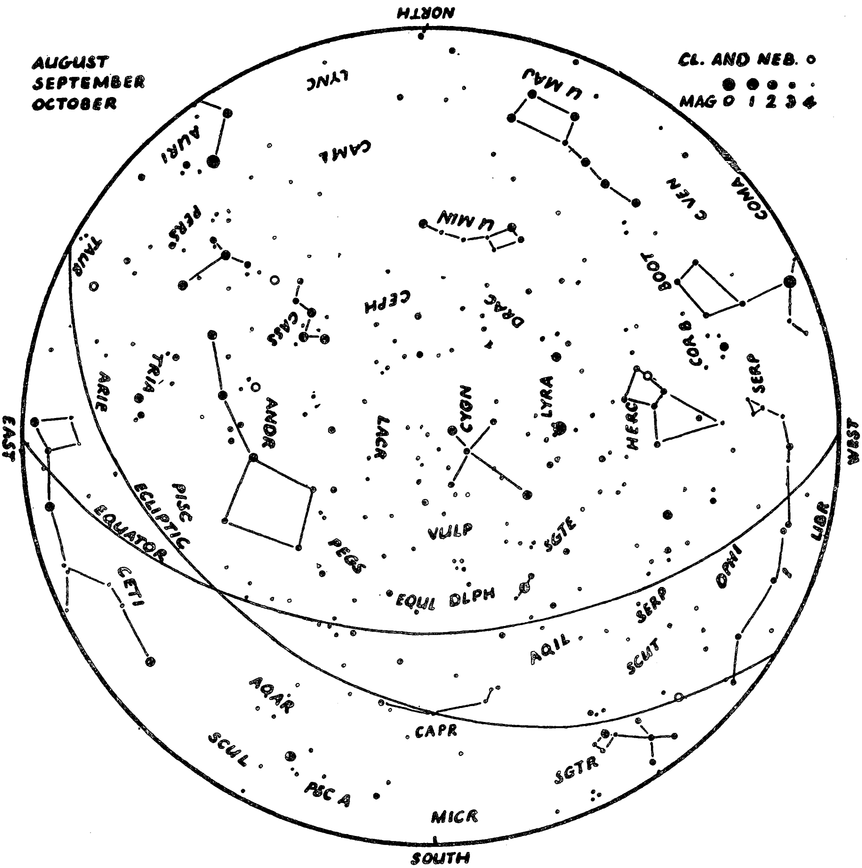


The above map represents the evening sky at

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.

STAR MAP 3

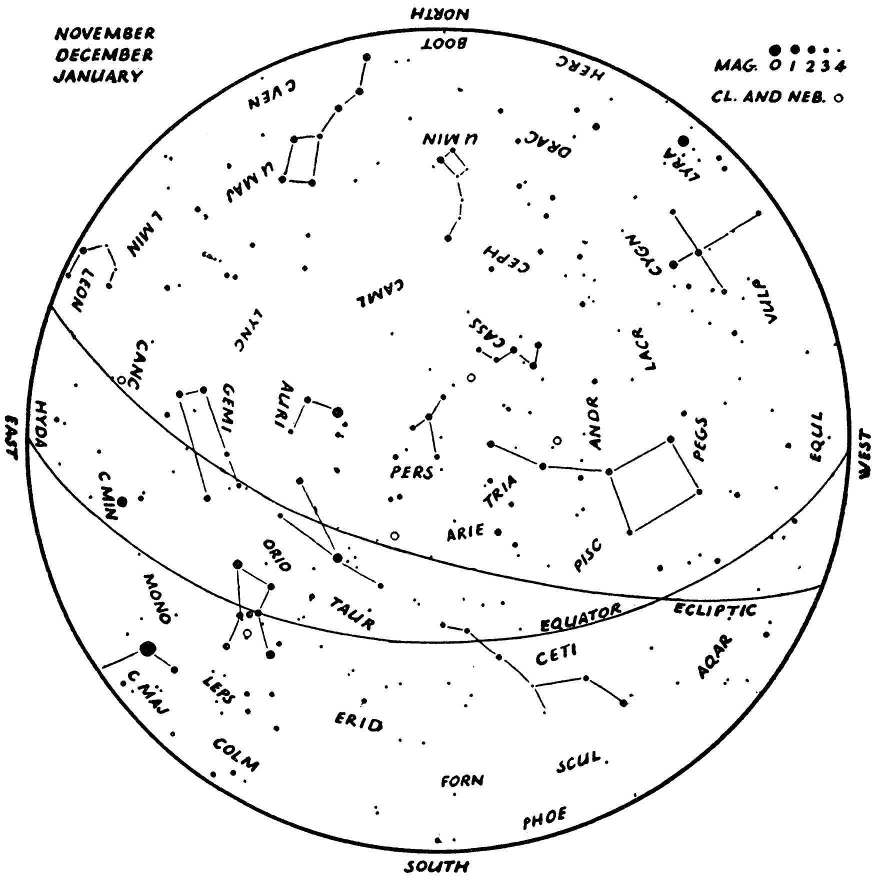


The above map represents the evening sky at

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.

STAR MAP 4



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.

CALENDAR 1969

January

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	

February

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	

March

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	11	12
13	14	15	16	17	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	16	17
18	19	20	21	22	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	13	14
15	16	17	18	19	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	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

August

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						

September

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				

October

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	

November

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						

December

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			