Norman Green

the OBSERVER'S HANDBOOK 1974

sixty-sixth 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 room 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 $12.50 ($7.50 for full-time students) are payable October 1 and include the publications for the following calendar year.

VISITING HOURS AT SOME CANADIAN OBSERVATORIES

Burke-Gaffney Observatory, Saint Mary's University, Halifax, Nova Scotia.
October-April: Saturday evenings 7:00 p.m.
May-September: Saturday evenings 9:00 p.m.

David Dunlap Observatory, Richmond Hill, Ontario.
Wednesday mornings throughout the year, 10:00 a.m.
Saturday evenings, April through October (by reservations, tel. 884-2112).

Dominion Astrophysical Observatory, Victoria, B.C.
May-August: Daily, 9:15 a.m.–4:30 p.m. (Guide, Monday to Friday).
Sept.-April: Monday to Friday, 9:15 a.m.–4:30 p.m.
Public observing, Saturday evenings, April–October, inclusive.

Dominion Observatory, Ottawa, Ontario K1A 0E4.
Monday–Friday, daytime, rotunda only. Saturday evenings, April–October.
Week nights, school classes (by reservation).

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.–Sun., 1:45 (children), 3:00, 7:15, 8:45 p.m.
(Closed Christmas day, New Year's day and Good Friday.)
Summer: Daily (except Tues.) 1:45 (children), 3:00, 4:15, 7:15 and 8:45 p.m.

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

H. R. MacMillan Planetarium, 1100 Chestnut Street, Vancouver 3, B.C.
Sept.–June: Tues. and Wed., 3:00 and 8:00 p.m.; Thurs, 8:00 p.m.; Fri., 7:30 and 9:00 p.m.; Sat. and holidays, 1:30, 3:00, 7:30 and 9:00 p.m.; Sun., 1:30, 3:00, 4:30 and 7:30 p.m.
July–August: Tues. to Sun., 1:30, 3:00, 7:30 and 9:00 p.m. Closed Mondays except holidays.

Manitoba Museum of Man & Nature Planetarium, 190 Rupert Ave., Winnipeg R3B 0N2, Man.
Sept.–June: Sun., 1:00, 2:30, 4:00 p.m.; Tues.–Fri., 3:15, 8:00 p.m.
Sat. and holidays, 1:00, 2:30, 4:00, 7:30, 9:00 p.m.
July–August: Sat., Sun. and holidays same as above; Mon. 3:30 p.m. (if a holiday falls on a Monday, times are: 1:00, 2:30; 4:00, 7:30 and 9:00 p.m.; Tues.–Fri., 11:30 a.m., 3:30, 7:30, 9:00 p.m. Open all holidays except Christmas and Good Friday.

McLaughlin Planetarium, 100 Queen's Park, Toronto 5, Ontario.
Tues.–Fri., 3:00, 8:00 p.m.; Sat., 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 weekday shows at 2:00, 3:30 and 8:00 p.m.).

McMaster University, School of Adult Education, GH-136, Hamilton, Ontario.
Group reservations only.

Queen Elizabeth Planetarium, Edmonton, Alberta.
Winter: Tues.–Fri., 8:00 p.m.; Sat., 3:30 p.m.; Sun., 3:00 and 8:00 p.m.
Summer: Mon.–Sat., 3:00, 8:00 p.m.; Sun. and holidays 2:00, 4:00 and 8:00 p.m.

Seneca College Planetarium, 1750 Finch Ave. East, Willowdale, Ontario M2N 5T7.
Group reservations only.

The University of Manitoba Planetarium, 394 University College, 500 Dysart Rd., Winnipeg 19, Man.
Phone 474-9785 for times of public shows and for group reservations.

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252 College Street, Toronto M5T 1R7, Canada

editor: JOHN R. PERCY

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THE OBSERVER'S HANDBOOK for 1974 is the sixty-sixth edition. I wish to thank all those who assisted in its preparation: those whose names appear in the various sections, and my assistant editor Marie Fidler Litchinsky. Special thanks go to Margaret W. Mayall, Director of the A.A.V.S.O., for the predictions of Algol and of the variable stars, to Leslie V. Morrison and Gordon E. Taylor, British Nautical Almanac Office, for the predictions of lunar occultations and of planetary appulses and occultations, respectively, and to Maude Towne and Isabel Williamson for the tables of moonrise and moonset. The planet and asteroid maps were drafted by Ron Upcraft. I thank the Department of Energy, Mines and Resources for the maps of time zones, the director of the David Dunlap Observatory for his support, and the Institute of Astronomy, University of Cambridge, England, where most of this edition was prepared. Finally, my deep indebtedness to the British Nautical Almanac Office and to the *American Ephemeris* is gratefully acknowledged.

JOHN R. PERCY

ANNIVERSARIES AND FESTIVALS, 1974

New Year's Day	Tues.	Jan. 1	Pentecost (Whit Sunday)		June 2
Epiphany	Sun.	Jan. 6	Trinity Sunday		June 9
Accession of Queen Elizabeth (1952)	Wed.	Feb. 6	Corpus Christi	Thur.	June 13
Septuagesima Sunday		Feb. 10	St. John Baptist (Mid-summer Day)	Mon.	June 24
Quinquagesima (Shrove) Sunday		Feb. 24	Dominion Day	Mon.	July 1
Ash Wednesday		Feb. 27	Birthday of Queen Mother Elizabeth (1900)	Sun.	Aug. 4
St. David	Fri.	Mar. 1	Labour Day	Mon.	Sept. 2
St. Patrick	Sun.	Mar. 17	Jewish New Year (Rosh Hashanah)	Tues.	Sept. 17
Palm Sunday		Apr. 7	Yom Kippur	Thur.	Sept. 26
First Day of Passover	Sun.	Apr. 7	St. Michael (Michaelmas Day)	Sun.	Sept. 29
Good Friday		Apr. 12	Thanksgiving	Mon.	Oct. 14
Easter Sunday		Apr. 14	All Saints' Day	Fri.	Nov. 1
Birthday of Queen Elizabeth (1926)	Sun.	Apr. 21	Remembrance Day	Mon.	Nov. 11
St. George	Tues.	Apr. 23	St. Andrew	Sat.	Nov. 30
Rogation Sunday		May 19	First Sunday in Advent		Dec. 1
Victoria Day	Mon.	May 20	Christmas Day	Wed.	Dec. 25
Ascension Day	Thur.	May 23			

JULIAN DAY CALENDAR, 1974

Jan. 1 2442049	May 1 2442169	Sept. 1 2442292
Feb. 1 2442080	June 1 2442200	Oct. 1 2442322
Mar. 1 2442108	July 1 2442230	Nov. 1 2442353
Apr. 1 2442139	Aug. 1 2442261	Dec. 1 2442383

The Julian Day commences at Noon. Thus J.D. 2442049 = Jan. 1.5 U.T. = Jan. 1, 12 hours U.T.

SYMBOLS AND ABBREVIATIONS

SUN, MOON AND PLANETS

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

ASPECTS AND ABBREVIATIONS

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

SIGNS OF THE ZODIAC

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

THE GREEK ALPHABET

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

THE CONFIGURATIONS OF JUPITER'S SATELLITES

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

CALCULATIONS FOR ALGOL

The calculations for the minima of Algol are based on the epoch J.D. 2440953.4677 and period 2.8673285 days as published in *Sky and Telescope*, 1971.

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

ā fāte; ā chāotic; ă tăp; *ă* fin*ăl*; å åsk; *a* id*ea*; â câre; ä älms; au aught; ē bē; e crēate; ĕ ĕnd; *ĕ* ang*ĕl*; ē makēr; ī tīme; ĭ bĭt; *ĭ* an*ĭ*mal; ō nōte; ō anatōmy; ŏ hŏt; *ŏ* *ŏ*ccur; ô ôrb; ōō mōōn; oo book; ou out; ū tūbe; ū unite; ŭ sŭn; *ŭ* s*ŭ*bmit; û hûrl.

MISCELLANEOUS ASTRONOMICAL DATA

Units of Length

1 Angstrom unit = 10^{-8} cm. 1 micron, μ = 10^{-4} cm. = 10^{4}A.
1 inch = exactly 2.54 centimetres 1 cm. = 10 mm. = 0.39370 ... in.
1 yard = exactly 0.9144 metre 1 m. = 10^{2} cm. = 1.0936 .... yd.
1 mile = exactly 1.609344 kilometres 1 km. = 10^{5} cm. = 0.62137 ... mi.
1 astronomical unit = 1.496×10^{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 $\oplus$ = 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 $\oplus$ = 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 = 2.997925×10^{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 = 6.670×10^{-8} c.g.s. units
Mass of the electron, m = 9.1083×10^{-28} gm.: mass of the proton = 1.6724×10^{-24} gm.
Planck's constant, h = 6.625×10^{-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 44 20	−23 03.1	+ 3 30	July 3	6 46 34	+23 00.6	+ 4 06
4	18 57 33	−22 47.0	+ 4 54	6	6 58 56	+22 45.1	+ 4 38
7	19 10 43	−22 26.8	+ 6 13	9	7 11 14	+22 26.0	+ 5 06
10	19 23 49	−22 02.7	+ 7 29	12	7 23 29	+22 03.3	+ 5 31
13	19 36 50	−21 34.7	+ 8 39	15	7 35 41	+21 37.3	+ 5 52
16	19 49 45	−21 03.0	+ 9 44	18	7 47 48	+21 08.0	+ 6 09
19	20 02 34	−20 27.5	+10 42	21	7 59 50	+20 35.4	+ 6 21
22	20 15 17	−19 48.7	+11 34	24	8 11 47	+19 59.7	+ 6 27
25	20 27 53	−19 06.5	+12 20	27	8 23 39	+19 21.0	+ 6 28
28	20 40 22	−18 21.1	+12 58	30	8 35 25	+18 39.5	+ 6 24
31	20 52 44	−17 32.8	+13 28				
				Aug. 2	8 47 06	+17 55.2	+ 6 14
Feb. 3	21 04 58	−16 41.7	+13 51	5	8 58 41	+17 08.3	+ 5 59
6	21 17 04	−15 47.9	+14 07	8	9 10 11	+16 18.9	+ 5 38
9	21 29 04	−14 51.8	+14 15	11	9 21 36	+15 27.1	+ 5 12
12	21 40 56	−13 53.4	+14 17	14	9 32 55	+14 33.0	+ 4 41
15	21 52 41	−12 52.9	+14 11	17	9 44 10	+13 36.9	+ 4 06
18	22 04 20	−11 50.5	+14 00	20	9 55 21	+12 38.8	+ 3 26
21	22 15 53	−10 46.4	+13 42	23	10 06 26	+11 39.0	+ 2 41
24	22 27 20	− 9 40.8	+13 18	26	10 17 28	+10 37.4	+ 1 53
27	22 38 42	− 8 33.9	+12 50	29	10 28 26	+ 9 34.4	+ 1 00
Mar. 2	22 49 59	− 7 25.9	+12 16	Sept. 1	10 39 21	+ 8 30.1	+ 0.05
5	23 01 10	− 6 16.9	+11 37	4	10 50 13	+ 7 24.5	− 0 53
8	23 12 18	− 5 07.2	+10 54	7	11 01 02	+ 6 17.8	− 1 54
11	23 23 22	− 3 56.9	+10 08	10	11 11 50	+ 5 10.1	− 2 56
14	23 34 24	− 2 46.1	+ 9 20	13	11 22 37	+ 4 01.7	− 3 59
17	23 45 23	− 1 35.0	+ 8 29	16	11 33 23	+ 2 52.6	− 5 02
20	23 56 20	− 0 23.8	+ 7 36	19	11 44 09	+ 1 43.0	− 6 06
23	0 07 16	+ 0 47.3	+ 6 43	22	11 54 55	+ 0 33.1	− 7 10
26	0 18 12	+ 1 58.2	+ 5 48	25	12 05 42	− 0 37.0	− 8 13
29	0 29 07	+ 3 08.7	+ 4 54	28	12 16 29	− 1 47.1	− 9 14
Apr. 1	0 40 02	+ 4 18.6	+ 4 00	Oct. 1	12 27 19	− 2 57.1	−10 13
4	0 50 58	+ 5 27.8	+ 3 06	4	12 38 11	− 4 06.8	−11 10
7	1 01 56	+ 6 36.1	+ 2 14	7	12 49 07	− 5 16.1	−12 04
10	1 12 55	+ 7 43.5	+ 1 24	10	13 00 06	− 6 24.8	−12 54
13	1 23 57	+ 8 49.6	+ 0 37	13	13 11 09	− 7 32.7	−13 40
16	1 35 01	+ 9 54.5	− 0 08	16	13 22 17	− 8 39.8	−14 21
19	1 46 09	+10 57.9	− 0 49	19	13 33 30	− 9 45.7	−14 56
22	1 57 21	+11 59.7	− 1 26	22	13 44 49	−10 50.3	−15 27
25	2 08 37	+12 59.7	− 1 59	25	13 56 13	−11 53.5	−15 51
28	2 19 57	+13 57.7	− 2 28	28	14 07 44	−12 55.0	−16 09
				31	14 19 21	−13 54.7	−16 20
May 1	2 31 21	+14 53.7	− 2 53				
4	2 42 50	+15 47.5	− 3 13	Nov. 3	14 31 05	−14 52.4	−16 25
7	2 54 24	+16 38.9	− 3 28	6	14 42 57	−15 48.0	−16 21
10	3 06 03	+17 27.8	− 3 38	9	14 54 56	−16 41.2	−16 10
13	3 17 47	+18 14.1	− 3 42	12	15 07 03	−17 31.9	−15 52
16	3 29 36	+18 57.6	− 3 42	15	15 19 18	−18 19.8	−15 25
19	3 41 31	+19 38.3	− 3 36	18	15 31 40	−19 04.9	−14 51
22	3 53 31	+20 15.9	− 3 25	21	15 44 10	−19 46.8	−14 10
25	4 05 35	+20 50.5	− 3 09	24	15 56 47	−20 25.6	−13 22
28	4 17 44	+21 21.8	− 2 49	27	16 09 30	−21 00.9	−12 27
31	4 29 57	+21 49.8	− 2 26	30	16 22 20	−21 32.7	−11 25
June 3	4 42 13	+22 14.3	− 1 58	Dec. 3	16 35 17	−22 00.8	−10 18
6	4 54 33	+22 35.4	− 1 27	6	16 48 19	−22 25.2	− 9 05
9	5 06 56	+22 52.9	− 0 54	9	17 01 26	−22 45.5	− 7 46
12	5 19 21	+23 06.8	− 0 18	12	17 14 37	−23 01.9	− 6 24
15	5 31 48	+23 17.0	+ 0 20	15	17 27 52	−23 14.2	− 4 59
18	5 44 17	+23 23.6	+ 0 59	18	17 41 09	−23 22.2	− 3 31
21	5 56 46	+23 26.4	+ 1 38	21	17 54 28	−23 26.1	− 2 02
24	6 09 15	+23 25.5	+ 2 17	24	18 07 47	−23 25.8	− 0 32
27	6 21 43	+23 20.9	+ 2 56	27	18 21 06	−23 21.2	+ 0 57
30	6 34 09	+23 12.6	+ 3 32	30	18 34 23	−23 12.4	+ 2 25

PRINCIPAL ELEMENTS OF THE SOLAR SYSTEM

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

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

PHYSICAL ELEMENTS

Object	Equatorial Diameter miles	Oblateness	Mass ⊕=1	Mean Density water =1	Surface Gravity ⊕=1	Rotation Period	Inclination of Equator to Orbit °	Albedo
☉ Sun	864,000	0	332,958	1.41	27.9	25^d–35^d†		
☾ Moon	2,160	0	0.0123	3.36	0.16	$27^d\,07^h\,43^m$	6.7	0.067
☿ Mercury	3,025	0	0.055	5.46	0.38	58^d16^h	<7°	0.056
♀ Venus	7,526	0	0.815	5.23	0.90	243^d(retro.)	~179°	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?	?	0.11	5?	0.6?	$6^d9^h17^m$	?	0.14?

†Depending on latitude. For the physical observations of the sun, p. 54, 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	Revolution Period h	Revolution Period m	Orbit Incl. ° ‡	Discovery
SATELLITE OF THE EARTH									
Moon	−12.7	2160	238,900	...	27	07	43	Var.§	
SATELLITES OF MARS									
Phobos	11.6	*14*	5,800	25	0	07	39	1.0	Hall, 1877
Deimos	12.8	*8*	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	*2273*	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)	(225)	100,000		0	17	59		A. Dollfus, 1966
Mimas	12.1	(550)	116,000	30	0	22	37	1.5	W. Herschel, 1789
Enceladus	11.8	350	148,000	38	1	08	53	0.0	W. Herschel, 1789
Tethys	10.3	750	183,000	48	1	21	18	1.1	G. Cassini, 1684
Dione	10.4	500	235,000	61	2	17	41	0.0	G. Cassini, 1684
Rhea	9.8	800	327,000	85	4	12	25	0.4	G. Cassini, 1672
Titan	8.4	3000	759,000	197	15	22	41	0.3	Huygens, 1655
Hyperion	14.2	(200)	920,000	239	21	06	38	0.4	G. Bond, 1848
Iapetus	11.0	(700)	2,213,000	575	79	07	56	14.7	G. Cassini, 1671
Phoebe	(14)	(160)	8,053,000	2096	550	11		150	W. Pickering, 1898
SATELLITES OF URANUS									
Miranda	16.5	(350)	77,000	9	1	09	56	0	Kuiper, 1948
Ariel	14.4	(900)	119,000	14	2	12	29	0	Lassell, 1851
Umbriel	15.3	(600)	166,000	20	4	03	38	0	Lassell, 1851
Titania	14.0	(1100)	272,000	33	8	16	56	0	W. Herschel, 1787
Oberon	14.2	(1000)	365,000	44	13	11	07	0	W. Herschel, 1787
SATELLITES OF NEPTUNE									
Triton	13.6	2350	220,000	17	5	21	03	160.0	Lassell, 1846
Nereid	18.7	(330)	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 *and* recent values in *italics*.

‡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 1973 will be about 43 seconds.

RADIO TIME SIGNALS

National time services distribute co-ordinated time called UTC, which on January 1, 1972, was adjusted so that the time interval is the atomic second. The resulting atomic time gains on mean solar time at a rate of about a second a year. An approximation to UT1 is maintained by stepping the atomic time scale in units of 1 second on June 30 or December 31 when required so that the divergence from mean solar time (DUT1 = UT1 − UTC) does not exceed 0.6 second. The first such "leap second" occurred on June 30, 1972. These changes are coordinated through the Bureau International de l'Heure (BIH), so that most time services are synchronized to the tenth of a millisecond.

DUT1 is identified each minute on CHU and WWV by a special group of split or double pulses. The number of such marker pulses in a group gives the value of DUT1 in tenths of a second. If the group starts with the first (not zero) second of each minute, DUT1 is positive and mean solar time is ahead of the transmitted time; if with the 9th second DUT1 is negative, and mean solar time is behind.

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.

$$1 \leqslant (k-1)!\, c_9 \left\{ (c_4{}^k \mu^{-1})^{r(\log r)^{\frac{1}{2}}} + (c_4{}^k c_5)^{r(\log r)^{\frac{1}{2}}} \sum_{i=2}^{k} |u_i| (r_i!)^{-1} \right\},$$

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$$h_2(z) = \exp\left(\frac{1}{2\pi} \int_0^{2\pi} \frac{e^{it}+z}{e^{it}-z} k(t)dt\right) \cdot \exp\left(-\frac{1}{2\pi} \int_{K''} \frac{e^{it}+z}{e^{it}-z} d\nu(t)\right)$$

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

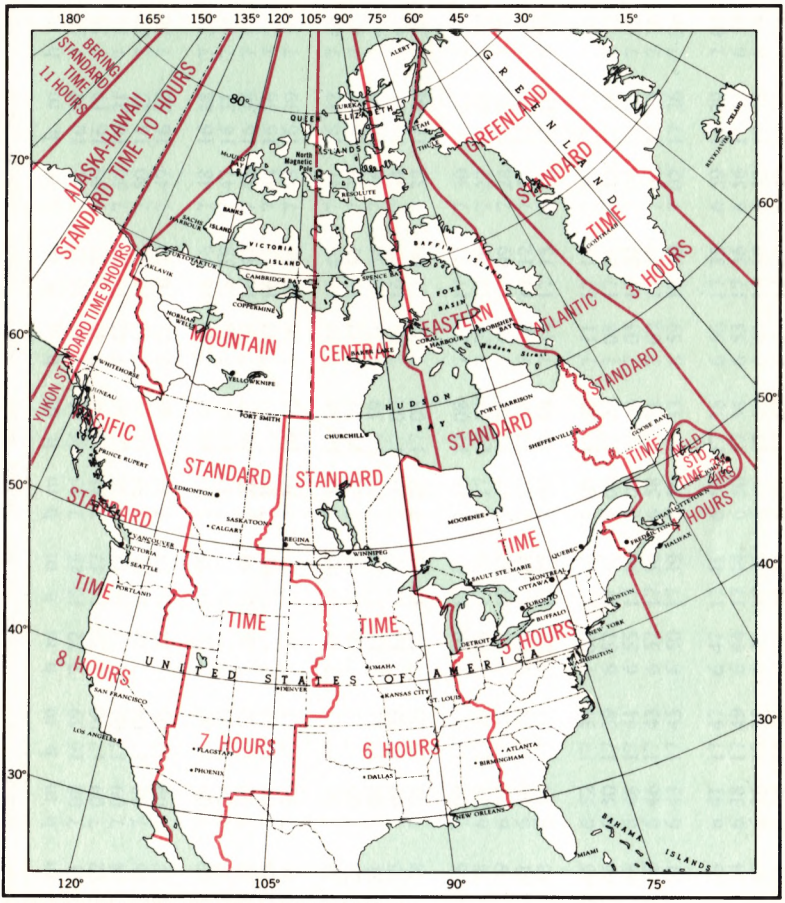
To derive the Standard Time of rising and setting phenomena for the places named, from the list below find the approximate latitude of the place and the correction in minutes which follows the name. Then find in the monthly table the Local Mean Time of the phenomenon for the proper latitude on the desired 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



PRODUCED BY THE SURVEYS AND MAPPING BRANCH, DEPARTMENT OF ENERGY, MINES AND RESOURCES, OTTAWA, CANADA, 1973.

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

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

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

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

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

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

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

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

MOONRISE AND MOONSET, 1974; LOCAL MEAN TIME

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

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

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

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

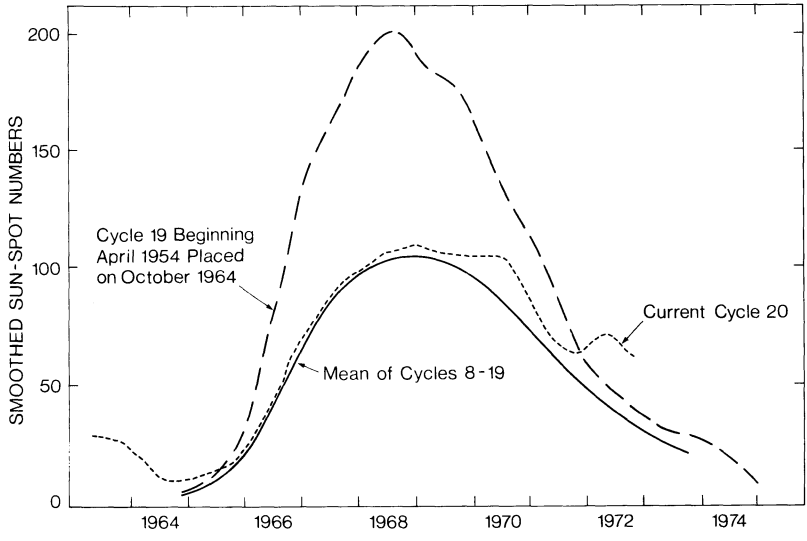
DATE	Latitude 30° Moon Rise	Moon Set	Latitude 35° Moon Rise	Moon Set	Latitude 40° Moon Rise	Moon Set	Latitude 45° Moon Rise	Moon Set	Latitude 50° Moon Rise	Moon Set	Latitude 54° Moon Rise	Moon Set
Sept.	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
1 ♍	18 06	05 25	18 07	05 22	18 09	05 19	18 11	05 15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

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

THE SUN AND PLANETS FOR 1974

THE SUN

The diagram represents the sun-spot activity for the current cycle (number 20) compared with that for the previous cycle (number 19) and with the mean of that for cycles 8 to 19. Sun-spot activity is decreasing and should reach a minimum in 1975.



MERCURY

Mercury, the planet nearest the sun, is difficult to observe with optical telescopes, but radio and radar observations have provided some information about the surface and rotation of this small planet. Its orbit is well within that of the earth, and it appears, from earth, to move quickly from one side of the sun to the other, several times in the year. Its greatest elongation (maximum angular distance from the sun) varies from 18° to 28°, and on such occasions it is visible to the naked eye for about two weeks. Despite its considerable brilliance, it is always viewed in the twilight sky, and one must look sharply to see it.

The following table lists the greatest elongations east (evening sky) and west (morning sky) during 1974. None is particularly favourable.

Date	Elong. East	Mag.	Date	Elong. West	Mag.
Feb. 9	18°	−0.3	Mar. 23	28°	+0.5
June 4	24°	+0.7	July 22	20°	+0.5
Oct. 1	26°	+0.2	Nov. 10	19°	−0.2

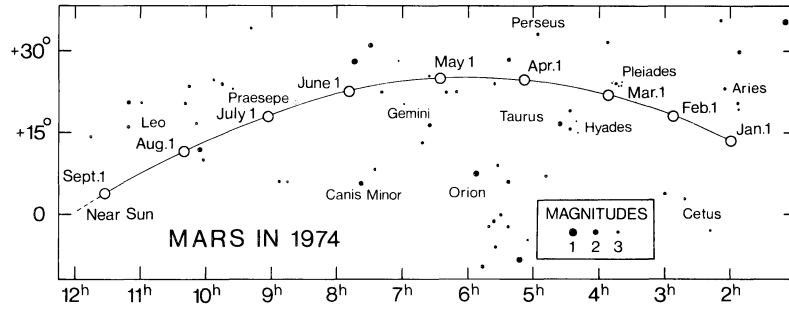
VENUS

Since the orbit of Venus lies within that of the earth, its apparent motion is like Mercury's, but is much slower and more stately. At inferior conjunction, it comes within 30 million miles of the earth, and its proximity and its reflective cloud layer make it the brightest of the planets. It is visible to the naked eye in daytime, if one knows where to look. In a small telescope, it displays a sequence of phases, like the moon.

In early 1974, Venus is visible in the evening. On Jan. 23, it is in inferior conjunction, and from then until October it is visible in the morning. Greatest elongation west is on Apr. 4. On Nov. 6 it is in superior conjunction and by December it is again visible in the evening. Venus is in conjunction with Jupiter on Apr. 15 and with Saturn on July 31.

MARS

Since the orbit of Mars is outside that of the earth, its planetary phenomena are quite different from those of Mercury and Venus. At intervals of about 780 days (the synodic period), Mars can be seen in opposition to the sun. At such times, its distance from earth is smallest and (if Mars is at perihelion) can be as small as 35 million miles. Such close approaches occur at intervals of 15 to 17 years; the most recent occurred in 1971.



The atmosphere of Mars is thin, and surface features are distinctly visible in a good telescope. Perhaps the most surprising result of the space programme so far is the discovery of craters, canyons and volcanoes on the Martian surface.

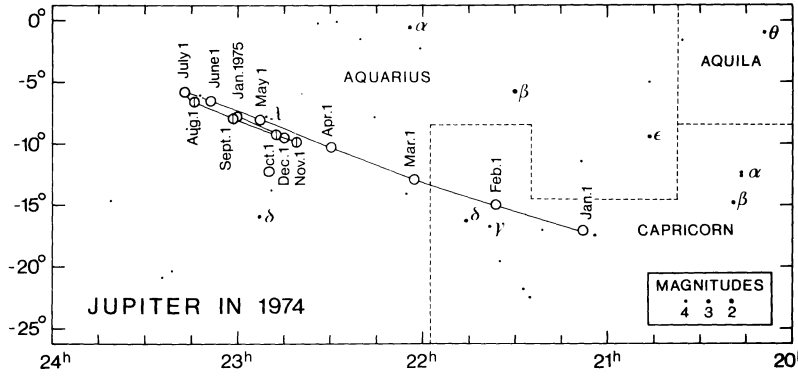
Mars is not conspicuous in 1974, but can be recognized by its reddish colour. It is in conjunction with Saturn on Apr. 20, with Regulus on July 26, with the sun on Oct. 14 and with Antares on Dec. 23.

JUPITER

Jupiter, the giant of the sun's family, is a fine object for the telescope. Belts of clouds may be observed, interrupted by irregular spots which may be short-lived or persist for weeks. The flattening of the planet, due to its fast rotation, is conspicuous, and the phenomena of its satellites provide a continual interest. In 1973 and 1974 the orbit plane of the Galilean satellites intersects the earth, and many mutual occultations and eclipses of these satellites occur. Further details appear in the publications of the *British Astronomical Association.*

In early 1974, Jupiter moves from Capricorn into Aquarius. Conjunction occurs on Feb. 13 and throughout most of the rest of 1974, the planet is well-placed for

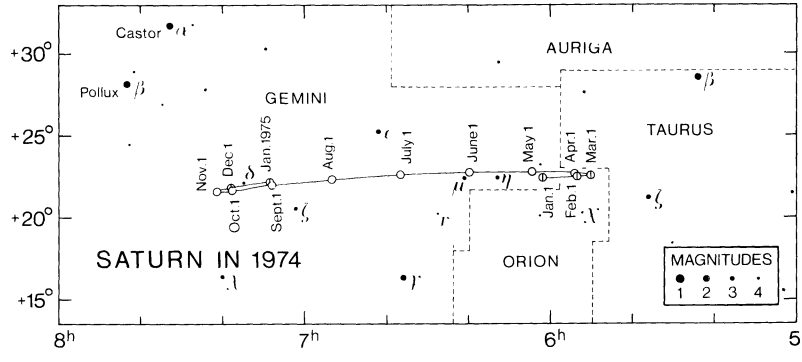
observation—a conspicuous object in an otherwise unspectacular part of the sky. On Apr. 15, Jupiter is in conjunction with Venus.



SATURN

Saturn was the outermost planet known until modern times and, with its unique system of rings, 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 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 open widest in 1973, the southern face being visible.

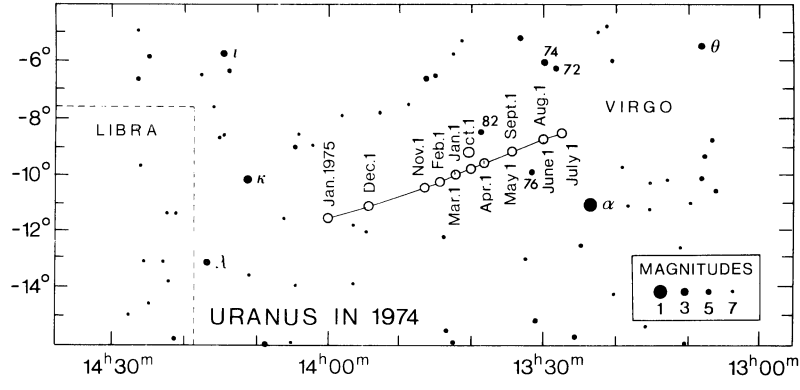
In 1974, Saturn is visible in the evening until mid-June when it becomes too close to the sun for observation. From mid-July, it is visible in the morning. Throughout most of 1974, it is in Gemini. Saturn is in conjunction with Mars on Apr. 20 and with Venus on July 30; on Aug. 29, Saturn and its rings occult a faint star, SAO 79100.



URANUS

Although Uranus at opposition can be seen with the naked eye under a clear dark sky, it was apparently unknown until 1781 when it was accidentally discovered (telescopically) by William Herschel. It can easily be seen with binoculars, and in a telescope, it shows a small, greenish, almost featureless disk.

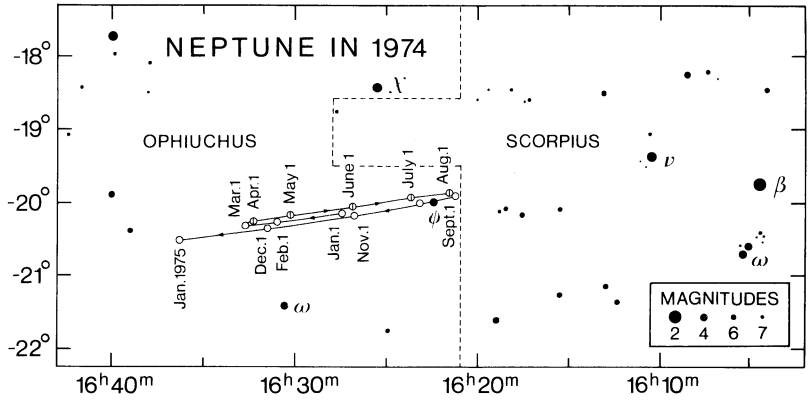
In 1974, Uranus is in Virgo, slightly northeast of Spica. Opposition occurs on Apr. 16.



NEPTUNE

The discovery of Neptune in 1846, after its existence in the sky had been predicted from independent calculations by Leverrier in France and Adams in England, was regarded as the crowning achievement of Newton's theory of universal gravitation. Actually, Neptune had been seen—but mistaken for a star— several times before its "discovery"!

In 1974, Neptune is in Ophiuchus, and in mid-July and again in mid-September it passes very close to ψ Ophiuchi (see map). At opposition on May 30, its apparent magnitude is +7.7 and its apparent diameter is 2.5″.



PLUTO

Pluto, the most distant known planet, was discovered at the Lowell Observatory in 1930, as a result of an extensive 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. At opposition on March 26, its astrometric position is R.A. (1950) $12^h46^m.5$, Dec. (1950) +13° 42′ and its apparent magnitude is +14.

THE SKY MONTH BY MONTH

By John F. Heard

THE SKY FOR JANUARY 1974

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 44 m to 20 h 57 m and its Decl. changes from 23° 03′ S. to 17° 16′ S. The equation of time changes from −3 m 36 s to −13 m 30 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 at perihelion, or nearest the sun, on the 4th at a distance of 91,400,000 miles. 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 23 m, Decl. 24° 42′ S., and on the 15th is in R.A. 20 h 02 m, Decl. 22° 36′ S. It is too close to the sun for observation, superior conjunction being on the 9th.

Venus on the 1st is in R.A. 20 h 53 m, Decl. 16° 10′ S., and on the 15th it is in R.A. 20 h 39 m, Decl. 13° 33′ S., mag. −3.7, and transits at 12 h 58 m. It is to be seen low in the south-west for about one and a half hours after sunset at mid-month, but by the 23rd it is in inferior conjunction.

Mars on the 15th is in R.A. 2 h 21 m, Decl. 15° 29′ N., mag. +0.2, and transits at 18 h 43 m. In Aries, it is nearing the meridian at sunset and is visible most of the night.

Jupiter on the 15th is in R.A. 21 h 21 m, Decl. 16° 17′ S., mag. −1.6, and transits at 13 h 42 m. In Capricornus, it is nearing the south-western horizon 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. 5 h 58 m, Decl. 22° 26′ N., mag. −0.1, and transits at 22 h 17 m. Moving from Gemini into Orion, it is fairly low in the east at sunset and sets about an hour before dawn.

Uranus on the 15th is in R.A. 13 h 44 m, Decl. 10° 05′ S., and transits at 6 h 05 m.

Neptune on the 15th is in R.A. 16 h 29 m, Decl. 20° 14′ S., and transits at 8 h 51 m.

Pluto—For information in regard to this planet, see p. 29.

1974		JANUARY E.S.T.			Min. of Algol	Config. of Jupiter's Sat. 18 h E.S.T.	Sun's Selen. Colong. 0 h U.T.
	d	h	m		h m		°
Tues.	1	11		Venus stationary	1 50	213O4	358.65[b]
		13	06	☽ First Quarter			
Wed.	2					3O124	10.80[l]
Thur.	3	08		Mars 3° S. of Moon	22 40	31O42	22.95
		10		Quadrantid Meteors			
Fri.	4	05		Earth at perihelion		423Od	35.10
Sat.	5					42O13	47.23
Sun.	6				19 30	41O23	59.37
Mon.	7	04		Saturn 0.9° S. of Moon. Occ'n.[1]		4O13d	71.49
Tues.	8			Saturn at perihelion		421Od	83.62
		06		Moon at perigee (221,550 mi.)			
		07	36	☽ Full Moon			
Wed.	9	03		Mercury in superior conjunction	16 20	43O21	95.74
Thur.	10	02		Juno in conjunction		431O2	107.86
Fri.	11					342Od	119.99
Sat.	12				13 10	2O143	132.12
Sun.	13					1O243	144.26[b]
Mon.	14					O2134	156.40
Tues.	15	02	04	☾ Last Quarter	9 50	21O34	168.55[l]
		11		Uranus 5° N. of Moon			
		23		Ceres in conjunction			
Wed.	16	07		Pluto stationary			180.71
Thur.	17						192.87
Fri.	18			Mercury greatest hel. lat. S.	6 40		205.05
		10	39	Appulse of Pallas and SAO 123571			
		17		Neptune 3° N. of Moon			
Sat.	19						217.22
Sun.	20						229.40
Mon.	21	17		Moon at apogee (252,570 mi.)	3 30		241.59
Tues.	22						253.77
Wed.	23	06	02	● New Moon			265.96
		16		Venus in inferior conjunction			
Thur.	24	08		Mercury 6° S. of Moon	0 20		278.15
		19		Jupiter 5° S. of Moon			
Fri.	25						290.34
Sat.	26				21 10		302.53
Sun.	27	20		Mercury 0.9° S. of Jupiter			314.71
Mon.	28			Venus at perihelion			326.90[b]
Tues.	29				18 00		339.07
Wed.	30						351.24
Thur.	31	02	39	☽ First Quarter			3.41[l]
		12		Mars 2° S. of Moon			

See explanation of time on p. 10, of colongitude on p. 56.

[l]Jan. 2, −7.67°; Jan. 15, +7.85°; Jan. 31, −7.12°.

[b]Jan. 1, −6.83°; Jan. 13, +6.76°; Jan. 28, −6.72°.

[1]Visible in N.E. Asia, Arctic, N. and E. of N. America.

THE SKY FOR FEBRUARY 1974

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 57 m to 22 h 46 m and its Decl. changes from 17° 16′ S. to 7° 49′ S. The equation of time changes from −13 m 38 s to a maximum of −14 m 17 s on the 11th and then to −12 m 36 s at the end of the month. For changes in the length of the day, see p. 13.

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

Mercury on the 1st is in R.A. 21 h 58 m, Decl. 13° 31′ S., and on the 15th is in R.A. 22 h 49 m, Decl. 5° 06′ S. On the 9th it is at greatest eastern elongation and stands about 14° above the western horizon at sunset. From about the 6th to the 16th it may be possible to see Mercury low in the west just after sunset. By the 24th it is in inferior conjunction.

Venus on the 1st is in R.A. 19 h 58 m, Decl. 12° 57′ S., and on the 15th it is in R.A. 19 h 46 m, Decl. 13° 54′ S., mag. −4.3, and transits at 10 h 05 m. It is a morning star and by the 15th it is visible low in the south-east for about two hours before sunrise. It is at greatest brilliancy on the 27th.

Mars on the 15th is in R.A. 3 h 22 m, Decl. 20° 06′ N., mag. +0.8, and transits at 17 h 42 m. Moving from Aries into Taurus, it is about on the meridian at sunset and sets about midnight.

Jupiter on the 15th is in R.A. 21 h 50 m, Decl. 13° 57′ S., mag. −1.5, and transits at 12 h 09 m. It is too close to the sun for observation, conjunction being on the 13th. 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. 5 h 51 m, Decl. 22° 31′ N., mag. +0.1, and transits at 20 h 08 m. In Orion, it is well up in the east at sunset and sets about 3 a.m. Saturn is stationary in right ascension on the 27th and resumes direct or eastward motion among the stars.

Uranus on the 15th is in R.A. 13 h 44 m, Decl. 10° 06′ S., and transits at 4 h 04 m.

Neptune on the 15th is in R.A. 16 h 32 m, Decl. 20° 18′ S., and transits at 6 h 52 m.

Pluto—For information in regard to this planet, see p. 29.

1974		FEBRUARY E.S.T.			Min. of Algol	Sun's Selen. Colong. 0 h U.T.
	d	h	m		h m	°
Fri.	1	02		Uranus stationary	14 50	15.56
Sat.	2					27.72
Sun.	3	11		Saturn 0.9° S. of Moon. Occ'n.[1]		39.86
Mon.	4				11 40	52.00
Tues.	5	19		Moon at perigee (222,690 mi.)		64.13
Wed.	6			Mercury at ascending node		76.26
		18	24	☽ Full Moon		
Thur.	7				8 30	88.39
Fri.	8					100.52
Sat.	9	03		Mercury greatest elong. E. (18°)		112.65
Sun.	10				5 20	124.79[b]
Mon.	11			Mercury at perihelion		136.93
		19		Uranus 5° N. of Moon		
Tues.	12	18		Vesta stationary		149.08[1]
Wed.	13	11		Jupiter in conjunction	2 10	161.23
		19	04	☾ Last Quarter		
Thur.	14					173.39
Fri.	15	00		Mercury stationary	22 00	185.56
		01		Neptune 3° N. of Moon		
Sat.	16	18	49	Appulse of Pallas and SAO 124318		197.73
Sun.	17					209.91
Mon.	18	03		Moon at apogee (252,160 mi.)	19 50	222.10
		22		Venus 4° N. of Moon		
Tues.	19			Venus greatest hel. lat. N.		234.29
Wed.	20	23		Vesta stationary		246.48
Thur.	21			Mercury greatest hel. lat. N.	16 40	258.68
Fri.	22	00	34	● New Moon		270.88
Sat.	23					283.08
Sun.	24	16		Mercury in inferior conjunction	13 30	295.28[b]
Mon.	25					307.48
Tues.	26					319.67
Wed.	27	07		Venus at greatest brilliancy	10 10	331.86[1]
		17		Saturn stationary		
Thur.	28	20		Mars 0.5° S. of Moon. Occ'n.[2]		344.05

[1]Feb. 12, +7.45°; Feb. 27, −5.95°. [b]Feb. 10, +6.60°; Feb. 24, −6.59°.

[1]Visible in N. Europe, N. Asia and Arctic.

[2]Visible in N. Pacific, N. of N. America, Atlantic.

THE SKY FOR MARCH 1974

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 46 m to 0 h 40 m and its Decl. changes from 7° 49′ S. to 4° 19′ N. The equation of time changes from −12 m 25 s to −4 m 14 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 09 m, Decl. 7° 45′ S., and on the 15th is in R.A. 22 h 02 m, Decl. 11° 42′ S. It is too close to the sun for easy observation, the greatest western elongation of the 23rd being a very unfavourable one.

Venus on the 1st is in R.A. 20 h 05 m, Decl. 14° 41′ S., and on the 15th it is in R.A. 20 h 44 m, Decl. 14° 21′ S., mag. −4.3, and transits at 9 h 14 m. It is a morning star, rising in the south-east about two hours before the sun.

Mars on the 15th is in R.A. 4 h 27 m, Decl. 23° 20′ N., mag. +1.2, and transits at 16 h 57 m. In Taurus, it is past the meridian at sunset and sets before midnight.

Jupiter on the 15th is in R.A. 22 h 15 m, Decl. 11° 41′ S., mag. −1.6, and transits at 10 h 44 m. It may be seen briefly, very low in the east just before sunrise. 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. 5 h 51 m, Decl. 22° 36′ N., mag. +0.2, and transits at 18 h 19 m. In Orion, it is about on the meridian at sunset and sets soon after midnight.

Uranus on the 15th is in R.A. 13 h 41 m, Decl. 9° 51′ S., and transits at 2 h 11 m.

Neptune on the 15th is in R.A. 16 h 33 m, Decl. 20° 19′ S., and transits at 5 h 02 m.

Pluto—For information in regard to this planet, see p. 29.

1974				MARCH E.S.T.	Min. of Algol	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m	°
Fri.	1	13	03	☽ First Quarter		356.23
Sat.	2	11		Mercury 4° N. of Jupiter	7 00	8.40
		18		Saturn 0.6° S. of Moon. Occ'n.[1]		
Sun.	3					20.56
Mon.	4					32.72
Tues.	5				3 50	44.88
Wed.	6	01		Moon at perigee (225,530 mi.)		57.02
Thur.	7					69.17
Fri.	8	05	03	○ Full Moon	0 40	81.31
		22		Mercury stationary		
Sat.	9					93.45[b]
Sun.	10				21 30	105.60
Mon.	11	04		Uranus 5° N. of Moon		117.74
Tues.	12	02		Neptune stationary		129.90[l]
Wed.	13				18 20	142.05
Thur.	14	09		Neptune 3° N. of Moon		154.22
Fri.	15	14	15	☾ Last Quarter		166.39
Sat.	16			Mercury at descending node	15 10	178.57
Sun.	17	19		Mars 7° N. of Aldebaran		190.75
		21		Moon at apogee (251,550 mi.)		
Mon.	18					202.94
Tues.	19	17		Venus 0.9° S. of Moon. Occ'n.[2]	12 00	215.14
Wed.	20	19		Equinox. Spring begins		227.34
Thur.	21	11		Mercury 0.1° S. of Jupiter		239.55
		12		Jupiter, Mercury 6° S. of Moon		
Fri.	22				8 50	251.76
Sat.	23	15		Mercury greatest elong. W. (28°)		263.97[b]
		16	24	● New Moon		
Sun.	24					276.19
Mon.	25				5 40	288.40[l]
Tues.	26	07		Pluto at opposition		300.62
Wed.	27			Mercury at aphelion		312.83
Thur.	28				2 30	325.04
Fri.	29	05		Mars 1.1° N. of Moon. Occ'n.[3]		337.24
Sat.	30	01		Saturn 0.2° S. of Moon. Occ'n.[4]	23 20	349.44
		20	44	☽ First Quarter		
Sun.	31	17		Vesta at opposition		1.63

[l]Mar. 12, +6.43°; Mar. 25, −5.03°. [b]Mar. 9, +6.53°; Mar. 23, −6.56°.
[1]Visible in N. of N. America, Greenland, Iceland, Europe, N. Atlantic, N. Africa.
[2]Visible in E. Asia, N. Pacific, Alaska. [3]Visible in S. Indian Ocean.
[4]Visible in S.E. Asia, N. Pacific.

THE SKY FOR APRIL 1974

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 40 m to 2 h 31 m and its Decl. changes from 4° 19′ N. to 14° 54′ N. The equation of time changes from −3 m 56 s to +2 m 47 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. 23 h 06 m, Decl. 8° 04′ S., and on the 15th is in R.A. 0 h 24 m, Decl. 0° 02′ S. It is too close to the sun for observation.

Venus on the 1st is in R.A. 21 h 45 m, Decl. 11° 53′ S., and on the 15th it is in R.A. 22 h 41 m, Decl. 8° 14′ S., mag. −3.9, and transits at 9 h 10 m. It is a morning star rising in the east about an hour and a half before the sun.

Mars on the 15th is in R.A. 5 h 46 m, Decl. 24° 57′ N., mag. +1.6, and transits at 16 h 14 m. Moving from Taurus into Gemini, it is well past the meridian at sunset and sets about four hours later. Mars and Saturn are close together during this month, being in conjunction on the 20th, with Mars 2° N of Saturn (See page 27).

Jupiter on the 15th is in R.A. 22 h 41 m, Decl. 9° 17′ S., mag. −1.7, and transits at 9 h 08 m. In Aquarius it rises in the east between one and two hours before the sun. 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. 5 h 59 m, Decl. 22° 42′ N., mag. +0.3, and transits at 16 h 24 m. Moving from Orion into Gemini, it is well past the meridian at sunset and sets before midnight.

Uranus on the 15th is in R.A. 13 h 37 m, Decl. 9° 24′ S., and transits at 0 h 05 m.

Neptune on the 15th is in R.A. 16 h 32 m, Decl. 20° 15′ S., and transits at 2 h 59 m.

Pluto—For information in regard to this planet, see p. 29.

1974				APRIL E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 5 h E.S.T.	Sun's Selen. Colong. 0 h U.T.
	d	h	m		h m		°
Mon.	1						13.81
Tues.	2	11		Moon at perigee (228,840 mi.)	20 10		25.99
Wed.	3	23		Venus greatest elong. W. (46°)			38.16
Thur.	4						50.33
Fri.	5				16 50		62.49[b]
Sat.	6	16	00	○ Full Moon			74.65
Sun.	7	12		Uranus 5° N. of Moon		321O4	86.81
Mon.	8				13 40	32O14	98.97
Tues.	9					1O324	111.14[l]
Wed.	10	17		Neptune 3° N. of Moon		O2134	123.30
Thur.	11				10 30	2O134	135.48
Fri.	12					1O24d	147.65
Sat.	13					3O124	159.84
Sun.	14	09	57	☾ Last Quarter	7 20	312O4	172.03
		17		Moon at apogee (251,150 mi.)			
		21		Venus 1.1° N. of Jupiter			
Mon.	15	22		Uranus at opposition		234O1	184.23
Tues.	16			Mercury greatest hel. lat. S.		41O32	196.43
				Venus at descending node			
Wed.	17				4 10	4O123	208.64
Thur.	18	08		Jupiter 6° S. of Moon		421O3	220.85
		14		Venus 6° S. of Moon			
Fri.	19					4O3d*	233.08[b]
Sat.	20	09		Mars 2° N. of Saturn	1 00	43O12	245.30
Sun.	21					4312O	257.53[l]
Mon.	22	05	17	● New Moon	21 50	432O1	269.76
		10		Lyrids			
Tues.	23					14O32	281.99
Wed.	24					O1243	294.22
Thur.	25				18 40	21O34	306.45
Fri.	26	10		Saturn 0.2° N. of Moon. Occ'n.[1]		2O134	318.68
		16		Mars 3° N. of Moon			
Sat.	27	11		Moon at perigee (229,490 mi.)		3O24*	330.90
Sun.	28				15 30	312O4	343.12
Mon.	29	02	39	☽ First Quarter		32O14	355.33
Tues.	30					1O234	7.53

[l]Apr. 9, +5.37°; Apr. 21, −5.23°. [b]Apr. 5, +6.56°; Apr. 19, −6.65°.

[1]Visible in N.E. of S. America, mid-Atlantic, Central Africa, Malagasy Republic.

THE SKY FOR MAY 1974

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 31 m to 4 h 34 m and its Decl. changes from 14° 54′ N. to 21° 58′ N. The equation of time changes from +2 m 54 s to a maximum of +3 m 43 s on the 14th and then to +2 m 24 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. 2 h 16 m, Decl. 12° 48′ N., and on the 15th is in R.A. 4 h 14 m, Decl. 22° 48′ N. Superior conjunction is on the 4th and the planet remains too close to the sun for observation until near the end of the month. (See June).

Venus on the 1st is in R.A. 23 h 46 m, Decl. 2° 41′ S., and on the 15th it is in R.A. 0 h 45 m, Decl. 2° 53′ N., mag. −3.6, and transits at 9 h 15 m. It is a morning star rising in the east about an hour before the sun.

Mars on the 15th is in R.A. 7 h 05 m, Decl. 24° 04′ N., mag. +1.8, and transits at 15 h 34 m. In Gemini, it is well down in the west by sunset and sets within three hours.

Jupiter on the 15th is in R.A. 23 h 01 m, Decl. 7° 22′ S., mag. −1.8, and transits at 7 h 30 m. In Aquarius, it rises about two and a half hours before the sun and is well up in the south-east by dawn. 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. 6 h 11 m, Decl. 22° 45′ N., mag. +0.3, and transits at 14 h 39 m. In Gemini, it is well down in the west at sunset and sets about three hours later.

Uranus on the 15th is in R.A. 13 h 32 m, Decl. 8° 58′ S., and transits at 21 h 58 m.

Neptune on the 15th is in R.A. 16 h 29 m, Decl. 20° 08′ S., and transits at 0 h 58 m.

Pluto—For information in regard to this planet, see p. 29.

1974				MAY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 4 h E.S.T.	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Wed.	1				12 20	O1423	19.73
Thur.	2					2143O3	31.92[b]
Fri.	3					42O13	44.10
Sat.	4	12		Mercury in superior conjunction	9 10	431O2	56.28
		18		Uranus 5° N. of Moon			
Sun.	5			Mercury at ascending node		43O2d	68.46
		12		η Aquarid meteors			
Mon.	6	03	55	☉ Full Moon		432O1	80.64[l]
Tues.	7				6 00	413O2	92.82
Wed.	8	01		Neptune 3° N. of Moon		4O123	105.00
Thur.	9					421O3	117.18
Fri.	10			Mercury at perihelion	2 40	24O13	129.37
Sat.	11					13O24	141.56
Sun.	12	12		Moon at apogee (251,270 mi.)	23 30	3O124	153.75
Mon.	13					32O14	165.95
Tues.	14	04	29	☾ Last Quarter		31O4*	178.16
Wed.	15				20 20	O1324	190.38
Thur.	16	02		Jupiter 7° S. of Moon		12O34	202.60
Fri.	17	05		Mercury 7° N. of Aldebaran		2O134	214.82[b]
Sat.	18	14		Venus 7° S. of Moon	17 10	13O42	227.06
Sun.	19	22		Vesta stationary		34O12	239.29[l]
Mon.	20			Mercury greatest hel. lat. N.		342O*	251.53
				Venus at aphelion			
		21		Pallas stationary			
Tues.	21	15	34	● New Moon	14 00	431O*	263.78
Wed.	22					4O132	276.02
Thur.	23	02		Mercury 2° N. of Moon		412O3	288.27
		23		Saturn 0.7° N. of Moon. Occ'n.[1]			
Fri.	24	08		Moon at perigee (226,420 mi.)	10 50	42O13	300.51
Sat.	25	05		Mars 4° N. of Moon		41O2d	312.76
Sun.	26					34O12	324.99
Mon.	27				7 40	32O**	337.22
Tues.	28			Mars greatest hel. lat. N.		32O4d	349.45
		08	03	☽ First Quarter			
Wed.	29	16		Mars 5° S. of Pollux		O1324	1.66[b]
		20		Neptune at opposition			
Thur.	30				4 30	1O34d	13.88
Fri.	31	23		Uranus 5° N. of Moon		2O134	26.08

[l]May 6, +4.95°; May 19, −6.02°.
[b]May 2, +6.67°; May 17, −6.77°, May 29, +6.74°.
[1]Visible in Australasia, S. Pacific.

THE SKY FOR JUNE 1974

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 34 m to 6 h 38 m and its Decl. changes from 21° 58′ N. to 23° 09′ N. The equation of time changes from +2 m 15 s to −3 m 34 s, being zero on the 13th. There is a total eclipse of the sun on the 20th, not visible in North America. For changes in the length of the day, see p. 15.

The Moon—For its phases, perigee and apogee times and distances and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 22. There is a partial eclipse of the moon on the 4th, not visible in North America.

Mercury on the 1st is in R.A. 6 h 15 m, Decl. 25° 22′ N., and on the 15th is in R.A. 6 h 58 m, Decl. 22° 13′ N. On the 4th it is in greatest eastern elongation. This is a favourable one, Mercury standing about 18° above the western horizon at sunset. For about a week before and after this date Mercury may be seen low in the west just after sunset. By the 30th it is in inferior conjunction.

Venus on the 1st is in R.A. 1 h 58 m, Decl. 9° 48′ N., and on the 15th it is in R.A. 3 h 01 m, Decl. 15° 00′ N., mag. −3.4, and transits at 9 h 30 m. It is a morning star rising north of east about an hour and a half before the sun.

Mars on the 15th is in R.A. 8 h 25 m, Decl. 20° 38′ N., mag. +2.0, and transits at 14 h 52 m. Moving into and through Cancer, it is low in the west at sunset and sets within about two hours.

Jupiter on the 15th is in R.A. 23 h 14 m, Decl. 6° 09′ S., mag. −2.0, and transits at 5 h 41 m. In Aquarius, it rises about at midnight and is nearing the meridian by dawn. 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. 6 h 27 m, Decl. 22° 41′ N., and transits at 12 h 53 m. Early in the month it may still be seen very low in the west just after sunset but later it is too close to the sun for observation, conjunction being on the 30th.

Uranus on the 15th is in R.A. 13 h 29 m, Decl. 8° 41′ S., and transits at 19 h 53 m.

Neptune on the 15th is in R.A. 16 h 25 m, Decl. 20° 00′ S., and transits at 22 h 49 m.

Pluto—For information in regard to this planet, see p. 29.

1974				JUNE E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 3 h E.S.T.	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Sat.	1	23		Mercury 2° N. of Saturn		1O234	38.28[l]
Sun.	2				1 20	3O124	50.48
Mon.	3					321O4	62.67
Tues.	4	02		Mercury greatest elong. E. (24°)	22 00	32O14	74.86
		07		Neptune 3° N. of Moon			
		17	10	☋ Full Moon. Eclipse of ☾, p. 55.			
Wed.	5					4O32*	87.05
Thur.	6					41O23	99.24
Fri.	7				18 50	42O13	111.43
Sat.	8					41O23	123.63
Sun.	9	05		Moon at apogee (251,800 mi.)		43O12	135.83
Mon.	10				15 40	4312O	148.03
Tues.	11					432O1	160.24
Wed.	12			Mercury at descending node		4O2**	172.45
				Venus greatest hel. lat. S.			
		17		Jupiter 7° S. of Moon			
		20	45	☾ Last Quarter			
Thur.	13				12 30	O243d	184.67[b]
Fri.	14					2O143	196.90
Sat.	15					1O34*	209.13
Sun.	16				9 20	3O124	221.37[l]
Mon.	17	09		Mercury stationary		312O4	233.61
		10		Venus 5° S. of Moon			
Tues.	18					32O14	245.86
Wed.	19	23	56	☌ New Moon. Eclipse of ☉, p. 55.	6 10	1O24*	258.11
Thur.	20					O234d	270.36
Fri.	21	09		Moon at perigee (223,770 mi.)		2O143	282.62
		11		Pluto stationary			
		14		Solstice. Summer begins			
Sat.	22	19		Mars 6° N. of Moon	3 00	41O3*	294.87
Sun.	23			Mercury at aphelion		43O12	307.12
Mon.	24				23 50	4312O	319.36
Tues.	25					432O1	331.60
Wed.	26	14	20	☽ First Quarter		413O2	343.84[b]
Thur.	27				20 30	4O123	356.06
Fri.	28	04		Uranus 5° N. of Moon		42O3*	8.28[l]
Sat.	29					421O3	20.50
Sun.	30	07		Saturn in conjunction	17 20	3O412	32.70
		15		Mercury in inferior conjunction			

[l]June 1, +5.63°; June 16, −6.88°; June 28, +6.87°.
[b]June 13, −6.85°; June 26, +6.76°.

THE SKY FOR JULY 1974

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 38 m to 8 h 43 m and its Decl. changes from 23° 09′ N. to 18° 10′ N. The equation of time changes from −3 m 46 s to a maximum of −6 m 29 s on the 26th and then to −6 m 21 s at the end of the month. The earth is at aphelion on the 4th at a distance of 94,507,000 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. 6 h 36 m, Decl. 18° 44′ N., and on the 15th is in R.A. 6 h 20 m, Decl. 19° 25′ N. Greatest western elongation is on the 22nd at which time the planet stands about 15° above the eastern horizon at sunrise. From a few days before this date until about two weeks after, Mercury may be seen very low in the east just before sunrise.

Venus on the 1st is in R.A. 4 h 17 m, Decl. 19° 43′ N., and on the 15th it is in R.A. 5 h 28 m, Decl. 22° 10′ N., mag. −3.4, and transits at 9 h 59 m. It is a morning star rising north of east about two hours before the sun. On the 17th at 06 hours E.S.T. there is an occultation visible in some parts of the world. On the 31st Venus passes less than a degree north of Saturn.

Mars on the 15th is in R.A. 9 h 40 m, Decl. 15° 14′ N., and transits at 14 h 08 m. Moving into Leo, it is very low in the west at sunset and sets within two hours.

Jupiter on the 15th is in R.A. 23 h 17 m, Decl. 6° 00′ S., mag. −2.3, and transits at 3 h 46 m. In Aquarius, it rises before midnight and is past the meridian at dawn. On the 8th it is stationary in right ascension and begins to retrograde, or move westward, among the stars. 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. 6 h 44 m, Decl. 22° 29′ N., and transits at 11 h 12 m. Early in the month it is too close to the sun for observation, but by the end of the month it may be seen as a morning star rising about two hours before the sun. At that time it is close to Venus.

Uranus on the 15th is in R.A. 13 h 29 m, Decl. 8° 41′ S., and transits at 17 h 55 m.

Neptune on the 15th is in R.A. 16 h 23 m, Decl. 19° 55′ S., and transits at 20 h 48 m.

Pluto—For information in regard to this planet, see p. 29.

1974				JULY 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		°
Mon.	1	12		Neptune 3° N. of Moon		31O24	44.91
Tues.	2	02		Uranus stationary		32O14	57.11
Wed.	3				14 10	31O24	69.30
Thur.	4	06		Venus 4° N. of Aldebaran		O3124	81.50
		07	40	♋ Full Moon			
		21		Earth at aphelion			
Fri.	5			Mars at aphelion		21O34	93.69
Sat.	6	16		Moon at apogee (252,320 mi.)	11 00	2O34d	105.89
Sun.	7					O1324	118.09
Mon.	8	03		Jupiter stationary		314O2	130.29
Tues.	9				7 50	342O1	142.49
Wed.	10	02		Jupiter 7° S. of Moon		431O2	154.70[b]
Thur.	11	20		Mercury stationary		4O312	166.91
Fri.	12	10	28	☾ Last Quarter	4 40	421O3	179.13
Sat.	13			Mercury greatest hel. lat. S.		42O13	191.35
Sun.	14					4O32*	203.58[l]
Mon.	15				1 30	431O2	215.82
Tues.	16	10		Ceres stationary		324O1	228.06
Wed.	17	06		Venus 0.4° S. of Moon. Occ'n.[1]	22 20	31O4*	240.31
		23		Mercury 2° S. of Moon			
Thur.	18	06		Saturn 1.4° N. of Moon		O3124	252.56
Fri.	19	07	07	● New Moon		12O34	264.81
		17		Moon at perigee (222,150 mi.)			
Sat.	20				19 00	2O134	277.06
Sun.	21	10		Mars 6° N. of Moon		O324*	289.32
Mon.	22	04		Mercury greatest elong. W. (20°)		3O24d	301.57
Tues.	23				15 50	32O14	313.81[b]
Wed.	24	11		Mercury 1.2° S. of Saturn		312O4	326.05
		12		Pallas at opposition			
		20		Juno stationary			
Thur.	25	10		Uranus 5° N. of Moon		4O12*	338.29
		22	51	☽ First Quarter			
Fri.	26	04		Mars 0.7° N. of Regulus	12 40	41O3d	350.51[l]
Sat.	27					42O13	2.73
Sun.	28	16		Neptune 3° N. of Moon		41O23	14.95
Mon.	29	08		δ Aquarid meteors	9 30	43O2d	27.16
Tues.	30					432O1	39.36
Wed.	31	04		Venus 0.2° N. of Saturn		4321O	51.56

[l]July 14, −7.38°; July 26, +7.75°. [b]July 10, −6.78°; July 23, +6.67°.

[1]Visible in Central America, E. of N. America, S. Greenland, N. Atlantic, Europe, N. of N. Africa, S.W. Asia.

THE SKY FOR AUGUST 1974

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 43 m to 10 h 39 m and its Decl. changes from 18° 10′ N. to 8° 30′ N. The equation of time changes from −6 m 17 s to −0 m 20 s. 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 35 m, Decl. 21° 35′ N., and on the 15th is in R.A. 9 h 29 m, Decl. 16° 42′ N. Except for the first few days of the month (see July) it is too close to the sun for observation, superior conjunction being on the 17th.

Venus on the 1st is in R.A. 6 h 56 m, Decl. 22° 30′ N., and on the 15th it is in R.A. 8 h 09 m, Decl. 20° 28′ N., mag. −3.3, and transits at 10 h 38 m. It is a morning star rising north of east about two hours before the sun.

Mars on the 15th is in R.A. 10 h 54 m, Decl. 8° 08′ N., and transits at 13 h 20 m. In Leo it is very low in the west at sunset and will be difficult to locate.

Jupiter on the 15th is in R.A. 23 h 09 m, Decl. 6° 58′ S., mag. −2.4, and transits at 1 h 36 m. In Aquarius, it rises an hour or two after sunset and is visible the rest of the night. 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. 7 h 00 m, Decl. 22° 11′ N., mag. +0.4, and transits at 9 h 26 m. In Gemini, it rises about four hours before the sun.

Uranus on the 15th is in R.A. 13 h 32 m, Decl. 8° 59′ S., and transits at 15 h 56 m.

Neptune on the 15th is in R.A. 16 h 21 m, Decl. 19° 53′ S., and transits at 18 h 45 m.

Pluto—For information in regard to this planet, see p. 29.

1974				AUGUST E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 0 h E.S.T.	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Thur.	1			Mercury at ascending node	6 20	43O12	63.75
Fri.	2	01		Mercury 7° S. of Pollux		1O23*	75.95
		20		Moon at apogee (252,500 mi.)			
		22	57	♋ Full Moon			
Sat.	3					2O143	88.14
Sun.	4				3 10	1O234	100.33
Mon.	5					3O124	112.52
Tues.	6			Mercury at perihelion		32O4*	124.72[b]
		02		Juno 0.9° N. of Moon. Occ'n.			
		05		Jupiter 7° S. of Moon			
Wed.	7			Venus at ascending node	0 00	321O4	136.91
Thur.	8					3O124	149.11
Fri.	9	21		Venus 7° S. of Pollux	20 40	1O234	161.31
Sat.	10	21	46	☾ Last Quarter		2O413	173.52
Sun.	11					41O23	185.74[l]
Mon.	12	12		Perseid meteors	17 30	4O12d	197.96
Tues.	13					4321O	210.18
Wed.	14	22		Saturn 1.8° N. of Moon		432Od	222.42
Thur.	15				14 20	43O12	234.66
Fri.	16			Mercury greatest hel. lat. N.		41O23	246.90
		04		Venus 4° N. of Moon			
Sat.	17	02		Moon at perigee (222,200 mi.)		42O13	259.14
		05		Mercury in superior conjunction			
		14	02	♍ New Moon			
Sun.	18				11 10	41O3*	271.39
Mon.	19	01		Mars 7° N. of Moon		O3412	283.64[b]
		06		Neptune stationary			
Tues.	20					312O4	295.88
Wed.	21	19		Uranus 5° N. of Moon	8 00	32O14	308.12
Thur.	22					3O124	320.35
Fri.	23					1O324	332.58[l]
Sat.	24	10	38	☽ First Quarter	4 50	2O134	344.80
		22		Neptune 2° N. of Moon			
Sun.	25					12O34	357.02
Mon.	26					O3142	9.22
Tues.	27				1 40	3124O	21.43
Wed.	28					342O1	33.62
Thur.	29	02	25	Occ'n. of SAO 79100 by Saturn, rings	22 20	43O2*	45.82
Fri.	30	00		Moon at apogee (252,270 mi.)		41O32	58.00
Sat.	31	19		Ceres at opposition		42O13	70.19

[l]Aug. 11, −7.21°; Aug. 23, +7.88°. [b]Aug. 6, −6.64°; Aug. 19, +6.53°.

THE SKY FOR SEPTEMBER 1974

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 39 m to 12 h 27 m and its Decl. changes from 8° 30′ N. to 2° 57′ S. The equation of time changes from −0 m 01 s to +9 m 58 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. 11 h 30 m, Decl. 4° 16′ N., and on the 15th is in R.A. 12 h 48 m, Decl. 6° 00′ S. It is too close to the sun for observation until the end of the month. (See October.)

Venus on the 1st is in R.A. 9 h 34 m, Decl. 15° 28′ N., and on the 15th it is in R.A. 10 h 41 m, Decl. 9° 44′ N., mag. −3.4, and transits at 11 h 07 m. It is a morning star rising just north of east about an hour before the sun.

Mars on the 15th is in R.A. 12 h 06 m, Decl. 0° 09′ N., and transits at 12 h 31 m. It is too close to the sun for easy observation.

Jupiter on the 15th is in R.A. 22 h 55 m, Decl. 8° 32′ S., mag. −2.4, and transits at 23 h 15 m. In Aquarius, it rises about at sunset and is visible all night. On the 5th it is at opposition. 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. 7 h 13 m, Decl. 21° 52′ N., mag. +0.4, and transits at 7 h 37 m. In Gemini, it rises at about midnight and is well up in the east at dawn.

Uranus on the 15th is in R.A. 13 h 37 m, Decl. 9° 31′ S., and transits at 14 h 00 m.

Neptune on the 15th is in R.A. 16 h 22 m, Decl. 19° 57′ S., and transits at 16 h 44 m.

Pluto—For information in regard to this planet, see p. 29.

1974				SEPTEMBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 0 h E.S.T.	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Sun.	1	14	25	⊛ Full Moon	19 10	412O3	82.37
		20		Mercury 0.1° S. of Mars			
Mon.	2	04		Jupiter 7° S. of Moon		4O312	94.55[b]
Tues.	3					431Od	106.73
Wed.	4				16 00	324O1	118.91
Thur.	5	00		Juno at opposition		31O24	131.09
		15		Jupiter at opposition			
Fri.	6					O324d	143.28
Sat.	7	14		Venus 0.7° N. of Regulus	12 50	2O134	155.46
Sun.	8			Mercury at descending node		21O34	167.66[l]
Mon.	9	07	01	☾ Last Quarter		O1324	179.86
Tues.	10			Venus at perihelion	9 40	31O24	192.06
Wed.	11	11		Saturn 2° N. of Moon		32O14	204.27
Thur.	12	13		Pallas stationary		31O24	216.49
Fri.	13				6 30	4O2d*	228.72
Sat.	14	11		Moon at perigee (223,960 mi.)		42O13	240.94
Sun.	15	21	45	● New Moon		421O3	253.18
Mon.	16				3 20	4O132	265.41[b]
Tues.	17	16		Mercury 3° N. of Moon		413O2	277.64
Wed.	18			Mercury at aphelion		432O1	289.87
		07		Uranus 4° N. of Moon			
Thur.	19				0 00	431O*	302.10
Fri.	20					43O12	314.32[l]
Sat.	21	07		Neptune 2° N. of Moon	20 50	2O43*	326.54
Sun.	22	06		Mercury 0.3° N. of Spica		21O43	338.75
Mon.	23	02	08	☽ First Quarter		O1234	350.96
		05		Equinox. Autumn begins			
Tues.	24				17 40	13O24	3.15
Wed.	25	17		Mercury 3° S. of Uranus		32O14	15.34
Thur.	26	12		Moon at apogee (251,760 mi.)		31O4*	27.53
Fri.	27				14 30	3O124	39.71
Sat.	28					21O34	51.88
Sun.	29	04		Jupiter 7° S. of Moon		2O3dd	64.05[b]
Mon.	30	01		Pluto in conjunction	11 20	4O123	76.22

[l]Sept. 8, −6.35°; Sept. 20, +7.26°

[b]Sept. 2, −6.55°; Sept. 16, +6.46°; Sept. 29, −6.58°.

THE SKY FOR OCTOBER 1974

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 27 m to 14 h 23 m and its Decl. changes from 2° 57′ S. to 14° 14′ S. The equation of time changes from +10 m 18 s to +16 m 21 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. 14 h 00 m, Decl. 15° 11′ S., and on the 15th is in R.A. 14 h 28 m, Decl. 18° 05′ S. Greatest eastern elongation is on the 1st but this one is most unfavourable, the planet being only about 8° above the south-western horizon at sunset. On the 25th it is in inferior conjunction.

Venus on the 1st is in R.A. 11 h 55 m, Decl. 2° 07′ N., and on the 15th it is in R.A. 12 h 59 m, Decl. 4° 52′ S., mag. −3.5, and transits at 11 h 27 m. It is still a morning star but too close to the sun for easy observation.

Mars on the 15th is in R.A. 13 h 19 m, Decl. 7° 44′ S., and transits at 11 h 45 m. It is too close to the sun for observation, conjunction being on the 14th.

Jupiter on the 15th is in R.A. 22 h 43 m, Decl. 9° 39′ S., mag. −2.3, and transits at 21 h 06 m. In Aquarius, it is well up in the east at sunset and sets before dawn. 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. 7 h 21 m, Decl. 21° 40′ N., mag. +0.3, and transits at 5 h 46 m. In Gemini, it rises about an hour before midnight and is past the meridian at dawn.

Uranus on the 15th is in R.A. 13 h 44 m, Decl. 10° 01′ S., and transits at 12 h 08 m.

Neptune on the 15th is in R.A. 16 h 25 m, Decl. 20° 05′ S., and transits at 14 h 49 m.

Pluto—For information in regard to this planet, see p. 29.

1974				OCTOBER 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	05		Mercury greatest elong. E. (26°)		432O1	88.39
		05	38	♍ Full Moon			
Wed.	2			Venus greatest hel. lat. N.		4312O	100.55
Thur.	3				8 10	43O12	112.71
Fri.	4					41O3d	124.88
Sat.	5					42O13	137.05[l]
Sun.	6				5 00	4O23*	149.22
Mon.	7					1O342	161.39
Tues.	8	14	46	☾ Last Quarter		32O14	173.57
		21		Saturn 3° N. of Moon			
Wed.	9			Mercury greatest hel. lat. S.	1 50	321O4	185.76
Thur.	10					3O124	197.95
Fri.	11				22 30	1O234	210.15
Sat.	12	11		Moon at perigee (227,030 mi.)		2O134	222.36
Sun.	13	18		Mercury stationary		1O34*	234.57[b]
Mon.	14	08		Mars in conjunction	19 20	O342d	246.78
Tues.	15	07	25	● New Moon		324O1	259.00
Wed.	16	11		Juno stationary		3421O	271.22
		14		Mercury 0.4° S. of Moon. Occ'n.[1]			
Thur.	17				16 10	43O12	283.43
Fri.	18	17		Neptune 2° N. of Moon		41O2*	295.65[l]
Sat.	19					42O13	307.85
Sun.	20				13 00	41O3*	320.06
Mon.	21	15		Orionid meteors		4O32d	332.26
		17		Uranus in conjunction			
Tues.	22	20	53	☽ First Quarter		432O*	344.45
Wed.	23				9 50	3214O	356.64
Thur.	24	06		Moon at apogee (251,320 mi.)		3O124	8.82
Fri.	25	08		Mercury in inferior conjunction		1O24*	20.99
Sat.	26	08		Jupiter 7° S. of Moon	6 40	2O134	33.16
		13		Ceres stationary			
Sun.	27					12O34	45.32[b]
Mon.	28			Mercury at ascending node		O1324	57.47
Tues.	29				3 30	32O4*	69.63
Wed.	30	20	19	♍ Full Moon		321O4	81.77
Thur.	31	11		Saturn stationary		3O142	93.92[l]

[l]Oct. 5, −5.08°; Oct. 18, +6.23°; Oct. 31, −4.53°.

[b]Oct. 13, +6.59°; Oct. 27, −6.72°.

[1]Visible in N. Pacific, S.W. of N. America, Central America, N. of S. America.

THE SKY FOR NOVEMBER 1974

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 23 m to 16 h 27 m and its Decl. changes from 14° 14′ S. to 21° 43′ S. The equation of time changes from +16 m 22 s to a maximum of +16 m 24 s on the 3rd and then to +11 m 21 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. There is a total eclipse of the moon on the 29th, visible in the north-western half of North America.

Mercury on the 1st is in R.A. 13 h 36 m, Decl. 8° 49′ S., and on the 15th is in R.A. 14 h 10 m, Decl. 10° 51′ S. On the 10th it is at greatest western elongation, standing about 16° above the south-eastern horizon at sunrise, quite close to Spica. From about the 3rd to the 20th it may be seen very low in the south-east just before sunrise.

Venus on the 1st is in R.A. 14 h 19 m, Decl. 12° 53′ S., and on the 15th it is in R.A. 15 h 28 m, Decl. 18° 24′ S., mag. −3.5, and transits at 11 h 54 m. On the 6th it is in superior conjunction, becoming an evening star, but it remains too close to the sun for easy observation.

Mars on the 15th is in R.A. 14 h 39 m, Decl. 15° 11′ S., and transits at 11 h 03 m. It is a morning star but too close to the sun for easy observation.

Jupiter on the 15th is in R.A. 22 h 41 m, Decl. 9° 43′ S., mag. −2.1, and transits at 19 h 03 m. In Aquarius, it is quite high in the south-east at sunset and sets soon after midnight. On the 3rd it is stationary in right ascension and resumes direct, or eastward, motion among the stars. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 71.

Saturn on the 15th is in R.A. 7 h 21 m, Decl. 21° 41′ N., mag. +0.1, and transits at 3 h 45 m. In Gemini, it rises about three hours after sunset and is visible the rest of the night.

Uranus on the 15th is in R.A. 13 h 51 m, Decl. 10° 51′ S., and transits at 10 h 14 m.

Neptune on the 15th is in R.A. 16 h 29 m, Decl. 20° 15′ S., and transits at 12 h 51 m.

Pluto—For information in regard to this planet, see p. 29.

1974				NOVEMBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 20 h E.S.T.	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Fri.	1			Mercury at perihelion	0 20	413O2	106.07
Sat.	2	20		Mercury stationary		42O13	118.21
Sun.	3	17		Jupiter stationary	21 00	412O3	130.36
Mon.	4			Taurid meteors		4O123	142.51
Tues.	5	03		Saturn 3° N. of Moon		431Od	154.67
Wed.	6	08		Venus in superior conjunction	17 50	432Od	166.83
		21	47	☾ Last Quarter			
Thur.	7	23		Moon at perigee (229,870 mi.)		43O2*	179.00
Fri.	8					431O2	191.18
Sat.	9				14 40	2O413	203.36[b]
Sun.	10	05		Mercury 1.9° N. of Uranus		21O43	215.55
		07		Mercury greatest elong. W. (19°)			
Mon.	11					O1234	227.74
Tues.	12			Mercury greatest hel. lat. N.	11 30	1O24d	239.94
		08		Uranus 4° N. of Moon			
		12		Mercury 6° N. of Moon			
Wed.	13	19	53	● New Moon		32O14	252.14
Thur.	14					3O4**	264.34
Fri.	15	04		Neptune 2° N. of Moon	8 20	31O24	276.54[l]
Sat.	16					2O134	288.74
Sun.	17	07		Leonid meteors		21O43	300.94
Mon.	18				5 10	4O123	313.13
Tues.	19					41O32	325.32
Wed.	20					432O1	337.50
Thur.	21	03		Moon at apogee (251,300 mi.)	2 00	431O*	349.68
		17	39	☽ First Quarter			
Fri.	22	18		Jupiter 7° S. of Moon		43O2d	1.85
Sat.	23				22 50	42O1*	14.01[b]
Sun.	24	16		Mercury 1.1° N. of Mars		421O3	26.17
Mon.	25					4O123	38.32
Tues.	26				19 40	1O342	50.46
Wed.	27			Venus at descending node		32O14	62.60[l]
Thur.	28					321O4	74.74[l]
Fri.	29	10	10	☾ Full Moon. Eclipse of ☾, p. 55.	16 20	3O124	86.87
Sat.	30					2O34*	99.01

[l]Nov. 15, +5.29°; Nov. 27, 28, −5.22°. [b]Nov. 9, +6.74°; Nov. 23, −6.85°.

THE SKY FOR DECEMBER 1974

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 27 m to 18 h 43 m and its Decl. changes from 21° 43′ S. to 23° 04′ S. The equation of time changes from +10 m 59 s to −2 m 59 s being zero on the 25th. There is a partial eclipse of the sun on the 13th, visible in North America. 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 44 m, Decl. 19° 12′ S., and on the 15th is in R.A. 17 h 16 m, Decl. 24° 03′ S. It is too close to the sun for observation, superior conjunction being on the 19th.

Venus on the 1st is in R.A. 16 h 52 m, Decl. 22° 41′ S., and on the 15th it is in R.A. 18 h 09 m, Decl. 24° 07′ S., mag. −3.4, and transits at 12 h 37 m. It is an evening star but barely above the south-western horizon at sunset.

Mars on the 15th is in R.A. 16 h 03 m, Decl. 20° 45′ S., and transits at 10 h 29 m. It is a morning star very low in the south-east just before dawn.

Jupiter on the 15th is in R.A. 22 h 51 m, Decl. 8° 39′ S., mag. −1.9, and transits at 17 h 15 m. In Aquarius, it is approaching the meridian at sunset and sets well 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. 7 h 14 m, Decl. 21° 55′ N., mag. −0.1, and transits at 1 h 40 m. In Gemini, it rises about two hours after sunset and is visible for the rest of the night.

Uranus on the 15th is in R.A. 13 h 57 m, Decl. 11° 24′ S., and transits at 8 h 22 m.

Neptune on the 15th is in R.A. 16 h 34 m, Decl. 20° 25′ S., and transits at 10 h 58 m.

Pluto—For information in regard to this planet, see p. 29.

1974				DECEMBER 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		°
Sun.	1	17		Neptune in conjunction		21O34	111.14
Mon.	2	08		Saturn 3° N. of Moon	13 10	O1234	123.27
Tues.	3	02		Moon at perigee (228,320 mi.)		1O324	135.41
Wed.	4					23O1d	147.55
Thur.	5			Mercury at descending node	10 00	3421O	159.70
Fri.	6	05	10	☾ Last Quarter		43O12	171.85[b]
Sat.	7					431O2	184.01
Sun.	8				6 50	421O3	196.18
Mon.	9	17		Uranus 4° N. of Moon		4O13*	208.35
Tues.	10					41O32	220.53
Wed.	11	21		Mars 0.9° N. of Moon. Occ'n.[1]	3 40	423O1	232.72[1]
Thur.	12			Mars at descending node		3214O	244.90
Fri.	13	11	25	● New Moon. Eclipse of ☉, p. 55	0 30	3O142	257.09
Sat.	14	05		Geminid meteors		31O24	269.29
Sun.	15			Mercury at aphelion		2O34d	281.48
Mon.	16				21 20	O34**	293.66
Tues.	17					1O234	305.85
Wed.	18	23		Moon at apogee (251,750 mi.)		23O14	318.03
Thur.	19	15		Mercury in superior conjunction	18 10	321O4	330.21
Fri.	20	08		Jupiter 7° S. of Moon		3O124	342.38[b]
Sat.	21	14	43	☽ First Quarter		314O2	354.55
Sun.	22	01		Solstice. Winter begins	15 00	42O13	6.71
		20		Ursid meteors			
Mon.	23	01		Mars 5° N. of Antares		42O3*	18.86
Tues.	24					41O23	31.01
Wed.	25	12		Mars 1.7° S. of Neptune	11 50	42O1d	43.15[1]
Thur.	26					4321O	55.29
Fri.	27					43O12	67.42
Sat.	28	22	51	○ Full Moon	8 40	431O2	79.54
Sun.	29	08		Vesta in conjunction		24O13	91.67
		14		Saturn 3° N. of Moon			
Mon.	30	19		Moon at perigee (224,790 mi.)		21O43	103.79
Tues.	31			Venus at aphelion	5 30	O234d	115.92

[1]Dec. 11, +5.28°; Dec. 25, −6.49°. [b]Dec. 6, +6.78°; Dec. 20, −6.83°.
[1]Visible in Antarctica.

SUN—EPHEMERIS FOR PHYSICAL OBSERVATIONS, 1974
For 0 h U.T.

Date	P	B_0	L_0	Date	P	B_0	L_0
	°	°	°		°	°	°
Jan. 1	+ 2.20	−3.03	63.75	July 5	− 1.05	+3.31	142.04
6	− 0.23	−3.60	357.90	10	+ 1.22	+3.83	75.87
11	− 2.63	−4.15	292.06	15	+ 3.46	+4.33	9.70
16	− 5.00	−4.66	226.22	20	+ 5.66	+4.80	303.54
21	− 7.31	−5.13	160.38	25	+ 7.81	+5.23	237.39
26	− 9.53	−5.57	94.55	30	+ 9.88	+5.63	171.25
31	−11.66	−5.96	28.72	Aug. 4	+11.87	+5.99	105.12
Feb. 5	−13.67	−6.30	322.89	9	+13.76	+6.31	39.01
10	−15.57	−6.59	257.05	14	+15.55	+6.59	332.90
15	−17.33	−6.83	191.21	19	+17.23	+6.82	266.82
20	−18.95	−7.02	125.37	24	+18.79	+7.00	200.74
25	−20.42	−7.15	59.52	29	+20.22	+7.14	134.68
Mar. 2	−21.74	−7.23	353.67	Sept. 3	+21.51	+7.22	68.63
7	−22.90	−7.25	287.79	8	+22.67	+7.25	2.60
12	−23.90	−7.21	221.91	13	+23.67	+7.23	296.57
17	−24.73	−7.13	156.01	18	+24.53	+7.15	230.57
22	−25.40	−6.98	90.09	23	+25.23	+7.03	164.57
27	−25.89	−6.79	24.16	28	+25.76	+6.85	98.58
Apr. 1	−26.20	−6.54	318.21	Oct. 3	+26.12	+6.62	32.60
6	−26.33	−6.25	252.24	8	+26.31	+6.34	326.62
11	−26.28	−5.91	186.24	13	+26.31	+6.02	260.66
16	−26.05	−5.53	120.23	18	+26.13	+5.64	194.71
21	−25.63	−5.11	54.20	23	+25.76	+5.23	128.77
26	−25.03	−4.65	348.15	28	+25.20	+4.77	62.82
May 1	−24.25	−4.17	282.08	Nov. 2	+24.44	+4.28	356.89
6	−23.29	−3.65	215.98	7	+23.48	+3.75	290.96
11	−22.15	−3.11	149.87	12	+22.33	+3.19	225.04
16	−20.84	−2.55	83.75	17	+20.98	+2.61	159.13
21	−19.36	−1.97	17.61	22	+19.45	+2.01	93.22
26	−17.74	−1.38	311.47	27	+17.75	+1.39	27.32
31	−15.97	−0.78	245.30	Dec. 2	+15.88	+0.76	321.42
June 5	−14.08	−0.18	179.13	7	+13.86	+0.12	255.53
10	−12.07	+0.42	112.95	12	+11.72	−0.52	189.65
15	− 9.98	+1.02	46.77	17	+ 9.47	−1.16	123.77
20	− 7.80	+1.61	340.59	22	+ 7.14	−1.79	57.90
25	− 5.58	+2.19	274.41	27	+ 4.75	−2.41	352.04
30	− 3.32	+2.76	208.22				

P—is the position angle of the axis of rotation, measured eastward from the north point on the disk, B_0 is the heliographic latitude of the centre of the disk, and L_0 is the heliographic longitude of the centre of the disk, from Carrington's solar meridian, measured in the direction of rotation.

CARRINGTON'S ROTATION NUMBERS—GREENWICH DATE OF COMMENCEMENT OF SYNODIC ROTATIONS, 1974

No.	Commences	No.	Commences	No.	Commences
1610	Jan. 5.84	1615	May 22.33	1620	Oct. 5.47
1611	Feb. 2.18	1616	June 18.53	1621	Nov. 1.76
1612	Mar. 1.52	1617	July 15.73	1622	Nov. 29.07
1613	Mar. 28.83	1618	Aug. 11.95	1623	Dec. 26.40
1614	Apr. 25.10	1619	Sept. 8.20		

ECLIPSES DURING 1974

In 1974 there will be four eclipses, two of the sun and two of the moon.

1. *A partial eclipse of the moon* on June 4, visible in Australia, Asia, Africa, Europe and the eastern coast of South America, but not in North America.

2. *A total eclipse of the sun* on June 20, visible in the Indian Ocean and at the south-west tip of Australia.

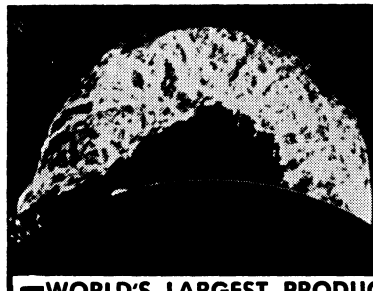
3. *A total eclipse of the moon* on November 29, the beginning visible in the north-western half of North America, the ending visible only in the extreme north-western part.

Moon enters penumbra	Nov. 29,	7.25 E.S.T.
Moon enters umbra		8.29 E.S.T.
Total eclipse begins		9.35 E.S.T.
Middle of eclipse		10.14 E.S.T.
Total eclipse ends		10.52 E.S.T.
Moon leaves umbra		11.58 E.S.T.
Moon leaves penumbra		13.02 E.S.T.

4. *A partial eclipse of the sun* on December 13, visible in all but the extreme north-western part of North America. In the eastern half of the continent the whole eclipse will be visible, beginning after sunrise and lasting for almost three hours; in the western half the sun will rise already in partial eclipse. The magnitude of greatest eclipse is 0.827.

PLANETARY APPULSES AND OCCULTATIONS

According to Mr. Gordon E. Taylor, H.M. Nautical Almanac Office, there will be no planetary appulses or occultations, involving bright stars, visible from North America in 1974. An appulse of Pallas and the $6^{m}.5$ star SAO 123571 at U.T. $15^{h}\ 39^{m}$ on January 18, and of Pallas and the $5^{m}.4$ star SAO 124318 at U.T. $23^{h}\ 49^{m}$ on February 16, may be of interest to observers. Also, on August 29, an occultation of the $9^{m}.0$ star SAO 79100 by the rings of Saturn (beginning, at Toronto, at U.T. $7^{h}\ 25^{m}$ or E.S.T. $2^{h}\ 25^{m}$) and by Saturn itself (beginning, at Toronto, at U.T. $8^{h}\ 16^{m}$ or E.S.T. $3^{h}\ 16^{m}$) will be visible in eastern North America.



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During 1974 the ascending node of the moon's orbit moves from Sagittarius into Ophiuchus (Ω from 268 to 249°). See p. 57 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.)

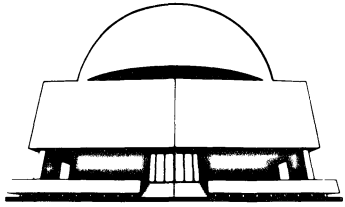
Sunrise will occur at a given point *east* of the central meridian of the moon when the sun's selenographic colongitude is equal to the eastern selenographic longitude of the point; at a point *west* of the central meridian when the sun's selenographic colongitude is equal to 360° minus the western selenographic 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.



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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 given in the tables.

LUNAR OCCULTATIONS VISIBLE AT HALIFAX AND MONTREAL, 1973

Date	Name	Z.C. No.	Mag.	I or E	Elong. of Moon	HALIFAX W. 63°600, N. 44°600				MONTREAL W. 73°600, N. 45°500			
						A.S.T.	a	b	P	E.S.T.	a	b	P
					°	h m	m	m	°	h m	m	m	°
Jan. 2	101 Psc	233	6.2	I	104	19 43.1	−1.4	+1.6	41	18 33.2	−0.9	+2.5	25
3	+18° 325	375	6.8	I	118	21 12.1	−1.5	+1.1	50	19 58.8	−1.4	+1.9	39
5	284 B. Tau	693	6.0	I	145	20 33.3	−1.6	+0.9	81	19 20.5	−1.2	+1.5	71
6	300 B. Tau	716	6.2	I	147	No occ.				0 22.0	.	.	23
7	Saturn	—	−0.2	I	163	5 19.8	+0.4	−1.7	128	4 21.3	+0.3	−2.1	137
7	Saturn	—	−0.2	E	163	6 04.0	+0.2	−0.9	254	5 03.5	−0.1	−0.8	246
10	209 B. Cnc	1364	6.5	E	206	6 11.0	−0.3	−2.0	317	5 04.9	−0.6	−1.9	308
11	14 Sex	1482	6.3	E	220	Sun				5 41.3	−1.3	−1.1	262
12	237 B. Leo	1582	6.3	E	232	1 41.6	−1.9	+1.4	260	0 25.7	−1.6	+2.4	249
12	55 Leo	1587	6.0	E	233	3 51.4	−1.3	−1.3	314	2 37.1	−1.4	−0.6	301
13	13 B. Vir	1713	5.8	E	247	5 56.0	−0.2	−2.9	358	4 48.7	−0.7	−2.0	341
14	21q Vir	1800	5.4	E	257	0 52.0	+0.1	+1.3	344	Low			
15	75 Vir	1944	5.6	E	272	Sun				5 40.3	−1.3	−0.9	317
16	236 G Vir	2051	5.7	E	282	3 41.8	−0.9	+0.6	295	Low			
17	64 G. Lib	2183	5.7	E	295	Sun				6 19.2	.	.	220
18	57 B. Sco	2305	5.9	E	306	5 40.3	+0.1	−1.4	343	Low			
25	−7° 5727	3259	7.4	I	27	Low				17 49.3	−0.6	−0.4	58
26	−2° 5858	3371	6.4	I	39	19 28.3	−0.4	−0.1	50	18 23.8	−0.5	+0.3	41
30	20 H¹ Ari	317	6.4	I	85	18 10.4	.	.	5	No occ.			
31	151 B. Ari	459	6.7	I	99	20 14.2	−1.6	+1.6	40	19 00.9	−1.4	+2.5	31
31	ζ Ari	472	5.0	I	100	No occ.				22 15.4	.	.	16
Feb. 1	τ Ari	486	5.2	I	102	Low				0 57.2	−0.6	+0.7	29
1/2	+22° 670m	630	7.5	I	114	0 30.5	−0.5	−1.1	83	23 23.3	−0.7	−1.3	90
3	η Gem	946	3.7v	I	139	18 54.5	−1.3	+0.6	100	17 44.2	−0.9	+1.2	91
3	η Gem	946	3.7v	E	139	20 06.9	−1.6	+0.7	268	18 52.9	−1.3	+0.8	274
3	μ Gem	976	3.2	I	141	No occ.				22 05.6	.	.	35
3	μ Gem	976	3.2	E	141	No occ.				22 34.4	.	.	350
12	−16° 3785	2011	6.5	E	252	No occ.				3 12.0	−0.2	−1.8	350
15	126 B. Sco	2398	6.1	E	286	5 03.3	−1.9	+1.6	246	Low			
25	+10° 128	163	7.2	I	44	18 53.1	−0.9	−2.6	113	Sun			
28	142 B. Tau	573	6.8	I	81	19 42.9	−1.5	−0.4	77	18 26.4	−1.7	0.0	75
28	Mars	—	1.1	I	82	21 33.4	−0.7	−1.7	102	20 23.2	−1.0	−1.9	107
28	Mars	—	1.1	E	82	22 38.6	−0.5	−1.0	257	21 31.2	−0.8	−0.8	250
Mar. 1	309 B. Tau	734	6.6	I	95	20 45.3	−1.9	+1.2	45	19 27.5	−1.9	+1.4	49
2	Saturn	—	0.2	I	107	No occ.				17 48.9	.	.	170
2	Saturn	—	0.2	E	107	No occ.				18 06.5	.	.	196
2	141 Tau	911	6.3	I	109	23 40.3	−0.5	−1.6	106	22 32.6	−0.7	−1.8	115
3	14 B. Gem	928	6.0	I	111	Low				1 50.3	0.0	−0.9	71
3	+21° 1426	1051	6.7	I	120	18 41.2	−1.6	+1.9	65	Sun			
3/4	ζ Gem	1077	3.9v	I	123	0 09.6	.	.	36	22 48.6	−1.9	+0.3	58
4	3 Cnc	1207	5.8	I	135	21 40.3	−1.8	−0.4	96	20 22.8	−1.7	−0.2	103
5	+16° 1657	1235	7.4	I	138	3 11.4	−0.2	−1.2	86	2 07.6	−0.4	−1.4	94
6	209 B. Cnc	1364	6.5	I	152	3 18.3	−0.7	−1.0	69	2 09.6	−0.9	−1.1	80
15	39 Oph	2490	5.4	E	267	Sun				4 51.0	−1.9	+0.4	269
17	o Sgr	2779	3.9	I	289	Sun				5 30.0	−1.8	+0.8	98
26	+18° 337pr	397	7.5	I	39	Graze				19 12.2	.	.	15
29	175 H¹ Tau	861	6.5	I	78	21 35.3	−1.0	−0.7	69	20 24.1	−1.2	−0.8	78
30	+20° 1549	1031	7.0	I	91	22 32.5	−0.1	−2.4	140	21 29.0	−0.1	−3.0	151
Apr. 2	6 h Leo	1410	5.3	I	130	18 55.6	−1.6	+1.1	86	Sun			
5	87 e Leo	1670	5.1	I	160	2 21.7	−1.4	−0.7	63	1 05.7	−1.7	−0.7	71
24	κ Tau	656	4.4	I	35	Low				20 33.4	−0.2	−0.4	51
24	67 Tau	657	5.4	I	35	Low				20 29.9	0.0	−0.9	75
28	29 Cnc	1271	5.9	I	88	23 12.6	+0.3	−2.6	163	22 14.0	+0.6	−3.3	177
30	ω Leo	1397	5.5	I	103	Low				0 22.8	+0.1	−2.0	145
May 1	66 Leo	1620	6.8	I	128	23 51.6	−0.2	−3.0	176	Graze			
3/4	370 B. Vir	1852	6.0	I	154	0 32.6	−1.6	−1.0	88	23 14.7	−1.8	−0.8	96
7	ρ Oph	2359	4.8	E	202	22 55.0	−1.1	+0.7	287	Low			
11	π Sgr	2797	3.0	E	237	2 03.0	−1.7	+1.4	250	0 48.9	−1.4	+1.7	249
24	+19° 1623	1084	7.3	I	43	20 39.4	−0.6	−0.6	58	Sun			
28	57 Leo	1590	6.9	I	98	23 09.4	.	.	40	21 53.4	−1.7	−0.3	85

Date	Name	Z.C. No.	Mag.	I or E	Elong. of Moon	HALIFAX W. 63°600, N. 44°600				MONTREAL W. 73°600, N. 45°500			
						A.S.T.	a	b	P	E.S T.	a	b	P
					°	h m	m	m	°	h m	m	m	°
June 1	75 Vir	1944	5.6	I	137	Low				0 19.7	−1.0	−2.5	154
July 7/8	47 C^2 Cap	3187	6.2	E	219	0 02.5	−1.2	+1.9	239	22 53.3	−0.9	+1.9	244
14	27 Ari	371	6.4	I	288	1 02.7	.	.	343	No occ.			
17	Venus	—	−3.4	I	330	5 00.1	+0.1	+2.3	55	4 05.3	+0.5	+2.7	40
17	Venus	—	−3.4	E	330	5 55.4	−1.0	+0.5	298	4 46.7	−0.9	0.0	314
27	−21° 4152	2226	7.0	I	111	20 48.0	−1.9	−0.1	65	Sun			
31	π Sgr	2797	3.0	I	156	21 31.7	−2.0	+0.4	100	20 14.3	−1.6	+0.9	98
31	π Sgr	2797	3.0	E	156	22 52.2	−1.7	+0.8	229	21 35.5	−1.8	+1.0	237
Aug. 11	δ Ari	465	4.5	I	271	1 58.5	−0.2	+2.3	46	1 00.7	+0.2	+2.5	30
11	δ Ari	465	4.5	E	271	2 59.5	−1.2	+1.1	276	1 48.5	−1.1	+0.8	292
26	−23° 13804	2597	7.0	I	115	20 17.9	−2.0	0.0	78	Sun			
26	−22° 4533	2608	6.9	I	115	21 31.7	−1.3	+0.2	48	20 18.5	−1.4	+0.9	36
27	33 Sgr	2746	5.8	I	126	20 27.4	−1.8	+0.9	54	Sun			
27	ξ Sgr	2759	3.6	I	127	23 03.7	−1.1	−0.2	57	21 52.3	−1.2	+0.4	43
30	τ Cap	3015	5.3	I	149	1 54.4	−1.1	−1.5	92	0 41.6	−1.2	−0.8	76
Sept. 6	40 Ari	415	6.0	E	239	22 06.4	−0.8	−0.2	318	No occ.			
7	45 Ari	432	5.9	E	240	No occ.				0 20.9	.	.	180
24	−19° 5492	2854	7.3	I	107	22 36.6	−1.7	−2.1	109	21 18.4	−1.7	−1.1	92
27	−9° 5854	3199	6.8	I	139	No occ.				19 51.9	.	.	134
28/29	207 B. Aqr	3326	6.4	I	152	1 04.6	−1.7	−1.6	97	23 46.5	−1.7	−0.5	80
30	κ Psc	3453	4.9	I	163	1 43.0	−1.6	−1.4	92	0 25.7	−1.7	−0.4	77
Oct. 4	36 Ari	402	6.5	E	211	2 56.1	.	.	186	1 49.6	−1.1	+3.1	205
5	247 B. Tau	665	5.7	E	233	22 23.5	−0.7	+0.3	308	21 15.0	.	.	331
6	o Tau	817	4.8	E	246	22 45.9	−0.9	−0.7	327	No occ.			
7	+21° 918	851	6.3	E	249	5 04.4	−1.9	+0.4	258	5 46.4	−1.8	+0.8	260
7	16 Gem	991	6.1	E	259	23 28.7	+0.2	+1.7	249	Low			
9	74 f Gem	1158	5.2	E	275	Sun				4 30.8	−1.5	0.0	290
10	29 Cnc	1271	5.9	E	287	1 28.5	+0.1	+1.8	253	Low			
19	−22° 4336	2504	7.4	I	53	Low				17 58.4	−1.2	−0.8	76
23	−14° 5839	3027	7.0	I	97	18 02.9	−1.5	+1.5	40	Sun			
25/26	51 Aqr	3287	5.8	I	121	0 22.3	−0.6	−0.3	55	23 15.7	−0.7	+0.3	43
26	−1° 4393	3397	7.4	I	132	23 46.8	−0.6	+1.5	22	22 44.4	−0.1	+3.2	2
Nov. 2	51 Tau	631	5.6	E	205	1 41.9	−2.1	−1.9	306	0 18.0	.	.	319
2	53 Tau	633	5.4	E	205	No occ.				0 38.8	.	.	195
2	105 Tau	766	6.0	E	215	20 42.1	−0.2	+0.9	288	Low			
3	109 n Tau	792	5.1	E	218	1 56.5	.	.	341	No occ.			
3	o Tau	817	4.8	E	219	Sun				5 24.5	−0.2	−4.1	336
4	ν Gem	995	4.1	I	233	Sun				5 43.9	.	.	174
8	14 Sex	1482	6.3	E	284	2 34.8	−0.5	+1.2	274	1 32.0	−0.3	+1.2	277
9	62 p^3 Leo	1605	6.2	E	298	4 32.9	−0.7	0.0	307	3 26.8	−0.5	+0.3	304
19	27 G. Cap	2995	6.2	I	67	20 38.2	−1.1	−1.8	97	19 25.5	−1.2	−1.0	81
22	−3° 5505	3340	7.5	I	100	20 37.1	−2.3	−1.6	102	19 14.6	−2.1	−0.1	83
25	45 Psc	51	7.2	I	124	Low				1 01.7	−0.5	+3.0	6
Dec. 3	2 B. Cnc	1198	6.2	E	226	0 24.8	.	.	350	No occ.			
3/4	α Cnc	1341	4.3	I	240	1 06.4	−1.1	+0.7	105	23 58.0	−0.8	+0.9	103
4	α Cnc	1341	4.3	E	240	2 17.3	−1.4	−0.1	298	1 04.9	−1.1	+0.2	296
6	237 B. Leo	1582	6.3	E	268	5 29.3	−1.1	−1.5	326	4 17.2	−1.1	−0.8	315
21	+3° 4909 m	3524	6.9	I	90	18 41.6	.	.	350	No occ.			
25	+19° 523	489	7.2	I	139	21 16.4	−1.6	+1.6	53	20 03.9	−1.2	+2.4	41
26	53 Tau	633	5.4	I	151	19 10.3	−1.5	+0.2	116	17 59.0	−0.9	+1.0	101
26	247 B. Tau	665	5.7	I	153	23 55.7	−1.7	+0.2	69	22 38.6	−1.8	+0.6	67
30	29 Cnc	1271	5.9	E	206	21 17.1	−0.5	+0.8	287	20 14.0	−0.3	+0.7	294
31	45 A^1 Cnc	1309	5.7	E	210	5 17.7	−1.3	−1.0	265	4 01.7	−1.8	−0.3	252

LUNAR OCCULTATIONS VISIBLE AT TORONTO AND WINNIPEG, 1974

Date	Name	Z.C. No.	Mag.	I or E	Elong. of Moon	TORONTO W. 79°400, N. 43°700				WINNIPEG W. 97°200, N. 49°900			
						E.S.T.	a	b	P	C.S.T.	a	b	P
					°	h m	m	m	°	h m	m	m	°
Jan. 2	101 Psc	233	6.2	I	104	18 23.4	−0.8	+2.8	22	No occ.			
3	+18° 325	375	6.8	I	118	19 47.5	−1.3	+2.1	40	No occ.			
4	114 B. Ari	411	7.3	I	121	Low				1 32.6	−0.3	−1.4	90
5	113 B. Tau	566	5.9	I	135	Low				2 28.2	−0.6	−0.5	55
5	142 B. Tau	573	6.8	I	135	Low				3 04.7	0.0	−1.6	104
5	284 B. Tau	693	6.0	I	145	19 11.3	−1.0	+1.6	70	18 16.0	0.0	+3.0	30
6	300 B. Tau	716	6.2	I	147	0 06.1	−1.9	+1.5	43	Graze			
7	Saturn	—	−0.2	I	163	4 27.4	+0.4	−2.5	150	3 15.9	+0.3	−3.4	160
7	Saturn	—	−0.2	E	163	5 03.0	−0.5	−0.4	234	3 47.0	−1.2	+0.1	224
10	209 B. Cnc	1364	6.5	E	206	5 03.9	−0.9	−1.7	298	3 35.6	−1.3	−1.0	287
11	14 Sex	1482	6.3	E	220	5 33.6	−1.9	−0.4	249	Graze			
11/12	237 B. Leo	1582	6.3	E	232	0 09.1	.	.	228	23 12.2	−0.5	+2.5	250
12	55 Leo	1587	6.0	E	233	2 29.0	−1.6	0.0	289	1 07.8	−1.0	+0.7	287
13	13 B. Vir	1713	5.8	E	247	4 46.7	−1.1	−1.6	328	3 21.6	−1.0	−0.5	316
15	75 Vir	1944	5.6	E	272	5 33.5	−1.5	−0.6	306	4 10.4	−1.1	+0.4	294
18	27 G. Sco	2314	5.8	E	306	5 57.6	−0.2	−1.1	338	Low			
26	−2° 5858	3371	6.4	I	39	18 19.6	−0.7	+0.4	42	Sun			
27	19 Psc	3501	5.3	I	51	No occ.				18 16.2	−1.6	−1.8	101
31	151 B. Ari	459	6.7	I	99	18 48.3	−1.4	+2.5	34	No occ.			
31	ζ Ari	472	5.0	I	100	22 02.7	−1.5	+1.5	33	No occ.			
31/1	τ Ari	486	5.2	I	102	0 53.8	−0.4	0.0	44	23 42.3	−0.9	+0.1	42
Feb. 1	63 Ari	487	5.2	I	102	Low				0 31.0	.	.	156
1	65 Ari	492	5.9	I	102	Low				1 07.1	+0.6	−3.0	142
1	+22° 670m	630	7.5	I	114	23 21.3	−0.8	−1.5	100	21 53.5	−1.3	−0.9	92
2	υ Tau	660	4.4	I	116	Low				1 34.8	−0.2	−1.3	88
2	72 Tau	664	5.4	I	116	Low				2 07.4	−0.5	−0.2	42
3	η Gem	946	3.7v	I	139	17 37.2	−0.8	+1.2	92	Sun			
3	η Gem	946	3.7v	E	139	18 43.9	−1.2	+1.0	271	17 30.7	−0.8	+0.4	304
3	μ Gem	976	3.2	I	141	21 47.3	−2.1	+2.0	53	No occ.			
3	μ Gem	976	3.2	E	141	22 37.5	−1.0	−3.2	330	No occ.			
9	87 e. Leo	1670	5.1	E	214	5 36.2	.	.	4	4 15.2	−0.5	−2.2	348
12	−16° 3785	2011	6.5	E	252	3 11.7	−0.7	−1.0	334	1 59.0	−0.4	−0.1	323
25	212 B. Psc	177	7.1	I	45	20 41.5	−0.3	−0.3	54	19 32.2	−0.7	+0.4	36
28	Mars	—	1.1	I	82	20 20.5	−1.2	−2.3	117	18 43.4	−1.7	−0.8	98
28	Mars	—	1.1	E	82	21 26.3	−1.2	−0.2	239	20 01.0	−1.4	−0.2	249
28	37 A. Tau	599	4.5	I	84	Low				23 29.0	−0.1	−1.6	99
28	39 Tau	601	6.0	I	84	Low				23 47.4	+0.2	−1.9	115
Mar. 1	309 B. Tau	734	6.6	I	95	19 14.2	−1.9	+1.2	58	Sun			
1/2	+22° 818	761	6.7	I	97	0 58.4	−0.2	−0.6	61	23 46.6	−0.6	−0.9	67
2	Saturn	—	0.2	I	107	No occ.				16 00.1	−1.1	+0.3	122
2	Saturn	—	0.2	E	107	No occ.				16 57.3	−0.9	+2.3	237
2	141 Tau	911	6.3	I	109	22 32.0	−0.7	−2.2	127	21 01.6	−1.2	−1.8	125
3	14 B. Gem	928	6.0	I	111	1 52.2	0.0	−1.1	83	0 40.8	−0.4	−1.4	89
3	+21° 1146	939	7.4v	I	111	Low				1 45.4	+0.3	−2.0	132
3	ζ Gem	1077	3.9v	I	123	22 38.1	−1.8	−0.3	74	21 06.4	−1.7	+0.5	73
4	3 Cnc	1207	5.8	I	135	20 13.8	−1.6	−0.3	113	18 51.2	−1.1	+0.9	97
5	+16° 1657	1235	7.4	I	138	2 07.9	−0.4	−1.5	102	0 47.0	−0.8	−1.6	111
6	209 B. Cnc	1364	6.5	I	152	2 06.4	−1.0	−1.3	90	0 38.6	−1.2	−1.2	101
11	83 Vir	1967	5.7	E	221	Sun				4 24.7	−1.5	−0.9	281
15	39 Oph	2490	5.4	E	267	4 38.6	−1.9	+0.8	264	Low			
16	1 Sgr	2630	5.1	E	278	5 06.7	−2.2	+2.4	214	Low			
17	o Sgr	2779	3.9	I	289	5 18.8	−1.6	+0.9	101	Low			
17	o Sgr	2779	3.9	E	289	Sun				5 18.8	−1.4	+1.6	245
29	175 H^1 Tau	861	6.5	I	78	20 18.9	−1.2	−1.1	90	Sun			
30	+20° 1549	1031	7.0	I	91	21 36.4	.	.	172	Graze			
Apr. 4/5	87 e Leo	1670	5.1	I	160	0 57.0	−1.8	−0.8	84	23 21.9	−1.6	−0.3	98
24	κ Tau	656	4.4	I	35	20 33.1	−0.2	−0.6	64	Sun			
24	67 Tau	657	5.4	I	35	20 31.6	0.0	−1.1	85	Sun			
25	+22° 925	828	6.5	I	49	Low				20 53.6	−0.5	−1.0	69
29/30	ω Leo	1397	5.5	I	103	0 27.1	+0.1	−2.2	152	23 12.0	−0.1	−2.4	159

Date	Name	Z.C. No.	Mag.	I or E	Elong. of Moon	TORONTO W. 79°400, N. 43°700				WINNIPEG W. 97°200, N. 49°000			
						E.S.T.	a	b	P	C.S.T.	a	b	P
					°	h m	m	m	°	h m	m	m	°
May 3	370 B. Vir	1852	6.0	I	154	23 05.5	−1.8	−0.7	106	21 35.0	−1.3	−0.1	117
9	51 Oph	2523	4.9	E	216	Sun				3 03.0	−1.7	+0.3	239
27	14 Sex	1482	6.3	I	86	No occ				21 56.1	.	.	45
28	57 Leo	1590	6.9	I	98	21 44.5	−1.7	−0.7	69	Sun			
31/1	75 Vir	1944	5.6	I	137	0 17.9	−1.1	−2.6	158	22 45.0	−1.0	−1.8	158
June 13	+1° 4744	3482	5.6	E	273	3 07.5	−0.1	+3.2	185	2 18.3	−0.3	+2.3	213
July 7	47 C^2 Cap	3187	6.2	E	219	22 44.9	−0.8	+2.0	243	Sun			
9	κ Aqr	3320	5.3	E	232	No occ				1 45.1	.	.	175
17	Venus	—	−3.4	I	330	4 04.1	+0.7	+2.6	37	No occ.			
17	Venus	—	−3.4	E	330	4 42.1	−0.7	−0.1	316	No occ.			
29	51 Oph	2523	4.9	I	135	No occ.				22 22.2	.	.	154
31	π Sgr	2797	3.0	I	156	20 03.9	−1.4	+1.0	102	Sun			
31	π Sgr	2797	3.0	E	156	21 22.7	−1.9	+1.4	237	Sun			
Aug. 11	δ Ari	465	4.5	I	271	0 57.9	+0.4	+2.5	27	No occ.			
11	δ Ari	465	4.5	E	271	1 41.0	−1.0	+0.7	296	No occ.			
13	108 Tau	784	6.2	E	297	Sun				3 23.7	−0.4	+1.2	279
26	−22° 4533	2608	6.9	I	115	20 07.4	−1.7	+1.3	36	Sun			
27	ξ Sgr	2759	3.6	I	127	21 44.0	−1.4	+0.8	40	20 33.5	.	.	5
29/30	τ Cap	3015	5.3	I	149	0 35.0	−1.4	−0.5	73	23 13.6	−1.1	+0.8	36
Sept. 3	19 Psc	3501	5.3	E	195	Sun				4 37.4	−1.2	−1.9	279
6/7	45 Ari	432	5.9	E	240	0 17.7	+0.6	+4.0	188	23 35.9	−0.1	+2.1	228
12	2 B. Cnc	1198	6.2	E	306	4 46.2	−0.6	+2.9	235	3 51.4	−0.3	+1.5	268
21	22 Oph	2430	7.0	I	74	No occ.				19 42.7	−1.8	−2.1	134
24	−19° 5492	2854	7.3	I	107	21 09.7	−1.9	−0.8	88	19 38.7	−1.6	+0.5	60
27	−9° 5854	3199	6.8	I	139	19 34.8	.	.	126	Sun			
28	κ Aqr	3320	5.3	I	151	21 13.9	.	.	130	19 39.7	−1.2	+1.4	90
28	207 B. Aqr	3326	6.4	I	152	23 36.6	−1.9	−0.1	77	22 14.3	−1.1	+1.4	39
29/30	κ Psc	3453	4.9	I	163	0 15.7	−1.9	0.0	75	22 55.1	−1.1	+1.6	36
Oct. 4	36 Ari	402	6.5	E	211	1 37.8	−1.0	+3.2	205	0 30.8	−1.1	+1.6	244
4	40 Ari	415	6.0	E	212	4 46.1	−1.5	−0.6	258	3 12.3	−1.8	−1.0	284
Oct. 5	22 H^1 Tau	534	6.0	E	224	4 36.7	.	.	333	No occ.			
7	+21°918	851	6.3	E	249	3 34.5	−1.7	+1.2	255	2 15.1	−1.2	+0.7	284
9	74 f Gem	1158	5.2	E	275	4 21.8	−1.4	+0.5	283	3 03.8	−0.9	+0.1	308
23	87 B. Cap	3051	7.0	I	99	22 43.8	−0.2	+0.9	26	No occ.			
25	51 Aqr	3287	5.8	I	121	23 10.5	−0.9	+0.5	43	22 13.6	.	.	349
26	−1° 4393	3397	7.4	I	132	22 38.1	.	.	359	No occ.			
Nov. 2	51 Tau	631	5.6	E	205	0 08.1	−2.4	−2.1	317	No occ.			
1/2	53 Tau	633	5.4	E	205	0 24.6	.	.	191	23 29.7	−0.9	+2.0	238
2	247 B. Tau	665	5.7	E	207	5 45.0	−0.7	−1.9	291	4 16.3	−1.2	−2.0	298
3	o Tau	817	4.8	E	219	5 27.7	−0.8	−2.9	319	3 49.8	−1 2	−3.9	332
4	16 Gem	991	6.1	E	232	5 45.1	−1.6	−0.6	265	4 13.0	−1.6	−0.1	270
9	62 p^3 Leo	1605	6.2	E	298	3 23.4	−0.4	+0.5	296	Low			
19	27 G. Cap	2995	6.2	I	67	19.19.5	−1.4	−0.8	78	17 56.1	−1.1	+0.6	42
22	−3° 5505	3340	7.5	I	100	19 02.3	−2.1	+0.4	78	17 41.1	−1.1	+1.7	44
25	45 Psc	51	7.2	I	124	0 54.5	−0.6	+1.8	17	No occ.			
Dec. 2	2 B. Cnc	1198	6.2	E	226	23 07.7	.	.	353	No occ.			
3	α Cnc	1341	4.3	I	240	23 52.6	−0.6	+0.7	108	22 54.3	−0.1	+1.7	82
3/4	α Cnc	1341	4.3	E	240	0 57.9	−1.0	+0.6	289	23 47.6	−0.5	+0.2	311
4	κ Cnc	1359	5.1	E	242	6 40.3	−1.6	−0.8	266	5 05.6	−1.9	+0.3	257
6	237 B. Leo	1582	6.3	E	268	4 11.2	−1.3	−0.3	303	2 53.9	−0.7	+0.2	307
6	55 Leo	1587	6.0	E	269	6 01.3	−0.4	−2.8	353	4 38.5	−0.5	−1.7	344
24	+16° 293	363	7.3	I	126	No occ.				17 43.8	−1.1	+1.3	91
25	36 Ari	402	6.5	I	130	Low				3 11.9	0.0	−1.2	80
25	+19° 523	489	7.2	I	139	19 52.8	−1.1	+2.5	41	No occ.			
26	53 Tau	633	5.4	I	151	17 52.4	−0.7	+1.1	99	16 56.0	0.0	+1.7	69
26	247 B. Tau	665	5.7	I	153	22 27.1	−1.8	+0.7	73	21 10.6	−1.0	+2.6	41
30	74 f Gem	1158	5.2	E	195	1 19.6	.	.	353	No occ.			
30	29 Cnc	1271	5.9	E	206	20 11.6	−0.1	+0.7	292	Low			
31	45 A^1 Cnc	1309	5.7	E	210	3 47.6	.	.	232	2 10.4	.	.	222

LUNAR OCCULTATIONS VISIBLE AT EDMONTON AND VANCOUVER, 1974

Date	Name	Z.C. No.	Mag.	I or E	Elong. of Moon	EDMONTON W. 113°400, N. 53°600				VANCOUVER W. 123°100, N. 49°200			
						M.S.T.	a	b	P	P.S.T.	a	b	P
					°	h m	m	m	°	h m	m	m	°
Jan. 2	104 Psc	244	6.9	I	105	17 31.7	.	.	134	Sun			
3	+18° 337 pr	397	7.5	I	119	21 17.0	.	.	146	No occ.			
3/4	114 B. Ari	411	7.3	I	121	0 19.8	−0.7	−1.4	88	23 19.2	−0.9	−1.9	106
5	113 B. Tau	566	5.9	I	135	1 14.8	−0.8	−0.5	58	0 08.4	−1.0	−0.8	78
5	142 B. Tau	573	6.8	I	135	1 55.9	−0.3	−1.9	109	1 02.7	−0.3	−2.8	131
5	32 Tau	582	5.8	I	136	No occ.				3 18.0	−0.6	+0.3	33
5	τ Tau	709	4.3	I	146	19 39.2	−1.8	−1.8	146	18 29.1	.	.	154
7	Saturn	—	−0.2	I	163	2 07.2	.	.	177	No occ.			
7	Saturn	—	−0.2	E	163	2 22.6	.	.	205	No occ.			
10	209 B. Cnc	1364	6.5	E	206	2 11.2	−1.4	−0.1	277	0 53.0	−1.9	+1.5	252
11	55 Leo	1587	6.0	E	233	23 58.3	−0.6	+1.0	288	22 48.1	−0.4	+1.5	269
12	62 p^3 Leo	1605	6.2	E	235	No occ.				2 59.7	−0.5	−1.8	344
13	13 B. Vir	1713	5.8	E	247	2 07.3	−0.7	+0.2	307	0 57.5	−0.8	+0.9	286
28	136 B. Psc	89	6.5	I	64	21 45.8	−0.3	−1.0	67	20 46.4	−0.6	−1.3	82
31	τ Ari	486	5.2	I	102	22 27.3	−1.1	+0.5	40	21 14.6	−1.3	+0.1	60
31	63 Ari	487	5.2	I	102	23 21.7	.	.	160	No occ			
Feb. 1	65 Ari	492	5.9	I	102	0 01.3	+0.3	−4.1	147	No occ.			
1	194 B. Tau	625	7.0	I	113	18 44.8	−1.9	−2.2	140	Sun			
1	+22° 670m	630	7.5	I	114	20 29.2	−1.4	+0.1	82	19 14.2	−1.6	+0.1	93
1/2	υ Tau	660	4.4	I	116	0 24.0	−0.5	−1.5	93	23 26.1	−0.6	−2.0	113
1/2	72 Tau	664	5.4	I	116	0 56.2	−0.7	−0.4	51	23 51.9	−0.8	−0.9	73
9	87e Leo	1670	5.1	E	214	2 58.6	−0.7	−1.3	332	1 54.0	−1.2	−0.8	310
24	45 Psc	51	7.2	I	34	19 24.2	−0.4	−0.4	51	18 21.3	−0.7	−0.6	65
28	Mars	—	1.1	I	82	17 16.9	−1.5	+0.7	81	15 58.9	−1.5	+0.9	87
28	Mars	—	1.1	E	82	18 36.7	−1.5	0.0	260	17 19.2	−1.6	+1.0	249
28	37 A Tau	599	4.5	I	84	22 18.5	−0.4	−1.8	103	21 23.0	−0.5	−2.5	124
28	39 Tau	601	6.0	I	84	22 39.4	−0.2	−2.3	121	21 51.1	+0.1	−3.9	148
Mar. 1	+22° 818	761	6.7	I	97	22 31.2	−0.9	−0.9	73	21 26.4	−1.1	−1.2	93
2	Saturn	—	0.2	I	107	14 51.9	−0.4	+1.3	98	13 43.6	−0.2	+1.2	99
2	Saturn	—	0.2	E	107	15 52.7	−0.6	+1.6	260	14 40.9	−0.3	+1.7	256
2	141 Tau	911	6.3	I	109	19 35.2	−1.3	−1.0	120	Sun			
2	14 B. Gem	928	6.0	I	111	23 26.5	−0.7	−1.5	98	22 26.4	−0.8	−1.9	117
2/3	+21° 1146	939	7.4v	I	111	0 40.3	+0.1	−2.4	143	23 57.8	.	.	175
3	ζ Gem	1077	3.9v	I	123	19 44.0	−1.4	+1.4	69	18 25.4	−1.3	+1.1	86
4	+19° 1685	1109	7.3	I	126	3 30.8	.	.	29	2 27.4	−0.4	−0.8	57
Mar. 4	+16° 1657	1235	7.4	I	138	23 27.0	−0.9	−1.5	122	22 25.4	−0.9	−2.1	144
4	+16° 1662	1238	6.1	I	138	No occ.				23 10.7	.	.	38
5	209 B. Cnc	1364	6.5	I	152	23 14.9	−1.2	−0.8	112	22 07.6	−1.2	−1.2	133
10	370 B. Vir	1852	6.0	E	208	4 29.4	−0.8	−1.7	333	3 27.3	−1.1	−1.5	320
10	−11° 3398	1858	6.5	E	209	Sun				5 20.2	−0.9	−1.7	301
11	83 Vir	1967	5.7	E	221	2 58.1	−1.5	0.0	272	1 38.7	−2.1	+1.1	252
15	191 B. Oph	2510	6.3	E	268	Sun				5 02.5	−1.7	+0.5	274
15	44 b Oph	2513	4.3	I	269	5 49.8	−1.6	+0.6	63	4 29.6	−1.7	+1.1	71
15	44 b Oph	2513	4.3	E	269	Sun				5 49.8	−1.8	−0.1	290
26	+18° 359	421	6.6	I	41	21 11.0	−0.8	+1.2	17	20 04.1	−0.5	−0.2	46
28	+22° 776	739	7.4	I	68	Low				23 22.8	+0.2	−1.2	86
Apr. 1	2 B. Cnc	1198	6.2	I	108	1 47.3	+0.4	−2.1	154	1 02.4	+0.7	−2.9	174
4	87 e Leo	1670	5.1	I	160	21 58.3	−1.2	+0.1	110	20 48.1	−0.9	−0.3	131
25	+21° 902f	843	7.2	I	50	22 10.8	+0.4	−2.1	138	21 27.5	+0.9	−3.3	163
27	74 f Gem	1158	5.2	I	77	23 05.1	0.0	−1.8	119	22 13.2	0.0	−2.0	134
29	ω Leo	1397	5.5	I	103	22 01.1	+0.1	−2.9	175	No occ.			
May 1	−0° 2422	1629	6.8	I	129	No occ				21 12.7	.	.	53
3	64 B. Vir	1752	6.5	I	144	1 25.3	−0.6	−2.0	153	0 28.7	−0.6	−2.3	165
May 9	51 Oph	2523	4.9	E	216	1 39.0	−1.5	+1.0	241	0 17.0	−1.7	+1.9	230
25	+15° 1805	1257	7.5	I	60	Low				22 01.1	0.0	−1.5	102
26	+10° 1972	1384	7.4	I	74	Low				22 51.3	+0.1	−1.8	131
27	19 Sex	1495	5.9	I	87	Low				22 48.3	−0.3	−1.9	126
28	+0° 2728	1604	6.1	I	100	23 12.7	−0.4	−1.9	135	22 16.6	−0.6	−2.1	145
June 9	τ Cap	3015	5.3	E	230	Sun				2 31.2	.	.	306
27	496 B. Vir	1918	7.0	I	108	22 18.1	−1.0	−1.7	130	21 14.9	−1.2	−1.7	139

Date	Name	Z.C. No.	Mag.	I or E	Elong. of Moon	EDMONTON W 113°400, N. 53°600				VANCOUVER W. 123°100, N. 49°200			
						M.S.T.	a	b	P	P.S.T.	a	b	P
					°	h m	m	m	°	h m	m	m	°
28	43 H. Vir	2039	5.6	I	120	22 57.2	−1.1	−1.2	85	21 49.1	−1.5	−0.9	91
28	231 G. Vir	2045	6.4	I	120	Low				23 12.8	−1.2	−2.5	156
July 8/9	κ Aqr	3320	5.3	E	232	0 48.6	−0.5	+2.3	201	23 33.0	−0.5	+2.5	201
9	207 B. Aqr	3326	6.4	E	233	Sun				2 10.2	−1.6	+1.1	259
10	κ Psc	3453	4.9	E	244	Sun				3 10.1	−1.2	+1.6	229
15	14 H[1] Tau	525	6.4	E	304	Sun				2 12.1	−0.4	+0.5	311
27	−22° 4020	2249	6.9	I	113	21 40.2	−1.4	−1.5	142	Sun			
Aug. 12	51 Tau	631	5.6	E	285	Sun				2 37.9	−0.1	+2.3	227
12	56 Tau	634	5.3	E	285	Sun				3 20.1	−0.6	+1.6	257
13	108 Tau	784	6.2	E	297	2 22.0	−0.3	+0.8	303	Low			
13	109 n Tau	792	5.1	E	298	3 57.9	−0.3	+2.0	245	2 48.1	0.0	+1.9	244
29	τ Cap	3015	5.3	I	149	22 04.9	.	.	8	20 49.1	.	.	4
Sept. 6	45 Ari	432	5.9	E	240	22 42.8	+0.1	+1.8	247	Low			
12	2 B. Cnc	1198	6.2	E	306	2 53.9	0.0	+1.0	288	Low			
12	5 Cnc	1210	5.9	E	307	4 04.3	−0.4	+0.6	305	2 58.3	−0.2	+0.7	298
20	δ Sco	2290	2.5	E	62	Low				18 40.0	−1.2	−0.8	250
22	−22° 4436	2567	7.1	I	86	19 33.7	−1.2	−0.2	56	Sun			
25	31 B. Cap	2986	6.4	I	120	Low				23 04.0	−1.6	−1.9	106
28	207 B. Aqr	3326	6.4	I	152	21 07.9	−0.5	+2.3	11	19 52.7	−0.3	+2.9	6
29	κ Psc	3453	4.9	I	163	21 52.2	−0.2	+2.7	5	20 38.6	.	.	357
Oct. 3	36 Ari	402	6.5	E	211	23 19.4	−0.9	+1.4	269	22 05.0	−0.7	+1.4	271
4	40 Ari	415	6.0	E	212	1 34.6	.	.	317	0 18.9	.	.	313
4	45 Ari	432	5.9	E	213	Sun				4 29.0	.	.	192
6/7	+21° 918	851	6.3	E	249	1 00.5	−0.9	+0.3	308	23 50.7	−0.7	+0.5	305
9	74 f Gem	1158	5.2	E	275	1 51.4	−0.7	−0.6	332	0 47.4	−0.4	−0.1	323
24	117 G. Cap	3184	7.1	I	111	Low				23 01.5	−1.7	−3.2	118
25	−5° 5790	3290	7.3	I	121	21 22.7	−2.2	−1.3	111	20 03.7	−2.4	−0.4	106
Nov. 1	53 Tau	633	5.4	E	205	22 24.0	−0.6	+1.6	262	21 12.0	−0.4	+1.6	261
2	247 B. Tau	665	5.7	E	207	2 47.5	−1.4	−2.0	309	1 38.2	−1.7	−0.9	293
3	o Tau	817	4.8	E	219	No occ.				1 10.3	.	.	330
4	16 Gem	991	6.1	E	232	2 49.5	−1.3	+0.3	278	1 33.3	−1.3	+1.1	265
4	ν Gem	995	4.1	I	233	2 34.9	.	.	163	No occ.			
4	ν Gem	995	4.1	E	233	3 05.3	.	.	212	No occ.			
6	29 Cnc	1271	5.9	E	260	4 55.8	−1.1	−1.1	319	3 47.0	−1.3	−0.2	299
22	−2° 5858	3371	6.4	I	103	Low				23 12.3	−0.7	−1.3	81
23	+1° 4744	3482	5.6	I	112	19 16.8	−1.9	+0.1	100	17 56.4	−1.8	+0.8	96
Dec. 4	κ Cnc	1359	5.1	E	242	3 39.3	−1.7	+1.5	249	No occ.			
5	14 Sex	1482	6.3	E	257	Graze				4 40.6	−0.8	−1.8	336
6	237 B. Leo	1582	6.3	E	268	1 46.8	−0.3	+0.3	311	Low			
6	55 Leo	1587	6.0	E	269	3 25.4	−0.4	−1.0	339	2 22.6	−0.6	−0.1	316
7	13 B. Vir	1713	5.8	E	283	5 41.1	−1.5	+1.0	266	4 15.6	.	.	233
25	36 Ari	402	6.5	I	130	2 04.5	−0.3	−1.3	81	1 07.1	−0.5	−1.7	99
26	227 B. Tau	651	5.9	I	152	17 44.5	−0.7	+0.8	122	Sun			
26	247 B. Tau	665	5.7	I	153	No occ				18 58.7	.	.	6
31	45 A[1] Cnc	1309	5.7	E	210	0 48.4	.	.	221	No occ.			
31	60 Cnc	1332	5.7	E	213	Sun				6 41.2	−0.5	−1.6	287

GRAZING OCCULTATIONS OVER CANADA DURING 1974

By L. V. Morrison

The maps show the tracks of stars brighter than $7^m.5$ which will graze the limb of the Moon when it is at a favourable elongation from the Sun and at least 10° above the observer's horizon (5° in the case of stars brighter than $5^m.5$ and 2° for those brighter than $3^m.5$). Each track starts in the West at some arbitrary time given in the tables and ends beyond the area of interest, except where the letters *A*, *B* or *S* are given. *A* denotes that the Moon is at a low altitude, *B* that the bright limb interferes, and *S* that daylight interferes. The tick marks along the tracks denote 10 minute intervals of time which, when added to the time at the beginning of the track, give the approximate time of the graze at places along the tracks.

Observers positioned on, or very near, one of these tracks will probably see the star disappear and reappear several times at the edge of features on the limb of the Moon. The recorded times of these events (to a precision of a second, if possible) are very valuable in the study of the shape and motion of the Moon currently being investigated at the Royal Greenwich Observatory and the U.S. Naval Observatory. Observers situated near to any of these tracks who are interested should write to Dr. David W. Dunham, Department of Astronomy, University of Texas, Austin, Texas 78712, at least two months before the event, giving their approximate latitude and longitude, and details of the event will be supplied.

The following table gives, for each track, the date, the name, Zodiacal Catalogue number and magnitude of the star, the time (U.T.) at the beginning of the track in the West, the percent of the Moon sunlit and whether the track is the northern (N) or southern (S) limit of the occultation. An asterisk after the track number refers the reader to the notes following the table; a dagger indicates that the star is a spectroscopic binary.

No	Date	Name	Z.C.	Mag.	U.T.	%	L	No.	Date	Name	Z.C.	Mag.	U.T.	%	L
					h m								h m		
1	Jan. 3	104 Psc	244	6.9	0 34	63	S	31	Mar. 4	ζ Gem	1077	3.7	3 48	77	N
2*	4	+18° 337	397	7.5	4 09	75	S	32	4	+19° 1685	1109	7.3	10 34	80	N
3	4	63 Ari	487	5.2	20 06	82	S	33	15	157 B Oph	2491	6.7	9 21	52	N
4	4	65 Ari	492	5.9	20 50	82	S	34	16	1 Sgr	2630	5.1	9 21	42	S
5	12	237 B Leo	1582	6.3	4 51	81	S	35	17	π Sgr	2797	3.0	14 51	32	N
6	Jan. 12	57 Leo	1590	6.9	6 54	80	S	36*	Mar. 27	+18° 337	397	7.5	0 18	11	N
7	12	+0° 2728	1604	6.1	11 47	78	S	37	27	+18° 359	421	6.6	4 21	13	N
8	15	562 B Vir	1960	6.9	14 10	46	S	38†	29	τ Tau	709	4.3	1 51	29	N
9	17	64 G Lib	2183	5.7	10 51	28	S	39	30	175 H Tau	861	6.5	1 47	40	N
10	26	−2° 5858	3371	6.4	23 42	11	N	40	Apr. 2	6 Leo	1410	5.3	23 27	83	N
11	Jan. 28	19 Psc	3501	5.3	0 32	19	S	41	Apr. 3	+9° 2226	1429	6.8	3 20	84	N
12	28	+3° 4900	3511	6.7	4 32	20	N	42	18	207 B Aqr	3326	6.4	9 34	15	N
13	30	20 H Ari	317	6.4	22 42	46	N	43	25	κ Tau	656	4.4	1 41	9	N
14	Feb. 1	151 B Ari	459	6.7	0 18	58	N	44	27	14 Gem	984	6.6	0 36	26	N
15	1	ζ Ari	472	5.0	2 37	59	N	45	28	+19° 1734	1130	7.2	1 16	37	N
16	Feb. 1	τ Ari	486	5.2	6 00	60	N	46	May 1	62 Leo	1605	6.2	23 54	80	N
17	2	192 B Tau	621	6.2	1 06	70	S	47	2	−0° 2422	1629	6.8	5 20	82	N
18	2	194 B Tau	625	7.0	1 44	70	S	48	25	+19° 1623	1084	7.3	0 46	14	N
19	2	72 Tau	664	5.4	8 17	72	N	49	28	14 Sex	1482	6.3	3 55	47	N
20	2	+22° 818	761	6.7	21 17	78	S	50	29	237 B Leo	1582	6.3	0 43	57	N
21*	Feb. 3	η Gem	946	3.2	23 07	88	N	51	May 29	57 Leo	1590	6.9	2 48	57	N
22*	4	μ Gem	976	3.2	2 11	89	N	52	30	13 B Vir	1713	5.8	4 34	69	N
23*	13	43 B Lib	2134	6.1	9 38	55	S	53	June 12	−3° 5505	3340	7.5	5 52	57	N
24	15	18 Oph	2417	7.0	12 13	34	S	54	14	45 Psc	51	7.2	9 37	36	N
25	28	133 B Tau	566	5.9	23 12	43	N	55	29	231 G Vir	2045	6.4	7 46	76	S
26	Mar. 1	32 Tau	582	5.8	2 02	44	N	56	July 14	27 Ari	371	6.4	5 04	34	N
27	2	309 B Tau	734	6.6	0 25	54	N	57	15	+20° 573	503	7.2	5 42	24	N
28	2	+22° 818	761	6.7	6 04	57	N	58	24	64 B Vir	1752	6.5	3 35	28	S
29	3	140 Tau	907	6.9	2 15	66	N	59	28	−22° 4020	2249	6.9	5 16	70	S
30	3	+21° 1426	1051	6.7	23 03	76	N	60*	Aug. 7	+3° 4909	3524	6.9	9 04	85	N

No.	Date	Name	Z.C.	Mag.	U.T.	%	L	No.	Date	Name	Z.C.	Mag.	U.T.	%	L
					h m								h m		
61	Aug 11	δ Ari	465	4.5	6 14	49	N	83†	Nov. 4	ν Gem	995	4.1	9 32	80	S
62	14	+21° 1203	969	7.1	10 14	16	S	84	7	+10°1972	1384	7.4	9 01	48	S
63*	25	−23° 12860	2357	6.6	5 38	54	S	85	8	19 Sex	1495	5.9	9 27	36	S
64*	25	ρ Oph	2359	4.8	5 45	54	S	86	10	49 B Vir	1745	7.0	13 23	15	S
65	Sept. 8	+20° 669	586	7.0	7 50	64	N	87	11	−11° 3418	1872	7.3	14 32	7	S
66	Sept. 13	α Cnc	1341	4.3	10 05	11	S	88†	Nov. 24	+1° 4744	3482	5.6	2 20	69	S
67	22	22 Oph	2430	7.0	2 13	36	S	89	24	+5° 25	29	7.2	22 23	77	S
68	26	31 B Cap	2986	6.4	7 33	75	S	90	25	45 Psc	51	7.2	6 14	79	N
69	26	9 Aqr	3072	6.6	22 38	81	S	91	Dec. 3	2 B Cnc	1198	6.2	3 50	84	N
70†	Oct. 6	247 B Tau	665	5.7	2 07	79	N	92	4	60 Cnc	1332	5.7	4 40	75	S
71	Oct. 7	o Tau	817	4.8	2 33	70	N	93†	Dec. 4	κ Cnc	1359	5.1	9 59	73	S
72*	7	+21° 902	843	7.2	6 03	68	N	94	6	57 Leo	1590	6.9	10 15	50	S
73*	8	15 Gem	989	6.6	3 07	59	N	95	6	+0° 2728	1604	6.1	14 53	48	S
74*	11	ω Leo	1397	5.5	7 01	24	S	96	7	13 B Vir	1713	5.8	11 59	38	S
75	13	87 Leo	1670	5.1	12 53	6	S	97	8	21 Vir	1800	5.4	7 35	29	S
76	Oct. 25	−10° 5714	3163	7.3	1 25	67	S	98	Dec. 9	−14° 3767	1958	7.5	13 56	18	S
77	25	117 G Cap	3184	7.1	7 22	69	S	99	17	8 Aqr	3070	6.6	23 17	16	S
78	25	46 Cap	3185	5.3	7 19	69	S	100	18	117 G Cap	3184	7.1	22 56	23	S
79	26	−5° 5790	3290	7.3	4 19	76	S	101	18	46 Cap	3185	5.3	22 49	23	S
80†	Nov. 3	ζ Tau	847	3.0	14 20	87	S	102	19	−5° 5790	3290	7.3	20 51	31	S
81	Nov. 4	+21° 1203	969	7.1	5 58	81	N	103	Dec. 25	+16° 293	363	7.3	0 11	80	S
82*	4	15 Gem	989	6.6	8 49	80	N								

NOTES ON DOUBLE STARS

2 ZC 397 is the preceding component of the triple system Aitken 2042. The B component is $7^{m}.7$, separation 3″.4 in p.a. 119°. The C component is $9^{m}.5$ with a wide separation.

21 ZC 946 is a spectroscopic binary and is the following component of the double star Aitken 4841. The companion is 6^{m}, separation 1″.5 in p.a. 268°.

22 ZC 976 is the brighter component of the system Aitken 4990. The companion is 10^{m}, separation 0″.8 in p.a. 260°.

23 ZC 2134 is the following component of the system Aitken 9446. The companion is $8^{m}.0$, separation 21″ in p.a. 300°.

36 See note on track 2.

60 ZC 3524 is the mean of the double star Aitken 17111. The components are $7^{m}.5$ and $8^{m}.0$, separation 0″.4 in p.a. 220°.

63 ZC 2357 is the mean of the double star Aitken 10045. The components are $8^{m}.1$ and $9^{m}.2$, separation 0″.8 in p.a. 17°.

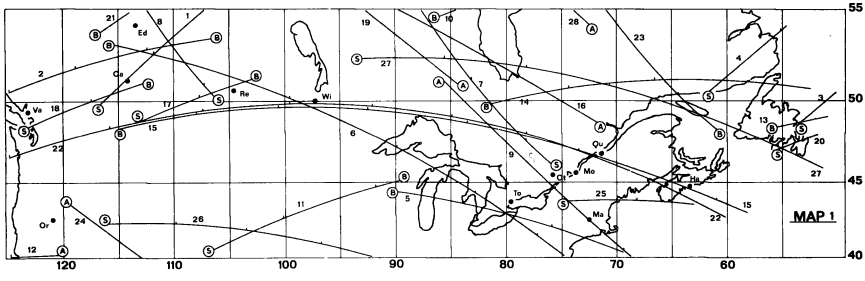
64 ZC 2359 is the mean of the double star Aitken 10049. The components are $5^{m}.3$ and $5^{m}.9$, separation 3″.0 in p.a. 344°.

72 ZC 843 is the following component of the double star Aitken 4200. The companion is $7^{m}.8$, separation 3″.8 in p.a. 269°.

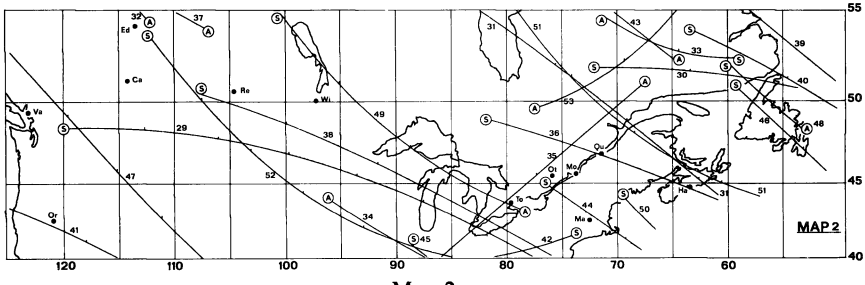
73 ZC 989 is the brighter component of the double star Aitken 5080. The companion is $8^{m}.5$, separation 27″ in p.a. 203°.

74 ZC 1397 is the mean of the double star Aitken 7390. The components are $6^{m}.0$ and $6^{m}.7$, separation 0″.5 in p.a. 1°.

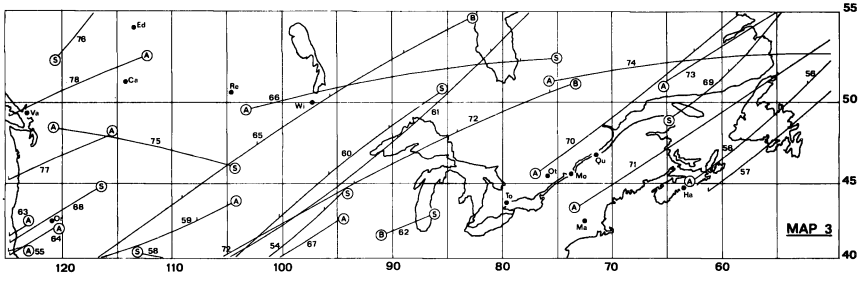
82 See note on track 73.



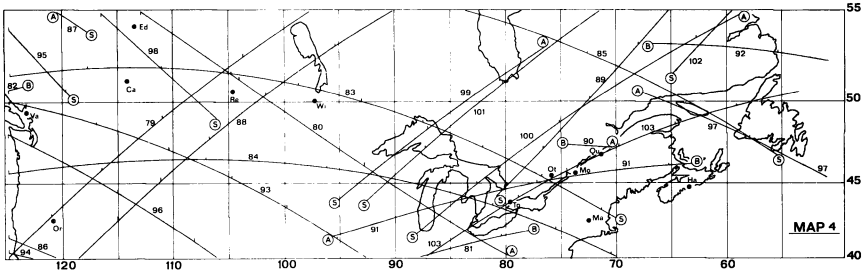
Map 1.



Map 2.

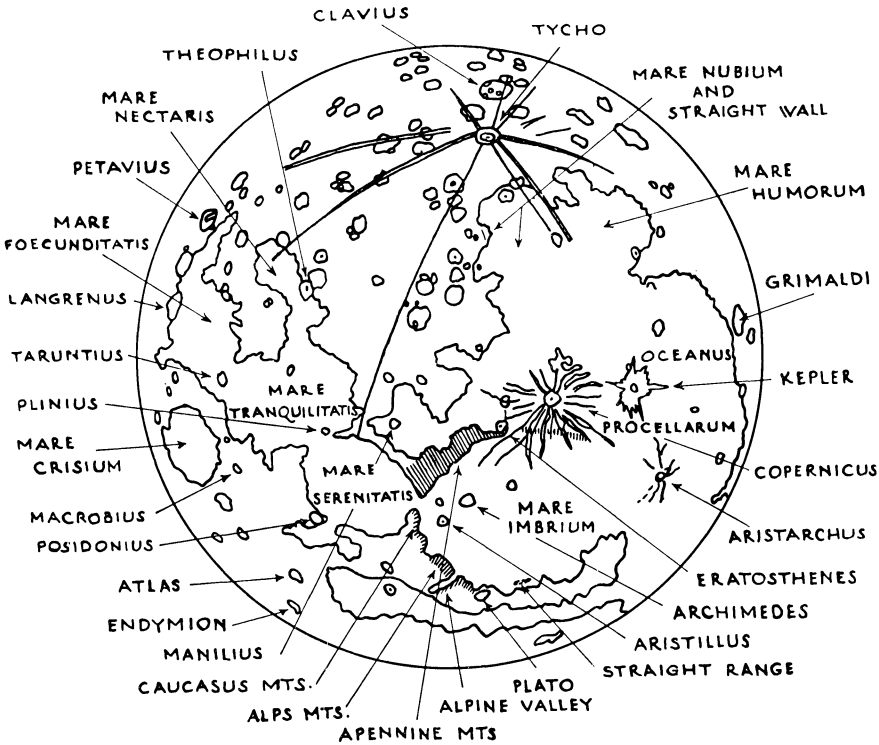


Map 3.



Map 4.

MAP OF THE MOON



South appears at the top.

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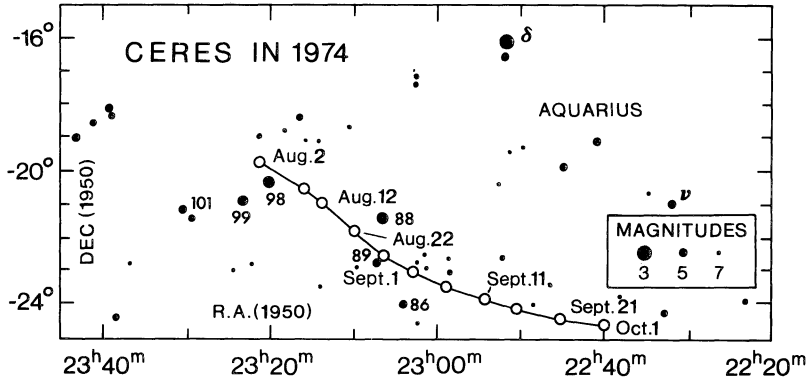
MARS—LONGITUDE OF THE CENTRAL MERIDIAN

The following table lists the longitude of the central meridian of the geometric disk of Mars for each date at 0 hours U.T. (19 hours E.S.T. on the preceding date). To obtain the longitude of the central meridian for other times, add 14.6° for each hour elapsed since 0 hours U.T.

A map of the surface of Mars appeared in the 1971 edition of the OBSERVER'S HANDBOOK; single copies of this map may be obtained without charge by writing to the Editor.

Date	Jan.	Feb.	Mar.	Apr.	May	June
1	275.02	338.52	68.91	129.88	200.15	260.09
2	265.52	328.91	59.27	120.23	190.49	250.39
3	256.02	319.29	49.63	110.57	180.82	240.69
4	246.51	309.68	39.99	100.92	171.15	230.99
5	236.99	300.06	30.35	91.27	161.48	221.29
6	227.47	290.44	20.70	81.62	151.82	211.59
7	217.94	280.82	11.06	71.96	142.15	201.89
8	208.41	271.20	1.42	62.31	132.47	192.18
9	198.87	261.58	351.77	52.66	122.80	182.48
10	189.33	251.95	342.13	43.00	113.13	172.77
11	179.78	242.33	332.48	33.35	103.46	163.06
12	170.23	232.70	322.84	23.69	93.78	153.35
13	160.68	223.08	313.19	14.04	84.11	143.64
14	151.12	213.45	303.55	4.38	74.43	133.92
15	141.56	203.82	293.90	354.73	64.76	124.21
16	131.99	194.19	284.26	345.07	55.08	114.49
17	122.42	184.56	274.61	335.41	45.40	104.78
18	112.85	174.92	264.96	325.76	35.72	95.06
19	103.27	165.29	255.32	316.10	26.04	85.34
20	93.69	155.66	245.67	306.44	16.36	75.61
21	84.11	146.02	236.02	296.78	6.67	65.89
22	74.52	136.38	226.37	287.12	356.99	56.16
23	64.93	126.75	216.73	277.46	347.31	46.44
24	55.34	117.11	207.08	267.80	337.62	36.71
25	45.75	107.47	197.43	258.14	327.93	26.98
26	36.15	97.83	187.78	248.47	318.24	17.25
27	26.55	88.19	178.13	238.81	308.55	7.51
28	16.95	78.55	168.48	229.15	298.86	357.78
29	7.35		158.83	219.48	289.17	348.04
30	357.74		149.18	209.82	279.48	338.31
31	348.13		139.53		269.78	



ASTEROIDS—EPHEMERIDES AT OPPOSITION, 1974

All of the four major asteroids come to opposition in 1974. The following tables give (for 0 hours U.T.) the apparent R.A. and declination within one month of opposition. Maps are given for Ceres and Vesta.

CERES
Opposition Sept. 1, mag. 7.3

Date	R.A.	Dec.
	h m	° ′
Aug. 2	23 23.7	−19 31
12	23 18.9	−20 40
17	23 15.8	−21 15
22	23 12 2	−21 50
27	23 08.4	−22 22
Sept. 1	23 04.3	−22 52
6	23 00.1	−23 18
11	22 55.8	−23 41
16	22 51.7	−23 59
21	22 47.8	−24 12
Oct. 1	22 41.1	−24 22

JUNO
Opposition Sept. 5, mag. 8.1

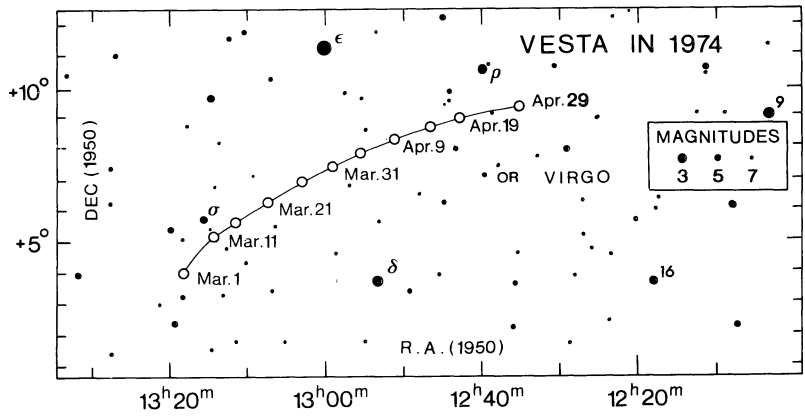
Date	R.A.	Dec.
	h m	° ′
Aug. 6	23 06.9	+0 39
16	23 02.9	−0 31
21	23 00.1	−1 15
26	22 57.0	−2 04
31	22 53.5	−2 58
Sept. 5	22 49.8	−3 55
10	22 46.0	−4 54
15	22 42.4	−5 53
20	22 38.9	−6 52
25	22 35.9	−7 48
Oct. 5	22 31.3	−9 30

PALLAS
Opposition July 24, mag. 9.2

Date	R.A.	Dec.
	h m	° ′
June 24	20 03.8	20 10
July 4	19 56.9	20 11
9	19 53.1	20 02
14	19 49.1	19 47
19	19 45.1	19 25
24	19 41.0	18 56
29	19 37.1	18 21
Aug. 2	19 34.1	17 48
7	19 30.5	17 03
12	19 27.3	16 13
22	19 22.0	14 24

VESTA
Opposition Mar. 31, mag. 5.9

Date	R.A.	Dec.
	h m	° ′
Mar. 1	13 19.4	3 48
11	13 15.5	4 56
16	13 12.5	5 33
21	13 09.0	6 10
26	13 04.9	6 47
31	13 00.5	7 21
Apr. 4	12 56.9	7 47
9	12 52.3	8 14
14	12 47.8	8 37
19	12 43.5	8 53
29	12 36.4	9 06



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).

Day (0^h U.T.)	SYSTEM I									SYSTEM II								
	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
1	314.6	7.6	220.5	277.7	135.2	354.2	54.3	269.0	322.3	62.7	246.8	223.1	51.4	32.3	14.8	206.0	184.2	8.6
2	112.3	165.4	18.3	75.7	293.2	152.2	212.2	66.8	120.0	212.8	36.9	13.4	201.8	182.7	165.2	356.3	334.4	158.7
3	270.0	323.2	176.2	233.6	91.2	310.2	10.2	224.6	277.7	2.9	187.1	163.6	352.1	333.1	315.6	146.6	124.6	308.8
4	67.8	121.0	334.1	31.6	249.2	108.3	168.1	22.4	75.5	153.0	337.3	313.8	142.4	123.5	106.0	297.0	274.8	98.9
5	225.5	278.8	132.0	189.5	47.2	266.3	326.1	180.3	233.2	303.1	127.5	104.1	292.7	273.9	256.4	87.3	65.0	249.0
6	23.3	76.6	289.9	347.5	205.3	64.3	124.0	338.1	30.9	93.2	277.7	254.3	83.1	64.3	46.8	237.6	215.1	39.1
7	181.0	234.4	87.7	145.4	3.3	222.4	281.9	135.9	188.6	243.3	67.8	44.6	233.4	214.7	197.2	27.9	5.3	189.2
8	338.8	32.2	245.6	303.4	161.3	20.4	79.9	293.7	346.3	33.5	218.0	194.9	23.7	5.1	347.6	178.2	155.5	339.3
9	136.5	190.1	43.5	101.4	319.3	178.4	237.8	91.5	144.1	183.6	8.2	345.1	174.0	155.5	138.0	328.5	305.7	129.4
10	294.3	347.9	201.4	259.3	117.4	336.4	35.7	249.3	301.8	333.7	158.4	135.4	324.4	305.9	288.4	118.8	95.8	279.4
11	92.0	145.7	359.3	57.3	275.4	134.5	193.6	47.1	99.5	123.8	308.6	285.6	114.7	96.3	78.8	269.1	246.0	69.5
12	249.8	303.5	157.2	215.3	73.4	292.5	351.5	204.9	257.2	274.0	98.8	75.9	265.1	246.7	229.2	59.4	36.2	219.6
13	47.6	101.3	315.1	13.3	231.5	90.5	149.5	2.7	54.9	64.1	249.0	226.2	55.4	37.1	19.6	209.6	186.3	9.7
14	205.3	259.2	113.0	171.2	29.5	248.5	307.4	160.4	212.6	214.2	39.2	16.4	205.7	187.5	169.9	0.1	336.5	159.7
15	3.1	57.0	270.9	329.2	187.5	46.5	105.3	318.2	10.3	4.4	189.4	166.7	356.1	337.9	320.3	150.2	126.6	309.8
16	160.8	214.8	68.8	127.2	345.6	204.5	263.2	116.0	168.0	154.5	339.6	317.0	146.4	128.3	110.7	300.5	276.8	99.9
17	318.6	12.7	226.7	285.2	143.6	2.5	61.1	273.8	325.7	304.6	129.8	107.3	296.8	278.7	261.1	90.7	66.9	249.9
18	116.4	170.5	24.6	83.2	301.6	160.5	218.9	71.6	123.4	94.8	280.0	257.6	87.2	69.1	51.5	241.0	217.1	40.0
19	274.2	328.3	182.6	241.1	99.7	318.5	16.8	229.3	281.0	244.9	70.2	47.8	237.5	219.5	201.8	31.2	7.2	190.1
20	71.9	126.2	340.5	39.1	257.7	116.5	174.7	27.1	78.7	35.1	220.4	198.1	27.9	9.9	352.2	181.5	157.3	340.1
21	229.7	284.0	138.4	197.1	55.7	274.5	332.6	184.8	236.4	185.2	10.6	348.4	178.2	160.3	142.6	331.7	307.5	130.2
22	27.5	81.9	296.3	355.1	213.8	72.5	130.5	342.6	34.1	335.3	160.8	138.7	328.6	310.7	292.9	122.0	97.6	280.2
23	185.3	239.7	94.2	153.1	11.8	230.5	288.3	140.4	191.8	125.5	311.0	289.0	119.0	101.1	83.3	272.2	247.7	70.3
24	343.1	37.6	252.2	311.1	169.9	28.5	86.2	298.1	349.5	275.6	101.3	79.3	269.3	251.5	233.6	62.4	37.9	220.3
25	140.8	195.4	50.1	109.1	327.9	186.5	244.1	95.9	147.1	65.8	251.5	229.6	59.7	41.9	24.0	212.7	188.0	10.4
26	298.6	353.3	208.0	267.1	125.9	344.4	41.9	253.6	304.8	216.0	41.7	19.9	210.1	192.3	174.3	2.9	338.1	160.4
27	96.4	151.1	6.0	65.1	284.0	142.4	199.8	51.3	102.5	6.1	191.9	170.2	0.4	342.7	324.7	153.1	128.2	310.5
28	254.2	309.0	163.9	223.1	82.0	300.4	357.6	209.1	260.2	156.3	342.2	320.5	150.8	133.2	115.0	303.3	278.3	100.5
29	52.0	106.9	321.8	21.1	240.0	98.3	155.5	6.8	57.8	306.4	132.4	110.8	301.2	283.6	265.3	93.6	68.4	250.6
30	209.8	264.7	119.8	179.1	38.1	256.3	313.3	164.6	215.5	96.6	282.6	261.1	91.6	74.0	55.7	243.8	218.5	40.6
31		62.6		337.2	196.1		111.1		13.2		72.9		242.0	224.4		34.0		190.6

JUPITER—PHENOMENA OF THE BRIGHTEST SATELLITES 1974

Times and dates given are E.S.T. The phenomena are given for latitude 44° N., for Jupiter at least one hour above the horizon, and the sun at least one hour below the horizon, as seen from Central North America.

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 west side until September 5, and on the east thereafter.

JANUARY

d	h	m	Sat.	Phen.
1	17	49	III	Se
3	18	26	IV	TI
	18	35	I	OD
4	18	15	I	Te
	18	55	I	Se
7	17	54	II	TI
8	18	13	III	SI
11	17	59	I	TI
	18	33	I	SI
12	17	58	I	ER

Jupiter being near the sun, phenomena are not given between Jan. 12 and May 4.

MAY

d	h	m	Sat.	Phen.
4	3	46	I	ED
5	4	27	I	Te
	4	52	II	TI
7	3	53	III	ER
12	4	09	I	TI
13	3	44	I	OR
14	4	19	III	ED
	4	53	II	OR
18	2	58	IV	SI
	3	07	III	Te
21	2	49	I	Te
23	2	32	II	Te
25	3	50	III	TI
27	3	57	I	ED
	4	53	IV	OR
28	2	30	I	TI
	3	25	I	Se
	4	39	II	ED
	4	45	I	Te
29	2	06	I	OR
30	2	21	II	TI
	2	28	II	Se

JUNE

d	h	m	Sat.	Phen.
1	2	22	III	SI
4	3	04	I	SI
	4	25	I	TI
5	4	01	I	OR
6	2	11	II	SI
8	2	04	II	OR
12	2	00	III	OD
	2	14	I	ED
13	1	41	I	Se
	3	01	I	Te
19	3	53	III	ER
	4	08	I	ED
20	1	19	I	SI
	2	39	I	TI
	3	34	I	Se
21	2	15	I	OR
22	1	40	II	ED
24	2	14	II	Te
26	4	21	III	ED
27	3	13	I	SI
28	0	31	I	ED
28	4	07	I	OR
29	0	26	IV	ED
	1	13	I	Te
	4	14	II	ED
30	2	59	III	Te

JULY

d	h	m	Sat.	Phen.
1	1	55	II	TI
	2	11	II	Se
5	2	25	I	ED
6	0	48	I	TI
	1	50	I	Se
	3	03	I	Te
7	0	24	I	OR
	1	51	III	Se
	3	25	III	TI
8	0	57	IV	Te
	1	56	II	SI
	4	24	II	TI
10	1	20	II	OR
12	4	19	I	ED
13	1	29	I	SI
	2	38	I	TI
	3	44	I	Se
14	2	13	I	OR
	2	22	III	SI
	23	19	I	Te
15	4	32	II	SI
17	3	44	II	OR
18	0	14	III	OR
20	3	22	I	SI
	4	25	I	TI
21	0	42	I	ED
	4	01	I	OR
	22	52	I	TI
22	0	06	I	Se
	1	07	I	Te
24	1	17	II	ED
	3	56	IV	SI
	23	53	III	ER
25	0	29	III	OD
	3	46	III	OR
	22	24	II	TI
	23	17	II	Se
26	1	11	II	Te
28	2	36	I	ED
	23	45	I	SI
29	0	39	I	TI
	2	01	I	Se
	2	54	I	Te
30	0	14	I	OR
31	3	52	II	ED

AUGUST

d	h	m	Sat.	Phen.
1	0	24	III	ED
	3	53	III	ER
	3	57	III	OD
	23	02	II	SI
2	0	10	IV	OR
	0	44	II	TI
	1	53	II	Se
	3	31	II	Te
4	4	30	I	ED
5	1	39	I	SI
5	2	25	I	TI
	3	55	I	Se
	4	40	I	Te
	22	59	I	ED
6	2	00	I	OR
	22	23	I	Se
	23	06	I	Te
8	4	25	III	ED
9	1	38	II	SI
	3	01	II	TI
	4	29	II	Se
	22	12	IV	SI
10	2	05	IV	Se
	5	05	IV	TI
	23	54	II	OR
11	21	52	III	Se
12	0	16	III	Te
	3	33	I	SI
	4	10	I	TI
13	0	53	I	ED
	3	45	I	OR
	22	01	I	SI
	22	36	I	TI
14	0	18	I	Se
	0	51	I	Te
	22	11	I	OR
16	4	14	II	SI
	5	18	II	TI
17	22	22	II	ED
18	2	11	II	OR
	22	26	III	SI
19	0	20	III	TI
	1	52	III	Se
	3	35	III	Te
	21	13	II	Te
20	2	48	I	ED
	23	55	I	SI
21	0	20	I	TI
	2	12	I	Se
	2	36	I	Te
	21	16	I	ED
	23	55	I	OR
22	21	02	I	Te
25	0	59	II	ED
	4	26	II	OR
26	2	26	III	SI
	3	37	III	TI
	20	08	II	SI
	20	15	IV	Se
	20	40	II	TI
	22	13	IV	Te
	22	58	II	Se
	23	27	II	Te
27	4	42	I	ED
28	1	50	I	SI
	2	04	I	TI
	4	07	I	Se
	4	20	I	Te
	23	11	I	ED
29	1	38	I	OR
	20	19	I	SI
	20	30	I	TI
	20	34	III	OR
	22	36	I	Se
	22	46	I	Te
30	20	04	I	OR

SEPTEMBER

d	h	m	Sat.	Phen.
1	3	36	II	ED
2	22	44	II	SI
	22	54	II	TI
3	1	34	II	Se
	1	41	II	Te
4	1	20	IV	ED
	3	45	I	SI
	3	47	I	TI
	5	10	IV	OR
	19	49	II	OR
5	1	05	I	ED
	3	22	I	OR
	20	30	III	ED
	22	13	I	TI
	22	14	I	SI
	23	55	III	ER
6	0	29	I	Te
	0	30	I	Se
	19	33	I	OD
	21	50	I	ER
10	1	07	II	TI
	1	20	II	SI
	3	54	II	Te
	4	09	II	Se
11	22	24	II	ER
12	2	50	I	OD
	5	16	I	ER
	23	47	III	OD
	23	57	I	TI
13	0	09	I	SI
	2	13	I	Te
	2	25	I	Se
	3	56	III	ER
	21	16	I	OD
	23	45	I	ER
14	20	39	I	Te
	20	54	I	Se
17	3	21	II	TI
	3	56	II	SI
18	21	28	II	OD
19	1	02	II	ER
	4	34	I	OD
20	1	41	I	TI
	2	04	I	SI
	3	03	III	OD
	3	58	I	Te
	4	21	I	Se
	19	16	II	Te
	19	28	IV	OR
	19	36	IV	ED
	20	03	II	Se
	23	00	I	OD
	23	18	IV	ER
21	1	39	I	ER
	20	08	I	TI
	20	32	I	SI
	22	24	I	Te
	22	49	I	Se
22	20	08	I	ER
23	20	01	III	Te
	21	56	III	Se
25	23	44	II	OD
26	3	40	II	ER
27	3	26	I	TI
	3	59	I	SI

d	h	m	Sat.	Phen.
27	19	51	II	SI
	21	31	II	Te
	22	38	II	Se
28	0	45	I	OD
	3	34	I	ER
	21	53	I	TI
	22	28	I	SI
	23	35	IV	TI
29	0	09	I	Te
	0	44	I	Se
	2	48	IV	Te
	19	11	I	OD
	22	03	I	ER
30	19	13	I	Se
	20	03	III	TI
	22	35	III	SI
	23	22	III	Te

OCTOBER

d	h	m	Sat.	Phen.
1	1	57	III	Se
3	2	02	II	OD
4	21	01	II	TI
	22	27	II	SI
	23	48	II	Te
5	1	14	II	Se
	2	30	I	OD
	23	39	I	TI
6	0	23	I	SI
	1	55	I	Te
	2	40	I	Se
	19	37	II	ER
	20	57	I	OD
	23	58	I	ER
7	18	52	I	SI
	20	22	I	Te
	21	09	I	Se
	23	26	III	TI
8	2	37	III	SI
	2	47	III	Te
	18	27	I	ER
11	20	00	III	ER
	23	20	II	TI
	1	03	II	SI
	2	07	II	Te
13	1	26	I	TI
	2	19	I	SI
	22	15	II	ER
	22	44	I	OD
14	1	53	I	ER
	19	53	I	TI
	20	48	I	SI

d	h	m	Sat.	Phen.
14	22	09	I	Te
	23	04	I	Se
15	20	22	I	ER
	23	30	IV	SI
18	20	02	III	OR
	20	40	III	ED
19	0	02	III	ER
	1	41	II	TI
20	19	56	II	OD
21	0	31	I	OD
	0	54	II	ER
	21	41	I	TI
	22	44	I	SI
	23	58	I	Te
22	1	00	I	Se
	18	59	I	OD
	19	42	II	Se
	22	17	I	ER
23	18	25	I	Te
	19	28	I	Se
	22	03	IV	OD
24	1	45	IV	OR
25	20	13	III	OD
	23	37	III	OR
26	0	42	III	ED
27	22	21	II	OD
28	23	31	I	TI
29	0	39	I	SI
	1	47	I	Te
	18	01	III	Se
	19	33	II	SI
	20	03	II	Te
	20	48	I	OD
	22	18	II	Se
30	0	12	I	ER
	17	59	I	TI
	19	08	I	SI
	20	15	I	Te
	21	24	I	Se
31	18	41	I	ER

NOVEMBER

d	h	m	Sat.	Phen.
1	17	52	IV	SI
	20	57	IV	Se
	23	52	III	OD
4	0	50	II	OD
5	18	46	III	SI
	19	44	II	TI
	22	03	III	Se
	22	09	II	SI
	22	30	II	Te

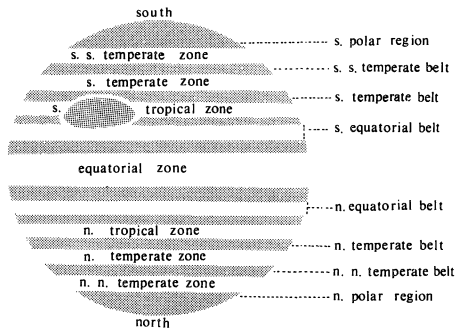
d	h	m	Sat.	Phen.
5	22	39	I	OD
6	0	54	II	Se
	19	50	I	TI
	21	04	I	SI
	22	06	I	Te
	23	20	I	Se
7	19	32	II	ER
	20	36	I	ER
8	17	49	I	Se
9	18	16	IV	OR
12	17	35	III	TI
	20	58	III	Te
	22	13	II	TI
	22	49	III	SI
13	0	31	I	OD
	0	45	II	SI
	0	59	II	Te
	21	43	I	TI
	23	00	I	SI
	23	59	I	Te
14	18	59	I	OD
	22	10	II	ER
	22	31	I	ER
15	17	29	I	SI
	18	27	I	Te
	19	45	I	Se
17	23	13	IV	TI
19	21	27	III	TI
20	23	37	I	TI
21	19	13	II	OD
	20	52	I	OD
22	18	05	I	TI
	19	25	I	SI
	20	22	I	Te
	21	41	I	Se
23	18	55	I	ER
	19	23	II	Se
	20	08	III	ER
26	20	51	IV	ED
	23	53	IV	ER
28	21	50	II	OD
	22	47	I	OD
29	20	01	I	TI
	21	22	I	SI
	22	17	I	Te
	23	37	I	Se
30	18	47	III	OR
	19	15	II	SI
	19	22	II	Te
	20	51	I	ER
	20	53	III	ED
	21	59	II	Se

DECEMBER

d	h	m	Sat.	Phen.
1	18	06	I	Se
4	17	13	IV	TI
	20	56	IV	Te
6	21	57	I	TI
	23	18	I	SI
7	19	11	I	OD
	19	13	II	TI
	19	25	III	OD
	21	51	II	SI
	21	59	II	Te
	22	46	I	ER
	22	51	III	OR
8	17	47	I	SI
	18	43	I	Te
	20	02	I	Se
9	17	15	I	ER
	19	26	II	ER
11	18	12	III	Se
13	18	01	IV	ER
14	21	08	I	OD
	21	52	II	TI
15	18	24	I	TI
	19	43	I	SI
	20	40	I	Te
	21	58	I	Se
16	19	10	I	ER
	22	05	II	ER
18	19	02	III	SI
	22	14	III	Se
22	20	22	I	TI
	21	39	I	SI
23	17	35	I	OD
	19	16	II	OD
	21	05	I	ER
24	17	08	I	Te
	18	23	I	Se
25	17	56	III	TI
	19	05	II	Se
	21	20	III	Te
29	21	36	IV	OD
	22	22	I	TI
30	19	34	I	OD
	22	02	II	OD
31	18	04	I	SI
	19	08	I	Te
	20	19	I	Se
32	17	30	I	ER
	18	57	II	SI

JUPITER'S BELTS AND ZONES

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



COMET KOHOUTEK (1973 F)

The appearance of a bright comet is a rare and usually unexpected event. However, on March 7, 1973, astronomer Lubos Kohoutek discovered a faint comet which, according to predictions, should become truly spectacular by Christmas 1973. The nine months advance warning has given professional astronomers an unprecedented opportunity to plan a variety of observations of this comet. Amateurs too can contribute useful observations—in particular, visual and photographic observations of the brightness, dimensions and appearance of the comet.

By October, the comet should be visible in a small telescope in the south-eastern sky before sunrise, moving through Sextans into northern Crater. In November, it should be visible to the naked eye, moving through Virgo and passing about 10° south of Spica late in the month. In December, it should brighten rapidly, approaching the sun, passing perihelion on Dec. 28, and moving into the evening sky. In January, it should be very conspicuous in the south-western sky after sunset, passing from Capricorn through Aquarius into Pisces. By February it will be in Aries, gradually fading in brightness.

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 kilometres 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 1974.

An observer located away from city lights and with perfect sky conditions will see an overall average of 7 sporadic meteors per hour apart from the shower meteors. These have been included in the hourly rates listed in the table. Slight haze or nearby lighting will greatly reduce the number of meteors seen. More meteors appear in the early morning hours than in the evening, and more during the last half of the year than during the first half.

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, Ontario, K1A 0R8. 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 1974

Shower	Shower Maximum			Radiant				Single Observer Hourly Rate	Velocity	Normal Duration to 1/4 strength of Max.
				Position at Max.		Daily Motion				
	Date	E.S.T.	Moon	R.A.	Dec.	R.A.	Dec.			
		h		h m	°	m	°		km/sec	days
Quadrantids	Jan. 3	10	F.Q.	15 28	+50	—	—	40	41	1.1
Lyrids	Apr. 22	10	N.M.	18 16	+34	+4.4	0.0	15	48	2
η Aquarids	May 5	12	F.M.	22 24	00	+3.6	+0.4	20	64	3
δ Aquarids	July 29	08	F.Q.	22 36	−17	+3.4	+0.17	20	40	—
Perseids	Aug. 12	12	L.Q.	03 04	+58	+5.4	+0.12	50	60	4.6
Orionids	Oct. 21	15	F.Q.	06 20	+15	+4.9	+0.13	25	66	2
Taurids	Nov. 4	—	L.Q.	03 32	+14	+2.7	+0.13	15	28	—
Leonids	Nov. 17	07	N.M.	10 08	+22	+2.8	−0.42	15	72	—
Geminids	Dec. 14	05	N.M.	07 32	+32	+4.2	−0.07	50	35	2.6
Ursids	Dec. 22	20	F.Q.	14 28	+76	—	—	15	34	2

SATURN AND ITS SATELLITES

BY TERENCE DICKINSON

Saturn, with its system of rings, is a unique sight through a telescope. There are three rings. The outer ring A has an outer diameter 169,000 miles. It is separated from the middle ring B by Cassini's gap, which has an outer diameter 149,000 miles, and an inner diameter 145,000 miles. The inner ring C, also known as the dusky or crape ring, has an outer diameter 112,000 miles and an inner diameter 93,000 miles. Evidence for a fourth, innermost ring has been found; this ring is very faint.

Saturn exhibits a system of belts and zones with names and appearances similar to those of Jupiter (see diagram pg. 72).

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.

ELONGATIONS OF SATURN'S SATELLITES, E.S.T.

JANUARY

d	h	Sat.	Elong.
1	13.3	Rh	E
3	17.1	Ti	W
6	01.6	Rh	E
9	09.4	Ia	W
10	13.9	Rh	E
11	20.4	Ti	E
15	02.2	Rh	E
19	14.5	Rh	E
19	14.6	Ti	W
24	02.8	Rh	E
27	17.9	Ti	E
28	15.2	Rh	E

FEBRUARY

d	h	Sat.	Elong.
2	03.5	Rh	E
4	12.3	Ti	W
6	15.9	Rh	E
11	04.3	Rh	E
12	15.8	Ti	E
15	16.7	Rh	E
17	11.2	Ia	E
20	05.1	Rh	E
20	10.5	Ti	W
24	17.5	Rh	E
28	14.2	Ti	E

MARCH

d	h	Sat.	Elong.
1	05.9	Rh	E
5	18.4	Rh	E
8	09.3	Ti	W
10	06.8	Rh	E
14	19.3	Rh	E
16	13.3	Ti	E
19	07.8	Rh	E
23	20.2	Rh	E
24	08.6	Ti	W
28	08.8	Rh	E
29	11.3	Ia	W

APRIL

d	h	Sat.	Elong.
1	12.9	Ti	E
1	21.3	Rh	E
6	09.8	Rh	E
9	08.4	Ti	W
10	22.3	Rh	E
15	10.9	Rh	E
17	13.0	Ti	E
19	23.4	Rh	E
24	12.0	Rh	E
25	08.6	Ti	W
29	00.6	Rh	E

MAY

d	h	Sat.	Elong.
3	13.1	Rh	E
3	13.6	Ti	E
8	01.7	Rh	E
8	18.1	Ia	E
11	09.1	Ti	W
12	14.3	Rh	E
17	02.9	Rh	E
19	14.4	Ti	E
21	15.5	Rh	E

Saturn being near the sun, elongations are not given between May 21 and August 6.

AUGUST

d	h	Sat.	Elong.
6	13.8	Rh	E
7	20.0	Ti	E
11	02.4	Rh	E
15	14.5	Ti	W
15	15.0	Rh	E
20	03.6	Rh	E
23	20.8	Ti	E
24	16.2	Rh	E
29	04.7	Rh	E
31	15.0	Ti	W

SEPTEMBER

d	h	Sat.	Elong.
2	17.3	Rh	E
7	05.8	Rh	E
7	19.9	Ia	W
8	21.2	Ti	E
11	18.3	Rh	E
16	06.9	Rh	E
16	15.2	Ti	W
20	19.4	Rh	E
24	21.3	Ti	E
25	07.9	Rh	E
29	20.4	Rh	E

OCTOBER

d	h	Sat.	Elong.
2	15.0	Ti	W
4	08.9	Rh	E
8	21.4	Rh	E
10	20.9	Ti	E
13	09.8	Rh	E
17	22.3	Rh	E
18	07.2	Ia	E
18	14.3	Ti	W
22	10.7	Rh	E
26	20.0	Ti	E
26	23.1	Rh	E
31	11.6	Rh	E

NOVEMBER

d	h	Sat.	Elong.
3	13.2	Ti	W
5	00.0	Rh	E
9	12.3	Rh	E
11	18.5	Ti	E
14	00.7	Rh	E
18	13.1	Rh	E
19	11.5	Ti	W
23	01.5	Rh	E
26	12.9	Ia	W
27	13.8	Rh	E
27	16.5	Ti	E

DECEMBER

d	h	Sat.	Elong.
2	02.1	Rh	E
5	09.3	Ti	W
6	14.5	Rh	E
11	02.8	Rh	E
13	14.1	Ti	E
15	15.1	Rh	E
20	03.4	Rh	E
21	06.8	Ti	W
24	15.7	Rh	E
29	04.0	Rh	E
29	11.3	Ti	E
35	21.6	Ia	E

TABLE OF PRECESSION FOR 50 YEARS

If Declination is positive, use inner R.A. scale; if declination is *negative*, use *outer* R.A. scale, and *reverse the sign of the precession in declination*

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 30	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	Con.	R.A.	Name	Con.	R.A.
Acamar, ā′*ka*-mär	θ Eri	02	Gienah, jē′*na*	γ Crv	12
Achernar, ā′kēr-när	α Eri	01	Hadar, hăd′ăr	β Cen	14
Acrux, ā′krŭks	α Cru	12	Hamal, hăm′ăl	α Ari	02
Adhara, *a*-dā′*ra*	ε CMa	06	Kaus Australis,		
Al Na'ir, ăl-nâr′	α Gru	22	kôs ôs-trā′lĭs	ε Sgr	18
Albireo, ăl-bĭr′ē-ō	β Cyg	19	Kochab, kō′kăb	β UMi	14
Alcyone, ăl-sī′ō-nē	η Tau	03	Markab, mär′kăb	α Peg	23
Aldebaran, ăl-dĕb′*a-ran*	α Tau	04	Megrez, mē′grĕz	δ UMa	12
Alderamin, ăl-dĕr′*a*-mĭn	α Cep	21	Menkar, mĕn′kär	α Cet	03
Algenib, ăl-jē′nĭb	γ Peg	00	Menkent, mĕn′kĕnt	θ Cen	14
Algol, ăl′gŏl	β Per	03	Merak, mē′răk	β UMa	10
Alioth, ăl′ĭ-ŏth	ε UMa	12	Miaplacidus,		
Alkaid, ăl-kād′	η UMa	13	mī′*a*-plăs′ĭ-d*us*	β Car	09
Almach, ăl′măk	γ And	02	Mira, mī′*ra*	ο Cet	02
Alnilam, ăl-nī′lăm	ε Ori	05	Mirach, mī′răk	β And	01
Alphard, ăl′färd	α Hya	09	Mirfak, mĭr′făk	α Per	03
Alphecca, ăl-fĕk′*a*	α CrB	15	Mizar, mī′zär	ζ UMa	13
Alpheratz, ăl-fē′răts	α And	00	Nunki, nŭn′kē	σ Sgr	18
Altair, ăl-târ′	α Aql	19	Peacock	α Pav	20
Ankaa	α Phe	00	Phecda, fĕk′*da*	γ UMa	11
Antares, ăn-tā′rēs	α Sco	16	Polaris	α UMi	01
Arcturus, ärk-tū′r*ŭs*	α Boo	14	Pollux, pŏl′*ŭ*ks	β Gem	07
Atria, ā′trĭ-*a*	α TrA	16	Procyon, prō′sĭ-ŏn	α CMi	07
Avior, ä-vĭ-ôr′	ε Car	08	Ras-Algethi, rås′*ăl*-jē′the	α Her	17
Bellatrix, bĕ-lā′trĭks	γ Ori	05	Rasalhague, rås′*ăl*-hā′gwē	α Oph	17
Betelgeuse, bĕt′*el*-juz	α Ori	05	Regulus, rĕg′u-l*ŭs*	α Leo	10
Canopus, k*a*-nō′p*ŭs*	α Car	06	Rigel, rī′*jel*	β Ori	05
Capella, k*a*-pĕl′*a*	α Aur	05	Rigil Kentaurus		
Caph, kăf	β Cas	00	rī′jĭl kĕn-tô′r*ŭs*	α Cen	14
Castor, kås′tĕr	α Gem	07	Sabik, sā′bĭk	η Oph	17
Deneb, dĕn′ĕb	α Cyg	20	Scheat, shē′ăt	β Peg	23
Denebola, dē-nĕb′ō-l*a*	β Leo	11	Schedar, shĕd′*ar*	α Cas	00
Diphda, dĭf′d*a*	β Cet	00	Shaula, shô′l*a*	λ Sco	17
Dubhe, dŭb′ē	α UMa	11	Sirius, sĭr′ĭ-*ŭs*	α CMa	06
Elnath, ĕl′năth	β Tau	05	Spica, spī′k*a*	α Vir	13
Eltanin, ĕl-tā′nĭn	γ Dra	17	Suhail, sŭ-hāl′	λ Vel	09
Enif, ĕn′ĭf	ε Peg	21	Vega, vē′g*a*	α Lyr	18
Fomalhaut, fō′m*ăl*-ôt	α PsA	22	Zubenelgenubi,		
Gacrux, gā′krŭks	γ Cru	12	zōō-bĕn′ĕl-jē-nū′bē	α Lib	14

Pronunciations are generally as given by G. A. Davis, *Popular Astronomy*, **52**, 8 (1944). Key to pronunciation on p. 5.

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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 h m	Dec. ° ′	*V*	*B–V*	Type	π ″	M_V	D l.y.	μ ″	R 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 *Algo*
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 h m	Dec. ° ′	V	$B-V$	Type	π ″	M_V	D l.y.	μ ″	R 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 h m	Dec. ° °	V	$B-V$	Type	π	M_V	D	μ	R	
						″		l.y.	″	km./sec.	
ν Pup	06 36.8	−43 10	3.19	−0.10	*B7 III*		−3.2	620	0.010	+28.2	
ε Gem	42.1	+25 10	3.00	+1.39	G8 Ib	0.009	−4.6	1080	0.016	+09.9	
ξ Gem	43.6	+12 56	3.38	+0.43	F5 IV	0.051	+1.9	64	0.224	+25.3	
α CMa *A*	43.8	−16 41	−1.42	+0.01	A1 V	0.375	+1.45	8.7	1.324	*−07.6*	*B* 8.66^m 1960: 9″, θ = 90° ***Sirius***
α Pic	48.1	−61 54	3.27	+0.21	*A5 V*		+2.1	57	0.272	+20.6	
τ Pup	49.2	−50 35	2.97	+1.17	*K0 III*		+0.1	124	0.079	*+36.4*	
ε CMa *A*	57.4	−28 56	1.48:	−0.18:	B2 II		−5.1	680	0.004	+27.4	*B* 7.5^m 8″ ***Adhara***
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, 141^d
π Pup	16.1	−37 03	2.81	+1.56:	(gK4)	0.023	−0.3	140	0.008	+15.8	
η CMa	22.9	−29 14	2.46	−0.08	B5 Ia		−7.1	2700	0.008	+41.1	
β CMi	25.7	+08 21	2.91	−0.09	B7 V	0.020	−1.1	210	0.065	+22	
σ Pup *A*	28.3	−43 14	3.28	+1.49	(gK5)	0.013	−0.4	180	0.195	*+88.1*	*B* 9.4^m 22″
α Gem *A*	32.7	+31 57	1.97	+0.00:	A1 V	0.072	+1.3	45	0.199	+06.0	5″, *B–V*+0.02, *C* 9.08v^m 73″ ***Castor***
α Gem *B*	32.7	+31 57	2.95	+0.07:	A5m	0.072	+2.3	45	0.199	−01.2	
α CMi *A*	37.7	+05 18	0.37	+0.41	F5 IV–V	0.288	+2.7	11.3	1.250	−03.2	*B* 10.7^m 5″ ***Procyon***
β Gem	43.5	+28 06	1.16	+1.02	K0 III	0.093	+1.0	35	0.625	+03.3	***Pollux***
ξ Pup	48.0	−24 48	3.34	+1.23	G3 Ib	−.003	−4.6	1240	0.005	*+02.7*	
χ Car	56.0	−52 54	3.48	−0.18	(B3)		−2.1	430	0.039	+19.1	
ζ Pup	08 02.5	−39 55	2.23	−0.26	O5f		*−7.1*	2400	0.033	−24	
ρ Pup	06.3	−24 13	2.80v	+0.42	F6 IIp	0.031	+0.3:	105:	0.098	+46.6	Var. *R* 2.72–2.87
γ Vel *A*	08.6	−47 16	1.88	−0.26	*WC7*		−4.1	520	0.011	+35	*B* 4.31^m 41″
ε Car	21.9	−59 24	1.97	+1.14:	(K0 + B)		−3.1:	340	0.030	+11.5	***Avior***
o UMa *A*	27.8	+60 49	3.37	+0.83	G5 III	0.004	+0.1	150	0.171	+19.8	*B* 15^m 7″
δ Vel *AB*	43.9	−54 36	1.95	+0.05	*A0 V*	0.043	+0.2	76	0.086	+02.2	*A* 2.0^m *B* 5.1^m 3″ *CD* 10^m 69″
ε Hya *ABC*	45.2	+06 32	3.39	+0.68	G0 comp.	0.010	+0.6	140	0.198	*+36.4*	*A*3.7^m*B*5.2^{m}0.2″15^y,*C*6.8^{m}3″*D*12^{m}20″
ζ Hya	53.8	+06 04	3.11	+1.00	K0 II–III	0.029	−1.1	220	0.101	+22.8	
ι UMa *A*	57.2	+48 09	3.12	+0.19	A7 V	0.066	*+2.2*	49	0.505	+12.2	*BC* 10.8^m 7″

Star	R.A. 1970 h m	Dec. ° ′	V	$B-V$	Type	π ″	M_V	D l.y.	μ ″	R 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 h m	Dec. ° ′	V	$B-V$	Type	π	M_V	D	μ	R	
						″		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	*Alkaip*
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 h m	Dec. ° ′	V	$B-V$	Type	π ″	M_V	D l.y.	μ ″	R 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* 0.7^m *B* 3.9^m 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* 3.19^m *B* 8.61^m 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* 2.47^m *B* 5.04^m 3″
α Lib *A*	49.2	−15 52	2.76	+0.15	A3m	0.049	+1.2	66	0.130	−10	*B* 5.15^m 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* 7.8^m 71″
δ Boo *A*	14.3	+33 26	3.47	+0.95	G8 III	0.028	+0.3	140	0.148	−12.2	*B* 7.84^m 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* 3.5^m *B* 3.7^m 1″
α CrB	33.4	+26 49	2.23v	−0.02	A0 V	0.043	+0.4	76	0.154	*+01.7*	Ecl. *R* 0.11^m, 17.4^d ***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* 3.47^m *B* 7.70^m 15″
δ Sco	58.6	−22 32	2.34	−0.13	B0 V		−4.0	590	0.032	−14	

Star	R.A. 1970 h m	Dec. ° ′	*V*	*B–V*	Type	π ″	M_V	D l.y.	μ ″	R 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 h m	Dec. ° ′	V	$B-V$	Type	π	M_V	D	μ	R	
						″		l.y.	″	km./sec.	
κ Sco	17 40.4	−39 01	2.39	−0.21	*B2 IV*		−3.4	470	0.031	−10	
β Oph	42.0	+04 35	2.77	+1.16	K2 III	0.023	−0.1	124	0.160	−12.0	
μ Her *A*	45.3	+27 45	3.42	+0.75	G5 IV	0.108	+3.6	30	0.811	−15.6	*BC* 9.78^m 33″
ι^1 Sco	45.5	−40 06	2.99	+0.49	F2 Ia	0.013	−7.1	3400	0.004	*−27.6*	
G Sco	47.7	−37 02	3.21	+1.18	(gK1)	0.032	+0.7	102	0.064	+24.7	
γ Dra	55.9	+51 29	2.21	+1.52	K5 III	0.017	−0.4	108	0.026	−27.6	*Eltanin*
ν Oph	57.4	−09 47	3.32	+1.00	G9 III	0.015	+0.2	140	0.118	+12.4	
γ Sgr	18 03.9	−30 26	2.97	+1.00	*K0 III*	0.018	+0.1	124	0.200	*+22.1*	
η Sgr *A*	15.6	−36 47	3.17	+1.55	*M3 II*	0.038	+1.1:	86:	0.218	+00.5	*B* 10^m 4″
δ Sgr	19.1	−29 50	2.71	+1.39	*K2 III*	0.039	+0.7	84	0.050	−20.0	
η Ser	19.7	−02 54	3.23	+0.94	K0 III–IV	0.054	+1.9	60	0.894	+08.9	
ε Sgr	22.2	−34 24	1.81	−0.02	*B9 IV*	0.015	−1.1	124	0.135	−11	*Kaus Australis*
λ Sgr	26.1	−25 27	2.80	+1.05	*K2 III*	0.046	+1.1	71	0.194	−43.3	
α Lyr	35.9	+38 45	0.04	0.00	A0 V	0.123	+0.5	26.5	0.345	−13.9	***Vega***
φ Sgr	43.8	−27 02	3.20	−0.11	*B8 III*		−3.1	590	0.052	+21.5	
β Lyr *A*	49.0	+33 20	3.38v	−0.05:	Bpe	−.011	−4.6	1300	0.007	*−19.2*	Ecl. *R* 3.38–4.36, 12.9^d, *B* 7.8^m 46″
*i*σ Sgr	53.4	−26 20	2.12	−0.21	B2 V		−2.7	300	0.059	−11	*Nunk*
ξ^2 Sgr	55.9	−21 08	3.51	+1.18:	(gK1)	0.006	+0.0	160	0.035	−19.9	
γ Lyr	57.8	+32 39	3.25	−0.05	B9 III	0.011	−2.1	370	0.007	−21.5	
ζ Sgr *AB*	19 00.7	−29 55	2.61	+0.08	*A2 IV*	0.020	+0.1	140	0.020	+22	*A* 3.3^m *B* 3.5^m 1″
ζ Aql *A*	04.0	+13 49	2.99	+0.01	A0 V:nn	0.036	+0.8	90	0.101	−26.3	*B* 12^m 5″
λ Aql	04.7	−04 56	3.44	−0.07	B9: V:n	0.025	−0.1	160	0.092	−14	
τ Sgr	05.1	−27 43	3.30	+1.18	(gK1)	0.038	+1.2	86	0.261	*+45.4*	
π Sgr *ABC*	08.0	−21 04	2.89	+0.35	F2 II–III	0.016	−0.7	250	0.040	−09.8	*A* 3.7^m *B* 3.8^m *C* 6.0^m < 1″
δ Dra	12.5	+67 37	3.06	+1.00	G9 III	0.028	+0.2	124	0.130	+24.8	
δ Aql	24.0	+03 03	3.38	+0.31	F0 IV	0.062	+2.3	53	0.267	*−29.9*	
β Cyg *A*	29.5	+27 54	3.07	+1.12	K3 II:+B:	0.004	−2.4	410	0.009	−24.0	*B* 5.11^m 35″ *Albireo*
δ Cyg *AB*	44.0	+45 04	2.87	−0.03	B9.5 III	0.021	−1.7	270	0.060	−21	*A* 2.91^m *B* 6.44^m 2″
γ Aql	44.8	+10 32	2.67	+1.48	K3 II	0.006	−2.4	340	0.012	−02.1	
α Aql	49.3	+08 47	0.77	+0.22	A7 IV, V	0.198	+2.2	16.5	0.658	−26.3	***Altair***

Star	R.A. 1970	Dec.	V	$B-V$	Type	π	M_V	D	μ	R	
	h m	° ′				″		l.y.	″	km./sec.	
θ Aql	20 09.8	−00 54	3.31	−0.07	B9.5 III	0.008	−1.7	330	0.034	*−27.3*	
β Cap *A*	19.3	−14 53	3.06	+0.76	comp.	0.005	+0.1	130	0.039	−18.9	Type gK0: + late B; *B* 5.97^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	

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 60 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.

The newest addition to the table is G158-27, which was reported in 1971 to have a parallax of 0″224. It is one of the faintest stars in the table, explaining why it has been unknown for so long, and indicating how difficult it is to be sure that all nearby stars have been detected.

Name	1970 α	1970 δ	π	D	Sp.	μ	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
G158-27	00 05	−07 41	.224	14.6	—	2.1	—	13.8	0.00005
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.

STAR ATLASES — ASTRONOMY BOOKS

Free science book catalogue

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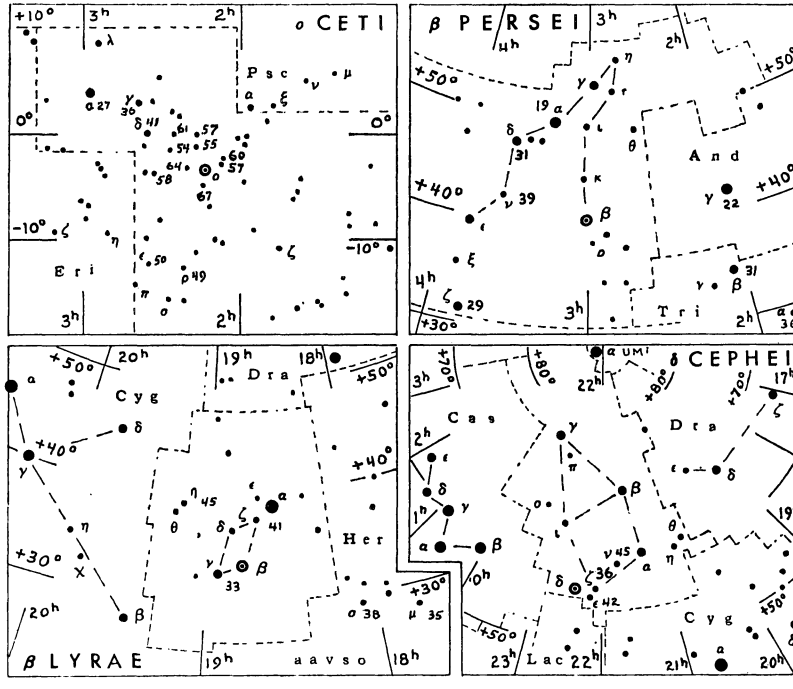
VARIABLE STARS

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*, 1973, International Supplement.



LONG-PERIOD VARIABLE STARS

Variable	Max. m	Per d	Epoch 1974	Variable	Max. m	Per d	Epoch 1974
001755 T Cas	7.8	445	Nov. 10	142539 V Boo	7.9	258	May 30
001838 R And	7.0	409	Aug. 23	143227 R Boo	7.2	223	Jan. 29
021143 W And	7.4	397	Oct. 7	151731 S CrB	7.3	361	Feb. 5
021*403* o Cet	3.4	332	Apr. 4	154639 V CrB	7.5	358	Nov. 4
0228*13* U Cet	7.5	235	Apr. 3	154615 R Ser	6.9	357	Sept. 28
023133 R Tri	6.2	266	Aug. 14	160625 RU Her	8.0	484	—
043065 T Cam	8.0	374	Nov. 21	162119 U Her	7.5	406	Mar. 27
0455*14* R Lep	6.8	432	Feb. 15	1621*12* V Oph	7.5	298	Feb. 21
050953 R Aur	7.7	459	May 28	163266 R Dra	7.6	245	Jan. 9
054920 U Ori	6.3	372	Aug. 2	164715 S Her	7.6	307	Aug. 27
061*702* V Mon	7.0	335	June 28	1702*15* R Oph	7.9	302	Apr. 30
065355 R Lyn	7.9	379	Mar. 14	171723 RS Her	7.9	219	Mar. 3
070122aR Gem	7.1	370	June 20	180531 T Her	8.0	165	May 8
070310 R CMi	8.0	338	Oct. 25	181136 W Lyr	7.9	196	Feb. 23
072708 S CMi	7.5	332	June 19	183308 X Oph	6.8	334	Apr. 2
081112 R Cnc	6.8	362	Dec. 29	190108 R Aql	6.1	300	Jan. 8
081617 V Cnc	7.9	272	Mar. 15	1910*17* T Sgr	8.0	392	Mar. 27
084803 S Hya	7.8	257	June 1	1910*19* R Sgr	7.3	269	Sept. 1
085*008* T Hya	7.8	288	Aug. 1	193449 R Cyg	7.5	426	—
093934 R LMi	7.1	372	Feb. 20	194048 RT Cyg	7.3	190	Mar. 3
094211 R Leo	5.8	313	Sept. 11	194632 χ Cyg	5.2	407	Mar. 21
103769 R UMa	7.5	302	Sept. 7	201647 U Cyg	7.2	465	July 21
1214*18* R Crv	7.5	317	Apr. 7	2044*05* T Aqr	7.7	202	Apr. 12
122001 SS Vir	6.8	355	Jan. 10	210868 T Cep	6.0	390	June 2
123160 T UMa	7.7	257	Aug. 27	213753 RU Cyg	8.0	234	May 9
123307 R Vir	6.9	146	Jan. 20	230110 R Peg	7.8	378	Jan. 30
123961 S UMa	7.8	226	Apr. 27	230759 V Cas	7.9	228	Jan. 10
131546 V CVn	6.8	192	Irr.	231508 S Peg	8.0	319	Mar. 5
132*706* S Vir	7.0	378	Jan. 1	2338*15* R Aqr	6.5	387	Dec. 12
134440 R CVn	7.7	328	Aug. 13	235350 R Cas	7.0	431	Sept. 27
142584 R Cam	7.9	270	Feb. 7	2357*15* W Cet	7.6	351	Apr. 4

OTHER TYPES OF VARIABLE STARS

Variable	Max. m	Min. m	Type	Sp. Cl.	Period d	Epoch 1974 E.S.T.
005381 U Cep	6.7	9.8	Ecl.	B8+gG2	2.49302	Jan. 3.31*
025838 ρ Per	3.3	4.0	Semi R	M4	33–55, 1100	—
030140 β Per	2.1	3.3	Ecl.	B8+G	2.86731	Jan. 3.09*
035512 λ Tau	3.5	4.0	Ecl.	B3	3.952952	Jan. 2.63*
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. 6.09
065820 ζ Gem	4.4	5.2	δ Cep	F7–G3	10.15172	Jan. 2.49
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.	—
184*205* R Sct	6.3	8.6	RVTau	G0e-K0p	144	—
184633 β Lyr	3.4	4.3	Ecl.	B8	12.931163	Jan. 8.32*
192242 RR Lyr	6.9	8.0	RR Lyr	A2–F1	0.5668223	Jan. 1.13
194700 η Aql	4.1	5.2	δ Cep	F6–G4	7.176641	Jan. 7.728
222557 δ Cep	4.1	5.2	δ Cep	F5–G2	5.366341	Jan. 5.88

*Minimum.

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 1974. 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 and of The Nearest Stars.)

Star	A.D.S.	R.A. 1970 h	m	Dec. 1970 °	′	Magnitudes comb.	A	B	Sep. 1974.0 ″	P.A. 1974.0 °	P (app.) years
λ Cas	434	00	30.1	+54	22	4.9	5.5	5.8	0.6	180	640
α Psc	1615	02	00.4	+02	37	4.0	4.3	5.3	1.8	285	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	247	1100
Σ 1338	7307	09	19.2	+38	19	5.8	6.5	6.7	1.1	244	220
35 Com	8695	12	51.8	+21	25	5.1*	5.2	7.4	1.0	157	510
Σ 2054	10052	16	23.3	+61	45	5.6	6.0	7.2	1.1	355	—
ε¹ Lyr†	11635	18	43.4	+39	39	5.1	5.4	6.5	2.7	357	1200
ε² Lyr†	11635	18	43.4	+39	36	4.4	5.1	5.3	2.3	86	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	11.7	304	480
Σ 186	1538	01	54.3	+01	42	6.0	6.8	6.8	1.3	53	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	61	50
α Gem	6175	07	32.7	+31	58	1.6	2.0	2.8	1.9	115	420
ζ Cnc AB	6650	08	10.4	+17	44	5.0	5.6	5.9	1.0	313	60
ζ Cnc AC	6650	08	10.4	+17	44	5.2	5.4	7.3	5.9	84	1150
+42° 1956	KUI	08	58.7	+41	53	3.9	4.1	6.2	0.4	134	22
γ Leo	7724	10	18.3	+20	00	1.8	2.1	3.4	4.3	123	620
ξ U Ma AB	8119	11	16.7	+31	42	3.8	4.3	4.8	3.1	117	60
γ Vir	8630	12	40.1	−01	18	2.8	3.5	3.5	4.3	301	170
Σ 1785	9031	13	47.7	+27	08	7.0	7.6	8.0	3.3	155	155
ζ Boo	9343	14	39.8	+13	52	3.8	4.5	4.5	1.1	306	125
ξ Boo	9413	14	50.0	+19	14	4.5	4.7	6.8	7.2	337	150
ζ Her	10157	16	40.2	+31	39	2.8	2.9	5.5	1.1	189	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	0.3	112	46
70 Oph	11046	18	03.9	+02	32	4.0	4.2	6.0	1.9	22	88
β 648	11871	18	56.0	+32	52	5.2	5.4	7.5	0.6	84	60
4 Aqr	14360	20	49.9	−05	45	6.0	6.4	7.2	1.0	10	150
τ Cyg	14787	21	13.6	+37	54	3.7	3.8	6.4	1.0	171	50
Σ 3050	17149	23	57.9	+33	34	5.8	6.5	6.7	1.6	299	800

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

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 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), usually as given by Becker and Fenkart (1971); Sp, the earliest spectral type of cluster stars as a mean determined from three colour photometry and directly from the stellar spectra. The spectral type indicates the age of the cluster, expressed in millions of years, thus: O5 = 2, B0 = 8, B5 = 70, A0 = 400, A5 = 1000, F0 = 3000 and F5 = 10000.

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

Open Clusters

NGC	α 1970 h m	δ ° ′	P	D	m	r	Sp	Remarks
188	00 41.0	+85 11	9.3	14	14.6	1.55	F2	oldest known
752	01 56.0	+37 32	6.6	45	9.6	0.38	A5	
869	02 16.9	+57 01	4.3	30	9.5	2.15	B1	h Per
884	02 20.3	+56 59	4.4	30	9.5	2.48	B0	χ Per, M supergiants
Perseus	03 20	+48 30	2.3	240	5	0.17	B1	moving cl., α Per
Pleiades	03 45.3	+24 02	1.6	120	4.2	0.125	B6	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	1.41	B5	
1976/80	05 33.9	−05 24	2.5	50	*5.5*	0.41	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*	1.62	O5	Rosette, very young
2264	06 39.4	+09 55	4.1	30	*8.0*	0.72	O8	S Mon
2287	06 45.8	−20 42	5.0	32	*8.8*	0.66	B4	M41
2362	07 17.6	−24 53	3.8	7	9.4	1.64	O9	τ CMa
2422	07 34.2	−14 26	4.3	30	9.8	0.48	B3	

*Basic for distance determination.

NGC	α 1970 h	m	δ °	′	P	D	m	r	Sp	Remarks
2437	07	40.4	−14	45	6.6	27	10.8	1.66	B8	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	B8	
2546	08	11.4	−37	33	5.0	45	7	0.84	B0	
2632	08	38.4	+20	06	3.9	90	7.5	0.158	A0	Praesepe, M44
IC2391	08	39.4	−52	57	2.6	45	3.5	0.15	B4	
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	B5	
IC2602	10	42.2	−64	14	1.6	65	6	0.15	B1	θ Car
Tr 16	10	44.0	−59	33	6.7	10	10	2.95	O5	η Car and Nebula
3532	11	05.1	−58	30	3.4	55	8.1	0.42	B8	
3766	11	34.7	−61	27	4.4	12	8.1	1.79	B1	
Coma	12	23.6	+26	16	2.9	300	5.5	0.08	A1	Very sparse cl.
4755	12	51.8	−60	10	5.2	12	7	2.10	B3	κ Cru, "jewel box"
6067	16	10.9	−54	08	6.5	16	10.9	1.45	B3	G and K supergiants
6231	16	51.9	−41	45	8.5	16	7.5	1.77	O9	O supergiants, WR-stars
Tr 24	16	54.9	−40	37	8.5	60	*7.3*	1.60	O5	
6405	17	38.1	−32	12	4.6	26	8.3	0.45	B4	M6
IC4665	17	45.2	+05	44	5.4	50	7	0.33	B8	
6475	17	51.9	−34	48	3.3	50	7.4	0.23	B5	M7
6494	17	55.1	−19	01	5.9	27	10.2	0.44	B8	M23
6523	18	01.3	−24	23	5.2	45	*7*	1.56	O5	M8, Lagoon neb. and very young cl. NGC6530
6611	18	17.2	−13	48	6.6	8	10.6	1.69	O7	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	1.70	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*	0.71	O6	Tr 37
7790	23	56.9	+61		7.1	4.5	11.7	3.16	B1	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 h ′	δ ° ′	Type	Size ′	S mag. sq″	m *	Dist. 10^3 l.y.	Remarks
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	

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) h m	δ ° ′	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, 4,500,000,000 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

EXTERNAL GALAXIES

BY S. VAN DEN BERGH

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

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

THE BRIGHTEST GALAXIES

NGC or name	M	α 1970 h m	δ ° ′	Type	m_{pg}	Dimensions ′ × ′	Distance millions of l.y.
55		00 13.5	−39 23	Sc or Ir	7.9	30×5	7.5
205		00 38.7	+41 32	E6p	8.89	12×6	2.1
221	32	00 41.1	+40 43	E2	9.06	3.4×2.9	2.1
224	31	00 41.1	+41 07	Sb I–II	4.33	163×42	2.1
247		00 45.6	−20 54	S IV	9.47	21×8.4	7.5
253		00 46.1	−25 27	Sep	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

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The Nearest Galaxies

Name	NGC	α 1970 h m	δ 1970 ° ′	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

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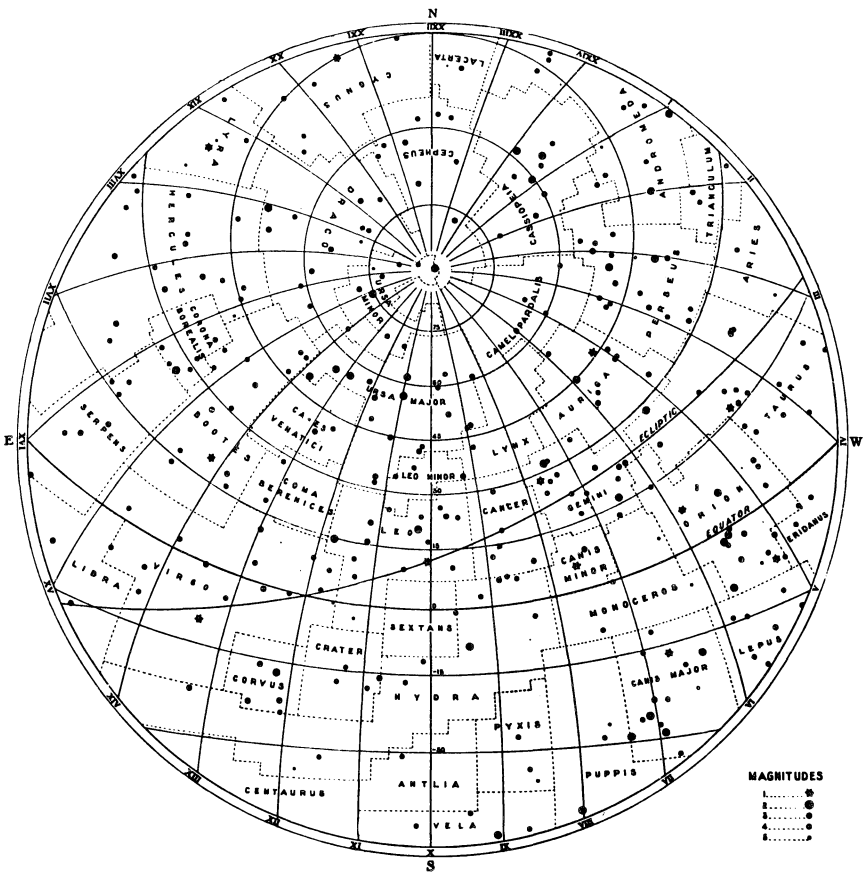
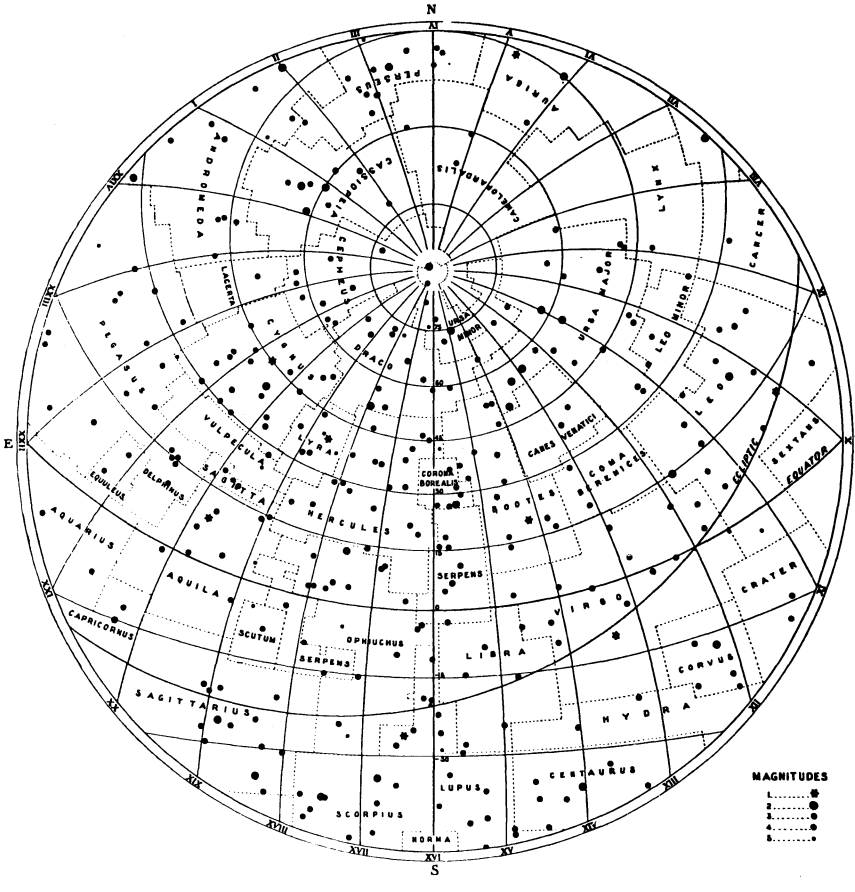


The above map represents the evening sky at

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

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

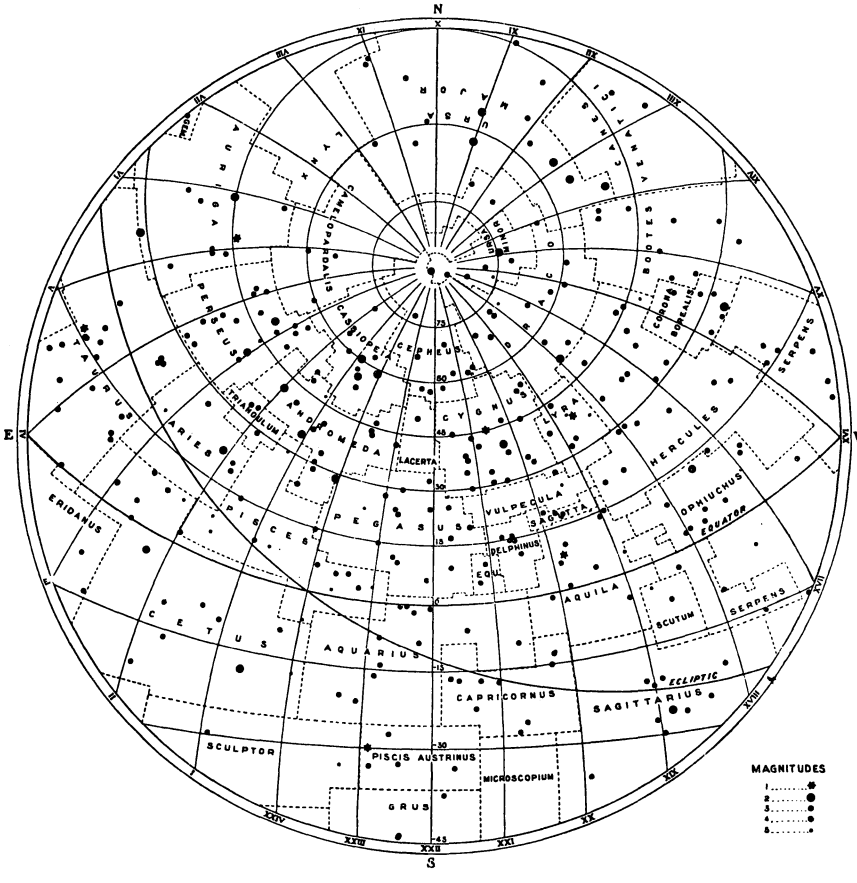


The above map represents the evening sky at

Midnight	.....	May 24
11 p.m.	.....	June 7
10 "	.....	" 22
9 "	.....	July 6
8 "	.....	" 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 3

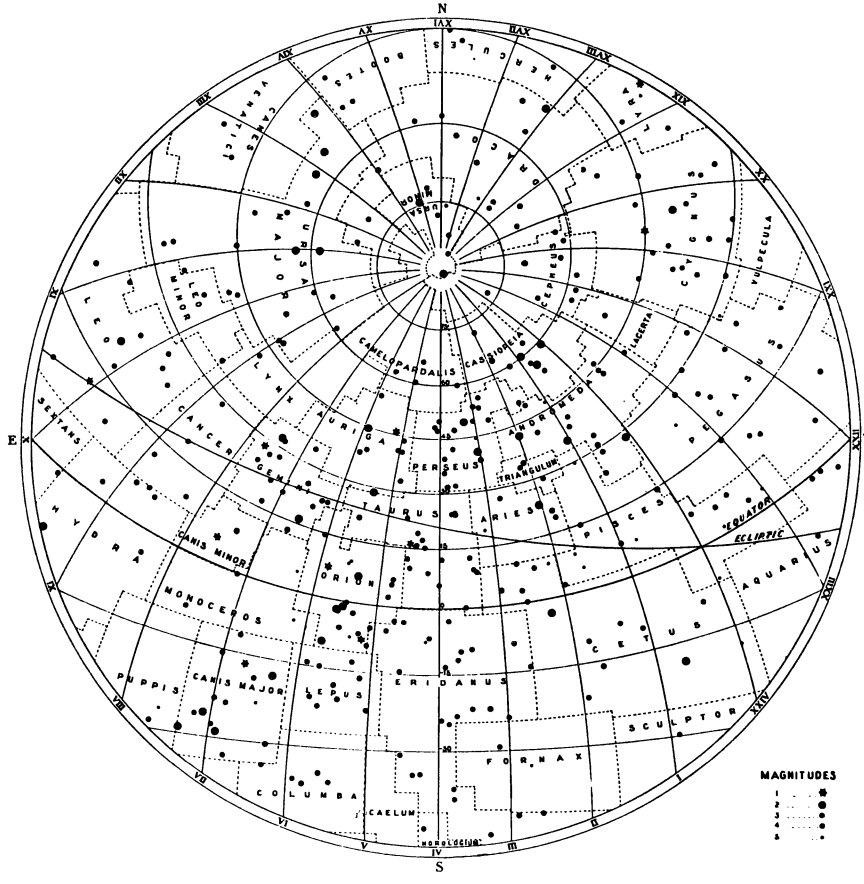


The above map represents the evening sky at

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

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.

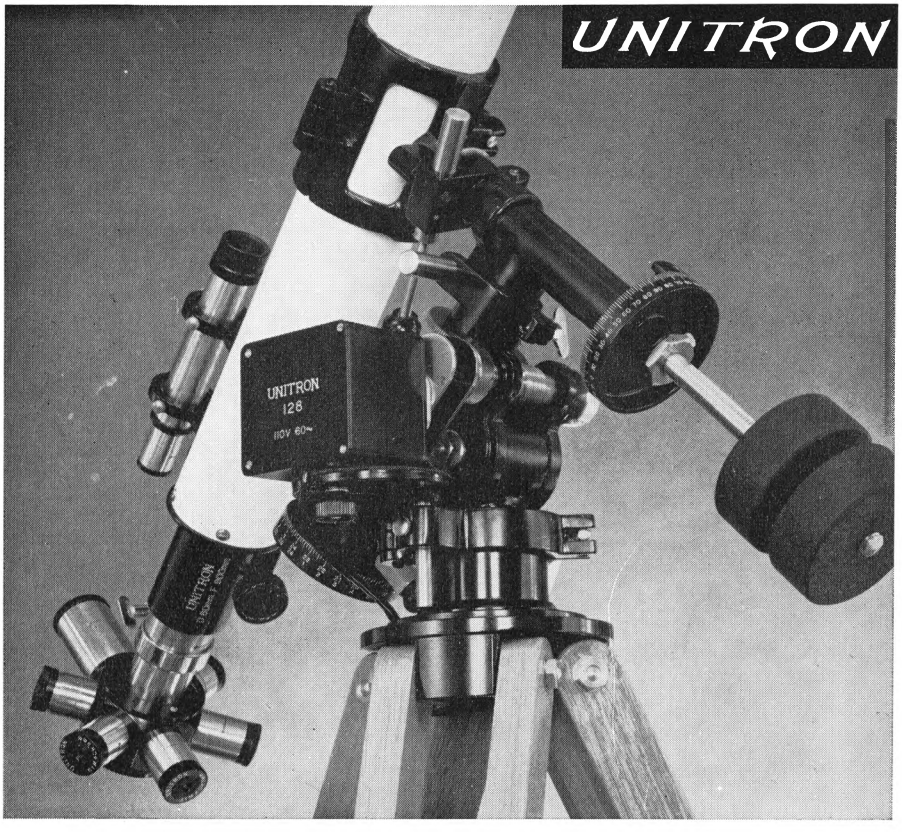
STAR MAP 4



The above map represents the evening sky at

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



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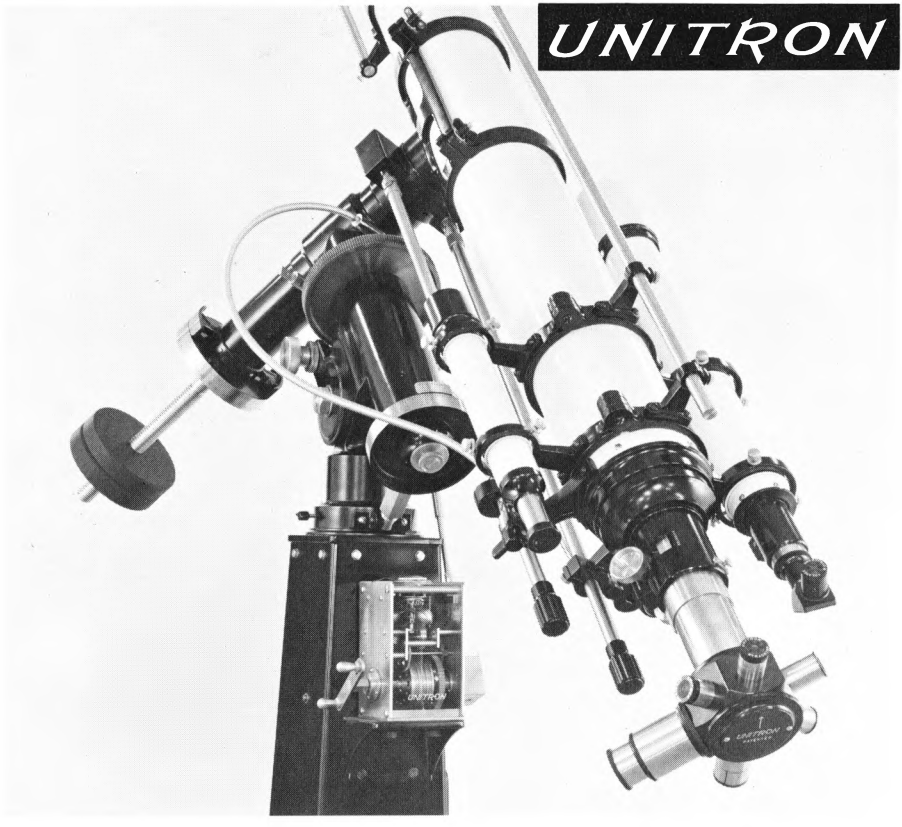

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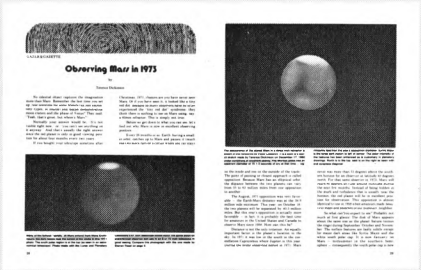

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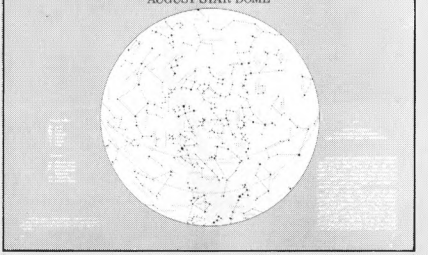

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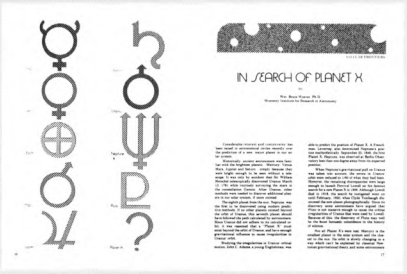

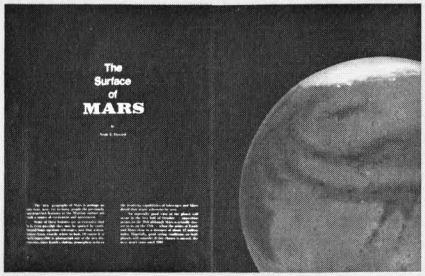

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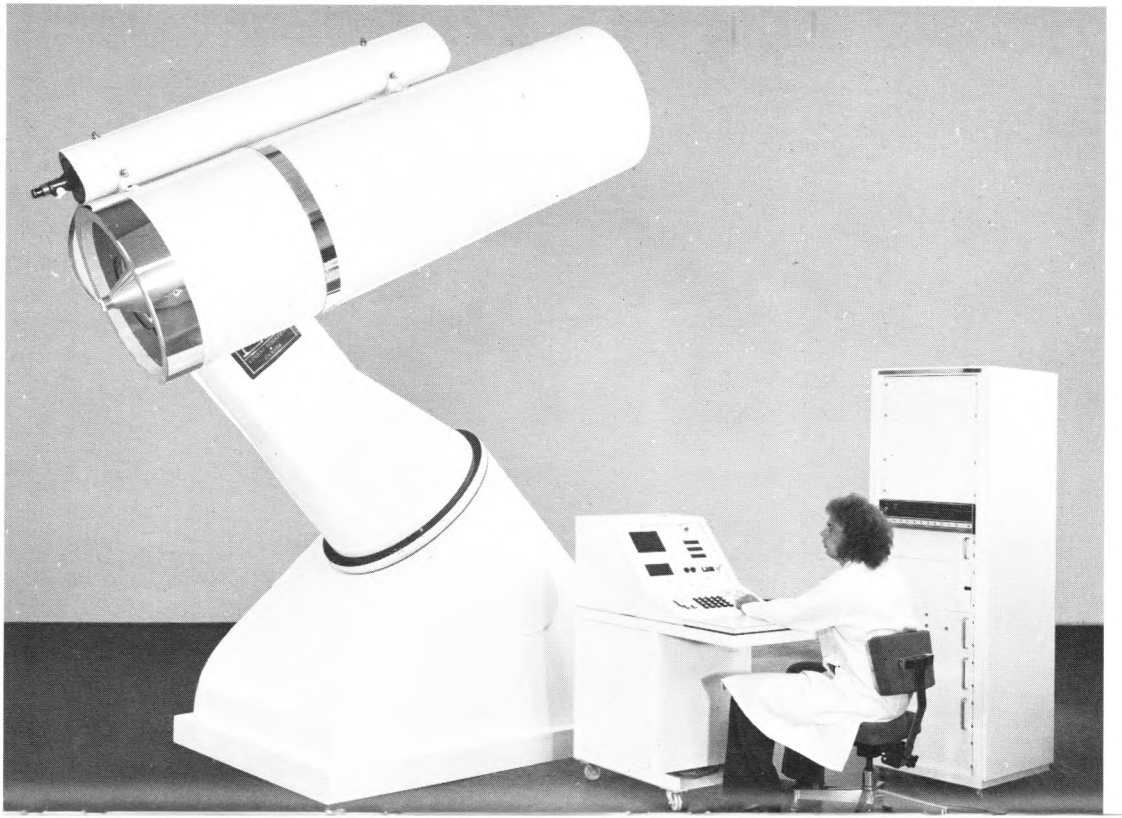

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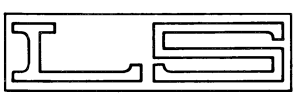

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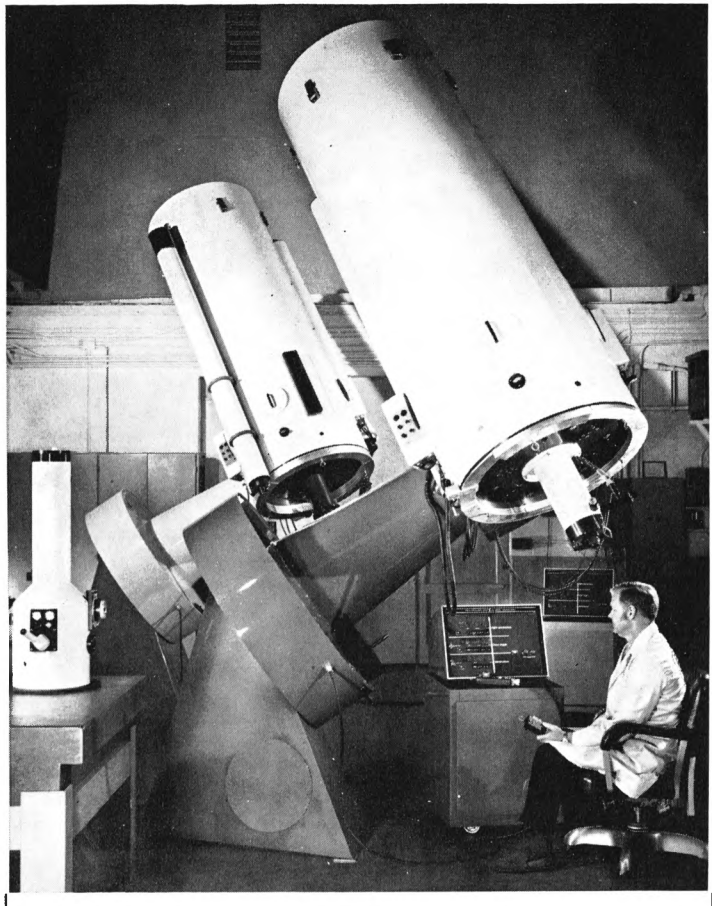

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January

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

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						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				

CALENDAR 1975

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
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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-inch Photo-Equatorial Refractor on left, 4-inch on right

Amateur and professional astronomers alike continue to proclaim their enthusiasm and high praise for UNITRON's 6-inch Photo-Equatorial Refractor. And little wonder — for this largest member of the distinguished UNITRON family offers features, precision, and performance usually associated only with custom-built observatory telescopes of much larger aperture. Here, indeed, is the ideal telescope for the serious observer and for the school and college observatory.

Imagine yourself at the controls of this 6″ UNITRON — searching the skies, seeing more than you have ever seen before, photographically recording your observations — truly, the intellectual adventure of a lifetime.

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