Norman Green

the OBSERVER'S HANDBOOK 1975

sixty-seventh year of publication

the ROYAL ASTRONOMICAL SOCIETY
of CANADA

editor: JOHN R. PERCY

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

Incorporated 1890 – Royal Charter 1903

Federally Incorporated 1968

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PRINTED IN CANADA
BY THE UNIVERSITY OF TORONTO PRESS

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252 College Street, Toronto M5T 1R7, Canada

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THE OBSERVER'S HANDBOOK 1975

THE OBSERVER'S HANDBOOK for 1975 is the sixty-seventh edition. I wish to thank all those who assisted in its preparation: those whose names appear in the various sections, those mentioned below, and especially my editorial assistant John F. A. Perkins.

There has been some rearrangement of material in this issue; both new readers and readers of past issues should skim through and find out "where everything is". Also in this issue, metric units have been introduced wherever possible. There is a new section on "Impact Craters", so that readers can find their way to visit some of these spectacular features.

The HANDBOOK is continually being expanded and improved. This year, I extend a warm welcome to three new contributors—P. Blyth Robertson, who prepared the section on impact craters, Brian G. Marsden, who supplied the material on periodic comets, and Janet Mattei, who as the new Director of the A.A.V.S.O. supplied the predictions of Algol and of other variable stars. At the same time, I want to take this opportunity to thank Margaret W. Mayall who before her retirement as Director of the A.A.V.S.O. supplied these predictions for many years.

Once again, special thanks go to Leslie V. Morrison and Gordon E. Taylor, H.M. Nautical Almanac Office, for the predictions of total and grazing lunar occultations and of planetary appulses and occultations; to Maude Towne and Isabel Williamson for the tables of moonrise and moonset; to the David Dunlap Observatory and Erindale College, University of Toronto, for financial, technical and moral support. Finally, my deep indebtedness to H.M. Nautical Almanac Office and to the *American Ephemeris* is gratefully acknowledged.

JOHN R. PERCY

ANNIVERSARIES AND FESTIVALS, 1975

New Year's Day	Wed.	Jan. 1
Epiphany	Mon.	Jan. 6
Septuagesima Sunday		Jan. 26
Accession of Queen Elizabeth (1952)	Thur.	Feb. 6
Quinquagesima (Shrove) Sunday		Feb. 9
Ash Wednesday		Feb. 12
St. David	Sat.	Mar. 1
St. Patrick	Mon.	Mar. 17
Palm Sunday		Mar. 23
First Day of Passover	Thur.	Mar. 27
Good Friday		Mar. 28
Easter Sunday		Mar. 30
Birthday of Queen Elizabeth (1926)	Mon.	Apr. 21
St. George	Wed.	Apr. 23
Rogation Sunday		May 4
Ascension Day	Thur.	May 8
Pentecost (Whit Sunday)		May 18
Victoria Day	Mon.	May 19
Trinity Sunday		May 25
Corpus Christi	Thur.	May 29
St. John Baptist (Mid-Summer Day)	Tues.	June 24
Dominion Day	Tues.	July 1
Birthday of Queen Mother Elizabeth (1900)	Mon.	Aug. 4
Labour Day	Mon.	Sept. 1
Jewish New Year (Rosh Hashanah)	Sat.	Sept. 6
Yom Kippur	Mon.	Sept. 15
St. Michael (Michaelmas Day)	Mon.	Sept. 29
Thanksgiving	Mon.	Oct. 13
All Saints' Day	Sat.	Nov. 1
Remembrance Day	Tues.	Nov. 11
St. Andrew	Sun.	Nov. 30
First Sunday in Advent		Nov. 30
Christmas Day	Thur.	Dec. 25

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

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* mī′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; á ásk; *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 inch = exactly 2.54 centimetres
1 yard = exactly 0.9144 metre
1 mile = exactly 1.609344 kilometres
1 micron, μ = 10^{-4} cm. = 10^4A.
1 cm. = 10 mm. = 0.39370 ... in.
1 m. = 10^2 cm. = 1.0936 .... yd.
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
= 3437′.75
= 206,265″
π = 3.141,592,653,6
No. of square degrees in the sky = 41,253
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 43 14	−23 04.2	+ 3 22
4	18 56 28	−22 48.4	+ 4 45
7	19 09 38	−22 28.6	+ 6 06
10	19 22 45	−22 04.8	+ 7 22
13	19 35 46	−21 37.1	+ 8 33
16	19 48 42	−21 05.6	+ 9 38
19	20 01 32	−20 30.5	+10 37
22	20 14 15	−19 51.9	+11 30
25	20 26 52	−19 10.0	+12 15
28	20 39 21	−18 24.9	+12 53
31	20 51 42	−17 36.9	+13 24
Feb. 3	21 03 57	−16 46.0	+13 48
6	21 16 04	−15 52.4	+14 05
9	21 28 05	−14 56.4	+14 14
12	21 39 58	−13 58.1	+14 16
15	21 51 44	−12 57.8	+14 12
18	22 03 24	−11 55.6	+14 01
21	22 14 57	−10 51.7	+13 43
24	22 26 24	− 9 46.2	+13 20
27	22 37 46	− 8 39.5	+12 51
Mar. 2	22 49 02	− 7 31.6	+12 17
5	23 00 15	− 6 22.7	+11 39
8	23 11 23	− 5 13.0	+10 57
11	23 22 28	− 4 02.6	+10 11
14	23 33 30	− 2 51.8	+ 9 23
17	23 44 29	− 1 40.8	+ 8 33
20	23 55 27	− 0 29.6	+ 7 40
23	0 06 23	+ 0 41.5	+ 6 47
26	0 17 18	+ 1 52.4	+ 5 52
29	0 28 13	+ 3 02.9	+ 4 57
Apr. 1	0 39 08	+ 4 12.8	+ 4 03
4	0 50 04	+ 5 22.1	+ 3 09
7	1 01 02	+ 6 30.6	+ 2 18
10	1 12 01	+ 7 38.0	+ 1 28
13	1 23 03	+ 8 44.3	+ 0 41
16	1 34 08	+ 9 49.3	− 0 04
19	1 45 15	+10 52.8	− 0 45
22	1 56 27	+11 54.7	− 1 23
25	2 07 42	+12 54.8	− 1 57
28	2 19 01	+13 53.0	− 2 27
May 1	2 30 24	+14 49.1	− 2 52
4	2 41 53	+15 43.1	− 3 12
7	2 53 27	+16 34.7	− 3 27
10	3 05 06	+17 23.9	− 3 37
13	3 16 50	+18 10.4	− 3 42
16	3 28 39	+18 54.2	− 3 41
19	3 40 33	+19 35.1	− 3 36
22	3 52 32	+20 13.0	− 3 26
25	4 04 36	+20 47.7	− 3 11
28	4 16 44	+21 19.3	− 2 52
31	4 28 57	+21 47.6	− 2 28
June 3	4 41 13	+22 12.4	− 2 01
6	4 53 33	+22 33.8	− 1 30
9	5 05 56	+22 51.6	− 0 56
12	5 18 22	+23 05.8	− 0 20
15	5 30 49	+23 16.3	+ 0 18
18	5 43 17	+23 23.1	+ 0 56
21	5 55 46	+23 26.3	+ 1 35
24	6 08 14	+23 25.7	+ 2 14
27	6 20 42	+23 21.4	+ 2 52
30	6 33 08	+23 13.4	+ 3 28
July 3	6 45 33	+23 01.7	+ 4 03
6	6 57 56	+22 46.4	+ 4 35
9	7 10 15	+22 27.5	+ 5 05
12	7 22 31	+22 05.2	+ 5 30
15	7 34 43	+21 39.5	+ 5 51
18	7 46 50	+21 10.4	+ 6 08
21	7 58 52	+20 38.1	+ 6 20
24	8 10 49	+20 02.7	+ 6 26
27	8 22 41	+19 24.3	+ 6 28
30	8 34 27	+18 43.0	+ 6 24
Aug. 2	8 46 09	+17 58.9	+ 6 14
5	8 57 45	+17 12.1	+ 6 00
8	9 09 16	+16 22.9	+ 5 40
11	9 20 41	+15 31.3	+ 5 15
14	9 32 01	+14 37.4	+ 4 44
17	9 43 16	+13 41.5	+ 4 09
20	9 54 26	+12 43.6	+ 3 29
23	10 05 32	+11 43.9	+ 2 44
26	10 16 34	+10 42.6	+ 1 56
29	10 27 32	+ 9 39.7	+ 1 04
Sept. 1	10 38 27	+ 8 35.4	+ 0 09
4	10 49 20	+ 7 29.8	− 0 49
7	11 00 10	+ 6 23.2	− 1 49
10	11 10 58	+ 5 15.6	− 2 50
13	11 21 45	+ 4 07.2	− 3 53
16	11 32 31	+ 2 58.2	− 4 57
19	11 43 16	+ 1 48.7	− 6 02
22	11 54 02	+ 0 38.9	− 7 06
25	12 04 48	− 0 31.2	− 8 09
28	12 15 36	− 1 41.3	− 9 10
Oct. 1	12 26 26	− 2 51.4	−10 09
4	12 37 18	− 4 01.1	−11 06
7	12 48 14	− 5 10.5	−12 00
10	12 59 13	− 6 19.3	−12 50
13	13 10 16	− 7 27.3	−13 36
16	13 21 23	− 8 34.3	−14 18
19	13 32 35	− 9 40.3	−14 54
22	13 43 53	−10 45.0	−15 25
25	13 55 16	−11 48.3	−15 50
28	14 06 47	−12 50.0	−16 08
31	14 18 24	−13 49.9	−16 20
Nov. 3	14 30 08	−14 47.8	−16 24
6	14 41 59	−15 43.6	−16 21
9	14 53 58	−16 37.0	−16 11
12	15 06 05	−17 27.8	−15 53
15	15 18 18	−18 16.0	−15 27
18	15 30 40	−19 01.3	−14 54
21	15 43 09	−19 43.5	−14 14
24	15 55 45	−20 22.5	−13 26
27	16 08 28	−20 58.1	−12 32
30	16 21 18	−21 30.2	−11 30
Dec. 3	16 34 15	−21 58.7	−10 22
6	16 47 17	−22 23.3	− 9 09
9	17 00 23	−22 44.0	− 7 51
12	17 13 34	−23 00.7	− 6 30
15	17 26 48	−23 13.3	− 5 05
18	17 40 05	−23 21.7	− 3 38
21	17 53 23	−23 25.9	− 2 09
24	18 06 42	−23 25.9	− 0 39
27	18 20 01	−23 21.7	+ 0 50
30	18 33 19	−23 13.2	+ 2 18

PRINCIPAL ELEMENTS OF THE SOLAR SYSTEM

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

Planet	Mean Distance from Sun (a)		Period of Revolution		Eccentricity (e)	Inclination (i)	Long. of Node (☊)	Long. of Perihelion (π)	Mean Long. at Epoch (L)
	A. U.	millions of Km.	Sidereal (P)	Synodic					
				days		°	°	°	°
Mercury	0.387	57.9	88.0d.	116	.206	7.0	47.9	76.8	222.6
Venus	0.723	108.1	224.7	584	.007	3.4	76.3	131.0	174.3
Earth	1.000	149.5	365.26	...	.017	0.0	0.0	102.3	100.2
Mars	1.524	227.8	687.0	780	.093	1.8	49.2	335.3	258.8
Jupiter	5.203	778.	11.86y.	399	.048	1.3	100.0	13.7	259.8
Saturn	9.539	1427.	29.46	378	.056	2.5	113.3	92.3	280.7
Uranus	19.18	2869.	84.01	370	.047	0.8	73.8	170.0	141.3
Neptune	30.06	4497.	164.8	367	.009	1.8	131.3	44.3	216.9
Pluto	39.44	5900.	247.7	367	.250	17.2	109.9	224.2	181.6

PHYSICAL ELEMENTS

Object	Equatorial Diameter Km.	Oblateness	Mass ⊕=1	Mean Density water =1	Surface Gravity ⊕=1	Rotation Period	Inclination of Equator to Orbit °	Albedo
☉ Sun	1,392,000	0	332,958	1.41	27.9	25^d–35^d†		
☾ Moon	3,476	0	0.0123	3.36	0.16	$27^d 07^h 43^m$	6.7	0.067
☿ Mercury	4,865	0	0.055	5.46	0.38	$58^d 16^h$	<7	0.056
♀ Venus	12,110	0	0.815	5.23	0.90	243^d(retro.)	~179	0.76
⊕ Earth	12,756	1/298	1.000	5.52	1.00	$23^h 56^m 04^s$	23.4	0.36
♂ Mars	6,788	1/192	0.107	3.93	0.38	24 37 23	24.0	0.16
♃ Jupiter	143,000	1/16	318.0	1.33	2.64	9 50 30	3.1	0.73
♄ Saturn	121,000	1/10	95.2	0.69	1.13	10 14	26.7	0.76
♅ Uranus	47,000	1/16	14.6	1.56	1.07	10 49	97.9	0.93
♆ Neptune	50,900	1/50	17.3	1.54	1.08	16	28.8	0.62
♇ Pluto	5,500?	?	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. Km.	Mean Distance from Planet		Revolution Period			Orbit Incl.	Discovery
	* †	†	Km.	″ *	d	h	m	° ‡	
SATELLITE OF THE EARTH									
Moon	−12.7	3476	384,500	...	27	07	43	Var.§	
SATELLITES OF MARS									
Phobos	11.6	23	9,000	25	0	07	39	1.0	Hall, 1877
Deimos	12.8	13	23,000	62	1	06	18	1.3	Hall, 1877
SATELLITES OF JUPITER									
V	13.0	(160)	180,000	59	0	11	57	0.4	Barnard, 1892
Io	4.8	3660	422,000	138	1	18	28	0	Galileo, 1610
Europa	5.2	2880	671,000	220	3	13	14	0	Galileo, 1610
Ganymede	4.5	5020	1,070,000	351	7	03	43	0	Galileo, 1610
Callisto	5.5	4460	1,885,000	618	16	16	32	0	Galileo, 1610
VI	13.7	(100)	11,470,000	3765	250	14		27.6	Perrine, 1904
VII	16	(40)	11,740,000	3850	259	16		24.8	Perrine, 1905
X	18.6	(14)	11,850,000	3888	263	13		29.0	Nicholson, 1938
XII	18.8	(12)	21,200,000	6958	631	02		147	Nicholson, 1951
XI	18.1	(16)	22,560,000	7404	692	12		164	Nicholson, 1938
VIII	18.8	(12)	23,500,000	7715	738	22		145	Melotte, 1908
IX	18.3	(14)	23,700,000	7779	758			153	Nicholson, 1914
SATELLITES OF SATURN									
Janus	(14)	(350)	160,000		0	17	59		A. Dollfus, 1966
Mimas	12.1	(900)	187,000	30	0	22	37	1.5	W. Herschel, 1789
Enceladus	11.8	550	238,000	38	1	08	53	0.0	W. Herschel, 1789
Tethys	10.3	1200	295,000	48	1	21	18	1.1	G. Cassini, 1684
Dione	10.4	800	378,000	61	2	17	41	0.0	G. Cassini, 1684
Rhea	9.8	1300	526,000	85	4	12	25	0.4	G. Cassini, 1672
Titan	8.4	4800	1,221,000	197	15	22	41	0.3	Huygens, 1655
Hyperion	14.2	(320)	1,481,000	239	21	06	38	0.4	G. Bond, 1848
Iapetus	11.0	(1150)	3,561,000	575	79	07	56	14.7	G. Cassini, 1671
Phoebe	(14)	(260)	12,960,000	2096	550	11		150	W. Pickering, 1898
SATELLITES OF URANUS									
Miranda	16.5	(550)	128,000	9	1	09	56	0	Kuiper, 1948
Ariel	14.4	(1450)	192,000	14	2	12	29	0	Lassell, 1851
Umbriel	15.3	(970)	267,000	20	4	03	38	0	Lassell, 1851
Titania	14.0	(1800)	438,000	33	8	16	56	0	W. Herschel, 1787
Oberon	14.2	(1600)	587,000	44	13	11	07	0	W. Herschel, 1787
SATELLITES OF NEPTUNE									
Triton	13.6	3800	354,000	17	5	21	03	160.0	Lassell, 1846
Nereid	18.7	(530)	5,600,000	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.

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. 14) 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 $\Delta T = ET - UT$. 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.

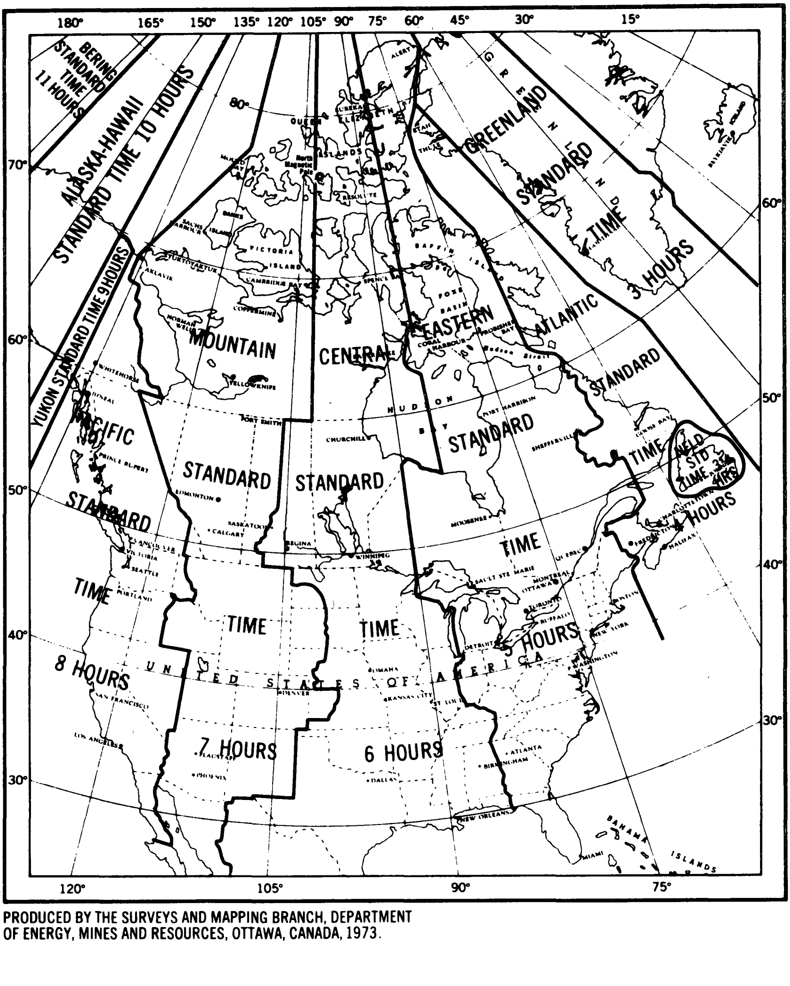
JULIAN DAY CALENDAR, 1975

Jan. 1........2442414	May 1.......2442534	Sept. 1.......2442657
Feb. 1........2442445	June 1.......2442565	Oct. 1.......2442687
Mar. 1........2442473	July 1.......2442595	Nov. 1.......2442718
Apr. 1........2442504	Aug. 1.......2442626	Dec. 1.......2442748

The Julian date is commonly used by astronomers to refer to the time of astronomical events, because it avoids some of the annoying complexities of the civil calendar. The Julian day corresponding to a given date is the number of days which have elapsed since Jan. 1, 4713 B.C. This date was believed, at one time, to have been the date of the creation of the earth.

The Julian day commences at noon, so that J.D. 2442414 = Jan 1.5 U.T. 1975 = 12 hours U.T., Jan. 1, 1975.

MAP OF STANDARD TIME ZONES



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

VISITING HOURS AT SOME CANADIAN OBSERVATORIES

COMPILED BY MARIE LITCHINSKY

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

David Dunlap Observatory, Richmond Hill, Ontario L4C 4Y6.
Wednesday mornings throughout the year, 10:00 a.m.
Saturday evenings, April through October (by reservation, tel. 884–2112).

Dominion Astrophysical Observatory, Victoria, B.C. V8X 3X3
May-August: Daily, 9:15 a.m.–4:15 p.m.
Sept.-April: Monday to Friday, 9:15 a.m.–4:15 p.m.
Public observing, Saturday evenings, April-October, inclusive.

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, Alberta.
Winter: Wed.-Fri., 7:30 and 8:45 p.m. Sat.-Sun., 1:45 (children), 3:00, 7:30 and 8:45 p.m. (Closed Christmas day, New Year's day and Good Friday.)
Summer: Daily (except Tues.) 1:45 (children), 3:00, 4:15, 7:30 and 8:45 p.m.

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

H. R. MacMillan Planetarium, 1100 Chestnut Street, Vancouver, 9 B.C.
Sept.-June: Tues. and Wed., 3:00 and 8:00 p.m.; Thurs. 8:00 p.m.; Fri. 7:30 and 9:00 p.m.; Sat. and holidays, 1:30, 3:00, 7:30 and 9:00 p.m.; Sun., 1:30, 3:00, 4:30 and 7:30 p.m.
July-August: Tues. to Sun. 1:00, 2:30, 4:00, 7:30 and 9:00 p.m. Closed Mondays except holidays.

Manitoba Museum of Man & Nature Planetarium, 190 Rupert Ave., Winnipeg, Man. R3B 0N2
Sept.-June: Tues.-Fri. 3:15 and 8:00 p.m. Sat. and holidays, 1:00, 2:30, 4:00, 7:30 and 9:00 p.m. Sun. 1:00, 2:30 and 4:00 p.m. Closed Mondays except holidays.
July-August: Mon. 3:30 p.m. (except holidays); Tues.-Fri. 11:30 a.m., 3:30, 7:30 and 9:00 p.m. Sat., Sun. and holidays 1:00, 2:30, 4:00, 7:30 and 9:00 p.m.
Special: Summer special July 8–Aug. 30, weekdays 2:00 p.m.

McLaughlin Planetarium, 100 Queen's Park, Toronto, Ont. M5S 2C6
Tues.-Fri. 3:00, 8:00 p.m. Sat. 2:00, 3:30, 7:30 and 9:00 p.m. Sun. 2:00, 3:30, 5:00 and 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, Ont. Group reservations only.

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

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

The University of Manitoba Planetarium, 394 University College, 500 Dysart Rd., Winnipeg, Man. R3T 2M8.
Telephone 474–9785 for times of public shows and for group reservations.

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 15 to 20, and of twilight on page 21. The times of moonrise and moonset for the 5 h meridian are given on pages 22 to 27. The times are given in Local Mean Time, and in the table below are given corrections to change from Local Mean Time to Standard Time for the cities and towns named.

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

The Standard Times for Any Station

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

CANADIAN CITIES AND TOWNS						AMERICAN CITIES		
	Lat.	Corr.		Lat.	Corr.		Lat.	Corr.
Athabasca	55°	+33M	Peterborough	44	+13E	Atlanta	34°	+37E
Baker Lake	64	+24C	Port Harrison	59	+13E	Baltimore	39	+06E
Brandon	50	+40C	Prince Albert	53	+63C	Birmingham	33	−13C
Brantford	43	+21E	Prince Rupert	54	+41P	Boston	42	−16E
Calgary	51	+36M	Quebec	47	−15E	Buffalo	43	+15E
Charlottetown	46	+12A	Regina	50	+58C	Chicago	42	−10C
Churchill	59	+17C	St. Catharines	43	+17E	Cincinnati	39	+38E
Cornwall	45	− 1E	St. Hyacinthe	46	−08E	Cleveland	42	+26E
Edmonton	54	+34M	Saint John, N.B.	45	+24A	Dallas	33	+27C
Fredericton	46	+27A	St. John's, Nfld.	48	+01N	Denver	40	00M
Gander	49	+ 8N	Sarnia	43	+29E	Detroit	42	+32E
Glace Bay	46	00A	Saskatoon	52	+67C	Fairbanks	65	−10AL
Goose Bay	53	+ 2A	Sault Ste. Marie	47	+37E	Flagstaff	35	+27M
Granby	45	−09E	Shawinigan	47	−09E	Indianapolis	40	−15C
Guelph	44	+21E	Sherbrooke	45	−12E	Juneau	58	+58P
Halifax	45	+14A	Stratford	43	+24E	Kansas City	39	+18C
Hamilton	43	+20E	Sudbury	47	+24E	Los Angeles	34	−07P
Hull	45	+03E	Sydney	46	+01A	Louisville	38	−17C
Kapuskasing	49	+30E	The Pas	54	+45C	Memphis	35	00C
Kingston	44	+06E	Timmins	48	+26E	Miami	26	+21E
Kitchener	43	+22E	Toronto	44	+18E	Milwaukee	43	−09C
London	43	+25E	Three Rivers	46	−10E	Minneapolis	45	+13C
Medicine Hat	50	+23M	Thunder Bay	48	+57E	New Orleans	30	00C
Moncton	46	+19A	Trail	49	−09P	New York	41	−04E
Montreal	46	−06E	Truro	45	+13A	Omaha	41	+24C
Moosonee	51	+23E	Vancouver	49	+12P	Philadelphia	40	+01E
Moose Jaw	50	+62C	Victoria	48	+13P	Phoenix	33	+28M
Niagara Falls	43	+16E	Whitehorse	61	00Y	Pittsburgh	40	+20E
North Bay	46	+18E	Windsor	42	+32E	St. Louis	39	+01C
Ottawa	45	+03E	Winnipeg	50	+29C	San Francisco	38	+10P
Owen Sound	45	+24E	Yellowknife	62	+38M	Seattle	48	+09P
Penticton	49°	−02P				Washington	39	+08E

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

In the above list Owen Sound is under "45°", and the correction is +24 min. On page 15 the time of sunrise on February 12 for latitude 45° is 7.06; add 24 min. and we get 7.30 (Eastern Standard Time).

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

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

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

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

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

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

BEGINNING OF MORNING AND ENDING OF EVENING TWILIGHT

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

The above table gives the local mean time of the beginning of morning twilight, and of the ending of evening twilight, for various latitudes. To obtain the corresponding standard time, the method used is the same as for correcting the sunrise and sunset tables, as described on page 14. 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, 1975; 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	21 27	09 27	21 24	09 31	21 22	09 36	21 19	09 40	21 15	09 46	21 12	09 51
2	22 31	10 07	22 32	10 07	22 33	10 09	22 33	10 10	22 34	10 11	22 35	10 12
3	23 35	10 45	23 39	10 42	23 42	10 41	23 47	10 38	23 52	10 35	23 58	10 32
4 ☾	.. ..	11 22	.. ..	11 17	.. ..	11 13	.. ..	11 06	.. ..	10 59	.. ..	10 53
5	00 38	12 01	00 44	11 54	00 51	11 46	00 59	11 37	01 08	11 26	01 18	11 15
6	01 40	12 42	01 48	12 34	01 58	12 23	02 08	12 11	02 22	11 56	02 36	11 41
7	02 39	13 27	02 50	13 16	03 02	13 03	03 16	12 49	03 33	12 31	03 50	12 13
8	03 38	14 15	03 50	14 02	04 03	13 49	04 19	13 33	04 39	13 13	04 58	12 53
9	04 33	15 06	04 45	14 53	05 00	14 39	05 16	14 22	05 37	14 02	05 58	13 41
10	05 24	15 59	05 36	15 47	05 50	15 34	06 06	15 18	06 27	14 58	06 48	14 38
11	06 11	16 53	06 22	16 43	06 34	16 31	06 50	16 17	07 08	15 58	07 27	15 41
12 ●	06 53	17 48	07 02	17 40	07 13	17 29	07 27	17 17	07 42	17 03	07 57	16 47
13	07 30	18 43	07 38	18 36	07 47	18 28	07 58	18 19	08 10	18 07	08 22	17 56
14	08 05	19 36	08 10	19 31	08 17	19 26	08 25	19 20	08 34	19 11	08 43	19 04
15	08 37	20 29	08 41	20 26	08 44	20 23	08 50	20 20	08 55	20 15	09 00	20 12
16	09 08	21 21	09 09	21 20	09 10	21 20	09 13	21 20	09 15	21 19	09 16	21 19
17	09 38	22 13	09 37	22 14	09 36	22 17	09 35	22 20	09 34	22 23	09 32	22 26
18	10 09	23 05	10 06	23 10	10 03	23 15	09 58	23 21	09 53	23 28	09 49	23 35
19	10 42	.. ..	10 37	.. ..	10 30	.. ..	10 23	.. ..	10 15	.. ..	10 06	.. ..
20 ☽	11 17	00 01	11 10	00 07	11 01	00 15	10 51	00 23	10 39	00 34	10 27	00 45
21	11 57	00 57	11 48	01 06	11 37	01 16	11 24	01 28	11 09	01 42	10 54	01 56
22	12 43	01 55	12 31	02 06	12 19	02 18	12 04	02 32	11 46	02 50	11 28	03 07
23	13 35	02 55	13 23	03 07	13 09	03 20	12 53	03 36	12 33	03 56	12 12	04 15
24	14 33	03 54	14 22	04 06	14 08	04 20	13 51	04 37	13 31	04 57	13 10	05 17
25	15 38	04 51	15 27	05 03	15 14	05 16	14 59	05 31	14 41	05 51	14 22	06 10
26	16 47	05 45	16 37	05 55	16 27	06 06	16 14	06 20	15 59	06 36	15 44	06 52
27 ○	17 57	06 35	17 50	06 42	17 43	06 51	17 34	07 01	17 23	07 14	17 12	07 26
28	19 06	07 20	19 03	07 24	18 59	07 30	18 53	07 37	18 48	07 45	18 42	07 53
29	20 15	08 01	20 15	08 04	20 13	08 06	20 12	08 09	20 11	08 12	20 10	08 16
30	21 22	08 41	21 24	08 40	21 27	08 40	21 30	08 39	21 33	08 38	21 37	08 37
31	22 27	09 20	22 32	09 17	22 38	09 13	22 44	09 08	22 52	09 03	23 00	08 58
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	23 31	10 01	23 39	09 54	23 47	09 47	23 58	09 40	.. ..	09 30	.. ..	09 20
2	.. ..	10 42	.. ..	10 34	.. ..	10 24	.. ..	10 13	00 09	10 00	00 21	09 46
3 ☾	00 34	11 26	00 43	11 15	00 53	11 04	01 07	10 51	01 23	10 33	01 39	10 16
4	01 33	12 13	01 44	12 01	01 57	11 48	02 12	11 33	02 31	11 13	02 50	10 54
5	02 29	13 03	02 41	12 51	02 55	12 37	03 11	12 21	03 31	12 00	03 52	11 39
6	03 21	13 55	03 33	13 43	03 47	13 29	04 04	13 14	04 24	12 53	04 44	12 33
7	04 08	14 49	04 20	14 38	04 34	14 25	04 48	14 10	05 08	13 52	05 26	13 33
8	04 51	15 43	05 02	15 34	05 13	15 23	05 27	15 10	05 43	14 54	06 00	14 38
9	05 30	16 37	05 39	16 30	05 49	16 21	06 00	16 11	06 13	15 58	06 27	15 45
10	06 06	17 31	06 12	17 25	06 20	17 19	06 28	17 11	06 39	17 02	06 49	16 53
11 ●	06 39	18 23	06 43	18 19	06 49	18 16	06 54	18 12	07 01	18 06	07 08	18 01
12	07 10	19 15	07 13	19 14	07 15	19 13	07 18	19 12	07 21	19 10	07 24	19 08
13	07 41	20 07	07 41	20 08	07 40	20 10	07 41	20 12	07 41	20 13	07 40	20 16
14	08 12	21 00	08 09	21 03	08 07	21 07	08 04	21 12	08 00	21 18	07 57	21 23
15	08 44	21 53	08 39	21 59	08 34	22 06	08 28	22 14	08 21	22 23	08 14	22 32
16	09 18	22 48	09 11	22 56	09 04	23 06	08 54	23 16	08 44	23 29	08 34	23 42
17	09 56	23 44	09 46	23 54	09 37	.. ..	09 25	.. ..	09 11	.. ..	08 58	.. ..
18	10 38	.. ..	10 26	.. ..	10 15	00 06	10 01	00 19	09 44	00 35	09 27	00 51
19 ☽	11 25	00 42	11 13	00 53	11 00	01 06	10 44	01 21	10 25	01 40	10 06	01 58
20	12 18	01 39	12 06	01 51	11 52	02 05	11 36	02 21	11 16	02 41	10 56	03 01
21	13 18	02 35	13 07	02 47	12 53	03 01	12 37	03 17	12 18	03 36	11 58	03 56
22	14 22	03 29	14 12	03 40	14 01	03 52	13 47	04 07	13 29	04 25	13 13	04 42
23	15 30	04 20	15 22	04 28	15 13	04 39	15 02	04 51	14 49	05 05	14 36	05 19
24	16 40	05 06	16 34	05 13	16 28	05 21	16 21	05 29	16 13	05 39	16 04	05 49
25 ○	17 50	05 51	17 47	05 54	17 45	05 58	17 41	06 04	17 37	06 10	17 34	06 15
26	18 59	06 32	19 00	06 33	19 00	06 34	19 00	06 35	19 02	06 36	19 03	06 38
27	20 07	07 13	20 11	07 11	20 14	07 08	20 19	07 06	20 25	07 03	20 31	07 00
28	21 14	07 54	21 20	07 49	21 28	07 44	21 36	07 38	21 46	07 30	21 56	07 23

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

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

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

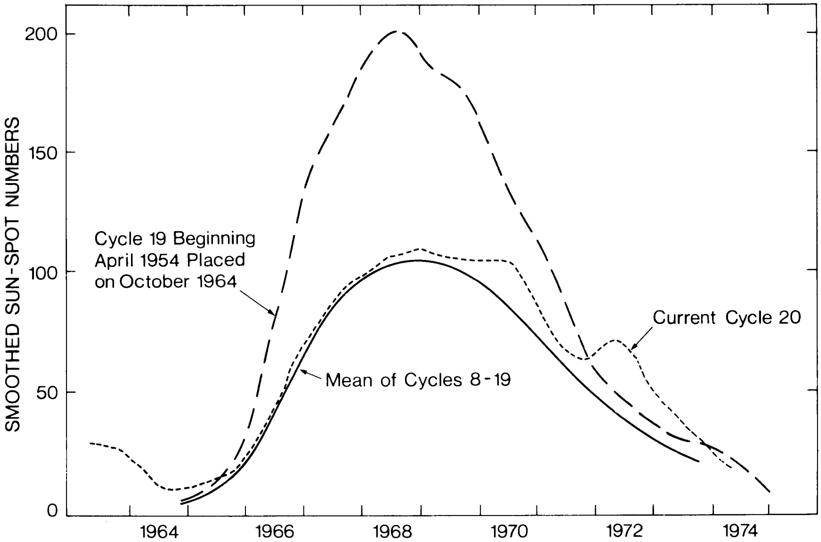
DATE	Latitude 30° Moon Rise	Latitude 30° Moon Set	Latitude 35° Moon Rise	Latitude 35° Moon Set	Latitude 40° Moon Rise	Latitude 40° Moon Set	Latitude 45° Moon Rise	Latitude 45° Moon Set	Latitude 50 ° Moon Rise	Latitude 50 ° Moon Set	Latitude 54° Moon Rise	Latitude 54° Moon Set
Sept.	h m	h m	h m	h m	h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

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

THE SUN AND PLANETS FOR 1975

THE SUN

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



MERCURY

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

The following table lists the greatest elongations east (evening sky) and west (morning sky) during the year; those marked * are most favourable.

Date (U.T.)	Elong. East	Mag.	Date (U.T.)	Elong. West	Mag.
Jan. 23	19°	−0.4	Mar. 6	27°	+0.3
*May 17	22°	+0.6	July 4	22°	+0.7
Sept. 13	27°	+0.4	*Oct. 25	18°	−0.3

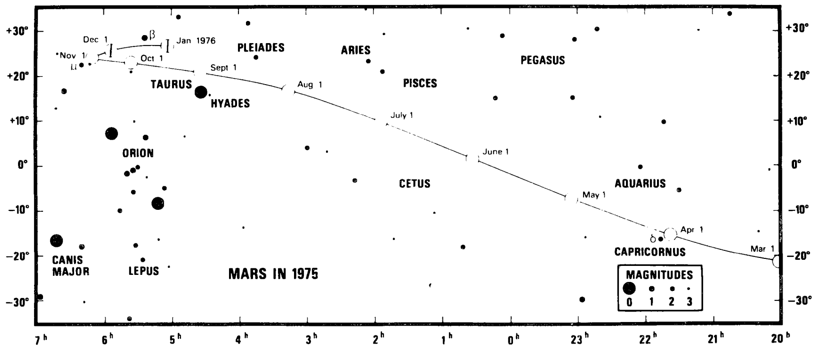
VENUS

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

Venus is easily identified by its superior brilliance. It is visible in the evening until late August, reaching greatest elongation (45°) in June. From September onwards, it is visible in the morning, reaching greatest elongation (47°) in November. It is in conjunction with Jupiter on Feb. 17, with Saturn on May 24 and with Mercury on Aug. 15. See also the section on planetary appulses and occultations.

MARS

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



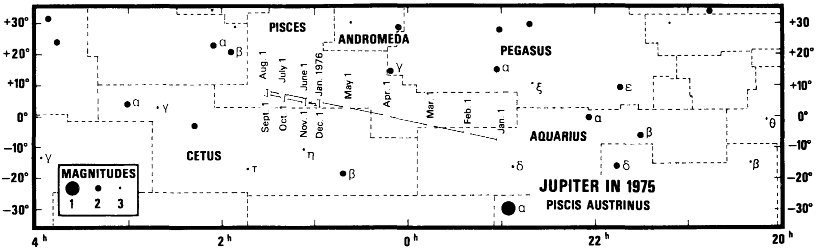
The atmosphere of Mars is thin, and surface features are distinctly visible in a good telescope. Perhaps the most surprising result of the space programme so far is the discovery of craters, canyons and volcanoes on the Martian surface.

Mars—conspicuous because of its reddish colour—is visible in the morning until opposition on Dec. 15. In January 1975, Mars is in Ophiuchus, and moves through Sagittarius, Capricornus, Aquarius, Pisces, Aries, Taurus (passing 4° N. of Aldebaran on Sept. 1) and into Gemini in October. By December it is back in Taurus. Mars is in conjunction with Jupiter on June 16.

JUPITER

Jupiter, the giant of the sun's family, is a fine object for the telescope. Belts of clouds may be observed, interrupted by irregular spots which may be short-lived or persist for weeks. The flattening of the planet, due to its fast rotation, is conspicuous, and the phenomena of its satellites provide a continual interest.

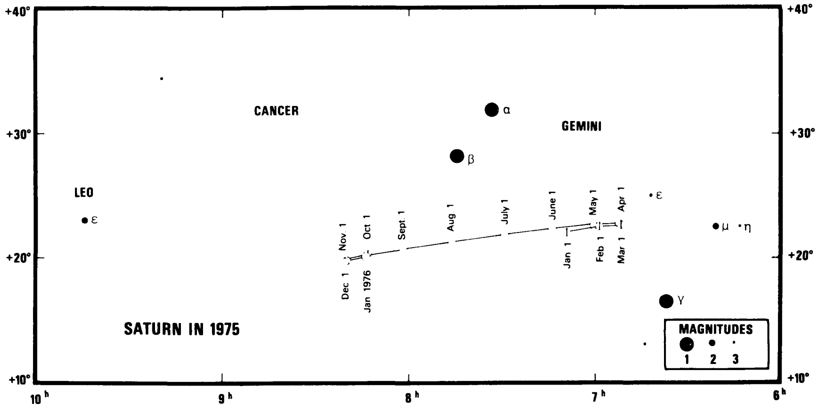
Throughout most of 1975, Jupiter is in Pisces, and is a conspicuous object in an otherwise unspectacular part of the sky. Conjunction with the sun occurs on March 22. Jupiter is visible in the morning sky until opposition on Oct. 13, and in the evening sky thereafter. Jupiter is in conjunction with Mercury on Apr. 6, with Venus on Feb. 17 and with Mars on June 16.



SATURN

Saturn was the outermost planet known until modern times and, with its unique system of rings, is one of the finest of celestial objects in a good telescope. The plane of the rings makes an angle of 27° with the plane of the planet's orbit, and twice during the planet's revolution period of 29½ years the rings appear to open out widest; then they slowly close until, midway between the maxima, the rings are presented edgewise to the sun or the earth, at which times they are invisible. The rings were open widest in 1973, the southern face being visible.

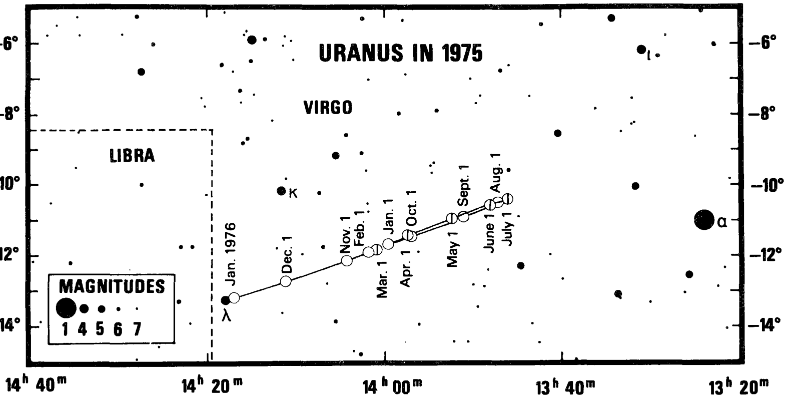
Saturn is at opposition on Jan. 6. From then until mid-June, it is visible in the constellation Gemini, in the evening sky. After mid-August, it is visible in Cancer, in the morning sky. On May 24, Saturn is in conjunction with Venus.



URANUS

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

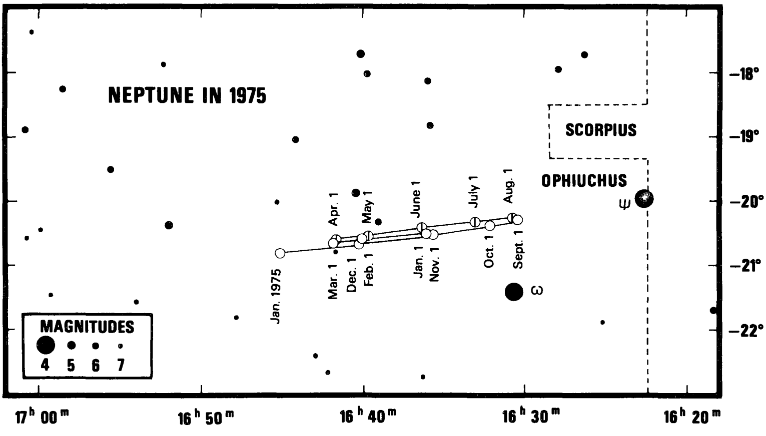
In 1975, Uranus is in Virgo, east of Spica, and by January 1976 is very close to λ Vir. Opposition occurs on Apr. 21, at which time its magnitude is +5.7 and its apparent diameter is 3.9″.



NEPTUNE

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

In 1975, Neptune is in Ophiuchus. At opposition on June 1, its magnitude is +7.7 and its apparent diameter is 2.5″.



PLUTO

Pluto, the most distant known planet, was discovered at the Lowell Observatory in 1930, as a result of an extensive search started two decades earlier by Percival Lowell. The faint star-like image was first detected by Clyde Tombaugh by comparing photographs taken on different dates. Further observations confirmed that the object was a distant planet.

At opposition on March 29, its astrometric position is R.A. (1950) $12^h55^m.4$, Dec. (1950) $+12°55'$ and its apparent magnitude is +14.

THE SKY MONTH BY MONTH

By John F. Heard

THE SKY FOR JANUARY 1975

For this and subsequent months, positions of the sun and planets are given for 0h Ephemeris Time. The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 14. Estimates of altitude are for an observer in latitude 45° N.

The Sun—During January the sun's R.A. increases from 18 h 43 m to 20 h 56 m and its Decl. changes from 23° 04′ S. to 17° 20′ S. The equation of time changes from −3 m 28 s to −13 m 26 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 following months. The earth is at perihelion on the 2nd at a distance of 147,100,000 km (91,402,000 miles) from the sun. For changes in the length of the day, see pp. 15–21.

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 pp. 22–27.

Mercury on the 1st is in R.A. 19 h 15 m, Decl. 24° 27′ S., and on the 15th is in R.A. 20 h 51 m, Decl. 19° 22′ S. During the last half of the month it may be seen as an evening star low in the south-west just after sunset. At greatest eastern elongation, on the 23rd, it is about 13° above the horizon at sunset.

Venus on the 1st is in R.A. 19 h 42 m, Decl. 22° 38′ S., and on the 15th it is in R.A. 20 h 55 m, Decl. 18° 56′ S., mag. −3.4, and transits at 13 h 21 m. It is an evening star to be seen very low in the south-west for about an hour after sunset.

Mars on the 15th is in R.A. 17 h 38 m, Decl. 23° 43′ S., and transits at 10 h 03 m. It is a morning star, but not well placed for observation, being very low in the south-east at sunrise.

Jupiter on the 15th is in R.A. 23 h 10 m, Decl. 6° 38′ S., mag. −1.7, and transits at 15 h 32 m. In Aquarius, it is well past the meridian at sunset and sets about four hours later.
For the configurations of Jupiter's satellites in this and following months see opposite pages, and for their eclipses, etc., see p. 73.

Saturn on the 15th is in R.A. 7 h 04 m, Decl. 22° 15′ N., mag. −0.2, and transits at 23 h 23 m. This is the month of Saturn's opposition (on the 6th) when it is at its brightest and rises as the sun sets and is visible all night. It is in Gemini to the south-west of the Twins.

Uranus on the 15th is in R.A. 14 h 01 m, Decl. 11° 45′ S., and transits at 6 h 24 m.

Neptune on the 15th is in R.A. 16 h 38 m, Decl. 20° 34′ S., and transits at 9 h 01 m.

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

Further information and instructions can be found at the foot of subsequent pages in this section.

1975				JANUARY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 20 h E.S.T.	Sun's Selen. Colong. 0 h U.T.
	d	h	m		h m		°
Wed.	1					2O314	128.04
Thur.	2	08		Earth at perihelion		321O4	140.18[b]
Fri.	3	16		Quadrantid Meteors	2 10	3O214	152.32
Sat.	4	14	04	☾ Last Quarter		31O24	164.46
Sun.	5			Mercury at greatest hel. lat. S.	23 00	2O14*	176.62
Mon.	6	01		Uranus 4° N. of Moon		21O43	188.78
		04		Saturn at opposition			
Tues.	7					4O23d	200.94[l]
Wed.	8	22		Neptune 1° N. of Moon	19 50	4O13d	213.12
Thur.	9	18		Mars 1° S. of Moon		4231O	225.29
Fri.	10	22		Occultation of SAO 79057 by Saturn		43O21	237.48
Sat.	11				16 40	431O2	249.66
Sun.	12	05	20	● New Moon		42O1*	261.85
Mon.	13	18		Mercury 6° S. of Moon		421O3	274.04
		21		Venus 6° S. of Moon			
Tues.	14				13 30	4O123	286.23
Wed.	15	16		Moon at apogee (406,130 km)		O23**	298.41
Thur.	16	01				231O4	310.60[b]
Fri.	17	01		Jupiter 7° S. of Moon	10 20	3O14*	322.78
Sat.	18	21		Pluto stationary		31O24	334.95
Sun.	19					23O14	347.12
Mon.	20	10	14	☽ First Quarter	7 10	21O34	359.29
Tues.	21					O1234	11.44
Wed.	22			Venus at greatest hel. lat. S.		1O234	23.60
Thur.	23	15		Mercury greatest elong. E. (19°)	4 00	231O4	35.74[l]
Fri.	24			Occultation of κ Gem by Eros?		34O1*	47.88
				Mercury at ascending node			
Sat.	25	22		Saturn 3° N. of Moon		431O2	60.01
Sun.	26				0 50	423O1	72.14
Mon.	27	10	09	○ Full Moon		421O3	84.27
Tues.	28			Mercury at perihelion	21 40	4O123	96.39
		04		Moon at perigee (357,600 km)			
Wed.	29	16		Mercury stationary		41O23	108.52
Thur.	30					423Od	120.65[b]
Fri.	31				18 30	342O1	132.78

[l]Jan. 7, +6.40°; Jan. 23, −7.59°.
[b]Jan. 2, +6.67°; Jan. 16, −6.68°; Jan. 30, +6.54°.

THE SKY FOR FEBRUARY 1975

For further information, see "The Sky for January 1975".

The Sun—During February the sun's R.A. increases from 20 h 56 m to 22 h 45 m and its Decl. changes from 17° 20′ S. to 7° 54′ S. The equation of time changes from −13 m 35 s to a maximum of −14 m 16 s on the 12th and then to −12 m 38 s at the end of the month.

Mercury on the 1st is in R.A. 21 h 47 m, Decl. 11° 06′ S., and on the 15th is in R.A. 20 h 54 m, Decl. 14° 00′ S. It is too close to the sun for easy observation, being in inferior conjunction on the 8th.

Venus on the 1st is in R.A. 22 h 19 m, Decl. 12° 08′ S., and on the 15th it is in R.A. 23 h 24 m, Decl. 5° 20′ S., mag. −3.4, and transits at 13 h 47 m. It is an evening star, standing at about 20° altitude in the south-west at sunset and setting about two hours later.

Mars on the 15th is in R.A. 19 h 18 m, Decl. 22° 58′ S., and transits at 9 h 40 m. It is a morning star, but only about 12° above the south-eastern horizon at sunrise.

Jupiter on the 15th is in R.A. 23 h 34 m, Decl. 3° 59′ S., mag. −1.6, and transits at 13 h 54 m. In Aquarius, it is well down in the west at sunset and sets in the early evening.

Saturn on the 15th is in R.A. 6 h 55 m, Decl. 22° 32′ N., mag. 0.0, and transits at 21 h 13 m. In Gemini, it is well up in the east at sunset.

Uranus on the 15th is in R.A. 14 h 02 m, Decl. 11° 48′ S., and transits at 4 h 23 m.

Neptune on the 15th is in R.A. 16 h 41 m, Decl. 20° 39′ S., and transits at 7 h 02 m.

CONFIGURATIONS OF JUPITER'S SATELLITES

In the Configurations of Jupiter's Satellites, 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.

The configurations have been read from diagrams in the *American Ephemeris and Nautical Almanac*. Where two satellites are nearly coincident, it is difficult to tell the correct order of the satellites from the diagram. Such ambiguous cases are indicated by bold face type: thus **12**O4 may actually be 13O4. An hour's observation usually reveals the correct configuration, because the apparent motion of the innermost satellites is much faster than that of the outermost. Also, the four satellites differ slightly in apparent magnitude.

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.

1975		FEBRUARY E.S.T.			Min. of Algol	Config. of Jupiter's Sat. 20 h E.S.T.	Sun's Selen. Colong. 0 h U.T.
	d	h	m		h m		°
Sat.	1					31042	144.92
Sun.	2	07		Uranus 4° N. of Moon		32014	157.07
Mon.	3	01	23	☾ Last Quarter	15 20	21034	169.22[l]
Tues.	4					01234	181.38[l]
Wed.	5	05		Neptune 1° N. of Moon		10234	193.55
Thur.	6	00		Uranus stationary	12 10	20314	205.73
Fri.	7	18		Mars 4° S. of Moon		3204*	217.91
Sat.	8			Mercury greatest hel. lat. N.		31024	230.90
		04		Mercury in inferior conjunction			
Sun.	9				9 00	3041d	242.28
Mon.	10					24103	254.48
Tues.	11	00	17	● New Moon		40213	266.67
		23		Moon at apogee (406,670 km)			
Wed.	12				5 40	41023	278.86[b]
Thur.	13	10		Venus 7° S. of Moon		42031	291.06
		19		Jupiter 6° S. of Moon			
Fri.	14					43210	303.25
Sat.	15				2 30	43102	315.44
Sun.	16					43021	327.63
Mon.	17	14		Venus 0.2° S. of Jupiter	23 20	2410*	339.81
Tues.	18	10		Pallas in conjunction with Sun		0413*	351.99
Wed.	19	02	39	☽ First Quarter		10243	4.16
Thur.	20	03		Mercury stationary	20 10	20134	16.32[l]
Fri.	21					23104	28.48
Sat.	22	06		Saturn 3° N. of Moon		30124	40.63
Sun.	23				17 00	30124	52.78
Mon.	24					2104*	64.92
Tues.	25	17		Moon at Perigee (356,510 km)		20143	77.05
		20	15	○ Full Moon			
Wed.	26				13 50	10423	89.19[b]
Thur.	27					42013	101.33
Fri.	28					42310	113.46

[l]Feb. 3, 4, +7.42°; Feb. 20, −7.97°.
[b]Feb. 12, −6.55°; Feb. 26, +6.50°.

THE SKY FOR MARCH 1975

For further information, see "The Sky for January 1975".

The Sun—During March the sun's R.A. increases from 22 h 45 m to 0 h 39 m and its Decl. changes from 7° 54′ S. to 4° 13′ N. The equation of time changes from −12 m 26 s to −4 m 17 s.

Mercury on the 1st is in R.A. 21 h 02 m, Decl. 16° 23′ S., and on the 15th is in R.A. 22 h 03 m, Decl. 13° 41′ S. It is in greatest western elongation on the 6th and so might be seen very low in the south-east just before sunrise at about this time. However, this is an unfavourable elongation, Mercury standing less than 10° above the horizon at sunrise.

Venus on the 1st is in R.A. 0 h 27 m, Decl. 1° 56′ N., and on the 15th it is in R.A. 1 h 29 m, Decl. 9° 05′ N., mag. −3.4, and transits at 14 h 02 m. It is relatively high in the western sky at sunset and sets within three hours.

Mars on the 15th is in R.A. 20 h 46 m, Decl. 19° 03′ S., and transits at 9 h 18 m. It is a morning star, but not very bright and only about 15° above the south-eastern horizon at sunrise.

Jupiter on the 15th is in R.A. 23 h 58 m, Decl. 1° 20′ S., mag. −1.6, and transits at 12 h 28 m. Early in the month it is still to be seen very low in the west just after sunset, but by the 21st it is in conjunction with the sun.

Saturn on the 15th is in R.A. 6 h 52 m, Decl. 22° 39′ N., mag. +0.2, and transits at 19 h 20 m. In Gemini, it is approaching the meridian at sunset and sets about an hour after midnight. On the 6th it is stationary in right ascension and resumes its usual eastward motion among the stars.

Uranus on the 15th is in R.A. 14 h 00 m, Decl. 11° 36′ S., and transits at 2 h 30 m.

Neptune on the 15th is in R.A. 16 h 42 m, Decl. 20° 39′ S., and transits at 5 h 12 m.

1975				MARCH E.S.T.	Min. of Algol		Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Sat.	1	15		Uranus 3° N. of Moon	10 40		125.61
Sun.	2						137.76
Mon.	3			Mercury at descending node			149.91
Tues.	4	12		Neptune 0.9° N. of Moon	7 30		162.07[l]
		15	20	☾ Last Quarter			
Wed.	5						174.24
Thur.	6	01		Mercury greatest elong. W. (27°)			186.42
Fri.	7				4 20		198.60
Sat.	8	22		Mars 6° S. of Moon			210.79
Sun.	9						222.99
Mon.	10	12		Mercury 6° S. of Moon	1 10		235.19
Tues.	11	00		Moon at apogee (406,590 km)			247.39[b]
Wed.	12	18	47	● New Moon	22 00		259.60[b]
Thur.	13			Mercury at aphelion			271.81
Fri.	14	01		Saturn stationary			284.01
		10		Neptune stationary			
Sat.	15	16		Venus 3° S. of Moon	18 50		296.22
Sun.	16						308.43
Mon.	17						320.63
Tues.	18				15 40		332.83
Wed.	19						345.02
Thur.	20			Venus at ascending node			357.21[l]
		15	05	☽ First Quarter			
Fri.	21	00	57	Equinox. Spring begins	12 30		9.40
		13		Saturn 3° N. of Moon			
		21		Jupiter in conjunction with sun			
Sat.	22						21.57
Sun.	23						33.74
Mon.	24				9 20		45.90
Tues.	25						58.06[b]
Wed.	26	04		Moon at perigee (358,690 km)			70.22
Thur.	27	05	36	○ Full Moon	6 00		82.37
Fri.	28	10		Spica 1° N. of Moon. Occ'n.			94.52
Sat.	29	00		Pluto at opposition			106.67
		00		Uranus 3° N. of Moon			
Sun.	30				2.50		118.83
Mon.	31	20		Neptune 0.7° N. of Moon. Occ'n.			130.99

[l]Mar. 4, +7.68°; Mar. 20, −7.42°.
[b]Mar. 11, 12, −6.55°; Mar. 25, +6.55°.

THE SKY FOR APRIL 1975

For further information, see "The Sky for January 1975".

The Sun—During April the sun's R.A. increases from 0 h 39 m to 2 h 30 m and its Decl. changes from 4° 13′ N. to 14° 49′ N. The equation of time changes from −3 m 59 s to +2 m 46 s, being zero on the 16th.

Mercury on the 1st is in R.A. 23 h 41 m, Decl. 4° 35′ S., and on the 15th is in R.A. 1 h 16 m, Decl. 6° 47′ N. It is too close to the sun for observation this month, superior conjunction being on the 18th.

Venus on the 1st is in R.A. 2 h 48 m, Decl. 16° 49′ N., and on the 15th it is in R.A. 3 h 55 m, Decl. 21° 45′ N., mag. −3.5, and transits at 14 h 26 m. It is quite high in the west at sunset and sets well north of west about three hours later.

Mars on the 15th is in R.A. 22 h 20 m, Decl. 11° 53′ S., mag. +1.2, and transits at 8 h 49 m. In Aquarius, it rises about two hours before the sun and stands at about 17° altitude in the south-east at sunrise.

Jupiter on the 15th is in R.A. 0 h 26 m, Decl. 1° 36′ N., mag. −1.6, and transits at 10 h 54 m. It is a morning star now and by the end of the month it can be seen very low in the east just before sunrise.

Saturn on the 15th is in R.A. 6 h 56 m, Decl. 22° 38′ N., mag. +0.3, and transits at 17 h 22 m. In Gemini, it is well past the meridian at sunset and sets before midnight.

Uranus on the 15th is in R.A. 13 h 55 m, Decl. 11° 12′ S., and transits at 0 h 24 m.

Neptune on the 15th is in R.A. 16 h 41 m, Decl. 20° 35′ S., and transits at 3 h 09 m.

1975				APRIL E.S.T.	Min. of Algol		Sun's Selen. Colong. 0 h U.T.
	d	h	m		h m		°
Tues.	1				23 40		143.16[l]
Wed.	2						155.34
Thur.	3			Mercury greatest hel. lat. S.			167.52
		07	25	☾ Last Quarter			
Fri.	4				20 30		179.71
Sat.	5						191.91
Sun.	6	15		Mercury 1.0° S. of Jupiter			204.11
Mon.	7	03		Mars 7° S. of Moon	17 20		216.32
		11		Moon at apogee (405,870 km)			
Tues.	8						228.53[b]
Wed.	9						240.75
Thur.	10	09		Jupiter 6° S. of Moon	14 10		252.97
		20		Ceres in conjunction with Sun			
Fri.	11	11	39	● New Moon			265.19
Sat.	12						277.42
Sun.	13				11 00		289.64
Mon.	14	16		Venus 1° N. of Moon			301.87
Tues.	15						314.09
Wed.	16				7 50		326.31
Thur.	17	21		Saturn 3° N. of Moon			338.52[l]
Fri.	18	16		Mercury in superior conjunction			350.73
		23	41	☽ First Quarter			
Sat.	19				4 40		2.93
Sun.	20	23		Uranus at opposition			15.13
Mon.	21						27.31[b]
Tues.	22			Mercury at ascending node	1 30		39.50[b]
				Venus at perihelion			
		16		Lyrid Meteors			
		16		Venus 7° N. of Aldebaran			
Wed.	23	08		Moon at perigee (363,270 km)			51.67
Thur.	24	02	37	Appulse of Venus and 95 Tau	22 20		63.85
		21		Spica 1° N. of Moon. Occ'n.			
Fri.	25	09		Uranus 3° N. of Moon			76.02
		14	55	○ Full Moon			
Sat.	26			Mercury at perihelion			88.19
Sun.	27				19 10		100.36
Mon.	28	05		Neptune 0.7° N. of Moon. Occ'n.			112.53
Tues.	29						124.71[l]
Wed.	30				15 00		136.89

[l]Apr. 1, +7.11°; Apr. 17, −6.20°; Apr. 29, +6.07°.
[b]Apr. 8, −6.69°; Apr. 21, 22, +6.65°.

THE SKY FOR MAY 1975

For further information, see "The Sky for January 1975".

The Sun—During May the sun's R.A. increases from 2 h 30 m to 4 h 33 m and its Decl. changes from 14° 49′ N. to 21° 56′ N. The equation of time changes from +2 m 54 s to a maximum of +3 m 42 s on the 15th and then to +2 m 27 s at the end of the month. There is a partial eclipse of the sun on the 11th, not visible generally in North America.

The Moon—There is an eclipse of the moon visible in North America on the night of the 24th–25th.

Mercury on the 1st is in R.A. 3 h 23 m, Decl. 20° 06′ N., and on the 15th it is in R.A. 4 h 55 m, Decl. 25° 03′ N. It is in greatest eastern elongation on the 16th and this is a favourable elongation; therefore during all of this month Mercury may be seen low in the west just after sunset. At mid-month it will be about 19° above the horizon at sunset.

Venus on the 1st is in R.A. 5 h 15 m, Decl. 25° 08′ N., and on the 15th it is in R.A. 6 h 26 m, Decl. 25° 48′ N., mag. −3.7, and transits at 14 h 58 m. A brilliant object in the west at sunset, it sets about three hours later.

Mars on the 15th is in R.A. 23 h 45 m, Decl. 3° 21′ S., mag. +1.0, and transits at 8 h 16 m. Moving from Aquarius into Pisces, it is beginning to be prominent in the south-east before sunrise.

Jupiter on the 15th is in R.A. 0 h 51 m, Decl. 4° 13′ N., mag. −1.7, and transits at 9 h 21 m. In Pisces, it rises an hour or so before the sun.

Saturn on the 15th is in R.A. 7 h 06 m, Decl. 22° 27′ N., mag. +0.4, and transits at 15 h 34 m. In Gemini, it is well down in the west at sunset and sets about three hours later.

Uranus on the 15th is in R.A. 13 h 50 m, Decl. 10° 46′ S., and transits at 22 h 17 m.

Neptune on the 15th is in R.A. 16 h 38 m, Decl. 20° 29′ S., and transits at 1 h 09 m.

TOTAL ECLIPSES OF THE SUN

No total eclipses of the sun occur in 1975. However, for those readers who like to plan ahead, the following list gives the date, maximum duration of totality and area of visibility of all total eclipses of the sun in the next 15 years. (1) 1976 Oct. 23, 4.9 min., Africa, Indian Ocean, Australia (2) 1977 Oct. 12, 2.8 min., Northern S. America (3) 1979 Feb. 26, 2.7 min., Northwest U.S. and Canada (4) 1980 Feb. 16, 4.3 min., Central Africa, India (5) 1981 July 31, 2.2 min., Siberia (6) 1983 June 11, 5.4 min., Indian Ocean, Indonesia (7) 1984 Nov. 22, 2.1 min., Indonesia, South America (8) 1987 March 29, 0.3 min., Central Africa (9) 1988 March 18, 4.0 min., Philippines, Indonesia, Pacific (10) 1990 July 22, 2.6 min., Finland, Arctic (11) 1991 July 11, 7.1 min., Hawaii, Central America, Brazil.

1975		MAY E.S.T.		Min. of Algol	Config. of Jupiter's Sat. 5 h E.S.T.	Sun's Selen. Colong. 0h U.T.
	d	h m		h m		°
Thur.	1					149.08
Fri.	2					161.28
Sat.	3	00 44	☾ Last Quarter	12 40		173.48
Sun.	4					185.69
Mon.	5	5	Moon at apogee (404,820 km)			197.90[b]
		18	η Aquarid Meteors			
Tues.	6	08	Mars 7° S. of Moon	9 30		210.12
Wed.	7		Mercury greatest hel. lat. N.			222.35
Thur.	8	05	Jupiter 5° S. of Moon			234.58
Fri.	9			6 20	4O123	246.81
Sat.	10				421O3	259.05
Sun.	11	01	Mercury 8° N. of Aldebaran		42O31	271.29
		02 05	● New Moon. Eclipse of ☉,			
Mon.	12	20	Mercury 4° N. of Moon	3 10	431O2	283.53
Tues.	13				34O21	295.77[l]
Wed.	14		Venus greatest hel. lat. N.	0 00	231O4	308.01
		13	Venus 6° N. of Moon			
Thur.	15	07	Saturn 4° N. of Moon		O134*	320.24
Fri.	16	19	Mercury greatest elong. E. (22°)		O234*	332.47
Sat.	17			20 50	21O34	344.70
Sun.	18		Mars greatest hel. lat. S		2O314	356.92
		05 29	☽ First Quarter			
Mon.	19				31O24	9.13[b]
Tues.	20	15	Moon at perigee (368,290 km)	17 40	3O214	21.33
Wed.	21				321O4	33.53
Thur.	22	05	Spica 1° N. of Moon. Occ'n.		O431*	45.72
		16	Uranus 3° N. of Moon			
Fri.	23	20	Venus 3° N. of Saturn	14 30	41O23	57.91
Sat.	24				412O3	70.10
Sun.	25	00 51	○ Full Moon. Eclipse of ☾,		42O13	82.28
		14	Neptune 0.7° N. of Moon. Occ'n.			
Mon.	26			12 20	431O2	94.47
Tues.	27				43O12	106.66[l]
Wed.	28				4321O	118.84
Thur.	29	15	Mercury stationary	8 00	423O1	131.04
Fri.	30		Mercury at descending node		41O23	143.24
Sat.	31	03	Venus 4° S. of Pollux		O143d	155.44

[l]May 13, −5.25°; May 27, +5.10°.
[b]May 5, −6.83°; May 19, +6.76°.

THE SKY FOR JUNE 1975

For further information, see "The Sky for January 1975".

The Sun—During June the sun's R.A. increases from 4 h 33 m to 6 h 37 m and its Decl. changes from 21° 56′ N. to 23° 10′ N. The equation of time changes from +2 m 18 s to −3 m 31 s, being zero on the 14th.

Mercury on the 1st is in R.A. 5 h 31 m, Decl. 22° 54′ N., and on the 15th is in R.A. 5 h 05 m, Decl. 18° 53′ N. It is too close to the sun for easy observation, inferior conjunction being on the 10th.

Venus on the 1st is in R.A. 7 h 47 m, Decl. 23° 46′ N., and on the 15th it is in R.A. 8 h 47 m, Decl. 20° 10′ N., mag. −3.9, and transits at 15 h 16 m. A brilliant object in the west at sunset, it sets about three hours later. Greatest eastern elongation is on the 18th.

Mars on the 15th is in R.A. 1 h 10 m, Decl. 5° 38′ N., mag. +0.8, and transits at 7 h 39 m. In Pisces, rising about three hours before the sun, it is now some 30° above the south-eastern horizon at sunrise. On the 16th there is a close conjunction with Jupiter.

Jupiter on the 15th is in R.A. 1 h 13 m, Decl. 6° 24′ N., mag. −1 8, and transits at 7 h 40 m. In Pisces, it rises about three hours before sunrise.

Saturn on the 15th is in R.A. 7 h 21 m, Decl. 22° 04′ N., mag. +0.4, and transits at 13 h 47 m. In Gemini, it is quite low in the west at sunset and sets soon after.

Uranus on the 15th is in R.A. 13 h 47 m, Decl. 10° 28′ S., and transits at 20 h 12 m.

Neptune on the 15th is in R.A. 16 h 35 m, Decl. 20° 23′ S., and transits at 22 h 59 m.

1975				JUNE E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 4 h E.S.T.	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Sun.	1	08		Neptune in Opposition	4 50	2O34*	167.65[b]
		18	23	☾ Last Quarter			
		23		Moon at apogee (404,220 km)			
Mon.	2					13O24	179.87
Tues.	3					3O124	192.09
Wed.	4	11		Mars 6° S. of Moon	1 40	321O4	204.32
Thur.	5	00		Jupiter 5° S. of Moon		23O14	216.55
Fri.	6				22 30	1O234	228.79
Sat.	7					O2143	241.03
Sun.	8					24O3*	253.28
Mon.	9			Mercury at aphelion	19 20	43O*d	265.53[l]
		13	49	● New Moon			
Tues.	10	13		Mercury in inferior conjunction		43O12	277.78
Wed.	11	19		Saturn 4° N. of Moon		4312O	290.03
Thur.	12				16 10	423O1	302.28
Fri.	13			Mars at perihelion		41O32	314.52
		05		Venus 7° N. of Moon			
Sat.	14	17		Moon at perigee (369,040 km)		4O213	326.77
Sun.	15	16		Juno in conjunction with Sun	13 00	421O3	339.00[b]
Mon.	16	01		Mars 0.5° S. of Jupiter		4O13*	351.23
		09	58	☽ First Quarter			
Tues.	17					3O142	3.45
Wed.	18	11		Venus greatest elong. E. (45°)	9 50	312O4	15.67
		12		Spica 1° N. of Moon. Occ'n.			
		22		Uranus 3° N. of Moon			
Thur.	19					32O14	27.88
Fri.	20					1O324	40.08
Sat.	21	19	27	Solstice. Summer begins	6 30	O2134	52.28
		20		Neptune 0.8° N. of Moon. Occ'n.[1]			
Sun.	22	11		Mercury stationary		21O34	64.47
Mon.	23	11	54	○ Full Moon		2O314	76.67[l]
Tues.	24	05		Pluto stationary	3 20	3O42*	88.86
Wed.	25					314Od	101.05
Thur.	26					432O1	113.25
Fri.	27				0 10	41O32	125.44
Sat.	28					4O123	137.65[b]
Sun.	29	18		Moon at apogee (404,480 km)	21 00	421O3	149.85
Mon.	30			Mercury greatest hel. lat. S.		42O13	162.06

[l]June 9, −5.34°; June 23, +4.79°.
[b]June 1, −6.85°; June 15, +6.74°; June 28, −6.73°.
[1]Visible in S. America.

THE SKY FOR JULY 1975

For further information, see "The Sky for January 1975".

The Sun—During July the sun's R.A. increases from 6 h 37 m to 8 h 42 m and its Decl. changes from 23° 10′ N. to 18° 14′ N. The equation of time changes from −3 m 43 s to a maximum of −6 m 28 s on the 26th and then to −6 m 21 s at the end of the month. The earth is in aphelion on the 5th at a distance of 152,100,000 km (94,512,000 miles) from the sun.

Mercury on the 1st is in R.A. 5 h 08 m, Decl. 19° 11′ N., and on the 15th it is in R.A. 6 h 18 m, Decl. 22° 29′ N. It is in greatest western elongation on the 4th, standing then about 12° above the eastern horizon at sunrise, so for a few days at this time it may be seen very low in the east just before sunrise.

Venus on the 1st is in R.A. 9 h 44 m, Decl. 14° 41′ N., and on the 15th it is in R.A. 10 h 22 m, Decl. 9° 27′ N., mag. −4.2, and transits at 14 h 51 m. Now closing towards the sun, it is noticeably lower in the sky at sunset, but brighter than before; greatest brilliancy is on the 21st.

Mars on the 15th is in R.A. 2 h 31 m, Decl. 13° 13′ N., mag. +0.6, and transits at 7 h 02 m. In Aries and following Jupiter by about an hour it rises about at midnight and dominates this part of the sky during the early morning hours.

Jupiter on the 15th is in R.A. 1 h 27 m, Decl. 7° 47′ N., mag. −2.0, and transits at 5 h 57 m. In Pisces it rises about an hour before midnight.

Saturn on the 15th is in R.A. 7 h 37 m, Decl. 21° 32′ N., and transits at 12 h 05 m. It is too close to the sun for easy observation, conjunction being on the 15th.

Uranus on the 15th is in R.A. 13 h 46 m, Decl. 10° 25′ S., and transits at 18 h 14 m.

Neptune on the 15th is in R.A. 16 h 32 m, Decl. 20° 17′ S., and transits at 20 h 59 m.

1975				JULY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 3 h E.S.T.	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Tues.	1	02		Pallas 1° N. of Moon. Occ'n.		43102	174.28
		11	37	☾ Last Quarter			
Wed.	2	16		Jupiter 5° S. of Moon	17 50	3402d	186.50
Thur.	3	11		Mars 4° S. of Moon		32401	198.73
Fri.	4			Jupiter greatest hel. lat. S.		13024	210.97
		09		Mercury greatest elong. W. (22°)			
Sat.	5	22		Earth at aphelion	14 40	01234	223.21
Sun.	6					21034	235.45[l]
Mon.	7	05		Uranus stationary		20134	247.70
		08		Mercury 0.5° S. of Moon. Occ'n.			
Tues.	8	18		Venus 0.4° S. of Regulus	11 30	31024	259.95
		23	10	● New Moon			
Wed.	9			Venus at descending node		30124	272.21
Thur.	10					3204*	284.46
Fri.	11	15		Moon at perigee (364,520 km)	8 20	104**	296.71
Sat.	12	05		Venus 5° N. of Moon		40123	308.96[b]
Sun.	13					41203	321.21
Mon.	14				5 00	42013	333.44
Tues.	15	10		Saturn in conjunction with Sun		41302	345.68
		14	47	☽ First Quarter			
		17		Spica 1° N. of Moon. Occ'n.			
Wed.	16	03		Uranus 3° N. of Moon		43012	357.90
Thur.	17				1 50	4320*	10.12
Fri.	18					430*d	22.33
Sat.	19			Mercury at ascending node	22 40	40132	34.54[l]
		02		Neptune 0.7° N. of Moon. Occ'n.[2]			
		09	58	Appulse of Ceres and SAO 93633			
Sun.	20					12043	46.74
Mon.	21	19		Venus greatest brilliancy		20143	58.93
Tues.	22				19 30	1024d	71.13
Wed.	23			Mercury at perihelion		30124	83.32
		00	28	○ Full Moon			
Thur.	24					32104	95.51
Fri.	25				16 20	3204d	107.71
Sat.	26					01324	119.90[b]
Sun.	27	11		Moon at apogee (405, 360 km)		1043d	132.10
		12		Saturn 7° S. of Pollux			
Mon.	28				13 10	20413	144.30
Tues.	29	13		δ Aquarid Meteors		41032	156.51
Wed.	30	05		Jupiter 4° S. of Moon		43012	168.72
Thur.	31	03	48	☾ Last Quarter	10 00	43210	180.94

[l]July 6, −6.14°; July 19, +5.60°.
[b]July 12, +6.61°; July 26, −6.60°.
[1]Visible in N. America, Greenland, Europe, N. Africa.
[2]Visible in S. America.

THE SKY FOR AUGUST 1975

For further information, see "The Sky for January 1975".

The Sun—During August the sun's R.A. increases from 8 h 42 m to 10 h 38 m and its Decl. changes from 18° 14′ N. to 8° 35′ N. The equation of time changes from −6 m 17 s to −0 m 24 s.

Mercury on the 1st is in R.A. 8 h 42 m, Decl. 19° 57′ N., and on the 15th it is in R.A. 10 h 29 m, Decl. 10° 55′ N. It is in superior conjunction on the 1st and during the whole month it is too close to the sun for easy observation.

Venus on the 1st is in R.A. 10 h 45 m, Decl. 3° 53′ N., and on the 15th it is in R.A. 10 h 37 m, Decl. 1° 31′ N., mag. −3.7, and transits at 13 h 02 m. At the first of the month it may still be seen very low in the west just after sunset, but by the 27th it is in inferior conjunction and technically becomes a morning star.

Mars on the 15th is in R.A. 3 h 53 m, Decl. 18° 54′ N., mag. +0.4, and transits at 6 h 21 m. Moving into Taurus and rising before midnight, it passes a few degrees north of Aldebaran ("the rival of Mars") late in the month.

Jupiter on the 15th is in R.A. 1 h 34 m, Decl. 8° 13′ N., mag. −2.2, and transits at 4 h 01 m. In Pisces, it rises about two hours after sunset. On the 15th it is stationary in right ascension and begins to retrograde, or move westward among the stars.

Saturn on the 15th is in R.A. 7 h 54 m, Decl. 20° 53′ N., mag. +0.4, and transits at 10 h 20 m. Moving into Cancer, it is now a morning star rising about two hours before the sun.

Uranus on the 15th is in R.A. 13 h 49 m, Decl. 10° 39′ S., and transits at 16 h 14 m.

Neptune on the 15th is in R.A. 16 h 30 m, Decl. 20° 16′ S., and transits at 18 h 55m.

1975				AUGUST E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 2 h E.S.T.	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Fri.	1	04		Mercury in superior conjunction		43201	193.16
		08		Mars 2° S. of Moon			
Sat.	2	16		Pallas stationary		4032*	205.39
Sun.	3			Mercury greatest hel. lat. N.	6 40	41023	217.62[l]
		16		Venus stationary			
Mon.	4					42013	229.86
Tues.	5					41023	242.10
Wed.	6	01		Saturn 4° N. of Moon	3 30	30412	254.35
		06		Vesta stationary			
Thur.	7	06	57	● New Moon		31204	266.60
Fri.	8	15		Moon at perigee (359,940 km)		32014	278.85[b]
Sat.	9	02		Venus 0.7° S. of Moon. Occ'n.[1]	0 20	10324	291.10
Sun.	10			Saturn at ascending node		0234d	303.34
Mon.	11	13		Mercury 1.2° N. of Regulus	21 10	20134	315.58
		23		Spica 0.7° N. of Moon. Occ'n.			
Tues.	12			Jupiter at perihelion		1034*	327.82
		10		Uranus 3° N. of Moon			
		18		Perseid Meteors			
Wed.	13			Venus at aphelion		30124	340.04
		21	24	☽ First Quarter			
Thur.	14				18 00	31204	352.27
Fri.	15	03		Jupiter stationary		32401	4.48[l]
		07		Neptune 0.5° N. of Moon. Occ'n.			
		17		Mercury 9° N. of Venus			
Sat.	16					41302	16.69
Sun.	17				14 50	40123	28.89
Mon.	18					4203*	41.08
Tues.	19					4103*	53.28
Wed.	20				11 40	43012	65.46
Thur.	21	14	48	○ Full Moon		43120	77.65
		16		Neptune stationary			
Fri.	22					32401	89.84[b]
Sat.	23	23		Moon at apogee (406,180 km)	8 20	1042*	102.02
Sun.	24					01234	114.21
Mon.	25					2034*	126.39
Tues.	26			Mercury at descending node	5 10	21034	138.58
		12		Jupiter 4° S. of Moon			
Wed.	27	08		Venus in inferior conjunction		30124	150.78
Thur.	28					3104d	162.98
Fri.	29	18	20	☾ Last Quarter	2 00	32014	175.18
Sat.	30	00		Mars 0.1° N. of Moon. Occ'n.[2]		13024	187.39
Sun.	31	19		Mars 4° N. of Aldebaran	22 50	40132	199.60[l]

[l]Aug. 3, −7.06°; Aug. 15, +6.85°; Aug 31, −7.60°.
[b]Aug. 8, +6.49°; Aug. 22, −6.55°.
[1]Visible in Asia, Japan, Philippines.
[2]Visible in N.E. of S. America, W. and Central Africa.

THE SKY FOR SEPTEMBER 1975

For further information, see "The Sky for January 1975".

The Sun—During September the sun's R.A. increases from 10 h 38 m to 12 h 26 m and its Decl. changes from 8° 35′ N. to 2° 51′ S. The equation of time changes from −0 m 05 s to +9 m 54 s.

Mercury on the 1st is in R.A. 12 h 05 m, Decl. 1° 24′ S., and on the 15th is in R.A. 13 h 03 m, Decl. 9° 39′ S. On the 13th it is in greatest eastern elongation, but this is a particularly unfavourable elongation, the planet being only about 7° above the horizon at sunset.

Venus on the 1st is in R.A. 10 h 00 m, Decl. 3° 10′ N., and on the 15th it is in R.A. 9 h 42 m, Decl. 6° 13′ N., mag. −4.0, and transits at 10 h 06 m. Now an easily observed morning star of great brilliance it rises an hour or so before sunrise.

Mars on the 15th is in R.A. 5 h 06 m, Decl. 22° 05′ N., mag. +0.1, and transits at 5 h 32 m. In Taurus, now following (and appreciably outshining) Aldebaran, it rises late in the evening.

Jupiter on the 15th is in R.A. 1 h 28 m, Decl. 7° 32′ N., mag. −2.4, and transits at 1 h 53 m. In Pisces, it rises soon after sunset.

Saturn on the 15th is in R.A. 8 h 08 m, Decl. 20° 15′ N., mag. +0.5, and transits at 8 h 33 m. In Cancer, it rises about four hours before the sun and is well up in the eastern sky by dawn.

Uranus on the 15th is in R.A. 13 h 54 m, Decl. 11° 08′ S., and transits at 14 h 17 m.

Neptune on the 15th is in R.A. 16 h 31 m, Decl. 20° 19′ S., and transits at 16 h 54 m.

MINIMA OF ALGOL

Algol, also known as β Persei and as "The Demon Star", was the first eclipsing binary star discovered (by Goodricke in 1783) and is still the most conspicuous member of this class. Every 68.8 hours, the larger, fainter member of the pair eclipses the smaller, brighter member, and the brightness of the system drops from $2^{m}.2$ to $3^{m}.5$. With the aid of the chart on page 94, the observer can measure the brightness of β by comparing it to α, δ and ν. Two to three hours before mid-eclipse, the brightness begins to decrease. After mid-eclipse, the brightness returns to normal.

The times of mid-eclipse are given in "Astronomical Phenomena Month by Month" and are calculated from the ephemeris

$$\text{heliocentric minimum} = 2440953.4677 + 2.8673285\,E$$

as given in *Sky and Telescope* 1974, and are rounded off to the nearest ten minutes.

1975				SEPTEMBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 1 h E.S.T.	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Mon.	1					42103	211.82
Tues.	2	17		Saturn 5° N. of Moon		4203d	224.05
Wed.	3				19 40	4012d	236.28
Thur.	4			Venus greatest hel. lat. S.		43102	248.52
Fri.	5			Mercury at aphelion		43201	260.75[b]
		14	19	● New Moon			
		23		Moon at perigee (357,290 km)			
Sat.	6				16 30	43102	272.99
Sun.	7	11		Mercury 2° N. of Moon		40132	285.23
Mon.	8	07		Spica 0.5° N. of Moon. Occ'n.		21403	297.47
		19		Uranus 3° N. of Moon			
Tues.	9				13 20	20143	309.70
Wed.	10					0324*	321.92
Thur.	11	13		Neptune 0.2° N. of Moon. Occ'n.		31024	334.14
Fri.	12	06	59	☽ First Quarter	10 00	32014	346.35[l]
Sat.	13	15	34	Appulse of Juno and SAO 117225		3104*	358.56
		17		Mercury greatest elong. E. (27°)			
Sun.	14					03124	10.76
Mon.	15				6 50	12034	22.95
Tues.	16	10		Venus stationary		20143	35.13
Wed.	17					41032	47.31
Thur.	18	05		Vesta at opposition	3 40	43102	59.49[b]
Fri.	19					43201	71.67
Sat.	20	02		Moon at apogee (406,420 km)		4310*	83.84
		06	50	○ Full Moon. Harvest Moon			
		19		Pallas at opposition			
Sun.	21				0 30	40312	96.01
Mon.	22	14		Jupiter 4° S. of Moon		41203	108.18
Tues.	23	10	55	Equinox. Autumn begins	21 20	42013	120.35
Wed.	24	14		Mercury 1.8° S. of Spica		41023	132.53
Thur.	25					3042d	144.70
Fri.	26			Mercury greatest hel. lat. S.	18 10	32014	156.88
		17		Mercury stationary			
Sat.	27	09		Mars 2° N. of Moon		31204	169.07
Sun.	28	06	46	☾ Last Quarter		0124*	181.26[l]
		20		Mercury 1.8° S. of Spica			
Mon.	29				15 00	1034d	193.46
Tues.	30	07		Saturn 5° N. of Moon		20134	205.66

[l]Sept. 12, +7.64°; Sept. 28, −7.44°.
[b]Sept. 5, +6.50°; Sept. 18, −6.63°.

For further information, see "The Sky for January 1975".

The Sun—During October the sun's R.A. increases from 12 h 26 m to 14 h 22 m and its Decl. changes from 2° 51′ S. to 14° 09′ S. The equation of time changes from +10 m 13 s to +16 m 21 s.

Mercury on the 1st is in R.A. 13 h 21 m, Decl. 12° 30′ S., and on the 15th is in R.A. 12 h 37 m, Decl. 4° 05′ S. Inferior conjunction is on the 9th, but by the 24th it is in greatest western elongation, standing then about 17° above the horizon just south of east at sunrise, so for the last half of the month it is an easily observed morning star.

Venus on the 1st is in R.A. 9 h 56 m, Decl. 7° 56′ N., and on the 15th it is in R.A. 10 h 31 m, Decl. 7° 04′ N., mag. −4.2, and transits at 8 h 59 m. For about three hours before sunrise it dominates the eastern sky; greatest brilliancy is on the 3rd.

Mars on the 15th is in R.A. 5 h 57 m, Decl. 23° 30′ N., mag. −0.4, and transits at 4 h 25 m. Moving from Taurus into Gemini, it rises late in the evening and dominates the parts of the sky between Aldebaran and the Twins.

Jupiter on the 15th is in R.A. 1 h 14 m, Decl. 6° 08′ N., mag. −2.5, and transits at 23 h 37 m. This is the month of Jupiter's opposition (on the 13th) when it is at its brightest and rises as the sun sets and is visible all night. See map below.

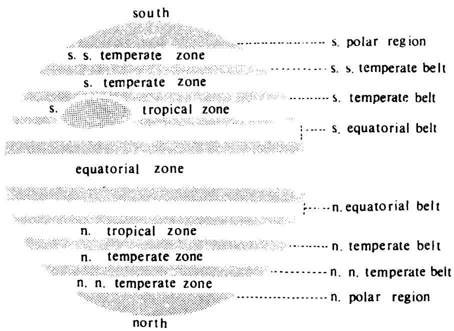
Saturn on the 15th is in R.A. 8 h 18 m, Decl. 19° 48′ N., mag. +0.5, and transits at 6 h 44 m. In Cancer, it rises at about midnight.

Uranus on the 15th is in R.A. 14 h 00 m, Decl. 11° 45′ S., and transits at 12 h 26 m.

Neptune on the 15th is in R.A. 16 h 34 m, Decl. 20° 26′ S., and transits at 14 h 59 m.

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.



1975				OCTOBER E.S.T.	Min. of Algol		Config. of Jupiter's Sat. 0 h E.S.T.	Sun's Selen. Colong. 0h U.T.
	d	h	m		h	m		°
Wed	1						1O234	217.87
Thur.	2	04		Venus 1° N. of Moon. Occ'n.	11	40	3O124	230.08[b]
		18		Pluto in conjunction with Sun				
Fri.	3	12		Venus greatest brilliancy			32O4*	242.30
Sat.	4	10		Moon at perigee (357,470 km)			3421O	254.52
		22	23	● New Moon				
Sun.	5	19		Venus 4° S. of Regulus	8	30	43O12	266.75
Mon.	6	08		Uranus 2° N. of Moon			41O23	278.97
Tues.	7						42O13	291.19
Wed.	8	22		Neptune 0.04° S of Moon. Occ'n.	5	20	41O23	303.41
Thur.	9	06		Mercury in inferior conjunction			43O12	315.62
Fri.	10						3421O	327.83[l]
Sat.	11	20	15	☽ First Quarter	2	10	324Od	340.03[l]
Sun.	12	21		Ceres stationary			3O142	352.22
Mon.	13			Mars at ascending node	23	00	1O234	4.41
		10		Jupiter at opposition				
Tues.	14						2O134	16.59
Wed.	15			Mercury at ascending node			1O34*	28.76[b]
Thur.	16				19	50	3O124	40.93
Fri.	17	06		Moon at apogee (406,020 km)			321O4	53.09
		15		Mercury stationary				
Sat.	18						32O14	65.25
Sun.	19			Mercury at perihelion	16	40	3O142	77.41
		13		Jupiter 5° S. of Moon				
Mon.	20	00	06	○ Full Moon. Hunters' Moon			14O23	89.57
Tues.	21	20		Orionid Meteors			42O13	101.72
Wed.	22				13	30	41O3*	113.88
Thur.	23						4O12d	126.03
Fri.	24	20		Mercury greatest elong. W. (18°)			4312O	138.19
Sat.	25	07		Mars 4° N. of Moon	10	10	432O1	150.35
Sun.	26	16		Uranus in conjunction with Sun			43O2*	162.52[l]
Mon.	27	17		Saturn 5° N. of Moon			41O32	174.69
		17	07	☾ Last Quarter				
Tues.	28				7	00	24O13	186.87
Wed.	29						12O43	199.05[b]
Thur.	30			Mercury greatest hel. lat. N.			O3124	211.24
				Venus at ascending node				
Fri.	31	03		Venus 5° N. of Moon	3	50	312O4	223.44
		22		Mercury 4° S. of Spica				

[l]Oct. 10, 11, +7.60°; Oct. 26, −6.55°.
[b]Oct. 2, +6.65°; Oct. 15, −6.77°; Oct. 29, +6.76°.
[1]Visible in S.E. of S. America.

THE SKY FOR NOVEMBER 1975

For further information, see "The Sky for January 1975".

The Sun—During November the sun's R.A. increases from 14 h 22 m to 16 h 26 m and its Decl. changes from 14° 09′ S. to 21° 40′ S. The equation of time changes from +16 m 22 s to a maximum of +16 m 24 s on the 3rd and then to +11 m 26 s at the end of the month. There is a partial eclipse of the sun on the 3rd, not visible in North America.

The Moon—There is a total eclipse of the moon visible in the eastern part of North America on the night of the 18th.

Mercury on the 1st is in R.A. 13 h 23 m, Decl. 6° 32′ S., and on the 15th is in R.A. 14 h 47 m, Decl. 15° 12′ S. It may be glimpsed as a morning star during the first few days of the month (see October) but by the 28th it is in superior conjunction.

Venus on the 1st is in R.A. 11 h 29 m, Decl. 3° 28′ N., and on the 15th it is in R.A. 12 h 23 m, Decl. 1° 00′ S., mag. −4.0, and transits at 8 h 49 m. Rising about four hours before the sun, it dominates the south-eastern sky during the early hours of the morning. Greatest western elongation is on the 7th.

Mars on the 15th is in R.A. 6 h 09 m, Decl. 24° 49′ N., mag. −1.1, and transits at 2 h 34 m. In Gemini and becoming very bright as it approaches opposition, it rises about three hours after sunset. On the 6th it is stationary in right ascension and begins to retrograde among the stars.

Jupiter on the 15th is in R.A. 1 h 01 m, Decl. 4° 49′ N., mag. −2.4, and transits at 21 h 22 m. In Pisces, it is well up in the east at sunset.

Saturn on the 15th is in R.A. 8 h 21 m, Decl. 19° 39′ N., mag. +0.3, and transits at 4 h 46 m. In Cancer, it rises before midnight. On the 14th it is stationary in right ascension and begins to retrograde, or move westward among the stars.

Uranus on the 15th is in R.A. 14 h 08 m, Decl. 12° 24′ S., and transits at 10 h 28 m.

Neptune on the 15th is in R.A. 16 h 38 m, Decl. 20° 35′ S., and transits at 13 h 01 m.

CERES APPROACHES OPPOSITION

During November, the asteroid Ceres moves westward through Taurus, reaching opposition on December 1. This is a particularly interesting opposition, as the asteroid—a sixth-magnitude object—moves through the Hyades star cluster. The rapid motion of the asteroid, and the map on page 71, should aid in its identification. During December, the asteroid continues westward, moving between the Hyades and the Pleiades.

1975				NOVEMBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 23 h E.S.T.	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Sat.	1	20		Moon at perigee (360,620 km)		31O24	235.64
Sun.	2	05		Spica 0.4° N. of Moon. Occ'n.[1]		O324d	247.84
		08		Mercury 5° N. of Moon			
Mon.	3	08	05	New Moon. Eclipse of ☉.	0 40	2O143	260.05
Tues.	4			Taurid Meteors		21O43	272.26
Wed.	5	10		Neptune 0.2° S. of Moon. Occ'n.	21 30	4O132	284.46
		20		Vesta stationary			
Thur.	6	09		Mars stationary		431O2	296.67
Fri.	7	01		Venus greatest elong. W. (47°)		432O1	308.87
Sat.	8	04		Mercury 1.1° N. of Uranus	18 20	431O2	321.06[l]
Sun.	9					4O12*	333.25
Mon.	10	13	21	☽ First Quarter		42O3*	345.43
Tues.	11				15 10	421O3	357.61[b]
Wed.	12	07		Pallas stationary		4O132	9.78
Thur.	13	19		Moon at apogee (405, 190 km)		31O24	21.94
Fri.	14	20		Saturn stationary	12 00	32O14	34.10
Sat.	15	14		Jupiter 5° S. of Moon		31O4*	46.25
Sun.	16					O124*	58.39
Mon.	17				8 50	2O34*	70.54
Tues.	18	17	28	Full Moon. Eclipse of ☾		21O34	82.68
Wed.	19					O1324	94.82
Thur.	20				5 30	31O24	106.96
Fri.	21	12		Mars 5° N. of Moon		324O1	119.09
Sat.	22			Mercury at descending node		341O*	131.24[l]
Sun.	23	23		Saturn 5° N. of Moon	2 20	43O12	143.38
Mon.	24					412O3	155.53
Tues.	25				23 10	42O3d	167.68[b]
Wed.	26	01	52	☾ Last Quarter		4O123	179.84
Thur.	27					413O2	192.01
Fri.	28	16		Mercury in superior conjunction	20 00	342O1	204.18
Sat.	29	14		Spica 0.4° N. of Moon. Occ'n.		3124O	216.36
		14		Venus 5° N. of Moon			
		15		Venus 5° N. of Spica			
		20		Moon at perigee (365,920 km)			
Sun.	30	10		Uranus 2° N. of Moon		3O142	228.55
		10	20	Occ'n. of Radio Source 4C-0634 by Venus			

[l]Nov. 8, +6.91°; Nov. 22, −5.34°.
[b]Nov. 11, −6.86°; Nov. 25, +6.75°.
[1]Visible in N.E. of S. America, S. Africa.

THE SKY FOR DECEMBER 1975

For further information, see "The Sky for January 1975".

The Sun—During December the sun's R.A. increases from 16 h 26 m to 18 h 42 m and its Decl. changes from 21° 40′ S. to 23° 05′ S. The equation of time changes from +11 m 04 s to −2 m 53 s, being zero on the 25th.

Mercury on the 1st is in R.A. 16 h 30 m, Decl. 22° 45′ S., and on the 15th is in R.A. 18 h 06 m, Decl. 25° 27′ S. It is too close to the sun for easy observation.

Venus on the 1st is in R.A. 13 h 29 m, Decl. 6° 59′ S., and on the 15th it is in R.A. 14 h 31 m, Decl. 12° 17′ S., mag. −3.7, and transits at 8 h 59 m. Though not so high as last month, it is still prominent in the south-eastern sky for about four hours before sunrise.

Mars on the 15th is in R.A. 5 h 30 m, Decl. 26° 02′ N., mag. −1.6, and transits at 23 h 51 m. This is the month of Mars′ opposition (on the 15th), its greatest brilliance and its closest approach to earth (on the 8th at 84,600,000 km or 52,566,000 miles). In Taurus, it rises as the sun sets and is visible all night. See map below.

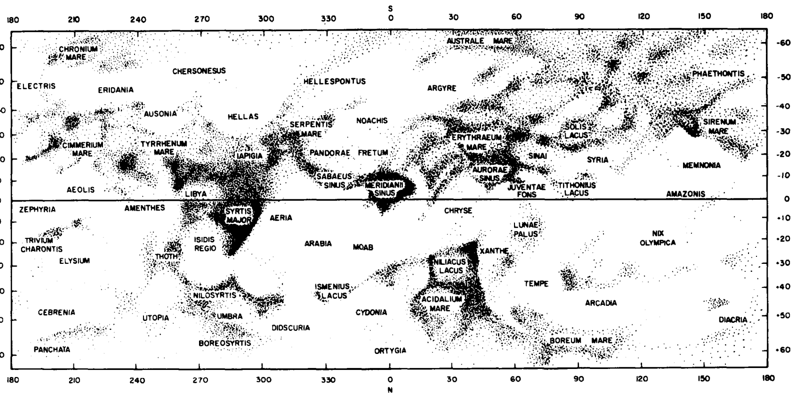
Jupiter on the 15th is in R.A. 0 h 57 m, Decl. 4° 33′ N., mag. −2.2, and transits at 19 h 21 m. In Pisces, it is high in the east at sunset and sets about an hour after midnight. On the 10th it is stationary in right ascension and resumes direct, or eastward, motion among the stars.

Saturn on the 15th is in R.A. 8 h 18 m, Decl. 19° 54′ N., mag. +0.1, and transits at 2 h 44 m. In Cancer, it rises about four hours after sunset.

Uranus on the 15th is in R.A. 14 h 14 m, Decl. 12° 57′ S., and transits at 8 h 40 m.

Neptune on the 15th is in R.A. 16 h 42 m, Decl. 20° 45′ S., and transits at 11 h 08 m.

MAP OF MARS



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

1975	d	h	m	DECEMBER E.S.T.	Min. of Algol h m	Config. of Jupiter's Sat. 22 h E.S.T.	Sun's Selen. Colong. 0h U.T. °
Mon.	1	01		Ceres at opposition	16 50	1O34d	240.74
Tues.	2			Mercury at aphelion		2O134	252.93
		19	50	New Moon			
Wed.	3			Venus at perihelion		O234*	265.13
Thur.	4	02		Neptune in conjunction with Sun	13 40	1O24d	277.32
Fri.	5					32O14	289.51
Sat.	6					312O4	301.70[l]
Sun.	7				10 30	3O142	313.89
Mon.	8	19		Mars nearest to Earth		14O23	326.07[b]
Tues.	9					42O13	338.25
Wed.	10	09	39	First Quarter	7 20	41O23	350.41
		22		Jupiter stationary			
Thur.	11	00		Venus 2° N. of Uranus		4O32d	2.58
		14		Moon at apogee (404,450 km)			
Fri.	12	20		Jupiter 5° S. of Moon		432O1	14.73
		22	22	Appulse of Venus and 2 Lib			
Sat.	13				4 10	4321O	26.88
Sun.	14	10		Geminid Meteors		43O12	39.03
Mon.	15	09		Mars at opposition		41O23	51.17
Tues.	16				1 00	2O413	63.30
Wed.	17					1O43*	75.44
Thur.	18	02		Mars 5° N. of Moon	21 50	O324d	87.56
		09	40	Full Moon			
Fri.	19					32O4*	99.69[l]
Sat.	20					321O4	111.82
Sun.	21	03		Saturn 5° N. of Moon	18 30	3O124	123.95
Mon.	22	06	46	Solstice. Winter begins		1O324	136.08
Tues.	23			Mercury greatest hel. lat. S.		2O134	148.22[b]
		02		Ursid Meteors			
		11	08	Appulse of Pallas and SAO 165913			
Wed.	24				15 20	1O43*	160.36
Thur.	25			Venus greatest hel. lat. N.		4O132	172.51
		09	52	Last Quarter			
		23		Moon at perigee (370,290 km)			
Fri.	26	21		Spica 0.3° N. of Moon. Occ'n.		432O*	184.67
Sat.	27	19		Uranus 2° N. of Moon	12 10	4321O	196.83
Sun.	28					43O12	209.00
Mon.	29	05		Venus 2° N. of Moon		41O2*	221.18
Tues.	30	08		Neptune 0.4° S. of Moon	9 00	42O13	233.36
Wed.	31					412O3	245.54

[l]Dec. 6, +5.77°; Dec. 19, −5.02°.
[b]Dec. 8, −6.78°; Dec. 23, +6.65°.

SUN—EPHEMERIS FOR PHYSICAL OBSERVATIONS, 1975

For 0 h U.T.

Date	P	B_0	L_0	Date	P	B_0	L_0
	°	°	°		°	°	°
Jan. 1	+ 2.32	−3.00	286.18	July 5	− 1.16	+3.28	4.49
6	− 0.10	−3.58	220.33	10	+ 1.11	+3.80	298.32
11	− 2.52	−4.12	154.49	15	+ 3.35	+4.30	232.15
16	− 4.89	−4.63	88.65	20	+ 5.56	+4.77	165.99
21	− 7.20	−5.11	22.82	25	+ 7.70	+5.21	99.84
26	− 9.42	−5.55	316.98	30	+ 9.78	+5.61	33.70
31	−11.55	−5.94	251.15	Aug. 4	+11.77	+5.98	327.57
Feb. 5	−13.57	−6.28	185.32	9	+13.67	+6.30	261.46
10	−15.47	−6.58	119.48	14	+15.47	+6.58	195.35
15	−17.24	−6.82	53.65	19	+17.15	+6.81	129.26
20	−18.87	−7.01	347.81	24	+18.71	+7.00	63.19
25	−20.35	−7.15	281.96	29	+20.15	+7.13	357.12
Mar. 2	−21.68	−7.23	216.09	Sept. 3	+21.45	+7.22	291.08
7	−22.85	−7.25	150.22	8	+22.61	+7.25	225.04
12	−23.85	−7.22	84.34	13	+23.63	+7.23	159.02
17	−24.69	−7.13	18.45	18	+24.49	+7.16	93.01
22	−25.37	−6.99	312.53	23	+25.19	+7.04	27.00
27	−25.86	−6.80	246.60	28	+25.73	+6.86	321.01
Apr. 1	−26.18	−6.56	180.64	Oct. 3	+26.11	+6.63	255.04
6	−26.33	−6.26	114.67	8	+26.30	+6.36	189.07
11	−26.29	−5.93	48.68	13	+26.32	+6.03	123.11
16	−26.06	−5.55	342.67	18	+26.14	+5.66	57.15
21	−25.66	−5.13	276.64	23	+25.78	+5.25	351.20
26	−25.06	−4.68	210.59	28	+25.23	+4.80	285.26
May 1	−24.29	−4.19	144.52	Nov. 2	+24.48	+4.30	219.33
6	−23.34	−3.68	78.43	7	+23.53	+3.78	153.40
11	−22.20	−3.14	12.32	12	+22.38	+3.22	87.48
16	−20.90	−2.58	306.20	17	+21.05	+2.64	21.57
21	−19.44	−2.00	240.07	22	+19.53	+2.04	315.66
26	−17.82	−1.41	173.91	27	+17.83	+1.42	249.75
31	−16.06	−0.82	107.75	Dec. 2	+15.97	+0.79	183.86
June 5	−14.17	−0.21	41.58	7	+13.96	+0.15	117.97
10	−12.17	+0.39	335.41	12	+11.82	−0.49	52.09
15	−10.08	+0.99	269.23	17	+ 9.58	−1.13	346.21
20	− 7.91	+1.58	203.04	22	+ 7.25	−1.76	280.34
25	− 5.69	+2.17	136.86	27	+ 4.86	−2.37	214.48
30	− 3.43	+2.73	70.67				

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

Carrington's Rotation Numbers—Greenwich Date of Commencement of Synodic Rotations, 1975

No.	Commences	No.	Commences	No.	Commences
1624	Jan. 22.73	1629	June 8.14	1634	Oct. 22.33
1625	Feb. 19.07	1630	July 5.34	1635	Nov. 18.64
1626	Mar. 18.40	1631	Aug. 1.55	1636	Dec. 15.95
1627	Apr. 14.69	1632	Aug. 28.78		
1628	May 11.93	1633	Sept. 25.05		

ECLIPSES DURING 1975

In 1975 there will be four eclipses, two of the sun and two of the moon.

1. *A partial eclipse of the sun* on May 11, visible in Northern Africa, Europe, Northern Asia and the extreme Northeastern corner of North America. Magnitude of greatest eclipse 0.864.

2. *A total eclipse of the moon* on the night of May 24–25, visible in North America.

Moon enters penumbra................	May 24	21.59 E.S.T.
Moon enters umbra........................	24	23.00 E.S.T.
Total eclipse begins.......................	25	0.03 E.S.T.
Middle of eclipse...........................		0.48 E.S.T.
Total eclipse ends...........................		1.33 E.S.T.
Moon leaves umbra..........................		2.36 E.S.T.
Moon leaves penumbra......................		3.38 E.S.T.

Magnitude of the eclipse 1.431

3. *A partial eclipse of the sun* on November 3, visible in the southern part of South America and Antarctica, but not in North America. Magnitude of greatest eclipse 0.959.

4. *A total eclipse of the moon* on the night of November 18, visible in part in the eastern part of North America.

Moon enters penumbra................	Nov. 18	14.26 E.S.T.
Moon enters umbra..........................		15.39 E.S.T.
Total eclipse begins.........................		17.03 E.S.T.
Middle of eclipse............................		17.23 E.S.T.
Total eclipse ends............................		17.44 E.S.T.
Moon leaves umbra..........................		19.08 E.S.T.
Moon leaves penumbra......................		20.21 E.S.T.

Magnitude of the eclipse 1.068

PLANETARY APPULSES AND OCCULTATIONS

A planetary *appulse*—or close approach of a star and a planet, satellite or asteroid—is an interesting but relatively unproductive astronomical event. However, a planetary *occultation*—or eclipse of a star by a planet, satellite or asteroid—can provide valuable information about the position, size, shape and atmosphere of the occulting body. In past years, the prediction of such events was very difficult, because of uncertainties in the positions of the stars and the motions of the solar system bodies. Often, the accurate prediction could be given only a week or two in advance. Nevertheless, observations *were* made, which yielded valuable results. These are described in *Sky and Telescope* **48**, 91 (August 1974); this article also describes the contributions which amateur and professional observers can make to this field.

Within the last year or two, it has become possible to make accurate predictions of these events many months in advance. Much of this progress is due to the work of Gordon E. Taylor, of H.M. Nautical Almanac Office, a contributor to this *Handbook* for many years. He lists the following appulses for 1975.

Planet	Date	UT of conjunction	Star Name or SAO No.	Vis. Mag.	Geocentric Separation	Horizontal Parallax
		h m			″	″
Venus	Apr. 24	07 37	95 Tauri	6.2	− 0.8	7.8
	Dec. 13	03 22	2 Librae	6.3	− 3.1	9.2
Mars	Apr. 20	09 58	165189	8.7	+ 0.9	5.0
	Aug. 28	22 23	76625	8.3	− 1.2	8.3
	Dec. 23	05 29	77081	8.9	+14.3	15.0
Jupiter	Feb. 14	21 48	146789	7.5	−16.0	1.5
	June 25	12 57	109812	8.8	+11.6	1.7
Saturn	Jan. 11	04 42	79057	9.0	+ 2.1	1.1
Ceres	July 19	14 58	93633	8.6	− 1.8	2.7
Pallas	Dec. 23	16 08	165913	8.0	+ 6.2	3.1
Juno	Sept. 13	20 34	117225	8.4	− 3.6	3.0
Eros	Jan. 24	?	κ Geminorum	3.7	?	58.2

The appulse of Eros to κ Geminorum could give rise to an actual occultation but an accurate ephemeris of Eros, required for the calculation of the predictions, is not yet available.

In addition to the possible occultation by Eros, on Jan. 11, Saturn and its rings will occult the $9^{m}0$ star SAO 79057. This occultation will be visible from south-western North America, beginning at approximately 3 h U.T. On Nov. 30, Venus will occult the radio source 4C-06.34, beginning at approximately 15 h 20 m U.T. Other occultations, not visible in North America, occur as follows: of 2 Lib by Venus on 13 Dec. (S. E. Europe and N. Africa); of SAO 76625 by Mars on 28 Aug. (S. Asia); of SAO 77081 by Mars on 23 Dec. (W. Europe); of SAO 146789 by Jupiter on 14 Feb. (S. America); of SAO 109812 by Jupiter on 25 June (Pacific). In each case, the star is nearly ten magnitudes fainter than the planet.

THE OBSERVATION OF THE MOON

During 1975 the ascending node of the moon's orbit moves from Ophiuchus into Libra (☊ from 249 to 229). See p. 61 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 $+1\frac{1}{2}°$ and $-1\frac{1}{2}°$ during the year.

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

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

Two areas suspected of showing changes are Alphonsus and Aristarchus.

OCCULTATIONS BY THE MOON

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

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

As in the case of eclipses, the times of immersion and emersion and the duration of the occultation are different for different places on the earth's surface. The tables given below, are adapted from data supplied by the British Nautical Almanac Office and give the times of immersion or emersion or both for occultations visible from six stations distributed across Canada. Stars of magnitude 7.5 or brighter are included as well as daytime occultations of very bright stars and planets. Since an occultation at the bright limb of the moon is difficult to observe the predictions are limited to phenomena occurring at the dark limb.

The terms *a* and *b* are for determining corrections to the times of the phenomena for stations within 300 miles of the standard stations. Thus if λ_0, ϕ_0, be the longitude and latitude of the standard station and λ, ϕ, the longitude and latitude of the neighbouring station then for the neighbouring station we have: Standard Time of phenomenon = Standard Time of phenomenon at the standard station $+a(\lambda - \lambda_0) + b(\phi - \phi_0)$ where $\lambda - \lambda_0$ and $\phi - \phi_0$ are expressed in degrees. This formula must be evaluated with due regard for the algebraic signs of the terms. The quantity *P* is the position angle of the point of contact on the moon's disk reckoned from the north point towards the east.

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

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

The co-ordinates of the standard stations are given in the tables.

LUNAR OCCULTATIONS VISIBLE AT HALIFAX AND MONTREAL, 1975

Date	Z.C. No.	Mag.	I or E	Elong. of Moon	HALIFAX W. 63°6, N. 44°6 A.S.T.	a	b	P	MONTREAL W. 73°6, N. 45°5 E.S.T.	a	b	P
				°	h m	m	m	°	h m	m	m	°
Jan. 0	1397	5.5	E	221	22 05.7	−0.3	+3.5	231	21 06.9	0.0	+2.6	240
3	1670	5.1	E	251	5 22.6	−1.4	−1.1	303	4 06.7	−1.6	−0.4	291
16	3371	6.4	I	49	18 30.5	−0.9	+0.3	46	17 22.1	−0.9	+1.1	32
17	3501	5.3	I	61	21 01.3	−0.4	−0.3	56	19 55.5	−0.7	0.0	50
20	313	7.5	I	95	21 37.1	−1.2	+1.5	30	20 26.0	−1.3	+2.3	24
21	432	5.9	I	105	18 10.3	−1.7	+1.0	75	Sun			
22	457	6.5	I	108	1 19.8	+0.1	−1.4	96	0 18.0	−0.1	−1.7	102
23/4	752	4.7	I	133	1 01.0	−0.7	−1.4	95	23 51.2	−1.0	−1.5	101
24	766	6.0	I	134	3 20.2	−0.9	+1.0	29	2 12.4	−0.8	0.0	44
29	1495	5.9	E	205	4 52.9	−1.5	−0.7	253	3 33.7	−2.5	+0.5	237
30	1605	6.2	E	217	1 19.2	−1.4	−0.1	294	0 05.8	−1.3	+0.5	285
Feb. 14	29	7.2	I	41	18 49.1	−1.2	−4.4	127	Sun			
18/9	531	5.5	I	89	0 09.3	+0.5	−2.5	134	23 11.4	+0.5	−3.4	144
20/1	847	3.0	I	113	0 22.6	−0.4	−1.5	100	23 15.8	−0.6	−1.7	108
21	847	3.0	E	113	1 22.0	−0.1	−1.5	279	0 18.4	−0.4	−1.4	271
21	991	6.1	I	124	18 59.3	−1.6	+1.7	68	Sun			
21	995	4.1	I	125	19 37.3	−1.7	−1.0	123	18 20.3	−1.6	−0.3	119
22	1025	7.4	I	127	1 25.2	−0.3	−1.7	109	0 19.6	−0.5	−1.9	117
23	1271	5.9	I	152	18 38.7	−0.8	+0.8	103	Sun			
Mar. 6	2635	5.7	E	289	5 09.6	−1.3	+0.5	297	Low			
17	480	7.3	I	57	19 44.5	−1.2	+0.2	49	18 31.9	−1.4	+0.4	52
18	628	4.8	I	69	21 18.6	−0.5	−1.5	94	20 10.6	−0.8	−1.6	100
18	646	6.1	I	70	No occ.				22 52.7	−0.9	+1.3	25
23	1359	5.1	I	134	22 10.6	−1.1	−1.8	138	20 58.1	−1.0	−2.0	149
24	1482	6.3	I	149	22 57.7	−1.8	−0.4	91	21 39.7	−1.7	−0.3	103
25	1495	5.9	I	151	2 29.0	−0.4	−1.9	129	1 22.1	−0.6	−2.0	136
29	2018	6.4	E	208	Sun				4 02.8	−1.4	−0.9	260
Apr. 3	2734	5.4	E	270	4 45.9	–	–	322	3 30.5	–	–	321
14	595	6.8	I	39	19 48.4	−0.7	−0.4	56	Sun			
16	894	4.6	I	63	20 23.0	+0.4	−4.2	163	No occ.			
18	1190	7.1	I	90	No occ.				21 45.4	–	–	34
19	1318	5.7	I	103	21 02.9	−1.0	−2.0	135	19 51.3	−1.0	−2.2	146
May 1	2814	5.0	I	249	1 15.3	–	–	4	Low			
1	2825	6.4	E	250	Sun				2 53.5	−1.6	+2.2	210
4	3185	5.3	E	283	3 20.0	−0.8	+3.0	199	Low			
16	1281	6.4	I	72	21 26.4	–	–	36	20 07.4	−1.7	−0.1	58
19	1639	7.0	I	113	No occ.				22 03.8	–	–	42
22	2018	6.4	I	154	23 25.3	−1.3	−1.7	148	22 12.1	−1.0	−1.6	157
23	2029	5.1	I	155	Low				1 14.4	−1.0	0.0	46
June 14	1495	5.9	I	70	Low				21 38.2	−0.3	−1.4	91
June 17	1845	6.5	I	109	21 49.6	−1.6	−0.8	77	20 31.9	−1.8	−0.6	84
29	3326	6.4	E	243	1 54.7	−1.7	+1.1	275	0 40.7	−1.3	+1.1	285
30	3444	6.5	E	253	0 26.5	−0.3	+2.5	213	Low			
30	3455	6.4	E	254	Sun				Graze			
July 5	497	6.4	E	311	2 57.0	−0.1	+1.1	280	Low			
7	4001	0.4	I	338	8 09.7	−1.5	+0.8	100	6 57.9	−1.0	+1.4	90
7	4001	0.4	E	338	9 34.1	−1.9	+1.1	260	8 17.8	−1.6	+1.2	266
15	1940	6.9	I	92	20 46.0	−1.4	−1.0	83	Sun			
17	2207	7.0	I	118	23 00.7	−1.0	−0.3	54	21 49.1	−1.4	+0.1	47
18	2348	7.1	I	130	21 09.2	−1.8	−0.8	121	Sun			
25	3185	5.3	E	202	No occ.				3 17.2	–	–	171
27	3512	5.8	E	233	23 16.7	−0.4	+2.2	230	22 15.2	−0.2	+2.0	236
Aug. 1	455	6.1	E	279	2 52.8	−1.1	+1.0	285	1 43.2	−1.0	+0.6	301
12	2029	5.1	I	74	20 17.4	−1.2	−2.4	151	Sun			
23	3494	4.6	E	204	No occ.				23 42.1	−0.4	+3.2	189
31	837	6.1	E	284	3 17.2	−0.9	+0.9	283	2 09.6	−0.7	+0.7	295
Sept. 2	1141	5.6	E	310	4 18.3	−0.6	+0.8	287	3 14.4	−0.4	+0.6	297
12	2547	4.9	I	94	20 32.6	−2.0	−1.8	123	19 11.5	−2.0	−1.0	113
13	2710	6.8	I	106	21 51.6	−0.6	+0.6	32	20 48.3	–	–	11
18	3320	5.3	I	161	18 44.1	−0.7	+2.0	60	Sun			

Date	Z.C. No.	Mag.	I or E	Elong. of Moon	HALIFAX W. 63°6, N. 44°6 A.S.T.	a	b	P	MONTREAL W. 73°6, N. 45°5 E.S.T.	a	b	P
				°	h m	m	m	°	h m	m	m	°
Sept. 27	793	6.2	E	254	4 57.5	–	–	211	3 44.0	−1.5	+3.3	219
28	940	5.7	E	266	3 19.4	−1.5	+0.2	293	2 06.0	−1.2	+0.1	303
Oct. 10	2642	7.1	I	74	18 12.0	–	–	17	No occ.			
13	3051	7.0	I	109	18 21.7	−2.2	+0.3	105	Sun			
15	3290	7.3	I	132	19 17.2	−1.7	+1.3	73	18 03.8	−1.3	+1.8	64
23	614	5.7	E	212	4 09.3	−1.6	−1.6	288	2 50.2	−1.9	−1.4	290
24	765	5.3	E	225	No occ.				5 15.8	–	–	341
24/5	888	6.0	E	234	0 30.9	−1.0	+1.3	270	23 22.8	−0.8	+1.1	280
25	895	5.9	E	235	1 54.7	−1.4	+2.2	241	0 44.0	−1.1	+1.9	250
28	1309	5.7	E	273	2 50.8	–	–	351	No occ.			
28	1318	5.7	E	274	5 35.3	−1.7	−0.2	288	4 19.3	−1.5	+0.3	284
Nov. 8	2889	7.1	I	67	19 35.7	−1.4	−1.2	92	18 20.5	−1.5	−0.5	77
10	3154	7.4	I	92	Low				22 22.0	−1.0	−2.6	112
11	3272	5.8	I	103	23 37.9	−0.2	+0.7	31	22 36.4	−0.2	+1.5	18
14	68	5.7	I	136	23 58.8	−1.3	−0.2	63	22 45.4	−1.4	+0.5	53
24	1281	6.4	E	244	No occ.				Graze			
25	1397	5.5	E	257	No occ.				4 40.1	–	–	356
29	1884	5.3	E	311	Sun				6 15.9	−0.4	−1.3	341
Dec. 5	2828	6.0	I	35	17 41.3	−1.0	−0.8	76	Sun			
7	3093	4.5	I	59	Low				19 34.1	−0.6	−0.3	55
9	3320	5.3	I	81	16 55.7	–	–	126	Sun			
9	3326	6.4	I	81	19 20.5	−1.6	0.0	66	18 05.7	−1.5	+0.8	51
10	3444	6.5	I	92	17 24.9	−1.9	+1.0	74	Sun			
10	3455	6.4	I	93	21 09.0	−0.3	+3.2	5	No occ.			
20/1	1234	6.1	E	212	1 11.1	−1.7	0.0	286	23 55.7	−1.4	+0.4	285
22	1359	5.1	E	225	2 02.5	−1.6	−0.3	294	0 47.7	−1.4	+0.2	290
23	1482	6.3	E	240	5 06.5	−1.3	−1.6	310	3 51.4	−1.5	−0.9	300
24	1605	6.2	E	254	Sun				6 08.0	−2.1	−0.1	254
29	2241	5.0	E	320	6 44.4	−0.7	−0.1	315	Low			

LUNAR OCCULTATIONS VISIBLE AT TORONTO AND WINNIPEG, 1975

Date	Z.C. No.	Mag.	I or E	Elong. of Moon	TORONTO W. 79°4, N. 43°7 E.S.T.	a	b	P	WINNIPEG W. 97°2, N. 49°9 C.S.T.	a	b	P
				°	h m	m	m	°	h m	m	m	°
Jan. 3	1670	5.1	E	251	3 57.1	−1.8	+0.2	279	2 34.2	−1.2	+1.0	274
15	3272	5.8	I	39	19 28.4	−0.1	+1.5	17	No occ.			
17	3501	5.3	I	61	19 51.1	−0.9	0.0	53	18 41.6	−0.6	+2.0	15
20	313	7.5	I	95	20 14.3	−1.4	+2.1	30	No occ.			
21/2	457	6.5	I	108	0 20.3	−0.2	−2.1	112	22 58.2	−0.9	−1.8	103
22	467	6.7	I	109	No occ.				1 39.6	0.0	−1.5	95
23	752	4.7	I	133	23 48.1	−1.1	−1.8	111	22 15.5	−1.5	−0.9	101
24	766	6.0	I	134	2 08.5	−0.7	−0.4	59	0 48.7	−1.2	−0.3	60
29	1605	6.2	E	217	23 57.0	−1.3	+1.0	273	22 47.4	−0.6	+1.1	281
Feb. 13	3482	5.6	I	31	No occ.				19 32.2	−0.3	−1.3	80
17	402	6.5	I	76	20 52.5	–	–	19	No occ.			
17	416	5.4	I	77	23 19.2	+0.8	−4.1	148	22 01.0	−0.1	−3.7	136
18	531	5.5	I	89	Graze				21 58.6	–	–	154
20	847	3.0	I	113	23 15.2	−0.7	−2.0	119	21 45.8	−1.2	−1.7	116
20/1	847	3.0	E	113	0 17.5	−0.7	−1.1	261	22 54.4	−1.2	−0.9	259
21	881	5.9	I	116	No occ.				2 40.1	+0.1	−1.3	90
21	995	4.1	I	125	18 11.9	−1.5	−0.4	124	No occ.			
21/2	1025	7.4	I	127	0 20.3	−0.5	−2.1	128	22 53.9	−0.9	−2.1	131
Mar. 3	2212	6.1	E	254	5 21.2	−1.8	−0.6	292	3 52.3	−1.3	+0.4	289
18	628	4.8	I	69	20 08.8	−0.9	−2.0	110	No occ.			
18	646	6.1	I	70	22 47.7	−0.6	+0.1	43	21 33.8	−1.0	+0.1	44
20/1	971	7.3	I	96	0 57.7	+0.2	−1.5	110	23 47.6	−0.2	−1.9	115
22	1116	7.4	I	110	No occ.				1 19.1	+0.1	−1.9	129
23	1359	5.1	I	134	20 57.0	−0.8	−2.9	164	19 27.4	−0.8	−1.8	158
24	1384	7.4	I	137	3 04.4	−0.7	+0.1	45	1 45.6	−1.2	−0.4	53

Date	Z.C. No.	Mag.	I or E	Elong. of Moon	TORONTO W. 79°4, N. 43°7				WINNIPEG W. 97°2, N. 49°9			
					E.S.T.	a	b	P	C.S.T.	a	b	P
				°	h m	m	m	°	h m	m	m	°
Mar. 24	1482	6.3	I	149	21 31.2	−1.5	−0.5	115	20 07.0	−1.1	+0.2	114
24/5	1495	5.9	I	151	1 22.3	−0.6	−2.1	145	23 57.5	−0.6	−2.1	155
29	2018	6.4	E	208	3 55.4	−1.6	−0.6	255	2 22.3	−1.8	+0.2	252
Apr. 3	2734	5.4	E	270	3 24.7	−1.0	0.0	313	No occ.			
5	2995	6.2	E	292	4 39.1	−1.2	+1.8	245	No occ.			
16	915	4.7	I	65	No occ.				22 07.7	−0.1	−1.7	107
18	1190	7.1	I	90	21 31.3	−1.8	0.0	59	No occ.			
18	1197	6.0	I	91	23 10.8	–	–	42	21 43.2	−1.6	−0.1	56
19	1212	7.1	I	92	No occ.				0 31.0	+0.2	−1.9	131
19	1318	5.7	I	103	19 50.7	−0.7	−3.0	161	No occ.			
19/0	1332	5.7	I	105	No occ.				Graze			
May 1	2825	6.4	E	250	2 39.6	−1.7	+2.7	206	No occ.			
14	1038	6.8	I	48	No occ.				21 29.4	0.0	−1.5	101
18	1543	6.6	I	101	No occ.				23 36.3	−0.7	−1.2	71
19	1639	7.0	I	113	21 48.3	−2.3	+0.1	63	No occ.			
22	2018	6.4	I	154	22 10.9	−0.5	−2.3	171	No occ.			
22/3	2029	5.1	I	155	1 07.5	−1.4	0.0	51	23 37.6	–	–	47
27	2614	6.2	E	207	No occ.				2 19.6	−1.9	−1.0	316
June 14	1495	5.9	I	70	21 38.4	−0.5	−1.5	97	No occ.			
29	3326	6.4	E	243	0 31.9	−1.0	+1.1	286	No occ.			
July 7	4001	0.4	I	338	6 49.9	−0.8	+1.4	91	5 54.6	0.0	+2.3	58
7	4001	0.4	E	338	8 06.8	−1.4	+1.4	264	6 53.4	−0.9	+0.7	296
17	2207	7.0	I	118	21 39.8	−1.7	+0.3	51	No occ.			
17	2214	6.2	I	119	No occ.				23 06.6	–	–	30
25	3185	5.3	E	202	3 14.0	–	–	179	2 09.7	−1.3	+1.0	225
Aug. 1	455	6.1	E	279	1 37.1	−0.8	+0.4	305	No occ.			
13	2171	6.8	I	88	21 29.1	–	–	27	No occ.			
13	2175	6.0	I	88	No occ.				20 31.3	−1.4	−1.8	141
16	2614	6.2	I	126	No occ.				23 06.3	−1.4	−1.1	93
23	3494	4.6	E	204	23 33.9	−0.5	+3.0	194	22 37.0	−0.7	+2.2	224
25	68	5.7	E	216	No occ.				2 53.8	−2.4	−1.1	290
26/7	299	6.3	E	237	No occ.				Graze			
31	837	6.1	E	284	2 04.7	−0.6	+0.6	296	No occ.			
Sept. 2	1141	5.6	E	310	3 11.6	−0.2	+0.6	296	No occ.			
12	2547	4.9	I	94	19 01.3	−2.1	−0.7	113	No occ.			
13	2710	6.8	I	106	20 43.2	–	–	6	No occ.			
27	793	6.2	E	254	3 29.6	−1.2	+3.9	214	2 26.1	−0.9	+1.9	251
28	940	5.7	E	266	1 59.0	−1.1	+0.2	302	No occ.			
30	1234	6.1	E	292	5 08.5	−1.3	+1.4	263	3 58.3	−0.7	+0.9	285
Oct. 1	1359	5.1	E	306	5 10.1	−1.0	+1.1	273	4 04.2	−0.4	+0.7	294
9	2509	6.0	I	63	19 17.0	−1.2	−1.0	87	No occ.			
10	2666	5.0	I	76	No occ.				20 03.3	−1.2	−1.0	84
11	2814	5.0	I	88	No occ.				19 17.7	–	–	138
11	2816	6.8	I	88	No occ.				19 30.3	−2.1	−1.4	119
14	3184	7.1	I	122	No occ.				19 36.2	−2.2	+0.1	111
14	3185	5.3	I	122	No occ.				19 49.1	–	–	132
17	3444	6.5	I	146	No occ.				2 08.6	−1.1	−3.8	123
23	614	5.7	E	212	2 40.6	−2.1	−0.9	284	0 52.7	–	–	326
24	765	5.3	E	225	5 19.7	−1.1	−3.7	323	No occ.			
24	888	6.0	E	234	23 16.8	−0.6	+1.1	281	22 12.1	−0.5	+0.2	316
24/5	895	5.9	E	235	0 34.8	−0.9	+2.0	249	23 32.0	−0.5	+1.2	280
25	913	5.2	E	237	5 54.0	−1.7	−0.7	268	4 19.9	−1.7	−0.3	278
28	1309	5.7	E	273	1 38.3	–	–	353	No occ.			
28	1318	5.7	E	274	4 09.7	−1.4	+0.8	276	2 55.5	−0.8	+0.7	294
Nov. 8	2889	7.1	I	67	18 12.1	−1.7	−0.2	74	No occ.			
10	3154	7.4	I	92	22 19.9	−1.3	−2.7	113	20 48.0	−1.2	−0.5	71
11	3272	5.8	I	103	22 32.2	−0.3	+1.6	19	No occ.			
14	68	5.7	I	136	22 35.7	−1.6	+0.8	53	21 26.7	−0.5	+3.2	10
21	888	6.0	E	208	No occ.				6 00.3	−0.5	−2.3	307
22	1040	6.2	E	220	No occ.				5 30.4	−2.1	+1.2	225
24	1281	6.4	E	244	4 11.7	−0.9	−3.5	345	Graze			

Date	Z.C. No.	Mag.	I or E	Elong. of Moon	TORONTO W. 79°4, N. 43°7				WINNIPEG W. 97°2, N. 49°9			
					E.S.T.	a	b	P	C.S.T.	a	b	P
				°	h m	m	m	°	h m	m	m	°
Nov. 25	1397	5.5	E	257	4 41.5	−1.0	−2.4	338	3 11.8	−0.7	−2.4	346
29	1884	5.3	E	311	6 14.6	−0.6	−0.7	326	5 04.8	−0.2	−0.2	326
30	2017	6.4	E	325	5 58.5	−0.7	+0.7	288	No occ.			
Dec. 6	2968	6.2	I	48	No occ.				19 10.3	–	–	354
6	2969	3.2	I	48	No occ.				19 11.5	–	–	5
7	3093	4.5	I	59	19 30.4	−0.8	−0.1	54	18 23.6	−0.2	+1.8	10
9	3326	6.4	I	81	17 55.2	−1.5	+1.2	47	No occ.			
9	3340	7.5	I	83	22 37.4	−0.3	0.0	48	21 35.8	−0.2	+2.0	10
10	3462	7.5	I	94	No occ.				20 06.4	−2.4	−2.4	116
12	145	6.7	I	116	No occ.				21 11.4	−2.1	−1.7	110
13	166	6.9	I	117	No occ.				1 03.5	−0.5	−0.3	51
20	1234	6.1	E	212	23 46.5	−1.3	+0.8	278	22 32.9	−0.7	+0.5	300
21/2	1359	5.1	E	225	0 39.1	−1.3	+0.7	281	23 25.9	−0.7	+0.5	299
23	1482	6.3	E	240	3 43.2	−1.7	−0.4	288	2 17.1	−1.2	+0.4	289
23	1495	5.9	E	241	No occ.				5 55.6	–	–	227
24	1605	6.2	E	254	5 51.9	–	–	236	No occ.			
26	1853	4.9	E	281	No occ.				5 34.6	–	–	10

LUNAR OCCULTATIONS VISIBLE AT EDMONTON AND VANCOUVER, 1975

Date	Z.C. No.	Mag.	I or E	Elong. of Moon	EDMONTON W. 113°4, N. 53°6				VANCOUVER W. 123°1, N. 49°2			
					M.S.T.	a	b	P	P.S.T.	a	b	P
				°	h m	m	m	°	h m	m	m	°
Jan. 3	1670	5.1	E	251	1 23.5	−0.7	+1.4	272	0 09.0	−0.6	+2.4	249
4	1800	5.4	E	267	7 40.3	−1.2	−1.0	290	6 29.7	−1.7	−0.5	275
16	3397	7.4	I	51	No occ.				20 20.2	–	–	352
21	457	6.5	I	108	21 34.8	−1.3	−1.1	94	20 25.9	−1.7	−1.4	108
21/2	467	6.7	I	109	0 31.3	−0.3	−1.7	97	23 36.5	−0.4	−2.4	117
23	752	4.7	I	133	20 50.3	−1.4	+0.3	90	19 34.8	−1.5	+0.3	101
23	766	6.0	I	134	23 27.5	−1.4	+0.1	61	22 13.5	−1.6	−0.2	80
Feb. 2	2018	6.4	E	262	No occ.				5 23.3	−0.7	−1.7	346
13	3482	5.6	I	31	18 19.9	−0.7	−0.7	63	Sun			
16	297	6.8	I	66	No occ.				21 46.1	–	–	8
17	416	5.4	I	77	20 40.0	−0.8	−3.2	128	No occ.			
17	429	6.9	I	78	23 29.3	+0.1	−2.0	110	22 41.4	+0.2	−3.1	133
17	433	5.6	I	78	Low				23 17.2	−0.1	−1.0	72
18	531	5.5	I	89	20 31.0	–	–	143	No occ.			
20	725	6.9	I	103	1 23.7	−0.6	0.0	34	0 20.5	−0.5	−0.7	59
20	847	3.0	I	113	20 19.3	−1.4	−0.8	111	19 09.2	−1.6	−1.3	127
20	847	3.0	E	113	21 31.2	−1.4	−0.3	259	20 14.3	−1.8	+1.1	239
21	881	5.9	I	116	1 34.5	−0.2	−1.6	97	0 40.2	−0.2	−1.9	114
21	1025	7.4	I	127	21 29.6	−1.2	−1.7	133	20 28.4	−1.2	−3.5	157
23	1197	6.0	I	145	Low				4 04.0	+0.1	−1.5	106
Mar. 3	2228	5.9	E	256	Sun				5 40.9	−1.6	−0.7	298
18	646	6.1	I	70	20 16.0	−1.3	+0.4	45	19 02.5	−1.5	−0.1	66
20	971	7.3	I	96	22 35.1	−0.5	−2.1	122	21 41.0	−0.4	−2.8	144
21/2	1116	7.4	I	110	0 10.9	−0.1	−2.2	138	23 21.3	+0.1	−3.0	159
23/4	1384	7.4	I	137	0 22.0	−1.4	−0.6	69	23 11.7	−1.4	−0.8	91
24	1495	5.9	I	151	22 40.9	−0.4	−2.3	170	No occ.			
29	2018	6.4	E	208	0 55.1	−1.9	+1.5	239	No occ.			
29	2029	5.1	E	209	No occ.				2 24.8	−0.7	−1.9	348
30	2172	4.7	E	223	Sun				4 17.7	−1.4	−1.1	303
Apr. 16	915	4.7	I	65	20 56.6	−0.4	−1.9	114	20 01.9	−0.4	−2.5	134
18	1212	7.1	I	92	23 24.2	−0.1	−2.1	138	22 34.1	0.0	−2.7	157
19	1332	5.7	I	105	21 51.6	−1.7	−0.1	59	20 36.8	−1.7	−0.5	85
22	1582	6.3	I	133	No occ.				0 10.2	–	–	48
22	1590	6.9	I	134	Low				2 03.1	−0.4	−1.4	86
23	1713	5.8	I	148	Low				2 30.1	–	–	182

Date	Z.C. No.	Mag.	I or E	Elong. of Moon	EDMONTON W. 113°4, N. 53°6				VANCOUVER W. 123°1, N. 49°2			
					M.S.T.	a	b	P	P.S.T.	a	b	P
				°	h m	m	m	°	h m	m	m	°
Apr. 30	2697	6.5	E	240	Sun				3 13.9	−1.7	+0.4	280
May 16	1318	5.7	I	76	Low				23 06.6	−0.4	−0.8	55
18	1543	6.6	I	101	22 16.9	−1.1	−1.2	80	21 10.3	−1.3	−1.2	96
18/9	1551	6.7	I	102	0 13.3	−0.2	−1.9	127	23 18.8	−0.4	−2.0	136
19	1655	6.7	I	115	No occ.				21 03.0	−2.3	+0.3	63
20	1670	5.1	I	116	Low				0 03.9	−0.6	−1.5	95
22	2029	5.1	I	155	22 06.9	−1.9	+1.0	60	20 45.3	−1.6	+1.0	82
26/7	2614	6.2	E	207	0 51.7	−1.2	−0.2	325	23 41.0	−1.0	+0.2	312
June 15	1629	6.8	I	85	Low				22 31.8	−0.6	−0.8	57
16	1745	var	I	99	Low				22 27.9	−0.6	−2.3	153
July 7	4001	0.4	I	338	5 09.0	+0.7	+3.2	29	4 04.4	+0.9	+3.0	29
7	4001	0.4	E	338	5 41.3	−0.9	−0.2	326	4 34.7	−0.6	−0.2	326
24/5	3185	5.3	E	202	0 51.6	−1.3	+1.1	246	23 32.7	−1.3	+1.5	248
Aug. 2	614	5.7	E	293	Sun				2 21.9	+0.3	+2.5	216
3	765	5.3	E	305	Sun				3 27.8	+0.1	+2.3	230
4	915	4.7	E	318	3 41.4	−0.2	+0.9	297	Low			
14	2337	6.4	I	102	Low				21 31.4	−1.0	−0.6	61
16	2614	6.2	I	126	21 41.1	−1.4	−0.2	77	20 25.7	−1.7	+0.3	79
16	2618	6.6	I	126	22 32.4	−1.4	−0.8	90	21 20.0	−1.7	−0.3	90
23	3494	4.6	E	204	21 36.1	−0.4	+2.0	237	Low			
24	3512	5.8	E	206	Sun				3 18.0	−0.9	+1.6	207
26	299	6.3	E	237	23 20.3	+0.1	+2.5	206	22 11.5	+0.3	+2.4	206
27/8	423	6.4	E	249	0 12.1	+0.1	+2.6	209	23 03.4	+0.3	+2.4	211
Sept. 11	2432	6.8	I	84	Low				20 00.5	−1.1	−0.5	62
13	2729	6.9	I	108	Low				21 04.3	−2.3	−2.1	130
14	2865	5.9	I	119	20 24.9	−2.0	−0.6	123	19 07.2	−2.0	−0.2	124
27	793	6.2	E	254	1 20.0	−0.6	+1.5	272	0 08.9	−0.3	+1.5	270
30	1234	6.1	E	292	2 53.0	−0.4	+0.7	303	1 47.4	−0.1	+0.8	295
Oct. 10	2666	5.0	I	76	18 41.0	−1.3	−0.2	66	Sun			
11	2828	6.0	I	89	20 37.7	−0.5	+0.4	28	19 28.6	−0.8	+0.9	26
14	3185	5.3	I	122	18 17.2	−1.4	+1.0	106	Sun			
16	3326	6.4	I	135	1 54.3	−0.5	−0.9	66	0 52.2	−0.8	−0.9	73
16/7	3444	6.5	I	146	0 39.3	−1.3	−1.4	93	23 29.5	−1.9	−1.2	97
17	3455	6.4	I	147	No occ.				2 41.7	–	–	3
23/4	760	6.5	E	224	0 53.3	–	–	201	23 30.6	–	–	189
24	895	5.9	E	235	22 29.1	−0.3	+0.8	302	Low			
25	913	5.2	E	237	2 54.4	−1.4	+0.1	289	1 39.1	−1.3	+0.8	278
26	1072	6.2	E	250	4 55.5	−1.6	+1.3	245	3 28.1	–	–	220
28	1318	5.7	E	274	1 48.6	−0.4	+0.5	309	0 43.3	−0.2	+0.6	299
28	1332	5.7	E	276	No occ.				5 04.9	−0.9	−2.7	345
Nov. 6	2599	6.8	I	44	Low				17 44.6	−0.3	+0.7	25
7	2763	6.7	I	57	18 47.7	−0.9	−0.6	62	17 39.4	−1.2	−0.2	61
10	3154	7.4	I	92	19 28.8	−1.1	+0.5	46	18 13.5	−1.3	+1.1	43
11	3287	5.8	I	104	Low				23 11.2	−0.4	+0.4	33
13	3512	5.8	I	126	23 00.2	−1.8	−2.5	115	21 50.8	–	–	120
21	888	6.0	E	208	4 40.8	−0.9	−2.1	303	3 37.0	−1.4	−1.2	284
21	895	5.9	E	208	6 04.3	−0.5	−2.1	298	5 05.0	−1.0	−1.5	279
22	1040	6.2	E	220	4 02.5	–	–	220	No occ.			
24	1281	6.4	E	244	No occ.				0 11.2	–	–	358
25	1397	5.5	E	257	1 51.1	–	–	2	0 54.7	−0.6	−0.9	334
Dec. 5	2846	6.9	I	36	17 12.7	−1.9	−2.3	129	Sun			
10	3462	7.5	I	94	18 31.4	−1.6	+0.3	83	17 12.1	−1.7	+1.0	80
10	3477	6.6	I	95	22 17.4	–	–	139	No occ.			
12	145	6.7	I	116	19 39.8	−1.6	+0.6	81	18 20.5	−1.6	+1.1	80
12	166	6.9	I	117	23 52.9	−0.8	+0.3	38	22 43.0	−1.1	+0.2	51
13	173	6.6	I	118	No occ.				0 59.5	−0.6	+2.0	14
15	423	6.4	I	141	4 02.3	0.0	−1.5	89	3 09.9	0.0	−1.9	107
20	1234	6.1	E	212	21 25.1	−0.4	+0.1	320	20 20.9	−0.2	+0.3	311
21	1359	5.1	E	225	22 19.7	−0.3	+0.3	315	Low			
22/3	1482	6.3	E	240	1 03.7	−0.7	+0.7	292	23 52.7	−0.6	+1.3	276
26	1853	4.9	E	281	4 29.5	0.0	−1.5	351	3 30.0	−0.4	−0.3	323

NAMES OF OCCULTED STARS

The stars which are occulted by the moon are stars which lie along the zodiac; hence they are known by their number in the "Zodiacal Catalogue" (ZC), compiled by James Robertson and published in the *Astronomical Papers Prepared for the Use of the American Ephemeris and Nautical Almanac*, vol. 10, pt. 2 (U.S. Govt. Printing Office; Washington, 1940). The other names listed in the table are either (1) Bayer names, in which small Greek letters are used for the brighter stars in a constellation and Roman letters, if necessary, for the fainter stars (2) Flamsteed names, in which the stars are numbered consecutively from west to east across the constellation (3) numbers in the catalogues of Bode (B.), Heis (H!), Gould (G.) and Hevelius (H.) or (4) numbers in the *Bonner Durchmusterung* or BD catalogue (e.g. +18° 325).

.C. No.	Name	Z.C. No.	Name	Z.C. No.	Name	Z.C. No.	Name	Z.C. No.	Name
29	+5° 25	793D.	351 B. Tau	1397D.	ω Leo	2214D.	150 B. Lib	2846	246 B. Sgr
68D.	51 Psc	837	372 B. Tau	1482	14 Sex	2228	172 B. Lib	2865	267 B. Sgr
45	180 B. Psc	847	ζ Tau	1495	19 Sex	2241	κ Lib	2889	−17° 5746
66	198 B. Psc	881D.	+20° 1105	1543	+3° 2379	2282	10 G. Sco	2968D.	16 B. Cap
73	210 B. Psc	888	+19° 1110	1551	+2° 2334	2327	83 B. Sco	2969	β Cap
97	+11° 172	892	203 B. Ori	1582	237 B. Leo	2330	84 B. Sco	2995	27 G. Cap
40	π Psc	894	54 Ori	1587D.	55 Leo	2337	51 G. Sco	3051	87 B. Cap
97	+14° 326	895	χ^1 Ori	1590	57 Leo	2348	−21° 4341	3075	35 B. Aqr
99	H^1 Ari	913	64 Ori	1605	62 Leo	2376	ω Oph	3093	ν Aqr
13	+15° 305	915	χ^2 Ori	1629	−0° 2422	2432D.	74 B. Oph	3104	51 G. Aqr
02	36 Ari	935	+20° 1302	1639D.	123 H! Leo	2445	−21° 4478	3154	−10° 5696
16D.	π Ari	940	68 Ori	1655	−1° 2521	2472	−21° 4544	3184	117 G. Cap
23	124 Ari	971	+19° 1313	1670	87 Leo	2509D.	190 B. Oph	3185	46 Cap
29	44 Ari	991	16 Gem	1688D.	431 B. Leo	2547	58 Oph	3229	30 Aqr
32	45 Ari	995D.	υ Gem	1713	13 B. Vir	2599	24 B. Sgr	3259	−7° 5727
33	ρ Ari	1025	+19° 1430	1745	49 B. Vir	2614	30 G. Sgr	3272	44 Aqr
55	53 Ari	1038	+18° 1338	1778	127 B. Vir	2618	42 B. Sgr	3287D.	51 Aqr
57	54 Ari	1040D.	74 B. Gem	1800	21 Vir	2633	μ Sgr	3290	−5° 5790
60	+18° 418	1072	110 B. Gem	1815	χ Vir	2635	14 Sgr	3320	κ Aqr
67	+18° 432	1116	+17° 1561	1845D.	343 B. Vir	2642	17 Sgr	3326	207 B. Aqr
80	+18° 459	1141	162 B. Gem	1853	Ψ Vir	2666D.	21 Sgr	3340	−3° 5505
97	175 B. Ari	1158	74 Gem	1884	49 Vir	2697	108 B. Sgr	3370	6 G. Psc
31	13 Tau	1176	+16° 1551	1919	497 B. Vir	2704	115 B. Sgr	3371	−2° 5858
95	164 B. Tau	1190D.	+16° 1580	1940	−12° 3830	2710	87 G. Sgr	3397	−1° 4393
14	43 Tau	1197	1 Cnc	1992	−13° 3786	2724	130 B. Sgr	3444	22 B. Psc
28	ω Tau	1212	+15° 1734	2017	621 B. Vir	2729	133 B. Sgr	3453	κ Psc
33	53 Tau	1234	30 B. Cnc	2018	214 G. Vir	2734D.	29 Sgr	3455	9 Psc
42	219 B. Tau	1256	+14° 1879	2029	40 H. Vir	2758	−19° 5242	3462	+0° 5009
46D.	224 B. Tau	1271	29 Cnc	2119	28 G. Lib	2763	−19° 5255	3477	15 Psc
51	227 B. Tau	1281	84 B. Cnc	2120	10 Lib	2773D.	171 B. Sgr	3482	16 Psc
25	+21° 707	1309	45 A.^{1} Cnc	2171	90 B. Lib	2791	190 B. Sgr	3494	λ Psc
52	ι Tau	1318	50 A.^{2} Cnc	2172D.	ι Lib	2798D.	195 B. Sgr	3501	19 Psc
55	330 B. Tau	1320	+13° 1994	2175	25 Lib	2814	43 Sgr	3512	22 Psc
60D.	333 B. Tau	1332	60 Cnc	2189	−19° 4076	2816	−19° 5387	4001	MERCURY
65	106 Tau	1359	κ Cnc	2207	137 B. Lib	2825	226 B. Sgr		
66	105 Tau	1384	+10° 1972	2212	147 B. Lib	2828	45 Sgr		

GRAZING OCCULTATIONS OVER CANADA DURING 1975

By L. V. Morrison

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

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

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

No.	Date	Name	Z.C.	Mag.	U.T.	%	L	No.	Date	Name	Z.C.	Mag.	U.T.	%	L
					h m								h m		
1	Jan. 2	84 B. Sex	1528	6.6	2 48	78	N	31	Apr. 20	+13° 1994	1320	6.8	1 25	61	N
2	2	+3° 2379	1543	6.6	5 40	77	S	32	20	60 Cnc	1332	5.7	5 15	63	N
3	2	+2° 2334	1551	6.7	8 18	77	S	33	22	237 B. Leo	1582	6.3	8 13	85	N
4	3	87 Leo	1670	5.1	7 45	66	S	34	May 1	−18° 5356	2833	7.0	9 33	66	N
5	15	−10° 5696	3154	7.4	0 08	6	N	†35	13	ζ Tau	847	3.0	22 01	8	N
6	Jan. 15	−7° 5727	3259	7.4	21 27	10	S	36	May 17	84 B. Cnc	1281	6.4	1 17	35	N
7	16	44 Aqr	3272	5.8	0 45	11	N	*37	18	ω Leo	1397	5.5	1 01	47	N
8	17	−1° 4393	3397	7.4	4 28	19	N	*38	20	123 H! Leo	1639	7.0	2 46	70	N
9	21	+15° 305	313	7.5	1 29	54	N	39	20	−1° 2521	1655	6.7	5 19	71	N
10	21	ρ Ari	433	5.6	22 35	64	S	*39a	25	—	2304	7.8	5 09	—	S
11	Jan. 22	+18° 418	460	7.0	6 00	66	N	*39b	May 25	SAO 184125	—	8.2	5 37	—	S
12	24	105 Tau	766	6.0	7 15	85	N	40	31	−10° 5696	3154	7.4	8 13	64	N
13	31	44 B. Vir	1743	6.8	7 09	80	N	*41	June 5	235 B. Psc	196	6.9	10 21	18	N
14	31	49 B. Vir	1745	7.0	8 43	79	S	42	16	62 Leo	1605	6.2	1 29	44	N
15	Feb. 2	214 G. Vir	2018	6.4	13 25	57	N	43	17	20 B. Vir	1723	7.1	0 54	55	N
16	Feb. 17	+14° 326	297	6.8	5 54	30	N	44	June 29	−3° 5505	3340	7.5	9 14	71	N
17	18	36 Ari	402	6.5	1 28	38	N	45	30	9 Psc	3455	6.4	6 21	63	N
18	21	16 Gem	991	6.1	23 18	79	N	46	30	+0° 5009	3462	7.5	7 46	63	S
19	Mar. 1	−12° 3830	1940	6.9	6 13	84	N	47	July 1	+5° 25	29	7.2	8 50	53	N
20	16	+16° 293	363	7.3	23 53	15	N	*48	30	100 Psc	230	7.4	10 24	60	N
21	Mar. 17	+18° 459	480	7.3	23 51	23	N	49	Aug. 1	53 Ari	455	6.1	6 22	42	N
22	19	219 B. Tau	642	6.9	3 10	34	N	50	14	25 Lib	2175	6.0	3 18	49	S
*23	19	224 B. Tau	646	6.1	3 49	34	N	51	26	210 B. Psc	173	6.6	4 14	85	N
24	19	227 B. Tau	651	5.9	4 12	34	N	52	26	241 B. Psc	203	6.9	11 03	83	N
25	31	−21° 4233	2281	7.0	5 11	80	S	53	27	12 H! Ari	299	6.3	5 35	77	S
26	Apr. 3	29 Sgr	2734	5.4	8 14	50	N	54	Aug. 31	+20° 969	826	6.8	5 16	38	N
27	14	164 B. Tau	595	6.8	23 59	11	N	55	31	372 B. Tau	837	6.1	6 49	37	N
28	16	330 B. Tau	755	6.3	3 19	20	N	†56	Sept. 14	133 B. Sgr	2729	6.9	5 27	66	S
*29	19	+16° 1580	1190	7.1	2 24	50	N	57	15	267 B. Sgr	2865	5.9	3 29	74	S
30	19	1 Cnc	1197	6.0	3 55	51	N	*58	27	351 B. Tau	793	6.2	8 10	63	S

No.	Date	Name	Z.C.	Mag.	U.T.	%	L	No.	Date	Name	Z.C.	Mag.	U.T.	%	L
					h m								h m		
59	Sept. 27	+20° 948	808	6.8	10 31	62	N	*77	Nov. 25	ω Leo	1397	5.5	8 37	61	N
60	28	68 Ori	940	5.7	6 28	53	N	78	26	+3° 2379	1543	6.6	14 43	47	S
61	Oct. 9	ω Oph	2376	4.6	3 13	19	S	79	27	−0° 2422	1629	6.8	9 52	38	S
62	12	43 Sgr	2814	5.0	1 10	48	S	*80	27	123 H[1] Leo	1639	7.0	11 41	37	S
63	12	−19° 5387	2816	6.8	1 55	48	S	81	27	−1° 2521	1655	6.7	14 32	36	S
64	Oct. 15	117 G. Cap	3184	7.1	1 51	77	S	82	Nov. 28	44 B. Vir	1743	6.8	7 53	28	S
65	15	46 Cap	3185	5.3	1 32	77	S	83	Dec. 5	−18° 5356	2833	7.0	23 06	9	S
66	16	κ Aqr	3320	5.3	6 55	85	S	84	6	246 B. Sgr	2846	6.9	0 34	10	S
67	24	106 Tau	765	5.3	8 38	85	N	85	9	κ Aqr	3320	5.3	21 27	42	S
68	24	107 Tau	769	6.6	9 27	85	S	86	11	+0° 5009	3462	7.5	2 03	54	S
69	Oct. 26	110 B. Gem	1072	6.2	11 03	67	S	87	11	15 Psc	3477	6.6	5 18	55	S
70	28	45 Cnc	1309	5.7	6 26	47	N	†88	11	+1° 4744	3482	5.6	6 46	55	N
71	Nov. 11	−7° 5727	3259	7.4	23 45	60	S	89	13	180 B. Psc	145	6.7	3 14	72	S
72	12	6 G. Psc	3370	6.2	23 46	70	S	90	13	210 B. Psc	173	6.6	9 12	74	N
73	13	λ Psc	3494	4.6	23 11	78	S	91	23	19 Sex	1495	5.9	11 21	74	S
74	Nov. 14	22 Psc	3512	5.8	6 08	80	S	92	24	62 Leo	1605	6.2	9 49	63	S
*74a	18	SAO 93525	—	9.4	22 17	—	N	93	25	24 B. Vir	1726	6.9	9 28	52	S
*74b	18	SAO 93540	—	9.1	22 40	—	S	94	25	44 B. Vir	1743	6.8	14 45	50	S
75	24	84 B. Cnc	1281	6.4	8 02	72	N	95	27	−13° 3786	1992	7.2	13 39	28	S
76	25	+10° 1972	1384	7.4	4 32	63	N	96	28	−17° 4172	2104	7.5	11 20	19	S

NOTES ON DOUBLE STARS

23 ZC 646 is the brighter component of the double star ADS 3158. The companion is 9th magnitude; separation 1″9 in p.a. 170°.

29 ZC 1190 is the brighter component of the double star ADS 6440. The companion is 11th magnitude; separation 16″ in p.a. 20°.

37 ZC 1397 is the mean of the double star ADS 7390. The components are 6^m0 and 6^m7; separation 0″5 in p.a. 3°.

38 ZC 1639 is the brighter component of the double star ADS 8131. The companion is 8^m0; separation 9″6 in p.a. 252°.

39ab These occultations occur during a lunar eclipse.

41 ZC 196 is the brighter component of the double star ADS 1097. The companion is 8th magnitude; separation 0″4 in p.a. 113°.

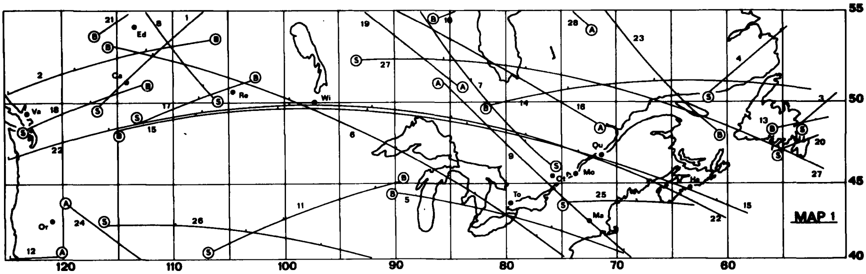
48 ZC 230 is the brightest component of the system ADS 1238. The brightest companion is 8^m4; separation 16″ in p.a. 79°.

58 ZC 793 is the brighter component of the double star ADS 3894. The companion is 10th magnitude; separation 9″0 in p.a. 204°.

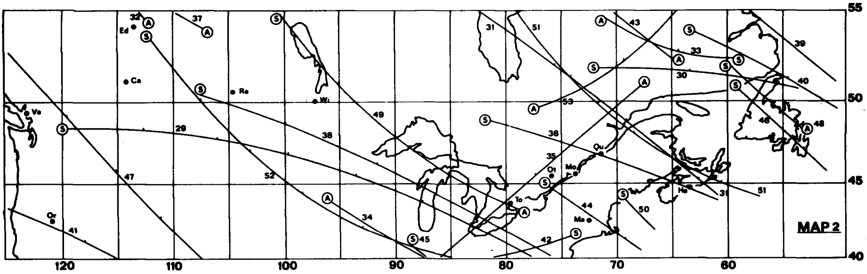
74ab These occultations occur during a lunar eclipse.

77 See note on track 37 above.

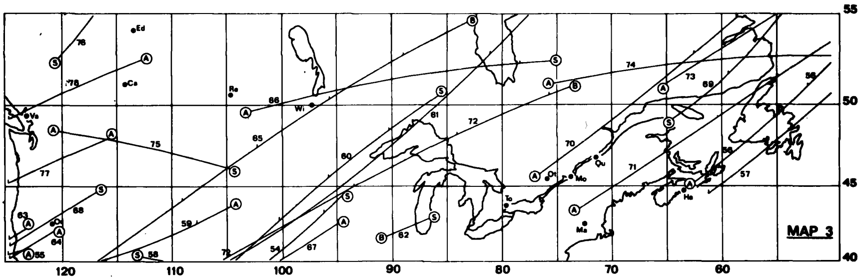
80 See note on track 38 above.



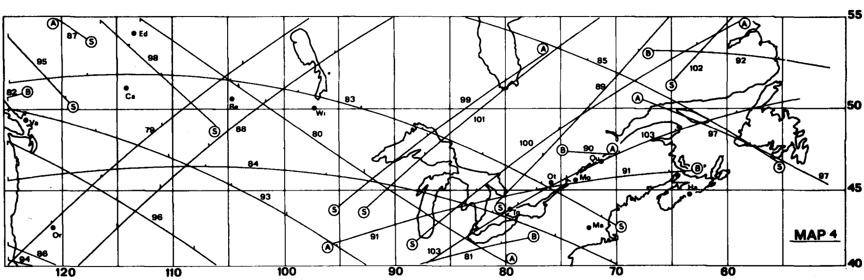
Map 1.



Map 2.

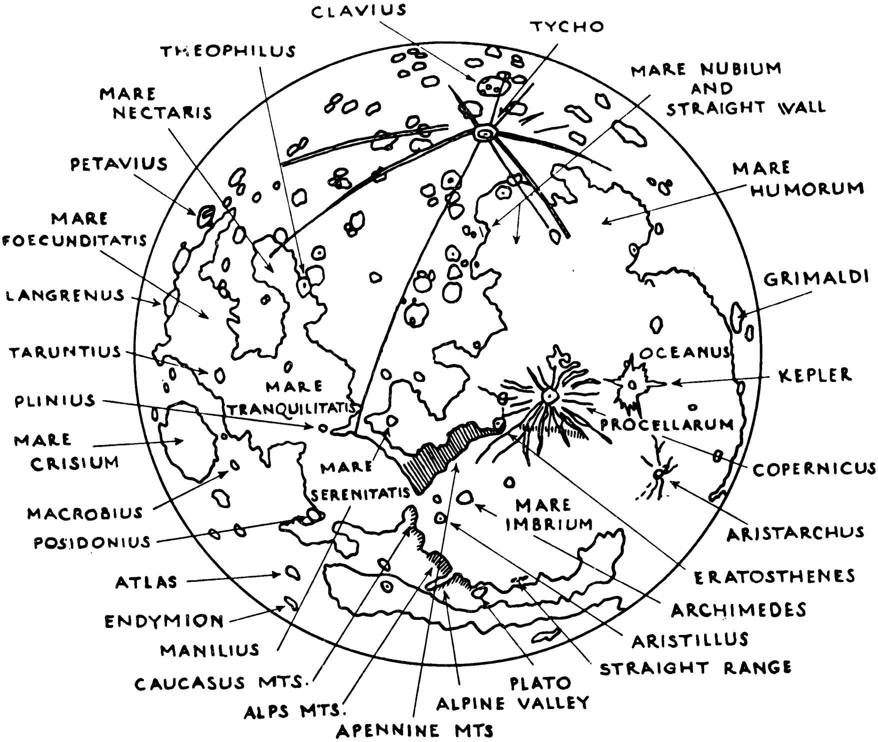


Map 3.



Map 4.

MAP OF THE MOON



South appears at the top.

MARS—LONGITUDE OF THE CENTRAL MERIDIAN

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

A map of the surface of Mars appears on p. 54.

Date	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1		228.12	280.50	344.55	41.68	102.06	175.82	246.35	336.32
2	155.68	218.19	270.60	334.74	31.97	92.46	166.36	237.17	327.49
3	145.79	208.26	260.70	324.92	22.25	82.85	156.91	228.01	318.67
4	135.89	198.33	250.80	315.11	12.54	73.25	147.47	218.85	309.86
5	125.99	188.40	240.91	305.30	2.83	63.66	138.03	209.71	301.06
6	116.09	178.47	231.01	295.49	353.13	54.07	128.60	200.58	292.26
7	106.19	168.53	221.12	285.69	343.43	44.48	119.17	191.46	283.47
8	96.29	158.60	211.23	275.89	333.73	34.90	109.75	182.35	274.68
9	86.38	148.67	201.35	266.09	324.04	25.32	100.35	173.26	265.90
10	76.48	138.74	191.46	256.30	314.35	15.75	90.94	164.18	257.12
11	66.57	128.81	181.58	246.50	304.66	6.18	81.55	155.11	248.34
12	56.66	118.88	171.70	236.72	294.98	356.61	72.16	146.05	239.56
13	46.75	108.95	161.83	226.94	285.30	347.05	62.79	137.01	230.79
14	36.83	99.02	151.95	217.16	275.63	337.50	53.41	127.98	222.01
15	26.92	89.09	142.08	207.38	265.96	327.95	44.05	118.96	213.24
16	17.00	79.17	132.22	197.61	256.29	318.40	34.70	109.96	204.46
17	7.08	69.24	122.35	187.84	246.62	308.86	25.36	100.96	195.68
18	357.17	59.32	112.49	178.07	236.96	299.32	16.02	91.99	186.90
19	347.25	49.39	102.63	168.31	227.30	289.79	6.69	83.02	178.12
20	337.32	39.47	92.77	158.55	217.65	280.26	357.38	74.06	169.33
21	327.40	29.55	82.92	148.79	207.99	270.74	348.07	65.12	160.54
22	317.48	19.63	73.07	139.03	198.35	261.22	338.77	56.19	151.74
23	307.55	9.71	63.22	129.28	188.70	251.71	329.48	47.27	142.94
24	297.63	359.79	53.38	119.54	179.06	242.21	320.20	38.36	134.13
25	287.70	349.87	43.54	109.79	169.42	232.70	310.93	29.47	125.31
26	277.77	339.96	33.70	100.05	159.79	223.21	301.67	20.59	116.49
27	267.84	330.04	23.87	90.32	150.16	213.72	292.43	11.71	107.66
28	257.91	320.13	14.03	80.58	140.53	204.24	283.19	2.85	98.82
29	247.98	310.22	4.20	70.85	130.91	194.76	273.96	353.99	89.97
30	238.06	300.31	354.38	61.13	121.29	185.29	264.75	345.15	81.11
31		290.41		51.40	111.68		255.54		72.24

ASTEROIDS—EPHEMERIDES AT OPPOSITION, 1975

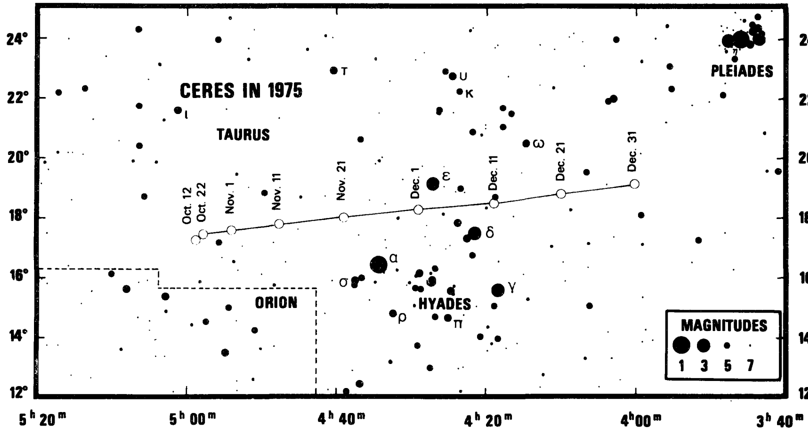
The following tables give, for 0 h U.T., the apparent R.A. and Dec. within one month of opposition. For information on appulses and occultations, see "Planetary Appulses and Occultations," page 57.

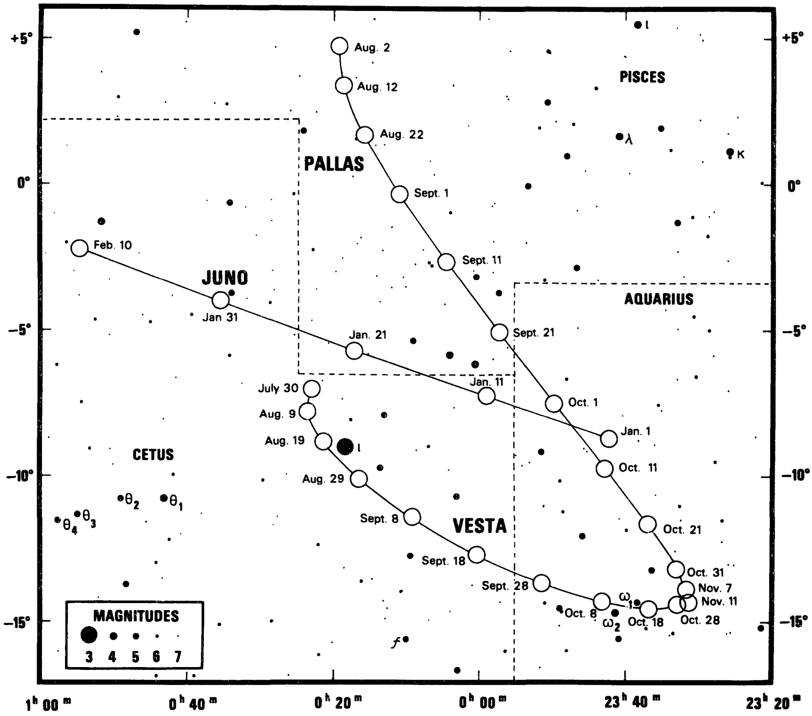
CERES
Opposition Dec. 1, mag. 6.7

Date	R.A.	Dec.
	h m	° ′
Oct. 12	4 59.2	+17 14
22	4 58.1	+17 25
Nov. 1	4 54.3	+17 36
11	4 47.8	+17 48
21	4 39.2	+18 01
Dec. 1	4 29.3	+18 15
11	4 19.2	+18 30
21	4 10.2	+18 48
31	4 03.1	+19 10

JUNO
No opposition in 1975

Date	R.A.	Dec.
	h m	° ′
Jan. 1	23 42.3	−8 42
11	23 59.1	−7 16
21	0 16.9	−5 41
31	0 35.4	−3 59
Feb. 10	0 54.7	−2 12
—		
Nov. 21	10 37.5	+0 49
Dec. 1	10 48.2	−0 07
11	10 57.0	−0 53
21	11 03.9	−1 24
31	11 08.6	−1 39


CERES IN 1975
TAURUS
ORION
HYADES
PLEIADES
Oct. 12
Oct. 22
Nov. 1
Nov. 11
Nov. 21
Dec. 1
Dec. 11
Dec. 21
Dec. 31
MAGNITUDES
1 3 5 7
24°
22°
20°
18°
16°
14°
12°
5h 20m
5h 00m
4h 40m
4h 20m
4h00m
3h 40m


PISCES
PALLAS
JUNO
AQUARIUS
CETUS
VESTA
Aug. 2
Aug. 12
Aug. 22
Sept. 1
Sept. 11
Sept. 21
Oct. 1
Oct. 11
Oct. 21
Oct. 31
Nov. 7
Nov. 11
Oct. 28
Feb. 10
Jan 31
Jan. 21
Jan. 11
Jan. 1
July 30
Aug. 9
Aug. 19
Aug. 29
Sept. 8
Sept. 18
Sept. 28
Oct. 8
Oct. 18
MAGNITUDES
3 4 5 6 7
+5°
0°
−5°
−10°
−15°
1h 00m
0h 40m
0h 20m
0h 00m
23h 40m
23h 20m

PALLAS
Opposition Sept. 21, mag. 8.4

Date	R.A.	Dec.
	h m	° ′
Aug. 2	0 19.4	+ 4 43
12	0 18.6	+ 3 24
22	0 15.7	+ 1 42
Sept. 1	0 11.0	− 0 20
11	0 04.7	− 2 38
21	23 57.4	− 5 05
Oct. 1	23 49.8	− 7 30
11	23 42.8	− 9 44
21	23 37.0	−11 39
31	23 33.1	−13 11
Nov. 10	23 31.4	−14 18

VESTA
Opposition Sept. 18, mag. 6.1

Date	R.A.	Dec.
	h m	° ′
July 30	0 22.8	− 7 00
Aug. 9	0 23.6	− 7 47
19	0 21.4	− 8 50
29	0 16.4	−10 05
Sept. 8	0 09.1	−11 24
18	0 00.3	−12 38
28	23 51.2	−13 38
Oct. 8	23 43.0	−14 18
18	23 36.6	−14 33
28	23 32.7	−14 24
Nov. 7	23 31.6	−13 54

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										SYSTEM II									
Day (0^h U.T.)	Jan.	Feb.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
1	170.9	18.1	10.1	220.3	274.8	129.2	346.1	46.9	265.6	323.2	340.7	311.4	344.3	318.0	143.5	121.5	101.8	293.7	275.8	104.5
2	328.5	175.7	167.8	18.1	72.6	287.2	144.2	204.9	63.5	121.0	130.7	101.4	134.4	108.2	293.8	271.8	252.2	84.1	66.2	254.8
3	126.2	333.4	325.5	175.9	230.5	85.1	302.2	3.0	221.5	278.9	280.8	251.4	284.5	258.3	84.0	62.1	42.6	234.5	216.5	45.0
4	283.9	131.0	123.3	333.7	28.3	243.0	100.2	161.0	19.5	76.7	70.8	41.4	74.6	48.5	234.2	212.4	193.0	24.9	6.8	195.2
5	81.5	288.6	281.0	131.5	186.2	41.0	258.2	319.1	177.4	234.6	220.8	191.4	224.7	198.7	24.4	2.7	343.3	175.3	157.2	345.4
6	239.2	86.3	78.7	289.3	344.0	198.9	56.2	117.1	335.4	32.4	10.9	341.4	14.8	348.8	174.7	153.0	133.7	325.7	307.5	135.6
7	36.8	243.9	236.4	87.1	141.9	356.8	214.2	275.1	133.4	190.2	160.9	131.5	164.9	139.0	324.9	303.3	284.1	116.1	97.8	285.8
8	194.5	41.6	34.2	244.9	299.8	154.8	12.2	73.2	291.3	348.1	310.9	281.5	315.0	289.1	115.1	93.6	74.5	266.5	248.2	76.0
9	352.2	199.2	191.9	42.6	97.6	312.7	170.2	231.2	89.3	145.9	100.9	71.5	105.1	79.3	265.4	243.9	224.9	57.0	38.5	226.2
10	149.8	356.8	349.6	200.4	255.5	110.7	328.2	29.3	247.2	303.7	251.0	221.5	255.2	229.5	55.6	34.2	15.3	207.4	188.8	16.4
11	307.5	154.5	147.4	358.3	53.4	268.6	126.3	187.3	45.2	101.5	41.0	11.5	45.3	19.6	205.8	184.6	165.6	357.8	339.1	166.6
12	105.1	312.1	305.1	156.1	211.2	66.6	284.3	345.3	203.1	259.4	191.0	161.5	195.4	169.8	356.1	334.9	316.0	148.2	129.4	316.8
13	262.8	109.8	102.9	313.9	9.1	224.5	82.3	143.4	1.0	57.2	341.1	311.5	345.6	320.0	146.3	125.2	106.4	298.6	279.7	107.0
14	60.4	267.4	260.6	111.7	167.0	22.5	240.3	301.4	159.0	215.0	131.1	101.5	135.7	110.2	296.6	275.5	256.8	89.0	70.0	257.2
15	218.1	65.0	58.4	269.5	324.9	180.5	38.4	99.4	316.9	12.8	281.1	251.5	285.8	260.4	86.8	65.9	47.2	239.4	220.3	47.3
16	15.7	222.7	216.1	67.3	122.8	338.4	196.4	257.5	114.8	170.6	71.1	41.5	75.9	50.5	237.1	216.2	197.6	29.8	10.6	197.5
17	173.4	20.3	13.9	225.1	280.6	136.4	354.4	55.5	272.7	328.4	221.1	191.6	226.0	200.7	27.3	6.5	348.0	180.2	160.9	347.7
18	331.0	178.0	171.6	22.9	78.5	294.4	152.4	213.5	70.7	126.2	11.2	341.6	16.1	350.9	177.6	156.9	138.4	330.6	311.2	137.8
19	128.7	335.6	329.4	180.7	236.4	92.3	310.5	11.5	228.6	284.0	161.2	131.6	166.3	141.1	327.9	307.2	288.8	121.0	101.5	288.0
20	286.3	133.2	127.1	338.6	34.3	250.3	108.5	169.6	26.5	81.7	311.2	281.6	316.4	291.3	118.1	97.6	79.2	271.4	251.8	78.2
21	84.0	290.9	284.9	136.4	192.2	48.3	266.5	327.6	184.4	239.5	101.2	71.6	106.5	81.5	268.4	247.9	229.6	61.7	42.0	228.3
22	241.6	88.5	82.6	294.2	350.1	206.2	64.6	125.6	342.3	37.3	251.2	221.6	256.6	231.7	58.7	38.2	20.0	212.1	192.3	18.5
23	39.3	246.2	240.4	92.0	148.0	4.2	222.6	283.6	140.2	195.1	41.3	11.6	16.8	21.9	208.9	188.6	170.4	2.5	342.6	168.6
24	196.9	43.8	38.2	249.9	305.9	162.2	20.6	81.6	298.1	352.9	191.3	161.6	196.9	172.1	359.2	338.9	320.8	152.9	132.8	318.7
25	354.6	201.4	195.9	47.7	103.8	320.2	178.7	239.6	95.9	150.6	341.3	311.6	347.0	322.3	149.5	129.3	111.2	303.3	283.1	108.9
26	152.2	359.1	353.7	205.5	261.7	118.2	336.7	37.6	253.8	308.4	131.3	101.7	137.2	112.5	299.8	279.7	261.6	93.6	73.3	259.0
27	309.9	156.7	151.5	3.4	59.7	276.2	134.8	195.6	51.7	106.2	281.3	251.7	287.3	262.7	90.0	70.0	52.0	244.0	223.6	49.2
28	107.5	314.4	309.2	161.2	217.6	74.2	292.8	353.6	209.6	263.9	71.3	41.7	77.5	52.9	240.3	220.4	202.5	34.4	13.8	199.3
29	265.1		107.0	319.1	15.5	232.2	90.8	151.6	7.4	61.7	221.3		227.6	203.1	30.6	10.7	352.9	184.7	164.1	349.4
30	62.8		264.8	116.9	173.4	30.2	248.9	309.6	165.3	219.4	11.4		17.7	353.3	180.9	161.1	143.3	335.1	314.3	139.5
31	220.4		62.6		331.3	188.1		107.6		17.2	161.4		167.9		331.2	311.5		125.5		289.7

JUPITER—PHENOMENA OF THE BRIGHTEST SATELLITES 1975

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

The symbols are as follows: E—eclipse, O—occultation, T—transit, S—shadow, D—disappearance, R—reappearance, I—ingress, e—egress. Satellites move from east to west across the face of the planet, and from west to east behind it. Before opposition, shadows fall to the west, and after opposition to the east. Thus eclipse phenomena occur on the west side until October 13, and on the east thereafter.

JANUARY

d	h	m	Sat.	Phen.
1	17	30	I	ER
	18	57	II	SI
	19	23	II	Te
	21	41	II	Se
	22	14	III	TI
5	20	17	III	ER
6	21	33	I	OD
7	18	52	I	TI
	19	30	IV	SI
	20	00	I	SI
	21	08	I	Te
	21	38	IV	Se
	22	15	I	Se
8	19	20	II	TI
	19	25	I	ER
	21	33	II	SI
	22	07	II	Te
10	19	21	II	ER
12	20	03	III	OR
	21	07	III	ED
14	20	52	I	TI
	21	56	I	SI
15	18	03	I	OD
	21	13	IV	OR
	21	20	I	ER
	22	06	II	TI
16	18	39	I	Se
17	21	59	II	ER
19	21	02	III	OD
22	20	04	I	OD
23	18	20	I	SI
	18	23	III	Se
	19	40	I	Te
	20	35	I	Se
24	19	54	II	OD
26	18	49	II	Se
30	19	08	III	Te
	19	17	III	SI
	19	25	I	TI
	20	16	I	SI
31	19	39	I	ER

FEBRUARY

d	h	m	Sat.	Phen.
2	18	40	II	SI
	19	53	II	Te
	21	25	II	Se
6	20	16	III	TI
7	18	37	I	OD
8	18	55	I	Se
9	19	54	II	TI
11	19	11	II	ER
14	20	39	I	OD
15	18	36	I	SI
	20	16	I	Te
17	20	25	III	ER

Jupiter being near the sun, phenomena are not given between Feb. 17 and May 29

MAY

d	h	m	Sat.	Phen.
29	4	35	III	ER
31	4	07	II	TI
31	4	37	II	Se
	4	47	I	SI

JUNE

d	h	m	Sat.	Phen.
1	5	19	I	OR
7	4	29	II	SI
8	3	51	I	ED
9	3	20	I	Se
	3	22	III	Te
	4	19	II	OR
	4	31	I	Te
16	2	37	III	Se
	3	03	I	SI
	4	18	I	TI
	4	59	III	TI
	5	14	I	Se
17	3	45	I	OR
23	3	48	III	SI
	4	26	II	ED
	4	57	I	SI
24	2	09	I	ED
25	1	36	I	Se
	1	46	II	TI
	1	47	II	Se
	2	53	I	Te
	4	27	II	Te
27	1	57	III	OR

JULY

d	h	m	Sat.	Phen.
1	4	03	I	ED
2	1	40	II	SI
	2	40	I	TI
	3	30	I	Se
	4	24	II	Se
	4	28	II	TI
	4	49	I	Te
3	2	08	I	OR
4	1	38	II	OR
	3	34	III	OD
9	3	13	I	SI
	4	17	II	SI
	4	35	I	TI
	5	23	I	Se
10	0	26	I	ED
	4	03	I	OR
11	1	12	I	Te
	1	31	II	ER
	1	39	II	OD
	1	50	III	ED
	4	14	II	OR
	4	37	III	ER
15	0	02	III	Te
16	5	07	I	SI
17	2	20	I	ED
18	0	58	I	TI
	1	26	II	ED
	1	45	I	Se
	3	06	I	Te
	4	05	II	ER
	4	14	II	OD
19	0	26	I	OR
20	1	43	II	Te
22	1	40	III	TI
	4	00	III	Te
24	4	15	I	ED
25	1	29	I	SI
	2	51	I	TI
	3	39	I	Se
	4	00	II	ED
	4	59	I	Te
26	2	19	I	OR
	23	27	I	Te
27	1	34	II	Se
	1	41	II	TI
	4	18	II	Te
28	23	53	III	SI
29	2	36	III	Se
	5	36	III	TI

AUGUST

d	h	m	Sat.	Phen.
1	3	22	I	SI
	4	43	I	TI
	5	32	I	Se
2	0	37	I	ED
	4	11	I	OR
	23	10	I	TI
3	0	01	I	Se
	1	19	I	Te
	1	28	II	SI
	4	11	II	Se
	4	14	II	TI
5	1	06	II	OR
	3	53	III	SI
8	5	16	I	SI
	23	27	III	OD
9	1	40	III	OR
	2	32	I	ED
	23	44	I	SI
10	1	01	I	TI
	1	54	I	Se
	3	09	I	Te
	4	05	II	SI
11	0	30	I	OR
	22	26	II	ED
12	3	34	II	OR
13	22	33	II	Te
16	0	39	III	ER
	3	11	III	OD
	4	26	I	ED
	5	22	III	OR
17	1	38	I	SI
	2	50	I	TI
	3	48	I	Se
	4	59	I	Te
	22	55	I	ED
18	2	19	I	OR
	22	17	I	Se
	23	26	I	Te
19	1	01	II	ED
	5	59	II	OR
20	22	25	II	TI
	22	42	II	Se
21	1	00	II	Te
23	1	58	III	ED
	4	39	III	ER
24	3	32	I	SI
	4	39	I	TI
	5	42	I	Se
25	0	49	I	ED
	4	08	I	OR
	22	00	I	SI
25	23	06	I	TI
26	0	10	I	Se
	1	14	I	Te
	3	36	II	ED
	22	35	I	OR
	22	39	III	Te
27	22	37	II	SI
28	0	49	II	TI
	1	19	II	Se
	3	24	II	Te
29	21	33	II	OR
30	5	59	III	ED
31	5	25	I	SI

SEPTEMBER

d	h	m	Sat.	Phen.
1	2	44	I	ED
	5	55	I	OR
	23	54	I	SI
2	0	52	I	TI
	2	04	I	Se
	3	01	I	Te
	6	11	II	ED
	21	12	I	ED
	22	35	III	Se
3	0	05	III	TI
	0	21	I	OR
	2	10	III	Te
	21	28	I	Te
4	1	14	II	SI
	3	11	II	TI
	3	56	II	Se
	5	45	II	Te
5	23	53	II	OR
8	4	38	I	ED
9	1	48	I	SI
	2	39	I	TI
	3	59	I	Se
	4	47	I	Te
	23	07	I	ED
	23	58	III	SI
10	2	07	I	OR
	2	35	III	Se
	3	33	III	TI
	5	37	III	Te
	21	05	I	TI
	22	27	I	Se
	23	14	I	Te
11	3	51	II	SI
	5	31	II	TI
	6	32	II	Se
	20	34	I	OR
12	22	04	II	ED
13	2	11	II	OR
14	21	14	II	Te
16	3	42	I	SI
	4	24	I	TI
	5	53	I	Se
	6	32	I	Te
17	1	01	I	ED
	3	53	I	OR
	3	59	III	SI
	6	35	III	Se
	22	10	I	SI
	22	50	I	TI
18	0	21	I	Se
	0	59	I	Te

d	h	m	Sat.	Phen.
18	6	28	II	SI
	22	19	I	OR
20	0	39	II	ED
	4	27	II	OR
	20	40	III	ER
	20	41	III	OD
	22	46	III	OR
21	19	46	II	SI
	20	57	II	TI
	22	27	II	Se
	23	31	II	Te
23	5	36	I	SI
	6	08	I	TI
24	2	56	I	ED
	5	37	I	OR
25	0	04	I	SI
	0	34	I	TI
	2	16	I	Se
	2	43	I	Te
	21	25	I	ED
26	0	03	I	OR
	20	44	I	Se
	21	09	I	Te
27	3	15	II	ED
	6	43	II	OR
	22	05	III	ED
28	2	04	III	OR
	22	23	II	SI
	23	12	II	TI
29	1	04	II	Se
	1	46	II	Te
30	19	50	II	OR

OCTOBER

d	h	m	Sat.	Phen.
1	4	51	I	ED
2	1	59	I	SI
	2	18	I	TI
	4	10	I	Se
	4	27	I	Te
	23	19	I	ED
3	1	47	I	OR
	20	27	I	SI
	20	44	I	TI
	22	39	I	Se
	22	53	I	Te
4	5	51	II	ED
	20	13	I	OR
5	2	07	III	ED
	5	21	III	OR
6	1	00	II	SI
	1	26	II	TI
	3	40	II	Se
	4	01	II	Te
7	19	09	II	ED
	22	04	II	OR
8	6	45	I	ED
	18	53	III	Te
9	3	54	I	SI
	4	01	I	TI
	6	05	I	Se
	6	11	I	Te
10	1	14	I	ED
	3	30	I	OR
	22	22	I	SI
	22	27	I	TI
11	0	34	I	Se
	0	37	I	Te
	19	43	I	ED
	21	56	I	OR
12	6	09	III	ED
	19	02	I	Te
	19	02	I	Se
13	3	37	II	SI
	3	40	II	TI
	6	14	II	Te
13	6	16	II	Se
14	21	43	II	OD
15	0	26	II	ER
	19	59	III	TI
	20	04	III	SI
	22	10	III	Te
	22	37	III	Se
16	5	44	I	TI
	5	48	I	SI
	19	21	II	Te
	19	35	II	Se
17	3	04	I	OD
	5	21	I	ER
18	0	10	I	TI
	0	17	I	SI
	2	20	I	Te
	2	28	I	Se
	21	30	I	OD
	23	49	I	ER
19	18	36	I	TI
	18	46	I	SI
	20	46	I	Te
	20	57	I	Se
20	5	54	II	TI
	6	14	II	SI
	18	18	I	ER
21	23	57	II	OD
22	3	03	II	ER
	23	14	III	TI
23	0	06	III	SI
	1	27	III	Te
	2	38	III	Se
	19	01	II	TI
	19	32	II	SI
	21	36	II	Te
	22	11	II	Se
24	4	48	I	OD
25	1	54	I	TI
	2	12	I	SI
	4	04	I	Te
	4	24	I	Se
	23	14	I	OD
26	1	44	I	ER
	20	20	I	TI
	20	41	I	SI
	22	30	I	Te
	22	52	I	Se
27	20	13	I	ER
29	2	12	II	OD
	5	40	II	ER
30	2	30	III	TI
	4	09	III	SI
	4	46	III	Te
	21	16	II	TI
	22	09	II	SI
	23	51	II	Te
31	0	47	II	Se

NOVEMBER

d	h	m	Sat.	Phen.
1	3	38	I	TI
	4	07	I	SI
	5	49	I	Te
	18	59	II	ER
2	0	58	I	OD
	3	39	I	ER
	20	45	III	ER
	22	05	I	TI
	22	36	I	SI
3	0	15	I	Te
	0	48	I	Se
	19	24	I	OD
	22	08	I	ER
4	18	41	I	Te
	19	16	I	Se
5	4	27	II	OD
6	23	32	II	TI
7	0	46	II	SI
	2	07	II	Te
	3	23	II	Se
8	5	24	I	TI
	21	37	II	ER
9	2	43	I	OD
	19	33	III	OD
	21	54	III	OR
	22	17	III	ED
	23	50	I	TI
10	0	31	I	SI
	0	47	III	ER
	2	01	I	Te
	2	43	I	Se
	21	10	I	OD
11	0	03	I	ER
	18	17	I	TI
	19	00	I	SI
	20	27	I	Te
	21	12	I	Se
12	18	32	I	ER
14	1	50	II	TI
	3	23	II	SI
	4	25	II	Te
15	19	55	II	OD
16	0	14	II	ER
	4	29	I	OD
	22	56	III	OD
17	1	21	III	OR
	1	37	I	TI
	2	19	III	ED
	2	27	I	SI
	3	47	I	Te
	4	38	I	Se
	4	49	III	ER
	17	35	II	Te
	19	17	II	Se
	22	56	I	OD
18	1	58	I	ER
	20	03	I	TI
	20	56	I	SI
	22	14	I	Te
	23	07	I	Se
19	20	27	I	ER
20	17	36	I	Se
	18	43	III	Se
21	4	10	II	TI
22	22	16	II	OD
23	2	53	II	ER
24	2	24	III	OD
	3	24	I	TI
	19	18	II	SI
	19	57	II	Te
	21	53	II	Se
25	0	43	I	OD
	3	54	I	ER
	21	51	I	TI
	22	52	I	SI
26	0	02	I	Te
	1	03	I	Se
	19	10	I	OD
	22	22	I	ER
27	17	20	I	SI
	18	30	I	Te
	18	34	III	Te
	19	31	I	Se
	20	17	III	SI
	22	44	III	Se
30	0	40	II	OD

DECEMBER

d	h	m	Sat.	Phen.
1	19	44	II	TI
	21	54	II	SI
	22	20	II	Te
2	0	29	II	Se
	2	32	I	OD
	23	41	I	TI
3	0	47	I	SI
	1	52	I	Te
	2	58	I	Se
	18	50	II	ER
	21	00	I	OD
4	0	18	I	ER
	18	08	I	TI
	19	16	I	SI
	19	42	III	TI
	20	19	I	Te
	21	27	I	Se
	22	13	III	Te
5	0	21	III	SI
	2	46	III	Se
	18	46	I	ER
7	3	06	II	OD
8	22	10	II	TI
9	0	31	II	SI
	0	46	II	Te
	3	05	II	Se
10	1	31	I	TI
	2	43	I	SI
	21	28	II	ER
	22	50	I	OD
11	2	13	I	ER
	19	59	I	TI
	21	12	I	SI
	22	10	I	Te
	23	23	I	Se
	23	23	III	TI
12	1	56	III	Te
	17	18	I	OD
	20	42	I	ER
13	17	52	I	Se
15	18	29	III	ED
	20	54	III	ER
16	0	38	II	TI
17	18	50	II	OD
18	0	07	II	ER
	0	41	I	OD
	21	51	I	TI
	23	08	I	SI
19	0	03	I	Te
	1	19	I	Se
	18	59	II	Se
	19	10	I	OD
	22	37	I	ER
20	17	37	I	SI
	18	31	I	Te
	19	48	I	Se
22	19	44	III	OR
	22	31	III	ED
23	0	56	III	ER
24	21	23	II	OD
25	2	34	I	OD
	2	46	II	ER
	23	45	I	TI
26	1	04	I	SI
	1	56	I	Te
	19	01	II	Te
	19	02	II	SI
	21	03	I	OD
	21	35	II	Se
27	0	33	I	ER
	18	13	I	TI
	19	33	I	SI
	20	25	I	Te
	21	44	I	Se
28	19	01	I	ER
29	21	01	III	OD
	23	40	III	OR
31	23	59	II	OD

COMETS IN 1975

The appearance of a bright comet is a rare and usually unexpected event. However, some comets are periodic and reasonably predictable. The following information was kindly provided by Dr. Brian G. Marsden, Smithsonian Astrophysical Observatory.

Four periodic comets are due at perihelion between late 1974 and the beginning of 1976.

Comet	Perihelion Date	Perihelion Distance	Period
Honda-Mrkos-Pajdušáková	1974 Dec. 28	0.58 A.U.	5.3 yr.
Arend	1975 May 24	1.85	8.0
Perrine-Mrkos	1975 Aug. 2	1.30	6.8
Westphal	1976 Jan. 3	0.92	63

Only the first will be at all a bright object, and even it will be observable only at the very beginning of 1975, in the southern part of the sky. Its ephemeris (referred to the equinox of 1950) is:

Date	R.A. (1950)	Dec. (1950)	Mag.
1975 Jan. 3	21^h04^m	$-22°22'$	
8	21^h14^m	$-26°58'$	7.6
13	21^h21^m	$-33°14'$	
18	21^h26^m	$-41°30'$	8.1
23	21^h29^m	$-51°57'$	
28	21^h31^m	$-64°37'$	8.9

Short-period comets are rarely bright objects (i.e. brighter than twelfth magnitude). Comet d'Arrest should come to about sixth magnitude in August 1976, and Comet Grigg-Skjellerup might be quite bright around April 1977. Comet Encke often performs well, of course, but the 1977 return is not particularly favourable.

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 1975.

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 1975

Shower	Shower Maximum Date	E.S.T.	Moon	Radiant Position at Max. R.A.	Dec.	Daily Motion R.A.	Dec.	Single Observer Hourly Rate	Velocity	Normal Duration to 1/4 strength of Max.
		h		h m	°	m	°		km/sec	days
Quadrantids	Jan. 3	16	L.Q.	15 28	+50	—	—	40	41	1.1
Lyrids	Apr. 22	16	F.M.	18 16	+34	+4.4	0.0	15	48	2
η Aquarids	May 5	18	L.Q.	22 24	00	+3.6	+0.4	20	64	3
δ Aquarids	July 29	13	L.Q.	22 36	−17	+3.4	+0.17	20	40	—
Perseids	Aug. 12	18	F.Q.	03 04	+58	+5.4	+0.12	50	60	4.6
Orionids	Oct. 21	20	F.M.	06 20	+15	+4.9	+0.13	25	66	2
Taurids	Nov. 4	—	L.Q.	03 32	+14	+2.7	+0.13	15	28	—
Geminids	Dec. 14	10	F.Q.	07 32	+32	+4.2	−0.07	50	35	2.6
Ursids	Dec. 23	02	L.Q.	14 28	+76	—	—	15	34	2

IMPACT CRATERS IN CANADA

BY P. BLYTH ROBERTSON, ENERGY, MINES AND RESOURCES CANADA

The search for ancient terrestrial meteorite craters, and investigations in the related fields of shock metamorphism and cratering mechanics, have been carried out since 1951 at the Earth Physics Branch (formerly Dominion Observatory), Department of Energy, Mines and Resources. At large craters, meteoritic material is not preserved; most is completely fused or vaporized at impact, the remainder is removed by erosion. Such impact sites must therefore be identified by the presence of shock metamorphism, the characteristic suite of deformations in the target rocks, uniquely produced by high shock pressures. The twenty "confirmed" structures in the Table contain evidence of shock metamorphism, and are listed in the order of discovery. The "possible" sites represent only a few of those under consideration, where shock metamorphism has not yet been found. The ages quoted are uncertain by at least 10 per cent, and as much as 50 per cent in the case of the values marked "?".

[NOTE: For the sake of brevity, the following letter-code has been used to describe the surface, geological and miscellaneous features of the craters. O: circular feature; WF: water-filled; FS: sediment-filled; SD: shallow depression; C: central elevation or islands; F: fractures; B: breccia; I: impact melt; SF: sedimentary float; BF: breccia float; SC: shatter cones; D: diamond-drilling survey carried out; G: geophysical survey carried out; *: accessible by road. "Float" is material in glacial deposits.—*Ed.*]

Name	Lat.	Long.	Diam. (km.)	Age (M. yr.)	Features
Confirmed sites					
New Quebec Crater, Que.	61°17′	73°40′	3	<1	O, WF/G
Brent, Ont.	46°05′	78°29′	4	450	FS, SD/F/D, G, *
Manicouagan, Que.	51°23′	68°42′	65	210	O, WF, C/I/G
Clearwater Lake West, Que.	56°13′	74°30′	25	285	O, WF, C/I/D, G
Clearwater Lake East, Que.	56°05′	74°07′	14.5	285	O, WF/SF/D, G
Holleford, Ont.	44°28′	76°38′	2	550	FS, SD/D, G, *
Deep Bay, Sask.	56°24′	102°59′	9	100?	O, WF/SF/D, G
Carswell, Sask.	58°27′	109°30′	30	485	O/SC, B/G
Lac Couture, Que.	60°08′	75°18′	10	300	O, WF/BF
West Hawk Lake, Man.	49°46′	95°11′	3	150	O, WF
Pilot Lake, N.W.T.	60°17′	111°01′	5	300?	O, WF/F, BF/D, G, *
Nicholson Lake, N.W.T.	62°40′	102°41′	12.5	300?	WF, C/B/G
Steen River, Alta.	59°31′	117°38′	13.5	95	D, G
Sudbury, Ont.	46°36′	81°11′	100	1700	SD/B, I, SC/D, G, *
Charlevoix, Que.	47°32′	70°18′	35	350	O, SD, C/BF, SC, I/G, *
Lake Mistastin, Labr.	55°53′	63°18′	20	40	WF, C/B, I
Lake St. Martin, Man.	51°47′	98°33′	24	225	I/D, G, *
Lake Wanapitei, Ont.	46°44′	80°44′	8.5	300?	O, WF/BF/G,*
Gow Lake, Sask.	56°27′	104°29′	5	>150	WF, C/B
Lac La Moinerie, Que.	57°26′	66°36′	8	>150	O, WF/BF
Possible sites					
Skeleton Lake, Ont.	45°15′	79°26′	4		O, WF/B, SF/G, *
Kakiattukallak Lake, Que.	57°42′	71°40′	6		O, WF/BF
Meen Lake, N.W.T.	64°58′	87°41′	4		O, WF/B
Charron Lake, Man.	52°44′	95°15′	5		O, WF
Eagle Butte, Alta.	49°42′	110°30′	10		D, *
McIntosh Bay, Ont.	52°35′	94°05′	5		O, WF

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. 50).

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, 1975 (E.S.T.)

JANUARY

d	h	Sat.	Elong.
2	16.3	Rh	E
4	21.6	Ia	E
6	04.1	Ti	W
7	04.6	Rh	E
11	16.9	Rh	E
14	08.5	Ti	E
16	05.2	Rh	E
20	17.5	Rh	E
22	01.4	Ti	W
25	05.9	Rh	E
29	18.2	Rh	E
30	05.8	Ti	E

FEBRUARY

d	h	Sat.	Elong.
3	06.5	Rh	E
6	22.8	Ti	W
7	18.8	Rh	E
12	07.2	Rh	E
12	17.8	Ia	W
15	03.4	Ti	E
16	19.5	Rh	E
21	07.9	Rh	E
22	20.7	Ti	W
25	20.3	Rh	E

MARCH

d	h	Sat.	Elong.
2	08.7	Rh	E
3	01.5	Ti	E
6	21.1	Rh	E
10	19.1	Ti	W
11	09.5	Rh	E
15	21.9	Rh	E
19	00.1	Ti	E
20	10.4	Rh	E
24	10.6	Ia	E
24	22.8	Rh	E
26	18.0	Ti	W
29	11.3	Rh	E

APRIL

d	h	Sat.	Elong.
2	23.8	Rh	E
3	23.3	Ti	E
7	12.3	Rh	E
11	17.4	Ti	W
12	00.8	Rh	E
16	13.3	Rh	E
19	23.0	Ti	E
21	01.8	Rh	E
25	14.3	Rh	E
27	17.2	Ti	W
30	02.9	Rh	E

MAY

d	h	Sat.	Elong.
3	09.1	Ia	W
4	15.4	Rh	E
5	23.2	Ti	E
9	04.0	Rh	E
13	16.5	Rh	E
13	17.5	Ti	W
18	05.1	Rh	E
21	23.7	Ti	E
22	17.7	Rh	E
27	06.3	Rh	E
29	18.0	Ti	W
31	18.9	Rh	E

JUNE

d	h	Sat.	Elong.
5	07.5	Rh	E
7	00.5	Ti	E

Saturn being near the sun, elongations are not given between June 7 and August 21.

AUGUST

d	h	Sat.	Elong.
21	05.6	Rh	E
25	18.2	Rh	E
26	05.3	Ti	E
30	06.8	Rh	E

SEPTEMBER

d	h	Sat.	Elong.
2	20.9	Ia	E
2	23.0	Ti	W
3	19.4	Rh	E
8	07.9	Rh	E
11	05.9	Ti	E
12	20.5	Rh	E
17	09.0	Rh	E
18	23.4	Ti	W
21	21.6	Rh	E
26	10.1	Rh	E
27	06.1	Ti	E
30	22.6	Rh	E

OCTOBER

d	h	Sat.	Elong.
4	23.4	Ti	W
5	11.1	Rh	E
9	23.6	Rh	E
12	16.1	Ia	W
13	06.0	Ti	E
14	12.1	Rh	E
19	00.6	Rh	E
20	23.0	Ti	W
23	13.1	Rh	E
28	01.5	Rh	E
29	05.4	Ti	E

NOVEMBER

d	h	Sat.	Elong.
1	14.0	Rh	E
5	22.2	Ti	W
6	02.4	Rh	E
10	14.8	Rh	E
14	04.4	Ti	E
15	03.3	Rh	E
19	15.7	Rh	E
21	20.9	Ti	W
22	04.2	Ia	E
24	04.1	Rh	E
28	16.4	Rh	E
30	02.8	Ti	E

DECEMBER

d	h	Sat.	Elong.
3	04.8	Rh	E
7	17.2	Rh	E
7	19.1	Ti	W
12	05.5	Rh	E
16	00.8	Ti	E
16	17.9	Rh	E
21	06.2	Rh	E
23	16.9	Ti	W
25	18.5	Rh	E
30	06.8	Rh	E
30	20.0	Ia	W
31	22.3	Ti	E

TABLE OF PRECESSION FOR 50 YEARS

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

R.A. for Dec. −	R.A. for Dec. +	Prec. in Dec.	Precession in right ascension											Prec. in Dec.	R.A. for Dec. +	R.A. for Dec. −
			δ=85°	80°	75°	70°	60°	50°	40°	30°	20°	10°	0°			
h m	h m	′	m	m	m	m	m	m	m	m	m	m	m	′	h m	*h m*
12 00	0 00	+16.7	+ 2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	−16.7	12 00	*24 00*
12 30	0 30	+16.6	4.22	3.38	3.10	2.96	2.81	2.73	2.68	2.64	2.61	2.59	2.56	−16.6	11 30	*23 30*
13 00	1 00	+16.1	5.85	4.19	3.64	3.36	3.06	2.90	2.80	2.73	2.67	2.61	2.56	−16.1	11 00	*23 00*
13 30	1 30	+15.4	7.43	4.98	4.15	3.73	3.30	3.07	2.92	2.81	2.72	2.64	2.56	−15.4	10 30	*22 30*
14 00	2 00	+14.5	8.92	5.72	4.64	4.09	3.52	3.22	3.03	2.88	2.76	2.66	2.56	−14.5	10 00	*22 00*
14 30	2 30	+13.2	10.31	6.40	5.09	4.42	3.73	3.37	3.13	2.95	2.81	2.68	2.56	−13.2	9 30	*21 30*
15 00	3 00	+11.8	11.56	7.02	5.50	4.73	3.92	3.50	3.22	3.02	2.85	2.70	2.56	−11.8	9 00	*21 00*
15 30	3 30	+10.2	12.66	7.57	5.86	4.99	4.09	3.61	3.30	3.07	2.88	2.72	2.56	−10.2	8 30	*20 30*
16 00	4 00	+ 8.3	13.58	8.03	6.16	5.21	4.23	3.71	3.37	3.12	2.91	2.73	2.56	− 8.3	8 00	*20 00*
16 30	4 30	+ 6.4	14.32	8.40	6.40	5.39	4.34	3.79	3.42	3.16	2.93	2.74	2.56	− 6.4	7 30	*19 30*
17 00	5 00	+ 4.3	14.85	8.66	6.58	5.52	4.42	3.84	3.46	3.18	2.95	2.75	2.56	− 4.3	7 00	*19 00*
17 30	5 30	+ 2.2	15.18	8 82	6.68	5.60	4.47	3.88	3.49	3.20	2.96	2.75	2.56	− 2.2	6 30	*18 30*
18 00	6 00	0.0	15.29	8.88	6.72	5.62	4.49	3.89	3.50	3.20	2.97	2.76	2.56	0.0	6 00	*18 00*
0 00	12 00	−16.7	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	+16.7	24 00	*12 00*
0 30	12 30	−16.6	+ 0.90	1.82	2.02	2.16	2.31	2.39	2.44	2.48	2.51	2.53	2.56	+16.6	23 30	*11 30*
1 00	13 00	−16.1	− 0.73	0.93	1.48	1.77	2.06	2.22	2.32	2.39	2.45	2.51	2.56	+16.1	23 00	*11 00*
1 30	13 30	−15.4	− 2.31	+0.14	0.97	1.39	1.82	2.05	2.20	2.31	2.40	2.49	2.56	+15 4	22 30	*10 30*
2 00	14 00	−14.5	− 3.80	−0.60	0.46	1.03	1.60	1.90	2.09	2.24	2.36	2.46	2.56	+14.5	22 00	*10 00*
2 30	14 30	−13 2	− 5.19	−1.28	+0.03	0.70	1.39	1.75	1.99	2.17	2.31	2.44	2.56	+13 2	21 30	*9 30*
3 00	15 00	−11 8	− 6.44	−1.90	−0.38	0.40	1.20	1.62	1.90	2.11	2.27	2.42	2.56	+11.8	21 00	*9 00*
3 30	15 30	−10.2	− 7.54	−2.45	−0.74	+0.13	1.03	1.51	1.81	2.05	2.24	2.40	2.56	+10.2	20 30	*8 30*
4 00	16 00	− 8.3	− 8.46	−2.91	−1.04	−0.09	0.89	1.41	1.75	2.00	2.21	2.39	2.56	+ 8.3	20 00	*8 00*
4 30	16 30	− 6.4	− 9.20	−3.27	−1.28	−0.27	0.78	1.33	1.70	1.97	2.19	2.38	2.56	+ 6.4	19 30	*7 30*
5 00	17 00	− 4.3	− 9.73	−3.54	−1.45	−0.40	0.70	1.28	1.66	1.94	2.17	2.37	2.56	+ 4.3	19 00	*7 00*
5 30	17 30	− 2.2	−10.06	−3.70	−1.56	−0.47	0.65	1.25	1.63	1.92	2.16	2.37	2.56	+ 2.2	18 30	*6 30*
6 00	18 00	0.0	−10.17	−3.75	−1.60	−0.50	0.63	1.23	1.62	1.92	2.16	2.36	2.56	0.0	18 00	*6 00*

FINDING LIST OF NAMED STARS

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

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

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

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

Star	R.A. 1970	Dec.	V	$B–V$	Type		π	M_V	D	μ	R		
	h m	° ′					″		l.y.	″	km./sec.		
γ UMa	11 52.2	+53 52	2.44	0.00	A0	V	0.020	+0.2	90	0.094	−12.9		*Phecda*
δ Cen	12 06.8	−50 33	2.59v	−0.15:	*B2*	*Ve*		−2.7	370	0.042	+09	Var. *R* 2.56–2.62	
ε Crv	08.6	−22 27	3.04	+1.33	K3	III		−0.2	140	0.069	+04.9		
δ Cru	13.5	−58 35	2.81v	−0.23	*B2*	*IV*		−3.4	570	0.041	+26.4	Var *R* 2.78–2.84	
δ UMa	13.9	+57 12	3.30	+0.07	A3	V	0.052	+1.9	63	0.106	−12.9		*Megrez*
γ Crv	14.3	−17 22	2.59	−0.10	B8	III		−3.1	450	0.163	−04.2		*Gienah*
α Cru *A*	24.9	−62 56	1.39	−0.25	*B1*	*IV*		−3.9	370	0.042	*−11.2*	} 5″, *C* 4.90ᵐ 89″	
α Cru *B*	24.9	−62 56	1.86	−0.25	(B3)			−3.4	370	0.042	*−00.6*	}	***Acrux***
δ Crv *A*	28.3	−16 21	2.97	−0.04	B9.5	V:n	0.018	+0.1	124	0.255	+09	*B* 8.26ᵐ 24″	
γ Cru	29.5	−56 57	1.69	+1.55	*M3*	*II*		−2.5	220	0.274	+21.3		*Gacrux*
β Crv	32.8	−23 14	2.66	+0.89	G5	III	0.027	+0.1	108	0.059	−07.7		
α Mus	35.4	−68 58	2.70v	−0.20	*B3*	*IV*		−2.9	430	0.037	+18	Var. *R* 2.66–2.73	
γ Cen *AB*	39.9	−48 48	2.17	+0.00	*A0*	*IV:*	0.006	−0.5	160	0.197	−07.5	*A* 2.9ᵐ *B* 2.9ᵐ 1″	
γ Vir *AB*	40.1	−01 17	2.76	+0.34	F0	V	0.101	+3.5	32	0.567	−19.7	*A* 3.50ᵐ *B* 3.52ᵐ 4″	
β Mus *AB*	44.4	−67 57	3.06	−0.17:	*B3*	*V*		−2.1	470	0.041	+42	*A* 3.7ᵐ *B* 4.0ᵐ 1″	
β Cru	46.0	−59 32	1.28	−0.25	*B0*	*III*		−4.6	490	0.049	+20.0		***Beta Crucis***
ε UMa	52.7	+56 07	1.79	−0.03	A0pv		0.008	+0.2	68	0.113	−09.3	Chromium-europium star	*Alioth*
α CVn *A*	54.6	+38 29	2.90	−0.10	B9.5pv		0.023	+0.1	118	0.238	*−03.3*	Silicon-europium star. *B* 5.61ᵐ 20″	
ε Vir	13 00.7	+11 08	2.86	+0.93	G9	II–III	0.036	+0.6	90	0.274	−14.0		
γ Hya	17.3	−23 01	2.98	+0.92	G8	III	0.021	+0.3	113	0.086	−05.4		
ι Cen	18.9	−36 33	2.76	+0.05	*A2*	*V*	0.046	+1.1	71	0.351	+00.1		
ζ UMa *A*	22.7	+55 05	2.26	+0.02	A2	V	0.037	+0.1	88	0.127	*−09.0*	*B* 3.94ᵐ 14″ (Alcor, 708″)	*Mizar*
α Vir	23.6	−11 00	0.91v	−0.24	B1	V	0.021	−3.3	220	0.054	*+01.0*	Ecl. *R* 0.91–1.01, 4.0ᵈ	***Spica***
ζ Vir	33.2	−00 27	3.40	+0.10	A3	Vn	0.035	+1.1	93	0.287	−13.2		
ε Cen	38.0	−53 19	2.33	−0.23	*B1*	*IV*		−3.9	570	0.033	+05.6		
η UMa	46.4	+49 28	1.87	−0.20	B3	V	0.004	−2.1	210	0.123	−10.9		*Alkaid*
ν Cen	47.7	−41 32	3.42	−0.22	B2	IV		−3.4	750	0.037	*+09.0*		
μ Cen	47.8	−42 20	3.12v	−0.13:	B2	V:pne		−2.7	470	0.032	+12.6	Var. *R* 3.08–3.17	
η Boo	53.3	+18 33	2.69	+0.59	G0	IV	0.102	+2.7	32	0.370	*−00.1*		
ζ Cen	53.7	−47 09	2.56	−0.23:	*B2*	*IV*		−3.4	520	0.076	*+06.5*		

Star	R.A. 1970	Dec.	*V*	*B–V*	Type		π	M_V	D	μ	R		
	h m	° ′					″		l.y.	″	km./sec.		
β Cen *AB*	14 01.7	−60 13	0.63	−0.23:	*B1*	*II:*	0.016	−5.2	490	0.035	*−12*	*A* 0.7^m *B* 3.9^m 1″	***Hadar***
π Hya	04.7	−26 32	3.25	+1.13	K2	III	0.039	+1.2	84	0.156	+27.2		
θ Cen	04.9	−36 14	2.04	+1.03	K0	III–IV	0.059	+0.9	55	0.738	+01.3		*Menkent*
α Boo	14.3	+19 20	−0.06	+1.23	K2	IIIp	0.090	−0.3	36	2.284	−05.2		***Arcturus***
γ Boo	30.9	+38 27	3.05	+0.19	A7	III	0.016	+0.2	118	0.186	−35.5		
η Cen	33.6	−42 01	2.39v	−0.21	B1.5	V:ne		−3.0	390	0.049	−00.2	Var, *R* 2.33–2.45	
α Cen *A*	37 6	−60 43	0.01	+0.68	*G2*	*V*	.751	+4.39	4.3	3.676	−24.6	18″	***Rigil Kentaurus***
α Cen *B*	37.6	−60 43	1.40:	+0.73:	(dK1)			+5.8	4.3		−20.7		
α Lup	40.0	−47 16	2.32	−0.22	B1	V		−3.3	430	0.033	+07.3		
α Cir *AB*	40.1	−64 50	3.18	+0.25	*F0*	*Vp*	0.049	+1.6	66	0.308	+07.4	Strontium star. *A* 3.19^m *B* 8.61^m 16″	
ε Boo *AB*	43.7	+27 12	2.37	+0.96	K1:	III:+A	0.013	+0.0	103	0.051	−16.5	*A* 2.47^m *B* 5.04^m 3″	
α Lib *A*	49.2	−15 52	2.76	+0.15	A3m		0.049	+1.2	66	0.130	−10	*B* 5.15^m 231″	*Zubenelgenubi*
β UMi	50.8	+74 16	2.04	+1.47	K4	III	0.031	−0.5	105	0.033	+16.9		*Kochab*
β Lup	56.6	−43 01	2.69	−0.23	B2	IV		−3.4	540	0.066	−00.3		
κ Cen	57.1	−41 59	3.15	−0.21	B2	V		−2.7	470	0.033	+09.1		
β Boo	15 00.8	+40 30	3.48	+0.95	G8	III	0.022	+0.3	140	0.059	−19.9		
σ Lib	02.3	−25 10	3.31	+1.65	M4	III	0.056	+2.0:	58:	0.089	−04.3		
ζ Lup *A*	10.1	−51 59	3.42	+0.90:	*K0*	*III*	0.036	+1.2	90	0.135	−09.7	*B* 7.8^m 71″	
δ Boo *A*	14.3	+33 26	3.47	+0.95	G8	III	0.028	+0.3	140	0.148	−12.2	*B* 7.84^m 105″	
β Lib	15.4	−09 16	2.61	−0.11	B8	V	−.012	−0.6	140	0.101	−35.2		
γ TrA	16.1	−68 34	2.94	−0.01	*A0*	*Vp*	0.005	+0.2	113	0.067	00	Europium star	
δ Lup	19.4	−40 32	3.24	−0.23	B2	IV		−3.4	680	0.032	+02		
γ UMi	20.8	+71 56	3.08	+0.06	A3	II–III	−.005	−1.5	270	0.026	*−03.9*		
ι Dra	24.3	+59 04	3.28	+1.18	K2	III	0.032	+0.8	102	0.012	−11.0		
γ Lup *AB*	33.1	−41 04	2.80	−0.22	B2	Vn		−2.7	570	0.037	+06	*A* 3.5^m *B* 3.7^m 1″	
α CrB	33.4	+26 49	2.23v	−0.02	A0	V	0.043	+0.4	76	0.154	*+01.7*	Ecl. *R* 0.11^m, 17.4^d	*Alphecca*
α Ser	42.8	+06 31	2.65	+1.17	K2	III	0.046	+1.0	71	0.139	+02.9		
β TrA	52.5	−63 20	2.87	+0.28:	*F2*	*V*	0.078	+2.3	42	0.448	−00.3		
π Sco	57.0	−26 02	2.92	−0.19	B1	V	0.005	−3.3	570	0.034	*−03*		
η Lup *AB*	58.1	−38 19	3.45	−0.23	B2	V		−2.7	570	0.042	+07	*A* 3.47^m *B* 7.70^m 15″	
δ Sco	58.6	−22 32	2.34	−0.13	B0	V		−4.0	590	0.032	−14		

Star	R.A. 1970	Dec.	V	$B–V$	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
β Sco *AB*	16 03.7	−19 43	2.65	−0.09	B0.5 V	0.004	−3.7	650	0.027	*−06.6*	*A* 2.78^m *B* 5.04^m 1″, *C* 4.93^m 14″	
δ Oph	12.8	−03 36	2.72	+1.59	M1 III	0.029	−0.5	140	0.156	−19.9		
ε Oph	16.7	−04 38	3.22	+0.97	G9 III	0.036	+1.0	90	0.089	−10.3		
σ Sco *A*	19.4	−25 31	2.86v	+0.14	B1 III		−4.4	570	0.030	*−00.4*	β CMa *R* 2.82–2.90, 0.25^d, *B* 8.49^m 20″	
η Dra *A*	23.6	+61 34	2.71	+0.92	G8 III	0.043	+0.9	76	0.062	−14.3	*B* 8.7^m 6″	
α Sco *A*	27.6	−26 22	0.92v	+1.84	M1 Ib+B	0.019	−5.1	520	0.029	−03.2	*A* 0.86^m–1.02^m *B* 5.07^m 3″	*Antares*
β Her	28.9	+21 33	2.78	+0.92	G8 III	0.017	+0.3	103	0.105	*−25.5*		
τ Sco	34.0	−28 09	2.85	−0.25	B0 V		−4.0	750	0.030	−00.7		
ζ Oph	35.5	−10 30	2.57	+0.00	O9.5 V	−.007	−4.3	520	0.022	−19		
ζ Her *AB*	40.2	+31 39	2.81	+0.64	G0 IV	0.110	+3.1	30	0.608	*−69.9*	*A* 2.91^m *B* 5.46^m 1″	
η Her	41.9	+38 59	3.46	+0.92	G7 III–IV	0.053	+2.1	62	0.097	+08.3		
α TrA	45.5	−68 59	1.93	+1.43	*K2 III*	0.024	−0.1	82	0.044	−03.6		*Atria*
ε Sco	48.2	−34 15	2.28	+1.16	*K2 III–IV*	0.049	+0.7	66	0.664	−02.5		
μ[1] Sco	49.8	−38 00	2.99v	−0.20	B1.5 V		−3.0	520	0.033	*−25*	Ecl. *R* 2.99–3.09, 1.4^d	
ζ Ara	56.1	−55 56	3.16	+1.61	(gK5)	0.036	+0.9	90	0.042	−06.0		
κ Oph	56.3	+09 26	3.18	+1.15	K2 III	0.026	−0.1	150	0.293	−55.6		
ζ Dra	17 08.7	+65 45	3.20	−0.12	B6 III	0.017	−3.2	620	0.026	−14.1		
η Oph *AB*	08.7	−15 41	2.46	+0.06	A2.5 V	0.047	+1.4	69	0.097	−00.9	*A* 3.0^m *B* 3.4^m 1″	*Sabik*
η Sco	10.0	−43 12	3.33	+0.38	*F2 III*	0.063	+2.3	52	0.293	−28.4		
α Her *AB*	13.3	+14 25	3.10v	+1.41	M5 II	−.007	−2.3	410	0.032	−33.1	*A* 3.2^m ± 0.3 *B* 5.4^m 5″	*Ras-Algethi*
δ Her	13.8	+24 52	3.14	+0.09	A3 IV	0.034	+0.8	96	0.164	−41		
π Her	14.0	+36 50	3.13	+1.43	K3 II	0.020	−2.4	410	0.029	−25.7		
θ Oph	20.2	−24 58	3.29	−0.22	B2 IV		−3.4	710	0.025	−03.6		
β Ara	22.8	−55 30	2.90	+1.45:	*K3 Ib*	0.026	−4.6	1030	0.035	−00.4		
γ Ara *A*	22.9	−56 21	3.32	−0.16	*B1 V*		−3.3	680	0.017	−04	*B* 10^m 18″	
υ Sco	28.7	−37 16	2.71	−0.22	*B2 IV*		−3.4	540	0.039	*+18*		
α Ara	29.5	−49 52	2.95	−0.18:	B2.5 V		−2.4	390	0.083	*−02*		
β Dra *A*	29.7	+52 20	2.77	+0.96	G2 II	0.009	−2.1	310	0.019	−20.0	*B* 11.49^m 4″	
λ Sco	31.6	−37 05	1.60	−0.24	B1 V		−3.3	310	0.031	00		*Shaula*
α Oph	33.5	+12 35	2.09	+0.16	A5 III	0.056	+0.8	58	0.260	+12.7		*Rasalhague*
θ Sco	35.2	−42 59	1.86	+0.39	*F0 Ib*	0.020	−4.6	650	0.012	+01.4		

Star	R.A. 1970	Dec.	V	B–V	Type	π	M_V	D	μ	R	
	h m	° ′				″		l.y.	″	km./sec.	
κ Sco	17 40.4	−39 01	2.39	−0.21	*B2 IV*		−3.4	470	0.031	−10	
β Oph	42.0	+04 35	2.77	+1.16	K2 III	0.023	−0.1	124	0.160	−12.0	
μ Her *A*	45.3	+27 45	3.42	+0.75	G5 IV	0.108	+3.6	30	0.811	−15.6	*BC* 9.78^m 33″
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	*Nunki*
ξ^2 Sgr	55.9	−21 08	3.51	+1.18:	(gK1)	0.006	+0.0	160	0.035	−19.9	
γ Lyr	57.8	+32 39	3.25	−0.05	B9 III	0.011	−2.1	370	0.007	−21.5	
ζ Sgr *AB*	19 00.7	−29 55	2.61	+0.08	*A2 IV*	0.020	+0.1	140	0.020	+22	*A* 3.3^m *B* 3.5^m 1″
ζ Aql *A*	04.0	+13 49	2.99	+0.01	A0 V:nn	0.036	+0.8	90	0.101	−26.3	*B* 12^m 5″
λ Aql	04.7	−04 56	3.44	−0.07	B9: V:n	0.025	−0.1	160	0.092	−14	
τ Sgr	05.1	−27 43	3.30	+1.18	(gK1)	0.038	+1.2	86	0.261	*+45.4*	
π Sgr *ABC*	08.0	−21 04	2.89	+0.35	F2 II–III	0.016	−0.7	250	0.040	−09.8	*A* 3.7^m *B* 3.8^m *C* 6.0^m < 1″
δ Dra	12.5	+67 37	3.06	+1.00	G9 III	0.028	+0.2	124	0.130	+24.8	
δ Aql	24.0	+03 03	3.38	+0.31	F0 IV	0.062	+2.3	53	0.267	*−29.9*	
β Cyg *A*	29.5	+27 54	3.07	+1.12	K3 II:+B:	0.004	−2.4	410	0.009	−24.0	*B* 5.11^m 35″ *Albireo*
δ Cyg *AB*	44.0	+45 04	2.87	−0.03	B9.5 III	0.021	−1.7	270	0.060	−21	*A* 2.91^m *B* 6.44^m 2″
γ Aql	44.8	+10 32	2.67	+1.48	K3 II	0.006	−2.4	340	0.012	−02.1	
α Aql	49.3	+08 47	0.77	+0.22	A7 IV, V	0.198	+2.2	16.5	0.658	−26.3	***Altair***

Star	R.A. 1970	Dec.	V	$B–V$	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
θ Aql	20 09.8	−00 54	3.31	−0.07	B9.5 III	0.008	−1.7	330	0.034	*−27.3*		
β Cap *A*	19.3	−14 53	3.06	+0.76	comp.	0.005	+0.1	130	0.039	−18.9	Type gK0: + late B; *B* 5.97ᵐ 205″	
γ Cyg	21.1	+40 09	2.22	+0.66	F8 Ib	−.006	−4.6	750	0.001	−07.5		
α Pav	23.3	−56 50	1.95	−0.20	*B3 IV*		−2.9	310	0.087	*+02.0*		*Peacock*
α Ind	35.5	−47 23	3.11	+1.00	*K0 III*	0.039	+1.1	84	0.082	−01.1		
α Cyg	40.4	+45 10	1.26	+0.09	A2 Ia	−.013	−7.1	1600	0.003	−04.6		***Deneb***
β Pav	42.3	−66 19	3.45	+0.16	*A5 III*	0.026	−0.1	160	0.046	+09.8		
η Cep	44.7	+61 43	3.41	+0.92	K0 IV	0.071	+2.7	46	0.825	−87.3		
ε Cyg	45.0	+33 51	2.46	+1.03	K0 III	0.044	+0.7	74	0.481	*−10.3*		
ζ Cyg	21 11.7	+30 06	3.25:		G8 II	0.021	−2.2	390	0.056	+17.4		
α Cep	17.9	+62 28	2.44	+0.24	A7 IV, V	0.063	+1.4	52	0.156	−10		*Alderamin*
β Cep	28.3	+70 25	3.15v	−0.22v	B2 III	0.005	−4.2	980	0.014	−08.2	β CMa *R* 3.14–3.16, 0.19ᵈ	
β Aqr	30.0	−05 43	2.86	+0.82	G0 Ib	0.000	−4.6	1030	0.017	+06.5		
ε Peg *A*	42.7	+09 45	2.31	+1.55	K2 Ib	−.005	−4.6	780	0.025	+04.7	*B* 11ᵐ 82″	*Enif*
δ Cap	45.4	−16 16	2.92v	+0.29	A6m	0.065	+2.0	50	0.392	*−06.3*	Var. *R* 2.88–2.95	
γ Gru	52.1	−37 30	3.03	−0.10	*B8 III:*	0.008	−3.1	540	0.102	−02.1		
α Aqr	22 04.2	−00 28	2.96	+0.96	G2 Ib	0.003	−4.6	1080	0.016	+07.5		
α Gru	06.3	−47 07	1.76	−0.14	*B5 V*	0.051	+0.3:	64:	0.194	+11.8		*Al Na'ir*
ζ Cep	09.8	+58 03	3.31	+1.55	K1 Ib	0.019	−4.6	1240	0.015	*−18.4*		
α Tuc	16.4	−60 24	2.87	+1.40	*K3 III–IV*	0.019	+1.5	62	0.079	*+42.2*		
δ Cep *A*	28.1	+58 16	3.96v	+0.66v	F5–G2 Ib	0.005	−4.0	1300	0.012	*−16.8*	Cep. *R* 3.51–4.42, 5.4ᵈ *B* 6.19ᵐ 41″	
ζ Peg	40.0	+10 41	3.40:	−0.08:	B8 V	−.004	−0.6	210	0.077	+07		
β Gru	40.9	−47 02	2.17v	+1.59	*M3 II*	0.003	−2.5	280	0.134	+01.6	Var. *R* 2.11–2.23	
η Peg	41.6	+30 04	2.95	+0.85	G8 II: + F?	−.002	−2.2	360	0.027	*+04.3*		
δ Aqr	53.1	−15 59	3.28	+0.08	A3 V	0.039	+1.2	84	0.047	+18.0		
α PsA	56.0	−29 47	1.19	+0.10	A3 V	0.144	+2.0	22.6	0.367	+06.5		***Fomalhaut***
β Peg	23 02.3	+27 55	2.5 v	+1.67	M2 II–III	0.015	−1.5	210	0.234	+08.7	Var. *R* 2.4–2.7	*Scheat*
α Peg	03.3	+15 02	2.50	−0.03	B9.5 III	0.030	−0.1	109	0.071	−03.5		*Markab*
γ Cep	38.1	+77 27	3.20	+1.02	K1 IV	0.064	+2.2	51	0.168	−42.4		

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.

THE NEAREST STARS

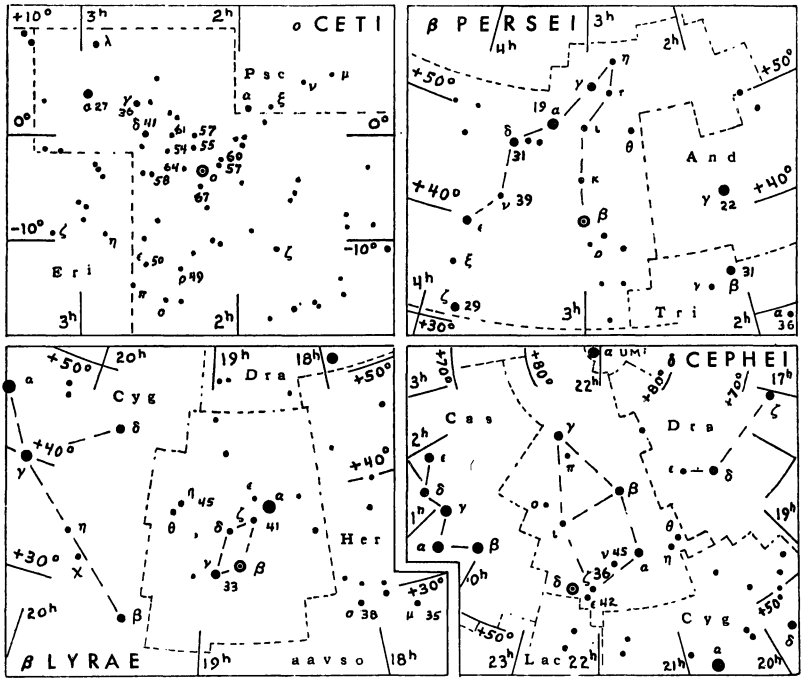
Name	1970								
	α	δ	π	D	Sp.	μ	W	m	L
	h m	° ′	″	l.y.		″	km./sec.		
Sun					G2			−26.8	1.0
α Cen A	14 37	−60 43	0.760	4.3	G2	3.68	32	0.1	1.3
B					K5			1.5	0.36
C	14 27	−62 33			M5*e*			11.0	0.00006
Barnard's*	17 56	+04 36	.552	5.9	M5	10.30	140	9.5	0.00044
Wolf 359	10 55	+07 13	.431	7.6	M6*e*	4.84	55	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.

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*, 1974, International Supplement.



LONG-PERIOD VARIABLE STARS

Variable	Max. m	Per d	Epoch 1975	Variable	Max. m	Per d	Epoch 1975
001755 T Cas	7.8	445	—	142539 V Boo	7.9	258	Feb. 14
001838 R And	7.0	409	Oct. 11	143227 R Boo	7.2	223	Apr. 17
021143 W And	7.4	397	Nov. 6	151731 S CrB	7.3	361	Feb. 1
0214*03* o Cet	3.4	332	Mar. 3	154639 V CrB	7.5	358	Oct. 31
0228*13* U Cet	7.5	235	July 5	154615 R Ser	6.9	357	Sept. 19
023133 R Tri	6.2	266	May 7	160625 RU Her	8.0	484	Mar. 22
043065 T Cam	8.0	374	Nov. 29	162119 U Her	7.5	406	May 7
0455*14* R Lep	6.8	432	Apr. 22	1621*12* V Oph	7.5	298	Oct. 9
050953 R Aur	7.7	459	Aug. 28	163266 R Dra	7.6	245	May 20
054920 U Ori	6.3	372	Aug. 8	164715 S Her	7.6	307	July 1
0617*02* V Mon	7.0	335	June 4	1702*15* R Oph	7.9	302	Feb. 28
065355 R Lyn	7.9	379	Apr. 2	171723 RS Her	7.9	219	May 15
070122aR Gem	7.1	370	June 21	180531 T Her	8.0	165	Mar. 22
070310 R CMi	8.0	338	Sept. 15	181136 W Lyr	7.9	196	Mar. 28
072708 S CMi	7.5	332	May 12	183308 X Oph	6.8	334	Feb. 28
081112 R Cnc	6.8	362	Dec. 24	190108 R Aql	6.1	300	Aug. 16
081617 V Cnc	7.9	272	Sept. 11	1910*17* T Sgr	8.0	392	Apr. 27
084803 S Hya	7.8	257	Feb. 16	1910*19* R Sgr	7.3	269	May 26
0850*08* T Hya	7.8	288	May 11	193449 R Cyg	7.5	426	Feb. 11
093934 R LMi	7.1	372	Mar. 1	194048 RT Cyg	7.3	190	Mar. 25
094211 R Leo	5.8	313	July 23	194632 χ Cyg	5.2	407	May 12
103769 R UMa	7.5	302	July 2	201647 U Cyg	7.2	465	Oct. 28
1214*18* R Crv	7.5	317	Feb. 17	2044*05* T Aqr	7.7	202	May 14
122001 SS Vir	6.8	355	Dec. 20	210868 T Cep	6.0	390	June 25
123160 T UMa	7.7	257	Apr. 26	213753 RU Cyg	8.0	234	Aug. 20
123307 R Vir	6.9	146	Apr. 4	230110 R Peg	7.8	378	Feb. 11
123961 S UMa	7.8	226	July 21	230759 V Cas	7.9	228	Apr. 12
131546 V CVn	6.8	192	June 6	231508 S Peg	8.0	319	Jan. 17
1327*06* S Vir	7.0	378	Jan. 14	2338*15* R Aqr	6.5	387	—
134440 R CVn	7.7	328	July 8	235350 R Cas	7.0	431	Nov. 23
142584 R Cam	7.9	270	July 25	2357*15* W Cet	7.6	351	Mar. 20

OTHER TYPES OF VARIABLE STARS

Variable	Max. m	Min. m	Type	Sp. Cl.	Period d	Epoch 1974 E.S.T.
005381 U Cep	6.7	9.8	Ecl.	B8+gG2	2.49302	Jan. 2.31*
025838 ρ Per	3.3	4.0	Semi R	M4	33–55, 1100	—
030140 β Per	2.1	3.3	Ecl.	B8+G	2.86731	Jan. 3.09*
035512 λ Tau	3.5	4.0	Ecl.	B3	3.952952	Jan. 1.30*
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. 19.38
065820 ζ Gem	4.4	5.2	δ Cep	F7–G3	10.15172	Jan. 2.92
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. 6.23*
192242 RR Lyr	6.9	8.0	RR Lyr	A2–F1	0.5668223	Jan. 1.17
194700 η Aql	4.1	5.2	δ Cep	F6–G4	7.176641	Jan. 1.56
222557 δ Cep	4.1	5.2	δ Cep	F5–G2	5.366341	Jan. 5.79

*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 1975. 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. 1975.0 h	m	Dec. °	′	Magnitudes comb.	A	B	P.A. 1975.0 °	Sep. ″	P (app.) years
λ	Cas	434	00	30.4	+54	24	4.9	5.5	5.8	181	0.6	640
α	Psc	1615	02	00.7	+02	39	4.0	4.3	5.3	285	1.8	720
33	Ori	4123	05	29.9	+03	16	5.7	6.0	7.3	27	1.8	—
OΣ	156	5447	06	46.0	+18	13	6.1	6.8	7.0	247	0.5	1100
Σ	1338	7307	09	19.4	+38	18	5.8	6.5	6.7	246	1.1	400
35	Com	8695	12	52.1	+21	23	5.1*	5.2	7.4	158	1.0	500
Σ	2054	10052	16	23.5	+61	45	5.6	6.0	7.2	355	1.1	—
ε^1	Lyr†	11635	18	43.5	+39	38	5.1	5.4	6.5	356	2.7	1200
ε^2	Lyr†	11635	18	43.5	+39	38	4.4	5.1	5.3	86	2.3	600
π	Aql	12962	19	47.5	+11	44	5.6	6.0	6.8	110	1.4	—
OΣ	500	16877	23	36.3	+44	18	5.9	6.4	7.1	350	0.5	—
η	Cas	671	00	47.4	+57	42	3.5*	3.5	7.2	304	11.7	480
Σ	186	1538	01	54.5	+01	44	6.0	6.8	6.8	53	1.3	160
γ	And AB	1630	02	02.1	+42	15	2.1*	2.1	5.1	64	9.8	—
γ	And BC	1630	02	02.1	+42	15	5.1	5.5	6.3	109	0.5	61
OΣ	65	2799	03	48.9	+25	31	5.2	5.8	6.2	206	0.7	62
α	CMa	5423	06	44.1	−16	40	−1.4	−1.4	8.5	59	11.2	50
α	Gem	6175	07	33.0	+31	56	1.6	2.0	2.8	112	2.0	420
ζ	Cnc AB	6650	08	10.8	+17	44	5.0	5.6	5.9	308	0.9	60
ζ	Cnc AC	6650	08	10.8	+17	44	5.2	5.4	7.3	83	5.9	1150
σ^2	UMa	7203	09	08.2	+67	14	4.8*	4.8	8.2	6	3.0	1100
γ	Leo	7724	10	18.6	+19	59	1.8	2.1	3.4	123	4.4	620
ξ	UMa	8119	11	16.8	+31	41	3.8	4.3	4.8	114	3.0	60
γ	Vir	8630	12	40.4	−01	19	2.8	3.5	3.5	300	4.2	170
ζ	Boo	9343	14	39.9	+13	50	3.8	4.5	4.5	307	1.1	125
ξ	Boo	9413	14	50.2	+19	13	4.5	4.7	6.8	336	7.2	150
ζ	Her	10157	16	40.4	+31	39	2.8	2.9	5.5	180	1.2	35
τ	Oph	11005	18	01.6	−08	11	4.7	5.2	5.9	276	1.9	280
70	Oph	11046	18	04.2	+02	32	4.0	4.2	6.0	12	1.9	88
δ	Cyg	12880	19	44.2	+45	03	2.9*	2.9	6.3	236	2.3	830
4	Aqr	14360	20	50.1	−05	54	6.0	6.4	7.2	10	0.9	150
τ	Cyg	14787	21	13.7	+37	56	3.7	3.8	6.4	167	1.0	50
μ	Cyg	15270	21	43.0	+28	38	4.5	4.8	6.1	294	1.9	500
ζ	Aqr	15971	22	27.5	−00	10	3.6	4.3	4.5	236	1.8	850
Σ	3050	17149	23	58.2	+33	35	5.8	6.5	6.7	302	1.5	350

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

MESSIER'S CATALOGUE OF DIFFUSE OBJECTS

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

M	NGC	Con	α 1970 δ		m_V	Type
1	1952	Tau	5 32.7	+22 01	11.3	DN*
2	7089	Aqr	21 31.9	−00 57	6.27	GC*
3	5272	CVn	13 40.8	+28 32	6.22	GC*
4	6121	Sco	16 21.8	−26 26	6.07	GC*
5	5904	Ser	15 17.0	+02 13	5.99	GC*
6	6405	Sco	17 38.1	−32 11	6	OC*
7	6475	Sco	17 51.9	−34 48	5	OC*
8	6523	Sgr	18 01.8	−24 23		DN*
9	6333	Oph	17 17.5	−18 29	7.58	GC
10	6254	Oph	16 55.5	−04 04	6.40	GC*
11	6705	Sct	18 49.5	−06 19	7	OC*
12	6218	Oph	16 45.6	−01 54	6.74	GC*
13	6205	Her	16 40.6	+36 31	5.78	GC*
14	6402	Oph	17 36.0	−03 14	7.82	GC
15	7078	Peg	21 28.6	+12 02	6.29	GC*
16	6611	Ser	18 17.2	−13 48	7	OC*
17	6618	Sgr	18 19.1	−16 12	7	DN*
18	6613	Sgr	18 18.2	−17 09	7	OC
19	6273	Oph	17 00.7	−26 13	6.94	GC
20	6514	Sgr	18 00.6	−23 02		DN*
21	6531	Sgr	18 02.8	−22 30	7	OC
22	6656	Sgr	18 34.6	−23 56	5.22	GC*
23	6494	Sgr	17 55.1	−19 00	6	OC*
24	6603	Sgr	18 16.7	−18 27	6	OC
25	4725†	Sgr	18 29.9	−19 16	6	OC*
26	6694	Sct	18 43.6	−09 26	9	OC
27	6853	Vul	19 58.4	+22 38	8.2	PN*
28	6626	Sgr	18 22.6	−24 52	7.07	GC
29	6913	Cyg	20 22.9	+38 25	8	OC
30	7099	Cap	21 38.6	−23 18	7.63	GC
31	224	And	0 41.1	+41 06	3.7	G-Sb*
32	221	And	0 41.1	+40 42	8.5	G-E*
33	598	Tri	1 32.2	+30 30	5.9	G-Sc*
34	1039	Per	2 40.1	+42 40	6	OC
35	2168	Gem	6 07.0	+24 21	6	OC*
36	1960	Aur	5 34.3	+34 05	6	OC
37	2099	Aur	5 50.4	+32 33	6	OC*
38	1912	Aur	5 26.6	+35 48	6	OC
39	7092	Cyg	21 31.1	+48 18	6	OC
40	—	UMa	—	—		2 stars
41	2287	CMa	6 45.8	−20 42	6	OC*
42	1976	Ori	5 33.9	−05 24		DN*
43	1982	Ori	5 34.1	−05 18		DN
44	2632	Cnc	8 38.2	+20 06	4	OC*
45	—	Tau	3 45.7	+24 01	2	OC*
46	2437	Pup	7 40.4	−14 45	7	OC*
47	2422	Pup	7 35.1	−14 26	5	OC
48	2548	Hya	8 12.0	−05 41	6	OC
49	4472	Vir	12 28.3	+08 10	8.9	G-E*
50	2323	Mon	7 01.5	−08 18	7	OC
51	5194	CVn	13 28.6	+47 21	8.4	G-Sc*
52	7654	Cas	23 22.9	+61 26	7	OC
53	5024	Com	13 11.5	+18 20	7.70	GC
54	6715	Sgr	18 53.2	−30 31	7.7	GC
55	6809	Sgr	19 38.1	−31 01	6.09	GC*
56	6779	Lyr	19 15.4	+30 07	8.33	GC
57	6720	Lyr	18 52.5	+33 00	9.0	PN*
58	4579	Vir	12 36.2	+11 59	9.9	G-SBb
59	4621	Vir	12 40.5	+11 50	10.3	G-E
60	4649	Vir	12 42.1	+11 44	9.3	G-E
61	4303	Vir	12 20.3	+04 39	9.7	G-Sc
62	6266	Sco	16 59.3	−30 04	7.2	GC
63	5055	CVn	13 14.4	+42 11	8.8	G-Sb*
64	4826	Com	12 55.2	+21 51	8.7	G-Sb*
65	3623	Leo	11 17.3	+13 16	9.6	G-Sa
66	3627	Leo	11 18.6	+13 10	9.2	G-Sb
67	2682	Cnc	8 49.5	+11 56	7	OC*
68	4590	Hya	12 37.8	−26 35	8.04	GC
69	6637	Sgr	18 29.4	−32 23	7.7	GC
70	6681	Sgr	18 41.3	−32 19	8.2	GC
71	6838	Sge	19 52.4	+18 42	6.9	GC
72	6981	Aqr	20 51.8	−12 41	9.15	GC
73	6994	Aqr	20 57.3	−12 46		OC
74	628	Psc	1 35.1	+15 38	9.5	G-Sc
75	6864	Sgr	20 04.3	−22 01	8.31	GC
76	650	Per	1 40.3	+51 25	11.4	PN*
77	1068	Cet	2 41.1	−00 07	9.1	G-Sb
78	2068	Ori	5 45.3	+00 02		DN
79	1904	Lep	5 22.9	−24 33	7.3	GC
80	6093	Sco	16 15.2	−22 55	7.17	GC
81	3031	UMa	9 53.4	+69 12	6.9	G-Sb*
82	3034	UMa	9 53.6	+69 50	8.7	G-Irr*
83	5236	Hya	13 35.3	−29 43	7.5	G-Sc*
84	4374	Vir	12 23.6	+13 03	9.8	G-E
85	4382	Com	12 23.8	+18 21	9.5	G-SO
86	4406	Vir	12 24.6	+13 06	9.8	G-E
87	4486	Vir	12 29.2	+12 33	9.3	G-Ep
88	4501	Com	12 30.4	+14 35	9.7	G-Sb
89	4552	Vir	12 34.1	+12 43	10.3	G-E
90	4569	Vir	12 35.3	+13 19	9.7	G-Sb
91	—	—	—	—		M58?
92	6341	Her	17 16.2	+43 11	6.33	GC*
93	2447	Pup	7 43.2	−23 48	6	OC
94	4736	CVn	12 49.6	+41 17	8.1	G-Sb*
95	3351	Leo	10 42.3	+11 52	9.9	G-SBb
96	3368	Leo	10 45.1	+11 59	9.4	G-Sa
97	3587	UMa	11 13.1	+55 11	11.1	PN*
98	4192	Com	12 12.2	+15 04	10.4	G-Sb
99	4254	Com	12 17.3	+14 35	9.9	G-Sc
100	4321	Com	12 21.4	+15 59	9.6	G-Sc
101	5457	UMa	14 02.1	+54 30	8.1	G-Sc*
102	—	—	—	—		M101?
103	581	Cas	1 31.2	+60 32	7	OC

†Index Catalogue Number.

STAR CLUSTERS

By T. Schmidt-Kaler

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

The first table includes all well-defined open clusters with diameters greater than 40′ or integrated magnitudes brighter than 5.0, as well as the richest clusters and some of special interest. *NGC* indicates the serial number of the cluster in Dreyer's *New General Catalogue of Clusters and Nebulae*, *M*, its number in Messier's catalogue, α and δ denote right ascension and declination, *P*, the apparent integrated photographic magnitude according to Collinder (1931), *D*, the apparent diameter in minutes of arc according to Trumpler (1930) when possible, in one case from Collinder; *m*, the photographic magnitude of the fifth-brightest star according to Shapley (1933) when possible or from new data, in italics; *r*, the distance of the cluster in kpcs (1 kpc = 3263 light-years), usually as given by Becker and Fenkart (1971); Sp, the earliest spectral type of cluster stars as a mean determined from three colour photometry and directly from the stellar spectra. The spectral type indicates the age of the cluster, expressed in millions of years, thus: O5 = 2, B0 = 8, B5 = 70, A0 = 400, A5 = 1000, F0 = 3000 and F5 = 10000.

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

Open Clusters

NGC	α 1970 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
2422	07 34.2	−14 26	4.3	30	9.8	0.48	B3	

***Basic for distance determination.**

NGC	α 1970 δ							
	h m	° ′	P	D	m	r	Sp	Remarks
2437	07 40.4	−14 45	6.6	27	10.8	1.66	B8	M46
2451	07 44.3	−37 54	3.7	37	6	0.30	B5	
2516	07 57.8	−60 49	3.3	50	10.1	0.37	B8	
2546	08 11.4	−37 33	5.0	45	7	0.84	B0	
2632	08 38.4	+20 06	3.9	90	7.5	0.158	A0	Praesepe, M44
IC2391	08 39.4	−52 57	2.6	45	3.5	0.15	B4	
IC2395	08 40.1	−48 05	4.6	20	10.1	0.90	B2	
2682	08 48.8	+11 56	7.4	18	10.8	0.83	F2	M67, old cl.
3114	10 01.7	−59 58	4.5	37	7	0.85	B5	
IC2602	10 42.2	−64 14	1.6	65	6	0.15	B1	θ Car
Tr 16	10 44.0	−59 33	6.7	10	10	2.95	O5	η Car and Nebula
3532	11 05.1	−58 30	3.4	55	8.1	0.42	B8	
3766	11 34.7	−61 27	4.4	12	8.1	1.79	B1	
Coma	12 23.6	+26 16	2.9	300	5.5	0.08	A1	Very sparse cl.
4755	12 51.8	−60 10	5.2	12	7	2.10	B3	κ Cru, "jewel box"
6067	16 10.9	−54 08	6.5	16	10.9	1.45	B3	G and K supergiants
6231	16 51.9	−41 45	8.5	16	7.5	1.77	O9	O supergiants, WR-stars
Tr 24	16 54.9	−40 37	8.5	60	*7.3*	1.60	O5	
6405	17 38.1	−32 12	4.6	26	8.3	0.45	B4	M6
IC4665	17 45.2	+05 44	5.4	50	7	0.33	B8	
6475	17 51.9	−34 48	3.3	50	7.4	0.23	B5	M7
6494	17 55.1	−19 01	5.9	27	10.2	0.44	B8	M23
6523	18 01.3	−24 23	5.2	45	*7*	1.56	O5	M8, Lagoon neb. and very young cl. NGC6530
6611	18 17.2	−13 48	6.6	8	10.6	1.69	O7	M16, nebula
IC4725	18 29.9	−19 16	6.2	35	9.3	0.60	B3	M25, Cepheid, U Sgr
IC4756	18 37.8	+05 25	5.4	50	8.5	0.44	A3	
6705	18 49.5	−06 19	6.8	12.5	12	1.70	B8	M11, very rich cl.
Mel 227	20 06.7	−79 25	5.2	60	*9*	0.24	B9	
IC1396	21 38.0	+57 22	5.1	60	*8.5*	0.71	O6	Tr 37
7790	23 56.9	+61	7.1	4.5	11.7	3.16	B1	C Ceph: CEa, CEb, CF Cas

Globular Clusters

NGC	M	α 1970 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 0532	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}.

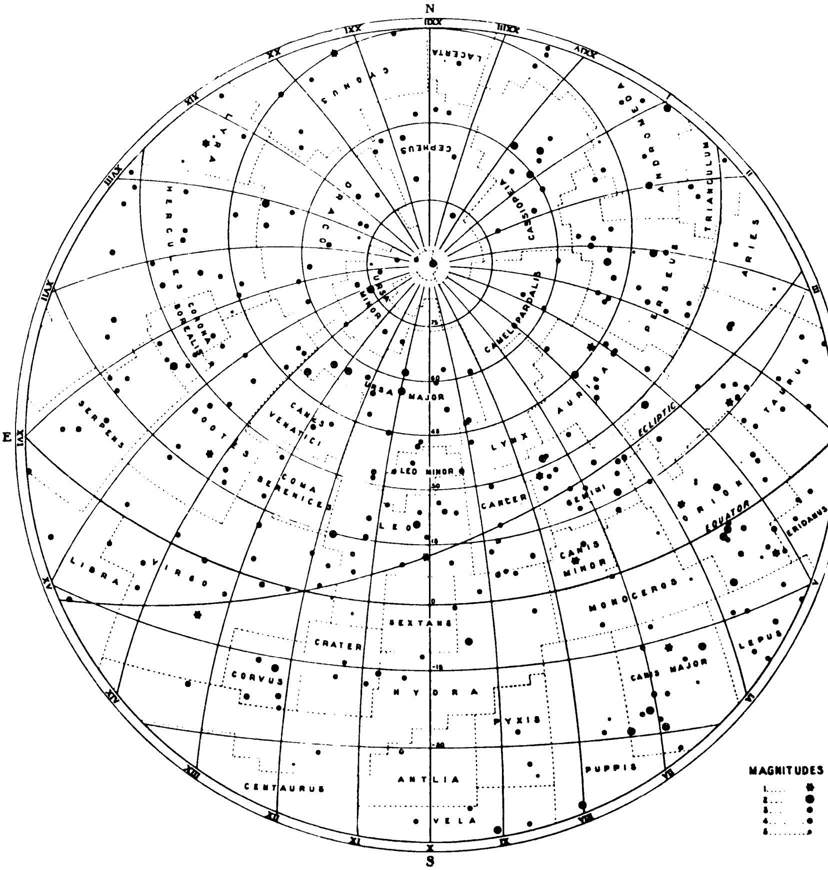
THE BRIGHTEST GALAXIES

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

THE NEAREST GALAXIES

Name	NGC	α 1970 δ h m	° ′	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

STAR MAP I

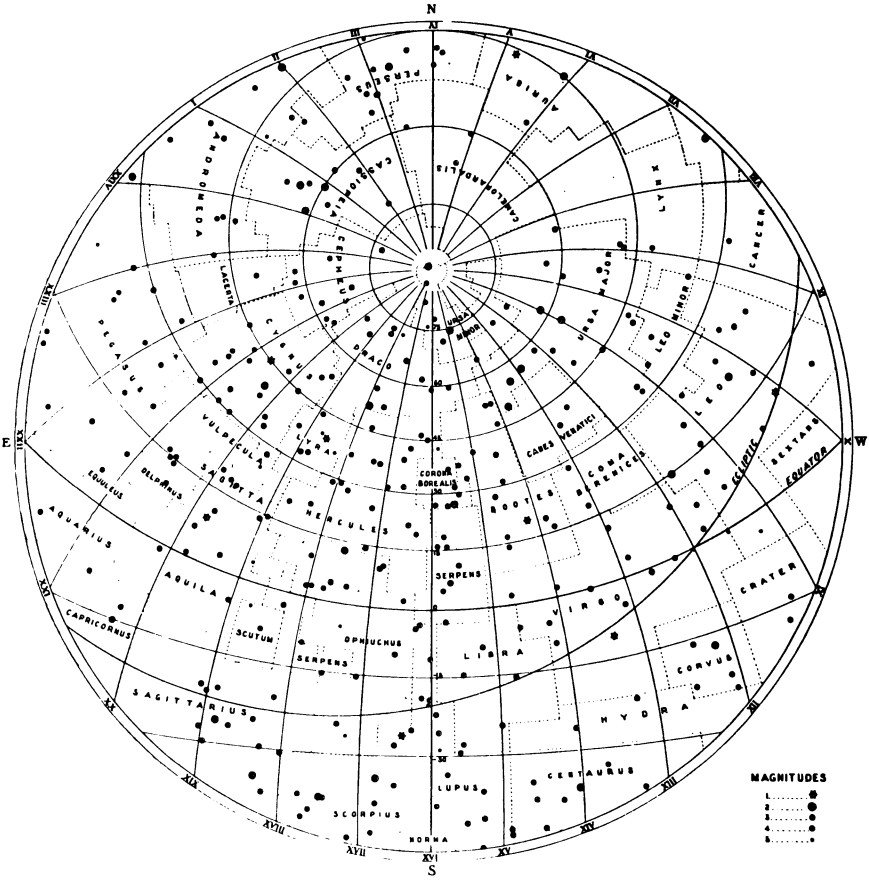


The above map represents the evening sky at

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.

STAR MAP 2

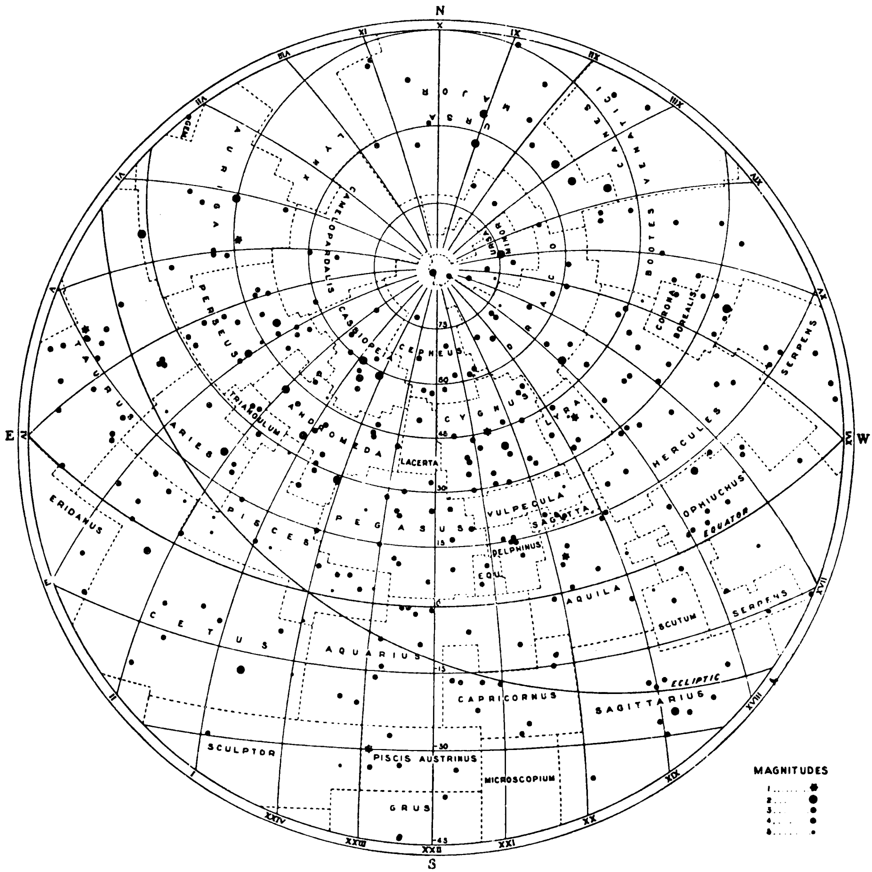


The above map represents the evening sky at

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

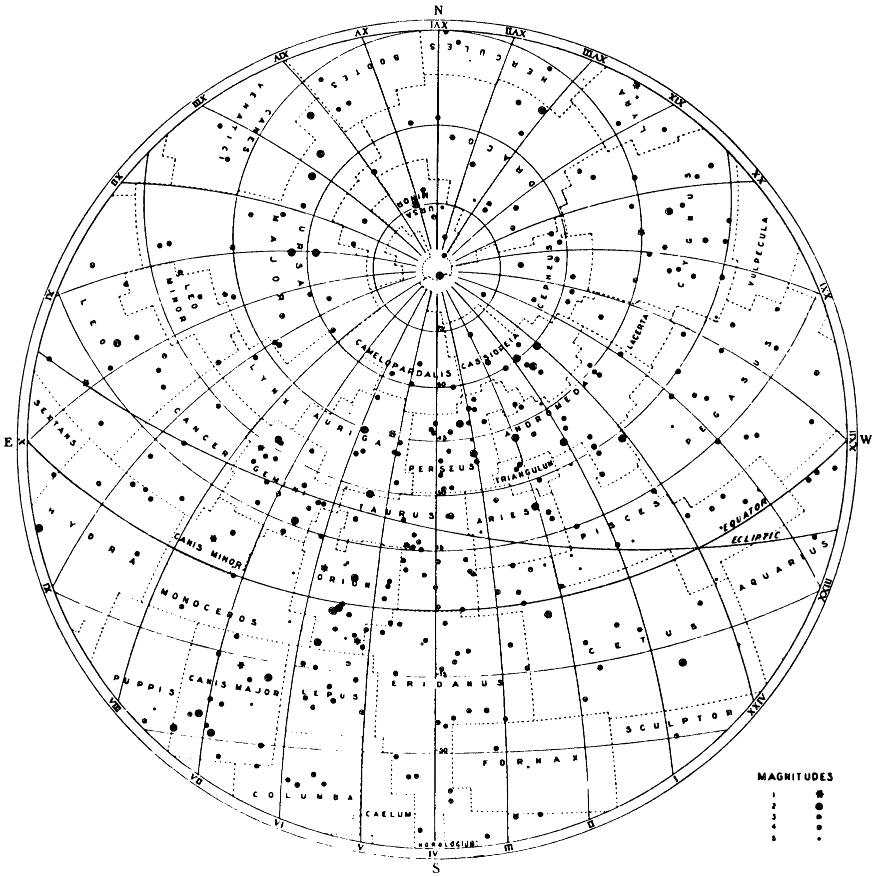


The above map represents the evening sky at

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.

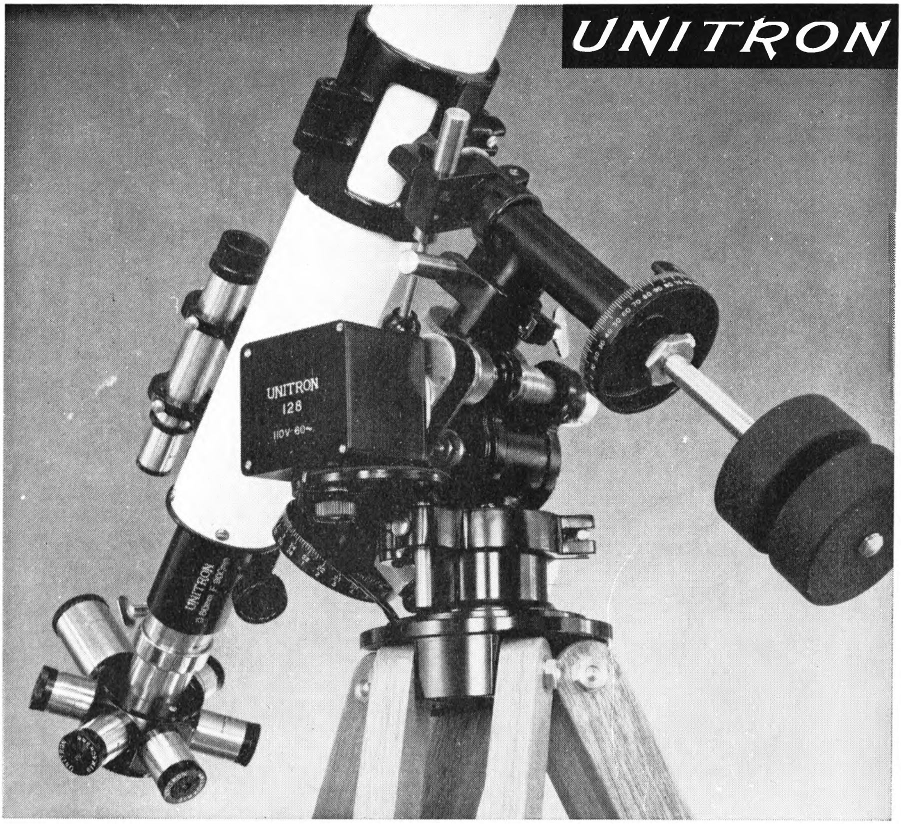
STAR MAP 4



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.



UNITRON's 2.4-Inch Equatorial with Motor Drive

Here is a fully equipped UNITRON which is small enough to be easily portable, yet large enough to be capable of serious research. Using the setting circles, you can easily find those difficult celestial objects that are too faint to be seen readily in the viewfinder. Once located, the image is kept centered in the field of view by the automatic action of the synchronous motor clock drive or, alternately, by the flexible cable hand-drive control.

UNITRON's 2.4-inch Equatorial comes complete with a wide variety of standard equipment accessories including five eyepieces, the auxilliary Achromatic Amplifier which doubles the power of each, the unique UNIHEX Rotary Eyepiece Selector which allows rapid selection of magnification, viewfinder, sun projecting screen, sunglass, etc. And when you receive your catalog, you will be pleasantly surprised at its modest price.

THERE ARE 22 UNITRON MODELS TO CHOOSE FROM

For the discriminating amateur who appreciates the advantages of the refractor design, UNITRON offers a choice among 22 models ranging in aperture from the 2.4″ pictured above to the 6″ model illustrated on the back cover. Each represents the pinnacle of precision and perfection in its size. This explains why for over 20 years UNITRON has been the world's most popular and prestigious refractor.

UNITRON SCIENTIFIC, INC. — 66 NEEDHAM ST., NEWTON HIGHLANDS, MASS. 02161, U.S.A.

UNITRON's 5-Inch Photo-Equatorial with Metal Pier

Fortunate indeed is the observer who has this UNITRON 5-Inch Photo-Equatorial at his command. Owning this mighty UNITRON is not an impossible dream – the price is less than you would expect for an instrument of this size and quality. Lack of a permanent observatory need be no drawback because a tripod model is also offered; with casters attached to the legs, the complete instrument can be rolled conveniently into a ground-level shelter.

Accessories for the 5-Inch model include the Super-UNIHEX Rotary Eyepiece Selector (illustrated above). Astro-photography is easy using UNITRON's reliable Astro Camera which attaches directly to the graduated focusing mechanism. With the aid of the 2.4-Inch Guide Telescope and the Clock Drive, you are sure to obtain truly spectacular results. When you write for your UNITRON catalog, also request Bulletin 500 to obtain complete specifications.

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To aid you in selecting the telescope best suited to your requirements and budget, we have issued a completely new catalog. Whether you plan an immediate purchase or not, you will certainly want to have a copy of this useful publication on your astronomy bookshelf. It's easy to get your free copy of the new catalog – merely send a postcard or letter to Dept. H at the address shown below.

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Sky and
TELESCOPE
FIRST AMERICAN MANNED SATELLITE
Sky and
TELESCOPE
Planets with Rings
The Large Solar Telescope at Kitt Peak
Sky and
TELESCOPE
Lunar
Eclipse
Roundup
Sky and
TELESCOPE

CALENDAR 1975

January

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

February

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

March

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

April

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

May

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

June

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

July

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

August

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

September

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

October

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

November

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

December

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

CALENDAR 1976

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
29						

March

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

April

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

May

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

June

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

July

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

August

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

September

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

October

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

November

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

December

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

UNITRON's 6-inch Photo-Equatorial Refractor on left, 4-inch on right