the OBSERVER'S HANDBOOK 1973

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

VISITING HOURS AT SOME CANADIAN OBSERVATORIES

David Dunlap Observatory, Richmond Hill, Ontario.
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–November.

Dominion Observatory, Ottawa, Ontario, K1A-0E4.
Monday–Friday, daytime, rotunda only.
Saturday evenings, April through 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. and Sun., 3:00, 7:15, 8:45 p.m. Closed Christmas day, New Year's day, and Good Friday.
Summer: Daily (except Tues.) 1:45, 3:00, 4:15, 7:15 and 8:45 p.m. Current program information: tel. 264-4060.

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

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

Manitoba Museum of Man & Nature Planetarium, 190 Rupert Ave., Winnipeg 2, Man.
Sept.–June: Sun., 1:00, 2:30, 4:00 p.m.; Tues.–Fri., 3:15, 8:30 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. 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.

The University of Manitoba Planetarium, 394 University College, 500 Dysart Rd., Winnipeg 19, Man.
Wed. and Fri., 12:40 and 8:00 p.m.

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252 College Street, Toronto 130, Canada

editor: JOHN R. PERCY

INDEX

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THE OBSERVER'S HANDBOOK for 1973 is the sixty-fifth edition. The major change in this edition is the inclusion of data on grazing occultations over Canada. These data were supplied by Mr. L. V. Morrison of the British Nautical Almanac Office.

My thanks go to all those who assisted in the preparation of this edition: to those whose names appear in the various sections and to my assistant editors Marie (Fidler) Litchinsky and Chris Smith. 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 Gordon E. Taylor, British Nautical Almanac Office, for the prediction of planetary appulses and occultations, and to Maude Towne and Isabel Williamson for the tables of moonrise and moonset. I also thank the Department of Energy, Mines and Resources for the maps of time zones, and the David Dunlap Observatory for their assistance and support. Finally, my deep indebtedness to the British Nautical Almanac Office and to the *American Ephemeris* is gratefully acknowledged.

JOHN R. PERCY

ANNIVERSARIES AND FESTIVALS, 1973

New Year's Day	Mon.	Jan. 1
Epiphany	Sat.	Jan. 6
Accession of Queen Elizabeth (1952)	Tues.	Feb. 6
Septuagesima Sunday		Feb. 18
St. David	Thur.	Mar. 1
Quinquagesima (Shrove Sunday)		Mar. 4
Ash Wednesday		Mar. 7
St. Patrick	Sat.	Mar. 17
Palm Sunday		Apr. 15
First day of Passover	Tues.	Apr. 17
Good Friday		Apr. 20
Birthday of Queen Elizabeth (1926)	Sat.	Apr. 21
Easter Sunday		Apr. 22
St. George	Mon.	Apr. 23
Victoria Day	Mon.	May 21
Rogation Sunday		May 27
Ascension Day	Thur.	May 31
Pentecost (Whit Sunday)		June 10
Trinity Sunday		June 17
Corpus Christi	Thur.	June 21
St. John Baptist (Mid-Summer Day)	Sun.	June 24
Dominion Day	Sun.	July 1
Birthday of Queen Mother Elizabeth (1900)	Sat.	Aug. 4
Labour Day	Mon.	Sept. 3
Jewish New Year (Rosh Hashanah)	Thur.	Sept. 27
St. Michael (Michaelmas Day)	Sat.	Sept. 29
Yom Kippur	Sat.	Oct. 6
Thanksgiving	Mon.	Oct. 8
All Saints' Day	Thur.	Nov. 1
Remembrance Day	Sun.	Nov. 11
St. Andrew	Fri.	Nov. 30
First Sunday in Advent		Dec. 2
Christmas Day	Tues.	Dec. 25

JULIAN DAY CALENDAR, 1973

Jan. 1	2441684	May 1	2441804	Sept. 1	2441927
Feb. 1	2441715	June 1	2441835	Oct. 1	2441957
Mar. 1	2441743	July 1	2441865	Nov. 1	2441988
Apr. 1	2441774	Aug. 1	2441896	Dec. 1	2442018

The Julian Day commences at noon. Thus J.D. 2441684 = 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

Α, α	Alpha	Ι, ι	Iota	Ρ, ρ	Rho
Β, β	Beta	Κ, κ	Kappa	Σ, σ	Sigma
Γ, γ	Gamma	Λ, λ	Lambda	Τ, τ	Tau
Δ, δ	Delta	Μ, μ	Mu	Υ, υ	Upsilon
Ε, ε	Epsilon	Ν, ν	Nu	Φ, φ	Phi
Ζ, ζ	Zeta	Ξ, ξ	Xi	Χ, χ	Chi
Η, η	Eta	Ο, ο	Omicron	Ψ, ψ	Psi
Θ, θ, ϑ	Theta	Π, π	Pi	Ω, ω	Omega

THE CONFIGURATIONS OF JUPITER'S SATELLITES

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

CALCULATIONS FOR ALGOL

The calculations for the minima of Algol are based on the epoch J.D. 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*ŭ*s	Aps	Apus
Aquarius, *a*-kwâr′ĭ-*ŭ*s	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*ŭ*m	Cae	Cael
Camelopardalis, k*a*-mĕl′ō-pär′d*a*-lĭs	Cam	Caml
Cancer, kăn′sẽr	Cnc	Canc
Canes Venatici, kā′nēz vē-năt′ĭ-sī	CVn	CVen
Canis Major, kā′nĭs mā′jẽr	CMa	CMaj
Canis Minor, kā′nĭs′ mī′nẽr	CMi	CMin
Capricornus, kăp′rĭ-kôr′n*ŭ*s	Cap	Capr
Carina, k*a*-rī′n*a*	Car	Cari
Cassiopeia, kăs′ĭ-ō-pē′y*a*′	Cas	Cas
Centaurus, sĕn-tô′r*ŭ*s	Cen	Cent
Cepheus, sē′fūs	Cep	Ceph
Cetus, sē′t*ŭ*s	Cet	Ceti
Chamaeleon, k*a*-mē′lē-ŭn	Cha	Cham
Circinus, sûr′sĭ-n*ŭ*s	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*ŭ*s	Crv	Corv
Crater, krā′tẽr	Crt	Crat
Crux, krŭks	Cru	Cruc
Cygnus, sĭg′n*ŭ*s	Cyg	Cygn
Delphinus, dĕl-fī′n*ŭ*s	Del	Dlph
Dorado, dō-rä′dō	Dor	Dora
Draco, drā′kō	Dra	Drac
Equuleus, ē-kwoo′lē-*ŭ*s	Equ	Equl
Eridanus, ē-rĭd′*a*-n*ŭ*s	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-*ŭ*m	Hor	Horo
Hydra, hī′dr*a*	Hya	Hyda
Hydrus, hī′dr*ŭ*s	Hyi	Hydi
Indus, ĭn′d*ŭ*s	Ind	Indi
Lacerta, l*a*-sûr′t*a*	Lac	Lacr
Leo, lē′ō	Leo	Leon
Leo Minor, lē′ō mī′nẽr	LMi	LMin
Lepus, lē′p*ŭ*s	Lep	Leps
Libra, lī′br*a*	Lib	Libr
Lupus, lū′p*ŭ*s	Lup	Lupi
Lynx, lĭngks	Lyn	Lync
Lyra, lī′r*a*	Lyr	Lyra
Mensa, mĕn′s*a*	Men	Mens
Microscopium, mī′krō-skō′pĭ-*ŭ*m	Mic	Micr
Monoceros, m-ōnŏs′ẽr-*ŏ*s	Mon	Mono
Musca, mŭs′k*a*	Mus	Musc
Norma, nôr′m*a*	Nor	Norm
Octans, ŏk′t*ă*nz	Oct	Octn
Ophiuchus, ŏf′ĭ-ūk*ŭ*s	Oph	Ophi
Orion, ō-rī′*ŏ*n	Ori	Orio
Pavo, Pā′vō	Pav	Pavo
Pegasus, pĕg′*a*-s*ŭ*s	Peg	Pegs
Perseus, pûr′sūs	Per	Pers
Phoenix, fē′nĭks	Phe	Phoe
Pictor, pĭk′tẽr	Pic	Pict
Pisces, pĭs′ēz	Psc	Pisc
Piscis Austrinus, pĭs′ĭs ôs-trī′n*ŭ*s	PsA	PscA
Puppis, pŭp′ĭs	Pup	Pupp
Pyxis, pĭk′sĭs	Pyx	Pyxi
Reticulum, rē-tĭk′ū-l*ŭ*m	Ret	Reti
Sagitta, s*a*-jĭt′*a*	Sge	Sgte
Sagittarius, săj′ĭ-tā′rĭ-*ŭ*s	Sgr	Sgtr
Scorpius, skôr′pĭ-*ŭ*s	Sco	Scor
Sculptor, skŭlp′tẽr	Scl	Scul
Scutum, skū′t*ŭ*m	Sct	Scut
Serpens, sûr′pĕnz	Ser	Serp
Sextans, sĕks′t*ă*nz	Sex	Sext
Taurus, tô′r*ŭ*s	Tau	Taur
Telescopium, tĕl′ē-skō′pĭ-*ŭ*m	Tel	Tele
Triangulum, trī-ăng′gū-l*ŭ*m	Tri	Tria
Triangulum Australe, trī-ăng′gū-l*ŭ*m ôs-trā′lē	Tra	TrAu
Tucana, tū-kā′n*a*	Tuc	Tucn
Ursa Major, ûr′s*a* mā′jẽr	UMa	UMaj
Ursa Minor, ûr′s*a* mi′nẽr	UMi	UMin
Vela, vē′l*a*	Vel	Velr
Virgo, vûr′gō	Vir	Virg
Volans, vō′l*ă*nz	Vol	Voln
Vulpecula, vŭl-pĕk′ū-l*a*	Vul	Vulp

ā fāte; ā chāotic; ă tăp; *ă* fin*ă*l; ȧ ȧsk; *a* ide*a*; â câre; ä älms; au aught; ē bē; e crēate; ĕ ĕnd; *ĕ* ang*ĕ*l; ẽ makẽr; 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. = 10^4A.
1 inch	= exactly 2.54 centimetres	1 cm. = 10 mm.	= 0.39370 ... in.
1 yard	= exactly 0.9144 metre	1 m. = 10^2 cm.	= 1.0936 .... yd.
1 mile	= exactly 1.609344 kilometres	1 km. = 10^5 cm.	= 0.62137 ... mi.
1 astronomical unit	= 1.496×10^{13} cm. = 1.496×10^8 km. = 9.2957×10^7 mi.		
1 light-year	= 9.461×10^{17} cm. = 5.88×10^{12} mi. = 0.3068 parsecs		
1 parsec	= 3.084×10^{18} cm. = 1.916×10^{13} mi. = 3.260 l.y.		
1 megaparsec	= 10^6 parsecs		

Units of Time

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

The Earth

Equatorial radius, a = 6378.160 km. = 3963.20 mi.: flattening, $c = (a - b)/a = 1/298.25$
Polar radius, b = 6356.77 km. = 3949.91 mi.
1° of latitude = $111.137 - 0.562 \cos 2\phi$ km. = $69.057 - 0.349 \cos 2\phi$ mi. (at lat. ϕ)
1° of longitude = $111.418 \cos\phi - 0.094 \cos 3\phi$ km. = $69.232 \cos\phi - 0.0584 \cos 3\phi$ mi.
Mass of earth = 5.98×10^{24} kgm. = 13.2×10^{24} lb.
Velocity of escape from ⊕ = 11.2 km./sec. = 6.94 mi./sec.

Earth's Orbital Motion

Solar parallax = 8″.794 (adopted)
Constant of aberration = 20″.496 (adopted)
Annual general precession = 50″.26; obliquity of ecliptic = 23° 26′ 35″ (1970)
Orbital velocity = 29.8 km./sec. = 18.5 mi./sec.
Parabolic velocity at ⊕ = 42.3 km./sec. = 26.2 mi./sec.

Solar Motion

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

The Galactic System

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

External Galaxies

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

Radiation Constants

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

Miscellaneous

Constant of gravitation, $G = 6.670 \times 10^{-8}$ c.g.s. units
Mass of the electron, $m = 9.1083 \times 10^{-28}$ gm.: mass of the proton = 1.6724×10^{-24} gm.
Planck's constant, $h = 6.625 \times 10^{-27}$ erg. sec.
Absolute temperature = T° K = T° C + 273° = 5/9 (T° F + 459°)

1 radian	= 57°.2958	π = 3.141,592,653,6
	= 3437′.75	No. of square degrees in the sky = 41,253
	= 206,265″	1 gram = 0.03527 oz.

SUN—EPHEMERIS AND CORRECTION TO SUN-DIAL

Date	Apparent R.A. 0h E.T.	Apparent Dec. 0h E.T.	Corr. to Sun-dial 12h E.T.
	h m s	°	m s
Jan. 1	18 45 24	−23 02.0	+ 3 38
4	18 58 38	−22 45.6	+ 5 01
7	19 11 48	−22 25.1	+ 6 21
10	19 24 54	−22 00.6	+ 7 37
13	19 37 55	−21 32.2	+ 8 47
16	19 50 49	−21 00.2	+ 9 51
19	20 03 38	−20 24.5	+10 48
22	20 16 20	−19 45.4	+11 40
25	20 28 55	−19 02.9	+12 24
28	20 41 23	−18 17.3	+13 01
31	20 53 44	−17 28.7	+13 31
Feb. 3	21 05 58	−16 37.4	+13 54
6	21 18 04	−15 43.4	+14 10
9	21 30 03	−14 47.0	+14 18
12	21 41 55	−13 48.4	+14 19
15	21 53 40	−12 47.7	+14 13
18	22 05 18	−11 45.3	+14 00
21	22 16 50	−10 41.1	+13 41
24	22 28 16	− 9 35.4	+13 17
27	22 39 37	− 8 28.4	+12 47
Mar. 2	22 50 53	− 7 20.3	+12 13
5	23 02 05	− 6 11.2	+11 35
8	23 13 13	− 5 01.4	+10 52
11	23 24 17	− 3 51.0	+10 06
14	23 35 18	− 2 40.2	+ 9 17
17	23 46 17	− 1 29.1	+ 8 26
20	23 57 14	− 0 18.0	+ 7 33
23	0 08 10	+ 0 53.1	+ 6 39
26	0 19 05	+ 2 03.9	+ 5 44
29	0 30 00	+ 3 14.3	+ 4 49
Apr. 1	0 40 55	+ 4 24.2	+ 3 55
4	0 51 52	+ 5 33.4	+ 3 02
7	1 02 49	+ 6 41.7	+ 2 11
10	1 13 49	+ 7 49.0	+ 1 21
13	1 24 51	+ 8 55.0	+ 0 34
16	1 35 56	+ 9 59.8	− 0 11
19	1 47 04	+11 03.0	− 0 52
22	1 58 15	+12 04.6	− 1 29
25	2 09 31	+13 04.4	− 2 03
28	2 20 51	+14 02.3	− 2 31
May 1	2 32 15	+14 58.1	− 2 56
4	2 43 45	+15 51.7	− 3 15
7	2 55 20	+16 43.0	− 3 29
10	3 06 59	+17 31.7	− 3 38
13	3 18 44	+18 17.7	− 3 43
16	3 30 33	+19 01.0	− 3 42
19	3 42 28	+19 41.4	− 3 36
22	3 54 28	+20 18.8	− 3 25
25	4 06 32	+20 53.1	− 3 10
28	4 18 41	+21 24.2	− 2 50
31	4 30 55	+21 51.9	− 2 25
June 3	4 43 12	+22 16.2	− 1 57
6	4 55 33	+22 37.0	− 1 25
9	5 07 56	+22 54.2	− 0 52
12	5 20 21	+23 07.8	− 0 16
15	5 32 48	+23 17.7	+ 0 22
18	5 45 16	+23 24.0	+ 1 00
21	5 57 45	+23 26.5	+ 1 39
24	6 10 13	+23 25.3	+ 2 18
27	6 22 41	+23 20.4	+ 2 56
30	6 35 08	+23 11.8	+ 3 33
July 3	6 47 32	+22 59.6	+ 4 08
6	6 59 54	+22 43.7	+ 4 39
9	7 12 13	+22 24.3	+ 5 08
12	7 24 28	+22 01.4	+ 5 32
15	7 36 38	+21 35.2	+ 5 52
18	7 48 45	+21 05.6	+ 6 08
21	8 00 46	+20 32.8	+ 6 19
24	8 12 43	+19 56.9	+ 6 25
27	8 24 34	+19 18.0	+ 6 26
30	8 36 20	+18 36.2	+ 6 22
Aug. 2	8 48 01	+17 51.6	+ 6 12
5	8 59 36	+17 04.5	+ 5 56
8	9 11 06	+16 14.8	+ 5 35
11	9 22 30	+15 22.9	+ 5 09
14	9 33 49	+14 28.7	+ 4 38
17	9 45 03	+13 32.5	+ 4 01
20	9 56 13	+12 34.3	+ 3 20
23	10 07 18	+11 34.3	+ 2 35
26	10 18 20	+10 32.6	+ 1 47
29	10 29 18	+ 9 29.4	+ 0 55
Sept. 1	10 40 13	+ 8 24.9	− 0 01
4	10 51 05	+ 7 19.2	− 0 59
7	11 01 54	+ 6 12.4	− 1 59
10	11 12 42	+ 5 04.7	− 3 01
13	11 23 28	+ 3 56.2	− 4 05
16	11 34 14	+ 2 47.1	− 5 09
19	11 44 59	+ 1 37.6	− 6 13
22	11 55 45	+ 0 27.6	− 7 17
25	12 06 32	− 0 42.5	− 8 19
28	12 17 21	− 1 52.7	− 9 20
Oct. 1	12 28 11	− 3 02.7	−10 19
4	12 39 04	− 4 12.4	−11 15
7	12 50 00	− 5 21.7	−12 09
10	13 00 59	− 6 30.3	−12 58
13	13 12 02	− 7 38.1	−13 44
16	13 23 10	− 8 45.0	−14 25
19	13 34 23	− 9 50.8	−15 01
22	13 45 42	−10 55.4	−15 30
25	13 57 07	−11 58.4	−15 54
28	14 08 39	−12 59.9	−16 11
31	14 20 17	−13 59.5	−16 21
Nov. 3	14 32 02	−14 57.0	−16 24
6	14 43 55	−15 52.4	−16 20
9	14 55 54	−16 45.4	−16 09
12	15 08 02	−17 35.8	−15 50
15	15 20 17	−18 23.6	−15 24
18	15 32 39	−19 08.4	−14 50
21	15 45 10	−19 50.1	−14 08
24	15 57 47	−20 28.6	−13 18
27	16 10 32	−21 03.7	−12 22
30	16 23 24	−21 35.2	−11 19
Dec. 3	16 36 21	−22 03.0	−10 11
6	16 49 23	−22 27.0	− 8 57
9	17 02 30	−22 47.1	− 7 39
12	17 15 41	−23 03.1	− 6 17
15	17 28 56	−23 15.0	− 4 52
18	17 42 13	−23 22.8	− 3 24
21	17 55 32	−23 26.3	− 1 55
24	18 08 51	−23 25.6	− 0 25
27	18 22 11	−23 20.7	+ 1 05
30	18 35 29	−23 11.5	+ 2 33

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

PHYSICAL ELEMENTS

Object	Equa-torial Di-ameter miles	Ob-late-ness	Mass ⊕=1	Mean Den-sity water =1	Sur-face Grav-ity ⊕=1	Rotation Period	Incli-nation of Equa-tor to Orbit °	Albedo
☉ Sun	864,000	0	332,958	1.41	27.9	25^d–35^d†		
☾ Moon	2,160	0	0.0123	3.36	0.16	$27^d 07^h 43^m$	6.7	0.067
☿ Mercury	3,025	0	0.055	5.46	0.38	$58^d 16^h$	<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?	$6^d 9^h 17^m$	?	0.14?

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

SATELLITES OF THE SOLAR SYSTEM

Name	Mag. * †	Diam. miles †	Mean Distance from Planet miles	″ *	Revolution Period d	h	m	Orbit Incl. ° ‡	Discovery
Satellite of the Earth									
Moon	−12.7	2160	238,900	...	27	07	43	Var.§	
Satellites of Mars									
Phobos	11.6	*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.

CALENDAR 1973

JANUARY

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

FEBRUARY

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

MARCH

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

APRIL

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

MAY

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

JUNE

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

JULY

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

AUGUST

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

SEPTEMBER

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

OCTOBER

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

NOVEMBER

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

DECEMBER

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

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

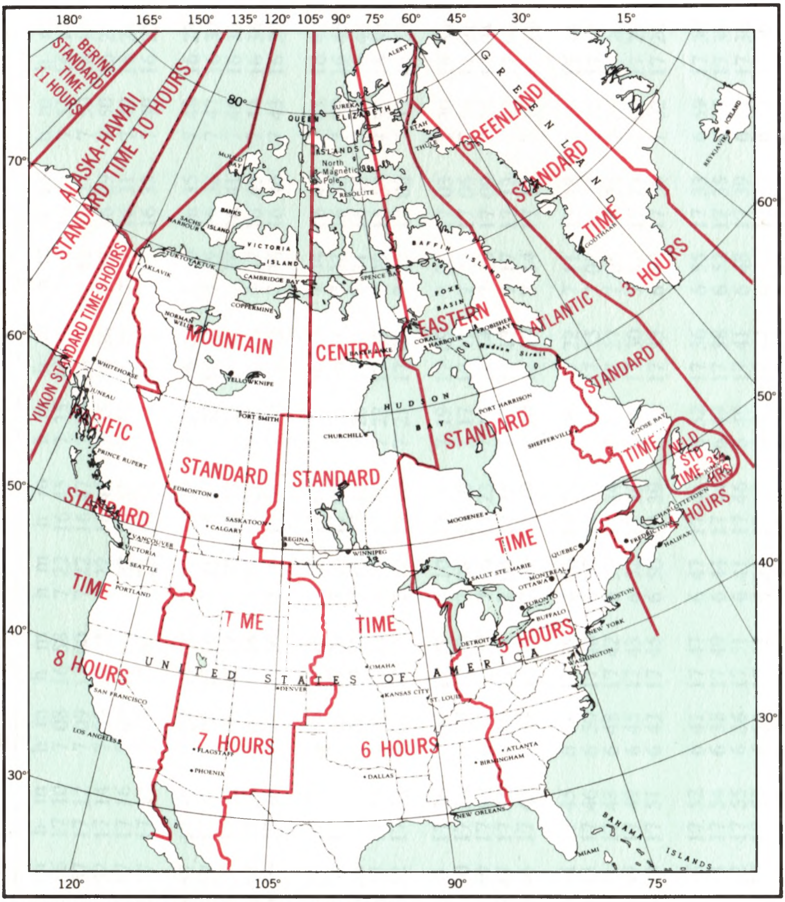
To derive the Standard Time of rising and setting phenomena for the places named, from the list below find the approximate latitude of the place and the correction in minutes which follows the name. Then find in the monthly table the Local Mean Time of the phenomenon for the proper latitude on the desired 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	00P	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, 1972.

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

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

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

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

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

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

TWILIGHT—BEGINNING OF MORNING AND ENDING OF EVENING

+1		Latitude 35°		Latitude 40°		Latitude 45°		Latitude 50°		Latitude 54°	
		Morn.	Eve.	Morn.	Eve.	Morn.	Eve.	Morn.	Eve.	Morn.	Eve.
		h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
Dec.	31	5 37	18 29	5 44	18 21	5 52	18 14	6 00	18 07	6 06	18 00
Jan.	10	5 39	18 37	5 46	18 30	5 53	18 23	6 00	18 16	6 05	18 10
	20	5 37	18 45	5 43	18 40	5 48	18 34	5 55	18 29	6 00	18 24
	30	5 34	18 54	5 39	18 50	5 42	18 46	5 46	18 43	5 49	18 41
Feb.	9	5 27	19 03	5 30	19 01	5 31	18 59	5 33	18 58	5 34	18 58
	19	5 18	19 11	5 18	19 11	5 19	19 11	5 18	19 13	5 15	19 16
Mar.	1	5 07	19 20	5 05	19 22	5 02	19 25	4 58	19 30	4 54	19 35
	11	4 54	19 28	4 50	19 32	4 44	19 38	4 37	19 46	4 29	19 55
	21	4 39	19 37	4 33	19 44	4 25	19 52	4 14	20 04	4 02	20 17
	31	4 24	19 46	4 15	19 56	4 04	20 08	3 49	20 24	3 32	20 41
Apr.	10	4 08	19 56	3 57	20 08	3 42	20 24	3 21	20 45	2 59	21 08
	20	3 53	20 07	3 38	20 22	3 19	20 42	2 53	21 09	2 24	21 40
	30	3 39	20 18	3 20	20 36	2 57	21 01	2 23	21 36	1 40	22 19
May	10	3 25	20 29	3 03	20 51	2 35	21 21	1 51	22 06	0 37	23 29
	20	3 14	20 41	2 49	21 06	2 14	21 42	1 15	22 42	——	——
	30	3 04	20 51	2 37	21 19	1 56	22 01	0 27	23 37	——	——
June	9	3 00	20 59	2 30	21 30	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 39	21 31	1 55	22 13	——	——	——	——
	19	3 17	20 54	2 50	21 20	2 12	21 58	1 01	23 06	——	——
	29	3 27	20 44	3 04	21 07	2 31	21 39	1 40	22 28	——	——
Aug.	8	3 39	20 31	3 19	20 51	2 52	21 18	2 12	21 55	1 18	22 47
	18	3 49	20 17	3 32	20 33	3 11	20 55	2 40	21 24	2 04	21 59
	28	4 00	20 02	3 46	20 15	3 28	20 32	3 04	20 55	2 38	21 21
Sept.	7	4 09	19 46	3 58	19 56	3 44	20 10	3 26	20 28	3 06	20 47
	17	4 18	19 30	4 10	19 38	3 59	19 48	3 45	20 01	3 30	20 15
	27	4 27	19 14	4 21	19 19	4 13	19 27	4 03	19 37	3 52	19 47
Oct.	7	4 34	19 00	4 31	19 03	4 27	19 07	4 20	19 13	4 12	19 20
	17	4 43	18 47	4 41	18 48	4 39	18 50	4 36	18 53	4 31	18 57
	27	4 50	18 36	4 51	18 35	4 52	18 35	4 51	18 35	4 49	18 36
Nov.	6	4 59	18 28	5 01	18 24	5 04	18 22	5 06	18 20	5 07	18 19
	16	5 07	18 22	5 11	18 17	5 15	18 13	5 19	18 08	5 22	18 05
	26	5 15	18 19	5 21	18 13	5 26	18 07	5 32	18 01	5 38	17 55
Dec.	6	5 23	18 18	5 29	18 12	5 36	18 05	5 44	17 57	5 50	17 50
	16	5 29	18 21	5 37	18 14	5 44	18 06	5 53	17 58	6 00	17 51
	26	5 35	18 26	5 42	18 19	5 50	18 11	5 58	18 02	6 05	17 55
Jan.	5	5 38	18 32	5 45	18 26	5 52	18 19	6 00	18 11	6 06	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, 1973; 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	04 29	14 44	04 42	14 30	04 58	14 14	05 18	13 54	05 43	13 30	06 07	13 04
2	05 21	15 34	05 35	15 19	05 52	15 02	06 12	14 42	06 38	14 17	07 04	13 51
3	06 11	16 28	06 24	16 14	06 41	15 57	07 00	15 39	07 24	15 14	07 50	14 49
4 ●	06 56	17 24	07 08	17 11	07 23	16 57	07 41	16 40	08 03	16 18	08 25	15 57
5	07 36	18 21	07 47	18 11	08 00	17 59	08 15	17 45	08 33	17 28	08 51	17 11
6	08 13	19 19	08 23	19 12	08 32	19 02	08 44	18 52	08 58	18 39	09 12	18 27
7	08 48	20 17	08 54	20 13	09 01	20 06	09 09	20 00	09 19	19 52	09 28	19 44
8	09 19	21 15	09 23	21 14	09 27	21 11	09 31	21 08	09 37	21 05	09 42	21 01
9	09 51	22 15	09 51	22 15	09 52	22 16	09 53	22 18	09 54	22 19	09 55	22 21
10	10 23	23 15	10 20	23 19	10 18	23 23	10 15	23 28	10 11	23 35	10 08	23 41
11	10 56	.. ..	10 51	.. ..	10 45	.. ..	10 38	.. ..	10 29	.. ..	10 22	.. ..
12 ☽	11 34	00 18	11 25	00 24	11 15	00 33	11 05	00 42	10 52	00 53	10 39	01 05
13	12 16	01 23	12 05	01 33	11 53	01 44	11 38	01 58	11 20	02 14	11 02	02 30
14	13 05	02 30	12 52	02 43	12 37	02 57	12 19	03 15	11 57	03 35	11 35	03 57
15	14 02	03 39	13 48	03 53	13 32	04 09	13 12	04 28	12 47	04 53	12 22	05 18
16	15 07	04 45	14 53	04 59	14 36	05 16	14 16	05 35	13 52	06 01	13 26	06 26
17	16 16	05 44	16 03	05 58	15 49	06 13	15 30	06 32	15 08	06 55	14 46	07 18
18 ○	17 26	06 37	17 16	06 48	17 04	07 01	16 49	07 16	16 32	07 35	16 15	07 54
19	18 35	07 21	18 26	07 30	18 18	07 40	18 08	07 51	17 56	08 05	17 44	08 19
20	19 39	08 00	19 35	08 06	19 29	08 13	19 24	08 20	19 17	08 29	19 10	08 37
21	20 41	08 36	20 40	08 38	20 38	08 41	20 37	08 45	20 35	08 49	20 23	08 53
22	21 40	09 07	21 42	09 07	21 43	09 07	21 46	09 07	21 49	09 07	21 52	09 06
23	22 38	09 38	22 42	09 36	22 47	09 32	22 54	09 28	23 01	09 24	23 08	09 19
24	23 34	10 10	23 41	10 04	23 50	09 58	.. ..	09 50	.. ..	09 41	.. ..	09 32
25	.. ..	10 42	.. ..	10 35	.. ..	10 25	00 00	10 13	00 12	10 01	00 23	09 48
26 ☾	00 30	11 18	00 40	11 07	00 51	10 55	01 04	10 40	01 21	10 23	01 37	10 06
27	01 25	11 57	01 38	11 44	01 51	11 29	02 08	11 12	02 28	10 51	02 48	10 30
28	02 20	12 40	02 34	12 26	02 50	12 09	03 08	11 50	03 32	11 27	03 56	11 01
29	03 14	13 27	03 28	13 13	03 45	12 56	04 05	12 36	04 30	12 11	04 56	11 44
30	04 04	14 18	04 19	14 05	04 35	13 48	04 55	13 28	05 20	13 04	05 46	12 38
31	04 51	15 14	05 05	15 01	05 20	14 46	05 39	14 28	06 01	14 06	06 25	13 43
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	05 33	16 12	05 46	16 01	05 59	15 48	06 16	15 33	06 35	15 14	06 55	14 55
2	06 12	17 10	06 22	17 02	06 33	16 52	06 47	16 40	07 02	16 25	07 17	16 11
3 ●	06 48	18 09	06 55	18 04	07 04	17 57	07 13	17 48	07 24	17 38	07 35	17 29
4	07 22	19 09	07 26	19 06	07 30	19 02	07 37	18 58	07 44	18 53	07 50	18 48
5	07 54	20 09	07 55	20 08	07 56	20 08	07 59	20 08	08 02	20 08	08 04	20 08
6	08 26	21 09	08 24	21 12	08 22	21 15	08 21	21 19	08 19	21 24	08 17	21 28
7	08 58	22 11	08 55	22 17	08 49	22 24	08 44	22 32	08 37	22 42	08 30	22 52
8	09 35	23 15	09 27	23 24	09 19	23 35	09 09	23 47	08 58	.. ..	08 47	.. ..
9	10 15	.. ..	10 05	.. ..	09 53	.. ..	09 40	.. ..	09 23	00 02	09 07	00 16
10 ☽	11 01	00 21	10 48	00 32	10 34	00 46	10 17	01 02	09 57	01 21	09 36	01 41
11	11 53	01 28	11 40	01 41	11 24	01 57	11 04	02 16	10 40	02 39	10 16	03 03
12	12 53	02 32	12 39	02 47	12 23	03 04	12 02	03 24	11 37	03 49	11 11	04 14
13	13 58	03 32	13 45	03 46	13 29	04 03	13 10	04 21	12 47	04 46	12 23	05 10
14	15 06	04 26	14 55	04 39	14 41	04 53	14 25	05 09	14 05	05 30	13 46	05 51
15	16 14	05 13	16 05	05 23	15 54	05 34	15 42	05 48	15 28	06 04	15 13	06 20
16	17 19	05 54	17 14	06 01	17 07	06 09	16 59	06 19	16 49	06 31	16 40	06 41
17 ○	18 23	06 30	18 20	06 34	18 16	06 40	18 13	06 45	18 08	06 52	18 04	06 58
18	19 23	07 04	19 24	07 05	19 24	07 06	19 24	07 09	19 24	07 10	19 25	07 12
19	20 22	07 36	20 26	07 34	20 29	07 32	20 33	07 30	20 38	07 28	20 44	07 25
20	21 20	08 08	21 27	08 03	21 33	07 58	21 41	07 52	21 51	07 45	22 01	07 39
21	22 18	08 40	22 26	08 33	22 36	08 25	22 48	08 15	23 02	08 04	23 16	07 53
22	23 14	09 15	23 25	09 05	23 38	08 55	23 53	08 42	.. ..	08 26	.. ..	08 10
23	.. ..	09 53	.. ..	09 41	.. ..	09 27	.. ..	09 11	00 11	08 52	00 30	08 33
24 ☾	00 09	10 34	00 23	10 21	00 38	10 05	00 55	09 47	01 17	09 24	01 40	09 01
25	01 04	11 19	01 18	11 05	01 34	10 49	01 53	10 29	02 18	10 05	02 44	09 39
26	01 55	12 10	02 10	11 55	02 27	11 38	02 47	11 19	03 12	10 54	03 38	10 28
27	02 43	13 04	02 57	12 50	03 14	12 34	03 33	12 16	03 57	11 52	04 21	11 28
28	03 28	14 00	03 40	13 48	03 55	13 34	04 12	13 18	04 33	12 57	04 55	12 36

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

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

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

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

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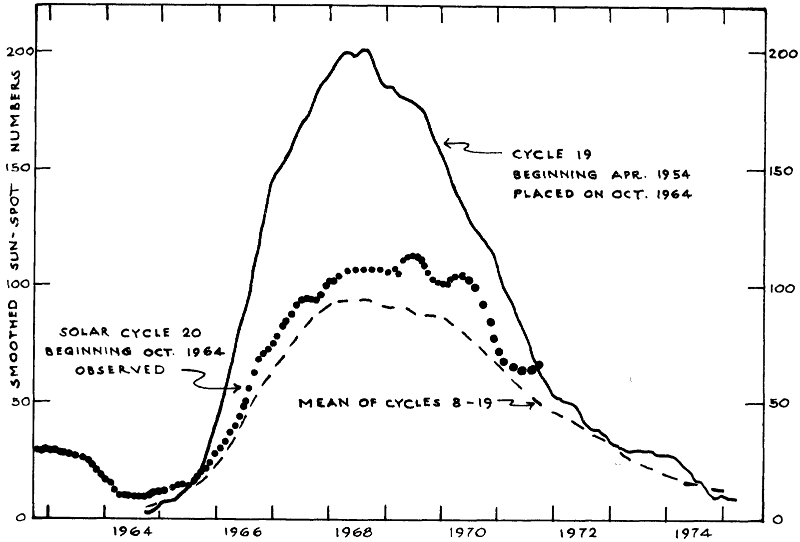
14	22 25	10 33	22 22	10 38	22 18	10 42	22 14	10 48	22 09	10 55	22 05	11 02
15	23 27	11 09	23 27	11 11	23 27	11 13	23 27	11 14	23 27	11 17	23 27	11 19
16 ☾	.. ..	11 44	.. ..	11 42	.. ..	11 41	.. ..	11 39	.. ..	11 37	.. ..	11 35
17	00 27	12 17	00 30	12 13	00 33	12 08	00 36	12 03	00 41	11 56	00 46	11 51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

THE SUN AND PLANETS FOR 1973

THE SUN

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



MERCURY

Mercury is exceptional in many ways. It is the planet nearest the sun and travels fastest in its orbit, its speed varying from 23 mi. per sec. at aphelion to 35 mi. per sec. at perihelion. The amount of heat and light from the sun received by it per square mile is, on the average, 6.7 times the amount received by the earth. By a radar technique in 1965, the period of rotation on its axis was found to be 59 days.

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

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

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

MAXIMUM ELONGATIONS OF MERCURY DURING 1973

Elong. East—Evening Sky			Elong. West—Morning Sky		
Date	Elong.	Mag.	Date	Elong.	Mag.
Feb. 25	18°	−0.2	Apr. 10	28°	+0.6
June 22	25°	+0.7	Aug. 8	19°	+0.4
Oct. 18	25°	+0.2	Nov. 27	20°	−0.2

The most favourable elongations are: in the evening, Feb. 25; in the morning, Aug. 8. Neither of these elongations is exceptionally favourable. The apparent diameter of the planet ranges from about 5″, at superior conjunction, to about 11″, at inferior conjunction.

On Nov. 10, a transit of Mercury will be seen (briefly, for a short time after sunrise) in eastern North America. The transit will be more favourably seen in South America, Europe, Africa and parts of Asia.

VENUS

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

Venus is a morning star until superior conjunction, Apr. 9, after which it is an evening star. Greatest elongation east occurs on Nov. 13 (47°) and greatest brilliancy (mag. −4.4) on Dec. 19. By the end of the year, the apparent diameter of the planet exceeds 50″.

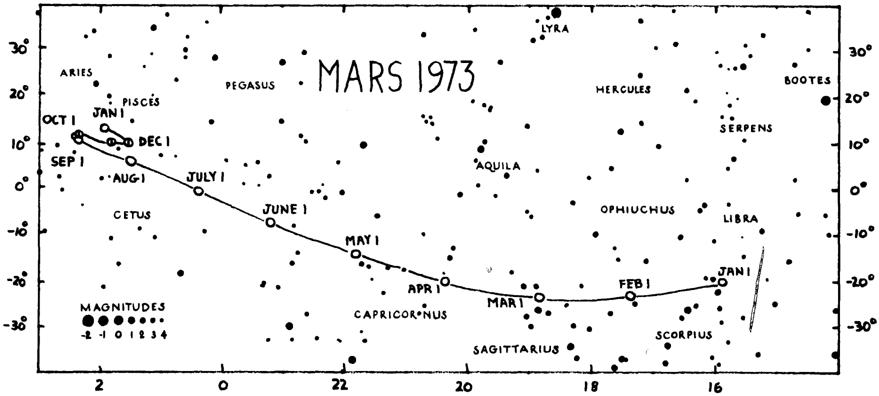
Its brilliance is due to its nearness and to dense clouds enshrouding the planet. Visits by Mariner II and V, and by the Russian Venera IV spacecraft, revealed a surface temperature close to 1000° F, a surface pressure of perhaps 100 times that of the earth, and little or no magnetic field. The atmosphere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

MARS

The orbit of Mars is outside that of the earth and consequently its planetary phenomena are quite different from those of the two inferior planets discussed above. Its mean distance from the sun is 141 million miles and the eccentricity of its orbit is 0.093, and a simple computation shows that its distance from the sun ranges between 128 and 154 million miles. Its distance from the earth varies from 35 to 235 million miles and its brightness changes accordingly. When Mars is nearest it is conspicuous in its fiery red, but when farthest away it is no brighter than Polaris. Unlike Venus, its atmosphere is very thin, and features on the solid surface are distinctly visible. Utilizing them its rotation period of 24 h. 37 m. 22.6689 s. has been accurately determined. Perhaps the most surprising result of the space programme so far is the revelation by Mariner IV that the surface of Mars contains craters much like those on the Moon. This discovery was confirmed in 1969 by Mariners VI and VII, which revealed also large areas free of craters, and other areas with unusual chaotic structure.

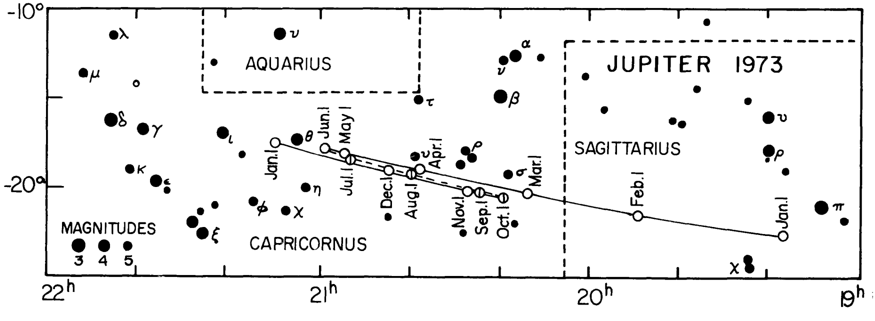
The sidereal, or true mechanical, period of revolution of Mars is 687 days; and the synodic period (for example, the interval from one opposition to the next one) is 780 days. This is the average value; it may vary from 764 to 810 days. At the opposition on August 10, 1971, the planet was closer to the earth—34,931,000 mi.—than it will be for many years. Such favourable oppositions occur at intervals of 15 to 17 years.

A favourable opposition of Mars occurs on Oct. 24, at which time its distance from earth is 40,500,000 miles and its magnitude and apparent diameter are, respectively, -2.3 and $21.5''$.



JUPITER

Jupiter is the giant of the family of the sun. Its mean diameter is 87,000 miles and its mass is 2½ times that of all the rest of the planets combined! Its mean distance is 483 million miles and the revolution period is 11.9 years. This planet is known to possess 12 satellites, the last discovered in 1951 (see p. 9). Bands of clouds may be observed on Jupiter, interrupted by irregular spots which may be short-lived or



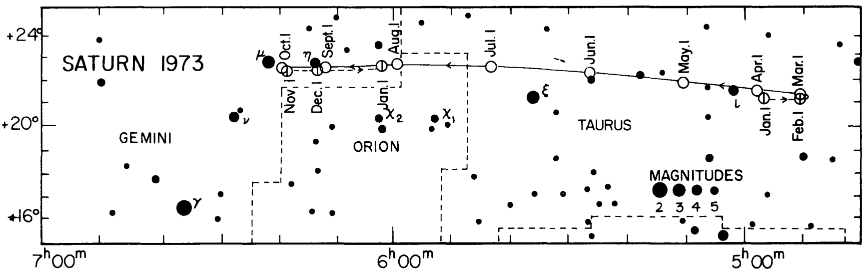
persist for weeks. The atmosphere contains ammonia and methane at a temperature of about −200° F. Intense radiation belts (like terrestrial Van Allen belts) have been disclosed by observations at radio wave-lengths. A correlation of radio bursts with the orbital position of the satellite Io has now been found.

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

During 1973, Jupiter moves from Sagittarius into Capricornus. Retrograde motion occurs between May 31 and Sept. 28, opposition occurring on July 30. At that time, the magnitude of the planet and its apparent diameter are, respectively, −2.4 and 45″. An occultation of Jupiter by the moon is visible from the north-west part of North America on Feb. 1.

SATURN

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



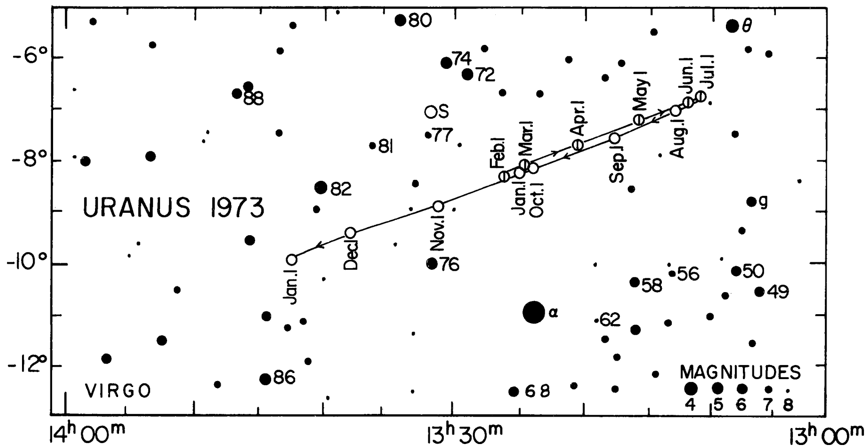
1973 will be an excellent year to view Saturn. Retrograde motion occurs between Oct. 17 and the end of the year. Opposition occurs on Dec. 23. At that time the magnitude of the planet reaches −0.3, and the apparent diameter of the disc reaches 18.5″. The rings open to the maximum extent (27°) in May, the southern face being visible.

Saturn passes from Taurus through Orion into Gemini in 1973; it is near ι Tau in April, M1 in June, and η and μ Gem in the autumn.

URANUS

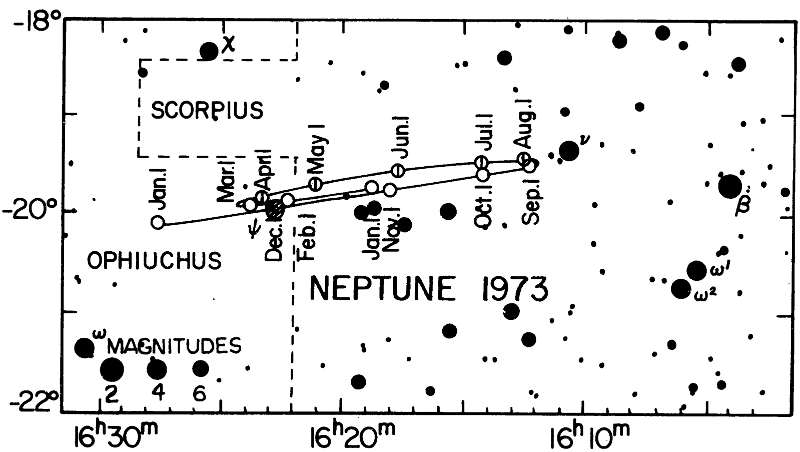
Uranus was discovered in 1781 by Sir William Herschel by means of a 6¼-in. mirror-telescope made by himself. The object did not look just like a star and he observed it again four days later. It had moved amongst the stars, and he assumed it to be a comet. He could not believe that it was a new planet.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

Uranus, in 1973, is in Virgo, a few degrees north of Spica. At opposition on April 10, its magnitude is +5.7; at that time it should be faintly visible to the naked eye under a clear dark sky. Its apparent diameter reaches 4″, easily resolvable with a small telescope under good seeing conditions. Conjunction occurs on Oct. 16.



NEPTUNE

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



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

In 1973, Neptune moves from Scorpius into Ophiuchus. Retrograde motion occurs between March 9 and Aug. 16; opposition occurs on May 27, at which time the planet has a magnitude of +7.7 and an apparent diameter of 2.5″. Neptune passes close to ψ Oph three times in 1973 (see map).

PLUTO

Pluto, the most distant known planet, was discovered at the Lowell Observatory in 1930 as a result of an extended search started two decades earlier by Percival Lowell. The faint star-like image was first detected by Clyde Tombaugh by comparing photographs taken on different dates. Further observations confirmed that the object was a distant planet. Its mean distance from the sun is 3671 million miles and its revolution period is 248 years. It appears as a 14th mag. star in the constellation Coma. At opposition on March 23 its position is: R.A. $12^h\ 38^m$, Dec. $+14°\ 27'$, and it is 2,800,000,000 miles from earth.

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

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

THE SKY MONTH BY MONTH

By John F. Heard

THE SKY FOR JANUARY 1973

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 45 m to 20 h 58 m and its Decl. changes from 23° 02′ S. to 17° 12′ S. The equation of time changes from −3 m 44 s to −13 m 33 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 2nd at a distance of 91,401,000 miles from the sun. There is an annular eclipse of the sun on the 4th, not visible in North America. For changes in the length of the day, see p. 13.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 20. There is a penumbral eclipse of the moon on the 18th.

Mercury on the 1st is in R.A. 17 h 37 m, Decl. 23° 21′ S., and on the 15th is in R.A. 19 h 10 m, Decl. 23° 56′ S. It is too close to the sun for observation, superior conjunction being on the 28th.

Venus on the 1st is in R.A. 17 h 02 m, Decl. 21° 52′ S., and on the 15th it is in R.A. 18 h 17 m, Decl. 23° 05′ S., mag. −3.4, and transits at 10 h 41 m. A morning star, it rises only about an hour and a half before the sun and is about 10° above the southeastern horizon at sunrise. There is a close conjunction with Jupiter on the 31st.

Mars on the 15th is in R.A. 16 h 36 m, Decl. 21° 54′ S., mag. +1.7, and transits at 8 h 58 m. Moving from Libra into Ophiuchus, it rises about three hours before the sun, but is not prominent in brightness.

Jupiter on the 15th is in R.A. 19 h 31 m, Decl. 21° 59′ S., mag. −1.4, and transits at 11 h 52 m. It is too close to the sun, early in the month, for easy observation, conjunction being on the 10th; but by month's end it is visible as a morning star, and on the 31st it is in close (0°.2) conjunction with Venus. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 73.

Saturn on the 15th is in R.A. 4 h 53 m, Decl. 20° 59′ N., mag. 0.0, and transits at 21 h 12 m. In Taurus, it is well up in the east at sunset and sets before dawn.

Uranus on the 15th is in R.A. 13 h 26 m, Decl. 8° 21′ S., and transits at 5 h 47 m.

Neptune on the 15th is in R.A. 16 h 20 m, Decl. 19° 52′ S., and transits at 8 h 41 m.

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

1973				JANUARY E.S.T.	Min. of Algol	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m	°
Mon.	1	08		Neptune 5° N. of Moon	22 10	228.74
Tues.	2			Earth at perihelion		240.93
		08		Venus 3° N. of Moon		
Wed.	3	03		Quadrantid meteors		253.11
		03		Mercury 1° N. of Moon		
Thur.	4	10	42	New Moon. Eclipse of ☉, p. 57	19 00	265.30
Fri.	5					277.49
Sat.	6					289.67
Sun.	7				15 50	301.86
Mon.	8					314.04
Tues.	9	09		Mars 1.4° S. of Neptune		326.22
Wed.	10	04		Jupiter in conjunction	12 40	338.40[l]
Thur.	11			Mercury at aphelion		350.56
Fri.	12	00	27	☽ First Quarter		2.72[b]
		03		Mars 5° N. of Antares		
Sat.	13	15		Pluto stationary	9 30	14.88
Sun.	14					27.03
Mon.	15	17		Saturn 4° S. of Moon		39.17
Tues.	16	16		Moon at perigee (225,200 mi.)	6 20	51.30
Wed.	17					63.43
Thur.	18	16	28	Full Moon. Penumbral eclipse		75.56
Fri.	19	11		Vesta stationary	3 10	87.68
Sat.	20					99.81
Sun.	21			Venus at descending node		111.94
Mon.	22				0 00	124.07
Tues.	23					136.21[l]
Wed.	24			Mars at descending node	20 40	148.35
Thur.	25	04		Uranus 6° N. of Moon		160.50[b]
Fri.	26	01	05	☾ Last Quarter		172.65
Sat.	27	05		Uranus stationary	17 30	184.81
Sun.	28	11		Moon at apogee (251,600 mi.)		196.98
		15		Mercury in superior conjunction		
		17		Neptune 5° N. of Moon		
Mon.	29	20		Mars 2° N of Moon		209.15
Tues.	30				14 20	221.33
Wed.	31			Mercury greatest hel. lat. S.		233.52
		13		Venus 0.2° S. of Jupiter		

See explanation of time on p. 10, of colongitude on p. 58.

[l]Jan. 10, −6.25°; Jan. 23, +6.31° [b]Jan. 12, −6.80°; Jan. 25, +6.81°.

THE SKY FOR FEBRUARY 1973

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 58 m to 22 h 47 m and its Decl. changes from 17° 12′ S. to 7° 43′ S. The equation of time changes from −13 m 41 s to a maximum of −14 m 19 s on the 11th and then to −12 m 34 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 09 m, Decl. 18° 32′ S., and on the 15th is in R.A. 22 h 45 m, Decl. 8° 53′ S. Greatest eastern elongation is on the 25th at which time Mercury stands about 15° above the western horizon at sunset. For about a week before and after this date it may be possible to see Mercury low in the western sky just after sunset.

Venus on the 1st is in R.A. 19 h 49 m, Decl. 21° 30′ S., and on the 15th it is in R.A. 21 h 02 m, Decl. 17° 52′ S., mag. −3.4, and transits at 11 h 23 m. It rises less than an hour before the sun and is only about 5° above the south-eastern horizon at sunrise.

Mars on the 15th is in R.A. 18 h 08 m, Decl. 23° 43′ S., mag. +1.5, and transits at 8 h 28 m. Moving into Sagittarius, it rises about three hours before the sun.

Jupiter on the 15th is in R.A. 20 h 01 m, Decl. 20° 46′ S., mag. −1.5, and transits at 10 h 20 m. Moving from Sagittarius into Capricornus, it rises about an hour and a half before the sun. For the configuration of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 73.

Saturn on the 15th is in R.A. 4 h 50 m, Decl. 21° 01′ N., mag. +0.2, and transits at 19 h 06 m. In Taurus, it is high in the east at sunset and sets about three hours after midnight. On the 13th it is stationary in right ascension and resumes direct or eastward motion among the stars.

Uranus on the 15th is in R.A. 13 h 26 m, Decl. 8° 19′ S., and transits at 3 h 45 m.

Neptune on the 15th is in R.A. 16 h 23 m, Decl. 19° 57′ S., and transits at 6 h 42 m.

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

1973			FEBRUARY E.S.T.	Min. of Algol	Sun's Selen. Colong. 0 h U.T.
d	h	m		h m	°
Thur. 1	16		Jupiter 1° S. of Moon. Occ'n.*		245.70
	19		Venus 1° S. of Moon		
Fri. 2				11 10	257.90
Sat. 3	04	23	● New Moon		270.09
Sun. 4					282.28
Mon. 5				8 00	294.47[l]
Tues. 6					306.66
Wed. 7					318.85
Thur. 8				4 50	331.04[b]
Fri. 9					343.21
Sat. 10	09	05	☽ First Quarter		355.38
Sun. 11	23		Saturn 4° S. of Moon	1 40	7.55
Mon. 12					19.70
Tues. 13	06		Moon at perigee (228,700 mi.)	22 30	31.86
	14		Saturn stationary		
Wed. 14					44.00
Thur. 15					56.14
Fri. 16				19 20	68.28
Sat. 17	05	07	○ Full Moon		80.41
Sun. 18					92.55
Mon. 19			Mercury at ascending node	16 10	104.69
Tues. 20					116.83[l]
Wed. 21	12		Uranus 6° N. of Moon		128.97[b]
Thur. 22				13 00	141.12
Fri. 23					153.27
Sat. 24			Mercury at perihelion		165.44
	22	10	☾ Last Quarter		
Sun. 25			Venus at aphelion	9 50	177.60
	02		Neptune 5° N. of Moon		
	08		Moon at apogee (251,200 mi.)		
	15		Mercury greatest elong. E. (18°)		
Mon. 26					189.78
Tues. 27	20		Mars 0.1° S. of Moon. Occ'n.**		201.96
Wed. 28				6 40	214.14

[l]Feb. 5, −5.30°; Feb. 20, +5.14°. [b]Feb. 8, −6.71°; Feb. 21, +6.69°.

*Visible in N. Pacific, N.W. of N. America.

**Visible in Indian Ocean and vicinity.

THE SKY FOR MARCH 1973

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 47 m to 0 h 41 m and its Decl. changes from 7° 43′ S. to 4° 24′ N. The equation of time changes from −12 m 23 s to −4 m 10 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. 23 h 48 m, Decl. 1° 06′ N., and on the 15th is in R.A. 23 h 25 m, Decl. 0° 04′ S. For the first few days of the month it may be possible to see Mercury low in the west just after sunset, but later in the month it is too close to the sun, inferior conjunction being on the 13th.

Venus on the 1st is in R.A. 22 h 11 m, Decl. 12° 34′ S., and on the 15th it is in R.A. 23 h 17 m, Decl. 6° 10′ S., mag. −3.4, and transits at 11 h 48 m. Still to be seen early in the month as a morning star very low in the south-east at sunrise it has approached the sun so closely at month's end as to make observation difficult.

Mars on the 15th is in R.A. 19 h 34 m, Decl. 22° 26′ S., mag. +1.2, and transits at 8 h 04 m. Moving from Sagittarius into Capricornus, it rises about three hours before the sun.

Jupiter on the 15th is in R.A. 20 h 25 m, Decl. 19° 34′ S., mag. −1.6, and transits at 8 h 54 m. In Capricornus, it rises about two hours before the sun. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 73.

Saturn on the 15th is in R.A. 4 h 53 m, Decl. 21° 13′ N., mag. +0.3, and transits at 17 h 20 m. In Taurus, it is past the meridian at sunset and sets within an hour after midnight.

Uranus on the 15th is in R.A. 13 h 23 m, Decl. 8° 01′ S., and transits at 1 h 52 m.

Neptune on the 15th is in R.A. 16 h 24 m, Decl. 19° 57′ S., and transits at 4 h 52 m.

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

1973				MARCH E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 5h E.S.T.	Sun's Selen. Colong. 0 h U.T.
	d	h	m		h m		°
Thur.	1	13		Jupiter 2° S. of Moon		31O4d	226.33
Fri.	2					32O14	238.53
Sat.	3	19		Mercury stationary	3 30	1O24*	250.73
Sun.	4	19	07	● New Moon		O1234	262.94[l]
Mon.	5	21		Mercury 2° S. of Moon		21O34	275.14
Tues.	6			Mercury greatest hel. lat. N.	0 20	2O134	287.35
Wed.	7	04		Uranus 3° N. of Spica		3O24*	299.55[b]
Thur.	8				21 10	31O24	311.75
Fri.	9	16		Neptune stationary		324O1	323.95
Sat.	10	03		Moon at perigee (229,700 mi.)		41O2*	336.15
Sun.	11	05		Saturn 4° S. of Moon	18 00	4O123	348.33
		16	26	☽ First Quarter			
Mon.	12					421O3	0.51
Tues.	13	15		Mercury in inferior conjunction		42O13	12.69
Wed.	14				14 40	431O2	24.85
Thur.	15					43O2d	37.02
Fri.	16					342O1	49.17
Sat.	17				11 30	314O*	61.33
Sun.	18	18	33	○ Full Moon		O1342	73.48
Mon.	19			Venus greatest hel. lat. S.		12O34	85.63[l]
		10		Pallas stationary			
Tues.	20	13	13	Equinox. Spring begins	8 20	2O134	97.78[b]
		19		Uranus 6° N. of Moon			
Wed.	21					1O24d	109.94
Thur.	22					3O124	122.09
Fri.	23	16		Pluto at opposition	5 10	32O4*	134.25
Sat.	24	10		Neptune 5° N. of Moon		31O4*	146.42
Sun.	25	04		Moon at apogee (251,300 mi.)		O4132	158.59
Mon.	26	01		Mercury stationary	2 00	142O3	170.77
		18	46	☾ Last Quarter			
Tues.	27					42O13	182.96
Wed.	28	23		Mars 3° S. of Moon	22 50	41O32	195.15
Thur.	29			Mercury at descending node		43O12	207.35
		8		Jupiter 3° S. of Moon			
Fri.	30					432O*	219.55
Sat.	31				19 40	4321O	231.76[l]

[l]Mar. 4, −5.50°; Mar. 19, +4.56°; Mar. 31, −6.40°.
[b]Mar. 7, −6.57°; Mar. 20, +6.57°.

THE SKY FOR APRIL 1973

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 41 m to 2 h 32 m and its Decl. changes from 4° 24′ N. to 14° 58′ N. The equation of time changes from −3 m 52 s to +2 m 50 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 09 m, Decl. 5° 58′ S., and on the 15th is in R.A. 23 h 55 m, Decl. 3° 09′ S. It is too close to the sun for easy observation despite the greatest western elongation on the 10th at which time it is only about 8° above the eastern horizon at sunrise.

Venus on the 1st is in R.A. 0 h 35 m, Decl. 2° 17′ N., and on the 15th it is in R.A. 1 h 39 m, Decl. 9° 08′ N., mag. −3.5, and transits at 12 h 07 m. Superior conjunction is on the 9th so that it is too close to the sun for observation until later in the month when it may be seen as an evening star low in the west just after sunset.

Mars on the 15th is in R.A. 21 h 06 m, Decl. 18° 00′ S., mag. +0.8, and transits at 7 h 33 m. In Capricornus, it rises about three hours before the sun. It is in conjunction with Jupiter on the 6th, passing less than a degree south.

Jupiter on the 15th is in R.A. 20 h 46 m, Decl. 18° 24′ S., mag. −1.8, and transits at 7 h 12 m. In Capricornus, it rises about three hours before the sun and is well up in the south-east at dawn. (See Mars.) For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 73.

Saturn on the 15th is in R.A. 5 h 03 m, Decl. 21° 34′ N., mag. +0.3, and transits at 15 h 28 m. In Taurus, it is well past the meridian at sunset and sets about an hour before midnight.

Uranus on the 15th is in R.A. 13 h 18 m, Decl. 7° 33′ S., and transits at 23 h 41 m.

Neptune on the 15th is in R.A. 16 h 22 m, Decl. 19° 52′ S., and transits at 2 h 49 m.

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

1973			APRIL E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 4h E.S.T.	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Sun. 1	12		Mercury 6° S. of Moon		40312	243.97
Mon. 2					41O3d	256.19
Tues. 3	06	45	● New Moon	16 30	2O13*	268.41[b]
Wed. 4					1O234	280.64
Thur. 5	23		Moon at perigee (226,700 mi.)		3O124	292.86
Fri. 6	09		Mars 0.8° S. of Jupiter	13 20	321O4	305.08
Sat. 7	14		Saturn 3° S. of Moon		32O14	317.30
Sun. 8					O124*	329.51
Mon. 9			Mercury at aphelion	10 10	1O234	341.71
	14		Venus in superior conjunction			
	23	28	☽ First Quarter			
Tues. 10	09		Mercury greatest elong. W. (28°)		2O143	353.91
	20		Uranus at opposition			
Wed. 11	13		Juno stationary		1O243	6.10
	19		Ceres stationary			
Thur. 12				7 00	43O12	18.29
Fri. 13					4312O	30.47
Sat. 14					432O1	42.65[l]
Sun. 15				3 50	43O2*	54.82
Mon. 16					41O23	66.99[b]
Tues. 17	00		Uranus 6° N. of Moon		42O13	79.16
	08	51	○ Full Moon			
Wed. 18				0 30	41O3*	91.33
Thur. 19					43O12	103.50
Fri. 20	17		Neptune 4° N. of Moon	21 20	312O4	115.67
Sat. 21	21		Moon at apogee (251,800 mi.)		32O14	127.85
Sun. 22	03		Lyrid meteors		13O24	140.03
Mon. 23				18 10	O234d	152.22
Tues. 24					2O134	164.41
Wed. 25	12	59	☾ Last Quarter		1O34*	176.60
Thur. 26	00		Jupiter 3° S. of Moon	15 00	3O124	188.81
	16		Pallas at opposition			
Fri. 27	01		Mars 5° S. of Moon		312O4	201.02
Sat. 28					32O41	213.23[l]
Sun. 29			Mercury greatest hel. lat. S.	11 50	431O2	225.46
Mon. 30					4O132	237.68

[l]Apr. 14, +5.15°; Apr. 28, −7.33°.
[b]Apr. 3, −6.49°; Apr. 16, +6.56°.

THE SKY FOR MAY 1973

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 32 m to 4 h 35 m and its Decl. changes from 14° 58′ N. to 22° 00′ N. The equation of time changes from +2 m 57 s to a maximum of +3 m 43 s on the 14th and then to +2 m 23 s at the end of the month. For changes in the length of the day, see p. 15.

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

Mercury on the 1st is in R.A. 1 h 21 m, Decl. 5° 55′ N., and on the 15th is in R.A. 3 h 01 m, Decl. 16° 30′ N. It is too close to the sun for observation, superior conjunction being on the 20th.

Venus on the 1st is in R.A. 2 h 55 m, Decl. 16° 06′ N., and on the 15th it is in R.A. 4 h 05 m, Decl. 20° 48′ N., mag. −3.4, and transits at 12 h 35 m. It is an evening star low in the west at sunset and setting within an hour.

Mars on the 15th is in R.A. 22 h 29 m, Decl. 11° 32′ S., mag. +0.5, and transits at 6 h 59 m. In Aquarius, it rises about three hours before the sun.

Jupiter on the 15th is in R.A. 20 h 57 m, Decl. 17° 44′ S., mag. −2.0, and transits at 5 h 25 m. In Capricornus, it rises about midnight and is well up in the south-east by dawn. On the 31st 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. 73.

Saturn on the 15th is in R.A. 5 h 17 m, Decl. 21° 56′ N., mag. +0.3, and transits at 13 h 44 m. In Taurus, it is well down in the west at sunset and sets within about two hours.

Uranus on the 15th is in R.A. 13 h 14 m, Decl. 7° 07′ S., and transits at 21 h 39 m.

Neptune on the 15th is in R.A. 16 h 19 m, Decl. 19° 44′ S., and transits at 0 h 48 m.

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

1973			MAY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 3h E.S.T.	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Tues. 1	12		Mercury 8° S. of Moon		42O3*	249.92[b]
Wed. 2	15	55	🌑 New Moon	8 40	421O3	262.15
Thur. 3					4O312	274.39
Fri. 4	01		Moon at perigee (223,800 mi.)		431O2	286.63
Sat. 5	03		Saturn 3° S. of Moon	5 30	432O1	298.87
	04		η Aquarid meteors			
Sun. 6					31O2*	311.10
Mon. 7					O3412	323.33
Tues. 8				2 20	2O43*	335.55
Wed. 9	07	07	☽ First Quarter		2O34d	347.77
Thur. 10				23 10	O3124	359.98
Fri. 11					31O24	12.18[l]
Sat. 12					32O14	24.38
Sun. 13				20 00	31O24	36.58[b]
Mon. 14	05		Uranus 6° N. of Moon		O3124	48.77
Tues. 15			Venus at ascending node		21O3d	60.96
Wed. 16	23	58	○ Full Moon	16 40	42O3d	73.14
Thur. 17	22		Neptune 4° N. of Moon		4O132	85.33
Fri. 18			Mercury at ascending node		431O2	97.51
Sat. 19	09		Moon at apogee (252,300 mi.)	13 30	432O1	109.70
Sun. 20	03		Mercury in superior conjunction		431O*	121.89
	12		Venus 6° N. of Aldebaran			
Mon. 21					4O12*	134.08
Tues. 22				10 20	412O3	146.27
Wed. 23			Mercury at perihelion		24O13	158.48
	11		Jupiter 4° S. of Moon			
Thur. 24					O234*	170.68
Fri. 25	03	40	☾ Last Quarter	7 10	31O24	182.89
Sat. 26	01		Mars 8° S. of Moon		32O14	195.11[l]
Sun. 27	08		Neptune at opposition		31O4*	207.34
Mon. 28				4 00	O124*	219.57[b]
Tues. 29					12O34	231.81
Wed. 30	05		Venus 1.7° N. of Saturn		2O134	244.05
Thur. 31	00		Mercury 3° N. of Saturn	0 50	O243*	256.30
	01		Jupiter stationary			
	23	34	🌑 New Moon			

[l]May 11, +6.41°; May 26, −7.75°.
[b]May 1, −6.58°; May 13, +6.66°; May 28, −6.74°.

THE SKY FOR JUNE 1973

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 35 m to 6 h 39 m and its Decl. changes from 22° 00′ N. to 23° 08′ N. The equation of time changes from +2 m 14 s to −3 m 35 s, being zero on the 13th. There is a total eclipse of the sun on the 30th, 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 penumbral eclipse of the moon on the 15th, not visible in North America.

Mercury on the 1st is in R.A. 5 h 33 m, Decl. 25° 11′ N., and on the 15th is in R.A. 7 h 16 m, Decl. 24° 01′ N. Greatest eastern elongation is on the 22nd at which time it is about 15° above the western horizon at sunset. Thus for about a week before and after this date Mercury may be seen low in the west just after sunset.

Venus on the 1st is in R.A. 5 h 34 m, Decl. 23° 59′ N., and on the 15th it is in R.A. 6 h 49 m, Decl. 24° 07′ N., mag. −3.3, and transits at 13 h 18 m. Seen low in the west at sunset, it sets within an hour and a half.

Mars on the 15th is in R.A. 23 h 50 m, Decl. 3° 53′ S., mag. +0.1, and transits at 6 h 17 m. In Pisces, it rises about four hours before the sun.

Jupiter on the 15th is in R.A. 20 h 58 m, Decl. 17° 50′ S., mag. −2.2, and transits at 3 h 24 m. In Capricornus, it rises about two hours before midnight. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 73.

Saturn on the 15th is in R.A. 5 h 34 m, Decl. 22° 13′ N., and transits at 11 h 59 m. It is too close to the sun for observation, conjunction being on the 15th.

Uranus on the 15th is in R.A. 13 h 11 m, Decl. 6° 52′ S., and transits at 19 h 34 m.

Neptune on the 15th is in R.A. 16 h 16 m, Decl. 19° 36′ S., and transits at 22 h 39 m.

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

1973				JUNE 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		°
Fri.	1	03		Mercury 1.2° N. of Venus		43O2d	268.55
		06		Ceres at opposition			
		09		Moon at perigee (222,200 mi.)			
Sat.	2			Mercury greatest hel. lat. N.	21 40	342O1	280.80
		00		Mercury 0.9° N. of Moon. Occ'n.*			
Sun.	3					4312O	293.05
Mon.	4					43O12	305.30
Tues.	5	05		Juno at opposition	18 30	41O23	317.54
Wed.	6					42O13	329.77
Thur.	7	16	11	☽ First Quarter		41O23	342.00
Fri.	8				15 20	4O12d	354.23[l]
Sat.	9					32O**	6.45
Sun.	10	09		Uranus 6° N. of Moon		321O4	18.66[b]
Mon.	11				12 00	3O124	30.87
Tues.	12					1O234	43.07
Wed.	13					2O134	55.27
Thur.	14	03		Neptune 4° N. of Moon	8 50	1O34*	67.46
Fri.	15	04		Saturn in conjunction		O3124	79.66
		12		Moon at apogee (252,400 mi.)			
		15	35	○ Full Moon. Eclipse of ☾, p. 57			
Sat.	16					32O4*	91.85
Sun.	17				5 40	32O4d	104.05
Mon.	18			Venus at perihelion		34O12	116.24
		19		Pluto stationary			
Tues.	19	16		Jupiter 4° S. of Moon		41O23	128.44
Wed.	20	04		Mercury 6° S. of Pollux	2 30	42O13	140.64
Thur.	21	08	01	Solstice. Summer begins		41O3*	152.85
Fri.	22	12		Mercury greatest elong. E. (25°)	23 20	4O312	165.06
Sat.	23	14	45	☾ Last Quarter		4312O	177.27
		21		Mars 9° S. of Moon			
Sun.	24					432Od	189.50[l,b]
Mon.	25			Mercury at descending node	20 10	34O12	201.72
		00		Pallas stationary			
		02		Venus 5° S. of Pollux			
Tues.	26					1O342	213.96
Wed.	27	00		Uranus stationary		2O143	226.20
Thur.	28				17 00	12O34	238.45
Fri.	29	19		Moon at perigee (222,300 mi.)		O3124	250.70
Sat.	30			Mars greatest hel. lat. S.		31O4d	262.95
		06	39	● New Moon. Eclipse of ☉, p. 57.			

[l]June 8, +7.29°; June 24, −7.48°.
[b]June 10, +6.77°; June 24, −6.81°.
*Visible in Australia, Indian Ocean.

THE SKY FOR JULY 1973

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 39 m to 8 h 44 m and its Decl. changes from 23° 08′ N. to 18° 07′ N. The equation of time changes from −3 m 47 s to a maximum of −6 m 26 s on the 26th and then to −6 m 18 s at the end of the month. The earth is in aphelion on the 3rd at a distance of 94,513,000 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. There is a penumbral eclipse of the moon on the 15th.

Mercury on the 1st is in R.A. 8 h 16 m, Decl. 18° 33′ N., and on the 15th is in R.A. 8 h 08 m, Decl. 15° 38′ N. It is too close to the sun for observation, inferior conjunction being on the 20th.

Venus on the 1st is in R.A. 8 h 13 m, Decl. 21° 28′ N., and on the 15th it is in R.A. 9 h 23 m, Decl. 17° 03′ N., mag. −3.3, and transits at 13 h 53 m. It is an evening star seen low in the west for less than an hour and a half after sunset.

Mars on the 15th is in R.A. 1 h 00 m, Decl. 3° 06′ N., mag. −0.3, and transits at 5 h 29 m. In Pisces, it rises before midnight.

Jupiter on the 15th is in R.A. 20 h 47 m, Decl. 18° 39′ S., mag. −2.3, and transits at 1 h 15 m. In Capricornus, rising about at sunset, it is visible all night. Opposition is on the 30th. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 73.

Saturn on the 15th is in R.A. 5 h 51 m, Decl. 22° 21′ N., mag. +0.3, and transits at 10 h 18 m. Moving from Taurus into Gemini, it is now a morning star to be seen low in the east just before sunrise.

Uranus on the 15th is in R.A. 13 h 11 m, Decl. 6° 55′ S., and transits at 17 h 37 m.

Neptune on the 15th is in R.A. 16 h 13 m, Decl. 19° 30′ S., and transits at 20 h 38 m.

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

1973				JULY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 0h E.S.T.	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Sun.	1	14		Mercury 3° S. of Venus	13 40	32O14	275.21
		21		Mercury 0.8° N. of Moon. Occ'n.*			
		22		Venus 4° N. of Moon			
Mon.	2					3O24*	287.46
Tues.	3					1O24*	299.72
Wed.	4			Earth at aphelion	10 30	2O13d	311.96
Thur.	5	18		Mercury stationary		412O3	324.21
Fri.	6			Mercury at aphelion		4O132	336.44[l]
Sat.	7	03	26	☽ First Quarter	7 20	413O2	348.67[b]
		15		Uranus 6° N. of Moon			
Sun.	8					432O1	0.90
Mon.	9			Venus greatest hel. lat. N.		431O2	13.12
Tues.	10				4 10	4O2d*	25.33
Wed.	11	08		Neptune 5° N. of Moon		42O13	37.54
Thur.	12	17		Moon at apogee (252,200 mi.)		214O3	49.74
Fri.	13				1 00	O1432	61.94
Sat.	14					13O24	74.14
Sun.	15	06	56	☺ Full Moon. Penumbral eclipse	21 50	32O14	86.33
Mon.	16	17		Jupiter 4° S. of Moon		31O4*	98.53
Tues.	17					3O124	110.72
Wed.	18				18 40	2O134	122.92
Thur.	19					21O34	135.12
Fri.	20	01		Mercury in inferior conjunction		O1423	147.32
Sat.	21				15 30	143O2	159.53[l,b]
Sun.	22	10		Mars 9° S. of Moon		432O1	171.74
		22	58	☾ Last Quarter			
Mon.	23	00		Ceres stationary		431O*	183.96
Tues.	24	02		Venus 1.2° N. of Regulus	12 20	43O12	196.18
Wed.	25					42O3*	208.41
Thur.	26			Mars at perihelion		421O3	220.65
				Mercury greatest hel. lat. S.			
		22		Vesta in conjunction			
Fri.	27	02		Saturn 2° S. of Moon	9 00	4O123	232.89
Sat.	28	02		Moon at perigee (224,100 mi.)		41O2d	245.14
Sun.	29	04		δ Aquarid meteors		32O1*	257.39
		13	59	● New Moon			
Mon.	30	08		Jupiter at opposition	5 50	312O4	269.64
		08		Mercury stationary			
Tues.	31	23		Venus 7° N. of Moon		3O124	281.89

[l]July 6, +7.47°; July 21, −6.53°.
[b]July 7, +6.83°; July 21, −6.75°.
*Visible in Australasia.

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 44 m to 10 h 40 m and its Decl. changes from 18° 07′ N. to 8° 25′ N. The equation of time changes from −6 m 15 s to −0 m 14 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 37 m, Decl. 18° 04′ N., and on the 15th is in R.A. 8 h 29 m, Decl. 19° 11′ N. Greatest western elongation is on the 8th and at that time Mercury stands about 14° above the eastern horizon at sunrise, so that for about 10 days one might see it as a morning star very low in the east just before sunrise.

Venus on the 1st is in R.A. 10 h 42 m, Decl. 9° 45′ N., and on the 15th it is in R.A. 11 h 44 m, Decl. 2° 49′ N., mag. −3.4, and transits at 14 h 11 m. Seen low in the west at sunset, it sets within an hour and a half.

Mars on the 15th is in R.A. 2 h 00 m, Decl. 8° 34′ N., mag. −0.9, and transits at 4 h 26 m. Moving into Aries, it rises two to three hours before midnight.

Jupiter on the 15th is in R.A. 20 h 31 m, Decl. 19° 42′ S., mag. −2.3, and transits at 22 h 53 m. In Capricornus, it is risen in the south-east by sunset and sets just before dawn. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 73.

Saturn on the 15th is in R.A. 6 h 06 m, Decl. 22° 22′ N., mag. +0.3, and transits at 8 h 31 m. In Gemini, it rises about four hours before the sun.

Uranus on the 15th is in R.A. 13 h 15 m, Decl. 7° 16′ S., and transits at 15 h 38 m.

Neptune on the 15th is in R.A. 16 h 12 m, Decl. 19° 29′ S., and transits at 18 h 35 m.

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

1973				AUGUST E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 23h E.S.T.	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Wed.	1					2O34d	294.14
Thur.	2				2 40	O1234	306.39
Fri.	3	14		Juno stationary		1O324	318.63[l,b]
Sat.	4	00		Uranus 6° N. of Moon	23 30	32O14	330.87
Sun.	5	04		Mercury 9° S. of Pollux		312O4	343.10
		17	27	☽ First Quarter			
Mon.	6					34O12	355.32
Tues.	7	14		Neptune 4° N. of Moon	20 20	41O3d	7.54
Wed.	8	13		Mercury greatest elong. W. (19°)		42O13	19.75
Thur.	9	05		Moon at apogee (251,700 mi.)		4O23*	31.95
Fri.	10				17 10	41O32	44.15
Sat.	11					432O1	56.35
Sun.	12	05		Perseid Meteors		4321O	68.54
		16		Jupiter 3° S. of Moon			
Mon.	13	21	17	○ Full Moon	14 00	34O12	80.73
Tues.	14			Mercury at ascending node		1O24*	92.92
Wed.	15					2O134	105.10
Thur.	16	19		Neptune stationary	10 40	O34**	117.29
Fri.	17					1O324	129.48[l]
Sat.	18					32O14	141.67[b]
Sun.	19			Mercury at perihelion	7 30	321O4	153.87
		14		Mars 8° S. of Moon			
Mon.	20					3O124	166.07
Tues.	21	05	22	☾ Last Quarter		1O24*	178.27
Wed.	22				4 20	24O13	190.49
Thur.	23	15		Saturn 1° S. of Moon		41O3*	202.71
Fri.	24					4O32d	214.93
Sat.	25	02		Moon at perigee (227,000 mi.)	1 10	432O1	227.17
Sun.	26					4321O	239.40
Mon.	27	22	25	● New Moon	22 00	43O12	251.64
Tues.	28					413O2	263.89
Wed.	29			Mercury greatest hel. lat. N.		42O13	276.13
Thur.	30				18 50	142O3	288.37[b]
Fri.	31	00		Venus 6° N. of Moon		O1432	300.60[l]
		11		Uranus 6° N. of Moon			

[l]Aug. 3, +7.00°; Aug. 17, −5.30°; Aug. 31, +6.17°.
[b]Aug. 3, +6.75°; Aug. 18, −6.63°; Aug. 30, +6.59°.

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 40 m to 12 h 28 m and its Decl. changes from 8° 25′ N. to 3° 03′ S. The equation of time changes from +0 m 05 s to +10 m 04 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. 10 h 36 m, Decl. 10° 43′ N., and on the 15th is in R.A. 12 h 10 m, Decl. 0° 11′ S. It is too close to the sun for observation, superior conjunction being on the 2nd.

Venus on the 1st is in R.A. 12 h 57 m, Decl. 5° 56′ S., and on the 15th it is in R.A. 13 h 58 m, Decl. 12° 47′ S., mag. −3.6, and transits at 14 h 23 m. Seen low in the south-west at sunset it sets about an hour and a hlaf later.

Mars on the 15th is in R.A. 2 h 31 m, Decl. 11° 17′ N., mag. −1.6, and transits at 2 h 55 m. In Aries, it rises about two hours after sunset, now very bright. On the 19th it is stationary in right ascension and begins to retrograde, i.e. to move westward among the stars.

Jupiter on the 15th is in R.A. 20 h 20 m, Decl. 20° 21′ S., mag. −2.2, and transits at 20 h 41 m. In Capricornus, it is well up in the south-east at sunset and sets well before dawn. On the 28th 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. 73.

Saturn on the 15th is in R.A. 6 h 16 m, Decl. 22° 19′ N., mag. +0.3, and transits at 6 h 39 m. In Gemini it rises before midnight and is approaching the meridian at dawn.

Uranus on the 15th is in R.A. 13 h 20 m, Decl. 7° 51′ S., and transits at 13 h 42 m.

Neptune on the 15th is in R.A. 16 h 13 m, Decl. 19° 33′ S., and transits at 16 h 34 m.

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

1973				SEPTEMBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 21h E.S.T.	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Sat.	1					3O4*d	312.84
Sun.	2	15		Mercury in superior conjunction	15 30	321O4	325.06
Mon.	3			Venus at descending node		3O124	337.29
		21		Neptune 4° N. of Moon			
Tues.	4	10	22	☽ First Quarter		13O24	349.50
Wed.	5	18		Venus 0.8° S. of Uranus	12 20	2O134	1.71
		22		Moon at apogee (251,200 mi.)			
Thur.	6					12O43	13.91
Fri.	7	00		Venus 2° N. of Spica		O1423	26.11
Sat.	8	19		Jupiter 3° S. of Moon	9 10	41O2d	38.30
Sun.	9					432Od	50.49
Mon.	10					43O12	62.67
Tues.	11				6 00	431O2	74.84
Wed.	12	10	16	○ Full Moon. Harvest Moon		42O13	87.02
Thur.	13					412O3	99.19[l]
Fri.	14				2 50	4O123	111.36[b]
Sat.	15					41O32	123.53
Sun.	16	06		Mars 8° S. of Moon	23 40	32O1*	135.71
Mon.	17					3O4**	147.89
Tues.	18					31O24	160.07
Wed.	19	08		Mars stationary	20 30	2O314	172.26
		11	11	☾ Last Quarter			
Thur.	20	00		Saturn 1° S. of Moon. Occ'n.*		21O34	184.46
		17		Moon at perigee (229,700 mi.)			
Fri.	21			Mercury at descending node		O1234	196.67
Sat.	22	23	21	Equinox. Autumn begins	17 20	1O324	208.88
Sun.	23					32O14	221.09
Mon.	24					3O4**	233.31
Tues.	25				14 00	341O2	245.54
Wed.	26	08	54	● New Moon		42O1*	257.76
Thur.	27	08		Pluto in conjunction		421O3	269.99[b]
		16		Mercury 1.4° S. of Uranus			
		19		Mercury 1.4° N. of Spica			
		23		Uranus 6° N. of Moon			
Fri.	28	00		Mercury 4° N. of Moon	10 50	4O123	282.21[l]
		09		Jupiter stationary			
Sat.	29	23		Venus 2° N. of Moon		41O32	294.44
Sun.	30	14		Uranus 3° N. of Spica		423O1	306.66

[l]Sept. 13, −4.79°; Sept. 28, +5.40°.
[b]Sept. 14, −6.54°; Sept. 27, +6.51°.
*Visible in Arctic, Siberia.

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 28 m to 14 h 24 m and its Decl. changes from 3° 03′ S. to 14° 19′ S. The equation of time changes from +10 m 23 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. 13 h 40 m, Decl. 11° 36′ S., and on the 15th is in R.A. 14 h 50 m, Decl. 19° 03′ S. Greatest eastern elongation is on the 18th, but this is an exceedingly unfavourable one, Mercury being only about 6° above the south-western horizon at sunset.

Venus on the 1st is in R.A. 15 h 10 m, Decl. 19° 31′ S., and on the 15th it is in R.A. 16 h 16 m, Decl. 23° 52′ S., mag. −3.8, and transits at 14 h 43 m. Seen low in the south-west at sunset, it sets about two hours later.

Mars on the 15th is in R.A. 2 h 14 m, Decl. 10° 52′ N., mag. −2.2, and transits at 0 h 39 m. In Aries, it is in opposition on the 24th so that it rises about at sunset and sets at dawn. Mars is nearest the earth on the 16th at a distance of 40,532,000 miles.

Jupiter on the 15th is in R.A. 20 h 21 m, Decl. 20° 18′ S., mag. −2.0, and transits at 18 h 43 m. In Capricornus, 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. 73.

Saturn on the 15th is in R.A. 6 h 21 m, Decl. 22° 16′ N., mag. +0.2, and transits at 4 h 45 m. In Gemini, it rises about four hours after sunset. On the 17th it is stationary in right ascension and begins to retrograde or move westward among the stars.

Uranus on the 15th is in R.A. 13 h 27 m, Decl. 8° 32′ S., and transits at 11 h 51 m.

Neptune on the 15th is in R.A. 16 h 16 m, Decl. 19° 42′ S., and transits at 14 h 39 m.

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

1973				OCTOBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 20h E.S.T.	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Mon.	1	07		Neptune 4° N. of Moon	7 40	4312O	318.87
Tues.	2			Mercury at aphelion		34O2d	331.08
Wed.	3	18		Moon at apogee (251,100 mi.)		O4*d*	343.29
Thur.	4	05	32	☽ First Quarter	4 30	21O34	355.48
Fri.	5					O2134	7.67
Sat.	6	02		Jupiter 3° S. of Moon		1O234	19.86
Sun.	7				1 20	23O14	32.04
Mon.	8			Venus at aphelion		312O4	44.21
Tues.	9				22 10	3O124	56.37
Wed.	10					3O24*	68.54[l]
Thur.	11	22	09	○ Full Moon. Hunter's moon		21O3d	80.69[b]
Fri.	12				19 00	4O13*	92.85
Sat.	13	07		Mars 7° S. of Moon		41O23	105.00
Sun.	14	17		Venus 4° S. of Neptune		423O1	117.16
Mon.	15	20		Moon at perigee (228,600 mi.)	15 40	4321O	129.32
Tues.	16	18		Uranus in conjunction		43O12	141.48
		23		Mars nearest to earth			
Wed.	17	01		Saturn stationary		431O2	153.64
		05		Venus 1.9° N. of Antares			
		06		Saturn 0.8° S. of Moon. Occ'n.*			
Thur.	18	17		Mercury greatest elong. E. (25°)	12 30	42O3d	165.81
		17	33	☾ Last Quarter			
Fri.	19					4O13*	177.99
Sat.	20					1O423	190.18
Sun.	21	07		Orionid meteors	9 20	2O14d	202.37
Mon.	22			Mercury greatest hel. lat. S.		321O4	214.57
Tues.	23					3O124	226.77
Wed.	24	22		Mars at opposition	6 10	31O24	238.97[b]
Thur.	25	22	17	● New Moon		2O134	251.18[l]
Fri.	26					2O34*	263.39
Sat.	27	19		Mercury 0.1° S. of Moon. Occ'n.**	3 00	1O423	275.60
Sun.	28	16		Neptune 4° N. of Moon		42O31	287.81
Mon.	29				23 50	4321O	300.02
Tues.	30			Mercury greatest hel. lat. S.		43O21	312.22
		01		Venus 3° S. of Moon			
		10		Mercury stationary			
Wed.	31	14		Moon at apogee (251,600 mi.)		431O2	324.41

[l]Oct. 10, −5.34°; Oct. 25, +5.27°.

[b]Oct. 11, −6.56°; Oct. 24, +6.59°.

*Visible in N. of N. America, Europe, E. Asia.

**Visible in S. Pacific.

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 24 m to 16 h 28 m and its Decl. changes from 14° 19′ S. to 21 ° 45′ S. The equation of time changes from +16 m 23 s to a maximum of +16 m 24 s on the 3rd and then to +11 m 15 s at the end of the month. For changes in the length of the day, see p. 18.

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

Mercury on the 1st is in R.A. 15 h 34 m, Decl. 21° 51′ S., and on the 15th is in R.A. 14 h 42 m, Decl. 14° 16′ S. On the 10th it is in inferior conjunction, a transit occurring on that date, but by the 27th it is in greatest western elongation, standing about 14° above the south-eastern horizon at sunrise. Thus for about 10 days it may be seen as a morning star.

Venus on the 1st is in R.A. 17 h 38 m, Decl. 26° 35′ S., and on the 15th it is in R.A. 18 h 43 m, Decl. 26° 30′ S., mag. −4.1, and transits at 15 h 07 m. Although greatest eastern elongation is on the 13th, it is only about 16° above the south-western horizon at sunset and sets within two and a half hours.

Mars on the 15th is in R.A. 1 h 38 m, Decl. 9° 36′ N., mag. −1.7, and transits at 21 h 57 m. Moving back into Pisces, it is now well up in the east at sunset. On the 19th it is stationary again in right ascension and resumes direct or eastward motion among the stars.

Jupiter on the 15th is in R.A. 20 h 33 m, Decl. 19° 33′ S., mag. −1.8, and transits at 16 h 55 m. In Capricornus, it is near the meridian at sunset and sets about five hours later. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 73.

Saturn on the 15th is in R.A. 6 h 17 m, Decl. 22° 18′ N., mag. 0.0, and transits at 2 h 40 m. In Gemini it rises about three hours after sunset.

Uranus on the 15th is in R.A. 13 h 34 m, Decl. 9° 14′ S., and transits at 9 h 56 m.

Neptune on the 15th is in R.A. 16 h 20 m, Decl. 19° 53′ S., and transits at 12 h 42 m.

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

1973			NOVEMBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 19 h E.S.T.	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Thur. 1				20 40	42O13	336.61
Fri. 2	14		Jupiter 4° S. of Moon		421O3	348.79
Sat. 3	01	29	☽ First Quarter		41O23	0.97
Sun. 4			Taurid meteors	17 30	4O31d	13.14
Mon. 5					2314O	25.31
Tues. 6					3O214	37.47
Wed. 7				14 20	31O24	49.62[l,b]
Thur. 8					2O314	61.77
Fri. 9	02		Mars 6° S. of Moon		21O34	73.91
Sat. 10			Mercury at ascending node	11 00	O234d	86.05
	06		Mercury in inferior conjunction, transit over sun, p. 57			
	09	27	○ Full Moon			
Sun. 11					O234*	98.19
Mon. 12	10		Moon at perigee (225,200 mi.)		231O4	110.33
Tues. 13	05		Venus greatest elong. E. (47°)	7 50	3O14*	122.47
	12		Saturn 0.6° S. of Moon. Occ'n.*			
Wed. 14					314O2	134.61
Thur. 15			Mercury at perihelion		42O1*	146.76
Fri. 16				4 40	421O3	158.91
Sat. 17	01		Leonid meteors		4O123	171.08
	01	34	☾ Last Quarter			
Sun. 18					4O23*	183.24
Mon. 19	04		Mercury stationary	1 30	4231O	195.42
Tues. 20					43O1*	207.60[l,b]
Wed. 21	20		Uranus 6° N. of Moon	22 20	341O2	219.78
Thur. 22					23O1*	231.97
Fri. 23	02		Mercury 6° N. of Moon		21O34	244.17
Sat. 24	14	55	● New Moon	19 10	O1234	256.36
Sun. 25			Mars at ascending node		1O234	268.56
			Mercury greatest hel. lat. N.			
Mon. 26					23O4d	280.75
Tues. 27	00		Mercury greatest elong. W. (20°)	16 00	32O14	292.95
	03		Mars stationary			
Wed. 28	08		Moon at apogee (252,200 mi.)		31O24	305.14
	23		Venus 5° S. of Moon			
Thur. 29	08		Neptune in conjunction		32O14	317.32
Fri. 30	06		Jupiter 4° S. of Moon	12 50	21O43	329.51

[l]Nov. 7, −6.38°; Nov. 20, +6.25°.
[b]Nov. 7, −6.69°; Nov. 20, +6.73°.
*Visible in N.W. of N. America, Asia.

THE SKY FOR DECEMBER 1973

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 28 m to 18 h 44 m and its Decl. changes from 21° 45′ S. to 23° 03′ S. The equation of time changes from +10 m 53 s to −3 m 08 s, being zero on the 25th. There is an annular eclipse of the sun on the 24th, visible as a partial eclipse in eastern 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. There is a partial eclipse of the moon on the 9th, visible in North America.

Mercury on the 1st is in R.A. 15 h 09 m, Decl. 15° 31′ S., and on the 15th is in R.A. 16 h 30 m, Decl. 21° 21′ S. Except for the first day or two of the month (see November) it is too close to the sun for observation.

Venus on the 1st is in R.A. 19 h 48 m, Decl. 24° 07′ S., and on the 15th it is in R.A. 20 h 31 m, Decl. 20° 41′ S., mag. −4.4, and transits at 14 h 55 m. It is to be seen low in the south-west for about three hours after sunset. Greatest brilliancy is on the 19th.

Mars on the 15th is in R.A. 1 h 41 m, Decl. 11° 18′ N., mag. −0.7, and transits at 20 h 04 m. Moving from Pisces into Aries, it is fairly high in the east at sunset and sets about three hours after midnight.

Jupiter on the 15th is in R.A. 20 h 54 m, Decl. 18° 13′ S., mag. −1.7, and transits at 15 h 17 m. In Capricornus, it is well past the meridian at sunset and sets within four hours thereafter. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 73.

Saturn on the 15th is in R.A. 6 h 08 m, Decl. 22° 22′ N., mag. −0.2, and transits at 0 h 33 m. In Gemini it rises about an hour after sunset, opposition being on the 23rd.

Uranus on the 15th is in R.A. 13 h 40 m, Decl. 9° 46′ S., and transits at 8 h 04 m.

Neptune on the 15th is in R.A. 16 h 25 m, Decl. 20° 05′ S., and transits at 10 h 48 m.

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

1973				DECEMBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 18h E.S.T.	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Sat.	1					4O123	341.68
Sun.	2	20	29	☽ First Quarter		41O23	353.86
Mon.	3				9 40	42O1d	6.02
Tues.	4					432O1	18.18[b]
Wed.	5					431O2	30.33[l,b]
Thur.	6	10		Mars 4° S. of Moon	6 30	43O1d	42.47
Fri.	7					421O3	54.61
Sat.	8					4O213	66.75
Sun.	9	20	34	⊕ Full Moon. Eclipse of ☾, p. 57	3 20	1O423	78.88
Mon.	10	17		Moon at perigee (222,500 mi.)		2O314	91.00
		19		Saturn 0.7° S. of Moon. Occ'n.*			
Tues.	11					321O4	103.13
Wed.	12				0 00	31O24	115.26
Thur.	13	22		Geminid meteors		3O214	127.39
Fri.	14	00		Mercury 1.0° S. of Neptune	20 50	21O34	139.52
		12		Mercury 5° N. of Antares			
Sat.	15					O134*	151.67
Sun.	16	12	13	☾ Last Quarter		1O243	163.81
		15		Pallas in conjunction			
Mon.	17				17 40	2O413	175.97[b]
Tues.	18			Mercury at descending node		4321O	188.13[l]
Wed.	19	01		Venus greatest brilliancy		43O2d	200.30
		04		Uranus 6° N. of Moon			
Thur.	20				14 30	43O21	212.47
Fri.	21	19	08	Solstice. Winter begins		421O*	224.65
Sat.	22	09		Neptune 3° N. of Moon		42O13	236.84
		15		Ursid meteors			
Sun.	23	01		Saturn at opposition	11 20	41O23	249.02
Mon.	24	10	07	● New Moon. Eclipse of ☉, p. 57		42O13	261.21
Tues.	25			Venus at ascending node		2431O	273.40
		17		Moon at apogee (252,600 mi.)			
Wed.	26				8 10	3O12*	285.59
Thur.	27	17		Venus 3° S. of Moon		3O24*	297.77
Fri.	28	00		Jupiter 5° S. of Moon		213O4	309.96
Sat.	29			Mercury at aphelion	5 00	2O134	322.14
Sun.	30					1O234	334.31
Mon.	31					2O134	346.48

[l]Dec. 5, −7.35°; Dec. 18, +7.38°.
[b]Dec. 4, 5, −6.78°; Dec. 17, +6.83°.
*Visible in N.E. of N. America, N. Europe, W. Asia.

SUN—EPHEMERIS FOR PHYSICAL OBSERVATIONS, 1973

For 0h U.T.

Date	P	B_0	L_0	Date	P	B_0	L_0
	°	°	°		°	°	°
Jan. 1	+ 2.08	−3.06	201.32	July 5	− 0.94	+3.33	279.59
6	− 0.35	−3.63	135.47	10	+ 1.33	+3.86	213.41
11	− 2.76	−4.18	69.63	15	+ 3.57	+4.35	147.24
16	− 5.12	−4.69	3.79	20	+ 5.77	+4.82	81.08
21	− 7.42	−5.16	297.95	25	+ 7.91	+5.25	14.93
26	− 9.64	−5.59	232.12	30	+ 9.98	+5.65	308.80
31	−11.76	−5.98	166.29	Aug. 4	+11.96	+6.01	242.67
Feb. 5	−13.77	−6.32	100.46	9	+13.85	+6.33	176.56
10	−15.66	−6.61	34.63	14	+15.64	+6.60	110.45
15	−17.41	−6.84	328.79	19	+17.31	+6.83	44.36
20	−19.03	−7.03	262.94	24	+18.86	+7.01	338.29
25	−20.49	−7.16	197.09	29	+20.29	+7.14	272.23
Mar. 2	−21.80	−7.23	131.23	Sept. 3	+21.57	+7.22	206.19
7	−22.96	−7.25	65.36	8	+22.72	+7.25	140.15
12	−23.95	−7.21	359.48	13	+23.72	+7.23	74.13
17	−24.77	−7.12	293.58	18	+24.57	+7.15	8.12
22	−25.43	−6.97	227.66	23	+25.26	+7.02	302.12
27	−25.91	−6.78	161.72	28	+25.78	+6.84	236.13
Apr. 1	−26.21	−6.53	95.77	Oct. 3	+26.14	+6.61	170.15
6	−26.33	−6.23	29.80	8	+26.32	+6.33	104.18
11	−26.28	−5.89	323.80	13	+26.31	+6.00	38.22
16	−26.04	−5.51	257.79	18	+26.12	+5.62	332.27
21	−25.61	−5.09	191.75	23	+25.74	+5.20	266.32
26	−25.00	−4.63	125.70	28	+25.17	+4.75	200.38
May 1	−24.21	−4.14	59.63	Nov. 2	+24.40	+4.25	134.45
6	−23.24	−3.62	353.54	7	+23.43	+3.72	68.52
11	−22.09	−3.08	287.43	12	+22.27	+3.16	2.60
16	−20.77	−2.52	221.30	17	+20.91	+2.58	296.69
21	−19.29	−1.94	155.16	22	+19.37	+1.98	230.78
26	−17.66	−1.35	89.01	27	+17.66	+1.36	164.88
31	−15.88	−0.75	22.85	Dec. 2	+15.78	+0.72	98.98
June 5	−13.98	−0.15	316.68	7	+13.76	+0.08	33.09
10	−11.97	+0.45	250.50	12	+11.61	−0.56	327.21
15	− 9.87	+1.05	184.32	17	+ 9.36	−1.19	261.33
20	− 7.70	+1.64	118.13	22	+ 7.02	−1.82	195.47
25	− 5.47	+2.22	51.95	27	+ 4.63	−2.44	129.61
30	− 3.21	+2.79	345.77				

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

Carrington's Rotation Numbers—Greenwich Date of Commencement of Synodic Rotations, 1973

No.	Commences	No.	Commences	No.	Commences
1597	Jan. 16.29	1602	June 1.73	1607	Oct. 15.90
1598	Feb. 12.63	1603	June 28.92	1608	Nov. 12.20
1599	Mar. 11.96	1604	July 26.13	1609	Dec. 9.51
1600	Apr. 8.26	1605	Aug. 22.36		
1601	May 5.51	1606	Sept. 18.61		

ECLIPSES DURING 1973

In 1973 there will be seven eclipses, three of the sun and four of the moon.

1. *An annular eclipse of the sun* on January 4, visible in the South Pacific, across the southern part of South America and in the South Atlantic, but not at all in North America.

2. *A penumbral eclipse of the moon* on January 18, the ending only being visible in the north-eastern half of North America.

Moon enters penumbra	Jan. 18,	14.17 E.S.T.
Middle of eclipse		16.17 E.S.T.
Moon leaves penumbra		18.18 E.S.T.

3. *A penumbral eclipse of the moon* on June 15, no part of which is visible in North America.

4. *A total eclipse of the sun* on June 30, totality visible in a narrow band extending from Guiana across the Atlantic and across central Africa, ending in the Indian Ocean.

5. *A penumbral eclipse of the moon* on July 15, visible in the western half of North America.

Moon enters penumbra	July 15,	5.43 E.S.T.
Middle of eclipse		6.39 E.S.T.
Moon leaves penumbra		7.34 E.S.T.

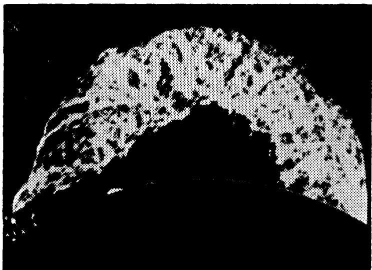
6. *A partial eclipse of the moon* on December 9, visible in North America.

Moon enters penumbra	Dec. 9	18.37 E.S.T.
Moon enters umbıa		20.09 E.S.T.
Middle of eclipse		20.45 E.S.T.
Moon leaves umbra		21.20 E.S.T.
Moon leaves penumbra		22.52 E.S.T.

7. *An annular eclipse of the sun* on December 24, visible across the northern part of South America, the Atlantic Ocean and north-west Africa. The partial phase will be visible in the eastern half of North America just after sunrise.

TRANSIT OF MERCURY

A transit of Mercury across the disk of the sun will occur on November 10. The latter part of this event will be visible in the eastern half of North America, the transit being already under way at sunrise and the egress from the disk (at position angle 293°) occuring at about 8.18 E.S.T.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THE OBSERVATION OF THE MOON

During 1973 the ascending node of the moon's orbit is in Sagittarius (☊ from 287 to 268°). See p. 59 for occultations of stars.

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

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

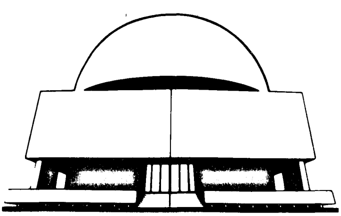
Sunrise will occur at a given point *east* of the central meridian of the moon when the sun's selenographic colongitude is equal to the eastern selenographic longitude of the point; at a point *west* of the central meridian when the sun's selenographic colongitude is equal to 360° minus the western selenographic 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 +1½° and −1½° 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: Halifax, λ_0 63° 36.0′, ϕ_0 +44° 38.0′; Montreal, λ_0 73° 34.5′, ϕ_0 +45° 30.3′; Toronto, λ_0 79° 24.0′, ϕ_0 +43° 39.8′; Winnipeg, λ_0 97° 06.0′, ϕ_0 +49° 55.0′; Edmonton, λ_0 113° 04.5′, ϕ_0 +53° 32.0′; Vancouver, λ_0 123° 06.0′, ϕ_0 +49° 30.0′.

Date	Name	Z.C. No.	Mag.	I or E	Elong. of Moon	HALIFAX W. 63°.600, N. 44°.633 A.T.	a	b	P	MONTREAL W. 73°.575, N. 45°.505 E.S.T.	a	b	P
					°	h m	m	m	°	h m	m	m	°
Jan. 13	ε Ari	440	4.6	I	114	22 33.8	−1.2	−0.8	80	21 19.7	−1.5	−0.4	78
14	36 Tau	598	5.7	I	128	23 49.3	−1.1	−1.0	85	22 36.2	−1.4	−0.8	87
15	+23° 624	611	7.0	I	129	1 59.8	+0.5	−3.1	145	1 03.5	.	.	163
15	98 k Tau	743	5.6	I	140	18 01.6	−0.7	+1.7	71	Sun			
23	13 B. Vir	1713	5.8	E	237	3 29.2	−2.4	+0.4	266	2 04.1	.	.	245
28	40 B. Sco	2286	5.4	E	294	6 02.2	.	.	351	4 59.0	−0.4	−0.6	333
Feb. 6	+3° 4909m	3524	6.9	I	43	18 45.6	−0.8	−0.6	69	Sun			
9	μ Ari	399	5.7	I	83	21 52.6	−0.4	−2.7	121	20 44.0	−0.8	−2.9	123
10	9 Tau	521	6.7	I	96	19 07.1	−1.6	+1.2	55	17 53.1	−1.4	+2.0	45
10/11	104 B. Tau	556	5.5	I	98	0 33.0	−0.2	−0.7	67	23 29.1	−0.4	−0.9	75
12	315 B. Tau	740	6.3	I	113	Low				1 40.2	+0.3	−1.5	110
12	399 B. Tau	880	7.2	I	123	21 24.6	−1.5	−1.4	116	20 07.2	−1.7	−1.1	117
12	132 Tau	882	5.0	I	124	22 06.4	−1.1	−2.5	135	20 51.8	−1.4	−2.7	140
13	412 B. Tau	898	6.0	I	125	1 43.6	0.0	−1.9	122	0 41.5	−0.1	−2.2	133
13	+23° 1491	1036	6.5	I	136	18 39.6	−1.1	+2.0	68	Sun			
13/14	+22° 1531	1059	6.9	I	138	1 04.5	−0.8	−1.5	103	23 54.6	−0.9	−1.7	114
19	87 e Leo	1670	5.1	E	204	3 21.5	−2.6	−0.1	249	No. Occ.			
23	18 G. Lib	2109	6.1	E	252	No occ.				3 18.3	—	—	358
Mar. 9	+21° 447	493	6.9	I	66	20 28.8	—	—	150	Graze			
10	62 Tau	652	6.4	I	79	18 53.8	−1.6	−0.7	91	Sun			
11	+24° 854	835	6.9	I	94	22 08.6	−0.9	−1.3	91	20 57.8	−1.1	−1.4	100
11/12	+24° 909	853	7.0	I	95	0 52.3	+0.4	−1.7	122	23 54.1	+0.3	−2.0	132
12	+23° 1425	1014	6.8	I	107	22 45.2	−0.6	−2.0	121	21 36.3	−0.8	−2.3	132
13	69 B. Gem	1033	6.8	I	109	Low				1 16.6	−0.3	−0.8	63
13	171 B. Gem	1150	6.8	I	120	23 07.6	−0.7	−2.1	132	21 58.5	−0.7	−2.5	144
20/21	75 Vir	1944	5.6	E	208	0 07.4	—	—	3	23 06.7	−0.2	−1.2	343
22	−19° 3880	2066	6.4	E	220	3 09.9	−1.8	−0.7	295	1 51.4	−1.8	−0.1	285
Apr. 6	+23° 624	611	7.0	I	49	No occ.				19 20.2	—	—	21
6	+23° 648	624	7.0	I	50	Low				21 17.4	−0.1	−0.8	71
8	9 Gem	956	6.3	I	76	20 27.5	−1.6	−0.1	62	19 11.3	−1.6	−0.3	73
8	10 Gem	960	6.6	I	76	21 21.1	−1.1	−0.6	67	20 08.8	−1.2	−0.8	79
8	11 Gem	962	7.0	I	76	21 29.9	−0.7	−1.3	91	20 21.0	−0.9	−1.5	102
8	12 Gem	964	7.0	I	76	21 39.4	−0.1	−2.2	131	20 35.5	−0.2	−2.6	143
8	36 B. Gem	983	6.0	I	78	No occ.				23 12.6	−0.8	+0.1	40
9/10	+20° 1798p	1123	7.2	I	91	0 05.5	0.0	−1.4	100	23 03.1	−0.2	−1.6	109
9/10	61 Gem	1127	5.9	I	91	0 44.0	+0.3	−1.7	126	23 45.3	+0.2	−1.9	134
10	+18° 1882	1241	6.4	I	102	19 28.3	−1.8	−0.6	102	Sun			
12	222 B. Cnc	1381	6.3	I	117	1 38.3	+0.2	−2.2	156	0 38.3	+0.2	−2.5	165
13	16 Sex	1489	6.8	I	130	2 12.1	0.0	−2.1	146	1 09.3	−0.1	−2.3	152
20	31 B. Sco	2269	5.4	E	212	Sun				4 04.6	−1.5	−0.6	247
24	222 B. Sgr	2822	5.6	E	255	3 51.4	−1.7	+1.6	224	2 36.0	−1.6	+1.9	225
May 5	—	5004	8.0	I	44	20 16.2	+0.5	−2.8	153	Sun			
7	+18° 1816	1203	7.1	I	72	20 49.1	−1.0	−1.1	83	Sun			
8	177 B. Cnc	1344	6.8	I	86	22 46.6	0.0	−2.2	146	21 44.2	0.0	−2.4	156
9	+9° 2239	1440	6.7	I	98	20 17.5	−0.9	−2.0	143	Sun			
10	+8° 2289	1457	6.7	I	100	Low				0 03.2	−0.3	−1.3	81
11	−1° 2521	1655	6.7	I	122	20 27.1	−1.9	−0.5	103	Sun			
11/12	87 e Leo	1670	5.1	I	124	0 19.3	−0.9	−1.5	89	23 07.1	−1.3	−1.5	96
June 5	6 h Leo	1410	5.3	I	67	20 56.5	−0.1	−2.4	159	19 54.2	+0.1	−2.8	172
6	84 B. Sex	1528	6.6	I	81	22 30.7	−0.2	−2.0	135	21 25.8	−0.4	−2.1	140
7	−0° 2422	1629	6.8	I	93	22 23.8	−1.1	−0.9	65	21 09.6	−1.5	−1.0	75
10	562 B. Vir	1960	6.9	I	129	Low				23 19.8	−1.3	−1.2	81
11	−19° 3880	2066	6.4	I	139	22 16.4	−1.9	−0.8	102	20 56.9	−1.8	−0.4	110
20	53 B Aqr	3109	6.5	E	228	2 45.5	−1.7	+1.1	240	1 29.6	−1.7	+1.3	251
20	−13° 5897	3112	6.2	E	228	3 01.8	—	—	180	1 57.1	−1.0	+2.1	200
23	+1° 4744	3482	5.6	E	263	2 51.5	−0.8	+2.1	219	1 46.1	−0.7	+2.0	230
July 4	55 Leo	1587	6.0	I	61	20 49.3	−0.6	−1.5	91	Sun			
4	57 Leo	1590	6.9	I	61	21 16.7	−0.2	−2.0	139	Sun			
10	31 B. Sco	2269	5.4	I	132	23 05.3	−1.9	−2.1	138	21 44.6	−1.9	−1.4	134
19	κ Aqr	3320	5.3	E	222	3 35.7	−2.1	−0.2	266	2 10.9	−2.8	−0.5	288
July 26	99 Tau	742	6.0	E	311	Sun				2 54.9	0.0	+1.5	256
27	1 Gem	916	4.3	I	325	3 40.5	−0.6	−0.3	145	Low			
27	1 Gem	916	4.3	E	325	4 10.3	+0.7	+2.9	212	3 17.7	+0.5	+2.0	230
Aug. 7	22 Sco	2371	4.9	I	112	Low				21 30.8	−1.6	−1.0	89
Sept. 3	64 G. Lib	2183	5.7	I	70	Low				19 21.9	—	—	40
3	24 G. Sco	2311	6.2	I	81	19 51.3	−1.6	−1.2	95	Sun			
4	88 B. Oph	2442	5.9	I	92	19 36.5	−1.6	+0.2	51	Sun			
5	63 Oph	2577	6.1	I	103	21 02.4	−1.9	−1.1	99	19 42.7	−2.0	−0.5	90
7	203 G. Sgr	2859	6.7	I	124	20 09.6	−1.3	+1.8	23	18 59.0	—	—	11
8	−17° 5975	2979	7.1	I	136	20 53.8	−1.6	+1.0	53	19 39.3	−1.5	+1.6	43

Date	Name	Z.C. No.	Mag.	I or E	Elong. of Moon	HALIFAX W. 63°600, N. 44°633				MONTREAL W. 73°575, N. 45°505			
						A.T.	a	b	P	E.S.T.	a	b	P
					°	h m	m	m	°	h m	m	m	°
Sept. 8	35 B. Cap	2989	6.8	I	136	No occ.				21 20.6	.	.	120
9	41 B. Cap	2997	7.1	I	137	1 10.7	−0.5	−0.2	52	0 05.7	−0.5	+0.4	36
9	53 B. Aqr	3109	6.5	I	148	21 34.1	−2.0	+0.6	81	20 16.7	−1.6	+1.2	69
16/17	ζ Ari	472	5.0	E	235	0 01.3	−1.0	+1.0	280	22 52.2	−1.0	+0.7	297
17	τ Ari	486	5.2	E	236	Graze				1 49.6	−0.6	+3.3	204
19/20	μ Gem	976	3.2	I	275	0 53.2	−0.7	−0.3	143	23 49.2	−0.2	+0.4	126
20	μ Gem	976	3.2	E	275	1 28.3	+0.4	+3.1	218	0 33.4	+0.3	+2.1	235
21	61 Gem	1127	5.9	E	289	3 03.7	−0.9	−0.1	314	1 55.4	−0.8	−0.7	328
Oct. 6	95 B. Cap	3066	6.0	I	117	22 29.4	−2.0	−1.8	104	21 09.1	−1.9	−0.5	84
8	−9° 5854	3199	6.8	I	129	Low				0 40.7	−0.1	+1.0	22
9	κ Aqr	3320	5.3	I	141	1 24.6	−1.1	−1.7	95	0 11.9	−1.2	−0.9	81
10	κ Psc	3453	4.9	I	153	2 08.4	−1.1	−2.1	103	0 54.4	−1.4	−1.3	90
14	133 B. Tau	566	5.9	E	216	20 00.3	—	—	331	No occ.			
14	32 Tau	582	5.8	E	217	23 11.6	−1.0	+1.2	271	22 03.3	−0.9	+0.9	286
17	3 Gem	929	5.8	E	246	2 18.4	−1.6	−0.6	307	1 02.4	−1.5	−0.9	319
17	6 Gem	942	6.3	E	246	3 49.1	−1.7	+0.3	273	2 33.1	−1.5	+0.5	277
17	Saturn	—	0.2	I	248	8 07.6	−0.2	−3.0	151	7 03.9	+0.1	−4.5	166
17	Saturn	—	0.2	E	248	8 52.8	−1.2	−0.3	239	7 36.7	−2.2	+1.2	223
Nov. 1	56 f Sgr	2886	5.1	I	73	17 58.3	−1.9	0.0	75	Sun			
4	128 B. Aqr	3248	6.6	I	107	No occ.				17 37.0	−2.7	0.0	114
4	−7° 5727	3259	7.4	I	108	22 02.0	−0.3	+1.8	13	Graze			
6	19 Psc	3501	5.3	I	131	20 22.6	−1.6	+1.1	63	19 10.1	−1.2	+1.7	47
7	+3° 4909m	3524	6.9	I	134	Low				1 54.6	−0.3	−1.9	101
7	136 B. Psc	89	6.5	I	145	23 18.4	−1.7	−0.4	82	22 01.7	−1.6	+0.5	67
11	υ Tau	660	4.4	E	197	18 43.4	+0.2	+1.2	263	Low			
11	72 Tau	664	5.4	E	197	19 02.6	−0.2	+0.8	294	Low			
12	+23° 1007	859	6.5	E	213	22 56.9	−1.1	+0.6	287	21 47.4	−0.9	+0.4	301
12	394 B. Tau	865	6.1	E	213	23 37.3	−1.1	+1.4	259	22 28.8	−0.8	+1.2	270
14	ζ Gem	1077	3.9v	I	231	Sun				6 00.2	−0.9	−1.8	120
14	81 G. Gem	1175	5.0	E	240	22 35.8	−0.3	+0.6	297	Low			
15	3 Cnc	1207	5.8	E	244	Sun				5 09.6	−2.0	0.0	260
19	87 e Leo	1670	5.1	E	295	5 46.3	−1.4	+0.3	290	4 33.8	−1.2	+0.9	281
Dec. 1	−9° 5854	3199	6.8	I	75	17 26.3	−1.6	+0.9	55	Sun			
2	κ Aqr	3320	5.3	I	87	No occ.				17 13.3	—	—	113
2	207 B. Aqr	3326	6.4	I	88	20 54.4	−1.5	−1.4	91	19 38.1	−1.6	−0.4	75
3	+1° 4731	3464	7.1	I	101	23 44.3	−0.3	+0.3	40	22 40.4	−0.5	+0.7	33
5	212 B. Psc	177	7.1	I	126	Graze				23 41.3	—	—	142
7	20 H[1] Ari	317	6.4	I	139	1 40.4	−0.8	−0.3	59	0 31.3	−1.0	−0.2	59
8	ζ Ari	472	5.0	I	154	4 22.2	−0.7	+0.8	29	3 15.7	−0.7	+0.3	39
10	Saturn	—	−0.2	I	192	18 55.3	−0.3	+0.4	126	17 54.9	+0.1	+0.7	113
10	Saturn	—	−0.2	E	192	19 38.2	+0.2	+2.1	233	18 41.7	+0.2	+1.7	247
10	μ Gem	976	3.2	I	195	23 51.4	−1.6	+1.5	70	22 39.1	−1.2	+2.0	64
10/11	μ Gem	976	3.2	E	195	0 56.8	−1.6	−1.4	307	23 39.9	−1.6	−1.1	309
14	6 h Leo	1410	5.3	E	238	4 44.4	−1.0	−1.9	326	3 31.5	−1.3	−1.3	314
18	370 B. Vir	1852	6.0	E	289	4 30.0	−0.3	−1.2	339	3 26.2	−0.3	−0.5	328
18	−11° 3398	1858	6.5	E	290	6 30.7	−0.6	−1.6	342	5 22.3	−0.8	−0.8	327
19	83 Vir	1967	5.7	E	301	5 14.9	−0.7	−0.1	314	4 08.8	−0.6	+0.4	303
28	−10° 5714	3163	7.3	I	45	17 26.4	−1.1	+0.3	49	Sun			
29	−5° 5790	3290	7.3	I	57	20 19.3	−1.4	−4.1	123	19 02.4	−1.5	−2.2	103
30	−1° 4393	3397	7.4	I	68	18 12.5	−0.7	+1.9	18	17 12.6	—	—	352
31	+3° 4909m	3524	6.9	I	80	20 03.7	—	—	134	18 33.8	−2.4	−1.8	106

LUNAR OCCULTATIONS VISIBLE AT TORONTO AND WINNIPEG, 1973

Date	Name	Z.C. No.	Mag.	I or E	Elong. of Moon	HALIFAX W. 63°600, N. 44°633				MONTREAL W. 73°575, N. 45°505			
						A.T.	a	b	P	E.S.T.	a	b	P
					°	h m	m	m	°	h m	m	m	°
Jan. 9	κ Psc	3453	4.9	I	63	Low				20 25.7	−0.6	−0.4	57
9	9 Psc	3455	6.4	I	63	Low				20 31.0	−0.8	−1.7	93
12/13	47 B. Ari	311	6.5	I	103	1 03.7	−0.5	+0.9	25	23 58.9	−1.0	+2.2	12
13	134 B. Ari	438	6.7	I	114	21 32.3	—	—	10	No occ.			
13	ε Ari	440	4.6	I	114	21 11.2	−1.7	−0.4	83	19 47.2	−1.3	+1.4	52
14	36 Tau	598	5.7	I	128	22 29.4	−1.6	−1.0	96	20 59.8	−1.5	+0.6	73
28	40 B. Sco	2286	5.4	E	294	4 56.7	−0.6	−0.1	319	Low			
Feb. 9	μ Ari	399	5.7	I	83	20 45.4	−1.0	−4.4	137	19 03.2	−1.6	−1.2	102
10	104 B. Tau	556	5.5	I	98	23 28.5	−0.5	−1.2	86	22 08.4	−1.0	−1.0	81
12	315 B. Tau	740	6.3	I	113	1 44.9	+0.3	−1.8	121	0 34.5	−0.1	−2.2	126
12	399 B. Tau	880	7.2	I	123	19 59.2	−1.8	−1.3	125	18 29.4	−1.3	+0.7	96
12	132 Tau	882	5.0	I	124	20 49.6	−1.4	−4.0	153	19 07.3	−1.5	−0.6	123
12/13	412 B. Tau	898	6.0	I	125	0 46.0	+0.1	−2.8	147	23 24.8	−0.3	−3.4	152
13	+22° 1531	1059	6.9	I	138	23 52.5	−0.9	−2.0	126	22 21.3	−1.2	−1.6	127
15	ζ Cnc	1236	5.1	I	155	Low				5 12.2	+0.2	−1.6	121

Date	Name	Z.C. No.	Mag.	I or E	Elong. of Moon	TORONTO W. 79°.400, N. 43°.663 E.S.T.	a	b	P	WINNIPEG W. 97°.100, N. 49°.917 C.S.T.	a	b	P
					°	h m	m	m	°	h m	m	m	°
Feb. 23	17 G. Lib	2108	6.4	E	252	2 28.5	+0.2	−1.7	350	Low			
23	18 G. Lib	2109	6.1	E	252	3 20.2	−0.5	−1.2	339	Low			
Mar. 7	101 Psc	233	6.2	I	41	Low				21 05.1	+0.1	−1.6	96
11	+24° 854	835	6.9	I	94	20 54.0	−1.2	−1.7	111	19 21.5	−1.5	−0.8	103
11/12	+24° 909	853	7.0	I	95	0 00.3	+0.5	−2.5	145	22 48.4	+0.2	−3.3	154
12	+23° 1425	1014	6.8	I	107	21 36.7	−0.7	−2.9	146	20 02.9	−1.2	−2.4	142
13	69 B. Gem	1033	6.8	I	109	1 16.6	−0.3	−1.0	74	0 00.7	−0.7	−1.3	83
13	171 B. Gem	1150	6.8	I	120	22 00.1	−0.5	−3.3	160	20 27.7	−0.9	−3.2	161
20	75 Vir	1944	5.6	E	208	23 06.2	−0.5	−0.6	327	Low			
22	−19° 3880	2066	6.4	E	220	1 39.9	−2.0	+0.4	274	0 15.5	−1.5	+1.5	261
Apr. 6	+23° 648	624	7.0	I	50	21 18.4	−0.1	−1.0	82	20 05.0	−0.6	−1.2	83
8	10 Gem	960	6.6	I	76	20 03.1	−1.3	−1.1	91	Sun			
8	11 Gem	962	7.0	I	76	20 18.7	−0.9	−1.7	113	Sun			
8	12 Gem	964	7.0	I	76	20 40.7	+0.1	−3.6	160	Sun			
8	36 B. Gem	983	6.0	I	78	23 09.3	−0.6	−0.5	57	21 51.6	−0.9	−0.8	67
9	+20° 1798p	1123	7.2	I	91	23 05.0	−0.2	−1.8	119	21 46.0	−0.5	−2.0	128
9	61 Gem	1127	5.9	I	91	23 50.5	+0.3	−2.1	144	22 38.8	+0.1	−2.6	155
12	222 B. Cnc	1381	6.3	I	117	0 45.1	+0.5	−3.0	177	No occ.			
12/13	16 Sex	1489	6.8	I	130	1 12.8	−0.1	−2.5	160	23 54.6	0.0	−2.8	174
20	31 B. Sco	2269	5.4	E	212	3 56.0	−1.8	−0.3	246	2 21.3	−2.0	+0.4	250
24	222 B. Sgr	2822	5.6	E	255	2 22.7	−1.6	+2.3	220	Low			
May 4	99 Tau	742	6.0	I	32	Low				20 45.8	+0.2	−1.5	104
5	1 Gem	916	4.3	I	46	Low				21 15.5	+0.3	−2.0	136
6	120 B. Gem	1086	6.5	I	61	No occ.				22 33.5	—	—	38
8	177 B. Cnc	1344	6.8	I	86	21 49.3	+0.2	−2.9	169	20 36.7	—	—	193
9	79 B. Leo	1454	7.1	I	99	No occ.				21 40.3	−2.1	−0.3	62
9/10	+8° 2289	1457	6.7	I	100	0 03.8	−0.4	−1.4	88	22 42.7	−0.9	−1.6	95
11	87 e Leo	1670	5.1	I	124	23 02.0	−1.4	−1.5	104	21 28.0	−1.4	−1.0	117
June 3	81 g Gem	1175	5.0	I	42	Low				21 44.4	+0.6	−2.1	161
6	84 B. Sex	1528	6.6	I	81	21 27.4	−0.4	−2.3	148	Sun			
7	−0° 2422	1629	6.8	I	93	21 02.3	−1.7	−1.1	85	Sun			
10	562 B. Vir	1960	6.9	I	129	23 13.5	−1.6	−1.1	85	21 36.4	−1.9	−0.5	90
11	−19° 3880	2066	6.4	I	139	20 47.2	−1.7	−0.4	119	Sun			
20	53 B. Aqr	3109	6.5	E	228	1 17.7	−1.6	+1.4	254	0 05.4	−0.9	+1.6	267
20	−13° 5897	3112	6.2	E	228	1 47.1	−1.1	+2.2	204	0 40.2	−1.0	+2.0	223
23	+1° 4744	3482	5.6	E	263	1 38.9	−0.5	+2.0	232	Low			
27	ζ Ari	472	5.0	E	316	3 07.0	+0.4	+1.8	225	Low			
July 10	31 B. Sco	2269	5.4	I	132	21 36.0	−1.9	−1.3	138	Sun			
19	κ Aqr	3320	5.3	E	222	1 54.0	—	—	298	No occ.			
20	κ Psc	3453	4.9	E	234	3 48.1	−1.5	+1.2	231	2 25.9	−1.7	+0.9	268
20	9 Psc	3455	6.4	E	234	3 35.9	−0.6	+2.5	193	2 30.3	−1.1	+1.5	232
26	99 Tau	742	6.0	E	311	2 52.7	+0.1	+1.4	258	Low			
Aug. 5	17 G. Lib	2108	6.4	I	90	21 00.9	−1.4	−1.3	91	Sun			
6	42 Lib	2237	5.1	I	102	Low				21 15.0	−1.4	−1.1	92
7	22 Sco	2371	4.9	I	112	21 22.6	−1.8	−0.8	88	Sun			
22	284 B. Tau	693	6.0	E	280	No occ.				0 47.5	+0.6	+2.2	213
Sept. 3	71 B. Sco	2317	6.6	I	81	19 57.6	−1.7	−1.5	110	Sun			
5	63 Oph	2577	6.1	I	103	19 31.4	−2.1	−0.2	89	Sun			
8	−17° 5975	2979	7.1	I	136	19 27.5	−1.5	+1.9	42	Sun			
8	35 B Cap	2989	6.8	I	136	21 05.1	−2.8	−0.5	114	19 32.8	−1.5	+1.1	90
9	41 B. Cap	2997	7.1	I	137	0 01.6	−0.6	+0.7	32	No occ.			
9	47 B. Cap	3005	6.2	I	138	Low				0 17.2	−0.9	−0.3	57
9	53 B. Aqr	3109	6.5	I	148	20 05.0	−1.5	+1.5	67	Sun			
9	−13° 5897	3112	6.2	I	148	21 05.3	—	—	126	19 34.3	−1.3	+1.3	97
16	ζ Ari	472	5.0	E	235	22 45.8	−0.9	+0.5	302	No occ.			
17	τ Ari	486	5.2	E	236	1 40.7	−0.5	+3.1	207	0 43.6	−0.6	+1.8	246
20	μ Gem	976	3.2	E	275	0 31.6	+0.4	+2.0	236	Low			
21	61 Gem	1127	5.9	E	289	1 52.4	−0.7	−0.6	328	No occ.			
Oct. 6	95 B. Cap	3066	6.0	I	117	20 58.5	−2.0	−0.1	79	19 33.3	−1.3	+1.1	48
8	−9° 5854	3199	6.8	I	129	0 37.9	−0.2	+1.1	22	No occ.			
8/9	κ Aqr	3320	5.3	I	141	0 05.5	−1.5	−0.7	79	22 44.2	−1.0	+0.9	39
9	207 B. Aqr	3326	6.4	I	142	2 20.0	−0.3	+0.5	35	No occ.			
9/10	κ Psc	3453	4.9	I	153	0 47.7	−1.7	−1.1	89	23 21.9	−1.2	+0.8	49
9	9 Psc	3455	6.4	I	153	No occ.				23 24.6	−1.7	−0.2	84
14	32 Tau	582	5.8	E	217	21 57.1	−0.7	+0.8	289	No occ.			
17	3 Gem	929	5.8	E	246	0 55.4	−1.4	−0.7	318	No occ.			
17	6 Gem	942	6.3	E	246	2 23.2	−1.4	+0.8	273	1 05.6	−1.0	+0.2	306
17	η Gem	946	3.7v	I	247	No occ.				1 33.1	−1.5	−1.4	149
17	η Gem	946	3.7v	E	247	No occ.				2 10.5	−0.6	+3.9	216
17	μ Gem	976	3.2	I	249	Sun				5 24.9	−1.5	−0.5	100
31	−22° 4928	2762	6.0	I	63	17 54.9	—	—	135	Sun			
Nov. 1	57 Sgr	2902	6.0	I	74	20 51.6	−0.4	+0.1	41	No occ.			
3	96 G. Cap	3145	6.8	I	96	No occ.				19 25.3	−2.0	−0.3	94
3	72 B. Aqr	3146	6.5	I	97	No occ.				19 52.2	−1.9	−0.5	91

Date	Name	Z.C. No.	Mag.	I or E	Elong. of Moon	TORONTO W. 79°.400, N. 43°.663				WINNIPEG W. 97°.100, N. 49°.917			
						E.S.T.	a	b	P	C.S.T.	a	b	P
					°	h m	m	m	°	h m	m	m	°
Nov. 6	19 Psc	3501	5.3	I	131	19 00.3	−1.0	+2.0	42	18 04.6	−0.1	+2.7	8
7	+3° 4909m	3524	6.9	I	134	1 56.0	−0.5	−2.3	108	0 32.0	−1.0	−0.9	76
7	136 B. Psc	89	6.5	I	145	21 50.9	−1.6	+0.9	64	20 40.6	−0.6	+2.2	25
12	+23° 1007	859	6.5	E	213	21 41.8	−0.8	+0.4	302	No occ.			
12	394 B. Tau	865	6.1	E	213	22 22.2	−0.7	+1.2	271	21 17.2	−0.5	+0.5	307
14	ζ Gem	1077	3.9v	I	231	5 58.7	−0.9	−2.1	132	4 27.7	−1.2	−1.7	133
14	ζ Gem	1077	3.9v	E	231	Sun				5 32.7	−1.5	−0.4	261
15	3 Cnc	1207	5.8	E	244	4 55.7	−2.5	+1.3	244	3 28.2	−1.6	+1.5	251
19	87 e Leo	1670	5.1	E	295	4 24.8	−1.2	+1.5	268	Low			
Dec. 2	κ Aqr	3320	5.3	I	87	16 57.3	−2.6	+0.1	104	Sun			
2	207 B. Aqr	3326	6.4	I	88	19 28.8	−1.7	0.0	71	18 09.7	−1.0	+1.5	32
2	−3° 5505	3340	7.5	I	89	Low				22 32.2	−0.5	−0.6	61
3	κ Psc	3453	4.9	I	99	No occ.				17 38.3	−1.7	+0.9	85
3	+1° 4731	3464	7.1	I	101	22 35.9	−0.7	+0.7	36	No occ.			
5	+10^{c} 128	163	7.2	I	124	No occ.				18 27.6	−1.7	+0.6	105
5	212 B. Psc	177	7.1	I	126	No occ.				21 49.4	−1.7	−0.9	96
6/7	20 H^1. Ari	317	6.4	I	139	0 25.3	−1.2	−0.3	66	23 05.7	−1.2	+1.2	39
8	ζ Ari	472	5.0	I	154	3 11.3	−0.7	−0.1	52	1 55.1	−1.1	+0.5	43
8	τ Ari	486	5.2	I	156	Low				4 32.3	−0.3	−0.6	57
10	Saturn	—	−0.2	I	192	17 54.4	+0.2	+0.7	111	Low			
10	Saturn	—	−0.2	E	192	18 40.4	+0.3	+1.5	249	17 53.5	+0.3	+1.0	278
10	μ Gem	976	3.2	I	195	22 29.1	−1.0	+1.9	67	21 40.7	—	—	17
10	μ Gem	976	3.2	E	195	23 32.1	−1.6	−0.6	302	21 56.2	—	—	349
14	6 h Leo	1410	5.3	E	238	3 25.3	−1.5	−0.7	301	2 00.1	−1.0	−0.1	305
17	64 B. Vir	1752	6.5	E	279	Sun				5 40.4	−2.2	+1.5	252
18	370 B. Vir	1852	6.0	E	289	3 24.6	−0.4	−0.1	315	Low			
18	−11° 3398	1858	6.5	E	290	5 18.2	−1.0	−0.4	314	4 05.1	−0.5	+0.3	309
29	−5° 5790	3290	7.3	I	57	18 56.7	−1.8	−2.0	102	17 24.6	−1.3	+0.3	59
31	+3° 4909m	3524	6.9	I	80	18 21.9	−2.6	−1.2	103	Sun			

LUNAR OCCULTATIONS VISIBLE AT EDMONTON AND VANCOUVER, 1973

Date	Name	Z.C. No.	Mag.	I or E	Elong. of Moon	EDMONTON W. 113°.075, N. 53°.533				VANCOUVER W. 123°.100, N. 49°.500			
						M.S.T.	a	b	P	P.S.T.	a	b	P
					°	h m	m	m	°	h m	m	m	°
Jan. 9	κ Psc	3453	4.9	I	63	19 15.2	−0.6	+0.6	33	18 04.7	−0.9	+0.9	34
9	9 Psc	3455	6.4	I	63	19 12.0	−1.0	−0.5	68	18 01.8	−1.3	−0.2	69
12	47 B. Ari	311	6.5	I	103	Graze				21 32.7	−1.1	+1.7	24
13	ε Ari	440	4.6	I	114	18.40.1	−0.5	+2.9	22	17 24.5	−0.2	+3.0	20
14	36 Tau	598	5.7	I	128	19 44.0	−1.0	+1.8	51	18 26.9	−0.9	+2.0	54
14	+23° 624	611	7.0	I	129	22 12.4	—	—	156	No occ.			
15	+24° 654	649	7.2	I	133	4 12.2	−0.2	−0.5	45	3 13.7	−0.1	−0.8	65
15	62 Tau	652	6.4	I	133	4 16.5	+0.1	−1.0	71	3 22.0	+0.1	−1.2	88
Feb. 9	+19° 432	425	7.0	I	86	23 41.6	+0.1	−2.2	116	22 54.8	+0.4	−4.1	144
10	104 B. Tau	556	5.5	I	98	20 47.8	−1.2	−0.4	75	19 35.6	−1.5	−0.4	89
10	+23° 563	564	6.1	I	98	No occ.				20 36.5	−1.5	+1.9	33
11	315 B. Tau	740	6.3	I	113	23 22.2	−0.4	−2.6	133	22 36.4	—	—	169
11	98 k Tau	743	5.6	I	113	No occ.				23 14.0	−1.5	+0.8	39
12	412 B. Tau	898	6.0	I	125	22 03.8	−0.7	−3.8	156	No occ.			
13	+22° 1531	1059	6.9	I	138	20 56.4	−1.3	−0.8	124	19 47.3	−1.4	−1.4	141
14	10 H. Cnc	1217	6.1	I	153	No occ.				23 05.2	−2.1	+0.8	68
15	ζ Cnc	1236	5.1	I	155	4 07.8	0.0	−1.9	129	3 15.8	0.0	−2.1	144
Mar. 6	136 B. Psc	89	6.5	I	28	19 31.2	−0.2	−1.3	80	Sun			
7	101 Psc	233	6.2	I	41	19 57.0	−0.3	−1.6	92	19 00.3	−0.6	−2.3	110
9	+22° 523	524	6.6	I	69	22 47.1	−0.1	−1.3	84	21 51.9	−0.1	−1.7	102
11	95 Tau	714	6.2	I	83	0 00.4	+0.5	−2.4	140	No occ.			
11	+24° 909	853	7.0	I	95	21 37.8	—	—	168	No occ.			
12	69 B. Gem	1033	6.8	I	109	22 43.0	−0.9	−1.3	94	21 38.9	−1.0	−1.6	114
14	209 B. Gem	1186	6.1	I	124	No occ.				1 35.5	−0.9	−0.7	54
22	9 G. Lib	2084	6.5	E	222	No occ.				3 17.6	—	—	349
24	σ Sco	2349	3.1	I	245	Sun				5 08.3	—	—	164
Aug. 8	+23° 1346	982	6.8	I	78	20 40.8	−1.7	+0.6	46	Sun			
8	36 B. Gem	983	6.0	I	78	20 32.2	−1.1	−0.8	78	Sun			
9	+20°1798p	1123	7.2	I	91	20 28.1	−0.7	−2.2	139	19 33.1	−0.3	−3.8	166
9	61 Gem	1127	5.9	I	91	21 30.6	+0.4	−3.8	173	No occ.			
14	62 p^3 Leo	1605	6.2	I	144	1 58.2	−0.5	−2.0	138	1 01.3	−0.5	−2.1	149
May 5	1 Gem	916	4.3	I	46	20 11.0	+0.2	−2.6	148	No occ.			
5	3 Gem	929	5.8	I	47	22 11.7	+0.3	−1.6	120	21 22.2	+0.4	−2.0	136
5	4 Gem	931	6.7	I	48	22 33.7	+0.5	−1.8	139	21 48.2	+0.8	−2.5	159
6	120 B. Gem	1086	6.5	I	61	21 18.2	−0.8	−0.8	57	20 13.8	−0.9	−1.1	80

Date	Name	Z.C. No.	Mag.	I or E	Elong. of Moon	EDMONTON W. 113°075, N. 53°533 M.S.T.	a	b	P	VANCOUVER W. 123°100, N. 49°500 P.S.T.	a	b	P
					°	h m	m	m	°	h m	m	m	°
May 9	+8° 2289	1457	6.7	I	100	21 21.2	−1.1	−1.4	108	Sun			
10	36 Sex	1566	6.6	I	112	No occ				20 22.0	.	.	63
June 8	64 B. Vir	1752	6.5	I	107	Low				22 42.3	−0.9	−1.7	104
11	9 G. Lib	2084	6.5	I	141	Low				23 06.6	−1.9	−0.2	53
July 19/20	κ Psc	3453	4.9	E	234	1 03.8	−1.5	+1.0	296	23 45.7	−1.3	+0.9	304
20	9 Psc	3455	6.4	E	234	1 18.6	−1.0	+1.6	253	0 02.9	−0.8	+1.7	257
25	32 Tau	582	5.8	E	298	1 46.6	+0.9	+2.6	192	Low			
Aug. 22	300 B. Tau	716	6.2	E	282	3 41.9	−0.3	+2.5	225	2 30.3	−0.1	+2.4	226
24	36 d Gem	1047	5.2	E	308	3 46.0	−0.1	+1.6	263	2 39.8	+0.1	+1.5	262
Sept. 6	154 B. Sgr	2754	5.9	I	116	Low				21 45.8	—	—	139
8	47 B. Cap	3005	6.2	I	138	23 04.6	−0.7	+0.6	29	21 53.6	−0.8	+1.2	23
9	61 B. Cap	3019	5.9	I	139	Low				0 55.5	−0.8	−0.9	74
10	72 B. Aqr	3146	6.5	I	151	2 13.2	−0.2	+0.5	24	1 08.2	−0.3	+0.8	24
15	101 Psc	233	6.2	E	212	3 57.4	.	.	318	2 49.2	—	—	308
16	τ Ari	486	5.2	E	236	23 40.6	−0.5	+1.5	269	22 31.1	−0.3	+1.4	273
20	+22° 1416	1021	6.3	E	279	Sun				4 18.1	−0.8	+4.2	217
22	90 B. Cnc	1284	6.3	E	305	Sun				4 11.3	−0.6	+0.8	290
Oct. 8	−9° 5876	3216	6.6	I	131	Low				0 51.3	−0.7	−1.1	79
8	κ Aqr	3320	5.3	I	141	21 38.3	−0.3	+2.1	7	20 27.1	—	—	356
9	22 B. Psc	3444	6.5	I	152	19 33.6	−1.4	+1.0	117	18 17.2	−1.0	+1.2	112
9	κ Psc	3453	4.9	I	153	22 12.3	−0.6	+1.8	20	20 58.6	−0.4	+2.4	12
9	9 Psc	3455	6.4	I	153	22 03.7	−1.1	+1.1	56	20 47.0	−1.1	+1.6	50
14	ζ Ari	472	5.0	E	208	5 19.7	−0.8	−2.3	298	4 17.2	−1.2	−1.4	280
16	6 Gem	942	6.3	E	246	23 46.7	—	—	345	22 40.1	—	—	345
16/17	η Gem	946	3.7v	I	247	0 17.4	−0.6	+0.7	119	23 09.4	−0.4	+0.7	121
Oct. 17	η Gem	946	3.7v	E	247	1 11.9	−0.5	+2.1	243	0 00.0	−0.2	+2.2	240
17	Saturn	—	0.2	I	248	4 02.4	—	—	165	No occ.			
17	Saturn	—	0.2	E	248	4 30.4	—	—	210	No occ.			
17	μ Gem	976	3.2	I	249	4 01.5	−1.3	+0.5	92	2 46.2	−1.3	+0.4	104
17	μ Gem	976	3.2	E	249	5 14.4	−1.4	−0.6	285	3 59.9	−1.6	+0.4	269
19	+16° 1662	1238	6.1	E	273	0 53.9	+0.2	+2.5	238	Low			
20	222 B. Cnc	1381	6.3	E	289	5 44.3	−0.8	−1.5	337	4 39.2	−0.9	−0.4	316
Nov. 1	247 G. Sgr	2908	6.9	I	75	19 48.7	−1.7	−1.6	108	18 35.7	−2.0	−1.0	102
2	61 B. Cap	3019	5.9	I	85	18 03.9	—	—	137	Sun			
3	96 G. Cap	3145	6.8	I	96	17 59.7	−1.4	+0.9	70	Sun			
3	72 B. Aqr	3146	6.5	I	97	18 26.9	−1.4	+0.8	66	Sun			
6	+3° 4909m	3524	6.9	I	134	23 14.4	−1.0	+0.2	53	22 01.4	−1.3	+0.6	54
11	τ Tau	709	4.3	I	200	21 02.0	−0.6	+0.9	116	19 53.5	−0.3	+0.9	114
11	τ Tau	709	4.3	E	200	21 50.2	−0.2	+2.3	226	20 40.2	0.0	+2.2	227
13	Saturn	—	0.0	I	221	No occ.				10 04.8	−0.1	−0.5	47
13	Saturn	—	0.0	E	221	No occ.				10 32.6	+0.8	−1.9	339
14	ζ Gem	1077	3.9v	I	231	3 03.1	−1.2	−1.0	130	1 55.7	−1.3	−1.9	149
14	ζ Gem	1077	3.9v	E	231	4 07.9	−1.5	+0.4	258	2 46.6	−1.7	+2.2	236
15	3 Cnc	1207	5.8	E	244	2 12.7	−1.0	+1.6	260	0 55.5	−0.7	+2.4	246
Dec. 1	−9° 5876	3216	6.6	I	77	18 17.3	—	—	118	16 55.4	−2.5	−0.3	108
2	207 B. Aqr	3326	6.4	I	88	17 07.5	—	—	0	Sun			
2	−3° 5505	3340	7.5	I	89	21 21.9	−0.6	+0.3	37	20 12.6	−0.9	+0.6	38
4	45 Psc	51	7.2	I	114	23 27.9	−1.1	−3.1	118	22 30.2	—	—	136
5	+10° 128	163	7.2	I	124	17 13.5	−0.7	+1.6	79	Sun			
5	212 B. Psc	177	7.1	I	126	20 24.8	−1.3	+0.8	69	19 07.4	−1.3	+1.3	66
6	20 H[1]. Ari	317	6.4	I	139	21 58.7	−0.5	+3.6	9	20 40.0	−0.4	+3.4	12
7/8	ζ Ari	472	5.0	I	154	0 39.5	−1.2	+1.5	32	23 21.6	−1.4	+1.2	47
8	ζ Ari	486	5.2	I	156	3 23.0	−0.6	−0.7	60	2 19.8	−0.8	−1.0	79
13/14	6 h Leo	1410	5.3	E	238	0 46.8	−0.7	+0.2	310	23 39.1	−0.5	+0.6	296
17	64 B. Vir	1752	6.5	E	279	4 14.9	—	—	234	No occ.			
28	47 c² Cap	3187	6.2	I	47	19 38.3	−0.5	−0.7	60	18 34.2	−0.8	−0.5	62

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GRAZING OCCULTATIONS OVER CANADA DURING 1973

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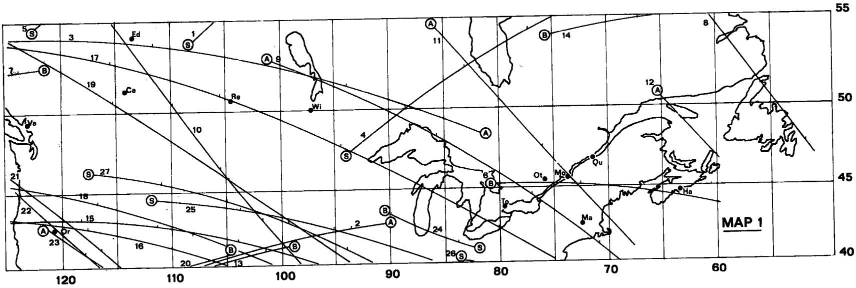
The maps show the tracks of stars brighter than 7.5 magnitude which will graze the limb of the Moon when it is at a favourable elongation from the Sun and at least 10° above the observer's horizon (5° in the case of stars brighter than 5.5, and 2° for those brighter than 3.5). Each track starts in the West at some arbitrary time given in the key 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.

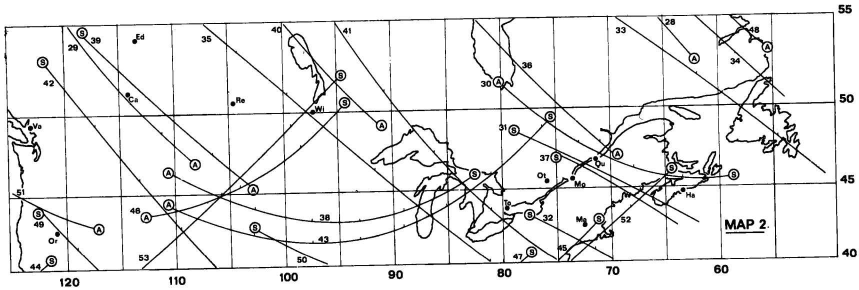
Observers sited near to any of these tracks who are interested should write to Dr. D. W. Dunham, Department of Astronomy, University of Texas, Austin, Texas 78712, at least two months before the event, giving their approximate latitude and longitude, and details of the event will be supplied.

*NOTES ON DOUBLE STARS

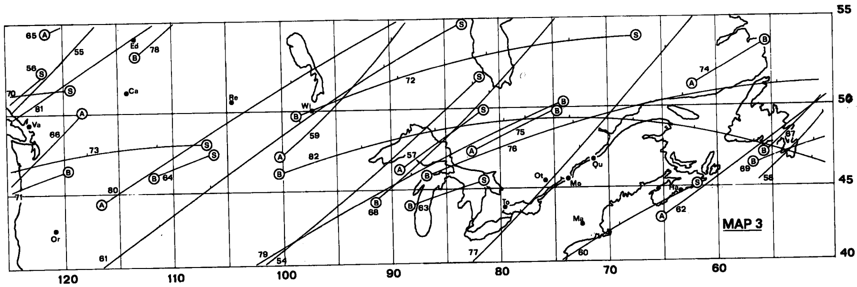
Track	Remark
6	ZC 438 is the mean of the double star Aitken 2253. The components are 7.5 and 7.6 magnitude; separation 0″.4 in p.a. 257°.
18	ZC 567 is the brightest component of the triple system Aitken 2795. The companions are 9.0 and 9.9 magnitude; separation 10″.3 and 3″.2 in p.a. 236° and 238° respectively. It is also a spectroscopic binary.
25	ZC 501 is the brighter component of the system Aitken 2552. The companion is 10th magnitude; separation 1″ in p.a. 68°.
26	ZC 822 is the brighter component of the double star Aitken 4068. The companion is 6.6 magnitude; separation 4″.8 in p.a. 205°.
47 112	ZC 3524 is the mean of the double star Aitken 17111. The components are 7.5 and 8.0 magnitude; separation 0″.4 in p.a. 220°.
49	ZC 1639 is the following component of the double star Aitken 8131. The preceding component is 8.0 magnitude; separation 9″.6 in p.a. 253°.
55	ZC 594 is the preceding component of the system Aitken 2926. The companion is magnitude 7.9; separation 7″.4 in p.a. 127°.
56	ZC 767 is a spectroscopic binary.
64 96	ZC 1054 is the brighter component of the double star Aitken 5564. The companion is 10th magnitude; separation 20″ in p.a. 170°.
79	ZC 929 is the mean of the two bright components of the double star Aitken 4751. The components are 6.0 and 8.0 magnitude; separation 0″.6 in p.a. 339°.
80	ZC 931 is the mean of two components of the double star Aitken 4768. The components are 7.2 and 7.5 magnitude; separation 0″.3 in p.a. 252°.
82	ZC 946, which is a spectroscopic binary, is the following component of the double star Aitken 4841. The companion is 6th magnitude; separation 1″.5 in p.a. 268°.
85	ZC 1587 is the brighter component of the double star Aitken 7982. The companion is 9th magnitude; separation 0″.6 in p.a. 79°.



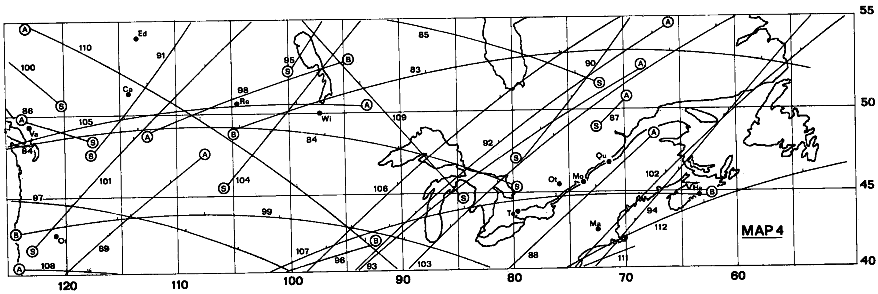
Map 1.



Map 2.



Map 3.



Map 4.

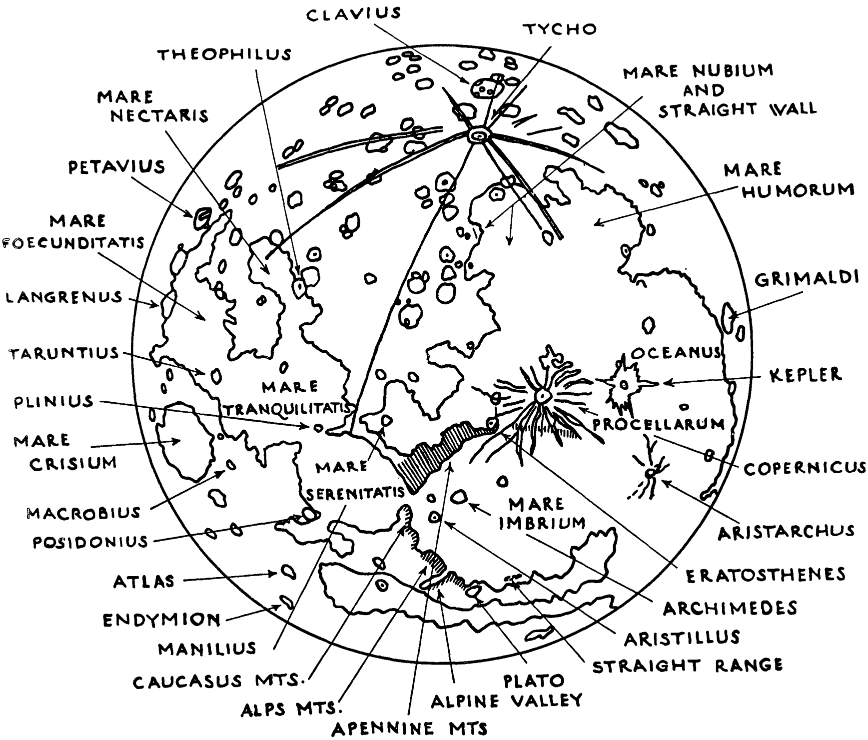
KEY TO MAPS 1 AND 2

Track	ZC	Name	Mag.	Beginning U.T.	Time h m	Percent Sunlit	N or S Limit
1	3444	22 B. Psc	6.5	Jan. 10	0 2	27	S
2	3455	9 Psc	6.4	Jan. 10	2 54	27	S
3	311	47 B. Ari	6.5	Jan. 13	5 51	61	N
4	425	+19° 432	7.0	Jan. 13	23 24	70	S
5	435	47 Ari	5.8	Jan. 14	0 56	71	S
6*	438	134 B. Ari	6.7	Jan. 14	2 46	71	N
7	611	+23° 624	7.0	Jan. 15	5 5	82	S
8	1605	62 Leo	6.2	Jan. 22	7 31	85	S
9	1713	13 B. Vir	5.8	Jan. 23	6 21	77	S
10	1833	−11° 3361	6.9	Jan. 24	11 51	66	S
11	2046	−19° 3846	6.9	Jan. 26	9 28	48	S
12	2152	−22° 3897	7.3	Jan. 27	8 46	38	S
13	399	μ Ari	5.7	Feb. 10	1 17	45	S
14	521	9 Tau	6.7	Feb. 10	23 27	55	N
15	550	+23° 537	6.8	Feb. 11	3 48	57	N
16	559	26 Tau	6.6	Feb. 11	4 39	58	N
17	564	+23° 563	6.1	Feb. 11	4 54	58	N
18*	567	+23° 569	6.8	Feb. 11	5 9	58	N
19	743	98 Tau	5.6	Feb. 12	7 24	70	N
20	882	132 Tau	5.0	Feb. 13	1 12	78	S
21	1893	−13° 3665	7.0	Feb. 21	8 47	82	S
22	2251	−24° 12275	7.5	Feb. 24	12 9	54	S
23	2524	151 G. Oph	6.0	Feb. 26	12 34	35	S
24	2659	70 B. Sgr	6.4	Feb. 27	11 23	27	N
25*	501	66 Ari	6.1	Mar. 10	1 56	31	N
26*	822	118 Tau	5.9	Mar. 12	0 5	53	N
27	1017	+23° 1433	6.8	Mar. 13	2 24	65	N
28	1033	69 B. Gem	6.8	Mar. 13	6 20	66	N
29	1186	209 B. Gem	6.1	Mar. 14	9 41	78	N
30	2455	31 Oph	6.8	Mar. 25	8 34	63	N
31	611	+23° 624	7.0	Apr. 7	0 25	17	N
32	954	8 Gem	6.1	Apr. 9	0 14	38	N
33	956	9 Gem	6.3	Apr. 9	0 32	38	N
34	960	10 Gem	6.6	Apr. 9	1 30	39	N
35	982	+23° 1346	6.8	Apr. 9	3 59	40	N
36	983	36 B. Gem	6.0	Apr. 9	4 10	40	N
37	1468	π Leo	4.9	Apr. 12	23 58	81	N
38	2692	24 Sgr	5.7	Apr. 23	9 4	70	N
39	923	2 Gem	6.9	May 6	4 22	16	N
40	1086	120 B. Gem	6.5	May 7	4 35	26	N
41	1454	79 B. Leo	7.1	May 10	3 51	58	N
42	1566	36 Sex	6.6	May 11	4 38	69	N
43	2785	−22° 4977	6.8	May 21	7 22	85	N
44	2806	−22° 5021	6.9	May 21	12 11	84	N
45	3029	−16° 5690	6.9	May 23	8 31	69	N
46	3281	162 B. Aqr	7.5	May 25	9 0	49	N
47*	3524	+3° 4909	6.9	May 27	9 5	28	N
48	1629	−0° 2422	6.8	June 8	2 27	53	N
49*	1639	123 H. Leo	7.0	June 8	4 32	54	N
50	1489	16 Sex	6.8	July 4	3 6	18	N
51	1605	62 Leo	6.2	July 5	4 54	28	N
52	425	+19° 432	7.0	July 24	7 58	37	N
53	435	47 Ari	5.8	July 24	9 18	36	N

KEY TO MAPS 3 AND 4

Track	ZC	Name	Mag.	Beginning U.T.	Time h m	Percent Sunlit	N or S Limit
54	584	33 Tau	6.0	July 25	8 34	26	N
55*	594	161 B. Tau	6.9	July 25	10 16	25	N
56*	767	103 Tau	5.5	July 26	11 27	15	N
57	923	2 Gem	6.9	July 27	8 59	8	N
58	89	136 B. Psc	6.5	Aug. 18	1 54	84	N
59	375	+18° 325	6.8	Aug. 20	5 0	64	N
60	524	+22° 523	6.6	Aug. 21	8 19	52	N
61	714	95 Tau	6.2	Aug. 22	9 2	40	N
62	839	121 Tau	5.3	Aug. 23	5 1	31	N
63	1047	36 Gem	5.2	Aug. 24	10 15	19	S
64*	1054	+21° 1428	6.8	Aug. 24	11 34	18	S
65	1192	+18° 1778	7.4	Aug. 25	11 24	10	S
66	2754	154 B. Sgr	5.9	Sept. 7	6 0	72	S
67	459	151 B. Ari	6.7	Sept. 17	1 16	79	N
68	472	ξ Ari	5.0	Sept. 17	3 29	78	N
69	486	τ Ari	5.2	Sept. 17	6 52	77	S
70	693	284 B. Tau	6.0	Sept. 18	12 54	64	S
71	839	121 Tau	5.3	Sept. 19	11 4	54	N
72	1001	+22° 1364	7.2	Sept. 20	8 58	43	S
73	1021	+22° 1416	6.3	Sept. 20	11 54	42	S
74	1113	56 Gem	5.2	Sept. 21	4 44	34	N
75	1127	61 Gem	5.9	Sept. 21	6 39	33	N
76	1135	+19° 1743	6.8	Sept. 21	7 48	32	S
77	2935	347 B. (Sgr)	7.0	Oct. 6	0 37	63	S
78	761	+22° 818	6.7	Oct. 16	5 0	80	S
79*	929	3 Gem	5.8	Oct. 17	5 21	70	N
80*	931	4 Gem	6.7	Oct. 17	5 45	70	N
81	942	6 Gem	6.3	Oct. 17	6 33	70	N
82*	946	η Gem	4.2	Oct. 17	7 44	69	S
83	1238	+16° 1662	6.1	Oct. 19	7 29	47	S
84	1247	+16° 1687	6.8	Oct. 19	10 11	46	S
85*	1587	55 Leo	6.0	Oct. 22	10 33	15	S
86	1713	13 B. Vir	5.8	Oct. 23	13 30	8	S
87	2610	27 G. Sgr	6.8	Oct. 30	22 3	19	S
88	2762	−22° 4928	6.0	Oct. 31	23 12	27	S
89	2908	247 G. Sgr	6.9	Nov. 2	3 13	37	S
90	3005	47 B. Cap	6.2	Nov. 2	22 33	45	S
91	3019	61 B. Cap	5.9	Nov. 3	1 5	46	S
92	3145	96 G. Cap	6.8	Nov. 4	1 57	56	S
93	3146	72 B. (Aqr)	6.5	Nov. 4	2 27	56	S
94	3248	128 B. Aqr	6.6	Nov. 4	22 52	65	S
95	3370	6 G. Psc	6.2	Nov. 5	23 45	75	S
96*	1054	+21° 1428	6.8	Nov. 14	5 55	83	N
97	1077	ξ Gem	4.1	Nov. 14	10 17	81	S
98	1192	+18° 1778	7.4	Nov. 15	5 44	73	N
99	1207	3 Cnc	5.8	Nov. 15	8 21	72	S
100	1235	+16° 1657	7.4	Nov. 15	14 33	70	S
101	3216	−9° 5876	6.6	Dec. 2	1 14	39	S
102	3320	κ Aqr	5.3	Dec. 2	22 27	48	S
103	3453	κ Psc	4.9	Dec. 4	0 9	59	S
104	3455	9 Psc	6.4	Dec. 3	23 54	59	S
105	51	45 Psc	7.2	Dec. 5	6 39	71	S
106	163	+10° 128	7.2	Dec. 6	0 34	79	S
107	177	212 B. Psc	7.1	Dec. 6	4 9	80	S
108	1528	84 B. Sex	6.6	Dec. 15	7 51	65	S
109	1543	+3° 2379	6.6	Dec. 15	11 59	64	S
110	1752	64 B. Vir	6.5	Dec. 17	10 54	42	S
111	3290	−5° 5790	7.3	Dec. 30	0 29	23	S
112*	3524	+3° 4909	6.9	Dec. 31	23 55	42	S

MAP OF THE MOON



South appears at the top.

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 1973. An occultation by the asteroid Pallas of the $9^{m}.2$ star SAO 120836 at 13^{h} 10^{m} U.T. on February 6 will probably be visible from some part of the western side of North America. An occultation by the asteroid Europa of the $9^{m}.1$ star SAO 189207 at 09^{h} 10^{m} on September 12 may be visible to observers, with good photoelectric equipment, from some part of the western side of North America. More refined predictions will be issued at a later date.

MARS—LONGITUDE OF THE CENTRAL MERIDIAN

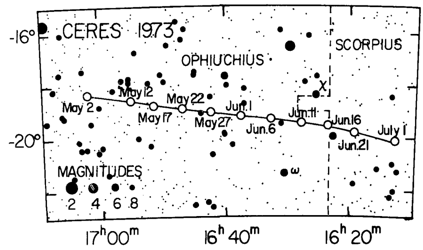
A favourable opposition of Mars occurs late in 1973. The following table lists the longitude of the central meridian of the geometric disk of Mars for each date at 0 hours U.T. (19 hours E.S.T. on the preceding date). To obtain the longitude of the central meridian for other times, add 14.6° for each 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	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	°	°	°	°	°	°	°	°
1	58.91	113.59	179.08	238.33	304.07	29.34	115.42	205.43
2	49.07	103.74	169.31	228.71	294.73	20.39	106.59	196.22
3	39.22	93.90	159.54	219.11	285.40	11.45	97.76	187.00
4	29.38	84.06	149.78	209.51	276.08	2.52	88.91	177.76
5	19.54	74.22	140.02	199.92	266.77	353.61	80.05	168.52
6	9.69	64.38	130.26	190.34	257.48	344.71	71.19	159.26
7	359.85	54.54	120.51	180.76	248.20	335.82	62.31	149.99
8	350.00	44.70	110.76	171.19	238.93	326.94	53.43	140.71
9	340.15	34.86	101.02	161.63	229.67	318.07	44.53	131.41
10	330.30	25.03	91.28	152.08	220.42	309.21	35.62	122.11
11	320.46	15.20	81.55	142.53	211.19	300.36	26.70	112.79
12	310.61	5.37	71.82	132.99	201.97	291.51	17.76	103.46
13	300.76	355.54	62.09	123.46	192.76	282.68	8.81	94.13
14	290.90	345.72	52.37	113.94	183.57	273.85	359.85	84.78
15	281.05	335.89	42.66	104.42	174.38	265.03	350.88	75.42
16	271.20	326.07	32.95	94.92	165.21	256.22	341.89	66.05
17	261.35	316.25	23.24	85.42	156.06	247.41	332.89	56.68
18	251.50	306.43	13.54	75.93	146.92	238.61	323.88	47.29
19	241.65	296.62	3.84	66.45	137.79	229.81	314.85	37.89
20	231.79	286.81	354.15	56.97	128.68	221.02	305.81	28.49
21	221.94	277.00	344.47	47.51	119.58	212.22	296.75	19.08
22	212.09	267.19	334.79	38.06	110.49	203.43	287.68	9.66
23	202.24	257.39	325.12	28.61	101.42	194.64	278.60	0.23
24	192.39	247.59	315.45	19.18	92.36	185.85	269.50	350.79
25	182.53	237.79	305.79	9.75	83.31	177.06	260.39	341.34
26	172.68	228.00	296.13	0.34	74.28	168.27	251.27	331.89
27	162.83	218.21	286.48	350.93	65.27	159.47	242.13	322.43
28	152.98	208.42	276.84	341.54	56.27	150.67	232.97	312.96
29	143.13	198.64	267.20	332.15	47.28	141.87	223.80	303.49
30	133.28	188.86	257.57	322.78	38.30	133.06	214.62	294.00
31	123.44		247.94	313.42		124.24		284.52

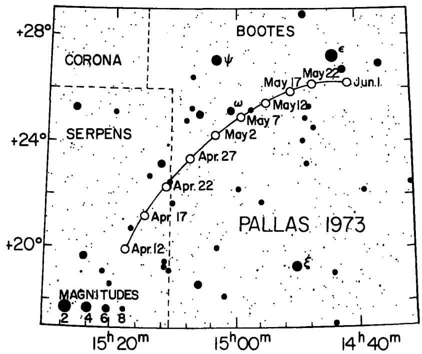
ASTEROIDS—EPHEMERIDES AT OPPOSITION, 1973

Three of the four major asteroids—Ceres, Pallas and Juno—come to opposition in 1973. Ephemerides near opposition are given for Ceres and Pallas, together with maps. Since Juno is fainter than magnitude 10.0 at opposition, no ephemeris or map is given. Its position at opposition on June 6 is R.A. $16^h 59^m 43^s$, Declination $-4°04'$.



Ceres (No. 1)
Opposition June 1 in Oph
Mag. 6.8

Date	R.A.	Dec.
	h m	° ′
May 2	17 02.1	−18 20
12	16 55.5	−18 35
17	16 51.5	−18 43
22	16 47.1	−18 51
27	16 42.4	−19 00
June 1	16 37.6	−19 08
6	16 32.8	−19 16
11	16 28.1	−19 25
16	16 23.6	−19 34
21	16 19.5	−19 44
July 1	16 12.7	−20 04

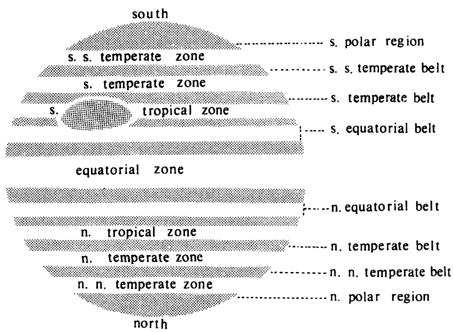


Pallas (No. 2)
Opposition May 2 in Boo
Mag. 8.0

Date	R.A.	Dec.
	h m	° ′
Apr. 2	15 23.1	+17 03
12	15 18.3	+19 52
17	15 15.2	+21 09
22	15 11.6	+22 18
27	15 07.7	+23 20
May 2	15 03.6	+24 12
7	14 59.4	+24 55
12	14 55.3	+25 29
17	14 51.4	+25 52
22	14 47.7	+26 06
June 1	14 41.5	+26 08

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.



JUPITER—LONGITUDE OF CENTRAL MERIDIAN

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

SYSTEM I

Day (0^h U.T.)	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	°	°	°	°	°	°	°	°	°	°
1	99.9	311.2	6.9	222.7	282.6	141.7	359.2	55.3	266.0	316.7
2	257.6	109.1	164.8	20.7	80.7	299.7	157.1	213.1	63.7	114.4
3	55.4	266.9	322.7	178.6	238.7	97.7	315.0	10.9	221.4	272.0
4	213.2	64.7	120.6	336.6	36.7	255.8	113.0	168.7	19.1	69.7
5	10.9	222.5	278.5	134.6	194.7	53.8	270.9	326.5	176.8	227.3
6	168.7	20.4	76.4	292.5	352.8	211.8	68.8	124.3	334.6	25.0
7	326.4	178.2	234.3	90.5	150.8	9.8	226.7	282.1	132.3	182.7
8	124.2	336.0	32.2	248.5	308.8	167.8	24.6	79.9	290.0	340.3
9	282.0	133.9	190.1	46.5	106.9	325.8	182.5	237.7	87.7	138.0
10	79.7	291.7	348.0	204.5	264.9	123.8	340.4	35.5	245.4	295.6
11	237.5	89.5	145.9	2.5	62.9	281.8	138.3	193.3	43.1	93.3
12	35.3	247.4	303.8	160.5	221.0	79.8	296.2	351.1	200.8	251.0
13	193.1	45.2	101.8	318.5	19.0	237.8	94.1	148.8	358.5	48.6
14	350.8	203.1	259.7	116.4	177.0	35.8	251.9	306.6	156.2	206.3
15	148.6	0.9	57.6	274.4	335.1	193.8	49.8	104.4	313.9	3.9
16	306.4	158.8	215.5	72.4	133.1	351.8	207.7	262.1	111.5	161.6
17	104.2	316.6	13.5	230.4	291.2	149.8	5.6	59.9	269.2	319.2
18	262.0	114.5	171.4	28.4	89.2	307.8	163.4	217.7	66.9	116.9
19	59.8	272.4	329.3	186.4	247.2	105.8	321.3	15.4	224.6	274.5
20	217.6	70.2	127.3	344.5	45.3	263.7	119.1	173.2	22.3	72.2
21	15.4	228.1	285.2	142.5	203.3	61.7	277.0	330.9	180.0	229.8
22	173.1	26.0	83.1	300.5	1.3	219.7	74.8	128.7	337.6	27.5
23	330.9	183.8	241.1	98.5	159.4	17.7	232.7	286.4	135.3	185.1
24	128.7	341.7	39.0	256.5	317.4	175.6	30.5	84.1	293.0	342.8
25	286.5	139.6	197.0	54.5	115.5	333.6	188.4	241.9	90.7	140.4
26	84.4	297.5	354.9	212.5	273.5	131.5	346.2	39.6	248.3	298.1
27	242.2	95.3	152.9	10.5	71.5	289.5	144.0	197.4	46.0	95.7
28	40.0	253.2	310.8	168.6	229.6	87.4	301.9	355.1	203.7	253.4
29	197.8	51.1	108.8	326.6	27.6	245.4	99.7	152.8	1.4	51.0
30	355.6	209.0	266.8	124.6	185.6	43.3	257.5	310.5	159.0	208.7
31	153.4		64.7		343.7	201.3		108.3		6.3

SYSTEM II

Day (0^h U.T.)	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	°	°	°	°	°	°	°	°	°	°
1	349.5	324.3	151.0	130.2	321.3	303.8	284.8	112.0	86.2	268.0
2	139.6	114.5	301.3	280.6	111.7	94.2	75.1	262.2	236.3	58.0
3	289.7	264.7	91.5	70.9	262.1	244.6	225.4	52.4	26.4	208.1
4	79.8	54.8	241.8	221.3	52.5	35.0	15.7	202.6	176.4	358.1
5	230.0	205.0	32.1	11.6	202.9	185.4	165.9	352.7	326.5	148.1
6	20.1	355.2	182.3	162.0	353.3	335.8	316.2	142.9	116.6	298.2
7	170.2	145.4	332.6	312.3	143.7	126.1	106.5	293.1	266.7	88.2
8	320.4	295.6	122.9	102.7	294.1	276.5	256.9	83.2	56.8	238.2
9	110.5	85.9	273.2	253.0	84.5	66.9	47.0	233.4	206.8	28.3
10	260.6	236.1	63.4	43.4	234.9	217.3	197.3	23.5	356.9	178.3
11	50.8	26.3	213.7	193.7	25.3	7.7	347.6	173.7	147.0	328.3
12	200.9	176.5	4.0	344.1	175.7	158.0	137.8	323.8	297.0	118.4
13	351.1	326.7	154.3	134.4	326.1	308.4	288.1	114.0	87.1	268.4
14	141.2	116.9	304.6	284.8	116.5	98.8	78.3	264.1	237.2	58.4
15	291.4	267.1	94.9	75.2	266.9	249.1	228.6	54.3	27.2	208.4
16	81.5	57.4	245.2	225.5	57.3	39.5	18.8	204.4	177.3	358.4
17	231.7	207.6	35.5	15.9	207.7	189.8	169.1	354.5	327.4	148.5
18	21.8	357.8	185.8	166.3	358.1	340.2	319.3	144.7	117.4	298.5
19	172.0	148.0	336.1	316.7	148.5	130.5	109.5	294.8	267.5	88.5
20	322.2	298.3	126.4	107.0	298.9	280.9	259.8	84.9	57.5	238.5
21	112.3	88.5	276.7	257.4	89.3	71.2	50.0	235.0	207.6	28.6
22	262.5	238.7	67.0	47.8	239.8	221.6	200.2	25.2	357.6	178.6
23	52.7	29.0	217.3	198.2	30.2	11.9	350.4	175.3	147.7	328.6
24	202.8	179.2	7.6	348.6	180.6	162.2	140.6	325.4	297.7	118.6
25	353.0	329.5	158.0	138.9	331.0	312.6	290.8	115.5	87.8	268.6
26	143.2	119.7	308.3	289.3	121.4	102.9	81.1	265.6	237.8	58.6
27	293.3	270.0	98.6	79.7	271.8	253.2	231.3	55.7	27.8	208.7
28	83.5	60.2	248.9	230.1	62.2	43.5	21.5	205.8	177.9	358.7
29	233.7	210.5	39.3	20.5	212.6	193.9	171.6	355.9	327.9	148.7
30	23.9	0.7	189.6	170.9	3.0	344.2	321.8	146.0	118.0	298.7
31	174.1		339.9		153.4	134.5		296.1		88.7

JUPITER—PHENOMENA OF THE BRIGHTEST SATELLITES 1973

Times and dates given are E.S.T. The phenomena are given for latitude 45° N., for Jupiter at least one hour above the horizon, and the sun at least one hour below the horizon.

The symbols are as follows: E—eclipse, O—occultation, T—transit, S—shadow, D—disappearance, R—reappearance, I—ingress, e—egress. Satellites move from east to west across the face of the planet, and from west to east behind it. Before opposition, shadows fall to the west, and after opposition to the east. Thus eclipse phenomena occur on the west side until July 30, and on the east thereafter.

MARCH

Jupiter being near the sun, phenomena are not given before March 8.

d	h	m	Sat.	Phen.
8	5	29	II	TI
	6	30	II	Se
	8	23	II	Te
10	7	28	III	ER
	7	50	III	OD
13	8	22	I	SI
14	5	37	I	ED
15	5	05	I	Se
	6	05	I	Te
	6	14	II	SI
	8	17	II	TI
17	5	31	II	OR
	6	13	IV	OD
	7	58	III	ED
21	5	54	III	Te
	7	31	I	ED
22	4	44	I	SI
	5	48	I	TI
	6	59	I	Se
23	5	25	I	OR
25	4	32	IV	SI
26	3	19	II	Te
28	5	30	III	Se
	6	39	III	TI
29	6	37	I	SI
	7	46	I	TI
30	3	54	I	ED
	7	23	I	OR
31	3	20	I	Se
	4	30	I	Te
	5	46	II	ED

APRIL

d	h	m	Sat.	Phen.
2	3	10	II	TI
	3	37	II	Se
	6	03	II	Te
3	6	21	IV	OR
4	6	01	III	SI
6	5	48	I	ED
7	2	59	I	SI
	4	12	I	TI
	5	14	I	Se
	6	27	I	Te
8	3	49	I	OR
	4	32	III	OR
9	3	22	II	SI
	5	53	II	TI
	6	13	II	Se
11	2	45	IV	Se
	2	58	II	OR
14	4	52	I	SI
	6	08	I	TI
	7	07	I	Se
15	3	26	III	ER
	5	07	III	OD
	5	46	I	OR
16	2	52	I	Te
	5	58	II	SI
18	5	37	II	OR
21	6	46	I	SI
22	3	53	III	ED
	4	04	I	ED
23	2	32	I	TI
	3	29	I	Se
	4	47	I	Te
24	2	10	I	OR
25	2	45	II	ED
26	2	48	III	Te
27	3	23	II	Te
28	5	15	IV	TI
29	5	57	I	ED
30	3	08	I	SI
	4	26	I	TI
	5	23	I	Se
	6	42	I	Te

MAY

d	h	m	Sat.	Phen.
1	4	04	I	OR
2	5	19	II	ED
3	1	25	III	Se
	3	15	III	TI
	6	49	III	Te
4	3	07	II	TI
	3	18	II	Se
	5	59	II	Te
6	2	43	IV	ED
7	5	01	I	SI
	6	19	I	TI
8	2	20	I	ED
	5	57	I	OR
9	0	47	I	TI
	1	45	I	SE
	3	03	I	Te
10	1	54	III	SI
	5	25	III	Se
11	3	03	II	SI
	5	41	II	TI
	5	54	II	Se
13	2	42	II	OR
14	0	45	III	OR
15	3	44	IV	Te
	4	13	I	ED
16	1	23	I	SI
	2	39	I	TI
	3	38	I	Se
	4	55	I	Te
17	2	17	I	OR
	5	53	III	SI
18	5	38	II	SI
20	5	13	II	OR
21	0	58	III	OD
	4	35	III	OR
22	0	19	II	Te
	6	07	I	ED
23	1	14	IV	ER
	3	16	I	SI
	4	30	I	TI
	5	32	I	Se
24	0	36	I	ED
	4	08	I	OR
25	0	00	I	Se
	1	14	I	Te
27	2	21	II	ED
	23	48	III	ED
28	3	22	III	ER
	4	43	III	OD
	23	56	II	TI
29	0	22	II	Se
	2	47	II	Te
30	5	10	I	SI
	6	20	I	TI
31	2	29	I	ED
	4	49	IV	SI
	5	58	I	OR
	23	38	I	SI

JUNE

d	h	m	Sat.	Phen.
1	0	48	I	TI
	1	54	I	Se
	3	04	I	Te
2	0	25	I	OR
3	4	56	II	ED
4	3	47	III	ED
5	0	07	II	SI
	2	22	II	TI
	2	57	II	Se
	5	12	II	Te
6	23	22	II	OR
7	4	23	I	ED
8	1	32	I	SI
	1	48	III	Te
	2	36	I	TI
	3	48	I	Se
	4	53	I	Te
	22	51	I	ED
9	0	49	IV	OD
	2	14	I	OR
	5	35	IV	OR
	23	20	I	Te
12	2	42	II	SI
	4	45	II	TI
	5	32	II	Se
14	1	45	II	OR
15	1	21	III	Se
	1	47	III	TI
	3	25	I	SI
	4	24	I	TI
	5	23	III	Te
	5	42	I	Se
16	0	45	I	ED
	4	01	I	OR
	22	51	I	TI
	22	54	IV	SI
17	0	10	I	Se
	1	08	I	Te
	3	23	IV	Se
	22	28	I	OR
19	5	17	II	SI
20	23	24	II	ED
21	4	07	II	OR
22	1	47	III	SI
	5	17	III	TI
	5	19	I	SI
	5	21	III	Se
	6	11	I	TI
	23	06	II	Te
23	2	39	I	ED
	5	47	I	OR
	23	47	I	SI
24	0	37	I	TI
	2	05	I	Se
	2	55	I	Te
25	0	14	I	OR
	22	38	III	OR
28	2	00	II	ED
	6	27	II	OR
29	5	47	III	SI
	22	34	II	TI
	23	59	II	Se
30	1	25	II	Te
	4	33	I	ED

JULY

d	h	m	Sat.	Phen.
1	1	41	I	SI
	2	23	I	TI
	3	59	I	Se
	4	41	I	Te
	23	01	I	ED
2	1	59	I	OR
	22	27	I	Se
	23	07	I	Te
3	2	01	III	OR
	21	33	IV	Se
	23	00	IV	TI
4	3	42	IV	Te
5	4	37	II	ED
6	23	43	II	SI
7	0	51	II	TI
	2	34	II	Se
	3	41	II	Te
	6	27	I	ED
8	3	35	I	SI
	4	08	I	TI
	5	53	I	Se
	6	26	I	Te
	21	55	II	OR
9	0	55	I	ED
	3	43	I	OR
	22	04	I	SI
	22	34	I	TI
	23	44	III	ED
10	0	22	I	Se
	0	52	I	Te
	5	22	III	OR
	22	09	I	OR
12	2	56	IV	ED
14	2	18	II	SI
	3	06	II	TI
	5	08	II	Se
	5	56	II	Te
15	5	30	I	SI
	5	52	I	TI
	20	32	II	ED
16	0	11	II	OR
	2	49	I	ED
	5	27	I	OR
	23	58	I	SI
17	0	18	I	TI
	2	16	I	Se
	2	36	I	Te
	3	43	III	ED
	21	18	I	ED
	23	53	I	OR
18	20	45	I	Se
	21	02	I	Te

d	h	m	Sat.	Phen.
20	21	22	III	Se
	22	20	III	Te
21	4	53	II	SI
	5	20	II	TI
22	23	09	II	ED
23	2	27	II	OR
	4	43	I	ED
24	1	53	I	SI
	2	02	I	TI
	4	11	I	Se
	4	20	I	Te
	21	01	II	Se
	21	17	II	Te
	23	12	I	ED
25	1	37	I	OR
	20	21	I	SI
	20	28	I	TI
	22	40	I	Se
	22	46	I	Te
26	20	03	I	OR
27	21	45	III	SI
	21	59	III	TI
28	1	22	III	Se
	1	36	III	Te
	21	02	IV	ED
29	2	04	IV	OR
30	1	46	II	ED
	4	42	II	OR
	6	38	I	ED
31	3	46	I	TI
	3	47	I	SI
	6	04	I	Te
	6	06	I	Se
	20	41	II	TI
	20	46	II	SI
	23	31	II	Te
	23	36	II	Se

AUGUST

d	h	m	Sat.	Phen.
1	1	04	I	OD
	3	23	I	ER
	22	12	I	TI
	22	16	I	SI
2	0	30	I	Te
	0	35	I	Se
	19	30	I	OD
	21	52	I	ER
4	1	16	III	TI
	1	45	III	SI
	4	52	III	Te
	5	22	III	Se
6	3	33	IV	TI
	4	02	II	OD
	5	14	IV	SI
7	5	30	I	TI
	5	42	I	SI
	19	21	III	ER
	22	54	II	TI
	23	21	II	SI
8	1	44	II	Te
	2	11	II	Se
	2	47	I	OD
	5	17	I	ER
	23	56	I	TI
9	0	11	I	SI
	2	15	I	Te
	2	30	I	Se
	20	38	II	ER
	21	13	I	OD
	23	46	I	ER
10	20	41	I	Te
	20	58	I	Se
11	4	33	III	TI
	5	46	III	SI
14	19	53	IV	ER
	23	21	III	ER
15	1	09	II	TI
	1	56	II	SI
	3	58	II	Te
	4	31	I	OD
	4	45	II	Se
16	1	41	I	TI
	2	06	I	SI
	3	59	I	Te
	4	24	I	Se
	19	26	II	OD
	22	57	I	OD
	23	16	II	ER
17	1	40	I	ER
	20	07	I	TI
	20	35	I	SI
	22	25	I	Te
	22	53	I	Se
18	20	09	I	ER
21	21	29	III	OD
22	3	22	III	ER
	3	24	II	TI
	4	31	II	SI
	22	33	IV	Te
	23	24	IV	SI
23	3	26	I	TI
	4	01	I	SI
	4	07	IV	Se
	21	44	II	OD
24	0	43	I	OD
	1	54	II	ER
	3	35	I	ER
	21	53	I	TI
	22	30	I	SI
25	0	11	I	Te
	0	48	I	Se
	19	09	I	OD
	19	22	II	Te
	20	38	II	Se
	22	04	I	ER
26	18	37	I	Te
	19	17	I	Se
29	0	51	III	OD
31	0	03	II	OD
	2	14	IV	OD
	2	28	I	OD
	4	32	II	ER
31	23	39	I	TI

SEPTEMBER

d	h	m	Sat.	Phen.
1	0	26	I	SI
	1	57	I	Te
	2	44	I	Se
	18	50	II	TI
	20	23	II	SI
	20	55	I	OD
	21	26	III	Se
	21	39	II	Te
	23	12	II	Se
	23	58	I	ER
2	18	54	I	SI
	20	24	I	Te
	21	12	I	Se
3	18	27	I	ER
5	4	17	III	OD
7	2	24	II	OD
8	1	27	I	TI
	2	21	I	SI
	3	45	I	Te
	21	10	II	TI
	21	43	III	Te
	21	50	III	SI
	22	19	IV	Se
	22	42	I	OD
	22	58	II	SI
	23	59	II	Te
9	1	26	III	Se
	1	48	II	Se
	1	53	I	ER
	19	54	I	TI
	20	50	I	SI
	22	12	I	Te
	23	08	I	Se
10	20	22	I	ER
	20	30	II	ER
15	3	15	I	TI
	21	40	III	TI
15	23	32	II	TI
16	0	30	I	OD
	1	16	III	Te
	1	34	II	SI
	1	50	III	SI
	2	21	II	Te
	21	43	I	TI
	22	23	IV	OR
	22	45	I	SI
17	0	00	I	Te
	1	03	I	Se
	18	01	II	OD
	18	57	I	OD
	22	17	I	ER
	23	08	II	ER
18	18	28	I	Te
	19	32	I	Se
19	19	25	III	ER
23	1	18	III	TI
	1	56	II	TI
	2	19	I	OD
	23	33	I	TI
24	0	41	I	SI
	1	50	I	Te
	20	28	II	OD
	20	47	I	OD
25	0	12	I	ER
	0	45	IV	TI
	1	47	II	ER
	18	01	I	TI
	19	10	I	SI
	20	18	I	Te
	21	28	I	Se
26	17	58	II	Te
	18	40	III	OR
	18	41	I	ER
	19	48	III	ED
	20	16	II	Se
	23	26	III	ER

OCTOBER

d	h	m	Sat.	Phen.
1	1	24	I	TI
	22	37	I	OD
	22	58	II	OD
2	2	07	I	ER
	19	52	I	TI
	21	06	I	SI
	22	10	I	Te
	23	23	I	Se
3	18	47	III	OD
	20	02	II	SI
	20	25	II	Te
	20	36	I	ER
	21	34	IV	ED
	22	24	III	OR
	22	51	II	Se
	23	48	III	ED
4	2	24	IV	ER
	17	52	I	Se
5	17	44	II	ER
7	17	32	III	Se
9	0	29	I	OD
	1	30	II	OD
	21	45	I	TI
	23	01	I	SI
10	0	02	I	Te
	1	19	I	Se
	18	58	I	OD
	20	07	II	TI
	22	31	I	ER
	22	36	III	OD
	22	38	II	SI
	22	55	II	Te
11	1	27	II	Se
	17	30	I	SI
	17	38	IV	TI
	18	31	I	Te
	19	48	I	Se
	22	16	IV	Te
12	20	23	II	ER
14	17	57	III	SI
	21	33	III	Se
16	23	39	I	TI
17	0	57	I	SI
	20	51	I	OD
	22	39	II	TI
18	0	26	I	ER
	1	14	II	SI
	18	08	I	TI
	19	26	I	SI
	20	25	I	Te
	21	44	I	Se
19	17	22	II	OD
	18	55	I	ER
	23	01	II	ER
20	20	35	IV	ER
21	17	20	II	Se
	20	13	III	Te
	21	58	III	SI
24	22	45	I	OD
25	20	03	I	TI
	21	22	I	SI
	22	20	I	Te
	23	39	I	Se
26	17	14	I	OD
	20	00	II	OD
	20	50	I	ER
27	18	08	I	Se
28	17	07	II	SI
	17	20	II	Te
	19	56	II	Se
	20	39	III	TI
29	0	11	IV	SI
	0	14	III	Te

NOVEMBER

d	h	m	Sat.	Phen.
1	19	33	III	ER
	21	59	I	TI
	23	18	I	SI
2	0	16	I	Te
	19	10	I	OD
	22	40	II	OD
	22	46	I	ER
3	17	47	I	SI
	18	46	I	Te
	20	04	I	Se
4	17	09	II	TI
	17	14	I	ER
	19	43	II	SI
	19	57	II	Te
	22	32	II	Se
5	21	42	IV	OD
6	17	37	II	ER
8	18	17	III	OR
	19	54	III	ED
	23	34	III	ER
	23	56	I	TI
9	21	07	I	OD
10	18	26	I	TI
	19	43	I	SI
	20	43	I	Te
	22	00	I	Se
11	19	10	I	ER
	19	48	II	TI
	22	19	II	SI
	22	37	II	Te
13	20	15	II	ER
14	18	25	IV	SI
	23	12	IV	Se
15	18	49	III	OD
	22	27	III	OR
16	23	04	I	OD
17	20	24	I	TI
	21	38	I	SI
	22	41	I	Te
18	17	34	I	OD
	21	05	I	ER
	22	29	II	TI
19	17	11	I	Te
	17	40	III	Se
19	18	24	I	Se

d	h	m	Sat.	Phen.
20	71	27	II	OD
	22	53	II	ER
22	16	47	IV	OD
	17	03	II	Se
	21	36	IV	OR
	23	03	III	OD
24	22	23	I	TI
25	19	32	I	OD
	23	00	I	ER
26	16	53	I	TI
	16	57	III	Te
	18	03	I	SI
	18	06	III	SI
	19	10	I	Te
	20	20	I	Se
	21	43	III	Se
27	17	29	I	ER
	20	13	II	OD
29	16	49	II	SI
	17	23	II	Te
	19	40	II	Se

DECEMBER

d	h	m	Sat.	Phen.
1	17	26	IV	Se
2	21	32	I	OD
3	17	39	III	TI
	18	53	I	TI
	19	59	I	SI
	21	10	I	Te
	21	16	III	Te
	22	07	III	SI
	22	16	I	Se
4	19	25	I	ER
5	16	45	I	Se
6	17	18	II	TI
	19	25	II	SI
6	20	08	II	Te
	22	16	II	Se
8	17	27	II	ER
9	17	23	IV	OR
	22	16	IV	ED
10	20	53	I	TI
	21	54	I	SI
	22	00	III	TI
11	18	02	I	OD
	21	20	I	ER
12	16	23	I	SI
	17	40	I	Te
	18	40	I	Se
13	20	04	II	TI
	22	02	II	SI
14	19	40	III	ER
15	20	04	II	ER
17	21	53	IV	TI
18	20	02	I	OD
19	17	24	I	TI
	18	18	I	SI
	19	41	I	Te
	20	36	I	Se
20	17	44	I	ER
22	18	01	II	OD
24	16	49	II	Se
26	19	25	I	TI
	20	14	I	SI
	21	18	IV	ER
27	19	39	I	ER
28	17	00	I	Se
	20	53	III	OD
29	20	51	II	OD
31	17	57	II	Te
	19	26	II	Se

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 1973.

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 1973

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.	E.A.	Dec.			
		h		h m	°	m	°		km/sec	days
Quadrantids	Jan. 3	03	N.M.	15 28	+50	—	—	40	41	1.1
Lyrids	Apr. 22	03	L.Q.	18 16	+34	+4.4	0.0	15	48	2
η Aquarids	May 5	04	N.M.	22 24	00	+3.6	+0.4	20	64	3
δ Aquarids	July 29	04	N.M.	22 36	−17	+3.4	+0.17	20	40	—
Perseids	Aug. 12	05	F.M.	03 04	+58	+5.4	+0.12	50	60	4.6
Orionids	Oct. 21	07	L.Q.	06 20	+15	+4.9	+0.13	25	66	2
Taurids	Nov. 4	—	F.Q.	03 32	+14	+2.7	+0.13	15	28	—
Leonids	Nov. 17	01	L.Q.	10 08	+22	+2.8	−0.42	15	72	—
Geminids	Dec. 13	22	L.Q.	07 32	+32	+4.2	−0.07	50	35	2.6
Ursids	Dec. 22	15	N.M.	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. 71).

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.
0	10.2	Rh	E
1	06.3	Ti	W
4	22.5	Rh	E
9	08.0	Ti	E
9	10.8	Rh	E
13	15.0	Ia	E
13	23.1	Rh	E
17	03.9	Ti	W
18	11.5	Rh	E
22	23.9	Rh	E
25	05.7	Ti	E
27	12.2	Rh	E

FEBRUARY

d	h	Sat.	Elong.
1	00.6	Rh	E
2	02.0	Ti	W
5	13.0	Rh	E
10	01.4	Rh	E
10	04.0	Ti	E
14	13.9	Rh	E
18	00.6	Ti	W
19	02.3	Rh	E
22	15.4	Ia	W
23	14.8	Rh	E
26	02.9	Ti	E
28	03.2	Rh	E

MARCH

d	h	Sat.	Elong.
4	15.7	Rh	E
5	23.8	Ti	W
9	04.2	Rh	E
13	16.7	Rh	E
14	02.4	Ti	E
18	05.2	Rh	E
21	23.4	Ti	W
22	17.7	Rh	E
27	06.3	Rh	E
30	02.4	Ti	E
31	18.8	Rh	E

APRIL

d	h	Sat.	Elong.
3	06.6	Ia	E
5	07.4	Rh	E
6	23.5	Ti	W
9	19.9	Rh	E
14	08.5	Rh	E
15	02.9	Ti	E
18	21.1	Rh	E
23	00.0	Ti	W
23	09.7	Rh	E
27	22.3	Rh	E

MAY

d	h	Sat.	Elong.
1	03.7	Ti	E
2	10.8	Rh	E
6	23.4	Rh	E
9	00.7	Ti	W

Saturn being near the sun, elongations of the satellites are not given between May 9 and July 22.

JULY

d	h	Sat.	Elong.
22	21.9	Rh	E
27	10.4	Rh	E
28	05.6	Ti	W
31	23.0	Rh	E

AUGUST

d	h	Sat.	Elong.
3	19.5	Ia	W
5	10.6	Ti	E
5	11.6	Rh	E
10	00.2	Rh	E
13	06.2	Ti	W
14	12.7	Rh	E
19	01.3	Rh	E
21	11.2	Ti	E
23	13.9	Rh	E
28	02.4	Rh	E
29	06.5	Ti	W

SEPTEMBER

d	h	Sat.	Elong.
1	14.9	Rh	E
6	03.4	Rh	E
6	11.4	Ti	E
10	16.0	Rh	E
13	04.0	Ia	E
14	06.4	Ti	W
15	04.5	Rh	E
19	16.9	Rh	E
22	11.2	Ti	E
24	05.4	Rh	E
28	17.9	Rh	E
30	05.9	Ti	W

OCTOBER

d	h	Sat.	Elong.
3	06.3	Rh	E
7	18.8	Rh	E
8	10.4	Ti	E
12	07.2	Rh	E
16	04.8	Ti	W
16	19.6	Rh	E
21	08.0	Rh	E
23	01.7	Ia	W
24	09.1	Ti	E
25	20.4	Rh	E
30	08.8	Rh	E

NOVEMBER

d	h	Sat.	Elong.
1	03.2	Ti	W
3	21.2	Rh	E
8	09.5	Rh	E
9	07.2	Ti	E
12	21.9	Rh	E
17	01.1	Ti	W
17	10.2	Rh	E
21	22.5	Rh	E
25	04.9	Ti	E
26	10.9	Rh	E
30	23.2	Rh	E

DECEMBER

d	h	Sat.	Elong.
1	07.6	Ia	E
2	22.7	Ti	W
5	11.5	Rh	E
9	23.8	Rh	E
11	02.1	Ti	E
14	12.1	Rh	E
18	19.9	Ti	W
19	00.4	Rh	E
23	12.7	Rh	E
26	23.2	Ti	E
28	01.0	Rh	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 50	2 30	+13.2	10.31	6.40	5.09	4.42	3.73	3.37	3.13	2.95	2.81	2.68	2.56	−13.2	9 30	*21 30*
15 00	3 00	+11.8	11.56	7.02	5.50	4.73	3.92	3.50	3.22	3.02	2.85	2.70	2.56	−11.8	9 00	*21 00*
15 30	3 30	+10.2	12.66	7.57	5.86	4.99	4.09	3.61	3.30	3.07	2.88	2.72	2.56	−10.2	8 30	*20 30*
16 00	4 00	+ 8.3	13.58	8.03	6.16	5.21	4.23	3.71	3.37	3.12	2.91	2.73	2.56	− 8.3	8 00	*20 00*
16 30	4 30	+ 6.4	14.32	8.40	6.40	5.39	4.34	3.79	3.42	3.16	2.93	2.74	2.56	− 6.4	7 30	*19 30*
17 00	5 00	+ 4.3	14.85	8.66	6.58	5.52	4.42	3.84	3.46	3.18	2.95	2.75	2.56	− 4.3	7 00	*19 00*
17 30	5 30	+ 2.2	15.18	8 82	6.68	5.60	4.47	3.88	3.49	3.20	2.96	2.75	2.56	− 2.2	6 30	*18 30*
18 00	6 00	0.0	15.29	8.88	6.72	5.62	4.49	3.89	3.50	3.20	2.97	2.76	2.56	0.0	6 00	*18 00*
0 00	12 00	−16.7	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	+16.7	24 00	*12 00*
0 30	12 30	−16.6	+ 0.90	1.82	2.02	2.16	2.31	2.39	2.44	2.48	2.51	2.53	2.56	+16.6	23 30	*11 30*
1 00	13 00	−16.1	− 0.73	0.93	1.48	1.77	2.06	2.22	2.32	2.39	2.45	2.51	2.56	+16.1	23 00	*11 00*
1 30	13 30	−15.4	− 2.31	+0.14	0.97	1.39	1.82	2.05	2.20	2.31	2.40	2.49	2.56	+15 4	22 30	*10 30*
2 00	14 00	−14.5	− 3.80	−0.60	0.46	1.03	1.60	1.90	2.09	2.24	2.36	2.46	2.56	+14.5	22 00	*10 00*
2 30	14 30	−13 2	− 5.19	−1.28	+0.03	0.70	1.39	1.75	1.99	2.17	2.31	2.44	2.56	+13 2	21 30	*9 30*
3 00	15 00	−11 8	− 6.44	−1.90	−0.38	0.40	1.20	1.62	1.90	2.11	2.27	2.42	2.56	+11.8	21 00	*9 00*
3 30	15 30	−10.2	− 7.54	−2.45	−0.74	+0.13	1.03	1.51	1.81	2.05	2.24	2.40	2.56	+10.2	20 30	*8 30*
4 00	16 00	− 8.3	− 8.46	−2.91	−1.04	−0.09	0.89	1.41	1.75	2.00	2.21	2.39	2.56	+ 8.3	20 00	*8 00*
4 30	16 30	− 6.4	− 9.20	−3.27	−1.28	−0.27	0.78	1.33	1.70	1.97	2.19	2.38	2.56	+ 6.4	19 30	*7 30*
5 00	17 00	− 4.3	− 9.73	−3.54	−1.45	−0.40	0.70	1.28	1.66	1.94	2.17	2.37	2.56	+ 4.3	19 00	*7 00*
5 30	17 30	− 2.2	−10.06	−3.70	−1.56	−0.47	0.65	1.25	1.63	1.92	2.16	2.37	2.56	+ 2.2	18 30	*6 30*
6 00	18 00	0.0	−10.17	−3.75	−1.60	−0.50	0.63	1.23	1.62	1.92	2.16	2.36	2.56	0.0	18 00	*6 00*

FINDING LIST OF NAMED STARS

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

	Right Ascension	Declination	Visual Magnitude	Colour Index	Spectral Classification		Parallax	Absolute Magnitude	Distance light-years	Proper Motion	Radial Velocity		
Star	R.A. 1970	Dec.	V	$B–V$	Type		π	M_V	D	μ	R		
	h m	° ′					″		l.y.	″	km./sec.		
Sun			-26.73	+0.63	G2	V		+4.84					***Sun***
α And	00 06.8	+28 55	2.06	−0.08	B9p		0.024	−0.1	90	0.209	*−11.7*	Manganese star	*Alpheratz*
β Cas	07.6	+58 59	2.26	+0.34	F2	IV	0.072	+1.6	45	0.555	+11.8		*Caph*
γ Peg	11.7	+15 01	2.84v	−0.23	B2	IV	−.004	−3.4	570	0.010	+04.1	β CMa type, R in V 2.83–2.85, 0.15^d	
β Hyi	24.2	−77 25	2.78	+0.62	*G1*	*IV*	0.153	+3.7	21	2.255	+22.8		γ Peg = *Algenib*
α Phe	24.8	−42 28	2.39	+1.08	*K0*	*III*	0.035	+0.1	93	0.442	*+74.6*		*Ankaa*
δ And *A*	37.7	+30 42	3.25:	+1.26	K3	III	0.024	−0.2	160	0.161	−07.3	*B* 12^m 28″	
α Cas	38.8	+56 22	2.16	+1.18	K0	II–III	0.009	−1.1	150	0.058	−03.8	Var.?	*Schedar*
β Cet	42.1	−18 09	2.02	+1.03	K1	III	0.057	+0.8	57	0.234	+13.1		*Diphda*
η Cas *A*	47.3	+57 39	3.47	+0.56	G0	V	0.182	+4.8	18	1.221	+09.4	*B* 7.26^m 9″	
γ Cas *A*	54.9	+60 33	2.13v	−0.16v	B0	IV:pe	0.034	−0.3:	96:	0.026	−06.8	Var. *B* 8.18^m 2″	
β Phe *AB*	01 04.7	−46.53	3.30	+0.88	*G8*	*III*	0.017	+0.3	190	0.035	−01.1	*A* 4.1^m *B* 4.1^m 2″	
η Cet	07.1	−10 20	3.47	+1.16	K3	III	0.032	+1.0	102	0.250	+11.5		
β And	08.0	+35 28	2.02	+1.57	M0	III	0.043	+0.2	76	0.211	+00.3		*Mirach*
δ Cas	23.8	+60 05	2.67	+0.13	A5	V	0.029	+2.1	43	0.301	+06.7	Ecl.? *R* $0.08{:}^m$ 759^d	
γ Phe	27.1	−43 28	3.44	+1.56	*K5*	*Ib*	−.003	−4.6	1300	0.209	*+25.7*		
α Eri	36.6	−57 23	0.51	−0.16	*B5*	*IV*:	0.023	−2.3	118	0.098	+19		***Achernar***
τ Cet	42.7	−16 06	3.50	+0.72	G8	Vp	0.275	+5.70	12	1.921	−16.2		

Star	R.A. 1970	Dec.	V	$B–V$	Type		π	M_V	D	μ	R		
	h m	° ′					″		l.y.	″	km./sec.		
α Tri	01 51.4	+29 26	3.45	+0.46	F6	IV	0.050	+2.0	65	0.230	*−12.6*		
ε Cas	52.2	+63 31	3.33	−0.15	B3	IV:p	0.007	−2.7	520	0.038	−08.1		
β Ari	53.0	+20 40	2.68	+0.14	A5	V	0.063	+1.7	52	0.147	*−01.9*		
α Hyi	57.8	−61 43	2.84	+0.28	*F0*	*V*		+2.9	31	0.265	+07		
γ And *A*	02 02.1	+42 11	2.14:	+1.16:	K3	II	0.005	−2.4	260	0.068	−11.7	*B* 5.4^m *C* 6.2^m *A–BC* 10″ *B–C* 0.7″ γ And =	*Almach*
α UMi *A*	02.5	+89 08	1.99v	+0.60v	F8	Ib	0.003	−4.6	680	0.046	*−17.4*	Cep., *R* 0.11^m 4.0^d, *B* 8.9^m 18″	*Polaris*
α Ari	05.5	+23 19	2.00	+1.15	K2	III	0.043	+0.2	76	0.241	−14.3		*Hamal*
β Tri	07.8	+34 51	3.00	+0.13	A5	III	0.012	−0.1	140	0.156	*+09.9*		
o Cet *A*	17.8	−03 07	2.0v			(gM6e)	0.013	−0.5	103	0.232	+63.8	LP, *R* 2.0–10.1, 332^d, *B* 10^m 1″	*Mira*
γ Cet *AB*	41.7	+03 07	3.48	+0.11	A2	V	0.048	+2.0	68	0.203	−05.1	*A* 3.57^m *B* 6.23^m 3″	
θ Eri *AB*	57.1	−40 25	2.92	+0.13	*A3*	*V*	0.028	+1.7	65	0.061	*+11.9*	*A* 3.25^m *B* 4.36^m 8″	*Acamar*
α Cet	03 00.7	+03 58	2.54	+1.63	M2	III	0.003	−0.5	130	0.075	−25.9		*Menkar*
γ Per	02.6	+53 23	2.91:	+0.72:	G8 III: +A3:		0.011	+0.3	113	0.004	*+02.5*		
ρ Per	03.1	+38 43	3.5v		M4	II–III	0.008	−1.0	260	0.172	+28.2	Irr. *R* 3.2–3.8	
β Per	06.0	+40 50	2.06v	−0.07	B8	V	0.031	−0.5	105	0.006	*+04.0*	Ecl. *R* 2.06–3.28, 2.87^d	*Algol*
α Per	22.2	+49 45	1.80	+0.48	F5	Ib	0.029	−4.4	570	0.035	−02.4		*Mirfak*
δ Per	40.8	+47 42	3.03	−0.14	B5	III	0.007	−3.3	590	0.046	−09		
η Tau	45.7	+24 01	2.86	−0.09	B7	III	0.005	−3.2	541	0.050	+10.1	in Pleiades	*Alcyone*
γ Hyi	47.7	−74 20	3.30	+1.61	*M2*	*II–III*	−.001	−1.5	300	0.125	+16.0		
ζ Per *A*	52.1	+31 48	2.83	+0.13	B1	Ib	0.007	−6.1	1000	0.015	+20.6	*B* 9.36^m 13″	
ε Per *A*	55.8	+39 55	2.88	−0.17	B0.5	V	−.001	−3.7	680	0.036	−01	*B* 7.99^m 9″	
γ Eri	56.6	−13 36	3.01	+1.58	M0	III	0.003	−0.5	160	0.126	+61.7		
α Ret *A*	04 14.0	−62 33	3.33	+0.91	*G6*	*II*	0.008	−2.1	390	0.064	+35.6	*B* 12^m 49″	
ε Tau	26.9	+19 07	3.54	+1.02	K0	III	0.018	+0.1	160	0.118	+38.6		
θ^2 Tau	26.9	+15 48	3.42	+0.17	A7	III	0.025	+0.2	140	0.108	*+39.5*		
α Dor	33.3	−55 06	3.28	−0.08	*A0*	*IIIp*	0.011	−1.2	260	0.051	+25.6	Silicon star	
α Tau *A*	34.2	+16 27	0.86v	+1.52	K5	III	0.048	−0.7	68	0.202	+54.1	Irr.? *R* 0.78–0.93, *B* 13^m 31″	***Aldebaran***
π^3 Ori	48.2	+06 55	3.17	+0.45	F6	V	0.125	+3.65	26	0.468	+24.3		
ι Aur	55.0	+33 07	2.64:	+1.49	K3	II	0.015	−2.4	330	0.021	+17.5		

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

Star	R.A. 1970	Dec.	V	$B–V$	Type	π	M_V	D	μ	R	
	h m	° ′				″		l.y.	″	km./sec.	
ε Aur	04 59.8	+43 47	3.0v	+0.50:	F0 Iap	0.004	−7.1	3400	0.008	*−02.5*	Ecl. *R* 0.81^{m} 9886^{d}
ε Lep	05 04.2	−22 25	3.21	+1.46	*K5 III*	0.006	−0.4	170	0.077	+01.0	
η Aur	04.4	+41 12	3.17	−0.18	B3 V	0.013	−2.1	370	0.077	+07.4	
β Eri	06.4	−05 07	2.79	+0.13	A3 III	0.042	+0.9	78	0.122	−08	
μ Lep	11.6	−16 14	3.29	−0.09	*B9 IIIp*	0.018	−2.1	390	0.049	+27.7	Manganese star
β Ori *A*	13.1	−08 14	0.14v	−0.04	B8 Ia	−.003	−7.1	900	0.001	*+20.7*	Irr. ? *R* 0.08–0.20, *B* 6.65^{m} 9″ ***Rigel***
α Aur	14.5	+45 58	0.05	+0.80	G8 III: +F	0.073	−0.6	45	0.435	*+30.2*	***Capella***
η Ori *AB*	23.0	−02 25	3.32v	−0.18	B0.5 V	0.004	−3.7	940	0.008	*+19.8*	Ecl. *R* 3.32–3.50, 8.0^{d}, *A* 3.59^{m} *B* 4.98^{m} 1″
γ Ori	23.5	+06 19	1.64	−0.23	B2 III	0.026	−4.2	470	0.015	+18.2	***Bellatrix***
β Tau	24.4	+28 35	1.65	−0.13	B7 III	0.018	−3.2	300	0.178	+08.0	***Elnath***
β Lep *A*	27.0	−20 47	2.81	+0.82	G5 III	0.014	+0.1	113	0.090	−13.5	*B* 9.4^{m} 3″
δ Ori *A*	30.5	−00 19	2.20v	−0.20	O9.5 II	0.004	−6.1	1500	0.002	*+16.0*	Ecl. *R* 2.20–2.35 5.7^{d}, B 6.74^{m} 53″
α Lep	31.4	−17 51	2.58	+0.22	F0 Ib	0.002	−4.6	900	0.006	+24.7	
λ Ori *AB*	33.5	+09 55	3.40	−0.18	O8	0.006	−5.1	1800	0.006	+33.5	*A* 3.56^{m} *B* 5.54^{m} 4″ *C* 10.92^{m} 29″
ι Ori *AB*	34.0	−05 56	2.76	−0.24	O9 III	0.021	−6.1	2000	0.005	*+21.5*	*A* 2.78^{m} *B* 7.31^{m} 11″
ε Ori	34.7	−01 13	1.70	−0.19	B0 Ia	−.007	−6.8	1600	0.000	+26.1	***Alnilam***
ζ Tau	35.9	+21 08	3.07:	−0.13:	B2 III:p	−.002	−4.2	940	0.023	*+24.3*	Shell star
α Col *A*	38.6	−34 05	2.64	−0.11	*B8 Ve*	−.005	−0.6	140	0.026	+35	*B* 12^{m} 12″
ζ Ori *AB*	39.2	−01 57	1.79	−0.22	O9.5 Ib	0.022	−6.6	1600	0.004	+18.1	*A* 1.91^{m} *B* 4.05^{m} 3″
κ Ori	46.3	−09 41	2.06	−0.17	B0.5 Ia	0.009	−6.9	2100	0.004	+20.6	
β Col	49.9	−35 47	3.12	+1.16	(gK1)	0.023	+0.0	140	0.402	+89.4	
α Ori	53.5	+07 24	0.41v	+1.87:	M2 Iab	0.005	−5.6	520	0.028	*+21.0*	Irr. ? *R* 0.06:–0.75:^{m} ***Betelgeuse***
β Aur	57.3	+44 57	1.86	+0.06	A2 V	0.037	−0.3	88	0.051	*−18.2*	
θ Aur *AB*	57.7	+37 13	2.65	−0.07	B9.5pv	0.018	+0.1	108	0.097	+29.3	Silicon star *A* 2.67^{m} *B* 7.14^{m} 3″
η Gem *A*	06 13.1	+22 31	3.33v	+1.58	M3 III	0.013	−0.6	200	0.066	*+19.0*	*R* 0.27^{m}, *B* 6.70^{m} 1″
ζ CMa	19.2	−30 03	3.04	−0.18	B2.5 V	−.003	−2.4	390	0.004	*+32.2*	
μ Gem	21.1	+22 32	2.92v	+1.63	M3 III	0.021	−0.6	160	0.129	+54.8	*R* 0.14^{m}
β CMa	21.4	−17 56	1.96	−0.24	B1 II–III	0.014	−4.8	750	0.004	*+33.7*	β CMa type variable
α Car	23.3	−52 41	−0.72	+0.16	F0 Ib–II	0.018	−3.1	98	0.025	+20.5	***Canopus***
γ Gem	36.0	+16 26	1.93	0.00	A0 IV	0.031	−0.6	105	0.066	*−12.5*	

Star	R.A. 1970	Dec.	V	$B-V$	Type	π	M_V	D	μ	R	Remarks
	h m	° ′				″		l.y.	″	km./sec.	
ν Pup	06 36.8	−43 10	3.19	−0.10	*B7 III*		−3.2	620	0.010	+28.2	
ε Gem	42.1	+25 10	3.00	+1.39	G8 Ib	0.009	−4.6	1080	0.016	+09.9	
ξ Gem	43.6	+12 56	3.38	+0.43	F5 IV	0.051	+1.9	64	0.224	+25.3	
α CMa *A*	43.8	−16 41	−1.42	+0.01	A1 V	0.375	+1.45	8.7	1.324	*−07.6*	*B* 8.66^m 1960: 9″, θ = 90° ***Sirius***
α Pic	48.1	−61 54	3.27	+0.21	*A5 V*		+2.1	57	0.272	+20.6	
τ Pup	49.2	−50 35	2.97	+1.17	*K0 III*		+0.1	124	0.079	*+36.4*	
ε CMa *A*	57.4	−28 56	1.48:	−0.18:	B2 II		−5.1	680	0.004	+27.4	*B* 7.5^m 8″ ***Adhara***
σ² 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***
ο UMa *A*	27.8	+60 49	3.37	+0.83	G5 III	0.004	+0.1	150	0.171	+19.8	*B* 15^m 7″
δ Vel *AB*	43.9	−54 36	1.95	+0.05	*A0 V*	0.043	+0.2	76	0.086	+02.2	*A* 2.0^m *B* 5.1^m 3″ *CD* 10^m 69″
ε Hya *ABC*	45.2	+06 32	3.39	+0.68	G0 comp.	0.010	+0.6	140	0.198	*+36.4*	*A*3.7^m*B*5.2^{m}0.2″15^y,*C*6.8^{m}3″*D*12^{m}20″
ζ Hya	53.8	+06 04	3.11	+1.00	K0 II–III	0.029	−1.1	220	0.101	+22.8	
ι UMa *A*	57.2	+48 09	3.12	+0.19	A7 V	0.066	+2.2	49	0.505	+12.2	*BC* 10.8^m 7″

Star	R.A. 1970	Dec.	*V*	*B–V*	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
λ Vel	09 06.9	−43 19	2.24	+1.64:	*K5 Ib*	0.015	−4.6	750	0.026	+18.4		*Suhail*
a Car	10.2	−58 50	3.43	−0.17	*B3 IV*		−2.9	590	0.028	+*23.3*		
β Car	12.9	−69 36	1.67	+0.01	*A0 III*	0.038	−0.4	86	0.183	−05		*Miaplacidus*
ι Car	16.3	−59 08	2.25	+0.17	*F0 Ib*		−4.6	750	0.019	+13.3		
α Lyn	19.3	+34 *32*	3.17	+1.54	M0 III	0.021	−0.5	180	0.217	+37.6		
κ Vel	21.2	−54 53	2.45	−0.15	*B2 IV*	0.007	−3.4	470	0.012	+*21.9*		
α Hya	26.1	−08 32	1.98	+1.44	K4 III	0.017	−0.3	94	0.034	−04.3		*Alphard*
N Vel	30.3	−56 54	3.19	+1.56	(gK5)	0.015	−0.4	170	0.036	−13.9		
θ UMa *A*	30.8	+51 49	3.19	+0.46	F6 IV	0.052	+1.8	63	1.094	+15.4	*B* 14^m 5″	
ε Leo	44.1	+23 54	2.99	+0.81	G0 II	0.002	−2.1	340	0.048	+05.0		
l Car	44.4	−62 23	4.1		(cG0)	0.019	−5.5	2700	0.016	+*04.0*	Cep. max. 3.4^m min. 4.8^m, 35.52^d	
υ Car *AB*	46.4	−64 56	2.95	+0.26	*A7 II*	0.020	−2.1	340	0.012	+13.6	*A* 3.02^m *B* 6.03^m 5″	
α Leo *A*	10 06.8	+12 07	1.36	−0.11	B7 V	0.039	−0.7	84	0.248	+03.5	*B* 8.1^m 177″	***Regulus***
ω Car	13.0	−69 53	3.33	−0.08	*B8.5 IV*		−1.5	300	0.029	+04		
ζ Leo	15.1	+23 34	3.46	+0.30	F0 III	0.009	+0.5	130	0.023	−15.0		
λ UMa	15.3	+43 04	3.45	+0.03	A2 IV	−.010	+0.1	150	0.170	+18.3		
q Car	16.1	−61 11	3.41v	+1.55	*K5 Ib*	0.018	−4.6	1300	0.023	+08.6	Var. *R* 3.38–3.44	
γ Leo *AB*	18.3	+20 00	1.99	+1.13	K0 IIIp	0.019	+0.1	90	0.350	−36.6	*A* 2.29^m *B* 3.54^m 4″	
μ UMa	20.5	+41 39	3.05	+1.55	M0 III	0.031	+0.5	105	0.086	−*20.5*		
p Car	31.0	−61 32	3.30v	−0.11	*B5 IVpe*		−2.3	430	0.021	+26.0	Var. *R* 3.22–3.39	
θ Car	41.9	−64 14	2.74	−0.22	*B0 Vp*		−4.0	710	0.018	+24		
μ Vel *AB*	45.5	−49 16	2.67	+0.89	*G5 III*		+0.1	108	0.085	+06.9	*A* 2.7^m *B* 7.2^m 2″	
ν Hya	48.1	−16 02	3.12	+1.25	K3 III	0.022	−0.2	150	0.221	−01.0		
β UMa	11 00.0	+56 33	2.37	−0.03	A1 V	0.042	+0.5	78	0.087	−12.0		*Merak*
α UMa *AB*	01.9	+61 55	1.81	+1.06	K0 III	0.031	−0.7	105	0.138	−08.9	*A* 1.88^m *B* 4.82^m 1″	*Dubhe*
ψ UMa	08.0	+44 39	3.00	+1.14	K1 III		+0.0	130	0.072	−03.8		
δ Leo	12.5	+20 41	2.57	+0.13	A4 V	0.040	+0.6	82	0.201	−20.6		
θ Leo	12.7	+15 36	3.34	0.00	A2 V	0.019	+1.1	90	0.104	+07.8		
λ Cen	34.4	−62 51	3.15	−0.05	*B9 III*		−2.1	370	0.039	+07.9		
β Leo	47.5	+14 44	2.14	+0.09	A3 V	0.076	+1.5	43	0.511	−00.1		*Denebola*

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

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

Star	R.A. 1970	Dec.	V	$B–V$	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
β Sco *AB*	16 03.7	−19 43	2.65	−0.09	B0.5 V	0.004	−3.7	650	0.027	*−06.6*	*A* 2.78ᵐ *B* 5.04ᵐ 1″, *C* 4.93ᵐ 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, 0.25ᵈ, *B* 8.49ᵐ 20″	
η Dra *A*	23.6	+61 34	2.71	+0.92	G8 III	0.043	+0.9	76	0.062	−14.3	*B* 8.7ᵐ 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* 0.86ᵐ–1.02ᵐ *B* 5.07ᵐ 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* 2.91ᵐ *B* 5.46ᵐ 1″	
η Her	41.9	+38 59	3.46	+0.92	G7 III–IV	0.053	+2.1	62	0.097	+08.3		
α TrA	45.5	−68 59	1.93	+1.43	*K2 III*	0.024	−0.1	82	0.044	−03.6		***Atria***
ε Sco	48.2	−34 15	2.28	+1.16	*K2 III–IV*	0.049	+0.7	66	0.664	−02.5		
μ¹ Sco	49.8	−38 00	2.99v	−0.20	B1.5 V		−3.0	520	0.033	*−25*	Ecl. *R* 2.99–3.09, 1.4ᵈ	
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* 3.0ᵐ *B* 3.4ᵐ 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* 3.2ᵐ ± 0.3 *B* 5.4ᵐ 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* 10ᵐ 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* 11.49ᵐ 4″	
λ Sco	31.6	−37 05	1.60	−0.24	B1 V		−3.3	310	0.031	00		***Shaula***
α Oph	33.5	+12 35	2.09	+0.16	A5 III	0.056	+0.8	58	0.260	+12.7		***Rasalhague***
θ Sco	35.2	−42 59	1.86	+0.39	*F0 Ib*	0.020	−4.6	650	0.012	+01.4		

Star	R.A. 1970	Dec.	V	$B-V$	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
κ Sco	17 40.4	−39 01	2.39	−0.21	*B2 IV*		−3.4	470	0.031	−10		
β Oph	42.0	+04 35	2.77	+1.16	K2 III	0.023	−0.1	124	0.160	−12.0		
μ Her *A*	45.3	+27 45	3.42	+0.75	G5 IV	0.108	+3.6	30	0.811	−15.6	*BC* 9.78^m 33″	
ι^1 Sco	45.5	−40 06	2.99	+0.49	F2 Ia	0.013	−7.1	3400	0.004	*−27.6*		
G Sco	47.7	−37 02	3.21	+1.18	(gK1)	0.032	+0.7	102	0.064	+24.7		
γ Dra	55.9	+51 29	2.21	+1.52	K5 III	0.017	−0.4	108	0.026	−27.6		*Eltanin*
ν Oph	57.4	−09 47	3.32	+1.00	G9 III	0.015	+0.2	140	0.118	+12.4		
γ Sgr	18 03.9	−30 26	2.97	+1.00	*K0 III*	0.018	+0.1	124	0.200	*+22.1*		
η Sgr *A*	15.6	−36 47	3.17	+1.55	*M3 II*	0.038	+1.1:	86:	0.218	+00.5	*B* 10^m 4″	
δ Sgr	19.1	−29 50	2.71	+1.39	*K2 III*	0.039	+0.7	84	0.050	−20.0		
η Ser	19.7	−02 54	3.23	+0.94	K0 III–IV	0.054	+1.9	60	0.894	+08.9		
ε Sgr	22.2	−34 24	1.81	−0.02	*B9 IV*	0.015	−1.1	124	0.135	−11		*Kaus Australis*
λ Sgr	26.1	−25 27	2.80	+1.05	*K2 III*	0.046	+1.1	71	0.194	−43.3		
α Lyr	35.9	+38 45	0.04	0.00	A0 V	0.123	+0.5	26.5	0.345	−13.9		***Vega***
φ Sgr	43.8	−27 02	3.20	−0.11	*B8 III*		−3.1	590	0.052	+21.5		
β Lyr *A*	49.0	+33 20	3.38v	−0.05:	Bpe	—.011	−4.6	1300	0.007	*−19.2*	Ecl. *R* 3.38–4.36, 12.9^d, *B* 7.8^m 46″	
*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.

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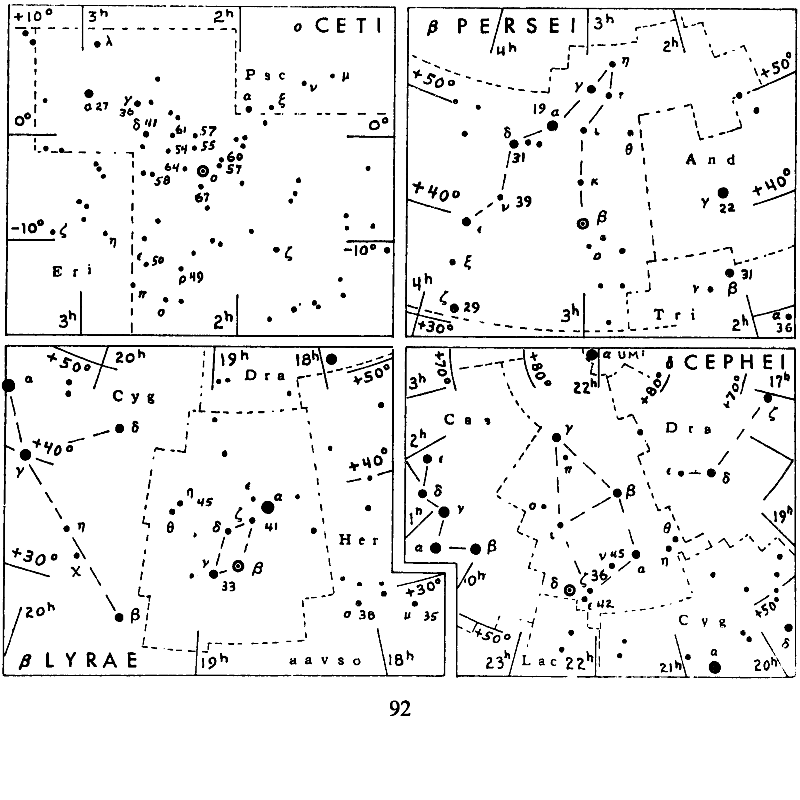
VARIABLE STARS

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*, 1972, International Supplement.



LONG-PERIOD VARIABLE STARS

Variable	Max. m	Per d	Epoch 1973	Variable	Max. m	Per d	Epoch 1973
001755 T Cas	7.8	445	Aug. 20	142539 V Boo	7.9	258	Sept. 11
001838 R And	7.0	409	July 10	143227 R Boo	7.2	223	June 15
021143 W And	7.4	397	Sept. 9	151731 S CrB	7.3	361	Feb. 5
0214*03* o Cet	3.4	332	May 1	154639 V CrB	7.5	358	Nov. 13
0228*13* U Cet	7.5	235	Aug. 8	154615 R Ser	6.9	357	Oct. 2
023133 R Tri	6.2	266	Mar. 8	160625 RU Her	8.0	484	Dec. 13
043065 T Cam	8.0	374	Nov. 11	162119 U Her	7.5	406	Feb. 11
0455*14* R Lep	6.8	432	—	1621*12* V Oph	7.5	298	Apr. 28
050953 R Aur	7.7	459	Feb. 27	163266 R Dra	7.6	245	May 12
054920 U Ori	6.3	372	Aug. 5	164715 S Her	7.6	307	Oct. 30
0617*02* V Mon	7.0	335	Aug. 3	1702*15* R Oph	7.9	302	June 13
065355 R Lyn	7.9	379	Feb. 26	171723 RS Her	7.9	219	July 24
070122aR Gem	7.1	370	June 6	180531 T Her	8.0	165	June 7
070310 R CMi	8.0	338	Nov. 13	181136 W Lyr	7.9	196	Jan. 31
072708 S CMi	7.5	332	July 17	183308 X Oph	6.8	334	May 5
081112 R Cnc	6.8	362	Dec. 28	190108 R Aql	6.1	300	Mar. 28
081617 V Cnc	7.9	272	June 16	1910*17* T Sgr	8.0	392	Mar. 2
084803 S Hya	7.8	257	Jan. 4	1910*19* R Sgr	7.3	269	Mar. 7
0850*08* T Hya	7.8	288	Oct. 14	193449 R Cyg	7.5	426	Dec. 13
093934 R LMi	7.1	372	Feb. 8	194048 RT Cyg	7.3	190	Feb. 18
094211 R Leo	5.8	313	Nov. 3	194632 χ Cyg	5.2	407	Jan. 27
103769 R UMa	7.5	302	Jan. 9	201647 U Cyg	7.2	465	Apr. 20
1214*18* R Crv	7.5	317	May 26	2044*05* T Aqr	7.7	202	Mar. 3
122001 SS Vir	6.8	355	Jan. 21	210868 T Cep	6.0	390	May 7
123160 T UMa	7.7	257	Mar. 28	213753 RU Cyg	8.0	234	Jan. 24
123307 R Vir	6.9	146	Mar. 20	230110 R Peg	7.8	378	Jan. 25
123961 S UMa	7.8	226	Jan. 17	230759 V Cas	7.9	228	May 25
131546 V CVn	6.8	192	Irreg.	231508 S Peg	8.0	319	Apr. 15
1327*06* S Vir	7.0	378	—	2338*15* R Aqr	6.5	387	Nov. 19
134440 R CVn	7.7	328	Sept. 7	235350 R Cas	7.0	431	July 16
142584 R Cam	7.9	270	May 17	2357*15* W Cet	7.6	351	May 4

OTHER TYPES OF VARIABLE STARS

Variable		Max. m	Min. m	Type	Sp. Cl.	Period d	Epoch 1973 E.S.T.
005381	U Cep	6.7	9.8	Ecl.	B8+gG2	2.49302	Jan. 1.82*
025838	ρ Per	3.3	4.0	Semi R	M4	33–55, 1100	—
030140	β Per	2.1	3.3	Ecl.	B8+G	2.86731	Jan. 1.92*
035512	λ Tau	3.5	4.0	Ecl.	B3	3.952952	Jan. 3.96*
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. 25.23
065820	ζ Gem	4.4	5.2	δ Cep	F7–G3	10.15172	Jan. 2.06
154428	R Cr B	5.8	14.8	R Cr B	cFpep		—
171014	α Her	3.0	4.0	Semi R	M5	50–130, 6 yrs.	—
1842*05*	R Sct	6.3	8.6	RVTau	G0e-K0p	144	—
184633	β Lyr	3.4	4.3	Ecl.	B8	12.931163	Jan. 12.20*
192242	RR Lyr	6.9	8.0	RR Lyr	A2–F1	0.5668223	Jan. 1.09
194700	η Aql	4.1	5.2	δ Cep	F6–G4	7.176641	Jan. 6.72
222557	δ Cep	4.1	5.2	δ Cep	F5–G2	5.366341	Jan. 5.96

*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 1973. 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. °	′	Magnitudes comb.	A	B	Sep. 1973.0 ″	P.A. °	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	286	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	248	1100
Σ	1338	7307	09	19.2	+38	19	5.8	6.5	6.7	1.0	243	220
35	Com	8695	12	51.8	+21	25	5.1*	5.2	7.4	0.8	162	670
Σ	2054	10052	16	23.3	+61	45	5.6	6.0	7.2	1.1	355	—
ε^1	Lyr†	11635	18	43.4	+39	39	5.1	5.4	6.5	2.7	357	1200
ε^2	Lyr†	11635	18	43.4	+39	36	4.4	5.1	5.3	2.3	87	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	11.6	303	480
Σ	186	1538	01	54.3	+01	42	6.0	6.8	6.8	1.4	56	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	11.3	63	50
α	Gem	6175	07	32.7	+31	58	1.6	2.0	2.8	1.9	119	420
ζ	Cnc AB	6650	08	10.4	+17	44	5.0	5.6	5.9	1.0	317	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	160	22
γ	Leo	7724	10	18.3	+20	00	1.8	2.1	3.4	4.4	122	620
ξ	U Ma AB	8119	11	16.7	+31	42	3.8	4.3	4.8	3.0	118	60
γ	Vir	8630	12	40.1	−01	18	2.8	3.5	3.5	4.4	302	170
Σ	1785	9031	13	47.7	+27	08	7.0	7.6	8.0	3.3	154	155
ζ	Boo	9343	14	39.8	+13	52	3.8	4.5	4.5	1.1	307	125
ξ	Boo	9413	14	50.0	+19	14	4.5	4.7	6.8	7.2	338	150
ζ	Her	10157	16	40.2	+31	39	2.8	2.9	5.5	1.1	197	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	0.4	126	46
70	Oph	11046	18	03.9	+02	32	4.0	4.2	6.0	2.0	30	88
β	648	11871	18	56.0	+32	52	5.2	5.4	7.5	0.5	96	60
4	Aqr	14360	20	49.9	−05	45	6.0	6.4	7.2	1.0	9	150
τ	Cyg	14787	21	13.6	+37	54	3.7	3.8	6.4	1.0	175	50
Σ	3050	17149	23	57.9	+33	34	5.8	6.5	6.7	1.6	300	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 1970	m_v	Type
1	1952	Tau	5 32.7	+22 01	11.3	DN*
2	7089	Aqr	21 31.9	−00 57	6.27	GC*
3	5272	CVn	13 40.8	+28 32	6.22	GC*
4	6121	Sco	16 21.8	−26 26	6.07	GC*
5	5904	Ser	15 17.0	+02 13	5.99	GC*
6	6405	Sco	17 38.1	−32 11	6	OC*
7	6475	Sco	17 51.9	−34 48	5	OC*
8	6523	Sgr	18 01.8	−24 23		DN*
9	6333	Oph	17 17.5	−18 29	7.58	GC
10	6254	Oph	16 55.5	−04 04	6.40	GC*
11	6705	Sct	18 49.5	−06 19	7	OC*
12	6218	Oph	16 45.6	−01 54	6.74	GC*
13	6205	Her	16 40.6	+36 31	5.78	GC*
14	6402	Oph	17 36.0	−03 14	7.82	GC
15	7078	Peg	21 28.6	+12 02	6.29	GC*
16	6611	Ser	18 17.2	−13 48	7	OC*
17	6618	Sgr	18 19.1	−16 12	7	DN*
18	6613	Sgr	18 18.2	−17 09	7	OC
19	6273	Oph	17 00.7	−26 13	6.94	GC
20	6514	Sgr	18 00.6	−23 02		DN*
21	6531	Sgr	18 02.8	−22 30	7	OC
22	6656	Sgr	18 34.6	−23 56	5.22	GC*
23	6494	Sgr	17 55.1	−19 00	6	OC*
24	6603	Sgr	18 16.7	−18 27	6	OC
25	4725†	Sgr	18 29.9	−19 16	6	OC*
26	6694	Sct	18 43.6	−09 26	9	OC
27	6853	Vul	19 58.4	+22 38	8.2	PN*
28	6626	Sgr	18 22.6	−24 52	7.07	GC
29	6913	Cyg	20 22.9	+38 25	8	OC
30	7099	Cap	21 38.6	−23 18	7.63	GC
31	224	And	0 41.1	+41 06	3.7	G-Sb*
32	221	And	0 41.1	+40 42	8.5	G-E*
33	598	Tri	1 32.2	+30 30	5.9	G-Sc*
34	1039	Per	2 40.1	+42 40	6	OC
35	2168	Gem	6 07.0	+24 21	6	OC*
36	1960	Aur	5 34.3	+34 05	6	OC
37	2099	Aur	5 50.4	+32 33	6	OC*
38	1912	Aur	5 26.6	+35 48	6	OC
39	7092	Cyg	21 31.1	+48 18	6	OC
40	—	UMa	—	—		2 stars
41	2287	CMa	6 45.8	−20 42	6	OC*
42	1976	Ori	5 33.9	−05 24		DN*
43	1982	Ori	5 34.1	−05 18		DN
44	2632	Cnc	8 38.2	+20 06	4	OC*
45	—	Tau	3 45.7	+24 01	2	OC*
46	2437	Pup	7 40.4	−14 45	7	OC*
47	2422	Pup	7 35.1	−14 26	5	OC
48	2548	Hya	8 12.0	−05 41	6	OC
49	4472	Vir	12 28.3	+08 10	8.9	G-E*
50	2323	Mon	7 01.5	−08 18	7	OC
51	5194	CVn	13 28.6	+47 21	8.4	G-Sc*
52	7654	Cas	23 22.9	+61 26	7	OC
53	5024	Com	13 11.5	+18 20	7.70	GC
54	6715	Sgr	18 53.2	−30 31	7.7	GC
55	6809	Sgr	19 38.1	−31 01	6.09	GC*
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 δ		P	D	m	r	Sp	Remarks
	h m	° ′						
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

*Basic for distance determination.

NGC	α 1970 δ h m	° ′	P	D	m	r	Sp	Remarks
2422	07 34.2	−14 26	4.3	30	9.8	0.48	B3	
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 δ h m	° ′	B	D	Sp	m	N	r	V
104	47 Tuc	00 22.6	−72 14	4.35	*44*	G3	13.54	11	5	−24
1851		05 13.0	−40 03	7.72:	*11.5*	F7		3	14.0	+309
2808		09 11.3	−64 44	7.4	*18.8*	F8	15.09	4	9.1	+101
5139	ω Cen	13 25.0	−47 09	4.5	*65.4*	F7	13.01	165	5.2	+230
5272	3	13 40.8	+28 32	6.86	9.3	F7	14.35	189	10.6	−153
5904	5	15 17.0	+02 12	6.69	10.7	F6	14.07	97	8.1	+49
6121	4	16 21.8	−26 27	7.05	22.6	*G0*	13.21	43	4.3	+65
6205	13	16 40.6	+36 31	6.43	12.9	F6	13.85	10	6.3	−241
6218	12	16 45.6	−01 54	7.58	21.5	F8	14.07	1	7.4	−16
6254	10	16 55.5	−04 04	7.26	16.2	G1	14.17	3	6.2	+71
6341	92	17 16.2	+43 11	6.94	12.3	F1	13.96	16	7.9	−118
6397		17 38.4	−53 40	6.9	*19*	F5	12.71	3	2.9	+11
6541		18 05.8	−43 45	7.5	*23.2*	F6	13.45	1	4.0	−148
6656	22	18 34.5	−23 57	6.15	26.2	F7	13.73	24	3.0	−144
6723		18 57.6	−36 40	7.37	11.7	G4	14.32	19	7.4	−3
6752		19 08.2	−60 02	6.8	*41.9*	F6	13.36	1	5.3	−39
6809	55	19 38.2	−31 00	6.72	21.1	F5	13.68	6	6.0	+170
7078	15	21 28.6	+12 02	6.96	9.4	F2	14.44	103	10.5	−107
7089	2	21 31.9	−00 58	6.94	6.8	F4	14.77	22	12.3	−5

GALACTIC NEBULAE

By René Racine

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

NGC	M	Con	α 1970 δ h ′	° ′	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) δ h m	° ′	Remarks
Tycho's s'nova	00 24.0	+63 58	Remnant of supernova of 1572
Andromeda gal.	00 41.0	+41 06	Closest normal spiral galaxy
IC 1795, W3	02 23.1	+61 58	Multiple HII region, OH emission
PKS 0237–23	02 38.7	−23 17	Quasar with large red shift Z = 2.2
NGC 1275, 3C 84	03 17.8	+41 24	Seyfert galaxy, radio variable
Fornax A	03 21.2	−37 17	10th mag. SO galaxy
CP 0328	03 30.5	+54 27	Pulsar, period = 0.7145 sec., H abs'n.
Crab neb, M1	05 32.6	+22 00	Remnant of supernova of 1054
NP 0527	05 32.6	+22 00	Radio, optical & X-ray pulsar
V 371 Orionis	05 32.2	+01 54	Red dwarf, radio & optical flare star
Orion neb, M42	05 33.8	−05 24	HII region, OH emission, IR source
IC 443	06 15.5	+22 36	Supernova remnant (date unknown)
Rosette neb	06 30.4	+04 53	HII region
YV CMa	07 21.8	−20 41	Optical var. IR source, OH, H_2O emission
3C 273	12 27.5	+02 13	Nearest, strongest quasar
Virgo A, M87	12 29.3	+12 33	EO galaxy with jet
Centaurus A	13 23.6	−42 52	NGC 5128 peculiar galaxy
3C 295	14 10.3	+52 21	21st mag. galaxy, 4,500,000,000 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 δ		Type	m_{pg}	Dimensions	Distance millions of l.y.
		h m	° ′			′ ′	
55		00 13.5	−39 23	Sc or Ir	7.9	30×5	7.5
205		00 38.7	+41 32	E6p	8.89	12×6	2.1
221	32	00 41.1	+40 43	E2	9.06	3.4×2.9	2.1
224	31	00 41.1	+41 07	Sb I–II	4.33	163×42	2.1
247		00 45.6	−20 54	S IV	9.47	21×8.4	7.5
253		00 46.1	−25 27	Scp	7.0:	22×4.6	7.5
SMC		00 51.7	−72 59	Ir IV or IV–V	2.86	216×216	0.2
300		00 53.5	−37 51	Sc III–IV	8.66	22×16.5	7.5
598	33	01 32.2	+30 30	Sc II–III	6.19	61×42	2.4
Fornax		02 38.3	−34 39	dE	9.1:	50×35	0.4
LMC		05 23.8	−69 47	Ir or Sc III–IV	0.86	432×432	0.2
2403		07 33.9	+65 40	Sc III	8.80	22×12	6.5
2903		09 30.4	+21 39	Sb I–II	9.48	16×6.8	19.0
3031	81	09 53.1	+69 12	Sb I–II	7.85	25×12	6.5
3034	82	09 53.6	+69 50	Scp:	9.20	10×1.5	6.5
4258		12 17.5	+47 28	Sbp	8.90	19×7	14.0
4472	49	12 28.3	+08 09	E4	9.33	9.8×6.6	37.0
4594	104	12 38.3	−11 28	Sb	9.18	7.9×4.7	37.0
4736	94	12 49.5	+41 16	Sbp II:	8.91	13×12	14.0
4826	64	12 55.3	+21 51	?	9.27	10×3.8	12.0:
4945		13 03.5	−49 19	Sb III	8.0	20×4	—
5055	63	13 14.4	+42 11	Sb II	9.26	8.0×3.0	14.0
5128		13 23.6	−42 51	E0p	7.87	23×20	—
5194	51	13 28.6	+47 21	Sc I	8.88	11×6.5	14.0
5236	83	13 35.4	−29 43	Sc I–II	7.0:	13×12	8.0:
5457	101	14 02.1	+54 29	Sc I	8.20	23×21	14.0
6822		19 43.2	−14 50	Ir IV–V	9.21	20×10	1.7

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The Nearest Galaxies

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

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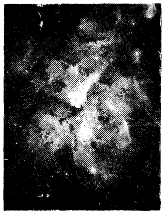

C-6. Eta Carinae Nebula. Photo taken with ADH Baker-Schmidt telescope at the Boyden Observatory, Bloemfontein, South Africa.

THE FOLLOWING ARE AVAILABLE

Black and White: 1. Third-quarter moon; 2. Orion nebula; 3. Triangulum spiral; 4. Great Andromeda galaxy; 5. Saturn and rings; 6. Southern section of the moon; 7. Solar prominences; 8. Edge-on spiral in Andromeda; 9. Canes Venatici spiral; 10. Full moon; 11. Solar corona and Venus; 12. Trifid nebula; 13. Horsehead nebula near Zeta Orionis. **Color:** C-3, Dumbbell nebula in Vulpecula; C-4, Lagoon nebula in Sagittarius; C-5, Canes Venatici spiral; C-6, Eta Carinae nebula.

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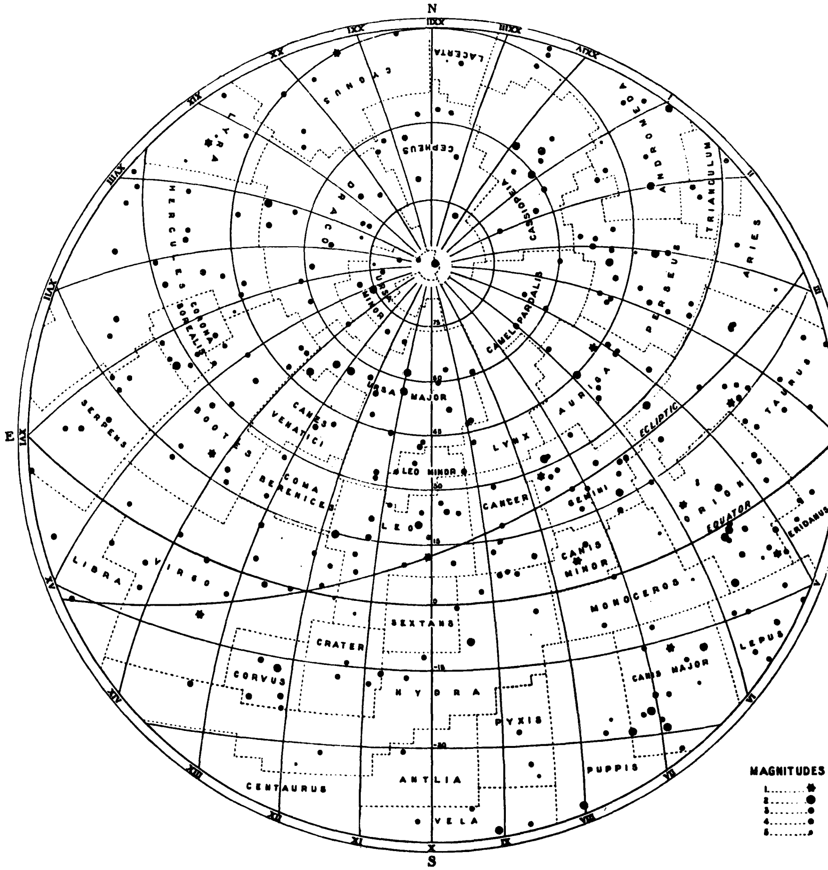
STAR MAP 1

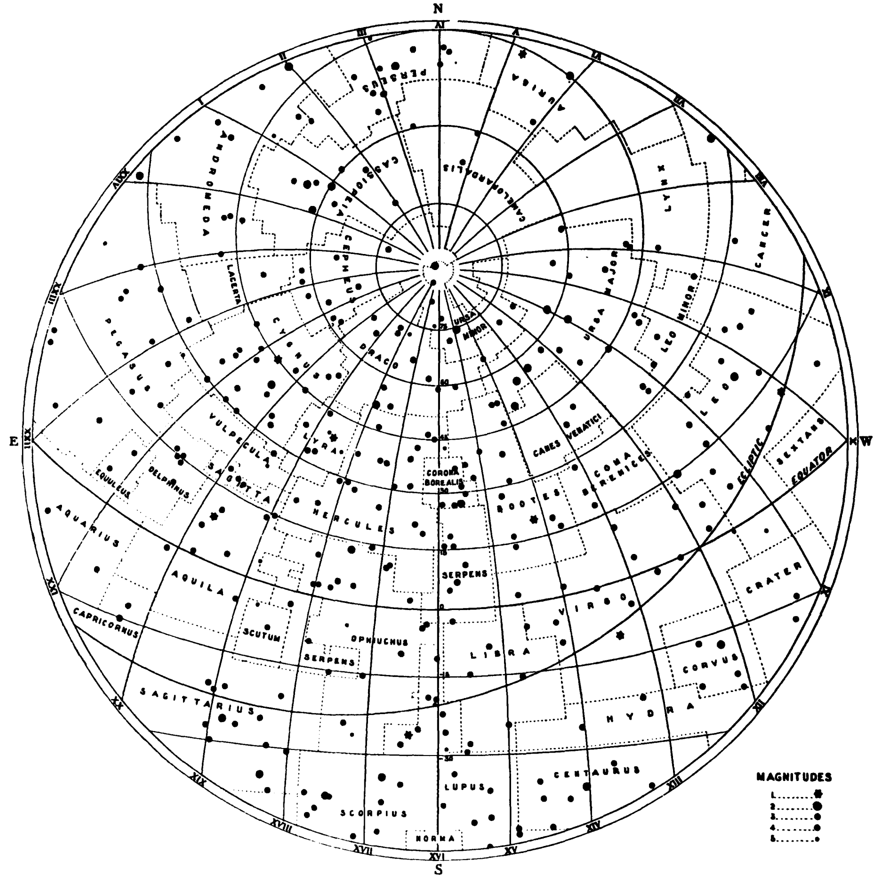


The above map represents the evening sky at

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

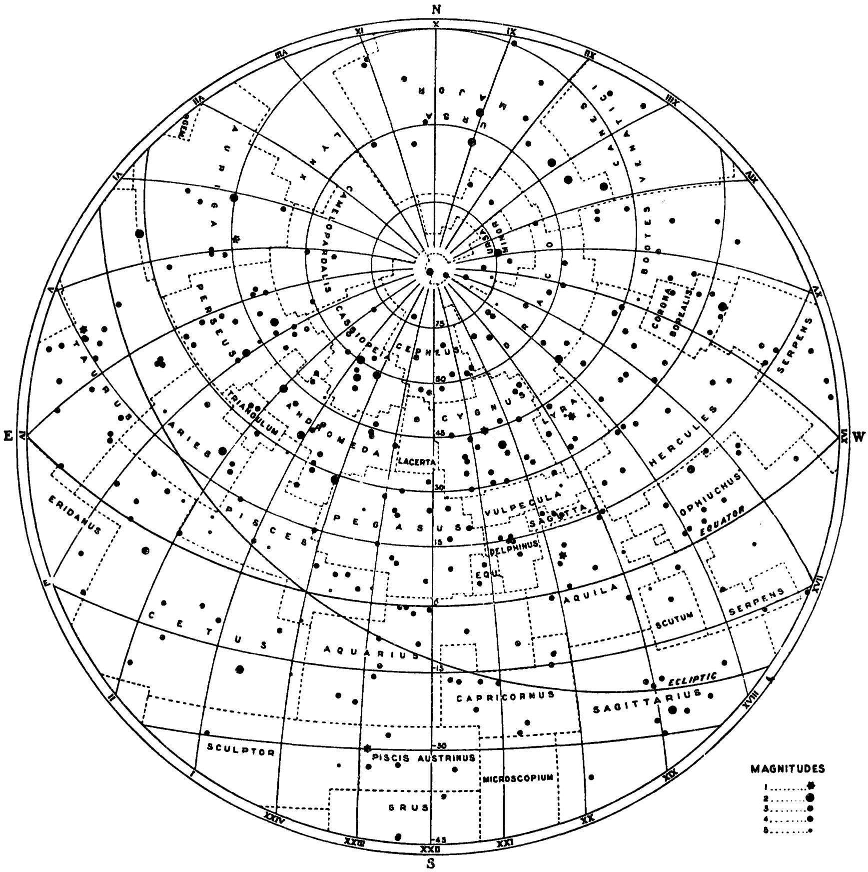


The above map represents the evening sky at

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

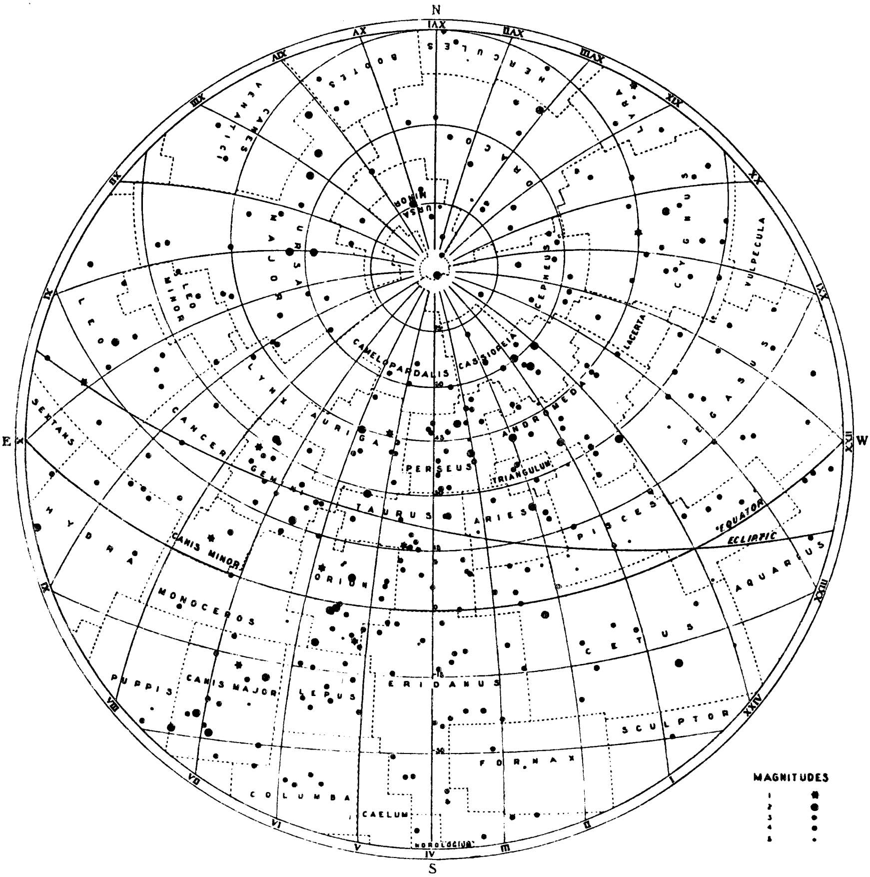


The above map represents the evening sky at

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.

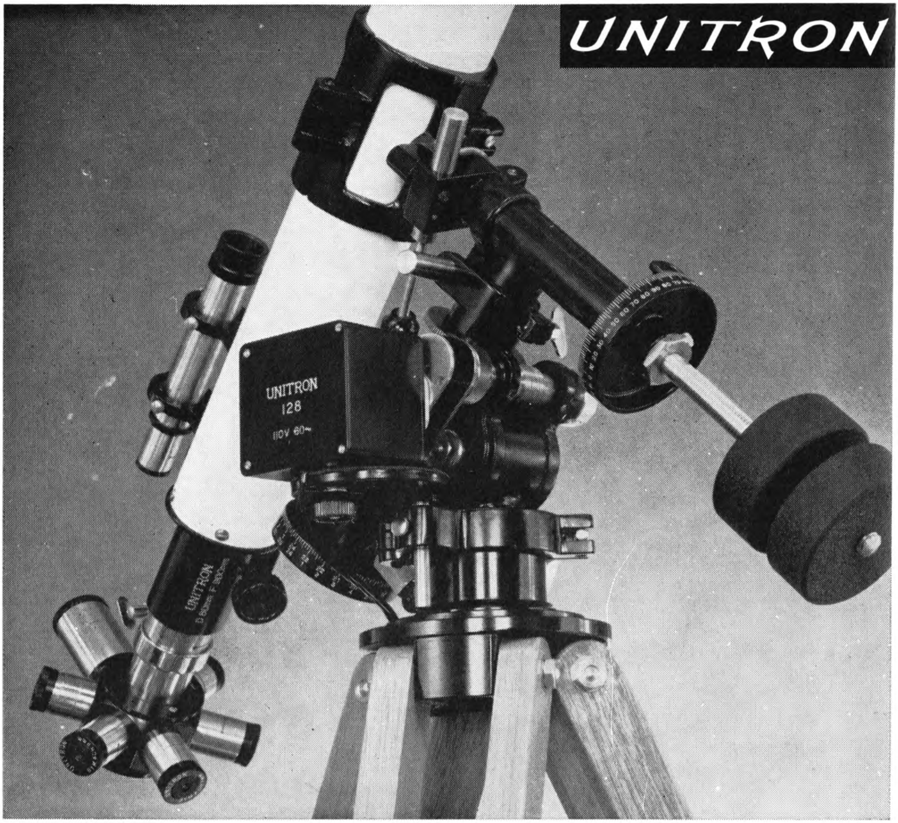
STAR MAP 4



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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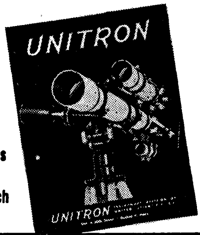

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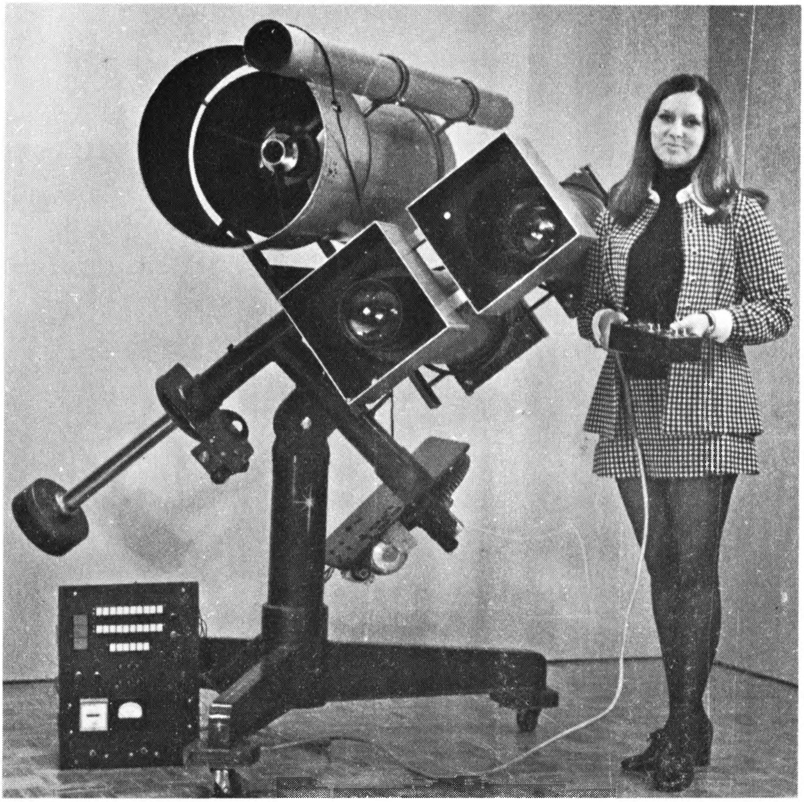

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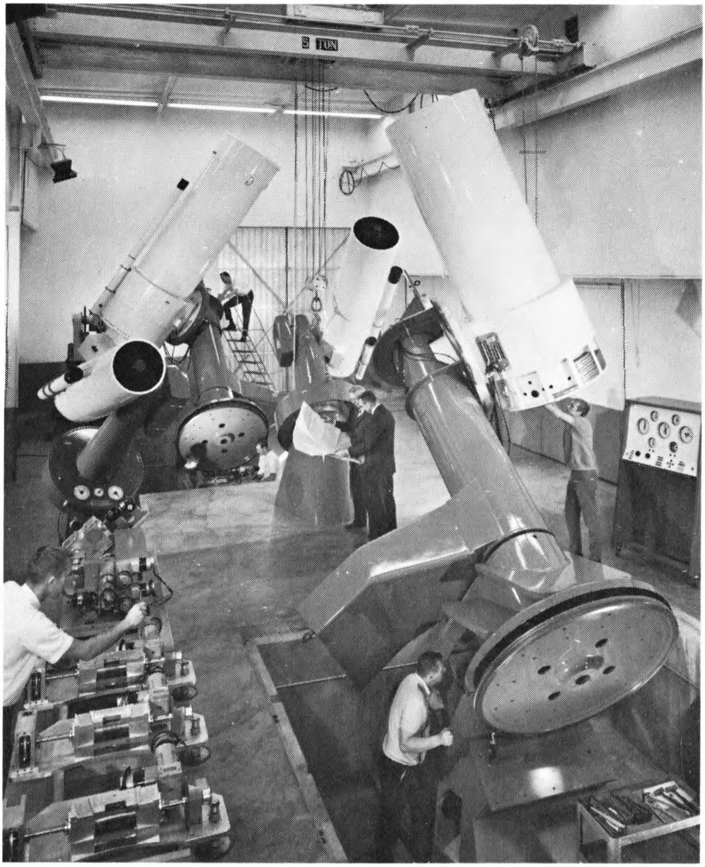

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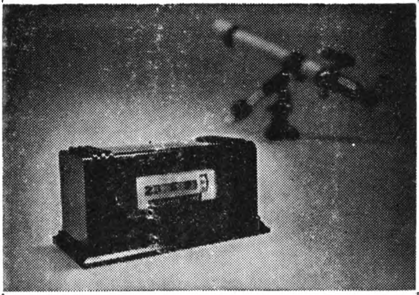

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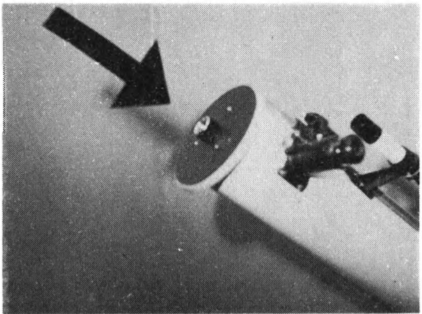

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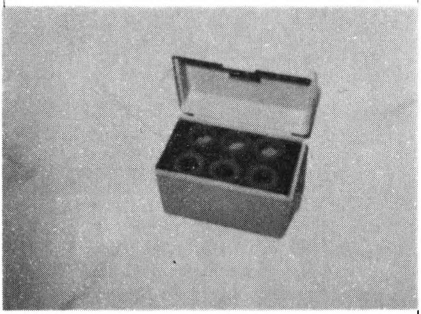

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