the OBSERVER'S HANDBOOK 1971

sixty-third year of publication

the ROYAL ASTRONOMICAL SOCIETY
of CANADA

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

Incorporated 1890 – Royal Charter 1903
Federally Incorporated 1968

The National Office of the Society is located at 252 College Street, Toronto 130, Ontario; the business office, reading rooms and astronomical library are housed here.

Membership is open to anyone interested in astronomy and applicants may affiliate with one of the eighteen Centres across Canada established in St. John's, Halifax, Quebec, Montreal, Ottawa, Kingston, Hamilton, Niagara Falls, London, Windsor, Winnipeg, Saskatoon, Edmonton, Calgary, Vancouver, Victoria and Toronto, or join the National Society direct.

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 $10.00 ($5.00 for full-time students) are payable October 1 and include the publications for the following calendar year.

VISITING HOURS AT SOME CANADIAN OBSERVATORIES

David Dunlap Observatory, Richmond Hill, Ontario.
Tuesday mornings, 10:00–11:00 a.m.
Saturday evenings, April through October (by reservation).

Dominion Astrophysical Observatory, Victoria, B.C.
Summer: Daily 9:30–4:30 (Guide, Monday to Friday).
Winter: Monday to Friday, 9:30–4:30 (Saturday evenings April through November).

Dominion Observatory, Ottawa, Ontario.
Monday to Friday, daytime, rotunda only.
Saturday evenings, April through October.

Dominion Radio Astrophysical Observatory, Penticton, B.C.
Sunday, July and August only (2:00–5:00 p.m.).

Planetariums

The Calgary Centennial Planetarium, Mewata Park, Calgary 2, Alberta.
Winter: Wed.–Fri., 7:15 and 8:45 p.m.; Sat. and Sun. 3:00, 7:15, 8:45 p.m.
Summer: Daily (except Tues.) 2:00, 3:00, 4:00, 7:15 and 8:45 p.m.

Dow Planetarium, 1000 St. Jacques St. W., Montreal, P.Q.
In English: Tues. through Fri. 12:15 p.m.; Sat. 1:00 and 3:30 p.m.; Sun. 2:15 p.m. Evenings (except Monday) 8:15 p.m.
In French: Tues. through Sat. 2:15 p.m., also Sat. 4:30 p.m.; Sun. 1:00, 3:30 and 4:30 p.m. Evenings (except Monday) 9:30 p.m.

H. R. MacMillan Planetarium, 1100 Chestnut St., Vancouver 9, B.C.
Sept.–June: Tues.–Thurs., 4:00 and 8:00 p.m., Fri., 4:00, 7:30, 9:00 p.m. Sat. and holidays, 1:00, 2:30, 4:00, 7:30, 9:00 p.m. Sun., 1:00, 2:30, 4:00, 7:30 p.m.
July–August: Tues.–Sat., 1:00, 2:30, 4:00, 7:30, 9:00 p.m.; Sun., 1:00, 2:30, 4:00, 7:30 p.m. (including Christmas and Easter weeks). Closed on Mondays except holidays.

Manitoba Museum of Man & Nature Planetarium, 190 Rupert Ave., Winnipeg 2, Man.
Sept.–June: Sun. and holidays, 1:00, 2:30, 4:00 p.m.; Tue.–Fri., 3:30, 8:30 p.m. Sat., 1:00, 2:30, 4:00, 7:30, 9:00 p.m.
July–August: Sat., Sun. and holidays same as above; Tue.–Fri., 11:00 a.m., 3:00, 7:30, 9:00 p.m. (Closed Mon. except holidays.) Christmas show, 3:30, 7:30, 9:00 p.m.

McLaughlin Planetarium, 100 Queen's Park, Toronto 5, Ontario.
Tue.–Fri., 3:30, 8:00 p.m.; Sat. 11:00 a.m., 2:00, 3:30, 7:30, 9:00 p.m., Sun. 2:00, 3:30, 5:00, 7:30 p.m. (During July and August, additional weekday show at 2:00 p.m.)

McMaster University, Dept. of Continuing Education, Hamilton, Ont.
Group reservations only.

Queen Elizabeth Planetarium, Edmonton, Alberta.
Winter: Tue.–Fri., 8:00 p.m., Sat. 3:00 p.m., Sun. and holidays, 2:00, 4:00 p.m.
Summer: Mon.–Sat., 3:00, 8:00 p.m., Sun. and holidays, 2:00, 4:00, 8:00 p.m.

The University of Manitoba Planetarium, 500 Dysart Rd., Winnipeg, Man.
Wed. and Thurs., 12:40, 8:30 p.m., Fri., 12:40, 7:00, 8:30 p.m.

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252 College Street, Toronto 130, Canada

editor: JOHN R. PERCY

INDEX

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THE OBSERVER'S HANDBOOK for 1971 is the 63rd edition. A number of small changes and additions have been made in response to suggestions from readers; further changes and additions are contemplated for the 1972 edition. Additional information about the planet Mars is included, in view of the favourable opposition which occurs in 1971.

Cordial thanks are offered to all those who assisted in the preparation of this edition: to those whose names appear in the various sections and to Marie Fidler, Edward Kipp, Roslyn Shemilt, Maude Towne and Isabel Williamson. Special thanks go to Donald Davis, for providing a new cover design, to Margaret W. Mayall, Director of the A.A.V.S.O., for the predictions of Algol and the variable stars, to Gordon E. Taylor for the prediction of planetary appulses and occultations, and to Malcolm M. Thomson and the Department of Energy, Mines and Resources, for providing a map of time zones. My deep indebtedness to the British Nautical Almanac Office and to the *American Ephemeris* is gratefully acknowledged. Finally, as only the third editor of the HANDBOOK in 63 years, I wish to record my sincere gratitude to the late Miss Ruth Northcott for her inspiration and for the high editorial standards which she established.

JOHN R. PERCY

ANNIVERSARIES AND FESTIVALS, 1971

New Year's Day	Fri.	Jan. 1	Victoria Day	Mon.	May 24
Epiphany	Wed.	Jan. 6	Trinity Sunday		June 6
Accession of Queen Elizabeth (1952)	Sat.	Feb. 6	Corpus Christi	Thur.	June 10
Septuagesima Sunday		Feb. 7	St. John Baptist (Mid-summer Day)	Thur.	June 24
Quinquagesima (Shrove Sunday)		Feb. 21	Dominion Day	Thur.	July 1
Ash Wednesday		Feb. 24	Birthday of Queen Mother Elizabeth (1900)	Wed.	Aug. 4
St. David	Mon.	Mar. 1	Labour Day	Mon.	Sept. 6
St. Patrick	Wed.	Mar. 17	Hebrew New Year (Rosh Hashanah)	Mon.	Sept. 20
Palm Sunday		Apr. 4	Yom Kippur	Wed.	Sept. 29
Good Friday		Apr. 9	St. Michael (Michaelmas Day)	Wed.	Sept. 29
First Day of Passover	Sat.	Apr. 10	Thanksgiving	Mon.	Oct. 11
Easter Sunday		Apr. 11	All Saints' Day	Mon.	Nov. 1
Birthday of Queen Elizabeth (1926)	Wed.	Apr. 21	Remembrance Day	Thur.	Nov. 11
St. George	Fri.	Apr. 23	First Sunday in Advent		Nov. 28
Rogation Sunday		May 16	St. Andrew	Tues.	Nov. 30
Ascension Day	Thur.	May 20	Christmas Day	Sat.	Dec. 25
Pentecost (Whit Sunday)		May 30			

JULIAN DAY CALENDAR, 1971

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

Jan. 1	40,953	May 1	41,073	Sept. 1	41,196
Feb. 1	40,984	June 1	41,104	Oct. 1	41,226
Mar. 1	41,012	July 1	41,134	Nov. 1	41,257
Apr. 1	41,043	Aug. 1	41,165	Dec. 1	41,287

The Julian Day commences at noon. Thus J.D. 2,440,953 = 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 Names with Pronunciations and Abbreviations

Andromeda, ăn-drŏm′ē-dȧ	And	Andr
Antlia, ănt′lĭ-ȧ	Ant	Antl
Apus, ā′pŭs	Aps	Apus
Aquarius, ȧ-kwâr′ĭ-ŭs	Aqr	Aqar
Aquila, ăk′wĭ-lȧ	Aql	Aqil
Ara, ā′rȧ	Ara	Arae
Aries, ā′rĭ-ēz	Ari	Arie
Auriga, ô-rī′gȧ	Aur	Auri
Boötes, bô-ō′tēz	Boo	Boot
Caelum, sē′lŭm	Cae	Cael
Camelopardalis, kȧ-mĕl′ô-pär′dȧ-lĭs	Cam	Caml
Cancer, kăn′sẽr	Cnc	Canc
Canes Venatici, kā′nēz vê-năt′ĭ-sī	CVn	CVen
Canis Major, kā′nĭs mā′jẽr	CMa	CMaj
Canis Minor, kā′nĭs′ mī′nẽr	CMi	CMin
Capricornus, kăp′rĭ-kôr′nŭs	Cap	Capr
Carina, kȧ-rī′nȧ	Car	Cari
Cassiopeia, kăs′ĭ-ô-pē′yȧ′	Cas	Cas
Centaurus, sĕn-tô′rŭs	Cen	Cent
Cepheus, sē′fūs	Cep	Ceph
Cetus, sē′tŭs	Cet	Ceti
Chamaeleon, kȧ-mē′lē-ŭn	Cha	Cham
Circinus, sûr′sĭ-nŭs	Cir	Circ
Columba, kô-lŭm′bȧ	Col	Colm
Coma Berenices, kō′mȧ bĕr′ê-nī′sēz	Com	Coma
Corona, Australis, kô-rō′nȧ ôs-trā′lĭs	CrA	CorA
Corona Borealis, kȧ-rō′nȧ bō′rê-ā′lĭs	CrB	CorB
Corvus, kôr′vŭs	Crv	Corv
Crater, krā′tẽr	Crt	Crat
Crux, krŭks	Cru	Cruc
Cygnus, sĭg′nŭs	Cyg	Cygn
Delphinus, dĕl-fī′nŭs	Del	Dlph
Dorado, dô-rä′dō	Dor	Dora
Draco, drā′kō	Dra	Drac
Equuleus, ê-kwōō′lê-ŭs	Equ	Equl
Eridanus, ê-rĭd′ȧ-nŭs	Eri	Erid
Fornax, fôr′năks	For	Forn
Gemini, jĕm′ĭ-nī	Gem	Gemi
Grus, grŭs	Gru	Grus
Hercules, hûr′kû′lēz	Her	Herc
Horologium, hŏr′ô-lō′jĭ-ŭm	Hor	Horo
Hydra, hī′drȧ	Hya	Hyda
Hydrus, hī′drŭs	Hyi	Hydi
Indus, ĭn′dŭs	Ind	Indi
Lacerta, lȧ-sûr′tȧ	Lac	Lacr
Leo, lē′ō	Leo	Leon
Leo Minor, lē′ō mī′nẽr	LMi	LMin
Lepus, lē′pŭs	Lep	Leps
Libra, lī′brȧ	Lib	Libr
Lupus, lū′pŭs	Lup	Lupi
Lynx, lĭngks	Lyn	Lync
Lyra, lī′rȧ	Lyr	Lyra
Mensa, mĕn′sȧ	Men	Mens
Microscopium, mī′krô-skō′pĭ-ŭm	Mic	Micr
Monoceros, m-ônŏs′ẽr-ŏs	Mon	Mono
Musca, mŭs′kȧ	Mus	Musc
Norma, nôr′mȧ	Nor	Norm
Octans, ŏk′tănz	Oct	Octn
Ophiuchus, ŏf′ĭ-ūkŭs	Oph	Ophi
Orion, ô-rī′ŏn	Ori	Orio
Pavo, Pā′vō	Pav	Pavo
Pegasus, pĕg′ȧ-sŭs	Peg	Pegs
Perseus, pûr′sūs	Per	Pers
Phoenix, fē′nĭks	Phe	Phoe
Pictor, pĭk′tẽr	Pic	Pict
Pisces, pĭs′ēz	Psc	Pisc
Piscis Austrinus, pĭs′ĭs ôs-trī′nŭs	PsA	PscA
Puppis, pŭp′ĭs	Pup	Pupp
Pyxis, pĭk′sĭs	Pyx	Pyxi
Reticulum, rê-tĭk′û-lŭm	Ret	Reti
Sagitta, sȧ-jĭt′ȧ	Sge	Sgte
Sagittarius, săj′ĭ-tā′rĭ-ŭs	Sgr	Sgtr
Scorpius, skôr′pĭ-ŭs	Sco	Scor
Sculptor, skŭlp′tẽr	Scl	Scul
Scutum, skū′tŭm	Sct	Scut
Serpens, sûr′pĕnz	Ser	Serp
Sextans, sĕks′tănz	Sex	Sext
Taurus, tô′rŭs	Tau	Taur
Telescopium, tĕl′ê-skō′pĭ-ŭm	Tel	Tele
Triangulum, trī-ăng′gû-lŭm	Tri	Tria
Triangulum Australe, trī-ăng′gû-lŭm ôs-trā′lē	Tra	TrAu
Tucana, tû-kā′nȧ	Tuc	Tucn
Ursa Major, ûr′sȧ mā′jẽr	UMa	UMaj
Ursa Minor, ûr′sȧ mī′nẽr	UMi	UMin
Vela, vē′la	Vel	Velr
Virgo, vûr′gō	Vir	Virg
Volans, vō′lănz	Vol	Voln
Vulpecula, vŭl-pĕk′û-lȧ	Vul	Vulp

ā fāte; ȧ chȧotic; ă tăp; ă finăl; ȧ ȧsk; ȧ ideȧ; â câre; ä älms; au aught; ē bē; ê crêatê; ĕ ĕnd; ĕ angĕl; ẽ makẽr; ī tīme; ĭ bĭt; ĭ anĭmal; ō nōte; ô anatômy; ŏ hŏt; ŏ ŏccur; ô ôrb; ōō mōōn; ŏŏ bŏŏk; ou out; ū tūbe; û ûnite; ŭ sŭn; ŭ sŭbmit; û hûrl.

MISCELLANEOUS ASTRONOMICAL DATA

UNITS OF LENGTH

1 Angstrom unit = 10^{-8} cm. 1 micron, μ = 10^{-4} cm. = 10^4A.
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 = 1.496×10^{13} cm. = 1.496×10^8 km. = 9.2957×10^7 mi.
1 light-year = 9.461×10^{17} cm. = 5.88×10^{12} mi. = 0.3068 parsecs
1 parsec = 3.084×10^{18} cm. = 1.916×10^{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 = 5.98×10^{24} kgm. = 13.2×10^{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) ~ 2.2×10^8 years
Mass ~ 2×10^{11} solar masses

EXTERNAL GALAXIES

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

RADIATION CONSTANTS

Velocity of light, $c = 2.997925 \times 10^{10}$ cm./sec. = 186.282.1 mi./sec.
Frequency, $v = c/\lambda$; v in Hertz (cycles per sec.), c in cm./sec., λ in cm.
Solar constant = 1.93 gram calories/square cm./minute
Light ratio for one magnitude = 2.512 . . . ; log ratio = exactly 0.4
Stefan's constant = 5.6694×10^{-5} c.g.s. units

MISCELLANEOUS

Constant of gravitation, $G = 6.670 \times 10^{-8}$ c.g.s. units
Mass of the electron, $m = 9.1083 \times 10^{-28}$ gm.: mass of the proton = 1.6724×10^{-24} gm.
Planck's constant, $h = 6.625 \times 10^{-27}$ erg. sec.
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.	Apparent Dec. 0h E.T.	Corr. to Sun-dial 12h E.T.	Date	Apparent R.A. 0h E.T.	Apparent Dec. 0h E.T.	Corr. to Sun-dial 12h E.T.
	h m s	° ′	m s		h m s	° ′	m s
Jan. 1	18 43 08	−23 04.5	+ 3 24	July 3	6 45 25	+23 02.0	+ 4 03
4	18 56 23	−22 48.7	+ 4 48	6	6 57 47	+22 46.8	+ 4 34
7	19 09 33	−22 28.9	+ 6 09	9	7 10 06	+22 28.0	+ 5 03
10	19 22 39	−22 05.1	+ 7 24	12	7 22 21	+22 05.7	+ 5 28
13	19 35 40	−21 37.5	+ 8 35	15	7 34 33	+21 40.0	+ 5 49
16	19 48 36	−21 06.1	+ 9 40	18	7 46 40	+21 11.0	+ 6 06
19	20 01 26	−20 31.0	+10 39	21	7 58 43	+20 38.7	+ 6 18
22	20 14 09	−19 52.6	+11 32	24	8 10 40	+20 03.3	+ 6 25
25	20 26 46	−19 10.5	+12 18	27	8 22 33	+19 24.9	+ 6 27
28	20 39 16	−18 25.4	+12 56	30	8 34 20	+18 43.6	+ 6 23
31	20 51 38	−17 37.3	+13 28				
				Aug. 2	8 46 01	+17 59.5	+ 6 14
Feb. 3	21 03 53	−16 46.4	+13 52	5	8 57 37	+17 12.9	+ 5 59
6	21 16 00	−15 52.9	+14 08	8	9 09 07	+16 23.7	+ 5 39
9	21 28 00	−14 56.9	+14 17	11	9 20 32	+15 32.1	+ 5 13
12	21 39 53	−13 58.7	+14 19	14	9 31 52	+14 38.3	+ 4 43
15	21 51 39	−12 58.4	+14 14	17	9 43 07	+13 42.4	+ 4 08
18	22 03 18	−11 56.2	+14 03	20	9 54 18	+12 44.5	+ 3 28
21	22 14 51	−10 52.3	+13 45	23	10 05 24	+11 44.7	+ 2 44
24	22 26 19	− 9 46.8	+13 22	26	10 16 26	+10 43.3	+ 1 56
27	22 37 41	− 8 40.0	+12 54	29	10 27 25	+ 9 40.4	+ 1 04
Mar. 2	22 48 58	− 7 32.1	+12 20	Sept. 1	10 38 20	+ 8 36.2	+ 0 09
5	23 00 10	− 6 23.2	+11 42	4	10 49 12	+ 7 30.7	− 0 49
8	23 11 18	− 5 13.5	+11 00	7	11 00 02	+ 6 24.1	− 1 49
11	23 22 23	− 4 03.2	+10 14	10	11 10 49	+ 5 16.5	− 2 51
14	23 33 24	− 2 52.5	+ 9 25	13	11 21 36	+ 4 08.2	− 3 55
17	23 44 23	− 1 41.5	+ 8 35	16	11 32 22	+ 2 59.1	− 4 58
20	23 55 21	− 0 30.3	+ 7 42	19	11 43 08	+ 1 49.6	− 6 02
23	0 06 17	+ 0 40.8	+ 6 48	22	11 53 54	+ 0 39.7	− 7 06
26	0 17 12	+ 1 51.8	+ 5 54	25	12 04 41	− 0 30.4	− 8 08
29	0 28 07	+ 3 02.3	+ 4 59	28	12 15 29	− 1 40.6	− 9 10
Apr. 1	0 39 03	+ 4 12.3	+ 4 05	Oct. 1	12 26 18	− 2 50.6	−10 09
4	0 49 59	+ 5 21.6	+ 3 12	4	12 37 10	− 4 00.4	−11 07
7	1 00 56	+ 6 30.1	+ 2 20	7	12 48 05	− 5 09.7	−12 01
10	1 11 55	+ 7 37.5	+ 1 30	10	12 59 04	− 6 18.4	−12 51
13	1 22 56	+ 8 43.7	+ 0 42	13	13 10 07	− 7 26.5	−13 37
16	1 34 01	+ 9 48.7	− 0 03	16	13 21 14	− 8 33.6	−14 19
19	1 45 08	+10 52.2	− 0 45	19	13 32 27	− 9 39.6	−14 55
22	1 56 19	+11 54.2	− 1 23	22	13 43 45	−10 44.4	−15 26
25	2 07 34	+12 54.3	− 1 57	25	13 55 09	−11 47.8	−15 50
28	2 18 54	+13 52.6	− 2 26	28	14 06 39	−12 49.5	−16 09
				31	14 18 16	−13 49.4	−16 20
May 1	2 30 18	+14 48.8	− 2 51				
4	2 41 47	+15 42.8	− 3 11	Nov. 3	14 30 00	−14 47.3	−16 25
7	2 53 20	+16 34.4	− 3 27	6	14 41 51	−15 43.0	−16 23
10	3 04 58	+17 23.5	− 3 37	9	14 53 49	−16 36.5	−16 12
13	3 16 42	+18 10.1	− 3 42	12	15 05 55	−17 27.4	−15 55
16	3 28 31	+18 53.9	− 3 42	15	15 18 09	−18 15.6	−15 29
19	3 40 25	+19 34.8	− 3 37	18	15 30 31	−19 01.0	−14 56
22	3 52 24	+20 12.7	− 3 27	21	15 43 01	−19 43.3	−14 15
25	4 04 28	+20 47.6	− 3 12	24	15 55 37	−20 22.3	−13 27
28	4 16 36	+21 19.2	− 2 52	27	16 08 20	−20 58.0	−12 32
31	4 28 49	+21 47.5	− 2 28	30	16 21 10	−21 30.1	−11 31
June 3	4 41 06	+22 12.4	− 2 01	Dec. 3	16 34 06	−21 58.6	−10 24
6	4 53 25	+22 33.7	− 1 31	6	16 47 08	−22 23.3	− 9 11
9	5 05 48	+22 51.6	− 0 57	9	17 00 14	−22 44.0	− 7 53
12	5 18 12	+23 05.8	− 0 22	12	17 13 25	−23 00.8	− 6 31
15	5 30 39	+23 16.4	+ 0 16	15	17 26 40	−23 13.4	− 5 06
18	5 43 07	+23 23.3	+ 0 54	18	17 39 57	−23 21.9	− 3 38
21	5 55 36	+23 26.5	+ 1 34	21	17 53 16	−23 26.1	− 2 09
24	6 08 05	+23 25.9	+ 2 13	24	18 06 35	−23 26.1	− 0 39
27	6 20 34	+23 21.6	+ 2 51	27	18 19 54	−23 21.9	+ 0 51
30	6 33 00	+23 13.7	+ 3 28	30	18 33 12	−23 13.5	+ 2 19

PRINCIPAL ELEMENTS OF THE SOLAR SYSTEM

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

Planet	Mean Distance from Sun (a) A. U.	millions of miles	Period of Revolution Sidereal (P)	Syn-odic	Eccen-tri-city (e)	In-clina-tion (i)	Long. of Node (☊)	Long. of Peri-helion (π)	Mean Long. at Epoch (L)
				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	Equa-torial Di-ameter miles	Ob-late-ness	Mass ⊕=1	Mean Den-sity water =1	Sur-face Grav-ity ⊕=1	Rotation Period	Incli-nation of Equa-tor to Orbit °	Albedo
⊙ Sun	864,000	0	332,958	1.41	27.9	25^d–35^d†		
☾ Moon	2,160	0	0.0123	3.36	0.16	$27^d\,07^h\,43^m$	6.7	0.067
☿ Mercury	3,025	0	0.055	5.46	0.38	58.65^d	?	0.056
♀ Venus	7,526	0	0.815	5.23	0.90	244^d(retro.)	10	0.76
⊕ Earth	7,927	1/298	1.000	5.52	1.00	$23^h\,56^m\,04^s$	23.4	0.36
♂ Mars	4,218	1/192	0.107	3.93	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	31,650	1/50	17.3	1.54	1.08	16	28.8	0.62
♇ Pluto	3,500?	?	0.06?	4?	0.3?	6.387^d	?	0.14?

†Depending on latitude. For the physical observations of the sun, p. 56, the sidereal period of rotation is 25.38 m.s.d.

SATELLITES OF THE SOLAR SYSTEM

Name	Mag. * †	Diam. miles †	Mean Distance from Planet miles	Mean Distance from Planet ″ *	Revolution Period d	h	m	Orbit Incl. ° ‡	Discovery
Satellite of the Earth									
Moon	−12.7	2160	238,900	...	27	07	43	Var.§	
Satellites of Mars									
Phobos	11.6	12	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. The atomic second has been defined; atomic time has been maintained in various labs, and an internationally acceptable atomic time scale is under discussion.

A sundial 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 sundial* 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 point of Aries is on the meridian. As the earth makes one more rotation with respect to the stars than it does with respect to the sun during a year, sidereal time gains on mean time $3^m\ 56^s$ 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 solar 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. Local Sidereal time may be found approximately from Standard or zone time (0 h at midnight) by applying the corrections for longitude (p. 12) and sundial (p. 7) to obtain apparent solar time, then adding 12 h and R.A. sun (p. 7). (Note that it is necessary to obtain R.A. of the sun and correction to sundial at the standard time involved.)

Local mean time varies continuously with longitude. 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, UT1 and UT2 are used differing from UT by polar variation and by the combined effects of polar variation and annual fluctuation respectively.

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

In Canada and the United States there are 9 standard time zones as follows: Newfoundland (N), $3^h\ 30^m$ 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; 150th meridian or Alaska-Hawaii, 10 hours; and 165th meridian or Bering, 11 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 has been redefined twice within the past two decades. In 1956 it was defined in terms of Ephemeris Time (ET) as 1/31,556,925.9747 of the tropical year 1900 January 0 at 12 hrs. ET. In 1967 it was redefined as 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium 133 atom. Ephemeris Time is required in celestial mechanics, while the cesium 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 tabulated in ET, but observed in UT. ΔT was zero near the beginning of the century, but in 1971 will be about 41 seconds.

RADIO TIME SIGNALS

National time services distribute co-ordinated time called UTC, which approximates UT2. It is derived from the cesium 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.

A growing body of public opinion favours the use of stepped atomic time, SAT, in place of UTC. The scientific advantage would be the use of the official cesium second in everyday timekeeping. An adjustment of 1.0 second would be made when necessary to maintain UT approximately. The change, which would pass unnoticed by the general public, will not be introduced before 1972.

Radio time signals readily available in Canada include:

CHU Ottawa, Canada	3330, 7335, 14670 kHz
WWV Fort Collins, Colorado	2.5, 5, 10, 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

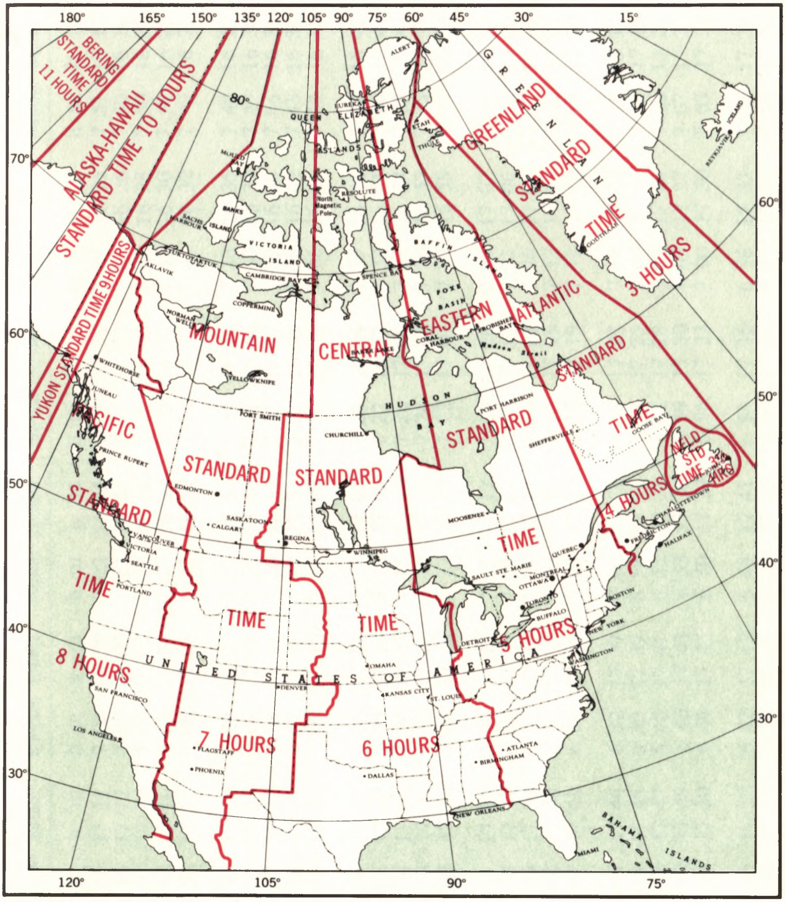
To derive the Standard Time of rising and setting phenomena for the places named, from the list below find the approximate latitude of the place and the correction in minutes which follows the name. Then find in the monthly table the Local Mean Time of the phenomenon for the proper latitude on the desired 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	Peterborough	44	+13E	Atlanta	34°	+37E
Baker Lake	64	+24C	Port Harrison	59	+13E	Baltimore	39	+06E
Brandon	50	+40C	Prince Albert	53	+63C	Birmingham	33	−13C
Brantford	43	+21E	Prince Rupert	54	+41P	Boston	42	−16E
Calgary	51	+36M	Quebec	47	−15E	Buffalo	43	+15E
Charlottetown	46	+12A	Regina	50	+58C	Chicago	42	−10C
Churchill	59	+17C	St. Catharines	43	+17E	Cincinnati	39	+38E
Cornwall	45	− 1E	St. Hyacinthe	46	−08E	Cleveland	42	+26E
Edmonton	54	+34M	Saint John, N.B.	45	+24A	Dallas	33	+27C
Fredericton	46	+27A	St. John's, Nfld.	48	+01N	Denver	40	00M
Gander	49	+ 8N	Sarnia	43	+29E	Detroit	42	+32E
Glace Bay	46	00A	Saskatoon	52	+67C	Fairbanks	65	−10AL
Goose Bay	53	+ 2A	Sault Ste. Marie	47	+37E	Flagstaff	35	+27M
Granby	45	−09E	Shawinigan	47	−09E	Indianapolis	40	−15C
Guelph	44	+21E	Sherbrooke	45	−12E	Juneau	58	+58P
Halifax	45	+14A	Stratford	43	+24E	Kansas City	39	+18C
Hamilton	43	+20E	Sudbury	47	+24E	Los Angeles	34	−07P
Hull	45	+03E	Sydney	46	+01A	Louisville	38	−17C
Kapuskasing	49	+30E	The Pas	54	+45C	Memphis	35	00C
Kingston	44	+06E	Timmins	48	+26E	Miami	26	+21E
Kitchener	43	+22E	Toronto	44	+18E	Milwaukee	43	−09C
London	43	+25E	Three Rivers	46	−10E	Minneapolis	45	+13C
Medicine Hat	50	+23M	Thunder Bay	48	+57E	New Orleans	30	00C
Moncton	46	+19A	Trail	49	−09P	New York	41	−04E
Montreal	46	−06E	Truro	45	+13A	Omaha	41	+24C
Moosonee	51	+23E	Vancouver	49	+12P	Philadelphia	40	+01E
Moose Jaw	50	+62C	Victoria	48	+13P	Phoenix	33	+28M
Niagara Falls	43	+16E	Whitehorse	61	00Y	Pittsburgh	40	+20E
North Bay	46	+18E	Windsor	42	+32E	St. Louis	39	+01C
Ottawa	45	+03E	Winnipeg	50	+29C	San Francisco	38	+10P
Owen Sound	45	+24E	Yellowknife	62	+38M	Seattle	48	+09P
Penticton	49°	−02P				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 7.06; add 24 min. and we get 7.30 (Eastern Standard Time).

MAP OF STANDARD TIME ZONES



DEPARTMENT OF ENERGY, MINES AND RESOURCES 1969

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

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

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

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

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

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

BEGINNING OF MORNING AND ENDING OF EVENING TWILIGHT

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

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, 1971; LOCAL MEAN TIME

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

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

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

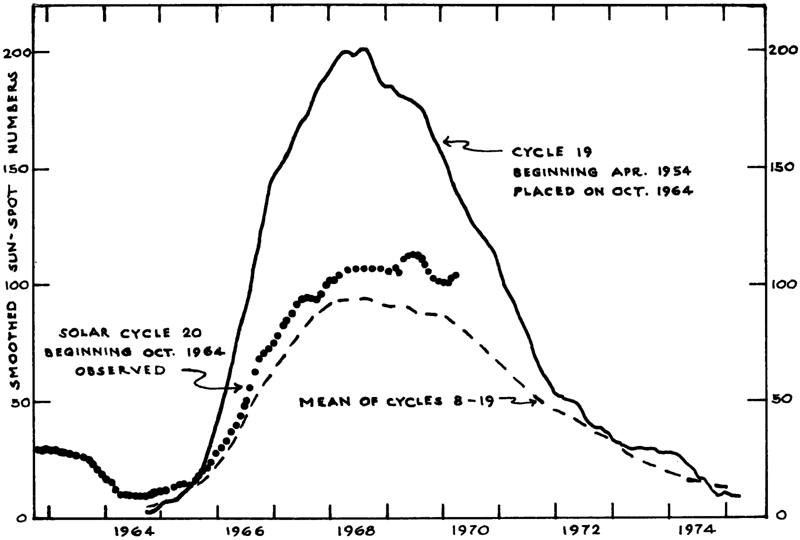
DATE	Latitude 30° Moon Rise	Latitude 30° Moon Set	Latitude 35° Moon Rise	Latitude 35° Moon Set	Latitude 40° Moon Rise	Latitude 40° Moon Set	Latitude 45° Moon Rise	Latitude 45° Moon Set	Latitude 50° Moon Rise	Latitude 50° Moon Set	Latitude 54° Moon Rise	Latitude 54° Moon Set
July	h m	h m	h m	h m	h m	h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

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

THE SUN

The diagram represents the sun-spot activity for 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 sun-spot number has remained constant near 110 for the past two years.



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 1971

Elong. East—Evening Sky			Elong. West—Morning Sky		
Date	Dist.	Mag.	Date	Dist.	Mag.
Apr. 1	19°	−0.1	Jan. 18	24°	0.0
July 29	27°	+0.6	May 17	26°	+0.7
Nov. 23	22°	−0.1	Sept. 12	18°	0.0

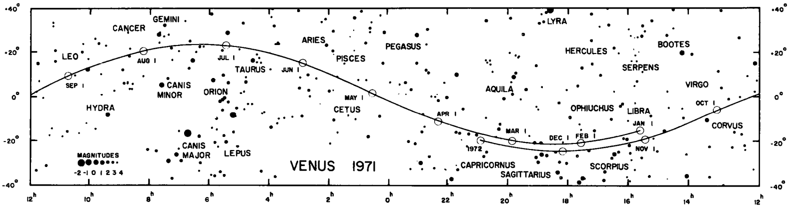
The most favourable elongations are: in the evening, April 1; in the morning, September 12. Neither of these elongations is exceptionally favourable. The apparent diameter of the planet ranges from 4.7″, at superior conjunction, through about 7.5″ at elongation, to 11″ at inferior conjunction.

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 January 1, 1971, Venus is near maximum brilliancy, magnitude −4.3, and reaches greatest elongation west on January 20. Its magnitude declines rapidly thereafter, remaining near −3.4 for most of the year. Superior conjunction occurs on August 27, and by the year's end, Venus is 32° east of the sun. The apparent diameter of Venus is greatest on January 1, being 33″ at that time.

Its brilliance is due to its nearness and to dense clouds enshrouding the planet. Visits by Mariner II and V, and by the Russian Venera IV spacecraft, revealed a surface temperature close to 1000° F, a surface pressure of perhaps 100 times that of the earth, and little or no magnetic field. The atmosphere consists mainly of carbon dioxide, and of course the clouds, whose nature is still uncertain.

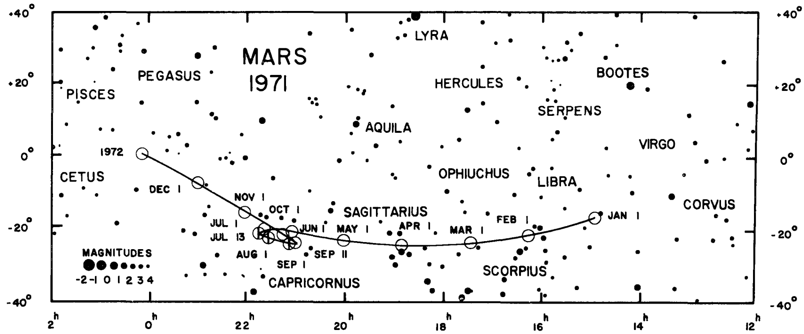


MARS

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 24 h. 37 m. 22.6689 s. 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. This discovery was confirmed in 1969 by Mariners VI and VII, which revealed also large areas free of craters, and other areas with unusual chaotic structure.

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. A very favourable opposition occurs on August 10, 1971, when the planet is only 35,000,000 miles from earth. Such favourable oppositions occur at intervals of 15 to 17 years.

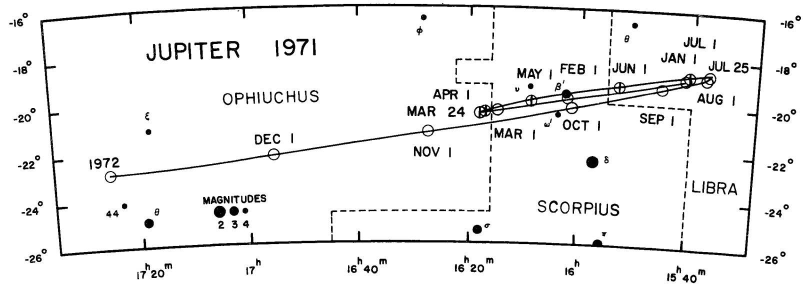
In January, Mars is in Libra; at opposition, it appears as a −2.6 magnitude object in Capricornus with an apparent diameter of 25″. Later in the year, it is an evening star in Pisces.



JUPITER

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

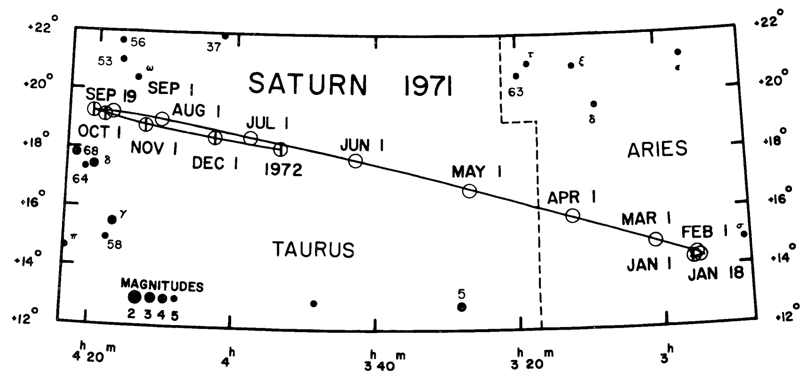
Jupiter is a fine object for the telescope. Many details of the cloud belts as well as the flattening of the planet, due to its short rotation period, are visible, and the phenomena of its satellites provide a continual interest.



On January 1, 1971, Jupiter is a morning star in Libra, from whence it moves rapidly into Scorpius. From March 23 until July 24, retrograde motion occurs and it crosses the boundary between Scorpius and Libra on the date of opposition, May 23, when it reaches its maximum brightness, −2.1 magnitude, and maximum apparent size, 42″. On December 9 it is in conjunction with the sun, and moves into the morning sky for the rest of the year.

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. (The tenth satellite was discovered in 1966.)



The ring system consists of an outer ring, of outer diameter 169,000 miles, Cassini's gap, of outer diameter 149,000 miles, an inner ring, of outer diameter

145,000 miles, and a dusky ring, of outer diameter 112,000 miles and inner diameter 93,000 miles. The equatorial diameter of the planet is 75,000 miles.

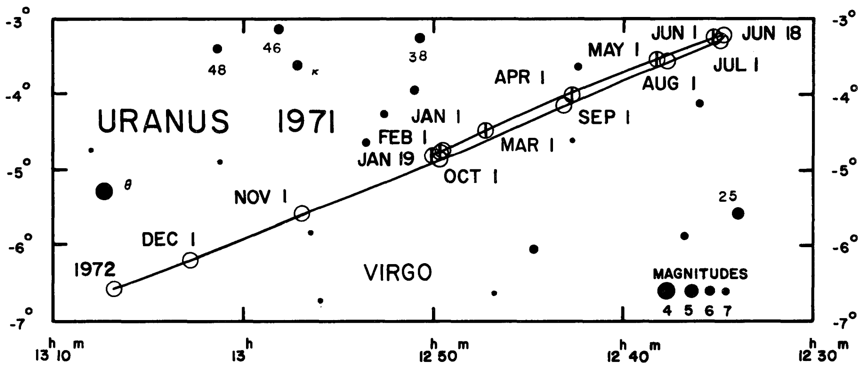
The inclination of the rings varies from 21° at the beginning of 1971 to 25° at the end. The major and minor axes reach a minimum of 37″ and 15″, respectively, in the spring, and a maximum of 46″ and 19″ in late autumn.

On January 1, 1971, Saturn is in Aries. Shortly thereafter, it moves into Taurus, where it remains for the rest of the year. Conjunction occurs on May 17, opposition on November 25, at which time the planet is visible all night as an object of magnitude −0.2. The apparent diameter of the ball of the planet reaches a maximum value of 18.4″ at opposition. The rings are open to over two-thirds of the maximum, 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.

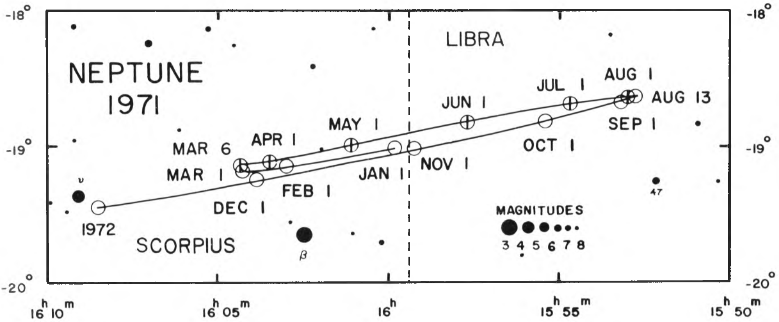
During 1971, Uranus is in Virgo (see map), faintly visible to the naked eye under good conditions. In January, it rises about midnight, and reaches opposition on April 1. At that time, its magnitude is +5.7, and its apparent diameter is about 4.0″. It remains an evening star until conjunction, on October 7, when it again moves into the morning sky.



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.

In January, Neptune is in Scorpius. On March 5, retrograde motion commences, and at opposition on May 23, the planet crosses from Scorpius into Libra. At that time, its magnitude is +7.7 and its apparent diameter is 2.5″. On August 12, eastward motion begins again, and Neptune, by now an evening star, moves rapidly into Scorpius. Neptune is close to Jupiter throughout much of 1971.



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 14th mag. star in the constellation Coma. At opposition on March 19, its position is: R.A. $12^h 20^m$, Dec. +15° 53′, and it is 2,830,000,000 miles from earth.

THE SKY MONTH BY MONTH

By John F. Heard

THE SKY FOR JANUARY 1971

Positions of the sun and planets are given for 0 h Greenwich Ephemeris Time.

The times of transit at the 75th meridian are given in local mean time, 0 h 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 18 h 43 m to 20 h 56 m and its Decl. changes from 23° 04′ S. to 17° 21′ S. The equation of time changes from −03 m 30 s to −13 m 29 s. 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 4th at a distance of 91,402,000 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. 20.

Mercury on the 1st is in R.A. 18 h 09 m, Decl. 20° 23′ S., and on the 15th is in R.A. 18 h 03 m, Decl. 21° 24′ S. Greatest western elongation is on the 18th; at that time Mercury stands about 15° above the south-eastern horizon at sunrise. For about a week centred on that date the planet may be seen low in the south-east just before sunrise.

Venus on the 1st is in R.A. 15 h 34 m, Decl. 15° 17′ S., and on the 15th is in R.A. 16 h 25 m, Decl. 17° 49′ S., mag. −4.2, and transits at 8 h 50 m. It is a very bright morning star rising about three hours before the sun. Greatest western elongation is on the 20th.

Mars on the 15th is in R.A. 15 h 31 m, Decl. 18° 19′ S., mag. +1.5, and transits at 21 h 55 m. Moving from Libra into Scorpius, it rises about four hours before sunrise. It is in close conjunction with Jupiter on the 25th.

Jupiter on the 15th is in R.A. 15 h 53 m, Decl. 19° 18′ S., mag. −1.4, and transits at 8 h 16 m. In Libra, it is a morning star rising about four hours before sunrise. It is in conjunction with Venus on the 4th and is in close conjunction with Mars on the 25th. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 70.

Saturn on the 15th is in R.A. 2 h 56 m, Decl. 14° 21′ N., mag. +0.3, and transits at 19 h 17 m. In Aries, it is high in the east at sunset and sets well before sunrise. On the 18th it is stationary in R.A. and resumes direct or eastward motion among the stars.

Uranus on the 15th is in R.A. 12 h 51 m, Decl. 4° 43′ S., and transits at 5 h 14 m.

Neptune on the 15th is in R.A. 16 h 03 m, Decl. 19° 02′ S., and transits at 8 h 25 m.

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

1971				JANUARY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 5h E.S.T.	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Fri.	1			Venus at perihelion	17 50	4O312	317.53
Sat.	2					d431O	329.70
Sun.	3	13		Quadrantid meteors		32O1*	341.87
		23	55	☽ First Quarter			
Mon.	4			Mercury greatest hel. lat. N.	14 40	31O24	354.03
				Earth at perihelion			
		0		Venus 3° N. of Jupiter			
Tues.	5					dO324	6.19
Wed.	6	13		Saturn 8° S. of moon		2O134	18.34
Thur.	7				11 30	21O34	30.48[b]
Fri.	8	0		Mercury stationary		O3124	42.62
		19		Venus 2° N. of Neptune			
Sat.	9	9		Pluto stationary		31O24	54.75[l]
Sun.	10				8 20	32O14	66.88
Mon.	11	8	20	○ Full Moon		31O24	79.01
Tues.	12					4O312	91.14
Wed.	13				5 10	42O3*	103.26
Thur.	14	14		Regulus 1° N. of moon		421O3	115.40
Fri.	15	9		Venus 8° N. of Antares		4O132	127.53
Sat.	16	6		Moon at apogee	2 00	431O2	139.67
Sun.	17					432O1	151.81
Mon.	18	3		Saturn stationary	22 50	431O*	163.96
		8		Uranus stationary			
		10		Uranus 5° N. of moon			
		23		Mercury greatest elong. W. (24°)			
Tues.	19	13	08	☾ Last Quarter		43O12	176.11
Wed.	20	11		Venus greatest elong. W. (47°)		2O43*	188.27
Thur.	21				19 40	21O43	200.44
Fri.	22			Venus greatest hel. lat. N.		O1234	212.61[lb]
		2		Mars 6° N. of moon			
		5		Jupiter 6° N. of moon			
		7		Neptune 7° N. of moon			
		17		Antares 0.5° N. of moon			
Sat.	23	7		Venus 8° N. of moon		13O24	224.79
Sun.	24				16 20	32O14	236.97
Mon.	25	0		Mercury 4° N. of moon		31O4*	249.16
		23		Mars 0.3° S. of Jupiter			
Tues.	26	17	55	● New Moon		3O124	261.35
Wed.	27	11		Mars 1.1° S. of Neptune	13 10	12O34	273.54
Thur.	28			Mercury at descending node		dd2O3	285.73
		5		Moon at perigee			
Fri.	29					4O123	297.93
Sat.	30				10 00	413O2	310.11
Sun.	31					432O1	322.30

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.

[l]Jan. 9, +5.36°; Jan. 22, −6.90°. [b]Jan. 7, −6.69°; Jan. 22, +6.79°.

THE SKY FOR FEBRUARY 1971

Positions of the sun and planets are given for 0 h Greenwich Ephemeris Time.

The times of transit at the 75th meridian are given in local mean time, 0 h 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 20 h 56 m to 22 h 45 m and its Decl. changes from 17° 21′ S. to 7° 55′ S. The equation of time changes from −13 m 37 s to a maximum of −14 m 19 s on the 11th, and then to −12 m 41 s at the end of the month. There is a partial eclipse of the sun, not visible in North America, on the 25th. 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. There is a total eclipse of the moon, visible in North America, on the night of the 9th–10th.

Mercury on the 1st is in R.A. 19 h 27 m, Decl. 22° 27′ S., and on the 15th is in R.A. 20 h 56 m, Decl. 19° 15′ S. It is too close to the sun for observation.

Venus on the 1st is in R.A. 17 h 39 m, Decl. 20° 41′ S., and on the 15th is in R.A. 18 h 45 m, Decl. 20° 48′ S., mag. −3.9, and transits at 9 h 08 m. It is a morning star, rising between two and three hours before the sun.

Mars on the 15th is in R.A. 16 h 52 m, Decl. 22° 10′ S., mag. +1.2, and transits at 7 h 14 m. In Scorpius and Ophiuchus, it rises about five hours before the sun.

Jupiter on the 15th is in R.A. 16 h 11 m, Decl. 20° 07′ S., mag. −1.6, and transits at 6 h 32 m. In Scorpius, it rises about six hours before the sun. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 70.

Saturn on the 15th is in R.A. 2 h 58 m, Decl. 14° 42′ N., mag. +0.5, and transits at 17 h 18 m. In Aries, it is close to the meridian at sunset and sets at about midnight.

Uranus on the 15th is in R.A. 12 h 50 m, Decl. 4° 34′ S., and transits at 3 h 11 m.

Neptune on the 15th is in R.A. 16 h 05 m, Decl. 19° 08′ S., and transits at 6 h 26 m. On the 2nd it is 0.8° north of Jupiter.

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

1971				FEBRUARY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 4h E.S.T.	Sun's Selen. Colong. 0 h U.T.
	d	h	m		h m		°
Mon.	1					4312O	334.47
Tues.	2	7		Jupiter 0.8° S. of Neptune	6 50	43O12	346.65
		9	31	☽ First Quarter			
		18		Saturn 8° S. of moon			
Wed.	3					d41O3	358.81[b]
Thur.	4					42O13	10.97[l]
Fri.	5	12		Mars 5° N. of Antares	3 40	4O23*	23.12
Sat.	6					1O342	35.27
Sun.	7			Mercury at aphelion		32O14	47.41
Mon.	8				0 30	321O4	59.55
Tues.	9					3O124	71.69
Wed.	10	2	41	○ Full Moon; eclipse of ☾, p. 58	21 20	1O234	83.82
		21		Regulus 1° N. of moon			
Thur.	11					2O134	95.96
Fri.	12	20		Moon at apogee		1O234	108.10
Sat.	13				18 10	dO324	120.24
Sun.	14	17		Uranus 5° N. of moon		d32O1	132.38
Mon.	15					3421O	144.53
Tues.	16				15 00	43O12	156.68
Wed.	17					41O32	168.84
Thur.	18	7	14	☾ Last Quarter		42O13	181.00[b]
		17		Neptune 7° N. of moon			
		20		Jupiter 6° N. of moon			
Fri.	19	2		Antares 0.5° N. of moon	11 50	41O3*	193.17
		18		Mars 5° N. of moon			
Sat.	20					4O132	205.35[l]
Sun.	21	22		Venus 5° N. of moon		432O1	217.53
Mon.	22				8 40	3241O	229.72
Tues.	23					3O142	241.92
Wed.	24					1O24*	254.12
Thur.	25	4	49	● New Moon; eclipse of ☉, p. 58	5 30	2O134	266.32
		16		Moon at perigee			
Fri.	26					1O34*	278.52
Sat.	27			Mercury greatest hel. lat. S.		O1324	290.73
Sun.	28				2 20	32O4*	302.93

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.
[l]Feb. 4, +6.57°; Feb. 20, −7.65°. [b]Feb. 3, −6.78°; Feb. 18, +6.85°.

Positions of the sun and planets are given for 0 h Greenwich Ephemeris Time.

The times of transit at the 75th meridian are given in local mean time, 0 h 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 22 h 45 m to 0 h 39 m and its Decl. changes from 7° 55′ S. to 4° 12′ N. The equation of time changes from −12 m 29 s to −4 m 20 s. For changes in the length of the day, see p. 14.

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

Mercury on the 1st is in R.A. 22 h 30 m, Decl. 11° 40′ S., and on the 15th is in R.A. 0 h 07 m, Decl. 0° 01′ N. Superior conjunction is on the 6th and Mercury passes east of the sun, becoming an evening star. During the last week of the month it is visible low in the west just after sunset.

Venus on the 1st is in R.A. 19 h 53 m, Decl. 19° 38′ S., and on the 15th is in R.A. 21 h 00 m, Decl. 16° 41′ S., mag. −3.6, and transits at 9 h 33 m. It is a morning star rising about two hours before the sun. On the 23rd at 20 h the geocentric position of Venus is only 0.3° south of the moon's, so that an occultation will be seen in some parts of the world.

Mars on the 15th is in R.A. 18 h 07 m, Decl. 23° 32′ S., mag. +0.8, and transits at 6 h 38 m. Moving into Sagittarius, it rises about five hours before the sun.

Jupiter on the 15th is in R.A. 16 h 19 m, Decl. 20° 25′ S., mag. −1.8, and transits at 4 h 49 m. In Scorpius, it rises at about midnight, an hour or so before Mars. On the 23rd it is stationary in R.A. and commences retrograde, or westward, motion among the stars. For the configuration of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 70.

Saturn on the 15th is in R.A. 3 h 06 m, Decl. 15° 23′ N., mag. +0.4, and transits at 15 h 36 m. In Aries, it is well past the meridian at sunset and sets an hour or more before midnight.

Uranus on the 15th is in R.A. 12 h 46 m, Decl. 4° 12′ S., and transits at 1 h 18 m.

Neptune on the 15th is in R.A. 16 h 05 m, Decl. 19° 07′ S., and transits at 4 h 36 m.

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

1971				MARCH E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 3h E.S.T.	Sun's Selen. Colong. 0 h U.T.
	d	h	m		h m		°
Mon.	1					d3204	315.12
Tues.	2	4		Saturn 8° S. of moon	23 10	30124	327.32
Wed.	3	21	01	☽ First Quarter		13402	339.50[b]
Thur.	4					42013	351.68[l]
Fri.	5	20		Neptune stationary	19 50	41203	3.86
Sat.	6	14		Mercury in superior conjunction		40123	16.02
Sun.	7					41302	28.19
Mon.	8				16 40	43201	40.35
Tues.	9			Mars at descending node		43012	52.50
Wed.	10	3		Regulus 1° N. of moon		43102	64.65
Thur.	11	21	34	○ Full Moon	13 30	24013	76.80
		23		Moon at apogee			
Fri.	12					21043	88.95
Sat.	13	21		Uranus 5° N. of moon		01234	101.11
Sun.	14				10 20	13024	113.26
Mon.	15					32104	125.41
Tues.	16					3024*	137.57
Wed.	17				7 10	31024	149.73[b]
Thur.	18			Mercury at ascending node		20134	161.90
		0		Neptune 7° N. of moon			
		6		Jupiter 6° N. of moon			
		9		Antares 0.4° N. of moon			
Fri.	19			Venus at descending node		21043	174.07
		10		Pluto at opposition			
		21	30	☾ Last Quarter			
Sat.	20	8		Mars 4° N. of moon	4 00	40123	186.25[l]
Sun.	21	1	38	Equinox. Spring begins		41032	198.44
Mon.	22					43201	210.64
Tues.	23			Mercury at perihelion	0 50	4310*	222.84
		9		Jupiter stationary			
		20		Venus 0.3° S. of moon			
Wed.	24	11		Pallas in conjunction with sun		d4302	235.04
Thur.	25				21 40	42013	247.26
Fri.	26	4		Moon at perigee		42103	259.47
		14	24	● New Moon			
Sat.	27	23		Mercury 3° S. of moon		40123	271.69
Sun.	28				18 30	1032*	283.91
Mon.	29	17		Saturn 7° S. of moon		32014	296.13
Tues.	30					3104*	308.34[b]
Wed.	31				15 20	30124	320.55

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.

[l] Mar. 4, +7.49°; Mar. 20, −7.59°.

[b] Mar. 3, −6.76°; Mar. 17, +6.74°; Mar. 30, −6.66°.

THE SKY FOR APRIL 1971

Positions of the sun and planets are given for 0 h Greenwich Ephemeris Time.

The times of transit at the 75th meridian are given in local mean time, 0 h 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 0 h 39 m to 2 h 30 m and its Decl. changes from 4° 12′ N. to 14° 49′ N. The equation of time changes from −4 m 02 s to +2 m 45 s, being zero on the 15th. For changes in the length of the day, see p. 14.

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

Mercury on the 1st is in R.A. 1 h 46 m, Decl. 13° 39′ N., and on the 15th is in R.A. 1 h 57 m, Decl. 14° 51′ N. Greatest eastern elongation is on the 1st; at that time Mercury stands about 19° above the western horizon at sunset. This is a favourable elongation, and Mercury will be easily seen during the first week of the month low in the west just after sunset. By the 19th, however, it is in inferior conjunction.

Venus on the 1st is in R.A. 22 h 20 m, Decl. 11° 06′ S., and on the 15th is in R.A. 23 h 24 m, Decl. 5° 18′ S., mag. −3.4, and transits at 9 h 54 m. It is a morning star, rising about an hour and a half before the sun.

Mars on the 15th is in R.A. 19 h 26 m, Decl. 22° 50′ S., mag. +0.3, and transits at 5 h 55 m. In Sagittarius, it rises about four hours before the sun.

Jupiter on the 15th is in R.A. 16 h 16 m, Decl. 20° 15′ S., mag. −2.0, and transits at 2 h 45 m. In Scorpius, it rises about three hours after sunset. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 70.

Saturn on the 15th is in R.A. 3 h 20 m, Decl. 16° 21′ N., mag. +0.4, and transits at 13 h 47 m. In Aries, it is low in the west at sunset and sets about two hours later.

Uranus on the 15th is in R.A. 12 h 41 m, Decl. 3° 41′ S., and transits at 23 h 07 m.

Neptune on the 15th is in R.A. 16 h 04 m, Decl. 19° 01′ S., and transits at 2 h 33 m.

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

1971				APRIL E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 1h E.S.T.	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Thur.	1	0		Mercury greatest elong. E. (19°)		d04**	332.76[l]
		17		Uranus at opposition			
Fri.	2			Mercury greatest hel. lat. N.		21034	344.96
		10	46	☽ First Quarter			
Sat.	3				12 10	01234	357.15
Sun.	4					10324	9.34
Mon.	5					23041	21.52
Tues.	6	9		Regulus 1° N. of moon	9 00	34120	33.70
Wed.	7					43012	45.87
Thur.	8	3		Moon at apogee		41302	58.04
Fri.	9	14		Mercury stationary	5 50	d4203	70.21
Sat.	10	1		Uranus 5° N. of moon		40123	82.38
		15	10	○ Full Moon			
Sun.	11					41032	94.54
Mon.	12				2 40	42301	106.71
Tues.	13					31240	118.88[b]
Wed.	14	5		Neptune 7° N. of moon	23 20	30412	131.05
		10		Jupiter 6° N. of moon			
		15		Antares 0.3° N. of moon			
Thur.	15					13024	143.23
Fri.	16					21034	155.41
Sat.	17	20		Mars 2° N. of moon	20 10	0134*	167.59[l]
Sun.	18	7	58	☾ Last Quarter		10234	179.79
Mon.	19	18		Mercury in inferior conjunction		23014	191.98
Tues.	20				17 00	32104	204.19
Wed.	21					30124	216.41
Thur.	22	15		Lyrid meteors		13402	228.63
		18		Venus 5° S. of moon			
Fri.	23			Venus at aphelion	13 50	42013	240.85
		13		Moon at perigee			
Sat.	24	23	02	● New Moon		403**	253.08
Sun.	25					41023	265.32
Mon.	26			Mercury at descending node	10 40	42301	277.55[b]
		9		Saturn 7° S. of moon			
Tues.	27					43210	289.79
Wed.	28					43012	302.02
Thur.	29				7 30	43102	314.24
Fri.	30					24013	326.47[l]

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.

[l]Apr. 1, +7.57°; Apr. 17, −6.72°; Apr. 30, +6.97°.

[b]Apr. 13, +6.60°; Apr. 26, −6.53°.

THE SKY FOR MAY 1971

Positions of the sun and planets are given for 0 h Greenwich Ephemeris Time.

The times of transit at the 75th meridian are given in local mean time, 0 h 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 2 h 30 m to 4 h 33 m and its Decl. changes from 14° 49′ N. to 21° 56′ N. The equation of time changes from +2 m 52 s to a maximum of +3 m 43 s on the 15th, and then to +2 m 27 s 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. 1 h 29 m, Decl. 7° 53′ N., and on the 15th is in R.A. 1 h 49 m, Decl. 7° 45′ N. It is a morning star during this month, and on the 17th it is at greatest western elongation. However, this elongation is unfavourable, Mercury being only about 11° above the eastern horizon at sunrise.

Venus on the 1st is in R.A. 0 h 35 m, Decl. 1° 59′ N. and on the 15th is in R.A. 1 h 38 m, Decl. 8° 21′ N., mag. −3.3, and transits at 10 h 10 m. It is a morning star, rising about an hour and a half before the sun.

Mars on the 15th is in R.A. 20 h 34 m, Decl. 20° 47′ S., mag. −0.4, and transits at 5 h 05 m. In Capricornus, it rises about four hours before the sun and is prominent in the south-east before dawn.

Jupiter on the 15th is in R.A. 16 h 03 m, Decl. 19° 42′ S., mag. −2.1, and transits at 0 h 34 m. In Scorpius, it rises at about sunset (being in opposition on the 23rd) and sets at about sunrise. For the configuration of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 70.

Saturn on the 15th is in R.A. 3 h 35 m, Decl. 17° 20′ N., and transits at 12 h 04 m. It is too close to the sun for easy observation, conjunction being on the 17th.

Uranus on the 15th is in R.A. 12 h 38 m, Decl. 3° 16′ S., and transits at 21 h 05 m.

Neptune on the 15th is in R.A. 16 h 01 m, Decl. 18° 52′ S., and transits at 0 h 32 m.

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

1971				MAY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 23h E.S.T.	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Sat.	1					O1234	338.69
Sun.	2	2	34	☽ First Quarter	4 20	dO134	350.90
		3		Mercury stationary			
Mon.	3					321O4	3.10
Tues.	4					3O214	15.31
Wed.	5	16		Moon at apogee	1 10	31O24	27.50
		16		η Aquarid meteors			
Thur.	6			Mercury at aphelion		2O314	39.69
Fri.	7	6		Uranus 5° N. of moon	22 00	21O43	51.88
Sat.	8					4O123	64.07
Sun.	9					4O23*	76.25
Mon.	10	6	24	○ Full Moon	18 50	4321O	88.43[b]
Tues.	11	9		Neptune 7° N. of moon		43O21	100.61
		11		Jupiter 6° N. of moon			
		21		Antares 0.1° N. of moon			
Wed.	12					431O2	112.79
Thur.	13				15 30	42O31	124.97
Fri.	14					421O3	137.16[l]
Sat.	15			Venus greatest hel. lat. S.		4O123	149.35
Sun.	16	5		Mars 1° S. of moon	12 20	1O423	161.55
Mon.	17	7		Saturn in conjunction with sun		d23O4	173.75
		12		Mercury greatest elong. W. (26°)			
		15	15	☾ Last Quarter			
Tues.	18					3O14*	185.96
Wed.	19				9 10	31O24	198.18
Thur.	20	13		Jupiter 0.7° S. of Neptune		2O14*	210.41
Fri.	21	12		Moon at perigee		21O34	222.64
Sat.	22	14		Venus 7° S. of moon	6 00	O1234	234.87
		16		Mercury 9° S. of moon			
Sun.	23	4		Jupiter at opposition		1O234	247.12[b]
		7		Neptune at opposition			
Mon.	24	7	32	● New Moon		23O14	259.36[b]
Tues.	25				2 50	342O1	271.61
Wed.	26			Mercury greatest hel. lat. S.		431O2	283.85
Thur.	27				23 40	423O1	296.10[l]
Fri.	28					421O3	308.34
Sat.	29					4O213	320.58
Sun.	30				20 10	41O23	332.81
Mon.	31	19	42	☽ First Quarter		423O1	345.04

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.

[l]May 14, −5.47°; May 27, +6.03°. [b]May 10, +6.52°; May 23, 24, −6.48°.

THE SKY FOR JUNE 1971

Positions of the sun and planets are given for 0 h Greenwich Ephemeris Time.

The times of transit at the 75th meridian are given in local mean time, 0 h 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 4 h 33 m to 6 h 37 m and its Decl. changes from 21° 56′ N. to 23° 10′ N. The equation of time changes from +2 m 18 s to −3 m 30 s, being zero on the 13th. 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. 3 h 09 m, Decl. 15° 15′ N., and on the 15th is in R.A. 4 h 57 m, Decl. 22° 42′ N. It is too close to the sun for observation, superior conjunction being on the 21st.

Venus on the 1st is in R.A. 2 h 57 m, Decl. 15° 20′ N., and on the 15th is in R.A. 4 h 06 m, Decl. 19° 48′ N., mag. −3.3, and transits at 10 h 36 m. It is a morning star, rising about an hour and a half before the sun.

Mars on the 15th is in R.A. 21 h 26 m, Decl. 18° 57′ S., mag. −1.2, and transits at 3 h 55 m. In Capricornus it is prominent in the south-eastern sky from before midnight until sunrise.

Jupiter on the 15th is in R.A. 15 h 47 m, Decl. 18° 59′ S., mag. −2.1, and transits at 22 h 12 m. In Libra, it is well up in the south-east at sunset and sets before sunrise. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 70.

Saturn on the 15th is in R.A. 3 h 51 m, Decl. 18° 13′ N., and transits at 10 h 18 m. In Taurus, it is a morning star, rising shortly before the sun.

Uranus on the 15th is in R.A. 12 h 36 m, Decl. 3° 06′ S., and transits at 19 h 01 m.

Neptune on the 15th is in R.A. 15 h 57 m, Decl. 18° 43′ S., and transits at 22 h 22 m.

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

1971				JUNE E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 22h E.S.T.	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Tues.	1					342O*	357.26
Wed.	2	9		Moon at apogee	17 20	31O42	9.48
Thur.	3	12		Uranus 5° N. of moon		d3O14	21.69
Fri.	4					21O34	33.89
Sat.	5				14 10	O2134	46.09
Sun.	6	7		Mercury 0.4° N. of Saturn		1O234	58.29
Mon.	7	12		Jupiter 6° N. of moon		23O14	70.48[b]
		15		Neptune 7° N. of moon			
Tues.	8	4		Antares 0.1° N. of moon	10 50	321O4	82.67
		19	04	Full Moon			
Wed.	9					d3O42	94.86[l]
Thur.	10	4		Ceres in conjunction with sun		34O21	107.05
		18		Vesta stationary			
Fri.	11	12		Venus 0.8° N. of Saturn	7 40	421O3	119.24
Sat.	12	5		Mercury 5° N. of Aldebaran		4O213	131.44
Sun.	13	8		Mars 4° S. of moon		41O23	143.64
Mon.	14			Mercury at ascending node	4 30	d42O1	155.84
		9		Pluto stationary			
Tues.	15	20	24	Last Quarter		4321O	168.05
Wed.	16					43O12	180.27
Thur.	17	5		Moon at perigee	1 20	43O2*	192.49
		18		Uranus stationary			
Fri.	18					21O3*	204.72
Sat.	19			Mercury at perihelion	22 00	O143*	216.96
Sun.	20	9		Venus 5° N. of Aldebaran		1O234	229.20[b]
		14		Saturn 7° S. of moon			
Mon.	21	5		Mercury in superior conjunction		2O314	241.45
		8		Venus 5° S. of moon			
		20	20	Solstice. Summer begins			
Tues.	22	16	57	New Moon	19 00	321O4	253.70
Wed.	23					3O124	265.95
Thur.	24					3O24*	278.21[l]
Fri.	25				15 50	21O34	290.46
Sat.	26					O413*	302.71
Sun.	27					41O23	314.95
Mon.	28				12 40	42O31	327.19
Tues.	29			Mercury greatest hel. lat. N.		4321O	339.43
Wed.	30	4		Moon at apogee		43O12	351.66
		13	11	First Quarter			
		20		Uranus 5° N. of moon			

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.

[l]June 9, −4.84°; June 24, +5.32°. [b]June 7, +6.60°; June 20, −6.61°.

THE SKY FOR JULY 1971

Positions of the sun and planets are given for 0 h Greenwich Ephemeris Time.

The times of transit at the 75th meridian are given in local mean time, 0 h 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 6 h 37 m to 8 h 42 m and its Decl. changes from 23° 10′ N. to 18° 15′ N. The equation of time changes from −3 m 42 s to a maximum of −6 m 27 s on the 26th and then to −6 m 21 s at the end of the month. There is a partial eclipse of the sun on the 22nd, not visible in North America. The earth is in aphelion on the 4th at a distance of 94,512,000 miles from the sun. 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. 7 h 27 m, Decl. 23° 51′ N. and on the 15th is in R.A. 9 h 09 m, Decl. 17° 35′ N. It is an evening star, and greatest eastern elongation is on the 29th. The elongation, however, is unfavourable, Mercury being only about 11° above the western horizon at sunset.

Venus on the 1st is in R.A. 5 h 29 m, Decl. 22° 50′ N., and on the 15th is in R.A. 6 h 43 m, Decl. 23° 14′ N., mag. −3.4, and transits at 11 h 15 m. It is a morning star, rising within an hour before sunrise.

Mars on the 15th is in R.A. 21 h 45 m, Decl. 19° 39′ S., mag. −2.1, and transits at 2 h 15 m. In Capricornus, it dominates the southern sky all night, rising shortly after sunset. On the 12th it is stationary in R.A. and begins to retrograde, or move westward among the stars.

Jupiter on the 15th is in R.A. 15 h 39 m, Decl. 18° 37′ S., mag. −1.9, and transits at 20 h 06 m. In Libra, it is approaching the meridian at sunset and sets shortly after midnight. On the 24th it is stationary in R.A. and resumes direct, or eastward, motion among the stars. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 70.

Saturn on the 15th is in R.A. 4 h 05 m, Decl. 18° 52′ N., mag. +0.4, and transits at 8 h 34 m. In Taurus, it rises about three hours before the sun.

Uranus on the 15th is in R.A. 12 h 37 m, Decl. 3° 15′ S., and transits at 17 h 05 m.

Neptune on the 15th is in R.A. 15 h 55 m, Decl. 18° 36′ S., and transits at 20 h 22 m.

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

1971				JULY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 22h E.S.T.	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Thur.	1				9 20	43102	3.88
Fri.	2	19		Mercury 5° S. of Pollux		42103	16.10
Sat.	3					42013	28.32
Sun.	4			Earth at aphelion	6 10	41023	40.52[b]
		16		Jupiter 6° N. of moon			
		23		Neptune 7° N. of moon			
Mon.	5	13		Antares 0.2° N. of moon		20431	52.73
Tues.	6					23104	64.92[l]
Wed.	7				3 00	30124	77.12
Thur.	8	5	37	○ Full Moon		31024	89.31
Fri.	9				23 50	2014*	101.50
Sat.	10	23		Mars 7° S. of moon		2034*	113.70
Sun.	11			Venus at ascending node		10234	125.89
Mon.	12	10		Moon at perigee	20 40	d0134	138.09
		22		Mars stationary			
Tues.	13					d2130	150.29
Wed.	14					34021	162.50
Thur.	15	0	47	☾ Last Quarter	17 30	43102	174.72
Fri.	16					42301	186.94
Sat.	17					4203*	199.17[b]
Sun.	18	2		Saturn 7° S. of moon	14 20	41023	211.41
Mon.	19					40213	223.65
Tues.	20					42130	235.89
Wed.	21				11 10	34021	248.14[l]
Thur.	22	4	15	● New Moon; eclipse of ⊙, p. 58		31042	260.40
		18		Vesta at opposition			
Fri.	23			Mercury at descending node		23014	272.65
Sat.	24	12		Mercury 1° N. of moon	7 50	21034	284.90
		22		Jupiter stationary			
Sun.	25					10234	297.15
Mon.	26	9		Mercury 1.1° S. of Regulus		02134	309.39
Tues.	27	22		Moon at apogee	4 40	21304	321.63
Wed.	28	5		Uranus 6° N. of moon		3014*	333.87
Thur.	29			δ Aquarid meteors		31042	346.10
		17		Mercury greatest elong. E. (27°)			
Fri.	30	6	07	☽ First Quarter	1 30	32401	358.33
Sat.	31					42103	10.55[b]

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.

[l]July 6, −5.22°; July 21, +5.30°.

[b]July 4, +6.76°; July 17, −6.75°; July 31, +6.85°.

THE SKY FOR AUGUST 1971

Positions of the sun and planets are given for 0 h Greenwich Ephemeris Time.

The times of transit at the 75th meridian are given in local mean time, 0 h 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 8 h 42 m to 10 h 38 m and its Decl. changes from 18° 15′ N. to 8° 36′ N. The equation of time changes from −6 m 17 s to −0 m 24 s. There is a partial eclipse of the sun on the 20th–21st, not visible in North America. 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 total eclipse of the moon on the 6th, not visible in North America.

Mercury on the 1st is in R.A. 10 h 25 m, Decl. 8° 05′ N., and on the 15th is in R.A. 10 h 41 m, Decl. 3° 45′ N. It is too close to the sun for observation; inferior conjunction is on the 26th.

Venus on the 1st is in R.A. 8 h 13 m, Decl. 20° 46′ N., and on the 15th is in R.A. 9 h 23 m, Decl. 16° 33′ N., mag. −3.5, and transits at 11 h 53 m. Early in the month it may be seen as a morning star rising just before the sun, but on the 27th it is in superior conjunction.

Mars on the 15th is in R.A. 21 h 22 m, Decl. 22° 37′ S., mag. −2.6, and transits at 23 h 45 m. In Capricornus, rising just before sunset, it dominates the southern sky all night. On the 10th it is in opposition, and on the 11th it is nearest the earth at a distance of 34,931,000 miles.

Jupiter on the 15th is in R.A. 15 h 41 m, Decl. 18° 51′ S., mag. −1.7, and transits at 18 h 06 m. In Libra, it is well past the meridian at sunset and sets before midnight. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 71.

Saturn on the 15th is in R.A. 4 h 16 m, Decl. 19° 16′ N., mag. +0.4, and transits at 6 h 43 m. In Taurus, it rises before midnight and is approaching the meridian at sunrise.

Uranus on the 15th is in R.A. 12 h 41 m, Decl. 3° 42′ S., and transits at 15 h 07 m.

Neptune on the 15th is in R.A. 15 h 54 m, Decl. 18° 35′ S., and transits at 18 h 19 m.

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

1971				AUGUST E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 21 h E.S.T.	Sun's Selen. Colong. 0 h U.T.
	d	h	m		h m		°
Sun.	1	0		Jupiter 6° N. of moon	22 20	4O123	22.76
		7		Neptune 7° N. of moon			
		22		Antares 0.2° N. of moon			
Mon.	2			Mercury at aphelion		4O23*	34.97
Tues.	3					421O3	47.17[l]
Wed.	4				19 10	432O1	59.37
Thur.	5					431O2	71.56
Fri.	6	14	42	○ Full Moon; eclipse of ☾, p. 58		432O1	83.75
Sat.	7	2		Mars 8° S. of moon	16 00	214O3	95.93
Sun.	8	20		Moon at perigee		O1243	108.12
Mon.	9					1O234	120.31
Tues.	10	2		Mars at opposition	12 50	d2O34	132.50
Wed.	11	19		Mercury stationary		32O14	144.69
		22		Mars nearest to ⊕			
Thur.	12	17		Perseid meteors		31O24	156.89
		19		Neptune stationary			
Fri.	13			Venus at perihelion	9 30	d3O14	169.10[b]
				Mars greatest hel. lat. S.			
		5	55	☾ Last Quarter			
Sat.	14	11		Saturn 7° S. of moon		21O34	181.32
Sun.	15					O2143	193.54
Mon.	16				6 20	41O23	205.77[l]
Tues.	17					d42O3	218.00
Wed.	18					432O*	230.24
Thur.	19				3 10	431O2	242.48
Fri.	20	11		Juno in conjunction with sun		43O21	254.72
		17	53	● New Moon; eclipse of ⊙, p. 58			
Sat.	21					421O*	266.96
Sun.	22			Mercury greatest hel. lat. S.	0 00	4O13*	279.21
Mon.	23					41O23	291.45
Tues.	24	15		Uranus 6° N. of moon	20 50	2O13*	303.69
		15		Moon at apogee			
Wed.	25					23O4*	315.92
Thur.	26	10		Mercury in inferior conjunction		31O24	328.15
Fri.	27	14		Venus in superior conjunction	17 40	3O214	340.38[b]
Sat.	28	11		Jupiter 6° N. of moon		213O4	352.60
		15		Neptune 7° N. of moon			
		21	56	☽ First Quarter			
Sun.	29	6		Antares 0.2° N. of moon		O134*	4.81
Mon.	30				14 30	1O234	17.02
Tues.	31					2O134	29.22[l]

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.

[l]Aug. 3, −6.13°; Aug. 16, +6.31°; Aug. 31, −6.98°.

[b]Aug. 13, −6.79°; Aug. 27, +6.80°.

THE SKY FOR SEPTEMBER 1971

Positions of the sun and planets are given for 0 h Greenwich Ephemeris Time.

The times of transit at the 75th meridian are given in local mean time, 0 h 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 10 h 38 m to 12 h 26 m and its Decl. changes from 8° 36′ N. to 2° 51′ S. The equation of time changes from −0 m 05 s to +9 m 54 s. 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. 9 h 59 m, Decl. 9° 12′ N., and on the 15th is in R.A. 10 h 25 m, Decl. 10° 55′ N. It is a morning star, greatest western elongation being on the 12th, at which time Mercury stands about 11° above the eastern horizon at sunrise. For a few days before and after this date it may be seen low in the east just before sunrise.

Venus on the 1st is in R.A. 10 h 45 m, Decl. 9° 28′ N., and on the 15th is in R.A. 11 h 49 m, Decl. 2° 40′ N., mag. −3.5, and transits at 12 h 16 m. It is now an evening star, but difficult to observe until the end of the month when it will be about 4° above the western horizon at sunset.

Mars on the 15th is in R.A. 21 h 05 m, Decl. 22° 18′ S., mag. −1.9, and transits at 21 h 27 m. In Capricornus, it is well up in the south-east at sunset and sets about two hours after midnight. It is beginning to decline in brilliancy, and on the 10th it is stationary in R.A. and resumes direct, or eastward, motion among the stars.

Jupiter on the 15th is in R.A. 15 h 54 m, Decl. 19° 39′ S., mag. −1.6, and transits at 16 h 18 m. Moving into Scorpius from Libra, it is well down in the south-west at sunset and sets within three hours. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 71.

Saturn on the 15th is in R.A. 4 h 20 m, Decl. 19° 22′ N., mag. +0.2, and transits at 4 h 45 m. In Taurus, north of Aldebaran, it rises late in the evening and is past the meridian by sunrise. On the 19th it is stationary in R.A. and begins to retrograde, or move westward among the stars.

Uranus on the 15th is in R.A. 12 h 47 m, Decl. 4° 22′ S., and transits at 13 h 11 m.

Neptune on the 15th is in R.A. 15 h 55 m, Decl. 18° 41′ S., and transits at 16 h 19 m.

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

1971			SEPTEMBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 19h E.S.T.	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Wed. 1					231O4	41.41
Thur. 2				11 10	34O12	53.60
Fri. 3	2		Mars 6° S. of moon		43O2*	65.78
	10		Vesta stationary			
Sat. 4			Venus greatest hel. lat. N.		4231O	77.95
	6		Mercury stationary			
	23	03	Full Moon			
Sun. 5				8 00	42O13	90.13
Mon. 6	0		Moon at perigee		41O23	102.30
Tues. 7					d4O13	114.48
Wed. 8			Mars at perihelion	4 50	d421O	126.65
Thur. 9					34O12	138.84[b]
Fri. 10			Mercury at ascending node		3O42*	151.02
	14		Mercury 0.5° S. of Regulus			
	19		Saturn 7° S. of moon			
	22		Mars stationary			
Sat. 11	13	23	Last Quarter	1 40	231O4	163.22
Sun. 12	0		Mercury greatest elong. W. (18°)		2O134	175.41
Mon. 13				22 30	1O234	187.62[l]
Tues. 14					O2134	199.83
Wed. 15			Mercury at perihelion		21O34	212.05
Thur. 16				19 20	3O214	224.27
Fri. 17	19		Jupiter 1.0° S. of Neptune		31O24	236.50
Sat. 18	2		Mercury 4° N. of moon		d32O4	248.72
Sun. 19	3		Saturn stationary	16 10	42O13	260.95
	9	42	New Moon			
Mon. 20					41O23	273.18
Tues. 21	0		Uranus 6° N. of moon		4O213	285.41
	1		Moon at apogee			
Wed. 22				12 50	421O3	297.64
Thur. 23	1		Pluto in conjunction with sun		43O1*	309.86
	11	45	Equinox. Autumn begins			
Fri. 24	23		Neptune 7° N. of moon		431O2	322.08[b]
Sat. 25			Mercury greatest hel. lat. N.	9 40	432O1	334.30
	1		Jupiter 6° N. of moon			
	13		Antares 0.04° N. of moon			
Sun. 26					24O**	346.50
Mon. 27	12	17	First Quarter		1O423	358.71
Tues. 28				6 30	O2143	10.90
Wed. 29					21O34	23.09[l]
Thur. 30	16		Mars 5° S. of moon		32O14·	35.27

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.

[l]Sept. 13, +7.49°; Sept. 29, −7.43°. [b]Sept. 9, −6.69°; Sept. 24, +6.67°.

THE SKY FOR OCTOBER 1971

Positions of the sun and planets are given for 0 h Greenwich Ephemeris Time.

The times of transit at the 75th meridian are given in local mean time, 0 h 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 12 h 26 m to 14 h 22 m and its Decl. changes from 2° 51′ S. to 14° 09′ S. The equation of time changes from +10 m 13s to +16 m 18 s. 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. 12 h 07 m, Decl. 1° 08′ N., and on the 15th is in R.A. 13 h 35 m, Decl. 9° 26′ S. It is too close to the sun all month for observation; superior conjunction is on the 8th.

Venus on the 1st is in R.A. 13 h 02 m, Decl. 5° 27′ S., and on the 15th is in R.A. 14 h 07 m, Decl. 12° 12′ S., mag. −3.4, and transits at 12 h 36 m. It is an evening star, visible very low in the western sky just after sunset.

Mars on the 15th is in R.A. 21 h 32 m, Decl. 18° 06′ S., mag. −1.1, and transits at 19 h 58 m. Moving from Capricornus into Aquarius, it is well up in the south-east at sunset and sets just after midnight.

Jupiter on the 15th is in R.A. 16 h 14 m, Decl. 20° 41′ S., mag. −1.4, and transits at 14 h 40 m. It is well down in the south-west at sunset and sets within two hours. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 71.

Saturn on the 15th is in R.A. 4 h 18 m, Decl. 19° 12′ N., mag. 0.0, and transits at 2 h 45 m. In Taurus, it rises about three hours after sunset.

Uranus on the 15th is in R.A. 12 h 54 m, Decl. 5° 06′ S., and transits at 11 h 20 m.

Neptune on the 15th is in R.A. 15 h 58 m, Decl. 18° 51′ S., and transits at 14 h 24 m.

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

1971				OCTOBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 18h E.S.T.	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Fri.	1				3 20	31O24	47.44
Sat.	2					32O14	59.61
Sun.	3					23104	71.77
Mon.	4	7	20	Full Moon	0 10	dO234	83.93
		10		Moon at perigee			
Tues.	5	12		Venus 3° N. of Spica		dO123	96.08
Wed.	6				21 00	421O3	108.24
Thur.	7	17		Uranus in conjunction with sun		423O1	120.40[b]
Fri.	8	2		Saturn 7° S. of moon		431O2	132.56
		10		Mercury in superior conjunction			
Sat.	9				17 50	d43O1	144.73
Sun.	10					4231O	156.91
Mon.	11	0	29	Last Quarter		d4O23	169.09[l]
Tues.	12				14 40	4O23*	181.27
Wed.	13					241O3	193.47
Thur.	14					d2O14	205.66
Fri.	15				11 30	31O24	217.87
Sat.	16					3O214	230.07
Sun.	17	8		Pallas stationary		231O4	242.28
Mon.	18	3		Moon at apogee	8 10	O134*	254.50
Tues.	19			Mercury at descending node		O234*	266.71
		2	59	New Moon			
Wed.	20	14		Venus 6° N. of moon		21O34	278.92
Thur.	21	19		Orionid meteors	5 00	2O314	291.13[b]
Fri.	22	6		Neptune 6° N. of moon		d31O2	303.34
		16		Jupiter 5° N. of moon			
		19		Antares 0.2° S. of moon			
Sat.	23					34O21	315.55
Sun.	24				1 50	4321O	327.75
Mon.	25					42O13	339.94
Tues.	26				22 40	41O23	352.13
Wed.	27	0	54	First Quarter		d42O3	4.31[l]
Thur.	28	19		Mars 4° S. of moon		42O13	16.49
Fri.	29			Mercury at aphelion	19 30	431O2	28.65
Sat.	30			Venus at descending node		34O12	40.81
		14		Jupiter 5° N. of Antares			
Sun.	31					321O4	52.96

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.

[l]Oct. 11, +8.09°; Oct. 27, −7.15°. [b]Oct. 7, −6.53°; Oct. 21, +6.56°.

Positions of the sun and planets are given for 0 h Greenwich Ephemeris Time.

The times of transit at the 75th meridian are given in local mean time, 0 h 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 14 h 22 m to 16 h 25 m and its Decl. changes from 14° 09′ S. to 21° 40′ S. The equation of time changes from +16 m 23 s to a maximum of +16 m 25 s on the 3rd, and then to +11 m 26 s at the end of the month. 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. 15 h 18 m, Decl. 19° 42′ S., and on the 15th is in R.A. 16 h 41 m, Decl. 24° 42′ S. It is an evening star, and greatest eastern elongation is on the 23rd. However, this is a most unfavourable elongation, Mercury being less than 10° above the south-western horizon at sunset.

Venus on the 1st is in R.A. 15 h 30 m, Decl. 19° 05′ S., and on the 15th is in R.A. 16 h 43 m, Decl. 22° 56′ S., mag. −3.3, and transits at 13 h 11 m. It is an evening star visible very low in the south-west for about an hour after sunset.

Mars on the 15th is in R.A. 22 h 28 m, Decl. 11° 24′ S., mag. −0.4, and transits at 18 h 53 m. In Aquarius, it is well up in the south-east at sunset and sets at about midnight.

Jupiter on the 15th is in R.A. 16 h 41 m, Decl. 21° 45′ S., mag. −1.3, and transits at 13 h 05 m. It is very low in the south-west at sunset and sets within an hour.

Saturn on the 15th is in R.A. 4 h 09 m, Decl. 18° 49′ N., mag. −0.2, and transits at 0 h 35 m. In Taurus, it rises just after sunset. Opposition is on the 25th.

Uranus on the 15th is in R.A. 13 h 01 m, Decl. 5° 48′ S., and transits at 9 h 25 m.

Neptune on the 15th is in R.A. 16 h 03 m, Decl. 19° 05′ S., and transits at 12 h 26 m.

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

1971				NOVEMBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 17 h E.S.T.	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Mon.	1	21		Moon at perigee	16 20	2O14*	65.11
Tues.	2	16	20	Full Moon		1O234	77.25
Wed.	3						89.39[b]
Thur.	4	10		Saturn 7° S. of moon	13 10		101.54
Fri.	5			Taurid meteors			113.68
Sat.	6	20		Venus 2° S. of Neptune			125.82
Sun.	7				9 50		137.97
Mon.	8	2		Mercury 4° S. of Neptune			150.13[l]
Tues.	9	15	51	Last Quarter			162.29
Wed.	10				6 40		174.46
Thur.	11	20		Venus 4° N. of Antares			186.63
Fri.	12	11		Mercury 2° N. of Antares			198.81
Sat.	13				3 30		210.99
Sun.	14	8		Venus 1.1° S. of Jupiter			223.18
		10		Moon at apogee			
		20		Mercury 3° S. of Jupiter			
		20		Uranus 6° N. of moon			
Mon.	15						235.38
Tues.	16				0 20		247.57
Wed.	17	13		Leonid meteors			259.77[b]
		20	46	New Moon			
Thur.	18			Mercury greatest hel. lat. S.	21 10		271.97
Fri.	19	1		Antares 0.3° S. of moon			284.17
		9		Jupiter 5° N. of moon			
		10		Pallas at opposition			
		19		Venus 3° N. of moon			
		19		Mercury 1° N. of moon			
Sat.	20						296.36
Sun.	21				18 00		308.56
Mon.	22						320.74
Tues.	23	13		Mercury greatest elongation E. (22°)			332.93
Wed.	24				14 50		345.11[l]
Thur.	25	11	37	First Quarter			357.28
		13		Neptune in conjunction with sun			
		18		Saturn at opposition			
Fri.	26	5		Mars 5° S. of moon			9.44
Sat.	27				11 40		21.60
Sun.	28						33.75
Mon.	29						45.89
Tues.	30	6		Moon at perigee	8 30		58.02[b]

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.

[l]Nov. 8, +7.84°; Nov. 24, −6.10°.

[b]Nov. 3, −6.50°; Nov. 17, +6.57°; Nov. 30, −6.56°.

THE SKY FOR DECEMBER 1971

Positions of the sun and planets are given for 0 h Greenwich Ephemeris Time.

The times of transit at the 75th meridian are given in local mean time, 0 h 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 16 h 25 m to 18 h 42 m and its Decl. changes from 21° 40′ S. to 23° 06′ S. The equation of time changes from +11 m 04 s to −2 m 53 s, being zero on the 25th. 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. 17 h 51 m, Decl. 25° 09′ S., and on the 15th is in R.A. 17 h 06 m, Decl. 20° 35′ S. It is too close to the sun for observation early in the month, inferior conjunction being on the 12th. By the end of the month it is approaching greatest western elongation; on the 31st it stands 15° above the south-eastern sky at sunrise.

Venus on the 1st is in R.A. 18 h 10 m, Decl. 24° 41′ S., and on the 15th is in R.A. 19 h 26 m, Decl. 23° 36′ S., mag. −3.4, and transits at 13 h 56 m. It is an evening star, visible low in the south-west for about two hours after sunset.

Mars on the 15th is in R.A. 23 h 24 m, Decl. 3° 31′ S., mag. +0.2, and transits at 18 h 00 m. Moving from Aquarius into Pisces, it is well up towards the meridian at sunset and sets at about midnight. It has by now declined considerably in brilliancy.

Jupiter on the 15th is in R.A. 17 h 10 m, Decl. 22° 32′ S., mag. −1.3, and transits at 11 h 36 m. It is too close to the sun for observation, being in conjunction on the 9th.

Saturn on the 15th is in R.A. 3 h 59 m, Decl. 18° 24′ N., mag. −0.1, and transits at 22 h 23 m. In Taurus, it is already risen at sunset and sets before sunrise.

Uranus on the 15th is in R.A. 13 h 06 m, Decl. 6° 19′ S., and transits at 7 h 32 m.

Neptune on the 15th is in R.A. 16 h 07 m, Decl. 19° 17′ S., and transits at 10 h 33 m.

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

1971				DECEMBER E.S.T.	Min. of Algol		Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Wed.	1	18		Saturn 7° S. of moon			70.16
Thur.	2	2	48	Full Moon			82.29
		22		Mercury stationary			
Fri.	3				5 20		94.41
Sat.	4			Venus at aphelion			106.54
Sun.	5						118.68
Mon.	6				2 00		130.81[l]
Tues.	7			Mercury at ascending node			142.95
Wed.	8				22 50		155.10
Thur.	9	11	02	Last Quarter			167.25
		23		Jupiter in conjunction with sun			
Fri.	10						179.41
Sat.	11				19 40		191.58
Sun.	12			Mercury at perihelion			203.75
		2		Moon at apogee			
		5		Uranus 6° N. of moon			
		16		Mercury in inferior conjunction			
Mon.	13						215.92
Tues.	14	9		Geminid meteors	16 30		228.10[b]
Wed.	15	23		Neptune 6° N. of moon			240.29
Thur.	16	8		Antares 0.3° S. of moon			252.48
Fri.	17	14	03	New Moon	13 20		264.66
Sat.	18						276.85
Sun.	19						289.04
Mon.	20	0		Venus 0.9° S. of moon	10 10		301.23[l]
Tues.	21						313.42
Wed.	22			Mercury greatest hel. lat. N.			325.60
		7	24	Solstice. Winter begins			
		17		Mercury stationary			
Thur.	23	3		Ursid meteors	7 00		337.77
Fri.	24	18		Mars 5° S. of moon			349.94
		20	35	First Quarter			
Sat.	25						2.10
Sun.	26			Venus greatest hel. lat. S.	3 50		14.25
Mon.	27	15		Ceres stationary			26.40[b]
Tues.	28	0		Moon at perigee			38.53
Wed.	29	0		Saturn 7° S. of moon	0 40		50.67
Thur.	30						62.80
Fri.	31	15	20	Full Moon	21 30		74.92

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.

[l]Dec. 6, +6.83°; Dec. 20, −4.92°. [b]Dec. 14, +6.70°; Dec. 27, −6.67°.

Date		P	B_0	L_0	Date		P	B_0	L_0
		°	°	°			°	°	°
Jan.	1	+ 2.33	−3.01	129.62	July	5	− 1.17	+3.28	207.92
	6	− 0.10	−3.58	63.77		10	+ 1.10	+3.81	141.75
	11	− 2.51	−4.12	357.93		15	+ 3.34	+4.31	75.58
	16	− 4.88	−4.64	292.09		20	+ 5.55	+4.78	9.42
	21	− 7.19	−5.11	226.25		25	+ 7.69	+5.21	303.27
	26	− 9.42	−5.55	160.42		30	+ 9.77	+5.62	237.13
	31	−11.55	−5.94	94.59	Aug.	4	+11.77	+5.98	171.00
Feb.	5	−13.58	−6.29	28.76		9	+13.67	+6.30	104.88
	10	−15.48	−6.58	322.93		14	+15.46	+6.58	38.78
	15	−17.24	−6.82	257.09		19	+17.15	+6.81	332.69
	20	−18.87	−7.01	191.24		24	+18.71	+7.00	266.61
	25	−20.35	−7.15	125.40		29	+20.15	+7.13	200.55
Mar.	2	−21.68	−7.23	59.54	Sept.	3	+21.45	+7.22	134.50
	7	−22.85	−7.25	353.67		8	+22.61	+7.25	68.47
	12	−23.86	−7.22	287.78		13	+23.63	+7.23	2.44
	17	−24.70	−7.13	221.88		18	+24.49	+7.16	296.43
	22	−25.37	−6.99	155.96		23	+25.20	+7.04	230.43
	27	−25.87	−6.80	90.03		28	+25.74	+6.86	164.44
Apr.	1	−26.19	−6.55	24.08	Oct.	3	+26.11	+6.63	98.46
	6	−26.34	−6.26	318.11		8	+26.31	+6.36	32.49
	11	−26.30	−5.93	252.12		13	+26.33	+6.03	326.53
	16	−26.07	−5.55	186.11		18	+26.16	+5.66	260.58
	21	−25.67	−5.13	120.07		23	+25.79	+5.25	194.63
	26	−25.08	−4.68	54.02		28	+25.24	+4.79	128.69
May	1	−24.30	−4.19	347.95	Nov.	2	+24.49	+4.30	62.76
	6	−23.35	−3.68	281.86		7	+23.54	+3.78	356.83
	11	−22.22	−3.14	215.75		12	+22.40	+3.22	290.91
	16	−20.92	−2.58	149.63		17	+21.06	+2.64	224.99
	21	−19.45	−2.00	83.49		22	+19.54	+2.04	159.09
	26	−17.83	−1.41	17.34		27	+17.85	+1.42	93.19
	31	−16.07	−0.81	311.18	Dec.	2	+15.99	+0.78	27.29
June	5	−14.18	−0.21	245.01		7	+13.98	+0.15	321.40
	10	−12.19	+0.39	178.84		12	+11.84	−0.49	255.51
	15	−10.09	+0.99	112.65		17	+ 9.59	−1.13	189.64
	20	− 7.93	+1.59	46.67		22	+ 7.26	−1.76	123.77
	25	− 5.70	+2.17	340.29		27	+ 4.87	−2.38	57.91
	30	− 3.44	+2.73	274.10					

Values are given for 0 h U.T. P is the position angle of the axis of rotation, measured eastward from the north point of the disk. B_0 is the heliographic latitude of the centre of the disk. L_0 is the heliographic longitude of the centre of the disk, from Carrington's solar meridian.

Carrington's Synodic Rotation Numbers

Greenwich date of commencement of synodic rotations, 1971, numbered in continuation of Carrington's Greenwich Photoheliographic series, of which no. 1 commenced on 1853 November 9.

1570	Jan.	10.84	1575	May	27.31	1580	Oct.	10.46
1571	Feb.	7.18	1576	June	23.51	1581	Nov.	6.76
1572	Mar.	6.52	1577	July	20.71	1582	Dec.	4.07
1573	Apr.	2.83	1578	Aug.	16.93	1583	Dec.	31.40
1574	Apr.	30.09	1579	Sept.	13.18			

THE OBSERVATION OF THE MOON

During 1971 the ascending node of the moon's orbit is in Capricornus (☊ from 326° to 305°). See p. 59 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 $\frac{1}{2}$° 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 0 h 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.

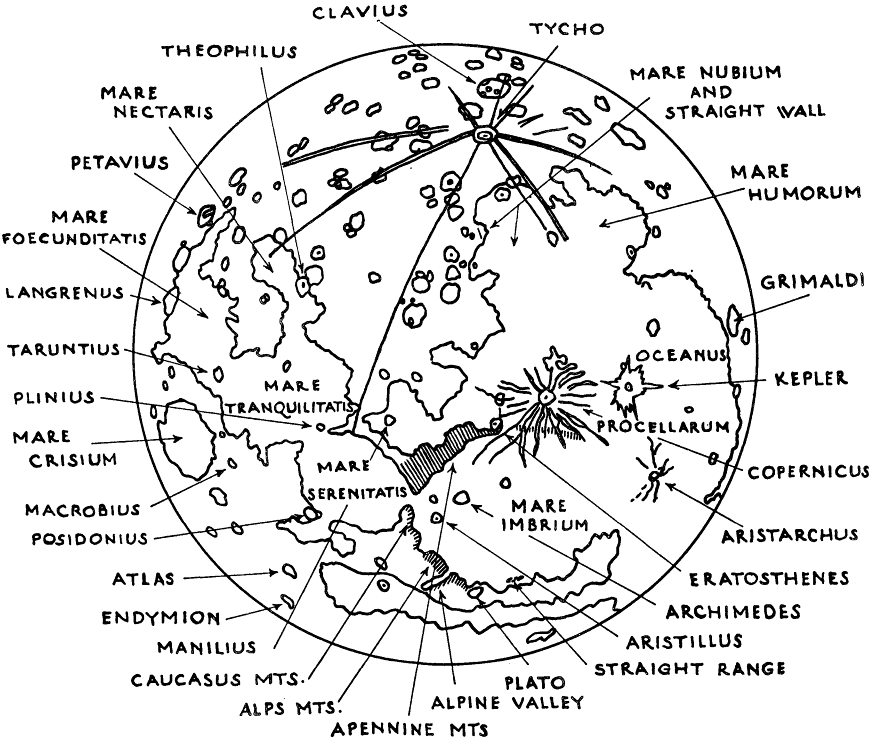
The sun's selenographic latitude varies between $+1\frac{1}{2}$° and $-1\frac{1}{2}$° during the year.

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.

ECLIPSES DURING 1971

In 1971 there will be five eclipses, three of the sun and two of the moon. Of these only the total eclipse of the moon on the night of February 9–10 will be visible in North America.

1. *A total eclipse of the moon* on the night of February 9–10, visible in North America.

Moon enters penumbra	February 9,	23 h 38 m E.S.T.
Moon enters umbra	February 10,	0 h 52 m E.S.T.
Total eclipse begins		2 h 3 m E.S.T.
Middle of the eclipse		2 h 45 m E.S.T.
Total eclipse ends		3 h 26 m E.S.T.
Moon leaves umbra		4 h 37 m E.S.T.
Moon leaves penumbra		5 h 51 m E.S.T.

Magnitude of the eclipse 1.313.

2. *A partial eclipse of the sun* on February 25, visible in the eastern Atlantic Ocean, in Europe and in north-west Africa.

3. *A partial eclipse of the sun* on July 22, visible in north-east Asia and the north-western tip of Alaska.

4. *A total eclipse of the moon* on the night of August 6, visible, generally speaking, in Asia, Australia, New Zealand, Africa, Europe and parts of South America and Antarctica.

5. *A partial eclipse of the sun* on August 20–21, visible in the south-eastern half of Australia, in New Zealand and in a part of Antarctica.

OCCULTATIONS BY THE MOON

The moon often passes between the earth and a star; the phenomenon is called an occultation. During an occultation a star suddenly disappears as the east limb of the moon crosses the line between the star and observer. This is referred to as immersion (I). The reappearance from behind the west limb of the moon is called emersion (E). Because the moon moves through an angle about equal to its own diameter every hour, the longest time for an occultation is about an hour. The time can be shorter if the occultation is not central. Occultations are equivalent to total solar eclipses, except that they are total eclipses of stars other than the sun.

The elongation of the moon is its angular distance from the sun, in degrees, counted eastward around the sky. Thus, elongations of 0°, 90°, 180° and 270° correspond to new, first quarter, full and last quarter moon. When elongation is less than 180°, a star will disappear at the dark limb and reappear at the bright limb. If the elongation is greater than 180° the reverse is true.

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. This formula must be evaluated with due regard for the algebraic signs of the terms. 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.

Since observing occultations is rather easy, provided the weather is good and the equipment is available, timing occultations should be part of any amateur's observing program. The method of timing is as follows: Using as large a telescope as is available, with a medium power eyepiece, the observer starts a stopwatch at the time of immersion or emersion. The watch is stopped again on a time signal from a WWV or CHU station. The elapsed time is read from the stopwatch and is then subtracted from the standard time signal to obtain the time of occultation. All times should be recorded to 0.1 second and all timing errors should be held to within 0.5 second if possible. The position angle P of the point of contact on the moon's disk reckoned from the north point towards the east may also be estimated.

The following information should be included: (1) Description of the star (catalogue number), (2) Date, (3) Derived time of the occultation, (4) Longitude and latitude to nearest second of arc, height above sea level to the nearest 100 feet, (5) Seeing conditions, (6) Stellar magnitude, (7) Immersion or emersion, (8) At dark or light limb; Presence or absence of earthshine, (9) Method used, (10) Estimate of accuracy, (11) Anomalous appearance: gradual disappearance, pausing on the limb. All occultation data should be sent to the world clearing house for occultation data: H.M. Nautical Almanac Office, Royal Greenwich Observatory, Herstmonceux Castle, Hailsham, Sussex, England.

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, 1971

Date		Z.C. No.	Mag.	Ph.	Elong. of Moon	Halifax U.T.	Halifax a	Halifax b	Halifax P	Montreal U.T.	Montreal a	Montreal b	Montreal P
					°	h m	m	m	°	h m	m	m	°
Jan.	2	3357	6.8	1	60		A			1 09.0	−1.0	−2.3	105
	3	0068	5.7	1	86	23 30.9	−1.8	−0.6	84	23 14.0	−1.6	+0.5	67
	5	0336	7.4	1	112	23 49.9	−2.5	−1.3	109	23 27.2	−1.9	+0.4	89
	7	0470	7.0	1	125	0 19.9	−2.0	+0.1	88	0 02.7	−1.6	+1.1	73
	7	0483	7.5	1	127		G			4 15.1	.	.	9
	15	1525	5.9	2	220	2 37.2	−0.5	−2.9	355	2 29.3	.	.	1
	15	1549	5.2	2	223	10 42.2	−0.4	−2.3	327	10 34.1	−0.8	−2.1	315
	31	0163	7.2	1	68	22 18.9	−1.2	+0.8	47		S		
Feb.	1	0177	7.1	1	70	1 25.9	−0.6	+0.3	41	1 19.7	−0.7	+0.5	38
	2	0311	6.5	1	83	2 18.0	−0.7	−0.1	51	2 10.1	−0.9	0.0	51
	5	0746	6.8	1	121	2 37.6	−1.5	−0.9	86	2 20.8	−1.7	−0.6	89
	5	0890	4.5	1	132	23 39.2	−1.6	+1.6	70	23 26.8	−1.2	+2.3	60
	6	0906	6.8	1	134	3 45.2	−1.1	−1.9	114	3 31.6	−1.3	−2.1	122
	6	0909	6.1	1	134		N			4 14.9	.	.	34
	7	1062	6.3	1	146	5 27.0	−2.1	+0.3	53	5 07.4	−1.9	−0.3	70
	12	1599	5.0	2	202	8 03.0	−1.0	−2.0	315	7 49.3	−1.5	−1.6	301
	13	1685	4.5	1	212	1 49.9	−0.5	+0.3	124		A		
	13	1685	4.5	2	212	3 00.1	−0.9	+0.2	303	2 52.7	−0.6	+0.5	297
	19	2383	2.9	1	282	9 28.8	−0.7	−0.8	155	9 27.2	.	.	176
	19	2383	2.9	2	282	10 19.4	−2.5	+1.2	231	9 52.8	.	.	215
Mar.	3	0538	5.6	1	79	2 36.6	−0.5	−0.8	69	2 30.3	−0.7	−1.0	76
	3	0542	5.8	1	79	3 05.3	+0.7	−3.3	143		G		
	3	0543	6.5	1	79	3 15.3	.	.	157		N		
	3	0555	6.8	1	79	3 55.6	−0.3	−0.1	45	3 51.9	−0.4	−0.5	56
	3	0701	6.5	1	90	23 32.5	−1.8	0.0	76	23 14.5	−1.8	+0.5	72
	6	1046	6.9	1	117		A			7 33.7	+0.3	−1.3	98
	9	1385	6.5	1	151	7 17.5	−0.5	−1.5	90	7 09.9	−0.7	−1.7	101
	10	1486	4.6	1	162	8 29.7	−0.1	−1.9	119	8 26.0	−0.3	−2.0	125
	29	0336	7.4	1	32	0 09.1	+0.2	−2.0	112	0 08.2	0.0	−2.5	118
Apr.	2	1099	6.0	1	95	23 44.1	−1.3	−2.4	136		S		
	5	1345	7.1	1	119	3 09.9	−0.4	−2.5	147	3 03.9	−0.2	−3.0	163
	6	1448	6.7	1	131	5 19.3	−0.2	−2.2	142	5 14.9	−0.2	−2.5	154
	7	1549	5.2	1	142	5 27.5	.	.	53	5 04.8	−2.1	−1.0	77
	14	2276	5.6	2	220	5 16.0	−1.7	+0.5	280	5 00.5	−1.6	+1.1	267
	29	0912	7.0	1	53		A			3 10.1	+0.3	−1.4	105
	30	1055	5.8	1	64	0 10.4	−0.6	−1.9	114		S		
May	1	1187	7.1	1	77	1 32.1	−0.4	−2.0	121	1 25.9	−0.5	−2.3	134
	2	1310	4.2	1	89	2 35.7	.	.	191		N		
	2	1321	6.7	1	90		N			5 12.2	.	.	46
	5	1599	5.0	1	122		N			2 00.8	.	.	65
	15	2861	5.7	2	238	7 10.2	−1.9	+0.3	285	6 53.3	−1.5	+0.7	288
	15	2864	4.7	2	239	7 30.3	−1.7	+0.8	239	7 14.6	−1.6	+1.2	243
	16	Mars	−0.4	1	252	9 22.0	−2.6	−0.5	107	8 59.4	−2.0	+0.5	92
	16	Mars	−0.4	2	252	10 17.3	−0.3	+1.4	193	10 10.7	−1.1	+0.9	212
	30	1375	5.6	1	69	2 15.6	+0.6	−2.8	176		G		
	31	1474	7.1	1	81	3 10.8	−0.1	−1.8	114	3 07.3	−0.3	−1.9	121
June	4	1852	6.0	1	124	2 48.3	−0.9	−2.3	161	2 38.8	−0.5	−2.4	174
	4	1858	6.5	1	125		A			4 49.1	−0.7	−2.9	174
	5	1960	6.9	1	135	2 30.6	−1.7	−1.3	118	2 13.5	−1.5	−1.0	129
	12	2961	6.0	2	221		S			6 57.7	−1.9	+0.4	270
	15	3367	6.4	2	260	6 45.8	.	.	302		N		
July	3	2027	7.2	1	115	1 46.1	−1.9	−0.8	78	1 25.0	−2.1	−0.5	86
	5	2276	5.6	1	139	3 16.5	−1.6	−0.8	81	2 58.3	−1.9	−0.4	80
	12	3334	6.3	2	229		N			5 46.7	−0.3	+2.5	181
	27	1688	6.3	1	51	0 29.2	−0.4	−2.1	130		S		
Aug.	8	2505	5.4	1	130	0 36.4	−2.0	+0.9	49		S		
	17	1055	5.8	2	317	7 06.0	−0.7	−0.4	327		N		
	28	2297	6.9	1	87	23 52.3	−1.7	−1.2	107		S		
	31	2601	6.7	1	111		A			2 38.5	−1.1	−0.5	63

Date		Z.C. No.	Mag.	Ph.	Elong. of Moon	Halifax U.T.	Halifax a	Halifax b	Halifax P	Montreal U.T.	Montreal a	Montreal b	Montreal P
					°	h m	m	m	°	h m	m	m	°
Sept.	2	2921	6.1	1	136	2 59.5	−0.9	+0.3	43	2 51.2	−0.8	+0.9	26
	2	2928	6.5	1	137	4 09.8	−1.0	−0.5	68	3 59.7	−1.0	0.0	52
	3	3079	4.2	1	151		A			6 33.3	−0.6	−0.3	56
	8	0233	6.2	2	220	4 04.7	−1.2	+1.3	260	3 54.2	−1.1	+1.2	277
	10	0539	4.4	1	250	8 51.3	−2.3	−2.1	123	8 28.3	−2.0	−0.3	107
	10	0539	4.4	2	250		S			9 32.6	−1.4	+2.2	218
	12	0844	5.7	2	273	4 29.0	−0.9	−0.2	321		N		
	12	0849	6.5	2	274	5 19.1	+0.1	+2.2	233	5 22.2	+0.2	+1.7	248
	14	1161	6.2	2	300		S			8 56.8	−0.9	+0.9	286
	29	2988	6.8	1	115	23 29.9	−2.1	+0.2	96	23 11.8	−1.7	+0.8	87
Oct.	8	0647	5.5	2	231		G			8 01.7	−1.2	+4.0	202
	16	1649	6.3	2	326		S			9 38.9	−0.4	+1.0	286
	24	2650	4.7	1	60		A			23 27.4	−0.8	−0.2	48
	26	2809	4.9	1	72		A			0 00.2	−1.9	−1.4	107
	27	3071	6.5	1	96	21 54.2	−1.1	+1.6	25		S		
	28	3079	4.2	1	97	0 57.5	−2.7	−2.5	118	0 33.7	−2.0	−0.6	92
	28	3091	6.9	1	98		A			2 46.8	−0.9	−0.8	74
	31	3507	6.4	1	139	3 45.0	−1.6	−1.2	92	3 28.7	−1.5	−0.1	74
	31	3512	5.8	1	140	5 41.3	−0.5	−0.1	52	5 35.2	−0.7	+0.3	43
Nov.	4	0537	3.8	1	196	3 00.7	−1.5	+0.7	94	2 49.4	−1.0	+1.4	78
	4	0539	4.4	1	196	3 31.8	−0.6	+3.1	26	3 36.1	.	.	357
	4	0541	4.0	1	196	3 35.0	−1.2	+1.7	59	3 27.4	−0.7	+2.3	43
	4	0537	3.8	2	196	4 06.6	−1.2	+2.0	228	3 56.6	−1.1	+1.6	242
	4	0536	5.4	2	196	4 14.2	−1.7	+0.6	264	3 58.3	−1.6	+0.5	278
	4	0539	4.4	2	196	4 23.0	−2.2	−1.0	297	3 55.6	.	.	324
	4	0552	3.0	1	196		N			4 15.3	.	.	132
	4	0541	4.0	2	196	4 46.9	−1.7	+0.4	265	4 29.8	−1.7	+0.3	278
	4	0552	3.0	2	196		N			4 51.6	.	.	192
	12	1611	5.7	2	295	6 50.6	−0.4	+1.4	274		A		
	23	3038	6.7	1	66	23 19.8	−0.7	+0.1	45	23 13.7	−0.6	+0.8	26
	23	3041	6.4	1	67	23 57.2	−0.4	+0.3	38	23 54.6	−0.2	+1.0	18
	28	0029	7.2	1	119	0 15.5	−1.4	+1.0	54	0 04.9	−1.0	+1.7	37
	28	0163	7.2	1	132	22 21.9	−1.2	+1.4	73	22 14.3	−0.7	+1.8	58
	29	0177	7.1	1	133	1 39.1	−2.2	−0.8	99	1 19.4	−1.7	+0.5	80
	30	0311	6.5	1	147	0 48.7	−0.2	+3.2	10		N		
Dec.	5	1118	6.0	2	215	1 03.0	+0.8	+3.9	213	1 11.4	+0.5	+2.3	233
	7	1375	5.6	2	240	3 00.0	.	.	356		N		
	10	1688	6.3	2	277	8 57.0	−1.7	+0.2	289	8 41.6	−1.5	+1.0	277
	21	3134	6.9	1	49	22 14.7	−0.2	+1.1	18	22 18.8	.	.	349
	22	3149	7.1	1	49		A			0 09.0	−0.8	−1.1	80
	28	0438	6.7	1	132	7 00.2	+0.3	−1.9	114	7 00.8	+0.2	−2.4	123
	28	0536	5.4	1	142	23 05.0	−1.0	+1.6	67	22 58.9	−0.5	+2.1	51
	28	0537	3.8	1	142	23 05.3	−1.6	+0.5	104	22 53.4	−1.0	+1.3	87
	28	0539	4.4	1	142	23 29.8	−0.7	+2.6	36	23 29.4	+0.2	+3.7	15
	28	0541	4.0	1	142	23 36.6	−1.2	+1.5	68	23 28.6	−0.7	+2.0	52
	28	0543	6.5	1	142	23 55.7	−0.9	+2.5	38	23 53.4	0.0	+3.6	17
	28	0542	5.8	1	142	23 56.6	−0.7	+3.0	28	23 59.0	.	.	2

Phase 1 = Disappearance 2 = Reappearance A = Low S = Sun G = Graze N = No occn.

LUNAR OCCULTATIONS VISIBLE AT TORONTO AND WINNIPEG, 1971

Date		Z.C. No.	Mag.	Ph.	Elong. of Moon	Toronto U.T.	Toronto a	Toronto b	Toronto P	Winnipeg U.T.	Winnipeg a	Winnipeg b	Winnipeg P
					°	h m	m	m	°	h m	m	m	°
Jan.	2	3357	6.8	1	60	1 06.5	−1.3	−2.3	106	0 39.9	−1.0	−0.1	60
	3	0068	5.7	1	86	23 03.6	−1.6	+0.9	62		S		
	5	0233	6.2	1	102		A			6 01.3	−0.5	+0.2	37
	5	0336	7.4	1	112	23 15.1	−1.8	+0.9	84		S		

Date	Z.C. No.	Mag.	Ph.	Elong. of Moon	Toronto					Winnipeg		
					U.T.	a	b	P	U.T.	a	b	P
					h m	m	m	°	h m	m	m	°
Jan. 6	0370	6.1	1	116	6 49.3	−0.3	−0.3	54	6 39.2	−0.7	−0.1	46
6	0470	7.0	1	125	23 51.5	−1.4	+1.4	70	23 49.9	−0.2	+2.6	29
7	0483	7.5	1	127	3 59.7	−1.6	+2.5	24		N		
15	1525	5.9	2	220	2 31.6	−0.4	−2.2	351		N		
15	1549	5.2	2	223	10 32.2	−1.1	−1.9	305	9 57.4	−1.7	−0.9	287
30	3460	7.1	1	43		A			1 46.8	−0.5	−0.9	73
Feb. 1	0177	7.1	1	70	1 13.9	−0.9	+0.5	43	1 09.3	−0.4	+3.2	2
2	0311	6.5	1	83	2 04.3	−1.1	−0.1	58	1 48.4	−1.0	+1.5	29
3	0470	7.0	1	99		A			6 59.6	0.0	−1.2	79
5	0746	6.8	1	121	2 11.5	−1.9	−0.7	97	1 41.1	−1.5	+1.2	71
5	0890	4.5	1	132	23 16.5	−0.9	+2.3	60		N		
6	0906	6.8	1	134	3 28.0	−1.4	−2.7	134	2 47.2	−1.7	−0.8	116
6	0909	6.1	1	134	3 56.8	−2.3	+1.1	55	3 31.1	.	.	38
7	1061	6.1	1	146	4 40.6	−2.8	+1.6	53	4 09.5	.	.	45
7	1062	6.3	1	146	4 57.5	−1.8	−0.7	85	4 22.7	−1.8	+0.3	83
12	1599	5.0	2	202	7 42.0	−1.9	−1.1	288	7 03.8	−2.0	+0.6	270
13	1685	4.5	2	212	2 47.9	−0.5	+0.9	287		A		
Mar. 3	0538	5.6	1	79	2 28.1	−0.8	−1.2	87	2 03.6	−1.3	−0.6	76
3	0555	6.8	1	79	3 50.7	−0.4	−0.7	68	3 34.5	−0.9	−0.7	66
3	0571	6.9	1	80		A			5 11.4	−0.7	−0.1	42
3	0574	6.8	1	80		A			5 29.3	−0.5	−0.3	45
6	1046	6.9	1	117	7 38.0	+0.3	−1.5	107	7 29.7	0.0	−1.9	117
6	1049	6.6	1	117		A			7 58.4	+0.2	−1.9	124
7	1178	6.2	1	129		N			9 35.1	.	.	38
9	1385	6.5	1	151	7 08.9	−0.8	−1.8	111	6 41.1	−1.0	−1.9	126
10	1486	4.6	1	162	8 27.9	−0.3	−2.1	133	8 06.0	−0.5	−2.2	147
29	0336	7.4	1	32	0 13.9	+0.1	−3.9	134		S		
Apr. 1	0833	7.1	1	74		A			5 37.0	+0.2	−1.6	104
4	1250	5.9	1	110	6 53.6	−0.2	−1.0	67	6 38.1	−0.6	−1.5	81
5	1345	7.1	1	119	3 11.0	.	.	183		N		
6	1448	6.7	1	131	5 18.8	0.0	−2.8	166	5 04.1	.	.	193
7	1549	5.2	1	142	4 55.1	−1.9	−1.2	92	4 16.4	−1.6	−0.8	111
18	2907	6.3	2	269	8 54.6	−1.4	+1.0	272		A		
28	0750	6.9	1	41		A			2 50.9	−0.1	−1.4	91
29	0912	7.0	1	53	3 14.7	+0.3	−1.6	115	3 07.0	0.0	−2.0	124
29	0926	7.0	1	54		A			4 41.2	−0.3	−0.6	48
May 1	1187	7.1	1	77	1 28.0	−0.4	−2.7	147		S		
2	1321	6.7	1	90	5 09.8	−0.5	−0.8	60	4 49.2	−0.9	−1.4	76
2	1327	6.8	1	91		A			6 26.1	+0.3	−2.0	146
5	1599	5.0	1	122	1 42.4	−2.7	0.0	88		S		
14	2721	3.3	1	228		S			9 42.8	−1.5	+0.4	58
15	2861	5.7	2	238	6 43.6	−1.3	+0.9	285		A		
15	2864	4.7	2	239	7 02.9	−1.6	+1.4	241		A		
16	Mars	−0.4	1	252	8 46.6	−1.9	+0.8	89	8 27.8	−1.1	+1.5	77
16	Mars	−0.4	2	252	10 01.8	−1.3	+1.1	218	9 43.1	−1.4	+1.2	240
29	1276	6.7	1	59		A			4 26.5	+0.3	−1.9	137
31	1474	7.1	1	81	3 09.1	−0.4	−2.0	128		S		
June 4	1852	6.0	1	124	2 43.2	.	.	191		N		
4	1858	6.5	1	125	4 50.9	.	.	181		G		
5	1960	6.9	1	135	2 07.0	−1.3	−1.1	139		S		
12	2961	6.0	2	221	6 45.8	−1.8	+0.7	273		A		
27	1439	5.9	1	49	2 32.7	−0.2	−1.3	77		S		
27	1442	Var.	1	50		A			3 05.0	−0.1	−2.0	130
30	1726	6.9	1	83	3 13.7	−0.5	−2.3	145		S		
July 5	2276	5.6	1	139	2 47.1	−2.1	−0.1	85		S		
12	3334	6.3	2	229	5 40.1	−0.4	+2.5	187	5 44.5	−0.5	+2.0	207
Aug. 31	2601	6.7	1	111	2 32.2	−1.3	−0.2	60	2 09.4	−1.4	+0.5	37
Sept. 1	2781	7.4	1	124	4 02.5	−1.8	−1.4	106	3 29.7	−1.5	−0.1	75
2	2921	6.1	1	136	2 44.3	−0.9	+1.3	20		N		
2	2928	6.5	1	137	3 53.3	−1.1	+0.3	46	3 43.5	−0.5	+1.4	9
3	3079	4.2	1	151	6 30.0	−0.7	−0.1	52	6 25.8	+0.1	+1.4	6

DATE	Z.C. No.	Mag.	Ph.	Elong. of Moon	Toronto				Winnipeg			
					U.T.	a	b	P	U.T.	a	b	P
					h m	m	m	°	h m	m	m	°
Sept. 3	3086	6.0	1	152		N			6 53.5	−1.7	−1.5	104
8	0233	6.2	2	220	3 45.8	−1.0	+1.1	283		N		
10	0539	4.4	1	250	8 16.7	−2.0	0.0	105	8 00.4	−0.7	+1.8	65
10	0541	4.0	1	250		N			8 15.9	−1.2	+1.0	96
10	0536	5.4	2	250		N			8 47.1	−0.7	+2.2	225
10	0539	4.4	2	250	9 20.6	−1.2	+2.5	216	9 09.3	−1.2	+1.3	255
10	0538	5.6	2	250	9 30.7	−2.4	−1.5	299		N		
10	0541	4.0	2	250		N			9 19.1	−0.9	+2.2	225
10	0542	5.8	2	250		S			9 32.5	−1.4	+0.9	262
10	0543	6.5	2	250		S			9 36.0	−1.3	+1.2	254
12	0849	6.5	2	274	5 20.4	+0.3	+1.5	251		A		
14	1161	6.2	2	300	8 50.6	−0.7	+0.9	285	8 43.3	−0.6	0.0	322
26	2397	6.5	1	68	0 05.9	.	.	153		S		
29	2861	5.7	1	104		N			1 08.6	.	.	143
Oct. 8	0647	5.5	2	231	7 48.1	.	.	198	7 46.4	−1.0	+1.7	243
24	2650	4.7	1	60	23 22.3	−1.0	+0.1	44		S		
25	2809	4.9	1	72	23 51.0	−2.0	−1.0	101		S		
27	3079	4.2	1	97	24 22.6	−2.0	−0.1	86	23 57.1	−1.3	+1.0	57
28	3091	6.9	1	98	2 42.2	−1.1	−0.5	70	2 26.8	−0.7	+0.6	29
29	3238	7.0	1	112		A			5 15.9	−0.9	−1.0	79
30	3362	5.9	1	124		N			2 21.2	−2.0	+0.1	98
31	3507	6.4	1	139	3 19.4	−1.6	+0.3	70	3 04.6	−0.8	+1.6	30
31	3512	5.8	1	140	5 30.2	−0.8	+0.4	44	5 29.3	+0.1	+3.1	355
Nov. 4	0537	3.8	1	196	2 41.8	−0.7	+1.5	74	2 48.3	+0.1	+2.2	39
4	0541	4.0	1	196	3 19.9	−0.4	+2.4	40		N		
4	0545	4.2	1	196		N			3 13.6	−0.7	+1.3	95
4	0537	3.8	2	196	3 47.4	−1.0	+1.6	245	3 38.3	−0.9	+1.0	283
4	0536	5.4	2	196	3 48.0	−1.6	+0.6	281		N		
4	0552	3.0	1	196	4 03.3	−2.4	−1.0	127	3 44.0	−0.7	+1.4	82
4	0541	4.0	2	196	4 19.1	−1.7	+0.4	280		N		
4	0545	4.2	2	196		N			4 09.2	−0.4	+2.1	226
4	0560	3.8	1	197		N			4 35.5	−1.7	−0.2	125
4	0552	3.0	2	196	4 42.1	−0.2	+4.1	194	4 46.3	−0.8	+1.8	240
4	0560	3.8	2	197		N			5 14.7	−0.1	+3.4	198
4	0561	5.2	2	197		N			5 27.3	−0.7	+2.3	220
6	0900	4.9	2	224		N			5 07.7	0.0	+2.9	220
7	1070	5.2	2	237		N			6 45.2	−0.4	+3.1	229
7	1092	5.8	2	240		S			12 07.2	−0.6	−3.1	333
10	1439	5.9	2	275		S			11 05.8	−0.6	−2.9	352
10	1441	6.4	2	275		S			12 09.4	−1.0	−1.8	331
10	1442	Var.	2	275		S			12 30.2	−1.3	−1.1	308
23	3038	6.7	1	66	23 08.7	−0.5	+1.2	20		N		
23	3041	6.4	1	67	23 51.6	−0.1	+1.5	11		N		
24	3058	5.9	1	68		N			2 11.0	−1.5	−2.0	107
25	3186	6.7	1	80		N			1 25.6	−1.5	−0.5	80
27	0029	7.2	1	119	23 56.2	−0.8	+2.0	31		N		
29	0177	7.1	1	133	1 08.2	−1.7	+0.9	75	0 58.4	−0.6	+1.9	37
Dec. 4	1030	3.2	1	206		N			10 23.8	.	.	38
4	1030	3.2	2	206		N			10 49.3	.	.	355
10	1688	6.3	2	277	8 29.8	−1.6	+2.0	261	8 23.0	−0.6	+1.8	269
21	3149	7.1	1	49	24 05.7	−1.0	−0.9	78	23 49.0	−0.7	+0.4	37
24	3420	7.1	1	76		A			3 00.0	−0.9	−1.0	79
28	0438	6.7	1	132	7 07.6	+0.4	−3.6	140	6 44.8	−0.6	−3.0	126
28	0537	3.8	1	142	22 45.9	−0.8	+1.4	83	22 51.1	0.0	+2.0	50
28	0536	5.4	1	142	22 52.7	−0.3	+2.1	47		G		
28	0541	4.0	1	142	23 21.3	−0.5	+2.1	48		G		
28	0539	4.4	1	142	23 24.7	+0.7	+4.1	8		N		
28	0543	6.5	1	142	23 47.4	+0.4	+3.9	12		N		
28	0545	4.2	1	142		N			23 22.5	−0.8	+1.0	108
28	0552	3.0	1	142		G			23 51.7	−0.7	+1.3	92
29	0561	5.2	1	143		N			0 42.1	−1.4	+0.4	115
29	0552	3.0	2	142		G			0 51.1	−0.5	+2.1	231

Phase 1 = Disappearance 2 = Reappearance A = Low S = Sun G = Graze N = No occn.

LUNAR OCCULTATIONS VISIBLE AT EDMONTON AND VANCOUVER, 1971

Date	Z.C. No.	Mag.	Ph.	Elong. of Moon	Edmonton U.T.	Edmonton a	Edmonton b	Edmonton P	Vancouver U.T.	Vancouver a	Vancouver b	Vancouver P
				°	h m	m	m	°	h m	m	m	°
Jan. 2	3357	6.8	1	60	0 27.5	−0.7	+0.9	30		S		
2	3380	6.2	1	63		A			5 00.1	−0.3	−0.3	50
3	3515	6.2	1	76	5 28.7	−0.2	0.0	39	5 25.5	−0.5	−0.1	49
5	0233	6.2	1	102	5 53.1	−0.7	+1.0	24	5 41.5	−0.9	+0.7	37
6	0370	6.1	1	116	6 26.7	−0.9	+0.5	38	6 14.8	−1.2	+0.3	53
15	1549	5.2	2	223	9 28.8	−1.7	+0.6	272	8 59.1	.	.	236
16	1635	5.4	2	233		N			8 11.7	.	.	9
16	1637	6.0	2	234		N			9 45.4	−0.5	−1.7	345
19	1944	5.6	2	268	13 20.1	−0.5	−1.2	345	13 16.4	−1.0	−0.8	324
21	2174	6.4	2	291	13 46.5	.	.	356	13 45.8	−0.6	−0.4	330
29	3322	6.4	1	30		A			2 34.0	−0.9	−2.5	109
30	3460	7.1	1	43	1 35.8	−0.6	−0.1	50		S		
Feb. 2	0311	6.5	1	83	1 49.0	.	.	349		S		
2	0336	7.4	1	86	6 30.7	+0.1	−2.7	120		N		
3	0470	7.0	1	99	6 51.8	−0.4	−1.4	83	6 53.9	−0.5	−1.9	102
5	0746	6.8	1	121	1 29.1	−0.8	+2.5	47		S		
5	0773	6.9	1	123		N			6 59.2	−1.8	+1.3	41
6	0906	6.8	1	134	2 22.7	−1.3	+0.7	98	2 06.9	−1.2	+0.8	103
6	0909	6.1	1	134		N			2 55.3	.	.	28
7	1061	6.1	1	146		G			3 27.0	−0.9	+3.4	48
7	1062	6.3	1	146	3 59.4	−1.4	+1.4	74	3 40.2	−1.3	+1.3	87
7	1099	6.0	1	149	12 11.6	0.0	−1.3	70	12 16.6	−0.1	−1.4	85
8	1224	5.4	1	161	12 35.2	+0.2	−1.7	115	12 44.3	+0.2	−1.9	126
12	1599	5.0	2	202	6 39.1	−1.6	+2.1	258		N		
Mar. 3	0542	5.8	1	79	2 22.0	.	.	151		N		
3	0555	6.8	1	79	3 16.4	−1.2	−0.2	63	3 04.6	−1.5	−0.4	78
3	0571	6.9	1	80	4 58.6	−0.9	−0.2	47	4 50.7	−1.0	−0.6	68
3	0574	6.8	1	80	5 18.0	−0.7	−0.4	52	5 12.5	−0.9	−0.8	72
6	1046	6.9	1	117	7 20.0	−0.2	−2.3	129	7 28.9	0.0	−3.1	153
6	1049	6.6	1	117	7 52.2	0.0	−2.4	137	8 05.0	+0.5	−3.4	162
6	1055	5.8	1	118	9 33.5	+0.7	−2.3	155		N		
7	1178	6.2	1	129	9 19.5	−0.8	−1.2	61	9 17.2	−0.8	−1.4	83
9	1385	6.5	1	151	6 18.9	−0.9	−1.8	141	6 19.9	−0.6	−3.0	167
10	1486	4.6	1	162	7 50.2	−0.3	−2.4	165		G		
Apr. 1	0833	7.1	1	74	5 32.0	0.0	−2.0	115	5 41.0	+0.1	−2.6	137
1	0844	5.7	1	75	7 23.1	+0.3	−1.4	99	7 32.4	+0.3	−1.7	115
4	1250	5.9	1	110	6 20.4	−0.9	−1.6	96	6 18.1	−0.9	−1.8	116
4	1261	7.2	1	111	8 49.5	+0.1	−1.8	116	8 57.8	+0.1	−2.0	128
7	1549	5.2	1	142	3 51.4	−1.2	−0.4	123	3 43.2	−0.9	−1.0	146
13	2174	6.4	2	211		A			10 47.0	−1.5	−0.8	306
28	0762	6.6	1	42	4 34.7	+0.7	−2.5	147		N		
29	0926	7.0	1	54	4 31.6	−0.5	−1.0	63	4 31.3	−0.5	−1.3	84
May 2	1321	6.7	1	90	4 27.4	−1.1	−1.4	93	4 22.1	−1.2	−1.6	114
2	1327	6.8	1	91	6 21.9	+0.2	−2.4	158	6 36.5	+0.8	−3.2	181
2	1331	Var.	1	91	7 18.6	+0.1	−1.9	129	7 27.6	+0.1	−2.1	141
2	1335	6.3	1	91	8 05.8	+0.2	−1.7	106	8 14.0	+0.1	−1.8	115
3	1425	6.9	1	101		N			5 27.5	−2.4	−0.4	66
3	1427	6.8	1	102	6 29.6	.	.	54	6 19.6	−1.4	−1.3	80
6	1717	7.3	1	136		A			9 17.0	−0.7	−1.9	114
14	2721	3.3	2	228		A			10 12.6	−1.6	+0.5	288
16	Mars	−0.4	2	252	9 28.9	−1.0	+1.6	245		A		
27	1030	3.2	1	35	5 01.7	+0.6	−1.8	144	5 17.2	+0.9	−2.3	163
June 15	3380	6.2	2	261	8 37.3	−0.4	+1.9	228		A		
July 3	2046	6.9	1	117		A			5 59.5	−1.7	−0.8	64
4	2164	6.8	1	129		A			6 58.4	−1.4	−1.2	98

Date	Z.C. No.	Mag.	Ph.	Elong. of Moon	Edmonton				Vancouver			
					U.T.	a	b	P	U.T.	a	b	P
				°	h m	m	m	°	h m	m	m	°
July 14	0068	5.7	2	258	8 55.4	+0.2	+2.4	182	8 47.1	+0.1	+2.3	190
Aug. 5	2864	4.7	1	158	6 16.4	.	.	144	5 55.7	.	.	136
13	0440	4.6	2	266	7 10.8	+0.7	+2.3	189	7 09.0	+0.7	+2.1	195
14	0587	6.4	2	279	6 53.0	.	.	176		A		
31	2621	7.4	1	112		A			4 42.3	−1.4	−0.1	59
Sept. 3	3086	6.0	1	152	6 27.9	−1.3	−0.1	73	6 13.6	−1.4	+0.5	66
10	0537	3.8	1	250	7 42.3	−0.7	+1.1	108	7 31.5	−0.4	+1.2	102
10	0539	4.4	1	250	8 01.8	0.0	+2.3	38	7 53.6	+0.3	+2.3	32
10	0541	4.0	1	250	8 08.4	−0.4	+1.8	70	7 58.2	−0.2	+1.8	65
10	0537	3.8	2	250	8 31.4	−0.1	+2.5	214	8 21.5	0.0	+2.2	219
10	0536	5.4	2	250	8 42.8	−0.6	+1.7	252	8 30.5	−0.5	+1.6	257
10	0539	4.4	2	250	8 55.1	−1.1	+1.0	283	8 40.8	−1.0	+1.0	288
10	0541	4.0	2	250	9 12.4	−0.8	+1.6	252	8 58.5	−1.3	+0.6	297
10	0542	5.8	2	250	9 14.0	−1.3	+0.6	291	8 58.8	−0.6	+1.6	256
10	0543	6.5	2	250	9 19.8	−1.2	+0.9	282	9 04.7	−1.1	+0.9	286
13	1030	3.2	2	287	7 59.3	+1.1	+3.0	209		A		
30	3026	7.3	1	119		A			6 55.0	−1.0	−0.7	74
Oct. 8	0647	5.5	2	231	7 37.0	−0.8	+1.3	268	7 24.0	−0.7	+1.3	271
9	0844	5.7	2	247		S			12 54.6	−1.5	−2.4	316
13	1375	5.6	2	294	12 17.8	−1.2	+2.9	246	11 49.7	.	.	216
27	2964	6.6	1	87		A			4 09.2	−0.6	+0.3	32
28	3091	6.9	1	98	2 27.3	.	.	350		N		
29	3238	7.0	1	112	5 00.2	−0.8	0.0	50	4 50.1	−1.0	+0.5	45
30	3362	5.9	1	124	2 00.1	−1.1	+1.2	71	1 43.9	−1.0	+1.5	66
30	3367	6.4	1	125	3 19.4	−2.1	−0.2	109	2 58.8	−1.8	+0.7	98
31	3507	6.4	1	139	3 06.4	+0.3	+2.6	354		G		
Nov. 4	0537	3.8	1	196	3 04.5	.	.	4		N		
4	0545	4.2	1	196	3 13.5	−0.1	+1.6	72	3 07.5	+0.2	+1.5	68
4	0537	3.8	2	196	3 24.9	.	.	320		N		
4	0552	3.0	1	196	3 44.4	−0.1	+1.8	58	3 37.4	+0.2	+1.8	53
4	0545	4.2	2	196	4 09.9	−0.3	+1.7	252	4 00.9	−0.2	+1.5	256
4	0560	3.8	1	197	4 21.6	−0.6	+1.3	93	4 11.4	−0.3	+1.4	88
4	0552	3.0	2	196	4 41.0	−0.6	+1.4	266	4 29.9	−0.4	+1.4	270
4	0560	3.8	2	197	5 18.2	−0.4	+2.0	231	5 06.7	−0.3	+1.9	235
4	0561	5.2	2	197	5 23.7	−0.6	+1.7	247	5 11.4	−0.5	+1.7	251
6	0900	4.9	2	224	5 15.5	0.0	+1.9	249	5 09.1	+0.2	+1.7	251
7	1070	5.2	2	237	6 48.0	−0.3	+1.9	255	6 38.9	0.0	+1.8	254
7	1092	5.8	2	240	11 43.9	−1.0	−2.5	329	11 38.6	−1.5	−1.2	307
10	1439	5.9	2	275	10 46.6	−0.5	−2.9	356	10 46.5	−0.7	−0.9	332
10	1441	6.4	2	275	11 49.1	−0.9	−1.0	327	11 41.2	−1.0	0.0	307
10	1442	Var.	2	275	12 07.6	−1.2	−0.1	302	11 53.9	−1.2	+0.9	282
23	2916	6.8	1	55	0 51.2	−0.7	+0.1	38		S		
24	3058	5.9	1	68	1 45.6	−1.2	−0.5	74	1 33.2	−1.4	+0.1	68
25	3186	6.7	1	80	1 05.4	−1.1	+0.6	52		S		
29	0177	7.1	1	133	1 02.3	+0.1	+2.5	8	0 55.0	+0.6	+2.9	357
30	0370	6.1	1	152	11 21.4	−0.8	+1.7	11	11 12.4	−0.6	+0.1	40
Dec. 4	1030	3.2	1	206	9 55.7	−2.0	+2.4	45	9 31.2	−1.7	+1.2	70
4	1030	3.2	2	206	10 33.5	−0.4	−3.9	342	10 35.9	−1.2	−2.0	315
23	3294	6.9	1	64	3 21.5	−0.2	+0.6	23	3 15.7	−0.4	+0.8	24
24	3420	7.1	1	76	2 43.8	−0.9	+0.1	52	2 32.9	−1.1	+0.5	50
27	0311	6.5	1	120		A			9 58.3	−0.2	−0.6	58
28	0438	6.7	1	132	6 20.9	−1.2	−2.1	113	6 17.3	−1.8	−3.5	131
28	0545	4.2	1	142	23 21.3	−0.1	+1.5	84		S		
28	0552	3.0	1	142	23 51.3	−0.1	+1.7	69		S		
29	0561	5.2	1	143	0 32.3	−0.5	+1.5	87		S		
29	0560	3.8	1	143	0 32.7	−0.7	+1.2	105	0 22.5	−0.4	+1.2	100
29	0552	3.0	2	142	0 49.5	−0.5	+1.6	256	0 39.4	−0.3	+1.5	261

Phase 1 = Disappearance 2 = Reappearance A = Low S = Sun G = Graze N = No occn.

PLANETARY APPULSES AND OCCULTATIONS

According to Mr. Gordon E. Taylor of H.M. Nautical Almanac Office, no planetary occultations are visible from North America in 1971. An occultation of SAO 95002 ($8^m.6$) by Juno on April 22, 1971, at about 02 h 46 m U.T. may possibly be visible from Mexico.

A close approach of Jupiter satellite III to β Scorpii occurs on May 13, 1971, at 09 h U.T. approximately, visible from North America (except the eastern part), New Zealand and part of Australia. Although it seems likely that satellite III will pass about 3″ north of the star (geocentrically) it is suggested that observers keep careful watch in case of an occultation. The farther north the observer is situated, the greater the chance of an occultation. Should such an occultation occur, there is the further possibility of the occultation of a 9^m star about 0.8″ distant from β Scorpii in position angle 106°, a few minutes earlier.

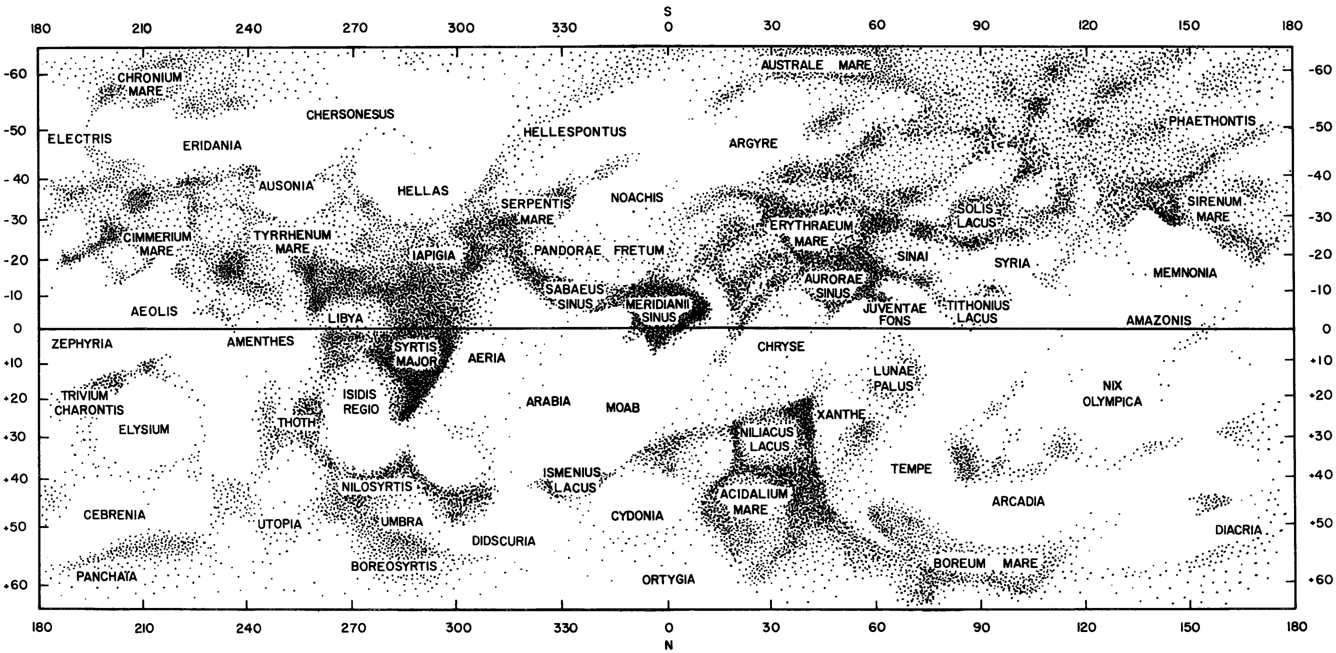
Jupiter itself later occults β Scorpii, but the event will not be visible from North America.

MARS—LONGITUDE OF CENTRAL MERIDIAN

The longitude of the central meridian of the geometric disk of Mars is given for 19 h 00 m E.S.T. on the given date. To obtain values for other times, add 14.6° for each hour elapsed since 0 h U.T. Syrtis Major, a prominent dark feature of the Martian globe, is located near longitude 290°.

Date	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	°	°	°	°	°	°	°	°	°
1	183.4	254.6	318.1	36.6	116.3	200.8	285.1	350.0	58.3
2	173.7	245.0	308.6	27.4	107.5	191.8	275.7	340.4	48.5
3	164.1	235.4	299.1	18.2	98.6	182.8	266.4	330.7	38.7
4	154.4	225.8	289.6	9.0	89.7	173.8	257.0	321.0	28.9
5	144.8	216.2	280.1	359.8	80.9	164.7	247.5	311.4	19.2
6	135.2	206.6	270.7	350.6	72.0	155.7	238.1	301.7	9.4
7	125.5	197.0	261.2	341.5	63.2	146.6	228.7	292.0	359.5
8	115.9	187.4	251.8	332.3	54.3	137.5	219.2	282.4	349.7
9	106.3	177.8	242.3	323.2	45.5	128.4	209.8	272.7	339.9
10	96.6	168 2	232.9	314.0	36.6	119.3	200.3	263.0	330.1
11	87.0	158.6	223.4	304.9	27.8	110.2	190.9	253.3	320.3
12	77.4	149.0	214.0	295.8	18.9	101.1	181.4	243.6	310.5
13	67.8	139.4	204.6	286.7	10.1	91.9	171.9	233.9	300.7
14	58.1	129.9	195.2	277.7	1.2	82.8	162.4	224.2	290.9
15	48.5	120.3	185.8	268.6	352.4	73.6	152.9	214.4	281.0
16	38.9	110.7	176.4	259.6	343.5	64.4	143.4	204.7	271.2
17	29.2	101.1	167.0	250.5	334.7	55.2	133.8	195.0	261.4
18	19.6	91.6	157.6	241.5	325.8	46.0	124.3	185.2	251.6
19	10.0	82.0	148.2	232.5	316.9	36.8	114.8	175.5	241.7
20	0.4	72.5	138.9	223.5	308.0	27.6	105.2	165.8	231.9
21	350.7	62.9	129.5	214.5	299.2	18.3	95.6	156.0	222.1
22	341.1	53.4	120.2	205.5	290.3	9.0	86.1	146.3	212.2
23	331.5	43.8	110.9	196.6	281.4	359.8	76.5	136.5	202.4
24	321.9	34.3	101.5	187.6	272.5	350.5	66.9	126.8	192.6
25	312.3	24.7	92.2	178.7	263.6	341.2	57.3	117.0	182.7
26	302.7	15.2	82.9	169.7	254.6	331.9	47.7	107.2	172.9
27	293.0	5.7	73.7	160.8	245.7	322.5	38.1	97.4	163.0
28	283.4	356.1	64.4	151.9	236.7	313.2	28.5	87.7	153.2
29	273.8	346.6	55.1	143.0	227.8	303.9	18.9	77.9	143.4
30	264.2	337.1	45.9	134.1	218.8	294.5	9.3	68.1	133.5
31		327.6		125.2	209.8		359.6		123.7

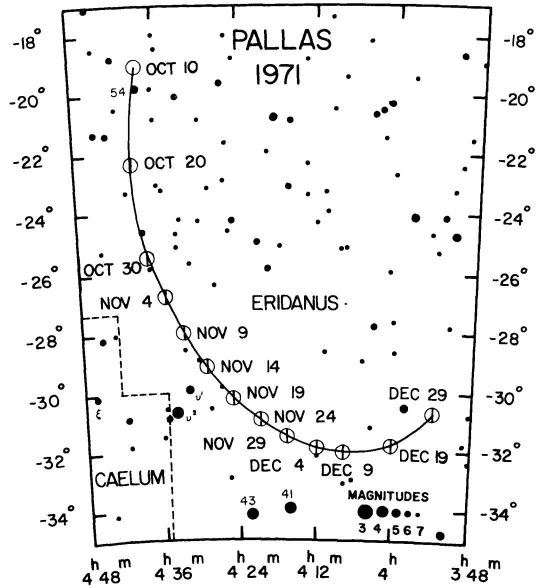
MAP OF MARS



Latitude is plotted on the vertical axis (south at the top); longitude is plotted on the horizontal axis

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

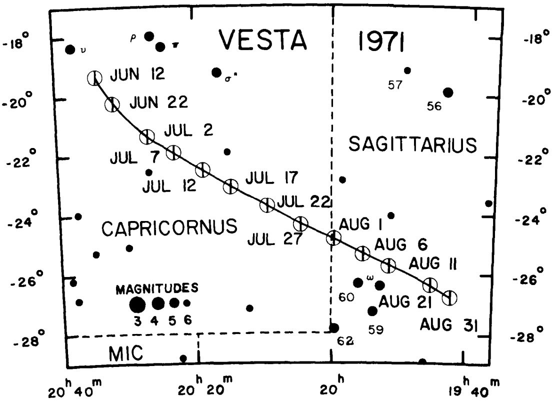
Only two of the four brightest asteroids come to opposition in 1971. Ephemerides near opposition are given for these, together with maps. Dates and times of the table are for 0 h E.T.



Pallas (No. 2)

Opposition Nov. 19 in Eri; Mag. 7.4

Date		R.A.	Dec.
		h m	° ′
Oct.	10	4 38.5	−19 02
	20	4 39.3	−22 15
	30	4 37.1	−25 19
Nov.	4	4 35.0	−26 43
	9	4 32.2	−28 01
	14	4 28.9	−29 09
	19	4 25.0	−30 08
	24	4 20.8	−30 55
	29	4 16.5	−31 30
Dec.	4	4 12.1	−31 53
	9	4 07.8	−32 02
	19	4 00.3	−31 45
	29	3 54.9	−30 42



Vesta (No. 4)

Opposition July 22 in Cap; Mag. 5.6

Date		R.A.	Dec.
		h m	° ′
June	12	20 33.8	−19 21
	22	20 31.8	−20 12
July	2	20 26.6	−21 16
	7	20 23.0	−21 52
	12	20 18.9	−22 29
	17	20 14.3	−23 06
	22	20 09.4	−23 42
	27	20 04.5	−24 17
Aug.	1	19 59.7	−24 49
	6	19 55.3	−25 18
	11	19 51.3	−25 43
	21	19 45.2	−26 21
	31	19 42.3	−26 44

JUPITER—LONGITUDE OF CENTRAL MERIDIAN

The table lists the longitude of the central meridian of the illuminated disk of Jupiter at 0^h U.T. daily during the period when the planet is favourably placed. Longitude increases hourly by 36.58° in System I (which applies to regions between the middle of the North Equatorial Belt and the middle of the South Equatorial Belt) and by 36.26° in System II (which applies to the rest of the planet). Detailed ancillary tables may be found on pages 274 and 275 of *The Planet Jupiter* by B. M. Peek (Faber and Faber, 1958).

SYSTEM I

Day (0^h U.T.)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
	°	°	°	°	°	°	°	°	°	°
1	341.4	193.4	294.0	150.5	210.9	69.9	128.8	342.3	192.7	243.5
2	139.2	351.3	92.0	308.5	9.0	227.9	286.7	140.1	350.4	41.2
3	297.0	149.1	249.9	106.5	167.0	25.9	84.6	297.9	148.1	198.9
4	94.7	307.0	47.8	264.5	325.0	183.9	242.5	95.7	305.9	356.5
5	252.5	104.8	205.7	62.5	123.1	341.9	40.4	253.4	103.6	154.2
6	50.3	262.7	3.6	220.5	281.1	139.9	198.3	51.2	261.3	311.9
7	208.1	60.6	161.6	18.5	79.2	297.9	356.2	209.0	59.0	109.6
8	5.9	218.4	319.5	176.5	237.2	95.9	154.1	6.8	216.7	267.2
9	163.7	16.3	117.4	334.5	35.2	253.9	312.0	164.6	14.4	64.9
10	321.5	174.1	275.4	132.5	193.3	51.9	109.9	322.3	172.1	222.6
11	119.2	332.0	73.3	290.5	351.3	209.9	267.7	120.1	329.8	20.2
12	277.0	129.9	231.2	88.5	149.3	7.9	65.6	277.9	127.5	177.9
13	74.8	287.7	29.2	246.5	307.4	165.8	223.5	75.6	285.2	335.6
14	232.6	85.6	187.1	44.5	105.4	323.8	21.3	233.4	82.9	133.2
15	30.4	243.5	345.1	202.5	263.4	121.8	179.2	31.2	240.6	290.9
16	188.2	41.4	143.0	0.6	61.5	279.7	337.0	188.9	38.3	88.5
17	346.1	199.3	301.0	158.6	219.5	77.7	134.9	346.7	196.0	246.2
18	143.9	357.1	98.9	316.6	17.6	235.7	292.7	144.4	353.7	43.9
19	301.7	155.0	256.9	114.6	175.6	33.6	90.6	302.2	151.3	201.5
20	99.5	312.9	54.8	272.6	333.6	191.6	248.4	99.9	309.0	359.2
21	257.3	110.8	212.8	70.7	131.7	349.5	46.3	257.7	106.7	156.9
22	55.1	268.7	10.8	228.7	289.7	147.5	204.1	55.4	264.4	314.5
23	212.9	66.6	168.7	26.7	87.7	305.4	1.9	213.2	62.1	112.2
24	10.8	224.5	326.7	184.7	245.7	103.3	159.8	10.9	219.8	269.8
25	168.6	22.4	124.7	342.8	43.8	261.3	317.6	168.6	17.5	67.5
26	326.4	180.3	282.6	140.8	201.8	59.2	115.4	326.4	175.1	225.2
27	124.3	338.2	80.6	298.8	359.8	217.1	273.2	124.1	332.8	22.8
28	282.1	136.1	238.6	96.8	157.8	15.1	71.0	281.8	130.5	180.5
29	79.9		36.6	254.9	315.9	173.0	228.9	79.5	288.2	338.1
30	237.8		194.6	52.9	113.9	330.9	26.7	237.3	85.8	135.8
31	35.6		352.5		271.9		184.5	35.0		293.5

SYSTEM II

Day (0^h U.T.)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
	°	°	°	°	°	°	°	°	°	°
1	138.7	114.2	1.1	341.1	172.6	155.0	345.0	321.9	295.9	117.8
2	288.8	264.4	151.4	131.4	323.0	305.4	135.3	112.1	86.0	267.9
3	79.0	54.6	301.7	281.8	113.4	95.8	285.6	262.3	236.0	57.9
4	229.1	204.8	92.0	72.1	263.8	246.1	75.8	52.4	26.1	207.9
5	19.3	355.1	242.3	222.5	54.2	36.5	226.1	202.6	176.2	358.0
6	169.4	145.3	32.6	12.9	204.6	186.9	16.4	352.8	326.3	148.0
7	319.6	295.5	182.9	163.2	355.0	337.2	166.6	142.9	116.4	298.1
8	109.7	85.7	333.2	313.6	145.4	127.6	316.9	293.1	266.5	88.1
9	259.9	236.0	123.5	104.0	295.8	278.0	107.1	83.2	56.5	238.1
10	50.1	26.2	273.8	254.3	86.2	68.3	257.4	233.4	206.6	28.2
11	200.2	176.4	64.1	44.7	236.6	218.7	47.6	23.5	356.7	178.2
12	350.4	326.7	214.4	195.1	27.0	9.0	197.9	173.6	146.7	328.3
13	140.6	116.9	4.7	345.5	177.4	159.4	348.1	323.8	296.8	118.3
14	290.7	267.2	155.0	135.9	327.8	309.7	138.3	113.9	86.9	268.3
15	80.9	57.4	305.3	286.2	118.2	100.0	288.6	264.0	236.9	58.4
16	231.1	207.7	95.6	76.6	268.6	250.4	78.8	54.2	27.0	208.4
17	21.3	357.9	246.0	227.0	59.1	40.7	229.0	204.3	177.1	358.4
18	171.4	148.2	36.3	17.4	209.5	191.0	19.2	354.4	327.1	148.5
19	321.6	298.4	186.6	167.8	359.9	341.4	169.5	144.5	117.2	298.5
20	111.8	88.7	336.9	318.2	150.3	131.7	319.7	294.6	267.3	88.5
21	262.0	238.9	127.3	108.6	300.7	282.0	109.9	84.8	57.3	238.6
22	52.2	29.2	277.6	259.0	91.1	72.3	260.1	234.9	207.4	28.6
23	202.4	179.5	67.9	49.4	241.5	222.6	50.3	25.0	357.4	178.6
24	352.6	329.7	218.3	199.8	31.9	13.0	200.5	175.1	147.5	328.7
25	142.8	120.0	8.6	350.2	182.3	163.3	350.7	325.2	297.5	118.7
26	293.0	270.3	159.0	140.6	332.7	313.6	140.9	115.3	87.6	268.7
27	83.2	60.6	309.3	291.0	123.1	103.9	291.1	265.4	237.6	58.7
28	233.4	210.8	99.6	81.4	273.5	254.1	81.2	55.5	27.7	208.8
29	23.6		250.0	231.8	63.8	44.4	231.4	205.6	177.7	358.8
30	173.8		40.3	22.2	214.2	194.7	21.6	355.7	327.8	148.8
31	324.0		190.7		4.6		171.8	145.8		298.9

JUPITER—PHENOMENA OF THE BRIGHTEST SATELLITES 1971

Times and dates given are E.S.T. 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.

The symbols are as follows: E–eclipse, O—occultation, T—transit, S—shadow, D—disappearance, R—reappearance, I—ingress, e—egress. 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 May 23 until December 10, and on the west side during the rest of the year.

JANUARY

d	h	m	Sat.	Phen.
2	1	38	II	SI
6	1	01	I	ED
7	0	18	I	Se
	1	13	I	Te
12	0	30	III	ER
14	0	02	I	SI
	1	01	I	TI
15	0	33	I	OR
18	0	54	II	ED
20	0	42	II	Te
21	23	16	I	ED
22	23	38	I	Te
27	0	51	II	TI
	1	10	II	Se
29	1	09	I	ED
	23	26	I	TI
30	0	27	I	Se
	0	54	III	TI

FEBRUARY

d	h	m	Sat.	Phen.
3	1	12	II	SI
5	0	22	II	OR
6	0	11	I	SI
	0	13	III	SI
	1	22	I	TI
7	0	51	I	OR
13	21	59	II	Te
	23	23	I	ED
14	21	46	I	TI
	22	42	I	Se
	23	56	I	Te
16	23	09	III	OD
19	0	31	II	ED
20	22	03	II	TI
	22	07	II	Se
21	0	34	II	Te
	22	26	I	SI
	23	40	I	TI
22	0	36	I	Se
	23	08	I	OR
23	22	03	III	ED
24	0	15	III	ER
27	22	09	II	SI
28	0	37	II	TI
	0	40	II	Se

MARCH

d	h	m	Sat.	Phen.
1	0	19	I	SI
	21	34	II	OR
	21	37	I	ED
2	22	12	I	Te
6	21	08	III	TI
	23	08	III	Te
8	23	30	I	ED
9	0	07	II	OR
	20	41	I	SI
	21	54	I	TI
	22	51	I	Se
10	0	04	I	Te
	21	20	I	OR
13	22	11	III	Se
15	21	35	II	ED
16	22	34	I	SI
	23	45	I	TI
17	21	20	II	Te
	23	11	I	OR
18	20	23	I	Te
20	23	58	III	SI
23	0	10	II	ED
24	20	30	III	OR
	21	17	II	TI
	21	36	II	Se
	21	44	I	ED
	23	46	II	Te
25	20	03	I	TI
	21	07	I	Se
	22	12	I	Te
26	19	27	I	OR
31	20	02	III	ER
	21	37	II	SI
	22	08	III	OD
	23	37	I	ED
	23	41	II	TI

APRIL

d	h	m	Sat.	Phen.
1	20	50	I	SI
	21	52	I	TI
	23	00	I	Se
2	20	46	II	OR
	21	15	I	OR
7	21	46	III	ED
8	22	43	I	SI
9	18	39	II	ED
	19	59	I	ED
	23	02	I	OR
	23	09	II	OR
10	18	06	I	TI
	19	22	I	Se
	20	16	I	Te
16	21	15	II	ED
	21	52	I	ED
17	19	05	I	SI
	19	53	I	TI
	21	16	I	Se
	22	03	I	Te
18	18	01	III	Se
	18	31	II	Se
	19	03	III	TI
	19	15	I	OR
	20	00	II	Te
	20	58	III	Te
24	20	59	I	SI
	21	38	I	TI
25	18	13	I	ED
	18	32	II	SI
	19	46	III	SI
	19	48	II	TI
	21	00	I	OR
	21	05	II	Se
	22	00	III	Se
	22	17	II	Te
	22	27	III	TI
26	17	39	I	Se
	18	15	I	Te

MAY

d	h	m	Sat.	Phen.
1	22	53	I	SI
2	20	07	I	ED
	21	05	II	SI
	22	03	II	TI
	22	44	I	OR
3	17	21	I	SI
	17	50	I	TI
	19	33	I	Se
	20	00	I	Te
4	17	10	I	OR
	19	17	II	OR
6	17	18	III	OR
9	22	00	I	ED
10	19	15	I	SI
	19	34	I	TI
	21	27	I	Se
	21	44	I	Te
11	16	29	I	ED
	18	23	II	ED
	18	54	I	OR
	21	34	II	OR
12	15	56	I	Se
	16	10	I	Te
13	15	54	II	Te
	17	33	III	ED
	20	36	III	OR
17	21	10	I	SI
	21	18	I	TI
18	18	22	I	ED
	20	38	I	OR
	20	59	II	ED
19	15	38	I	SI
	15	44	I	TI
	17	50	I	Se
	17	54	I	Te
20	15	29	II	SI
	15	37	II	TI
	18	02	II	Se
	18	08	II	Te
	21	32	III	ED
25	20	13	I	OD
26	17	28	I	TI
	17	33	I	SI
	19	38	I	Te
	19	44	I	Se
27	16	54	I	ER
	17	51	II	TI
	18	03	II	SI
	20	21	II	Te
	20	36	II	Se
29	15	33	II	ER
31	15	37	III	SI
	16	56	III	Te
	17	54	III	Se

JUNE

d	h	m	Sat.	Phen.
1	21	56	I	OD
2	19	12	I	TI
	19	27	I	SI
	21	23	I	Te
	21	39	I	Se
3	16	22	I	OD
	18	48	I	ER
	20	05	II	TI
	20	37	II	SI
4	15	49	I	Te
	16	07	I	Se
5	18	10	II	ER
7	18	13	III	TI
	19	36	III	SI
	20	15	III	Te
9	20	57	I	TI
	21	22	I	SI
10	18	07	I	OD
	20	43	I	ER
11	15	51	I	SI
	17	34	I	Te
	18	02	I	Se
12	17	09	II	OD
	20	46	II	ER
17	19	52	I	OD
18	15	45	III	ER
	17	09	I	TI
	17	45	I	SI
	19	19	I	Te
	19	57	I	Se
19	17	06	I	ER
	19	27	II	OD
21	16	16	II	Te
	17	37	II	Se
25	16	37	III	OR
	17	24	III	ED
	18	55	I	TI
	19	40	I	SI
	19	44	III	ER
26	16	04	I	OD
	19	00	I	ER
27	16	20	I	Se
28	16	02	II	TI
	17	37	II	SI
	18	34	II	Te

JULY

d	h	m	Sat.	Phen.
2	17	52	III	OD
3	17	51	I	OD
4	16	04	I	SI
	17	20	I	Te
	18	15	I	Se
5	18	22	II	TI
7	17	55	II	ER
10	19	39	I	OD
11	16	58	I	TI
	17	59	I	SI
	19	09	I	Te
12	17	18	I	ER

d	h	m	Sat.	Phen.
13	17	50	III	Se
14	15	45	II	OD
18	18	48	I	TI
19	15	56	I	OD
20	16	33	I	Se
	17	15	III	Te
21	18	11	II	OD
23	17	15	II	Se
26	17	46	I	OD
27	16	18	I	SI
	17	17	I	Te
	18	28	I	Se
	18	41	III	TI
28	15	37	I	ER
30	17	16	II	SI

d	h	m	Sat.	Phen.
	17	26	II	Te
31	15	43	III	ER

AUGUST

d	h	m	Sat.	Phen.
3	16	59	I	TI
4	17	32	I	ER
6	17	22	II	TI
7	17	18	III	ED
8	17	38	II	ER
11	15	59	I	OD
12	15	31	I	Te
	16	47	I	Se
14	16	04	III	OD
19	15	16	I	TI
	16	32	I	SI
20	15	51	I	ER
25	15	27	III	SI
28	15	05	I	Se

SEPTEMBER

d	h	m	Sat.	Phen.
2	14	44	II	ER
4	14	51	I	SI
	15	47	I	Te
16	14	56	II	OD
18	14	09	II	Se
19	14	39	I	OD
	15	03	III	OR
20	14	11	I	Te
25	14	07	II	SI
	14	33	II	Te
27	14	00	I	TI
28	14	25	I	ER
30	13	51	III	Se

OCTOBER

d	h	m	Sat.	Phen.
6	13	38	I	Se

Jupiter being near the sun, phenomena of the satellites are not given between Oct. 6 and the end of the year.

JUPITER'S BELTS AND ZONES

Viewed through a telescope of 3-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.

A diagram of the belts and zones of Jupiter was published in the 1970 edition of the Observer's Handbook; single copies of this diagram may be obtained without charge by writing to the Editor.

METEORS, FIREBALLS AND METEORITES

BY PETER M. MILLMAN

Meteoroids are small solid particles moving in orbits about the sun. On entering the earth's atmosphere at velocities ranging from 15 to 75 kilometers per second they become luminous and appear as meteors or fireballs and in rare cases, if large enough to avoid complete vaporization, 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 1971.

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 1971

Shower	Shower Maximum			Radiant					Single Observer Hourly Rate	Velocity	Normal Duration to 1/4 strength of Max.
	Date	E.S.T.	Moon	Position at Max. R.A.		Dec.	Daily Motion R.A.	Dec.			
		h		h	m	°	m	°		km/sec	days
Quadrantids	Jan. 3	13	F.Q.	15	28	+50	—	—	40	41	1.1
Lyrids	Apr. 22	15	N.M.	18	16	+34	+4.4	0.0	15	48	2
η Aquarids	May 5	16	F.Q.	22	24	00	+3.6	+0.4	20	64	3
δ Aquarids	July 29	—	F.Q.	22	36	−17	+3.4	+0.17	20	40	—
Perseids	Aug. 12	17	L.Q.	03	04	+58	+5.4	+0.12	50	60	4.6
Orionids	Oct. 21	19	N.M.	06	20	+15	+4.9	+0.13	25	66	2
Taurids	Nov. 5	—	F.M.	03	32	+14	+2.7	+0.13	15	28	—
Leonids	Nov. 17	13	N.M.	10	08	+22	+2.8	−0.42	15	72	—
Geminids	Dec. 14	09	N.M.	07	32	+32	+4.2	−0.07	50	35	2.6
Ursids	Dec. 23	03	F.Q.	14	28	+76	—	—	15	34	2

SATURN'S SATELLITES TITAN, RHEA AND IAPETUS

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.

*Magnitudes given are at mean opposition; dates and times are E.S.T.

TITAN Elong. E.			TITAN Elong. W.		
	d	h		d	h
Jan.	5	09.5	Jan.	13	09.4
	21	08.1		29	08.2
Feb.	6	07.2	Feb.	14	07.5
	22	06.8	Mar.	2	07.3
Mar.	10	07.0		18	07.4
	26	07.5	Apr.	3	07.9
	..	....		..	....
June	30	13.7	July	8	12.6
July	16	14.4		24	13.0
Aug.	1	14.8	Aug.	9	13.1
	17	14.8		25	12.7
Sept.	2	14.3	Sept.	10	11.9
	18	13.3		26	10.6
Oct.	4	11.7	Oct.	12	08.8
	20	09.5		28	06.5
Nov.	5	07.0	Nov.	13	03.9
	21	04.1		29	01.2
Dec.	7	01.2	Dec.	14	22.5
	22	22.5		30	20.1

IAPETUS Elong. E.			IAPETUS Elong. W.		
	d	h		d	h
Jan.	23	19.2	Mar.	6	00.2
	..	....		..	....
July	5	07.8	Aug.	15	13.1
Sept.	23	17.6	Nov.	2	17.4
Dec.	10	22.5			

RHEA Elong. E.			RHEA Elong. E.		
	d	h		d	h
Jan.	3	17.1	Aug.	13	08.0
	8	05.5		17	20.5
	12	17.9		22	08.9
	17	06.3		26	21.4
	21	18.7		31	09.9
	26	07.2	Sept.	4	22.3
	30	19.6		9	10.8
Feb.	4	08.1		13	23.2
	8	20.6		18	11.6
	13	09.1		23	00.0
	17	21.6		27	12.4
	22	10.1	Oct.	2	00.8
	26	22.6		6	13.2
Mar.	3	11.1		11	01.5
	7	23.7		15	13.9
	12	12.2		20	02.2
	17	00.8		24	14.6
	21	13.4		29	02.9
	26	01.9	Nov.	2	15.2
	30	14.5		7	03.5
Apr.	4	03.1		11	15.8
	..	....		16	04.1
June	29	02.5		20	16.4
July	3	15.1		25	04.7
	8	03.6		29	17.0
	12	16.2	Dec.	4	05.3
	17	04.8		8	17.6
	21	17.3		13	05.9
	26	05.9		17	18.2
	30	18.4		22	06.6
Aug.	4	06.9		26	18.8
	8	19.4		31	07.2

TABLE OF PRECESSION FOR 50 YEARS

If Declination is positive, use inner R.A. scale; if declination is *negative*, use *outer* R.A. scale

R.A. for Dec.−	R.A. for Dec.+	Prec. in Dec.	Precession in right ascension											Prec. in Dec.	R.A. for Dec.+	R.A. for Dec.−
			δ=85°	80°	75°	70°	60°	50°	40°	30°	20°	10°	0°			
h m	h m		m	m	m	m	m	m	m	m	m	m	m		h m	h m
12 00	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	−16.7	12 00	*24 00*
12 30	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	−16.6	11 30	*23 30*
13 00	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	−16.1	11 00	*23 00*
13 30	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	−15.4	10 30	*22 30*
14 00	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	−14.5	10 00	*22 00*
14 50	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	−13.2	9 30	*21 30*
15 00	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	−11.8	9 00	*21 00*
15 30	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	−10.2	8 30	*20 30*
16 00	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	− 8.3	8 00	*20 00*
16 30	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	− 6.4	7 30	*19 30*
17 00	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	− 4.3	7 00	*19 00*
17 30	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	− 2.2	6 30	*18 30*
18 00	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	0.0	6 00	*18 00*
0 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	+16.7	24 00	*12 00*
0 30	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	+16.6	23 30	*11 30*
1 00	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	+16.1	23 00	*11 00*
1 30	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	+15 4	22 30	*10 30*
2 00	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	+14.5	22 00	*10 00*
2 30	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	+13 2	21 30	*9 30*
3 00	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	+11.8	21 00	*9 00*
3 30	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	+10.2	20 30	*8 30*
4 00	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	+ 8.3	20 00	*8 00*
4 30	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	+ 6.4	19 30	*7 30*
5 00	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	+ 4.3	19 00	*7 00*
5 30	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	+ 2.2	18 30	*6 30*
6 00	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	0.0	18 00	*6 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 relation 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 R.A. 1970	Declination Dec.	Visual Magnitude V	Colour Index $B-V$	Spectral Classification Type		Parallax π	Absolute Magnitude M_V	Distance light-years D	Proper Motion μ	Radial Velocity 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		
	h 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^m *C* 6.2^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^m 4.0^d, *B* 8.9^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*		
o 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^d, *B* 10^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^m *B* 6.23^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^m *B* 4.36^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:	G8 III: +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^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^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^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^m 49″	
ε Tau	26.9	+19 07	3.54	+1.02	K0 III	0.018	+0.1	160	0.118	+38.6		
$θ^2$ 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^m 31″	***Aldebaran***
$π^3$ 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	G8 III: +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* 8.66ᵐ 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* 7.5ᵐ 8″ ***Adhara***
$σ^2$ 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, 141ᵈ
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* 9.4ᵐ 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* 9.08vᵐ 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* 10.7ᵐ 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* 4.31ᵐ 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* 15ᵐ 7″
δ Vel *AB*	43.9	−54 36	1.95	+0.05	*A0 V*	0.043	+0.2	76	0.086	+02.2	*A* 2.0ᵐ *B* 5.1ᵐ 3″ *CD* 10ᵐ 69″
ε Hya *ABC*	45.2	+06 32	3.39	+0.68	G0 comp.	0.010	+0.6	140	0.198	*+36.4*	*A* 3.7ᵐ *B* 5.2ᵐ 0.2″ 15ʸ, *C* 6.8ᵐ 3″ *D* 12ᵐ 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* 10.8ᵐ 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* 4.90^m 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* 8.26^m 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* 2.9^m *B* 2.9^m 1″	
γ Vir *AB*	40.1	−01 17	2.76	+0.34	F0	V	0.101	+3.5	32	0.567	−19.7	*A* 3.50^m *B* 3.52^m 4″	
β Mus *AB*	44.4	−67 57	3.06	−0.17:	*B3*	*V*		−2.1	470	0.041	+42	*A* 3.7^m *B* 4.0^m 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* 5.61^m 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* 3.94^m 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, 4.0^d	***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		
μ^1 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″	
ι¹ 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″	
*i*σ Sgr	53.4	−26 20	2.12	−0.21	B2 V		−2.7	300	0.059	−11		*Nunk*
ξ² 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* 5.97^m 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, 0.19^d
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* 11^m 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, 5.4^d, *B* 6.19^m 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 1971. 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. 75, and of The Nearest Stars, p. 87.)

Star	A.D.S.	R.A. 1970 h m	Dec. 1970 ° '	Magnitudes comb.	A	B	Sep. 1971.0 "	P.A. 1971.0 °	P (app.) years
λ Cas	434	00 30.1	+54 22	4.9	5.5	5.8	0.6	179	640
α Psc	1615	02 00.4	+02 37	4.0	4.3	5.3	1.8	287	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	250	1100
Σ 1338	7307	09 19.2	+38 19	5.8	6.5	6.7	1.1	240	220
35 Com	8695	12 51.8	+21 25	5.1*	5.2	7.4	0.9	159	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	357	1200
ϵ^2 Lyr†	11635	18 43.4	+39 36	4.4	5.1	5.3	2.3	88	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	11.5	302	480
Σ 186	1538	01 54.3	+01 42	6.0	6.8	6.8	1.3	51	160
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	11.2	66	50
α Gem	6175	07 32.7	+31 58	1.6	2.0	2.8	1.9	127	420
ζ Cnc AB	6650	08 10.4	+17 44	5.0	5.6	5.9	1.0	325	60
ζ Cnc AC	6650	08 10.4	+17 44	5.2	5.4	7.3	5.9	85	1150
+42° 1956	KUI	08 58.7	+41 53	3.9	4.1	6.2	0.5	198	22
γ Leo	7724	10 18.3	+20 00	1.8	2.1	3.4	4.2	123	620
ξ U Ma AB	8119	11 16.7	+31 42	3.8	4.3	4.8	3.0	123	60
γ Vir	8630	12 40.1	−01 18	2.8	3.5	3.5	4.5	303	170
Σ 1785	9031	13 47.7	+27 08	7.0	7.6	8.0	3.3	153	155
ζ Boo	9343	14 39.8	+13 52	3.8	4.5	4.5	1.2	307	125
ξ Boo	9413	14 50.0	+19 14	4.5	4.7	6.8	7.1	339	150
ζ Her	10157	16 40.2	+31 39	2.8	2.9	5.5	1.0	218	35
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	0.6	139	46
70 Oph	11046	18 03.9	+02 32	4.0	4.2	6.0	2.2	48	88
β 648	11871	18 56.0	+32 52	5.2	5.4	7.5	0.4	136	60
4 Aqr	14360	20 49.9	−05 45	6.0	6.4	7.2	1.0	8	150
τ Cyg	14787	21 13.6	+37 54	3.7	3.8	6.4	1.0	181	50
Σ 3050	17149	23 57.9	+33 34	5.8	6.5	6.7	1.6	297	800

*There is a marked colour difference between the components.

†The separation of the two pairs of ε Lyr is 208".

THE NEAREST STARS

BY ALAN H. BATTEN AND RUSSELL O. REDMAN

The accompanying table is similar to one that has been published in the HANDBOOK for several years past. Like its predecessor, it has been based on the work of Professor van de Kamp who published in the *Publications of the Astronomical Society of the Pacific* for 1969 a revision of his list of the nearest stars. The new list contains three new stars (two of them forming a binary system) and three new unseen companions of stars already in the list. In addition, many distances have been revised, and this has changed the order of stars in the list. The relative luminosities in the last column have also been changed a little, partly because of the revisions of distances, but also because of a small change in the adopted absolute magnitude of the sun.

Measuring the distances of the stars is one of the most difficult and most important tasks of the observational astronomer. As the earth travels around the sun each year, the directions of the nearer stars seem to change very slightly when measured against the background of the more distant stars. This change is called annual parallax. Even for the nearest star, the parallax is less than one second of arc—which is the angle subtended by a penny at a distance of about 2.5 miles. That explains the difficulty of the task. Its importance stems from the fact that all our knowledge of the luminosities of stars, and hence of the structure of the galaxy, depends on the relatively few stellar distances that can be directly and accurately measured. To describe these vast distances, astronomers have invented new units. The most familiar is the light-year—the distance light travels in a year, nearly six million million miles. More convenient in many calculations is the parsec, which is about 3.26 light-years. The distance in parsecs is simply the reciprocal of the parallax.

The table gives the name and position of each star, the annual parallax π, the distance in light-years D, the spectral type, the proper motion μ in seconds of arc per year (that is the apparent motion of the star across the sky each year—nearby stars often have large proper motions), the total space velocity W in km./sec., if known, the visual apparent magnitude and the luminosity in terms of the sun. In column 6, *wd* stands for white dwarf, and *e* indicates the presence of emission lines in the spectrum. Note how very few stars in our neighbourhood are brighter than the sun. There are no very luminous or very hot stars at all. Most stars in this part of the galaxy are small, cool, and insignificant objects.

The list contains 59 stars, including the sun, and seven unseen companions. Thirty-one of these objects are either single stars or have only unseen companions. There are eleven double-star systems and two triple systems. Of the unseen companions, one of the most interesting is that of Barnard's Star. Van de Kamp has shown that the observed perturbations in the motion of Barnard's Star can be explained on the assumption that the star is accompanied by a body about twice the size of Jupiter. Alternatively, two objects each about the size of Jupiter could produce the observed perturbations. Perhaps this star has the first planetary system to be discovered outside our own system.

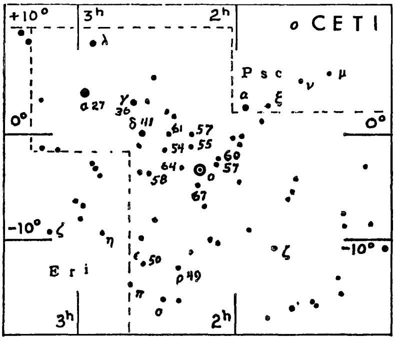
Name	1970 α	1970 δ	π	D	Sp.		W	m	L
	h m	° ′	″	l.y.		″	km./sec.		
Sun					G2			−26.8	1.0
α Cen A	14 37	−60 43	0.760	4.3	G2	3.68	32	0.1	1.3
B					K5			1.5	0.36
C	14 27	−62 33			M5*e*			11.0	0.00006
Barnard's*	17 56	+04 36	.552	5.9	M5	10.30	140	9.5	0.00044
Wolf 359	10 55	+07 13	.431	7.6	M6*e*	4.84	55	13.5	0.00002
Lal. 21185*	11 02	+36 10	.402	8.1	M2	4.78	103	7.5	0.0052
Sirius A	6 44	−16 41	.377	8.6	A1	1.32	18	−1.5	23.
B					*wd*			7.2	0.008
Luy. 726–8A	1 37	−18 07	.365	8.9	M6*e*	3.35	52	12.5	0.00006
B					M6*e*			13.0	0.00004
Ross 154	18 48	−23 51	.345	9.4	M5*e*	0.74	12	10.6	0.0004
Ross 248	23 40	+44 01	.317	10.3	M6*e*	1.82	86	12.2	0.00011
ε Eri	03 32	−09 34	.305	10.7	K2	0.97	22	3.7	0.30
Luy. 789–6	22 37	−15 31	.302	10.8	M6	3.27	79	12.2	0.00012
Ross 128	11 46	+01 01	.301	10.8	M5	1.40	26	11.1	0.00033
61 Cyg A	21 06	+38 36	.292	11.2	K5	5.22	106	5.2	0.083
B*					K7			6.0	0.040
ε Ind	22 02	−56 55	.291	11.2	K5	4.67	86	4.7	0.13
Procyon A	07 38	+05 18	.287	11.4	F5	1.25	21	0.3	7.6
B					*wd*			10.8	0.0005
Σ 2398 A	18 42	+59 35	.284	11.5	M3.5	2.29	39	8.9	0.0028
B					M4			9.7	0.0013
Groom. 34 A	00 17	+43 51	.282	11.6	M1	2.91	52	8.1	0.0058
B					M6			11.0	0.00040
Lacaille 9352	23 04	−36 02	.279	11.7	M2	6.87	117	7.4	0.012
τ Ceti	01 43	−16 06	.273	11.9	G8	1.92	37	3.5	0.44
BD+5°1668*	07 26	+05 28	.266	12.2	M4	3.73	71	9.8	0.0014
Lacaille 8760	21 15	−39 00	.260	12.5	M1	3.46	67	6.7	0.025
Kapteyn's	05 11	−45 00	.256	12.7	M0	8.79	292	8.8	0.0040
Kruger 60 A	22 27	+57 33	.254	12.8	M4	0.87	31	9.7	0.0017
B					M6			11.2	0.00044
Ross 614 A	06 28	−02 48	.249	13.1	M5*e*	0.97	30	11.3	0.0004
B					?			14.8	0.00002
BD−12°4523	16 29	−12 35	.249	13.1	M5	1.18	38	10.0	0.0013
van Maanen's	00 47	+05 16	.234	13.9	*wd*F	2.98	270	12.4	0.00017
Wolf 424 A	12 32	+09 12	.229	14.2	M6*e*	1.87	39	12.6	0.00014
B					M6*e*			12.6	0.00014
CD−37°15492	00 03	−37 30	.225	14.5	M3	6.09	130	8.6	0.0058
Groom. 1618	10 09	+49 36	.217	15.0	M0	1.45	40	6.6	0.040
CD−46°11540	17 27	−46 53	.216	15.1	M4	1.15		9.4	0.0030
CD−49°13515	21 31	−49 08	.214	15.2	M3	0.78		8.7	0.0058
CD−44°11909	17 36	−44 17	.213	15.3	M5	1.14		11.2	0.00063
Luy. 1159–16	01 58	+12 57	.212	15.4	(M7)	2.08		12.3	0.00023
Lal. 25372	13 44	+15 04	.208	15.7	M3.5	2.30	55	8.5	0.0076
AOe 17415–6*	17 37	+68 22	.207	15.7	M3.5	1.31	34	9.1	0.0044
CC 658	11 44	−64 39	.206	15.8	*wd*	2.69		11.0	0.0008
Ross 780	22 51	−14 25	.206	15.8	M5	1.17	28	10.2	0.0016
o^2 Eri A	04 14	−07 42	.205	15.9	K0	4.08	104	4.4	0.33
B					*wd*A			9.9	0.0027
C					M4*e*			11.2	0.00063
BD+20°2465*	10 18	+20 01	.202	16.1	M4.5	0.49	15	9.4	0.0036
Altair	19 49	+08 47	.196	16.6	A7	0.66	31	0.8	10.
70 Oph. A	18 04	+02 31	.195	16.7	K1	1.13	29	4.2	0.44
B					K6			6.0	0.083
AC+79°3888	11 45	+78 50	.194	16.8	M4	0.87	121	11.0	0.0009
BD+43°4305*	22 46	+44 11	.193	16.9	M5*e*	0.84	21	10.1	0.0021
Stein 2051 A	04 29	+58 56	.192	17.0	(M5)	2.37		11.1	0.0008
B					*wd*			12.4	0.0003

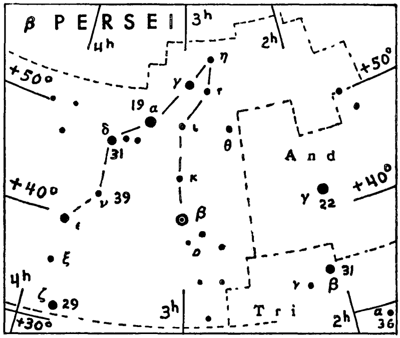
*Star has an unseen component.

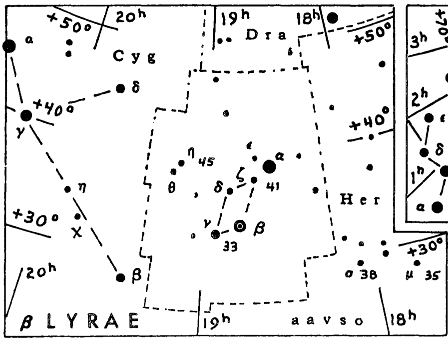
VARIABLE STARS

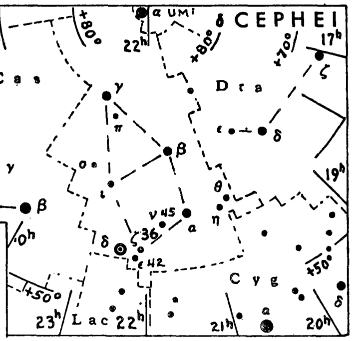
The systematic observation of variable stars is an area in which an amateur can make a valuable contribution to astronomy. For beginning observers, maps of the fields of four bright variable stars are given below. In each case, the magnitudes (with decimal point omitted) of several suitable comparison stars are given. Using two comparison stars, one brighter, one fainter than the variable, estimate the brightness of the variable in terms of these two stars. Record also the date and time of observation. When a number of observations have been made, a graph of magnitude versus date may be plotted. The shape of this "light curve" depends on the type of variable. Further information about variable star observing may be obtained from the American Association of Variable Star Observers, 187 Concord Ave., Cambridge, Mass. 02138.

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*, 1970, International Supplement.









LONG-PERIOD VARIABLE STARS

Variable	Max. m	Per d	Epoch 1971	Variable	Max. m	Per d	Epoch 1971
001755 T Cas	7.8	445	Feb. 27	142539 V Boo	7.9	258	July 30
001838 R And	7.0	409	Apr. 23	143227 R Boo	7.2	223	Jan. 3
021143 W And	7.4	397	Aug. 4	151731 S CrB	7.3	361	Feb. 15
0214*03* o Cet	3.4	332	June 17	154639 V CrB	7.5	358	Nov. 30
0228*13* U Cet	7.5	235	Jan. 11	154615 R Ser	6.9	357	Oct. 22
023133 R Tri	6.2	266	Sept. 9	160625 RU Her	8.0	484	Apr. 24
043065 T Cam	8.0	374	Nov. 28	162119 U Her	7.5	406	Dec. 26
0455*14* R Lep	6.8	432	Oct. 7	1621*12* V Oph	7.5	298	Sept. 15
050953 R Aur	7.7	459	Nov. 12	163266 R Dra	7.6	245	May 3
054920 U Ori	6.3	372	July 24	164715 S Her	7.6	307	Apr. 25
0617*02* V Mon	7.0	335	Oct. 9	1702*15* R Oph	7.9	302	Oct. 18
065355 R Lyn	7.9	379	Feb. 6	171723 RS Her	7.9	219	Sept. 22
070122aR Gem	7.1	370	May 25	180531 T Her	8.0	165	Mar. 15
070310 R CMi	8.0	338	Feb. 5	181136 W Lyr	7.9	196	June 9
072708 S CMi	7.5	332	Sept. 14	183308 X Oph	6.8	334	July 3
081112 R Cnc	6.8	362	Jan. 1	190108 R Aql	6.1	300	Sept. 30
081617 V Cnc	7.9	272	Mar. 28	1910*17* T Sgr	8.0	392	Jan. 8
084803 S Hya	7.8	257	Aug. 5	1910*19* R Sgr	7.3	269	Sept. 11
0850*08* T Hya	7.8	288	Apr. 9	193449 R Cyg	7.5	426	Aug. 19
093934 R LMi	7.1	372	Jan. 28	194048 RT Cyg	7.3	190	Jan. 13
094211 R Leo	5.8	313	Apr. 11	194632 χ Cyg	5.2	407	Dec. 11
103769 R UMa	7.5	302	May 8	201647 U Cyg	7.2	465	——
1214*18* R Crv	7.5	317	Aug. 26	2044*05* T Aqr	7.7	202	July 6
122001 SS Vir	6.8	355	Feb. 3	210868 T Cep	6.0	390	Apr. 20
123160 T UMa	7.7	257	Feb. 17	213753 RU Cyg	8.0	234	Feb. 17
123307 R Vir	6.9	146	Mar. 22	230110 R Peg	7.8	378	Dec. 29
123961 S UMa	7.8	226	Mar. 11	230759 V Cas	7.9	228	June 28
131546 V CVn	6.8	192	Mar. 22	231508 S Peg	8.0	319	July 17
1327*06* S Vir	7.0	378	Dec. 11	2338*15* R Aqr	6.5	387	Oct. 13
134440 R CVn	7.7	328	Nov. 14	235350 R Cas	7.0	431	Mar. 30
142584 R Cam	7.9	270	Feb. 21	2357*15* W Cet	7.6	351	Mar. 30

OTHER TYPES OF VARIABLE STARS

Variable	Max. m	Min. m	Type	Sp. Cl.	Period d	Epoch 1971 E.S.T.
005381 U Cep	6.7	9.8	Ecl.	B8+gG2	2.49302	Jan. 2.34*
025838 ρ Per	3.3	4.0	Semi R	M4	33–55, 1100	
030140 β Per	2.1	3.3	Ecl.	B8+G	2.86731	Jan. 1.74*
035512 λ Tau	3.5	4.0	Ecl.	B3	3.952952	Jan. 3.66*
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. 21.27
065820 ζ Gem	4.4	5.2	δ Cep	F7–G3	10.15172	Jan. 2.50
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. 5.84*
192242 RR Lyr	6.9	8.0	RR Lyr	A2–F1	0.5668223	Jan. 1.45
194700 η Aql	4.1	5.2	δ Cep	F6–G4	7.176641	Jan. 5.70
222557 δ Cep	4.1	5.2	δ Cep	F5–G2	5.366341	Jan. 1.78

*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 δ		P	D	m	r	Sp	Remarks
	h m	° ′						
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*	0.40	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 h m	δ ° ′	P	D	m	r	Sp	Remarks
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	0.30	b5	
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	Osupergiants, WR-stars
Tr 24	16 54.9	−40 37	8.5	60	*7.3*	*0.58*	*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	0.44	a3	
6705	18 49.5	−06 19	6.8	12.5	12	1.72	b8	M11, very rich cl.
Mel 227	20 06.7	−79 25	5.2	60	*9*	*0.24*	*b9*	
IC1396	21 38.0	+57 22	5.1	60	*8.5*	*0.73*	*O6*	Tr 37
7790	23 56.9	+61	7.1	4.5	11.7	3.39	b4	C Ceph: CEa, CEb, CF Cas

Globular Clusters

NGC	M	α 1970 h m	δ ° ′	B	D	Sp	m	N	r	V
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

By René Racine

The following objects were selected from the brightest and largest of the various classes to illustrate the different types of interactions between stars and interstellar matter in our galaxy. *Emission regions* (HII) are excited by the strong ultraviolet flux of young, hot stars and are characterized by the lines of hydrogen in their spectra. *Reflection nebulae* (Ref) result from the diffusion of starlight by clouds of interstellar dust. At certain stages of their evolution stars become unstable and explode, shedding their outer layers into what becomes a *planetary nebula* (Pl) or a *supernova remnant* (SN). Protostellar nebulae (PrS) are objects still poorly understood; they are somewhat similar to the reflection nebulae, but their associated stars, often variable, are very luminous infrared stars which may be in the earliest stages of stellar evolution. Also included in the selection are four *extended complexes* (Compl) of special interest for their rich population of dark and bright nebulosities of various types. In the table S is the optical surface brightness in magnitude per square second of arc of representative regions of the nebula, and m* is the magnitude of the associated star.

NGC	M	Con	α 1970 δ		Type	Size	S mag.	m	Dist. 10^3	Remarks
			h ′	° ′		′	sq′′	*	l.y.	
650/1	76	Per	01 40.3	+51 25	Pl	1.5	20	17	15	
IC348		Per	03 42.6	+32 05	Ref	3	21	8	0.5	Nebulous cluster
1435		Tau	03 45.7	+23 59	Ref	15	20	4	0.4	Merope nebula
1535		Eri	04 12.8	−12 49	Pl	0.5	17	12		
1952	1	Tau	05 32.7	+22 05	SN	5	19	16v	4	"Crab" + pulsar
1976	42	Ori	05 33.8	−05 25	HII	30	18	4	1.5	Orion nebula
1999		Ori	05 35.0	−06 45	PrS	1		10v	1.5	
ζ Ori		Ori	05 39.3	−01 57	Comp	2°			1.5	Incl. "Horsehead"
2068	78	Ori	05 45.3	+00 02	Ref	5	20		1.5	
IC443		Gem	06 15.8	+22 36	SN	40			2	
2244		Mon	06 30.8	+04 53	HII	50	21	7	3	Rosette neb.
2247		Mon	06 31.5	+10 20	PrS	2	20	9	3	
2261		Mon	06 37.5	+08 45	PrS	2		12v	4	Hubble's var. neb.
2392		Gem	07 27.4	+20 58	Pl	0.3	18	10	10	Clown face neb.
3587	97	UMa	11 13.0	+55 11	Pl	3	21	13	12	Owl nebula
ρOph		Oph	16 23.8	−23 23	Comp	4°			0.5	Bright + dark neb.
θOph		Oph	17 20.1	−24 58	Comp	5°				Incl. "S" neb.
6514	20	Sgr	18 00.6	−23 02	HII	15	19		3.5	Trifid nebula
6523	8	Sgr	18 01.8	−24 23	HII	40	18		4.5	Lagoon nebula
6543		Dra	17 58.6	+66 37	Pl	0.4	15	11	3.5	
6611	16	Ser	18 17.2	−13 48	HII	15	19	10	6	
6618	17	Sgr	18 19.1	−16 12	HII	20	19		3	Horseshoe neb.
6720	57	Lyr	18 52.5	+33 00	Pl	1.2	18	15	5	Ring nebula
6826		Cyg	19 44.1	+50 27	Pl	0.7	16	10	3.5	
6853	27	Vul	19 58.2	+22 38	Pl	7	20	13	3.5	Dumb-bell neb.
6888		Cyg	20 11.2	+38 19	HII	15				
γCyg		Cyg	20 21.1	+40 10	Comp	6°				HII + dark neb.
6960/95		Cyg	20 44.4	+30 36	SN	150			2.5	Cygnus loop
7000		Cyg	20 57.8	+44 12	HII	100	22		3.5	N. America neb.
7009		Aqr	21 02.5	−11 30	Pl	0.5	16	12	3	Saturn nebula
7023		Cep	21 01.3	+68 03	Ref	5	21	7	1.3	
7027		Cyg	21 06.0	+42 07	Pl	0.2	15	13		
7129		Cep	21 42.3	+65 57	Ref	3	21	10	2.5	Small cluster
7293		Aqr	22 28.0	−20 57	Pl	13	22	13		Helix nebula
7662		And	23 24.5	+42 22	Pl	0.3	16	12	4	

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 δ h m	° ′	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	Sc II–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

Although several thousand radio sources have been catalogued most of them are only observable with the largest radio telescopes. This list contains the few strong sources which could be detected with amateur radio telescopes as well as representative examples of astronomical objects which emit radio waves.

Name	α (1970) δ h m	° ′	Remarks
Tycho's s'nova	00 24.0	+63 58	Remnant of supernova of 1572
Andromeda gal.	00 41.0	+41 06	Closest normal spiral galaxy
IC 1795, W3	02 23.1	+61 58	Multiple HII region, OH emission
PKS 0237–23	02 38.7	−23 17	Quasar with large red shift Z = 2.2
NGC 1275, 3C 84	03 17.8	+41 24	Seyfert galaxy, radio variable
Fornax A	03 21.2	−37 17	10th mag. SO galaxy
CP 0328	03 30.5	+54 27	Pulsar, period = 0.7145 sec., H abs'n.
Crab neb, M1	05 32.6	+22 00	Remnant of supernova of 1054
NP 0527	05 32.6	+22 00	Radio, optical & X-ray pulsar
V 371 Orionis	05 32.2	+01 54	Red dwarf, radio & optical flare star
Orion neb, M42	05 33.8	−05 24	HII region, OH emission, IR source
IC 443	06 15.5	+22 36	Supernova remnant (date unknown)
Rosette neb	06 30.4	+04 53	HII region
YV CMa	07 21.8	−20 41	Optical var. IR source, OH, H_2O emission
3C 273	12 27.5	+02 13	Nearest, strongest quasar
Virgo A, M87	12 29.3	+12 33	EO galaxy with jet
Centaurus A	13 23.6	−42 52	NGC 5128 peculiar galaxy
3C 295	14 10.3	+52 21	21st mag. galaxy, 4,500,000 light years
Scorpio X-1	16 18.2	−15 34	X-ray, radio optical variable
3C 353	17 19.0	−00 57	Double source, probably galaxy
Kepler's s'nova	17 27.0	−21 16	Remnant of supernova of 1604
Galactic nucleus	17 43.7	−28 56	Complex region OH, NH_3 em., H_2CO abs'n.
Omega neb, M17	18 18.7	−16 10	HII region, double structure
W 49	19 08.9	+09 04	HII region s'nova remnant, OH emission
CP 1919	19 20.4	+21 49	First pulsar discovered, P = 1.337 sec.
Cygnus A	19 58.4	+40 39	Strong radio galaxy, double source
Cygnus X	20 21.5	+40 17	Complex region
NML Cygnus	20 45.4	+40 00	Infrared source, OH emission
Cygnus loop	20 51.0	+29 34	S'nova remnant (Network nebula)
N. America	20 54.0	+43 57	Radio shape resembles photographs
3C 446	22 24.2	−05 07	Quasar, optical mag. & spectrum var.
Cassiopeia A	23 22.0	+58 39	Strongest source, s'nova remnant
Sun			Continuous emission & bursts
Moon			Thermal source only
Jupiter			Radio bursts controlled by Io

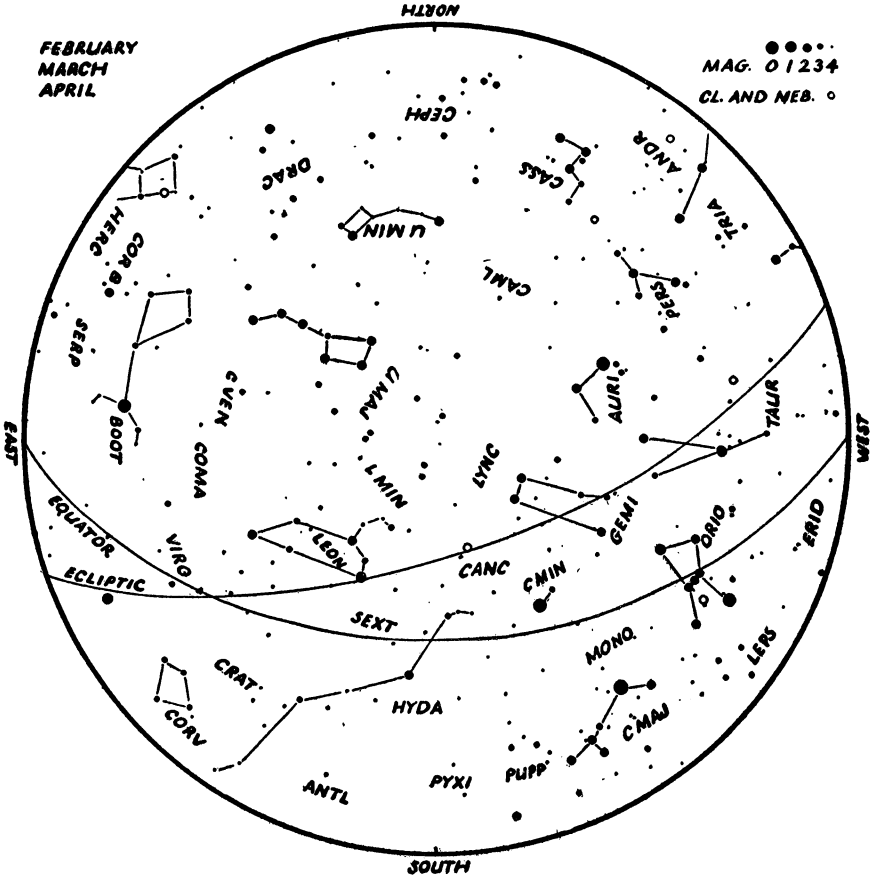
MESSIER'S CATALOGUE OF DIFFUSE OBJECTS

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	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*
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

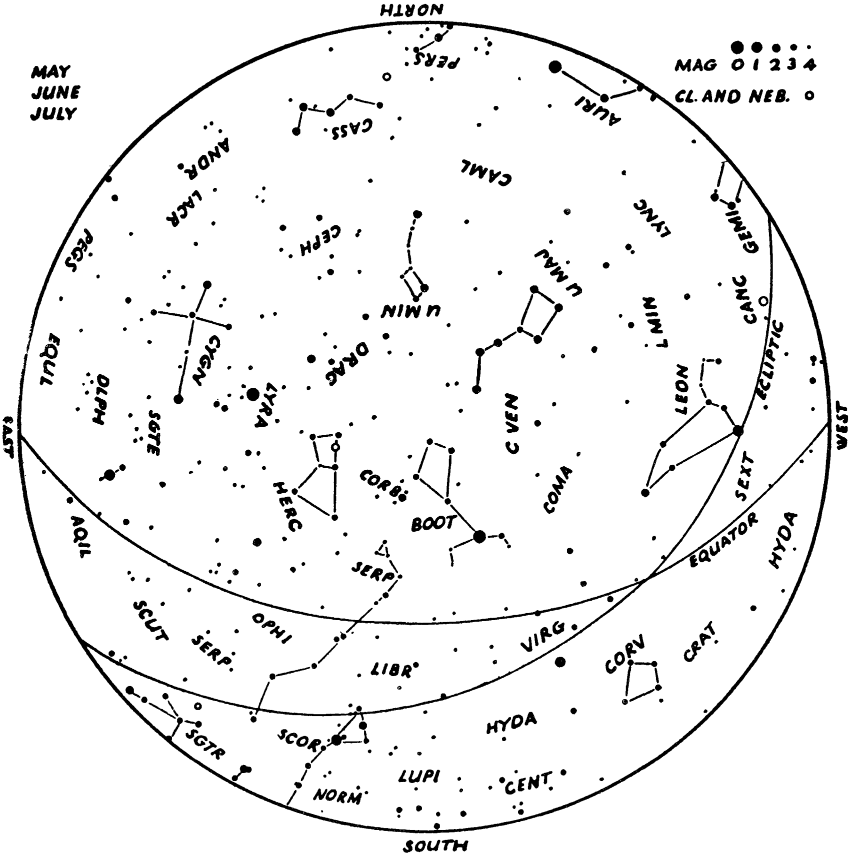


The above map represents the evening sky at

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

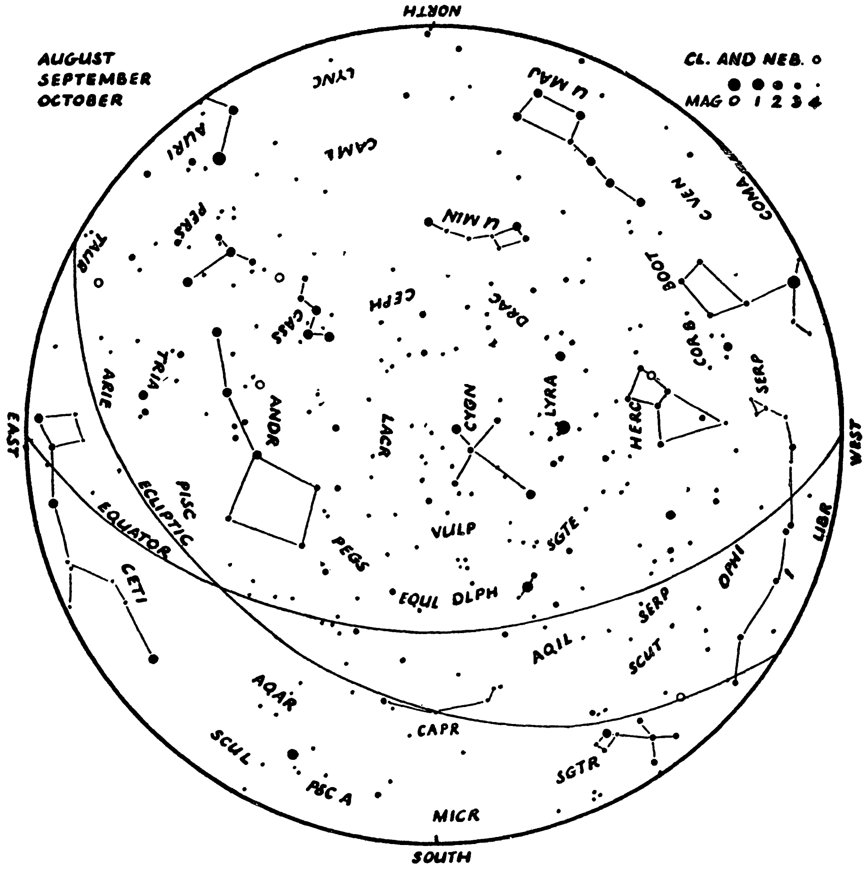


The above map represents the evening sky at

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

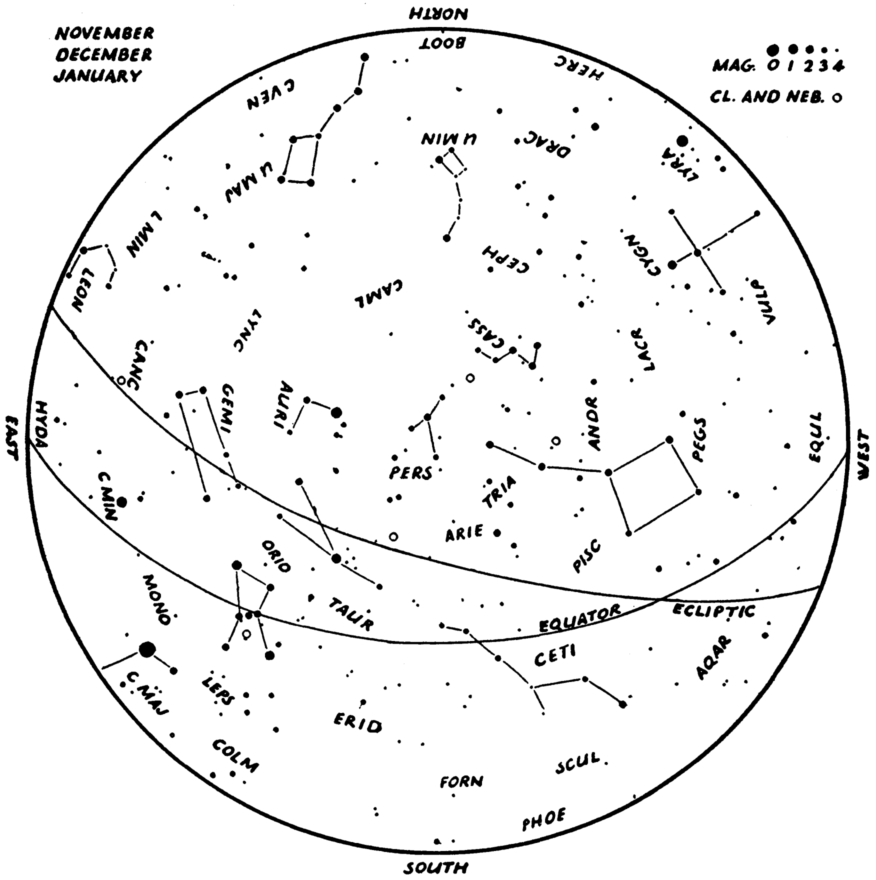


The above map represents the evening sky at

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.

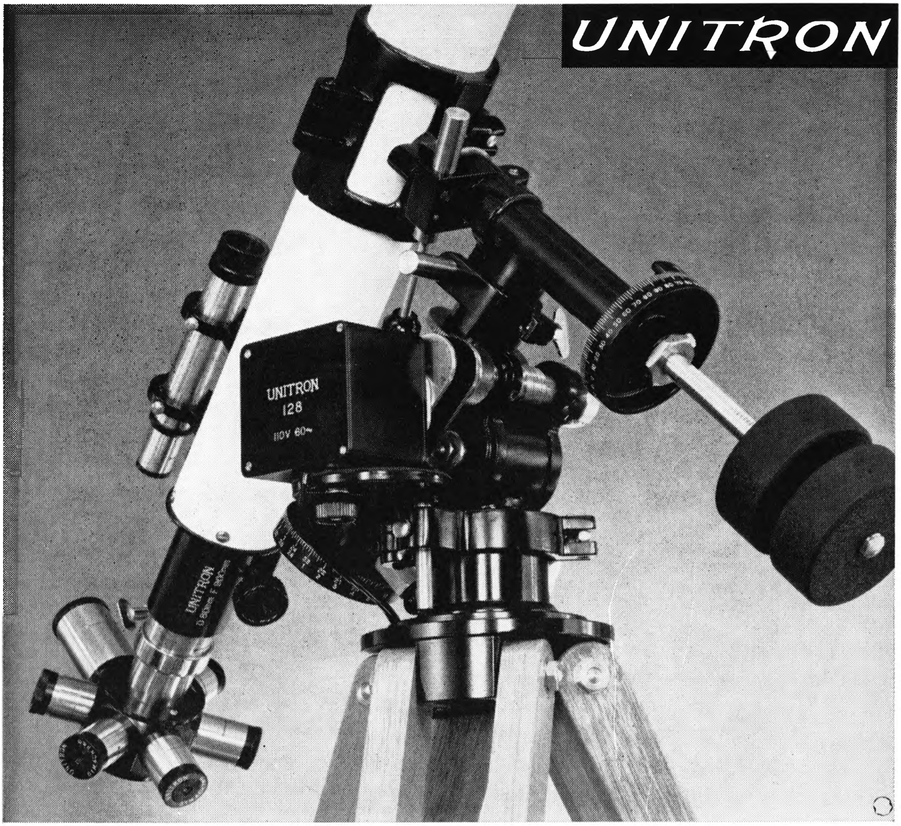
STAR MAP 4



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.



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The Large Solar Telescope at Kitt Peak
Lunar Eclipse Roundup

CALENDAR 1971

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	

UNITRON'S 6″ Refractor on left, 4″ on right