THE OBSERVER'S HANDBOOK 1961

Fifty-third Year of Publication

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

Price One Dollar

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

Incorporated 1890 — Royal Charter 1903

The National Headquarters of the Royal Astronomical Society of Canada is located at 252 College Street, Toronto 2B, Ontario. The business office of the Society, reading rooms and astronomical library, are housed here, as well as a large room for the accommodation of telescope making groups.

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THE OBSERVER'S HANDBOOK 1961

EDITOR
RUTH J. NORTHCOTT

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THE ROYAL ASTRONOMICAL SOCIETY OF CANADA
252 COLLEGE STREET, TORONTO 2B, ONTARIO

CONTENTS

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THE OBSERVER'S HANDBOOK for 1961 is the 53rd issue. Several additions have been made: the pronunciations of the names of the constellations, a finding list of named stars, a small map of the moon and the maximum and minimum values of the moon's libration in longitude and latitude. Additional explanations are given for sidereal time and for the correction for longitude in changing from local mean to standard time. Opposition ephemerides are given for the four brightest asteroids, together with a map of the path of Vesta near the time of opposition.

Cordial thanks are offered to those who assisted in the preparation of this volume, to those who are named and to Judith Bancroft, Barbara Gaizauskas, William Greig, Richard Henry, Külli Millěs, Susan Priddle, Isabel Williamson and Dorothy Yane. Special thanks are due to Gordon E. Taylor and the British Astronomical Association for the data on planetary appulses and occultations and to Margaret W. Mayall, Director of the A.A.V.S.O., for the predictions of the times of maxima of the long-period variables.

Our deep indebtedness to the British Nautical Almanac Office and to the *American Ephemeris* is thankfully acknowledged.

RUTH J. NORTHCOTT

ANNIVERSARIES AND FESTIVALS, 1961

New Year's Day	Sun.	Jan. 1
Epiphany	Fri.	Jan. 6
Septuagesima Sunday		Jan. 29
Accession of Queen Elizabeth (1952)	Mon.	Feb. 6
Quinquagesima (Shrove Sunday)		Feb. 12
Ash Wednesday		Feb. 15
St. David	Wed.	Mar. 1
St. Patrick	Fri.	Mar. 17
Palm Sunday		Mar. 26
Good Friday		Mar. 31
Easter Sunday		Apr. 2
Birthday of Queen Elizabeth (1926)	Fri.	Apr. 21
St. George	Sun.	Apr. 23
Rogation Sunday		May 7
Ascension Day	Thu.	May 11
Pentecost (Whit Sunday)		May 21
Victoria Day	Mon.	May 22
Trinity Sunday		May 28
Corpus Christi	Thu.	June 1
St. John Baptist (mid-Summer Day)	Sat.	June 24
Dominion Day	Sat.	July 1
Birthday of Queen Mother Elizabeth (1900)	Fri.	Aug. 4
Labour Day	Mon.	Sept. 4
Hebrew New Year (Rosh Hashanah)	Mon.	Sept. 11
St. Michael (Michaelmas Day)	Fri.	Sept. 29
Thanksgiving	Mon.	Oct. 9
All Saints' Day	Wed.	Nov. 1
Remembrance Day	Sat.	Nov. 11
St. Andrew	Thu.	Nov. 30
First Sunday in Advent		Dec. 3
Christmas Day	Mon.	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

THE CONFIGURATIONS OF JUPITER'S SATELLITES

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

CALCULATIONS FOR ALGOL

The calculations for the minima of Algol are based on the epoch J.D. 2434576.5110 and period 2.86731 days as published in the 1954 International Supplement, Kracow Observatory.

CELESTIAL DISTANCES

Celestial distances given herein are based on the standard value of 8.80″ for the sun's parallax, not the more recent value 8.790″ determined by Sir Harold Spencer Jones.

THE CONSTELLATIONS

Latin Names with Pronunciations and Abbreviations

Andromeda, ăn-drŏm′ē-dȧ	And	Andr
Antlia, ănt′lĭ-ȧ	Ant	Antl
Apus, ā′pŭs	Aps	Apus
Aquarius, ȧ-kwâr′ĭ-ŭs	Aqr	Aqar
Aquila, ăk′wĭ-lȧ	Aql	Aqil
Ara, ā′rȧ	Ara	Arae
Aries, ā′rĭ-ēz	Ari	Arie
Auriga, ô-rī′gȧ	Aur	Auri
Boötes, bō-ō′tēz	Boo	Boot
Caelum, sē′lŭm	Cae	Cael
Camelopardalis, kȧ-mĕl′ō-pär′dȧ-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′nŭs	Cap	Capr
Carina, kȧ-rī′nȧ	Car	Cari
Cassiopeia, kăs′ĭ-ō-pē′yȧ	Cas	Cass
Centaurus, sĕn-tô′rŭs	Cen	Cent
Cepheus, sē′fūs	Cep	Ceph
Cetus, sē′tŭs	Cet	Ceti
Chamaeleon, kȧ-mē′lē-ŭn	Cha	Cham
Circinus, sûr′sĭ-nŭs	Cir	Circ
Columba, kō-lŭm′bȧ	Col	Colm
Coma Berenices, kō′mȧ bĕr′ē-nī′sēz	Com	Coma
Corona Australis, kō-rō′nȧ ôs-trā′lĭs	CrA	CorA
Corona Borealis, kȧ-rō′nȧ bō′rē-ā′lĭs	CrB	CorB
Corvus, kôr′vŭs	Crv	Corv
Crater, krā′tẽr	Crt	Crat
Crux, krŭks	Cru	Cruc
Cygnus, sĭg′nŭs	Cyg	Cygn
Delphinus, dĕl-fī′nŭs	Del	Dlph
Dorado, dō-rä′dō	Dor	Dora
Draco, drā′kō	Dra	Drac
Equuleus, ē-kwōō′lē-ŭs	Equ	Equl
Eridanus, ē-rĭd′ȧ-nŭs	Eri	Erid
Fornax, fôr′năks	For	Forn
Gemini, jĕm′ĭ-nī	Gem	Gemi
Grus, grŭs	Gru	Grus
Hercules, hûr′kū-lēz	Her	Herc
Horologium, hŏr′ō-lō′jĭ-ŭm	Hor	Horo
Hydra, hī′drȧ	Hya	Hyda
Hydrus, hī′drŭs	Hyi	Hydi

Indus, ĭn′dŭs	Ind	Indi
Lacerta, lȧ-sûr′tȧ	Lac	Lacr
Leo, lē′ō	Leo	Leon
Leo Minor, lē′ō mī′nẽr	LMi	LMin
Lepus, lē′pŭs	Lep	Leps
Libra, lī′brȧ	Lib	Libr
Lupus, lū′pŭs	Lup	Lupi
Lynx, lĭngks	Lyn	Lync
Lyra, lī′rȧ	Lyr	Lyra
Mensa, mĕn′sȧ	Men	Mens
Microscopium, mī′krō-skō′pĭ-ŭm	Mic	Micr
Monoceros, mō-nŏs′ẽr-ŏs	Mon	Mono
Musca, mŭs′kȧ	Mus	Musc
Norma, nôr′mȧ	Nor	Norm
Octans, ŏk′tănz	Oct	Octn
Ophiuchus, ŏf′ĭ-ū′kŭs	Oph	Ophi
Orion, ō-rī′ŏn	Ori	Orio
Pavo, Pā′vō	Pav	Pavo
Pegasus, pĕg′ȧ-sŭs	Peg	Pegs
Perseus, pûr′sūs	Per	Pers
Phoenix, fē′nĭks	Phe	Phoe
Pictor, pĭk′tẽr	Pic	Pict
Pisces, pĭs′ēz	Psc	Pisc
Piscis Austrinus, pĭs′ĭs ôs-trī′nŭs	PsA	PscA
Puppis, pŭp′ĭs	Pup	Pupp
Pyxis, pĭk′sĭs	Pyx	Pyxi
Reticulum, rē-tĭk′ū-lŭm	Ret	Reti
Sagitta, sȧ-jĭt′ȧ	Sge	Sgte
Sagittarius, săj′ĭ-tā′rĭ-ŭs	Sgr	Sgtr
Scorpius, skôr′pĭ-ŭs	Sco	Scor
Sculptor, skŭlp′tẽr	Scl	Scul
Scutum, skū′tŭm	Sct	Scut
Serpens, sûr′pĕnz	Ser	Serp
Sextans, sĕks′tănz	Sex	Sext
Taurus, tô′rŭs	Tau	Taur
Telescopium, tĕl′ē-skō′pĭ-ŭm	Tel	Tele
Triangulum, trī-ăng′gū-lŭm	Tri	Tria
Triangulum Australe, trī-ăng′gū-lŭm ôs-trā′lē	TrA	TrAu
Tucana, tū-kā′nȧ	Tuc	Tucn
Ursa Major, ûr′sȧ mā′jẽr	UMa	UMaj
Ursa Minor, ûr′sȧ mi′nẽr	UMi	UMin
Vela, vē′lȧ	Vel	Velr
Virgo, vûr′gō	Vir	Virg
Volans, vō′lănz	Vol	Voln
Vulpecula, vŭl-pĕk′ū-lȧ	Vul	Vulp

ā fāte; ȧ chȧotic; ă tăp; ă finăl; ȧ ȧsk; ȧ ideȧ; â câre; ä älms; au aught; ē bē; ė crėate; ĕ ĕnd; ĕ angĕl; ẽ makẽr; ī tīme; ĭ bĭt; ĭ anĭmal; ō nōte; ȯ anatȯmy; ŏ hŏt; ŏ ŏccur; ô ôrb; o͞o mo͞on; o͝o bo͝ok; ou out; ū tūbe; ů ůnite; ŭ sŭn; ŭ sŭbmit; û hûrl.

MISCELLANEOUS ASTRONOMICAL DATA

UNITS OF LENGTH

1 Angstrom unit	= 10^{-8} cm.		
1 micron	= 10^{-4} cm.		
1 meter	= 10^{2} cm.	= 3.28084 feet	
1 kilometer	= 10^{5} cm.	= 0.62137 miles	
1 mile	= 1.60935×10^{5} cm.	= 1.60935 km.	
1 astronomical unit	= 1.49504×10^{13} cm.	= 92,897,416 miles	
1 light year	= 9.463×10^{17} cm.	= 5.880×10^{12} miles	= 0.3069 parsecs
1 parsec	= 30.84×10^{17} cm.	= 19.16×10^{12} miles	= 3.259 l.y.
1 megaparsec	= 30.84×10^{23} cm.	= 19.16×10^{18} miles	= 3.259×10^{6} l.y.

UNITS OF TIME

Sidereal day = $23h\ 56m\ 04.09s$ of mean solar time
Mean solar day = $24h\ 03m\ 56.56s$ of mean sidereal time
Synodical month = $29d\ 12h\ 44m$; sidereal month = $27d\ 07h\ 43m$
Tropical year (ordinary) = $365d\ 05h\ 48m\ 46s$
Sidereal year = $365d\ 06h\ 09m\ 10s$
Eclipse year = $346d\ 14h\ 53m$

THE EARTH

Equatorial radius, a = 3963.35 miles; flattening, $c = (a - b)/a = 1/297.0$
Polar radius, b = 3950.01 miles
1° of latitude = $69.057 - 0.349 \cos 2\phi$ miles (at latitude ϕ)
1° of longitude = $69.232 \cos \phi - 0.0584 \cos 3\phi$ miles
Mass of earth = 6.6×10^{21} tons; velocity of escape from ⊕ = 6.94 miles/sec.

EARTH'S ORBITAL MOTION

Solar parallax = 8.″80; constant of aberration = 20.″47
Annual general precession = 50.″26; obliquity of ecliptic = 23° 26′ 40″ (1960)
Orbital velocity = 18.5 miles/sec.; parabolic velocity at ⊕ = 26.2 miles/sec.

SOLAR MOTION

Solar apex, R.A. $18h\ 04m$; Dec. + 31°
Solar velocity = 12.2 miles/sec.

THE GALACTIC SYSTEM

North pole of galactic plane R.A. $12h\ 49m$, Dec. + 27.°4 (1959)
Centre of galaxy R.A. $17h\ 42m$, Dec. −29° (1950)
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

EXTRA-GALACTIC NEBULAE

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

RADIATION CONSTANTS

Velocity of light = 299,860 km./sec. = 186,324 miles/sec.
Solar constant = 1.93 gram calories/square cm./minute
Light ratio for one magnitude = 2.512; log ratio = 0.4000
Radiation from a star of zero apparent magnitude = 3×10^{-6} meter candles
Total energy emitted by a star of zero absolute magnitude = 5×10^{25} horsepower

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, $h = 6.6234 \times 10^{-27}$ erg. sec.
Loschmidt's number = 2.6872×10^{19} molecules/cu. cm. of gas at N.T.P.
Absolute temperature = $T°$ K = $T°$ C+273° = 5/9 ($T°$ F+459°)

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

1961 EPHEMERIS OF THE SUN AT 0h U.T.

Date 1961		Apparent R.A.	Corr. to Sun-dial	Apparent Dec.
		h m s	m s	° ′
Jan.	1	18 45 00	+ 3 22	−23 02.3
	4	18 58 13	+ 4 46	−22 46.0
	7	19 11 23	+ 6 06	−22 25.7
	10	19 24 29	+ 7 22	−22 01.3
	13	19 37 29	+ 8 34	−21 33.1
	16	19 50 25	+ 9 39	−21 01.2
	19	20 03 14	+10 39	−20 25.6
	22	20 15 57	+11 32	−19 46.5
	25	20 28 32	+12 18	−19 04.2
	28	20 41 00	+12 56	−18 18.7
	31	20 53 21	+13 27	−17 30.2
Feb.	3	21 05 35	+13 51	−16 39.0
	6	21 17 41	+14 08	−15 45.1
	9	21 29 40	+14 17	−14 48.8
	12	21 41 32	+14 19	−13 50.3
	15	21 53 17	+14 15	−12 49.7
	18	22 04 56	+14 04	−11 47.2
	21	22 16 29	+13 47	−10 43.1
	24	22 27 55	+13 24	− 9 37.4
	27	22 39 16	+12 55	− 8 30.5
Mar.	2	22 50 32	+12 21	− 7 22.5
	5	23 01 43	+11 43	− 6 13.5
	8	23 12 51	+11 01	− 5 03.7
	11	23 23 55	+10 15	− 3 53.4
	14	23 34 56	+ 9 27	− 2 42.6
	17	23 45 55	+ 8 37	− 1 31.5
	20	23 56 53	+ 7 44	− 0 20.3
	23	0 07 49	+ 6 51	+ 0 50.8
	26	0 18 44	+ 5 56	+ 2 01.6
	29	0 29 38	+ 5 01	+ 3 12.0
Apr.	1	0 40 33	+ 4 06	+ 4 21.9
	4	0 51 29	+ 3 13	+ 5 31.1
	7	1 02 27	+ 2 20	+ 6 39.3
	10	1 13 26	+ 1 30	+ 7 46.6
	13	1 24 28	+ 0 42	+ 8 52.7
	16	1 35 33	− 0 02	+ 9 57.5
	19	1 46 41	− 0 44	+11 00.8
	22	1 57 53	− 1 22	+12 02.5
	25	2 09 08	− 1 56	+13 02.4
	28	2 20 28	− 2 26	+14 00.3
May	1	2 31 52	− 2 52	+14 56.2
	4	2 43 21	− 3 13	+15 49.8
	7	2 54 55	− 3 28	+16 41.1
	10	3 06 34	− 3 39	+17 29.9
	13	3 18 19	− 3 44	+18 16.1
	16	3 30 08	− 3 44	+18 59.5
	19	3 42 03	− 3 38	+19 40.0
	22	3 54 03	− 3 28	+20 17.5
	25	4 06 07	− 3 14	+20 51.9
	28	4 18 16	− 2 55	+21 23.1
	31	4 30 29	− 2 32	+21 50.9
June	3	4 42 45	− 2 05	+22 15.3
	6	4 55 05	− 1 34	+22 36.2
	9	5 07 28	− 1 01	+22 53.6
	12	5 19 54	− 0 25	+23 07.3
	15	5 32 21	− 0 13	+23 17.4
	18	5 44 50	+ 0 52	+23 23.8
	21	5 57 19	+ 1 31	+23 26.4
	24	6 09 47	+ 2 10	+23 25.4
	27	6 22 15	+ 2 48	+23 20.6
	30	6 34 41	+ 3 24	+23 12.2

Date 1961		Apparent R.A.	Corr. to Sun-dial	Apparent Dec.
		h m s	m s	° ′
July	3	6 47 05	+ 3 59	+23 00.0
	6	6 59 27	+ 4 31	+22 44.3
	9	7 11 46	+ 5 00	+22 25.0
	12	7 24 01	+ 5 26	+22 02.3
	15	7 36 13	+ 5 47	+21 36.1
	18	7 48 19	+ 6 04	+21 06.6
	21	8 00 21	+ 6 17	+20 33.9
	24	8 12 18	+ 6 24	+19 58.1
	27	8 24 09	+ 6 25	+19 19.3
	30	8 35 55	+ 6 22	+18 37.7
Aug.	2	8 47 36	+ 6 12	+17 53.2
	5	8 59 11	+ 5 58	+17 06.2
	8	9 10 41	+ 5 38	+16 16.6
	11	9 22 06	+ 5 13	+15 24.7
	14	9 33 26	+ 4 44	+14 30.6
	17	9 44 40	+ 4 09	+13 34.4
	20	9 55 50	+ 3 29	+12 36.2
	23	10 06 56	+ 2 45	+11 36.3
	26	10 17 57	+ 1 56	+10 34.7
	29	10 28 55	+ 1 05	+ 9 31.6
Sept.	1	10 39 50	+ 0 10	+ 8 27.2
	4	10 50 42	− 0 48	+ 7 21.5
	7	11 01 32	− 1 48	+ 6 14.7
	10	11 12 20	− 2 49	+ 5 07.0
	13	11 23 07	− 3 52	+ 3 58.5
	16	11 33 53	− 4 56	+ 2 49.4
	19	11 44 38	− 5 59	+ 1 39.8
	22	11 55 24	− 7 03	+ 0 29.9
	25	12 06 11	− 8 06	− 0 40.2
	28	12 16 59	− 9 08	− 1 50.3
Oct.	1	12 27 49	−10 08	− 3 00.3
	4	12 38 42	−11 05	− 4 10.0
	7	12 49 38	−11 58	− 5 19.3
	10	13 00 37	−12 48	− 6 28.0
	13	13 11 41	−13 34	− 7 36.0
	16	13 22 49	−14 16	− 8 42.9
	19	13 34 02	−14 52	− 9 48.8
	22	13 45 21	−15 23	−10 53.3
	25	13 56 45	−15 49	−11 56.4
	28	14 08 16	−16 07	−12 57.9
	31	14 19 54	−16 19	−13 57.5
Nov.	3	14 31 39	−16 24	−14 55.2
	6	14 43 32	−16 21	−15 50.6
	9	14 55 32	−16 11	−16 43.7
	12	15 07 39	−15 53	−17 34.3
	15	15 19 54	−15 27	−18 22.1
	18	15 32 17	−14 54	−19 07.0
	21	15 44 47	−14 14	−19 48.9
	24	15 57 24	−13 27	−20 27.4
	27	16 10 08	−12 32	−21 02.6
	30	16 22 59	−11 31	−21 34.2
Dec.	3	16 35 56	−10 24	−22 02.2
	6	16 48 58	− 9 11	−22 26.3
	9	17 02 06	− 7 53	−22 46.5
	12	17 15 18	− 6 31	−23 02.7
	15	17 28 32	− 5 06	−23 14.7
	18	17 41 49	− 3 39	−23 22.6
	21	17 55 08	− 2 10	−23 26.2
	24	18 08 27	− 0 40	−23 25.7
	27	18 21 46	+ 0 49	−23 20.9
	30	18 35 03	+ 2 17	−23 11.8

PRINCIPAL ELEMENTS OF THE SOLAR SYSTEM

ORBITAL ELEMENTS (1954, Dec. 31, 12^h U.T.)

Planet	Mean Distance from Sun (a) $\oplus = 1$	Mean Distance from Sun (a) millions of miles	Period of Revolution Sidereal (P)	Period of Revolution Mean Synodic	Eccentricity (e)	Inclination (i)	Long. of Node (☊)	Long. of Perihelion (π)	Mean Long. of Planet
				days		°	°	°	°
Mercury	0.387	36.0	88.0d.	116	.206	7.0	47.8	76.8	305.8
Venus	0.723	67.2	224.7	584	.007	3.4	76.3	130.9	127.1
Earth	1.000	92.9	365.3	. . .	.017	. . . .	. . . .	102.2	99.4
Mars	1.524	141.5	687.0	780	.093	1.8	49.2	335.2	21.3
Jupiter	5.203	483.3	11.86y.	399	.048	1.3	100.0	13.6	108.0
Saturn	9.539	886.	29.46	378	.056	2.5	113.3	92.2	219.5
Uranus	19.18	1783.	84.01	370	.047	0.8	73.8	169.9	119.8
Neptune	30.06	2791.	164.8	367	.009	1.8	131.3	44.2	205.9
Pluto	39.52	3671.	248.4	367	.249	17.1	109.6	223.2	137.6

PHYSICAL ELEMENTS

Object	Symbol	Mean Diameter* miles	Mass* $\oplus = 1$	Mean Density* water = 1	Axial Rotation	Mean Surface Gravity* $\oplus = 1$	Albedo*	Magnitude at Greatest Brilliancy
Sun	☉	864,000	332,000	1.41	$24^d.7$ (equatorial)	27.9		−26.8
Moon	☾	2,160	0.0123	3.33	27^d 7.7^h	0.16	0.072	−12.6
Mercury	☿	3,010	0.0543	5.46	88^d	0.38	0.058	− 1.9
Venus	♀	7,610	0.8136	5.06	?	0.88	0.76	− 4.4
Earth	⊕	7,918	1.0000	5.52	23^h $56^m.1$	1.00	0.39	
Mars	♂	4,140	0.1069	4.12	24^h $37^m.4$	0.39	0.148	− 2.8
Jupiter	♃	86,900	318.35	1.35	9^h $50^m\pm$	2.65	0.51	− 2.5
Saturn	♄	71,500	95.3	0.71	10^h $02^m\pm$	1.17	0.50	− 0.4
Uranus	♅	29,500	14.54	1.56	$10^h.8\pm$	1.05	0.66	+ 5.7
Neptune	♆	26,800	17.2	2.47	$15^h.8\pm$	1.23	0.62	+ 7.6
Pluto	♇	3,600	0.033?	2?	$6^d.390$	0.16?	0.16	+14

*Kuiper, "The Atmospheres of the Earth and Planets," 1952.

SATELLITES OF THE SOLAR SYSTEM

Name	Stellar Mag.	Mean Dist. from Planet ″ *	Mean Dist. from Planet Miles	Revolution Period d	h	m	Diameter Miles	Discoverer
Satellite of the Earth								
Moon	−12.6	530	238,857	27	07	43	2160	
Satellites of Mars								
Phobos	12	8	5,800	0	07	39	10?	Hall, 1877
Deimos	13	21	14,600	1	06	18	5?	Hall, 1877
Satellites of Jupiter								
V	13	48	112,600	0	11	57	100?	Barnard, 1892
Io	5	112	261,800	1	18	28	2300	Galileo, 1610
Europa	6	178	416,600	3	13	14	2000	Galileo, 1610
Ganymede	5	284	664,200	7	03	43	3200	Galileo, 1610
Callisto	6	499	1,169,000	16	16	32	3200	Galileo, 1610
VI	14	3037	7,114,000	250	16		100?	Perrine, 1904
VII	16	3113	7,292,000	260	01		40?	Perrine, 1905
X	18	3116	7,300,000	260			15?	Nicholson, 1938
XI	18	5990	14,000,000	692			15?	Nicholson, 1938
VIII	16	6240	14,600,000	739			40?	Melotte, 1908
IX	17	6360	14,900,000	758			20?	Nicholson, 1914
XII	18	—	—	631			15?	Nicholson, 1951
Satellites of Saturn								
Mimas	12	27	115,000	0	22	37	400?	W. Herschel, 1789
Enceladus	12	34	148,000	1	08	53	500?	W. Herschel, 1789
Tethys	11	43	183,000	1	21	18	800?	G. Cassini, 1684
Dione	11	55	234,000	2	17	41	700?	G. Cassini, 1684
Rhea	10	76	327,000	4	12	25	1100?	G. Cassini, 1672
Titan	8	177	759,000	15	22	41	2600?	Huygens, 1655
Hyperion	13	214	920,000	21	06	38	300?	G. Bond, 1848
Iapetus	11	515	2,210,000	79	07	56	1000?	G. Cassini, 1671
Phoebe	14	1870	8,034,000	550			200?	W. Pickering, 1898
Satellites of Uranus								
Miranda	17	9	81,000	1	09	56		Kuiper, 1948
Ariel	16	14	119,000	2	12	29	600?	Lassell, 1851
Umbriel	16	19	166,000	4	03	28	400?	Lassell, 1851
Titania	14	32	272,000	8	16	56	1000?	W. Herschel, 1787
Oberon	14	42	364,000	13	11	07	900?	W. Herschel, 1787
Satellites of Neptune								
Triton	13	16	220,000	5	21	03	3000?	Lassell, 1846
Nereid	19	260	3,460,000	359			200?	Kuiper, 1949

*As seen from the sun.

Satellites Io, Europa, Ganymede, Callisto are usually denoted I, II, III, IV respectively, in order of distance from the planet.

SOLAR, SIDEREAL AND EPHEMERIS TIME

Any recurring event may be used to measure time. The various times commonly used are defined by the daily passages of the sun or stars caused by the rotation of the earth on its axis. The more uniform revolution of the earth about the sun, causing the return of the seasons, defines ephemeris time.

A sun-dial indicates *apparent solar time*, but this is far from uniform because of the earth's elliptical orbit and the inclination of the ecliptic. If the real sun is replaced by a fictitious mean sun moving uniformly in the equator, we have *mean* (solar) *time*. *Apparent time—mean time = equation of time*. This is the same as *correction to sun-dial* on page 7, with reversed sign.

If instead of the sun we use stars, we have *sidereal time*. The sidereal time is zero when the vernal equinox or first of Aries is on the meridian. As the earth makes one more revolution with respect to the stars than it does with respect to the sun, sidereal time gains on mean time 3^m56^s per day or 2 hours per month. Right Ascension (R.A.) is measured east from the vernal equinox, so that the R.A. of a body on the meridian is equal to the sidereal time.

Sidereal time is equal to mean time plus 12 hours plus the R.A. of the fictitious mean sun, so that by observation of one kind of time we can calculate the other. Sidereal time = Standard time (0h at midnight) − correction for longtitude (p. 12) + 12 h + R. A. sun (p. 7) − correction to sun-dial (p. 7). (Note that it is necessary to obtain R. A. of the sun at the standard time involved.)

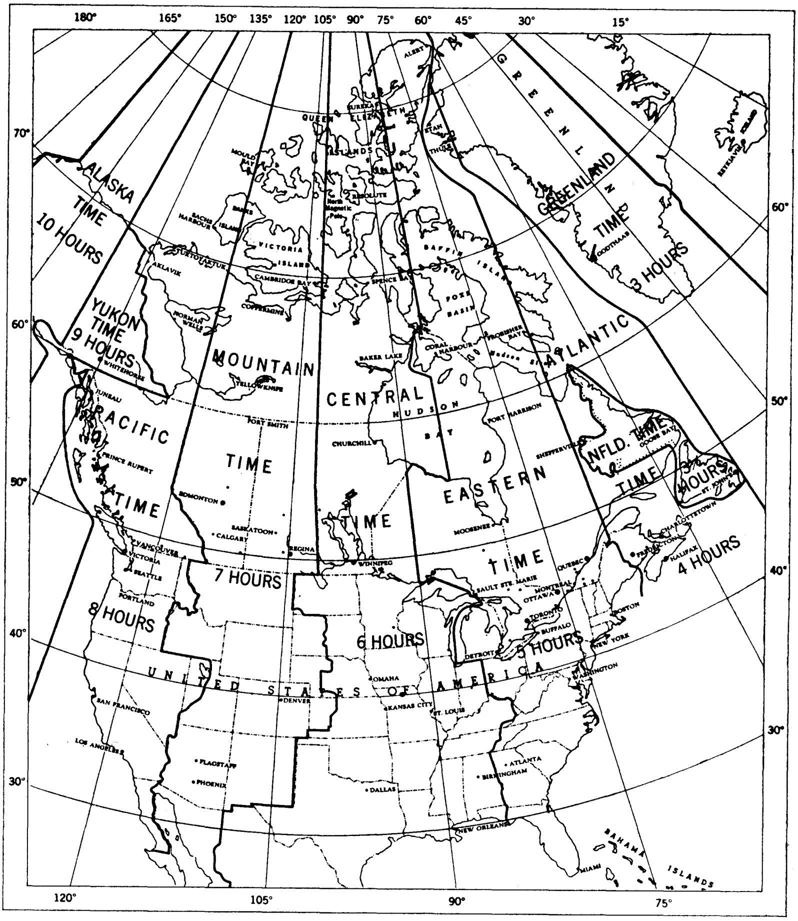
The foregoing refers to *local* time, in general different in different places on the earth. The local mean time of Greenwich, now known as *Universal Time* (UT) is used as a common basis for timekeeping. Navigation and surveying tables are generally prepared in terms of UT. When great precision is required, UT 1 and UT 2 are used differing from UT by polar variation and by the combined effects of polar variation and annual fluctuation respectively.

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

In Canada and the United States there are 8 standard time zones as follows: Newfoundland (N), 3^h30^m slower than Greenwich; 60th meridian or Atlantic (A), 4 hours; 75th meridian or Eastern (E), 5 hours; 90th meridian or Central (C), 6 hours; 105th meridian or Mountain (M), 7 hours; 120th meridian or Pacific (P), 8 hours; 135th meridian or Yukon (Y), 9 hours; and 150th meridian or Alaska (AL), 10 hours slower than Greenwich.

Universal time, even after the corrections mentioned have been applied, is still somewhat variable, as shown by atomic clocks or the orbital motion of the moon. *Ephemeris Time* (ET) is used when these irregularities must be avoided. The second, formerly defined as 1/86,400 of the mean solar day, is now defined as 1/31,556,925.9747 of the tropical year Jan. 0 at 12 hours E.T. 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 1960 will be about 35 seconds.

MAP OF STANDARD TIME ZONES



JULIAN DAY CALENDAR, 1961

J.D. 2,430,000 plus the following:

Jan. 1 7,301	May 1 7,421	Sept. 1 7,544
Feb. 1 7,332	June 1 7,452	Oct. 1 7,574
Mar. 1 7,360	July 1 7,482	Nov. 1 7,605
Apr. 1 7,391	Aug. 1 7,513	Dec. 1 7,635

The Julian Day commences at noon. Thus J.D. 2,437,301.0 = Jan. 1.5 U.T.

TIMES OF RISING AND SETTING OF THE SUN AND MOON

The times of sunrise and sunset for places in latitudes ranging from 32° to 54° are given on pages 13 to 18, and of twilight on page 19. The times of moonrise and moonset for the 5 h meridian are given on pages 20 to 25. The times are given in Local Mean Time, and in the table below are given corrections to change from Local Mean Time to Standard Time for the cities and towns named.

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

The sun's declination, apparent diameter and the equation of time do not have precisely the same values on corresponding days from year to year. As the times of sunrise and sunset depend upon these factors, these tables for the solar phenomena can give only average values which may be in error by one or two minutes.

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.
Athabaska	55°	+33M	Penticton	49°	−02P	Atlanta	34°	+37E
Baker Lake	64	+24C	Peterborough	44	+13E	Baltimore	39	+06E
Brandon	50	+40C	Port Harrison	59	+13E	Birmingham	33	−13C
Brantford	43	+21E	Port Arthur	48	+57E	Boston	42	−16E
Calgary	51	+36M	Prince Albert	53	+03M	Buffalo	43	+15E
Charlottetown	46	+12A	Prince Rupert	54	+41P	Chicago	42	−10C
Churchill	60	+17C	Quebec	47	−15E	Cincinnati	39	+38E
Cornwall	45	− 1E	Regina	50	−02M	Cleveland	42	+26E
Edmonton	54	+31M	St. Catharines	43	+17E	Dallas	33	+27C
Fort William	48	+57E	St. Hyacinthe	46	−08E	Denver	40	00M
Fredericton	46	+27A	St. John, N.B.	45	+24A	Detroit	42	+32E
Gander	49	+ 8N	St. John's, Nfld.	48	+01N	Fairbanks	65	−10AL
Glace Bay	46	00A	Sarnia	43	+29E	Flagstaff	35	+27M
Goose Bay	53	+ 2A	Saskatoon	52	+07M	Indianapolis	40	−15C
Granby	45	−09E	Sault Ste. Marie	47	+37E	Juneau	58	+58P
Guelph	44	+21E	Shawinigan Falls	47	−09E	Kansas City	39	+18C
Halifax	45	+14A	Sherbrooke	45	−12E	Los Angeles	34	−07P
Hamilton	43	+20E	Stratford	43	+24E	Louisville	38	−17C
Hull	45	+03E	Sudbury	47	+24E	Memphis	35	00C
Kapuskasing	49	+30E	Sydney	46	+01A	Miami	26	+21E
Kingston	44	+06E	The Pas	54	+45C	Milwaukee	43	−09C
Kitchener	43	+22E	Timmins	48	+26E	Minneapolis	45	+13C
London	43	+25E	Toronto	44	+18E	New Orleans	30	00C
Medicine Hat	50	+23M	Three Rivers	46	−10E	New York	41	−04E
Moncton	46	+19A	Trail	49	−09P	Omaha	41	+24C
Montreal	46	−06E	Truro	45	+13A	Philadelphia	40	+01E
Moosonee	51	+23E	Vancouver	49	+12P	Phoenix	33	+28M
Moose Jaw	50	+02M	Victoria	48	+13P	Pittsburgh	40	+20E
Niagara Falls	43	+16E	Whitehorse	61	00Y	St. Louis	39	+01C
North Bay	46	+18E	Windsor	42	+32E	San Francisco	38	+10P
Ottawa	45	+03E	Winnipeg	50	+29C	Seattle	40	+09P
Owen Sound	45	+24E	Yellowknife	62	+38M	Washington	39	+08E

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

In the above list Owen Sound is under "45°", and the correction is + 24 min On page 13 the time of sunrise on February 12 for latitude 45° is 7.07; add 24 min. and we get 7.31 (Eastern Standard Time).

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

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

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

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

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

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

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

TIME OF MOONRISE AND MOONSET, 1961 (Local Mean Time)

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

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

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

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

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

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

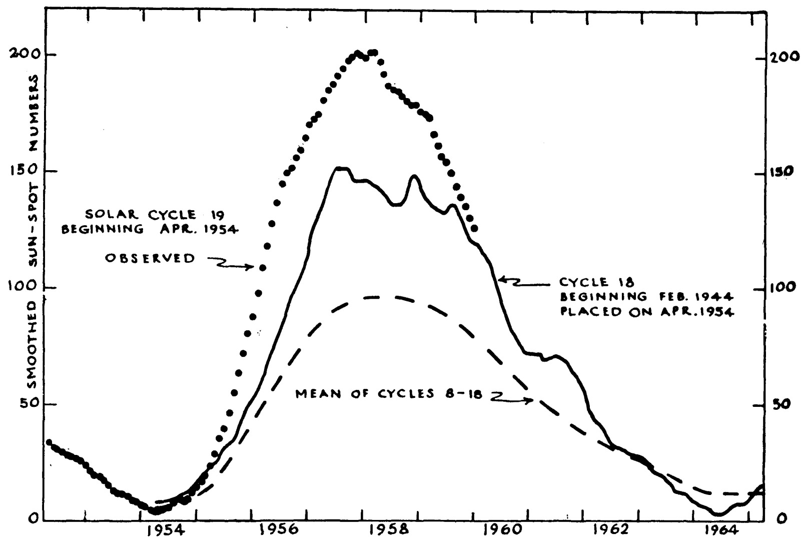
THE PLANETS FOR 1961

THE SUN

The diagram represents the sun-spot activity of the current 19th cycle, as far as the final numbers are available. The present cycle began at the minimum in April 1954. For comparison, cycle 18 which began February 1944 (solid curve), and the mean of cycles 8 to 18 (dashed curve), are placed with their minima on April 1954.

The present cycle reached its maximum in January 1958 and since then has been declining slowly.

The observations for sun-spot numbers may be performed by devoted amateur astronomers with small-sized telescopes (suitably protected). Here is a field for amateurs who wish to make a valuable contribution to solar astronomy.



MERCURY

Mercury is exceptional in many ways. It is the planet nearest the sun and travels fastest in its orbit, its speed varying from 23 mi. per sec. at aphelion to 35 mi. per sec. at perihelion. The amount of heat and light from the sun received by it per square mile is, on the average, 6.7 times the amount received by the earth. Its period of rotation on its axis is believed to be the same as its period of revolution about the sun, which is 88 days.

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

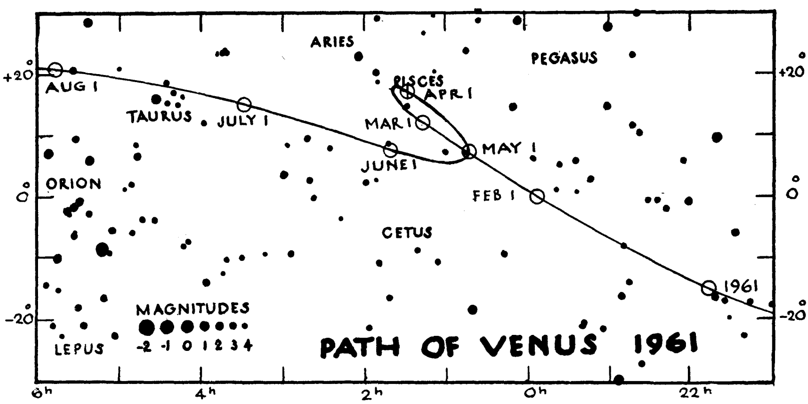
When the elongation of Mercury is east of the sun it is an evening star, setting soon after the sun. When the elongation is west, it is a morning star and rises shortly before the sun. Its brightness when it is treated as a star is considerable but it is always viewed in the twilight sky and one must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

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

MAXIMUM ELONGATIONS OF MERCURY DURING 1961

Elong. East – Evening Star			Elong. West – Morning Star		
Date	Dist.	Mag.	Date	Dist.	Mag.
Feb. 6	18°	−0.4	Mar. 20	28°	+0.5
May 31	23°	+0.6	July 19	20°	+0.5
Sept. 28	26°	+0.3	Nov. 7	19°	−0.3

The most favourable elongations to observe are: in the evening, May 31; in the morning, Nov. 7. At these times Mercury looks like a half-moon in a telescope. On May 31 and Nov. 7 it is respectively about 8″ and 7″ in apparent diameter and about 77 and 92 million miles from the earth.



VENUS

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

On Jan. 1, 1961, Venus is in the evening sky and crosses the meridian about 3 hours after the sun. Its declination is −15° and it appears in the south-south-western sky at sunset. It is brilliant, its stellar magnitude being −3.8. It reaches greatest elongation east, 47°, on Jan. 29; its declination is −1° and it transits the meridian 3 hours after the sun. Greatest brilliancy, mag. -4.3, is attained on Mar. 5. By Apr. 10 it is in inferior conjunction with the sun, and becomes a morning star. It again attains greatest brilliancy, mag. -4.2, on May 16. It reaches greatest elongation west, 46°, on June 19; its declination is $+13°$, and it transits about 3 hours before the sun. It remains in the morning sky for the rest of the year, getting close to the sun by Dec. 31.

With the exception of the sun and moon, Venus is the brightest object in the sky. Its brilliance is largely due to the dense clouds which cover the surface of the planet. They reflect well the sun's light; but they also prevent the astronomer from detecting any solid object on the surface of the body. If such could be observed it would enable him to determine the planet's rotation period.

MARS

The orbit of Mars is outside that of the earth and consequently its planetary phenomena are quite different from those of the two inferior planets discussed above. Its mean distance from the sun is 141 million miles and the eccentricity of its orbit is 0.093, and a simple computation shows that its distance from the sun ranges between 128 and 154 million miles. Its distance from the earth varies from 35 to 235 million miles and its brightness changes accordingly. When Mars is nearest it is conspicuous in its fiery red, but when farthest away it is no brighter than Polaris. Unlike Venus, its atmosphere is very thin, and features on the solid surface are distinctly visible. Utilizing them its rotation period of 24h. 37m. has been accurately determined.

The sidereal, or true mechanical, period of revolution of Mars is 687 days; and the synodic period (for example, the interval from one opposition to the next one) is 780 days. This is the average value; it may vary from 764 to 810 days. At the opposition on Sept. 10, 1956, the planet was closer to the earth than it will be for some years. The last opposition was on Dec. 30, 1960; the next on Feb. 4, 1963.

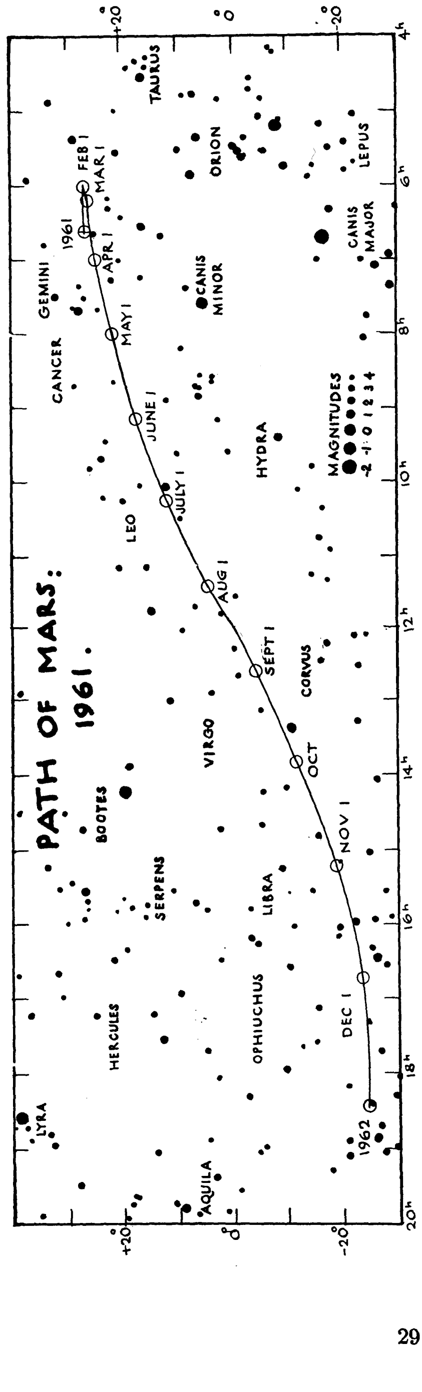
On Jan. 1, 1961 Mars is in Gemini and is just rising in the north-eastern sky at sunset; its stellar magnitude is -1.3. It remains in the evening sky until it comes into conjunction with the sun on Dec. 14. On Dec. 31 it is in the morning sky but is too close to the sun for observation. For its position throughout the year see the map.

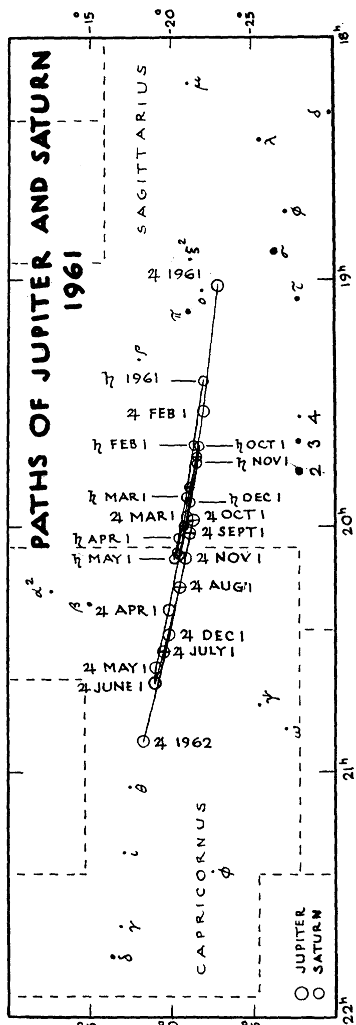
JUPITER

Jupiter is the giant of the family of the sun. Its mean diameter is 87,000 miles and its mass is $2\frac{1}{2}$ times that of all the rest of the planets combined! Its mean distance is 483 million miles and the revolution period is 11.9 years. This planet is known to possess 12 satellites, the last discovered in 1951 (see p. 9). Not so long ago it was generally believed that the planet was still cooling down from its original high temperature, but from actual measurements of the radiation from it to the earth it has been deduced that the surface is at about $-200°$F. The spectroscope shows that its atmosphere contains ammonia and methane.

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

On Jan. 1, 1961, Jupiter is close to the sun in the evening sky in the constellation Sagittarius; by Jan. 5 it is in conjunction with the sun and then emerges in the


PATH OF MARS: 1961.
GEMINI
CANCER
LEO
BOOTES
HERCULES
LYRA
AQUILA
TAURUS
ORION
CANIS MINOR
HYDRA
VIRGO
SERPENS
LIBRA
OPHIUCHUS
LEPUS
CANIS MAJOR
CORVUS
MAGNITUDES
-2 -1 0 1 2 3 4
1961
FEB 1
MAR 1
APR 1
MAY 1
JUNE 1
JULY 1
AUG 1
SEPT 1
OCT
NOV 1
DEC 1
1962
+20°
0°
-20°
4h
6h
8h
10h
12h
14h
16h
18h
20h

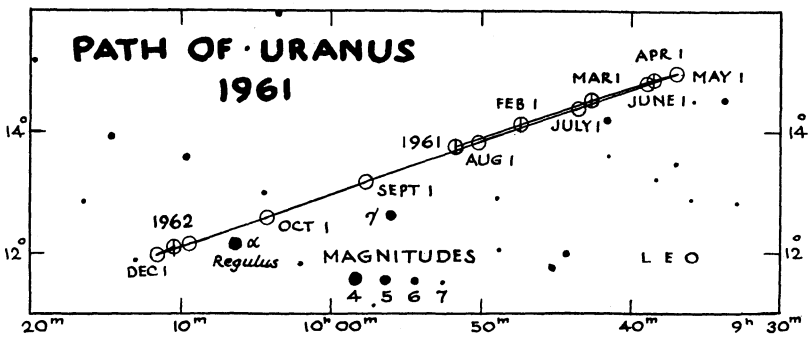

PATHS OF JUPITER AND SATURN 1961
SAGITTARIUS
CAPRICORNUS
♃ 1961
♄ 1961
♃ FEB 1
♄ FEB 1
♄ OCT 1
♄ NOV 1
♄ MAR 1
♄ DEC 1
♃ MAR 1
♃ OCT 1
♃ SEPT 1
♄ APR 1
♄ MAY 1
♃ NOV 1
♃ AUG 1
♃ APR 1
♃ DEC 1
♃ JULY 1
♃ MAY 1
♃ JUNE 1
♃ 1962
JUPITER
SATURN
2 3 4
-15°
-20°
-25°
18h
19h
20h
21h
22h

morning sky. It comes into opposition with the sun on July 25, when it moves into the evening sky and is visible all night. It is then in Capricornus, with magnitude −2.3. It retrogrades from May 25 to Sept. 23 (*see map*). On Dec. 31 it is in Capricornus, and is low in the south-western sky at sunset; its magnitude has faded to −1.6. During 1961 Jupiter overtakes Saturn, conjunction occurring on Feb. 18. Note: on the map, circles with vertical lines denote retrograde motion.

SATURN

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

On Jan. 1, 1961, Saturn is close to the sun in the evening sky, and by Jan. 11 is in conjunction with the sun. On Feb. 18 Saturn is overtaken by Jupiter. It reaches opposition with the sun on July 19, when its stellar magnitude is +0.3. It retrogrades from May 9 to Sept. 27 (*see map*). On Dec. 31 it is near the western edge of Capricornus, and is low in the south-western sky at sunset (mag. +0.8). Jupiter is higher in the sky, about ten degrees away. Note: on the map, circles with vertical lines denote retrograde motion.

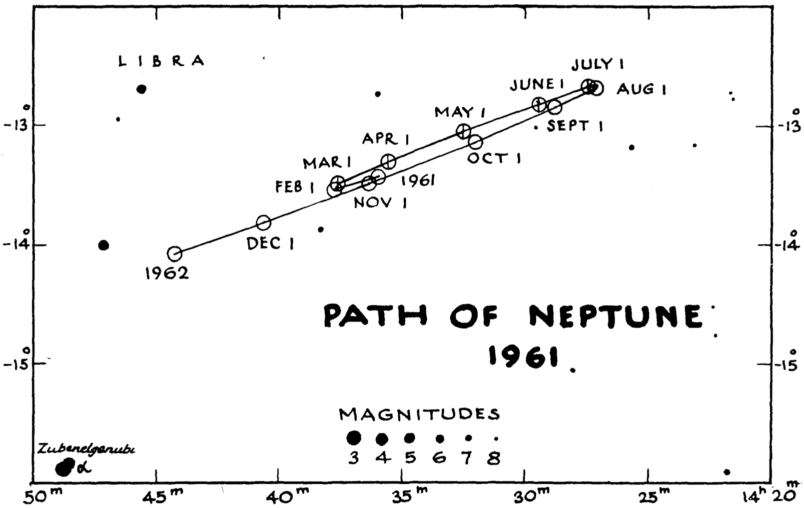


URANUS

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

During 1961 Uranus is in Leo (*see map*). At the beginning of the year it is in the morning sky and is retrograding (direct motion is resumed on Apr. 29). On

Feb. 12 it is in opposition to the sun and is above the horizon all night; its apparent diameter is 3.9″ and its stellar magnitude is +5.7. By the time of conjunction on Aug. 19 its magnitude has faded to +5.9. It is in the morning sky for the rest of the year, passing close to Regulus in October. It is to be noted that Mars passes close to the planet on June 15.



NEPTUNE

Neptune was discovered in 1846 after its existence in the sky had been predicted from independent calculations by Leverrier in France and Adams in England. It caused a sensation at the time. Its distance from the sun is 2791 million miles and its period of revolution is 165 years. A satellite was discovered in 1846 soon after the planet. A second satellite was discovered by G. P. Kuiper at the McDonald Observatory on May 1, 1949. Its magnitude is about 19.5, its period about a year, and diameter about 200 miles. It is named Nereid.

During 1961 Neptune is in Libra (*see map*). It is in opposition to the sun on Apr. 30, when it is above the horizon all night. Its stellar magnitude is then +7.70, and during the year it fades slightly to +7.84. Thus it is too faint to be seen with the naked eye. In the telescope it shows a greenish tint and an apparent diameter of from 2.5″ to 2.3″. It is in conjunction with the sun on Nov. 3 and moves into the morning sky for the rest of the year.

PLUTO

Pluto, the most distant known planet, was discovered at the Lowell Observatory in 1930 as a result of an extended search started two decades earlier by Percival Lowell. The faint star-like image was first detected by Clyde Tombaugh by comparing photographs taken on different dates. Further observations confirmed that the object was a distant planet. Its mean distance from the sun is 3671 million miles and its revolution period is 248 years. It appears as a 15th mag. star in the constellation Leo. It is in opposition to the sun on Feb. 25, at which time its astrometric position is R.A. $10^h\ 54^m$, Dec. +21° 11′.

THE SKY MONTH BY MONTH

By J. F. Heard

THE SKY FOR JANUARY, 1961

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

The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

The Sun—During January the sun's R.A. increases from 18h 45m to 20h 57m and its Decl. changes from 23° 02′ S. to 17° 13′ S. The equation of time changes from −3m 22s to −13m 36s. The earth is in perihelion or closest to the sun on the 2nd.

For changes in the length of the day, see p. 13.

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

Mercury on the 15th is in R.A. 20h 12m, Decl. 22° 08′ S., and transits at 12h 38m. It is too close to the sun for observation, being in superior conjunction on the 5th.

Venus on the 15th is in R.A. 22h 51m, Decl. 8° 11′ S., mag. −3.9, and transits at 15h 14m. It is a brilliant evening star, dominating the south-western sky for about three hours after sunset. On the evening of the 19th it is very close to the moon. Greatest eastern elongation is on the 29th.

Mars on the 15th is in R.A. 6h 14m, Decl. 27° 13′ N., mag. −1.0, and transits at 22h 32m. In Gemini, it has risen before sunset and is visible all night.

Jupiter on the 15th is in R.A. 19h 15m, Decl. 22° 26′ S., and transits at 11h 36 m. It is in conjunction on the 5th, and is too close to the sun for observation.

Saturn on the 15th is in R.A. 19h 32m, Decl. 21° 40′ S., and transits at 11h 53m. It is in conjunction on the 11th and is too close to the sun for observation.

Uranus on the 15th is in R.A. 9h 50m, Decl. 13° 56′ N., and transits at 2h 12m. It rises about 3 hours after sunset.

Neptune on the 15th is in R.A. 14h 37m, Decl. 13° 29′ S. and transits at 6h 58m. It rises about two hours after midnight.

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

			JANUARY E.S.T.	Min. of Algol		Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Sun. 1	12		☌ ♂ ☾ ♂ 8° N.			76.81
	18	06	🌕 Full Moon.			
Mon. 2			⊕ at perihelion. Dist. from ☉, 91,337,000 mi.			88.94
Tue. 3			Quadrantid meteors (see p. 64).	14 40		101.07
	8		☾ at apogee. Dist. from ⊕, 252,500 mi.			
Wed. 4			. . . .			113.20
Thu. 5	13		☌ ♅ ☾ ♅ 2° N.			125.33
	13		☌ ♃ ☉.			
	18		☌ ☿ ☉ superior.			
Fri. 6			. . . .	11 29		137.46
Sat. 7			. . . .			149.61
Sun. 8			. . . .			161.75
Mon. 9	22	03	☾ Last Quarter.	8 18		173.90
Tue. 10			. . . .			186.05
Wed. 11	1		☌ ♄ ☉.			198.22[l]
	11		☌ ♆ ☾ ♆ 3° S.			
Thu. 12			. . . .	5 07		210.38
Fri. 13			. . . .			222.56
Sat. 14			. . . .			234.74[b]
Sun. 15			. . . .	1 57		246.93
Mon. 16			☿ greatest hel. lat. S.			259.12
	12		☌ Juno ☉.			
	16	30	🌑 New Moon.			
	18		☾ at perigee. Dist. from ⊕, 221,600 mi.			
Tue. 17			. . . .	22 46		271.31
Wed. 18			. . . .			283.50
Thu. 19			. . . .			295.69
Fri. 20	0		☌ ♀ ☾ ♀ 0.6° N.	19 35		307.88
Sat. 21			. . . .			320.06
Sun. 22			. . . .			332.23
Mon. 23	11	14	☽ First Quarter.	16 24		344.40[l]
Tue. 24			♀ at ☊.			356.56
Wed. 25			. . . .			8.72
Thu. 26			. . . .	13 14		20.87[b]
Fri. 27			. . . .			33.02
Sat. 28	2		☌ ♂ ☾ ♂ 8° N.			45.16
Sun. 29	2		♀ greatest elongation E., 47°.	10 03		57.29
Mon. 30	8		☾ at apogee. Dist. from ⊕, 252,500 mi.			69.43
Tue. 31			□ ♆ ☉ West.			
	13	47	🌕 Full Moon.			81.56

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 56

[l]Jan. 11, −7.96°; Jan. 23, +7.52°. [b]Jan. 14, −6.64°; Jan. 26, +6.75°.

THE SKY FOR FEBRUARY, 1961

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

The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

The Sun—During February the sun's R.A. increases from 20h 57m to 22h 47m and its Decl. changes from 17° 13′ S. to 7° 45′ S. The equation of time changes from −13m 36s to a minimum of −14m 19s on the 12th and then to −12m 33s at the end of the month. There is a total eclipse of the sun on the 15th.

For changes in the length of the day, see p. 13.

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

Mercury on the 15th is in R.A. 22h 37m, Decl. 5° 39′ S., and transits at 12h 54m. It is at greatest eastern elongation on the 6th, and for a few evenings about this time may be seen low in the south-west just after sunset; this is a reasonably favourable elongation. By the 21st it is in inferior conjunction.

Venus on the 15th is in R.A. 0h 40m, Decl. 6° 58′ N, mag. −4.2, and transits at 15h 00m. It is a brilliant evening star, dominating the western sky for nearly four hours after sunset.

Mars on the 15th is in R.A. 6h 02m, Decl. 26° 46′ N., mag. −0.1, and transits at 20h 19m. In Gemini, it is well up at sunset and may be observed most of the night. On the 5th it is stationary in right ascension and resumes direct, or eastward, motion among the stars.

Jupiter on the 15th is in R.A. 19h 45m, Decl. 21° 25′ S., mag. −1.5, and transits at 10h 04m. It is in Sagittarius, very low in the south-east at sunrise. On the 18th there is a very close conjunction with Saturn.

Saturn on the 15th is in R.A. 19h 47m, Decl. 21° 07′ S., mag. +0.8, and transits at 10h 06m. It is very close to Jupiter (q.v.).

Uranus on the 15th is in R.A. 9h 45m, Decl. 14° 22′ N., and transits at 0h 05m. It rises about at sunset. Opposition is on the 12th.

Neptune on the 15th is in R.A. 14h 38m, Decl. 13° 32′ S., and transits at 4h 57m. It rises about at midnight.

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

* 9 pm π³ Orion very much brighter !

	d	h	m	FEBRUARY E.S.T.	Min. of Algol		Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Wed.	1	16		☌ ♅ ☾ ♅ 2° N.	6 52		93.70
Thu.	2			. . . .			105.83
Fri.	3			. . . .			117.96
Sat.	4			☿ at ☊	3 42		130.11
Sun.	5	22		♂ stationary in R.A.			142.25
* Mon.	6	7		☿ greatest elongation E., 18°			154.39
Tue.	7	19		☌ ♆ ☾ ♆ 3° S.	0 31		166.55
Wed.	8			☿ at perihelion			178.70[l]
		10		☌ Pallas ☉			
		11	50	☾ Last Quarter			
Thu.	9			. . . .	21 20		190.87
Fri.	10			. . . .			203.04[b]
Sat.	11	20		♆ stationary in R.A.			215.22
Sun.	12	4		☿ stationary in R.A.	18 10		227.41
		12		☍ ♅ ☉ Dist. from ⊕, 1,614,000,000 mi.			
Mon.	13	1		☌ ♃ ☾ ♃ 4° S.			239.60
		2		☌ ♄ ☾ ♄ 3° S.			
Tue.	14	6		☾ at perigee. Dist. from ⊕, 222,600 mi.			251.79
Wed.	15	3	11	● New Moon. Eclipse, see p. 60	14 59		263.99
Thu.	16			. . . .			276.19
Fri.	17			. . . .			288.39
Sat.	18			☿ greatest hel. lat. N.	11 48		300.59
		6		☌ ♀ ☾ ♀ 7° N.			
		10		☌ ♃ ♄ ♃ 0.2° S.			
Sun.	19			. . . .			312.78
Mon.	20			. . . .			324.97[l]
Tue.	21	19		☌ ☿ ☉ inferior	8 38		337.15
Wed.	22	3	35	☽ First Quarter			349.33
Thu.	23			. . . .			1.50[b]
Fri.	24	12		☌ ♂ ☾ ♂ 8° N.	5 27		13.67
Sat.	25	12		☍ ♇ ☉ Dist. from ⊕, 3,028,000,000 mi.			25.83
Sun.	26			♀ at perihelion			37.98
		16		☾ at apogee. Dist. from ⊕, 252,200 mi.			
Mon.	27			. . . .	2 16		50.13
Tue.	28	21		☌ ♅ ☾ ♅ 2° N.			62.28

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 56

[l]Feb. 8, −7.53°; Feb. 20, +7.12°. [b]Feb. 10, −6.79°; Feb. 23, +6.83°.

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

The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

The Sun—During March the sun's R.A. increases from 22h 47m to 0h 41m and its Decl. changes from 7° 45′ S. to 4° 22′ N. The equation of time changes from −12m 33s to −4m 06s. On the 20th at 15h 32m E.S.T. the sun crosses the equator on its way north, enters the sign of Aries and spring commences. This is the vernal equinox. For changes in the length of the day, see p. 14.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 21. On the 21st at 23h E.S.T. there is an occultation of Aldebaran visible in parts of America. There is a partial eclipse of the moon on the morning of the 2nd.

Mercury on the 15th is in R.A. 21h 58m, Decl. 12° 31′ S., and transits at 10h 28m. It is at greatest western elongation on the 20th, and for a few mornings at this time it may be seen low in the east before sunrise. This is not a favourable elongation.

Venus on the 15th is in R.A. 1h 36m, Decl. 16° 55′ N., mag. −4.2, and transits at 14h 04m. It is a brilliant evening star seen low in the western sky for about three hours after sunset, though it is rapidly approaching the sun during the month. Greatest brilliancy is on the 5th.

Mars on the 15th is in R.A. 6h 31m, Decl. 25° 58′ N., mag. +0.6, and transits at 18h 59m. In Gemini, now fading perceptibly, it is nearly to the meridian at sunset and sets about two hours after midnight.

Jupiter on the 15th is in R.A. 20h 09m, Decl. 20° 23′ S., mag. −1.6, and transits at 8h 37m. Moving into Capricornus, it may be seen very low in the south-east just before sunrise. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 58.

Saturn on the 15th is in R.A. 19h 58m, Decl. 20° 39′ S., mag. +0.9, and transits at 8h 27m. It is just a few degrees west of Jupiter (q.v.).

Uranus on the 15th is in R.A. 9h 41m, Decl. 14° 44′ N., and transits at 22h 06m. It is well up in the east at sunset.

Neptune on the 15th is in R.A. 14h 37m, Decl. 13° 25′ S., and transits at 3h 06m. It rises in the late evening.

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

MARCH E.S.T.				Min. of Algol	Config. of Jupiter's Sat. 5h 15m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Wed. 1			....	23 05	O1234	74.43
Thu. 2	8	35	○ Full Moon. Eclipse, see p. 60....		12O43	86.58
Fri. 3			....		42O13	98.72
Sat. 4			....	19 55	413O2	110.87
Sun. 5	12		♀ greatest brilliancy, mag. −4.3...		43O12	123.01
Mon. 6	0		☿ stationary in R.A..............		432O*	135.17
Tue. 7	0		☌♆☾ ♆ 3° S.............	16 44	d43O*	147.32
Wed. 8			....		4O132	159.48[l]
Thu. 9	21	58	☾ Last Quarter..................		412O3	171.65[b]
Fri. 10			....	13 33	24O13	183.82
Sat. 11			....		d1O42	196.00
Sun. 12	15		☌♄☾ ♄ 3° S.............		3O124	208.19
	19		☌♃☾ ♃ 3° S.............			
Mon. 13			....	10 23	321O4	220.39
Tue. 14			☿ at ☋......................		d32O4	232.59
	13		☾ at perigee. Dist. from ⊕, 225,300 mi.			
	15		☌☿☾ ☿ 0.9° S............			
Wed. 15			....		O1324	244.80
Thu. 16	13	51	● New Moon..................	7 12	d1O34	257.01
	14		☌ Vesta ☉........................			
Fri. 17			....		2O134	269.23
Sat. 18	14		☌♀☾ ♀ 12° N............		1O324	281.44
Sun. 19	13		♀ stationary in R.A..............	4 01	d3O12	293.65
Mon. 20			♀ greatest hel. lat. N.............		3421O	305.86
	15		☿ greatest elongation W., 28°.....			
	15	32	☉ enters ♈. Spring commences....			
Tue. 21			....		432O1	318.07[l]
Wed. 22			....	0 50	4O32*	330.27[b]
Thu. 23	21	49	☽ First Quarter..................		41O23	342.46
Fri. 24			☿ at aphelion..................	21 40	42O13	354.66
	8		☌ Ceres ☉........................			
	13		☌♂☾ ♂ 7° N............			
Sat. 25			....		41O23	6.84
Sun. 26	10		☾ at apogee. Dist. from ⊕, 251,600 mi.		43O12	19.02
Mon. 27			....	18 29	312O*	31.19
Tue. 28	2		☌♅☾ ♅ 2° N............		32O41	43.37
Wed. 29			♂ greatest hel. lat. N............		O324*	55.53
Thu. 30			....	15 18	dO234	67.69
Fri. 31			....		2O134	79.86

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 56

[l]Mar. 8, −6.35°; Mar. 21, +6.21°. [b]Mar. 9, −6.79°; Mar. 22, +6.80°.

THE SKY FOR APRIL, 1961

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

The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

The Sun—During April the sun's R.A. increases from 0h 41m to 2h 32m and its Decl. changes from 4° 22′ N. to 14° 56′ N. The equation of time changes from −4m 06s to +2m 52s, being zero on the 15th. For changes in the length of the day, see p. 14.

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

Mercury on the 15th is in R.A. 0h 32m, Decl. 1° 00′ N., and transits at 11h 02m. It is too close to the sun for observation.

Venus on the 15th is in R.A. 0h 58m, Decl. 13° 11′ N., mag. −3.3, and transits at 11h 22m. Although still visible at the beginning of the month as an evening star low in the west at sunset, it reaches inferior conjunction by the 10th and thereafter becomes a morning star, though not easy to observe.

Mars on the 15th is in R.A. 7h 26m, Decl. 24° 08′ N., mag. +1.1, and transits at 17h 53m. In Gemini, it is past the meridian at sunset and sets soon after midnight.

Jupiter on the 15th is in R.A. 20h 28m, Decl. 19° 24′ S., mag. −1.8, and transits at 6h 55m. In Capricornus, it rises almost four hours before the sun, but remains low in the south-east because of its low declination. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 58.

Saturn on the 15th is in R.A. 20h 06m, Decl. 20° 18′ S., mag. +0.8, and transits at 6h 33m. It is in Capricornus, preceding Jupiter by about 5 degrees and visible for about four hours before sunrise.

Uranus on the 15th is in R.A. 9h 37m, Decl. 14° 58′ N., and transits at 20h 02m. It is approaching the meridian at sunset.

Neptune on the 15th is in R.A. 14h 34m, Decl. 13° 12′ S., and transits at 1h 02m. It rises soon after sunset. Opposition is on the 30th.

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

	d	h	m	APRIL E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 4h 00m	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Sat.	1	0	48	○ Full Moon....................		1034*	92.02
Sun.	2			....	12 07	30124	104.18
Mon.	3	5		☌♆☾ ♆ 3° S............		31204	116.34[l]
Tue.	4			□♂☉ East...............		32014	128.50
Wed.	5			♄ at ☋.........................	8 56	d1302	140.67[b]
Thu.	6			....		40123	152.84
Fri.	7			....		4203*	165.02
Sat.	8	5	16	☾ Last Quarter..................	5 46	4103*	177.21
Sun.	9	1		☌♄☾ ♄ 3° S............		43012	189.40
		9		☌♃☾ ♃ 3° S............			
Mon.	10	19		☌♀☉ inferior............		43120	201.61
Tue.	11	3		☾ at perigee. Dist. from ⊕, 228,600 mi.	2 35	43201	213.82
Wed.	12			....		4102*	226.03
Thu.	13	16		☌☿☾ ☿ 0.3 °N..........	23 24	40132	238.25
Fri.	14			☿ greatest hel. lat. S.............		2043*	250.48
Sat.	15	0	38	● New Moon..................		d2034	262.71
Sun.	16			....	20 13	30124	274.94
Mon.	17	20		☌☿♀ ☿ 9° S............		d3104	287.16
Tue.	18			....		32014	299.39[l,b]
Wed.	19			□♄☉ West...............	17 02	31024	311.61
Thu.	20			....		01324	323.84
Fri.	21			Lyrid meteors (see p. 64).............		21043	336.05
Sat.	22	0		☌♂☾ ♂ 5° N............	13 51	d2403	348.26
		16	50	☽ First Quarter..................			
Sun.	23	5		☾ at apogee. Dist. from ⊕, 251,100 mi.		d4012	0.47
Mon.	24	9		☌♅☾ ♅ 2° N............		43102	12.67
Tue.	25			....	10 40	43201	24.86
Wed.	26			□♃☉ West...............		43102	37.05
Thu.	27			....		40312	49.23
Fri.	28			....	7 29	41203	61.41
Sat.	29	8		♅ stationary in R.A.............		42013	73.59
		12		♀ stationary in R.A.............			
Sun.	30	8		☍♆☉ Dist. from ⊕, 2,724,000,000 mi..		4032*	85.76[l]
		12		☌♆☾ ♆ 3° S............			
		13	41	○ Full Moon....................			

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 56

[l]Apr. 3, −5.41°; Apr. 18, +5.19°; Apr. 30, −5.46°. [b]Apr. 5, −6.67°; Apr. 18, +6.66°.

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

The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

The Sun—During May the sun's R.A. increases from 2h 32m to 4h 35m and its Decl. changes from 14° 56′ N. to 21° 59′ N. The equation of time changes from +2m 52s to a maximum of +3m 44s on the 14th and then to +2m 23s at the end of the month. For changes in the length of the day, see p. 15.

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

Mercury on the 15th is in R.A. 4h 26m, Decl. 23° 34′ N., and transits at 12h 59m. It is in superior conjunction on the 1st, and is too close to the sun for observation except for the last few days of the month, being at greatest eastern elongation on the 31st. Thus for the last few days of the month it may easily be seen low in the west after sunset.

Venus on the 15th is in R.A. 0h 58m, Decl. 6° 17′ N., mag. −4.2, and transits at 9h 26m. It is a morning star visible low in the eastern sky for an hour or so before sunrise. Greatest brilliancy is on the 16th.

Mars on the 15th is in R.A. 8h 30m, Decl. 20° 45′ N., mag. +1.5, and transits at 16h 58m. In Cancer, no longer very prominent, it is well past the meridian at sunset and sets about at midnight.

Jupiter on the 15th is in R.A. 20h 38m, Decl. 18° 55′ S., mag. −2.0, and transits at 5h 06m. In Capricornus, it rises about at midnight and reaches the meridian about at sunrise. On the 25th it is stationary in right ascension and begins to retrograde, i.e. move westward among the stars. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 58.

Saturn on the 15th is in R.A. 20h 08m, Decl. 20° 15′ S., mag. +0.7, and transits at 4h 37m. In Capricornus, it precedes Jupiter by about 7 degrees, rising a little before midnight. On the 9th it is stationary in right ascension and begins to retrograde, i.e. move westward among the stars.

Uranus on the 15th is in R.A. 9h 38m. Decl. 14° 57′ N., and transits at 18h 04m. It is a little past the meridian at sunset.

Neptune on the 15th is in R.A. 14h 31m, Decl. 12° 56′ S., and transits at 22h 56m. It is low in the south-east at sunset.

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

			MAY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 3h 15m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Mon. 1	18		☌ ☿ ☉ superior	4 18	31O24	97.94
Tue. 2					32O14	110.11[b]
Wed. 3			☿ at ☊		31O4*	122.29
Thu. 4			η Aquarid meteors (see p. 64)	1 07	O3124	134.47
Fri. 5			♂ at aphelion		12O34	146.66
Sat. 6	7		☌ ♄ ☾ ♄ 3° S.	21 56	2O134	158.85
	7		☾ at perigee. Dist. from ⊕, 229,600 mi.			
	19		☌ ♃ ☾ ♃ 3° S.			
Sun. 7			☿ at perihelion		1O324	171.05
	10	58	☾ Last Quarter			
Mon. 8					d3O42	183.25
Tue. 9	16		♄ stationary in R.A.	18 45	324O1	195.47
Wed. 10					431O*	207.69
Thu. 11	11		☌ ♀ ☾ ♀ 4° N.		4O12*	219.91
Fri. 12			□ ♅ ☉ East	15 34	d41O3	232.15
Sat. 13					42O13	244.39
Sun. 14	11	55	● New Moon		41O23	256.63
Mon. 15			♀ at ☋	12 23	43O12	268.87[l,b]
	17		☌ ☿ ☾ ☿ 7° N.			
Tue. 16	15		♀ greatest brilliancy, mag. −4.2		342O*	281.11
Wed. 17			☿ greatest hel. lat. N.		312O4	293.35
Thu. 18				9 12	O124*	305.59
Fri. 19					1O234	317.82
Sat. 20	13		☌ ♂ ☾ ♂ 4° N.		2O134	330.06
Sun. 21	0		☾ at apogee. Dist. from ⊕, 251,200 mi.	6 01	1O234	342.28
	14		♇ stationary in R.A.			
	17		☌ ♅ ☾ ♅ 2° N.			
Mon. 22	11	19	☽ First Quarter		3O124	354.50
Tue. 23					32O4*	6.72
Wed. 24				2 50	321O4	18.93
Thu. 25	20		♃ stationary in R.A.		3O412	31.13
Fri. 26				23 39	41O23	43.33
Sat. 27	19		☌ ♆ ☾ ♆ 3° S.		42O13	55.53[l]
Sun. 28					41O23	67.72
Mon. 29	23	38	○ Full Moon	20 28	43O12	79.90
Tue. 30					4321O	92.09[b]
Wed. 31	23		☿ greatest elongation E., 23°		d432O	104.27

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 56

[l]May 15, +4.72°; May 27, −6.23°. [b]May 2, −6.52°; May 15, +6.54°; May 30, −6.52°.

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

The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

The Sun—During June the sun's R.A. increases from 4h 35m to 6h 39m and its Decl. changes from 21° 59′ N. to 23° 09′ N. The equation of time changes from +2m 23s to −3m 36s, being zero on the 14th. The summer solstice is on the 21st at 10h 30m E.S.T. For changes in the length of the day, see p. 15.

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

Mercury on the 15th is in R.A. 6h 45m, Decl. 21° 50′ N., and transits at 13h 10m. It is near greatest eastern elongation as the month begins, and at that time may be easily seen for a few evenings low in the west after sunset. It is in inferior conjunction on the 27th.

Venus on the 15th is in R.A. 2h 26m, Decl. 11° 34′ N., mag. −4.0, and transits at 8h 54m. It is a morning star seen low in the east for an hour or so before sunrise. Greatest western elongation is on the 19th.

Mars on the 15th is in R.A. 9h 39m, Decl. 15° 27′ N., mag. +1.7, and transits at 16h 05m. In Leo, it is well down in the west at sunset and sets before midnight.

Jupiter on the 15th is in R.A. 20h 36m, Decl. 19° 08′ S., mag. −2.2, and transits at 3h 03m. In Capricornus, it rises before midnight and is west of the meridian by sunrise. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 58.

Saturn on the 15th is in R.A. 20h 04m, Decl. 20° 30′ S., mag. +0.5, and transits at 2h 31m. Moving from Capricornus into Sagittarius, it precedes Jupiter by about 7 degrees and so rises about half-an-hour earlier.

Uranus on the 15th is in R.A. 9h 41m, Decl. 14° 39′ N., and transits at 16h 05m. It is well past the meridian at sunset.

Neptune on the 15th is in R.A. 14h 28m, Decl. 12° 44′ S., and transits at 20h 52m. It is approaching the meridian at sunset.

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

			JUNE E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 2h 30m	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Thu. 1	22		☾ at perigee. Dist. from ⊕, 227,000 mi.	17 17	43O12	116.46
Fri. 2	13		☌ ♄ ☾ ♄ 3° S.		41O23	128.65
Sat. 3	1		☌ ♃ ☾ ♃ 2° S.		2O413	140.84
Sun. 4			. . . .	14 05	1O34*	153.04
Mon. 5	16	19	☾ Last Quarter.		dO124	165.25
Tue. 6			. . . .		312O4	177.47
Wed. 7			. . . .	10 54	32O14	189.69
Thu. 8			. . . .		3O24*	201.92
Fri. 9	4		☌ ♀ ☾ ♀ 2° N.		1O324	214.15
Sat. 10			☿ at ☋	7 43	2O143	226.39[l]
Sun. 11			. . . .		124O3	238.64[b]
Mon. 12			. . . .		4O312	250.89[b]
Tue. 13	0	17	● New Moon.	4 32	d431O	263.13
Wed. 14	5		☿ stationary in R.A.		432O1	275.39
	13		☌ ☿ ☾ ☿ 3° N.			
Thu. 15	19		☌ ♂ ♅ ♂ 0.6° N.		431O2	287.63
Fri. 16			. . . .	1 20	41O32	299.88
Sat. 17	17		☾ at apogee. Dist. from ⊕, 251,800 mi.		42O13	312.13
Sun. 18	2		☌ ♅ ☾ ♅ 1° N.	22 09	412O3	324.37
	5		☌ ♂ ☾ ♂ 2° N.			
Mon. 19			♀ at aphelion.		O312*	336.61
	21		♀ greatest elongation W., 46°.			
Tue. 20			☿ at aphelion.		d31O4	348.84
Wed. 21	4	02	☽ First Quarter.	18 58	32O14	1.06
	10	30	☉ enters ♋. Summer commences . .			
Thu. 22			. . . .		31O24	13.29
Fri. 23			. . . .		dO324	25.50
Sat. 24	4		☌ ♆ ☾ ♆ 3° S.	15 47	2O134	37.71[l]
Sun. 25			. . . .		21O34	49.91
Mon. 26			. . . .		O1324	62.11[b]
Tue. 27	7		☌ ☿ ☉ inferior.	12 35	13O24	74.30
Wed. 28	7	38	○ Full Moon.		324O1	86.49
Thu. 29	19		☌ ♄ ☾ ♄ 3° S.		341O2	98.68
	20		☾ at perigee. Dist. from ⊕, 224,000 mi.			
Fri. 30	7		☌ ♃ ☾ ♃ 3° S.	9 24	43O12	110.87

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 56

[l]June 10, +5.27°; June 24, −7.10°. [b]June 11, 12, +6.54°; June 26, −6.63°.

THE SKY FOR JULY, 1961

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

The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

The Sun—During July the sun's R.A. increases from 6h 39m to 8h 44m and its Decl. changes from 23° 09′ N. to 18° 08′ N. The equation of time changes from −3m 36s to a minimum of −6m 25s on the 26th and then to −6m 16s at the end of the month. On the 5th the earth is in aphelion or farthest from the sun. For changes in the length of the day, see p. 16.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 23.

Mercury on the 15th is in R.A. 6h 13m, Decl. 19° 58′ N., and transits at 10h 41m. It is at greatest western elongation on the 19th, and for a few mornings at that time may be seen low in the east before sunrise.

Venus on the 15th is in R.A. 4h 28m, Decl. 19° 00′ N., mag. −3.7, and transits at 8h 58m. It is a morning star which rises about two hours before the sun.

Mars on the 15th is in R.A. 10h 46m, Decl. 8° 53′ N., mag. +1.8, and transits at 15h 14m. In Leo, it is well down in the west at sunset and sets about two hours later.

Jupiter on the 15th is in R.A. 20h 24m, Decl. 19° 56′ S., mag. −2.3, and transits at 0h 53m. In Capricornus it rises soon after sunset, reaches the meridian about at midnight and sets before sunrise. Opposition is on the 25th. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 58.

Saturn on the 15th is in R.A. 19h 56m, Decl. 20° 56′ S., mag. +0.3, and transits at 0h 24m. In Sagittarius, it precedes Jupiter by about 7 degrees, rising at about sunset. Opposition is on the 19th.

Uranus on the 15th is in R.A. 9h 46m, Decl. 14° 11′ N., and transits at 14h 13m. It is low in the west at sunset.

Neptune on the 15th is in R.A. 14h 27m, Decl. 12° 39′ S., and transits at 18h 53m. It is past the meridian at sunset.

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

	d	h	m	JULY E.S.T.	Min. of Algol h m	Config. of Jupiter's Sat. 1h 00m	Sun's Selen. Colong. 0h U.T. °
Sat.	1					42O3*	123.06
Sun.	2					421O3	135.26
Mon.	3				6 13	4O123	147.46
Tue.	4	22	33	☾ Last Quarter		413O2	159.67
Wed.	5			⊕ at aphelion. Dist. from ☉, 94,451,000 mi.		324O1	171.89
Thu.	6				3 01	31O**	184.11
Fri.	7					3O124	196.34[l]
Sat.	8	14		☿ stationary in R.A.	23 50	12O34	208.57
		15		☌ ♀ ☾ ♀ 2° N.			
Sun.	9					d2O34	220.82[b]
Mon.	10			☿ greatest hel. lat. S.		O1234	233.06
Tue.	11			♀ greatest hel. lat. S.	20 39	13O24	245.31
		1		☌ ☿ ☾ ☿ 0.2° N.			
Wed.	12	14	12	● New Moon		32O14	257.56
Thu.	13					312O4	269.81
Fri.	14				17 27	3O412	282.06
Sat.	15	6		☾ at apogee. Dist. from ⊕, 252,300 mi.		412O3	294.31
		12		☌ ♅ ☾ ♅ 1° N.			
Sun.	16	9		Pallas stationary in R.A.		42O13	306.56
		21		☌ ♂ ☾ ♂ 0.3° S.			
Mon.	17				14 16	4O23*	318.81
Tue.	18					d41O2	331.05
Wed.	19	4		☿ greatest elongation W., 20°		432O1	343.28
		6		☍ ♄ ☉ Dist. from ⊕, 836,100,000 mi.			
Thu.	20	18	14	☽ First Quarter	11 04	4312O	355.51
Fri.	21	4		♆ stationary in R.A.		43O12	7.73
		12		☌ ♆ ☾ ♆ 3° S.			
Sat.	22					d14O3	19.95[l]
Sun.	23				7 53	2O143	32.16[b]
Mon.	24					O234*	44.36
Tue.	25	6		☍ ♃ ☉ Dist. from ⊕, 380,400,000 mi.		1O324	56.56
Wed.	26				4 42	32O14	68.75
Thu.	27	2		☌ ♄ ☾ ♄ 3° S.		321O4	80.94
		12		☌ ♃ ☾ ♃ 3° S.			
		14	51	○ Full Moon			
Fri.	28	4		☾ at perigee. Dist. from ⊕, 222,200 mi.		3O124	93.13
Sat.	29			δ Aquarid meteors (see p. 64)	1 30	1O324	105.32
Sun.	30			☿ at ☊		2O143	117.51
Mon.	31			□ ♆ ☉ East	22 19	14O23	129.70

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 56

[l]July 7, +6.52°; July 22, −7.59°.   [b]July 9, +6.68°; July 23, −6.76°.

THE SKY FOR AUGUST, 1961

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

The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

The Sun—During August the sun's R.A. increases from 8h 44m to 10h 40m and its Decl. changes from 18° 08′ N. to 8° 27′ N. The equation of time changes from −6m 16s to −0m 10s. There is an annular eclipse of the sun on the 11th. For changes in the length of the day, see p. 16.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 23. There is a partial eclipse of the moon on the night of the 25th.

Mercury on the 15th is in R.A. 9h 41m, Decl. 15° 44′ N., and transits at 12h 11m. It is in superior conjunction on the 14th, and is too close to the sun for observation all month.

Venus on the 15th is in R.A. 6h 56m, Decl. 21° 34′ N., mag. −3.5, and transits at 9h 24m. It is a morning star dominating the eastern sky for about three hours before sunrise.

Mars on the 15th is in R.A. 11h 56m, Decl. 1° 05′ N., mag. +1.9, and transits at 14h 22m. Moving into Virgo, it is too low on the western horizon at sunset to be observed easily.

Jupiter on the 15th is in R.A. 20h 08m, Decl. 20° 51′ S., mag. −2.3, and transits at 22h 30m. Moving from Capricornus into Sagittarius, it is risen at sunset, past the meridian at midnight and set before sunrise. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 58.

Saturn on the 15th is in R.A. 19h 47m, Decl. 21° 23′ S., mag. +0.4, and transits at 22h 09m. In Sagittarius, it precedes Jupiter by about 5 degrees.

Uranus on the 15th is in R.A. 9h 53m, Decl. 13° 33′ N., and transits at 12h 18m. It is too close to the sun for observation. Conjunction is on the 19th.

Neptune on the 15th is in R.A. 14h 28m, Decl. 12° 44′ S., and transits at 16h 51m. It is well down in the south-west at sunset.

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

d	h	m	AUGUST E.S.T.	Min. of Algol h m	Config. of Jupiter's Sat. 23h 15m	Sun's Selen. Colong. 0h U.T. °
Tue. 1			....		43201	141.90
Wed. 2			....		43210	154.10
Thu. 3			☿ at perihelion..................	19 07	43012	166.31
	6	48	☾ Last Quarter..................			
Fri. 4			....		41032	178.53[l]
Sat. 5			....		42013	190.75[b]
Sun. 6			....	15 56	4103*	202.98
Mon. 7	13		☌ ♀ ☾ ♀ 3° N.............		40132	215.22
Tue. 8			....		3204*	227.45
Wed. 9			....	12 44	32104	239.70
Thu. 10	13		Juno stationary in R.A...............		30124	251.94
Fri. 11	5	36	● New Moon. Eclipse, see p. 60...		1024*	264.19
	12		☾ at apogee. Dist. from ⊕, 252,600 mi.			
Sat. 12			Perseid meteors (see p. 64)............	9 33	20134	276.43
Sun. 13			☿ greatest hel. lat. N.............		12034	288.68
Mon. 14	10		☌ ☿ ☉ superior		01324	300.92
	13		☌ ♂ ☾ ♂ 2° S.............			
Tue. 15			....	6 22	32104	313.16
Wed. 16			....		d3240	325.40
Thu. 17	19		☌ ♆ ☾ ♆ 3° S....................		43012	337.63
Fri. 18			....	3 10	41302	349.85
Sat. 19	4		☌ ♅ ☉............................		42013	2.07[l]
	5	52	☽ First Quarter................			
Sun. 20			....	23 59	41203	14.28[b]
Mon. 21			....		40132	26.49
Tue. 22			....		d4130	38.68
Wed. 23	10		☌ ♄ ☾ ♄ 3° S............	20 47	d3240	50.88
	18		☌ ♃ ☾ ♃ 3° S............			
Thu. 24			....		302**	63.06
Fri. 25	14		☾ at perigee. Dist. from ⊕, 222,000 mi.		31024	75.24
	22	14	○ Full Moon. Eclipse, see p. 60....			
Sat. 26			....	17 36	20134	87.42
Sun. 27			....		12034	99.60
Mon. 28			....		01234	111.78
Tue. 29			....	14 24	13024	123.96
Wed. 30			....		32014	136.14
Thu. 31	8		☌ ♇ ☉............................		304**	148.34

Explanation of symbols and abbrevations on p. 4, of time on p. 10, of colongitude on p. 56

[l]Aug. 4, +7.51°; Aug. 19, −7.43°. [b]Aug. 5, +6.81°; Aug. 20, −6.79°.

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

The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

The Sun—During September the sun's R.A. increases from 10h 40m to 12h 28m and its Decl. changes from 8° 27′ N. to 3° 00′ S. The equation of time changes from −0m 10s to +10m 08s, being zero during the first day of the month. On the 23rd at 1h 43m E.S.T. the sun crosses the equator moving southward, enters the sign of Libra, and Autumn commences. For changes in the length of the day, see p. 17.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 24. During the night of the 29th–30th there is an occultation of Aldebaran visible in parts of North America.

Mercury on the 15th is in R.A. 12h 53m, Decl. 6° 54′ S., and transits at 13h 19m. It is at greatest eastern elongation on the 28th, and for a few evenings at that time might be glimpsed low in the south-west after sunset. This is not a favourable elongation.

Venus on the 15th is in R.A. 9h 28m, Decl. 15° 24′ N., mag. −3.4, and transits at 9h 54m. It is a morning star visible in the east for about two hours before sunrise.

Mars on the 15th is in R.A. 13h 10m, Decl. 7° 05′ S., mag. +1.9, and transits at 13h 34m. In Virgo, it is too low on the western horizon at sunset to be observed easily.

Jupiter on the 15th is in R.A. 19h 59m, Decl. 21° 20′ S., mag. −2.2, and transits at 20h 19m. In Sagittarius, it is well up in the south-east at sunset and visible until about an hour after midnight. On the 23rd it is stationary in right ascension and resumes direct, or eastward, motion among the stars. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 58.

Saturn on the 15th is in R.A. 19h 41m, Decl. 21° 39′ S., mag. +0.6, and transits at 20h 02m. In Sagittarius, it precedes Jupiter by about 5 degrees. On the 27th it is stationary in right ascension and resumes direct, or eastward, motion among the stars.

Uranus on the 15th is in R.A. 10h 01m, Decl. 12° 54′ N., and transits at 10h 24m. It rises an hour or two before the sun.

Neptune on the 15th is in R.A. 14h 30m, Decl. 12° 58′ S., and transits at 14h 52m. It is low in the south-west at sunset.

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

	d	h	m	SEPTEMBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 21h 00m	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Fri.	1	18	06	☾ Last Quarter..................	11 13	d3042	160.53[l,b]
Sat.	2			....		42013	172.74
Sun.	3			....		42103	184.95
Mon.	4			....	8 01	40123	197.16
Tue.	5			♀ at ☊.......................		41032	209.38
Wed.	6			☿ at ☋........................		43201	221.61
		19		☌ ♀ ☾ ♀ 2° N............			
Thu.	7	15		☾ at apogee. Dist. from ⊕, 252,400 mi.	4 50	43120	233.84
Fri.	8	6		☌ ♅ ☾ ♅ 0.7° N..........		43012	246.07
Sat.	9	12		☍ Pallas ☉........................		4203*	258.30
		21	50	● New Moon..................			
Sun.	10			....	1 39	2103*	270.53
Mon.	11	17		☌ ☿ ☾ ☿ 4° S............		01243	282.77
Tue.	12	6		☌ ♂ ☾ ♂ 4° S............	22 27	10324	295.00
Wed.	13			....		32014	307.23
Thu.	14	2		☌ ♆ ☾ ♆ 3° S............		31204	319.46
Fri.	15			....	19 16	30124	331.68
Sat.	16			☿ at aphelion..................		d04**	343.89[b,l]
Sun.	17	9		☍ Juno ☉.........................		21043	356.10
		15	24	☽ First Quarter................			
Mon.	18			....	16 04	40123	8.30
Tue.	19	17		☌ ♄ ☾ ♄ 3° S............		41032	20.49
Wed.	20	0		☌ ♃ ☾ ♃ 3° S............		43201	32.68
Thu.	21	22		☌ ♀ ♅ ♀ 0.1° N..........	12 53	43120	44.86
Fri.	22	16		☌ ☿ ♂ ☿ 3° S............		43012	57.03
		23		☾ at perigee. Dist. from ⊕, 223,600 mi.			
Sat.	23	1	43	☉ enters ♎. Autumn commences.....		4102*	69.20
		11		♃ stationary in R.A.............			
		19		Ceres stationary in R.A.			
Sun.	24	6	34	○ Full Moon....................	9 42	d4203	81.36
Mon.	25			....		40123	93.53
Tue.	26			....		14032	105.69
Wed.	27	12		♄ stationary in R.A.............	6 30	32014	117.86
Thu.	28	5		☿ greatest elongation E., 26°......		32104	130.03[b]
Fri.	29			....		30124	142.20[l]
Sat.	30			....	3 19	13024	154.38

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 56

[l]Sept. 1, +7.82°; Sept. 16, −6.57°; Sept. 29, +7.36°.
[b]Sept. 1, +6.83°; Sept. 16, −6.76°; Sept. 28, +6.70°.

THE SKY FOR OCTOBER, 1961

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

The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

The Sun—During October the sun's R.A. increases from 12h 28m to 14h 24m and its Decl. changes from 3° 00′ S. to 14° 17′ S. The equation of time changes from +10m 08s to +16m 21s. For changes in the length of the day, see p. 17.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 24.

Mercury on the 15th is in R.A. 14h 14m, Decl. 16° 43′ S., and transits at 12h 37m. It is at inferior conjunction on the 22nd and is too close to the sun for observation.

Venus on the 15th is in R.A. 11h 48m, Decl. 2° 53′ N., mag. −3.4, and transits at 10h 15m. It is a morning star, rising in the east about two hours before the sun.

Mars on the 15th is in R.A. 14h 26m, Decl. 14° 31′ S., and transits at 12h 52m. It is too close to the sun for easy observation.

Jupiter on the 15th is in R.A. 20h 01m, Decl. 21° 12′ S., mag. −2.0, and transits at 18h 24m. In Sagittarius, moving back into Capricornus, it is approaching the meridian at sunset and visible until about midnight. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 58.

Saturn on the 15th is in R.A. 19h 42m, Decl. 21° 39′ S., mag. +0.7, and transits at 18h 05m. In Sagittarius, it precedes Jupiter by about 5 degrees.

Uranus on the 15th is in R.A. 10h 07m, Decl. 12° 23′ N., and transits at 8h 32m. It is well up in the east at sunrise.

Neptune on the 15th is in R.A. 14h 34m, Decl. 13° 17′ S., and transits at 12h 58m. It is too close to the sun for easy observation.

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

				OCTOBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 19h 45m	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Sun.	1	6		Vesta stationary in R.A.		20134	166.57
		9	10	☾ Last Quarter			
Mon.	2			....		034**	178.76
Tue.	3			....	0 08	10324	190.95
Wed.	4			....		23014	203.15
Thu.	5	3		☾ at apogee. Dist. from ⊕,251,900 mi.	20 56	32140	215.36
		16		☌ ♅ ☾ ♅ 0.5° N.			
Fri.	6			☿ greatest hel. lat. S.		34012	227.57
Sat.	7	3		☌ ♀ ☾ ♀ 0.5° S.		41302	239.79
Sun.	8			....	17 45	42013	252.00
Mon.	9			♀ at perihelion		41203	264.22
		13	53	● New Moon			
Tue.	10	20		☿ stationary in R.A.		d4023	276.44
Wed.	11	1		☌ ♂ ☾ ♂ 5° S.	14 34	d4201	288.66
		2		☌ ☿ ☾ ☿ 9° S.			
		10		☌ ♆ ☾ ♆ 3° S.			
		15		☌ ☿ ♂ ☿ 4° S.			
Thu.	12			....		34210	300.87
Fri.	13			♂ at ☋		3021*	313.08[l,b]
Sat.	14			....	11 22	31024	325.29[l]
Sun.	15			....		20134	337.49
Mon.	16			□ ♄ ☉ East		12034	349.69
		23	35	☽ First Quarter			
Tue.	17	0		☌ ♄ ☾ ♄ 3° S.	8 11	d0234	1.87
		9		☌ ♃ ☾ ♃ 3° S.			
		17		☌ ♂ ♆ ♂ 1.9° S.			
Wed.	18			....		d034*	14.05
Thu.	19			....		32104	26.23
Fri.	20			Orionid meteors (see p. 64)	5 00	30214	38.39
Sat.	21	2		☾ at perigee. Dist. from ⊕, 226,600 mi.		31042	50.55
Sun.	22			□ ♃ ☉ East		24031	62.70
		14		☌ ☿ ☉ inferior			
Mon.	23	16	31	○ Full Moon	1 48	41203	74.85
Tue.	24			....		40123	87.00
Wed.	25			☿ at ☊	22 37	4023*	99.15
Thu.	26			....		43210	111.29[b]
Fri.	27	13		Juno stationary in R.A.		4301*	123.45[l]
Sat.	28			....	19 26	43102	135.60
Sun.	29			....		42031	147.76
Mon.	30			☿ at perihelion		21043	159.93
		7		Pallas stationary in R.A.			
Tue.	31			♀ greatest hel. lat. N.	16 15	01243	172.10
		3		☿ stationary in R.A.			
		3	59	☾ Last Quarter			

[l]Oct. 13, 14, −5.30°; Oct. 27, +6.40°. [b]Oct. 13, −6.64°; Oct. 26, +6.55°.

THE SKY FOR NOVEMBER, 1961

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

The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

The Sun—During November the sun's R.A. increases from 14h 24m to 16h 27m and its Decl. changes from 14° 17′ S. to 21° 44′ S. The equation of time changes from +16m 21s to a maximum of +16m 24s on the 3rd and then to +11m 09s at the end of the month. For changes in the length of the day, see p. 18.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 25. During the evening of the 22nd there is an occultation of Aldebaran visible in North America.

Mercury on the 15th is in R.A. 14h 15m, Decl. 11° 28′ S., and transits at 10h 41m. It is at greatest western elongation on the 7th and for a few mornings at that time may be seen low in the south-east before sunrise very close to Venus. This is a favourable elongation.

Venus on the 15th is in R.A. 14h 12m, Decl. 11° 46′ S., mag. −3.4, and transits at 10h 37m. It is a morning star seen low in the south-east for about an hour before sunrise.

Mars on the 15th is in R.A. 15h 54m, Decl. 20° 38′ S., and transits at 12h 18m. It is too close to the sun for observation.

Jupiter on the 15th is in R.A. 20h 16m, Decl. 20° 28′ S., mag. −1.8, and transits at 16h 37m. In Capricornus, it is about on the meridian at sunset and sets before midnight. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 58.

Saturn on the 15th is in R.A. 19h 48m, Decl. 21° 24′ S., mag. +0.8, and transits at 16h 10m. In Sagittarius, it precedes Jupiter by about 5 degrees.

Uranus on the 15th is in R.A. 10h 11m, Decl. 12° 03′ N., and transits at 6h 33m. It rises about at midnight.

Neptune on the 15th is in R.A. 14h 38m, Decl. 13° 38′ S., and transits at 11h 00m. It is too close to the sun for observation, being in conjunction on the 3rd.

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

				NOVEMBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 18h 30m	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Wed.	1	21		☾ at apogee. Dist. from ⊕, 251,300 mi.		10234	184.27
Thu.	2	1		☌ ♅ ☾ ♅ 0.2° N.		d2304	196.46
Fri.	3	12		☌ ♆ ☉	13 04	304**	208.64
Sat.	4			. . . .		31024	220.83
Sun.	5			Taurid meteors (see p. 64).		23014	233.03
Mon.	6	11		☌ ♀ ☾ ♀ 3° S.	9 53	21034	245.23
		13		☌ ☿ ☾ ☿ 2° S.			
Tue.	7	10		☿ greatest elongation W., 19°.		04123	257.43
Wed.	8	4	59	● New Moon.		41023	269.64
Thu.	9			☿ greatest hel. lat. N.	6 41	42301	281.84[l,b]
Fri.	10			. . . .		43210	294.04
Sat.	11			. . . .		43102	306.24
Sun.	12	5		☍ Ceres ☉	3 30	43201	318.43
Mon.	13	8		☌ ♄ ☾ ♄ 3° S.		42103	330.62
		19		☌ ♃ ☾ ♃ 3° S.			
Tue.	14			. . . .		40213	342.80
Wed.	15	7	13	☽ First Quarter.	0 19	14023	354.98
Thu.	15			Leonid meteors (see p. 64).		23014	7.15
Fri.	17	0		☾ at perigee. Dist. from ⊕, 229,700 mi.	21 08	32104	19.31
Sat.	18	21		☍ Vesta ☉		d3024	31.46
		23		☌ ☿ ♆ ☿ 0.1° S.			
Sun.	19			. . . .		d3014	43.60
Mon.	20	11		☌ ♀ ♆ ♀ 0.5° S.	17 57	21034	55.75
Tue.	21			. . . .		02134	67.88
Wed.	22			□ ♅ ☉ West.		10234	80.02[b]
		4	44	○ Full Moon.			
Thu.	23			. . . .	14 46	d2014	92.15
Fri.	24			. . . .		d3210	104.29[l]
Sat.	25			. . . .		d3402	116.42
Sun.	26			. . . .	11 35	4302*	128.56
Mon.	27			. . . .		42103	140.71
Tue.	28			. . . .		4013*	152.86
Wed.	29	10		☌ ♅ ☾ ♅ 0.1° S.	8 24	41023	165.01
		17		☾ at apogee. Dist. from ⊕, 251,200 mi.			
Thu.	30	1	19	☾ Last Quarter.		42031	177.17

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 56

[l]Nov. 9, −4.72°; Nov. 24, +5.42°. [b]Nov. 9, −6.55°; Nov. 22, +6.53°.

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

The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

The Sun—During December the sun's R.A. increases from 16h 27m to 18h 44m and its Decl. changes from 21° 44′ S. to 23° 04′ S. The equation of time changes from +11m 09s to −3m 14s, being zero on the 25th. The winter solstice is on the 21st at 21h 20m E.S.T. For changes in the length of the day, see p. 18.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 25. On the morning of the 20th there is an occultation of Aldebaran visible in parts of North America.

Mercury on the 15th is in R.A. 17h 25m, Decl. 24° 25′ S., and transits at 11h 53m. It is in superior conjunction on the 16th and is too close to the sun for observation during the whole month.

Venus on the 15th is in R.A. 16h 44m, Decl. 21° 50′ S., mag. −3.4, and transits at 11h 11m. It is a morning star, but (especially later in the month) it is too close to the sun for easy observation.

Mars on the 15th is in R.A. 17h 28m, Decl. 23° 51′ S., and transits at 11h 54m. It is in conjunction on the 14th, and becomes thereafter a morning star, but it is too close to the sun all month for observation.

Jupiter on the 15th is in R.A. 20h 38m, Decl. 19° 12′ S., mag. −1.6, and transits at 15h 01m. In Capricornus, it is well past the meridian at sunset and sets about three hours later. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 58.

Saturn on the 15th is in R.A. 20h 00m, Decl. 20° 54′ S., mag. +0.8, and transits at 14h 23m. In Sagittarius, it precedes Jupiter by about 5 degrees, setting about half-an-hour earlier.

Uranus on the 15th is in R.A. 10h 11m, Decl. 12° 00′ N., and transits at 4h 36m. It rises in the late evening.

Neptune on the 15th is in R.A. 14h 42m, Decl. 13° 56′ S., and transits at 9h 06m. It rises several hours before the sun.

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

	d	h	m	DECEMBER E.S.T.	Min. of Algol h m	Config. of Jupiter's Sat. 17h 45m	Sun's Selen. Colong. 0h U.T. °
Fri.	1					43210	189.33
Sat.	2				5 13	34012	201.51
Sun.	3			☿ at ☋		3024*	213.68
Mon.	4					2104*	225.86
Tue.	5	5		☌♆☾ ♆ 3° S.	2 02	20134	238.05
Wed.	6	7		♅ stationary in R.A.		10234	250.24[l,b]
		18		☌♀☾ ♀ 4° S.			
Thu.	7	18	52	● New Moon	22 51	20134	262.43
Fri.	8					23104	274.62
Sat.	9					30124	286.81
Sun.	10	19		☌♄☾ ♄ 2° S.	19 40	31024	299.01
Mon.	11	9		☌♃☾ ♃ 2° S.		d240*	311.19
		19		☾ at perigee. Dist. from ⊕, 228,900 mi.			
Tue.	12					42013	323.37
Wed.	13			Geminid meteors (see p. 64)	16 29	41023	335.55
				☿ at aphelion			
Thu.	14	13		☌♂☉		d4013	347.72
		15	06	☽ First Quarter			
Fri.	15					42130	359.88
Sat.	16	3		☌☿☉ superior	13 18	43012	12.03
Sun.	17					43102	24.18
Mon.	18	17		♇ stationary in R.A.		42301	36.32
Tue.	19			♆ greatest hel. lat. N.	10 07	2403*	48.46[b]
Wed.	20					10423	60.59
Thu.	21	19	42	○ Full Moon		02134	72.72[l]
		21	20	☉ enters ♑. Winter commences			
Fri.	22			Ursid meteors (see p. 64)	6 57	21304	84.84
Sat.	23					3014*	96.97
Sun.	24					31024	109.10
Mon.	25				3 46	32014	121.23
Tue.	26			♀ at ☋		21034	133.37
		18		☌♅☾ ♅ 0.3° S.			
Wed.	27	14		☾ at apogee. Dist. from ⊕, 251,500 mi.		10423	145.51
Thu.	28				0 35	40123	157.65
Fri.	29	22	57	☾ Last Quarter		d4210	169.80
Sat.	30				21 24	4301*	181.96
Sun.	31					43102	194.12

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 56

[l]Dec. 6, −5.31°; Dec. 21, +5.11°. [b]Dec. 6, −6.59°; Dec. 19, +6.63°.

During 1961 the ascending node of the moon's orbit occurs in the constellation Leo (☊ from 159° to 140°). Every month the moon will pass within a degree of the bright stars Aldebaran and Regulus.

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

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

Sunrise will occur at a given point *east* of the central meridian of the moon when the sun's selenographic colongitude is equal to the eastern selenographic longitude of the point; at a point *west* of the central meridian when the sun's selenographic colongitude is equal to 360° minus the western selenographic longitude of the point. The longitude of the sunset terminator differs by 180° from that of the sunrise terminator.

The sun's selenographic latitude varies between +1½° and −1½° during the year.

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

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

A map of the moon, with identifications of some of the markings, appears on p. 90.

OPPOSITION EPHEMERIDES OF THE BRIGHTEST ASTEROIDS, 1961

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

Ephemerides for the four brightest asteroids are given when the asteroids are near opposition. Right ascensions and declinations are for 0h E.T. and equinox of 1950.0.

PALLAS (No. 2)

Opp. Sept. 9 in Psc Mag. 8.7

Aug.	20	23^h	15.6^m	+4°43′
	25	23	12.4	+3 48
	30	23	08.9	+2 49
Sept.	4	23	05.2	+1 47
	9	23	01.4	+0 42
	14	22	57.7	−0 25
	19	22	54.0	−1 33
	24	22	50.5	−2 40
	29	22	47.2	−3 46

JUNO (No. 3)

Opp. Sept. 17 in Psc Mag. 7.7

Aug.	28	23^h	53.9^m	+0°10′
Sept.	2	23	51.6	−0 43
	7	23	48.8	−1 41
	12	23	45.6	−2 42
	17	23	42.2	−3 46
	22	23	38.7	−4 50
	27	23	35.2	−5 54
Oct.	2	23	32.0	−6 55
	7	23	29.1	−7 52

CERES (No. 1)

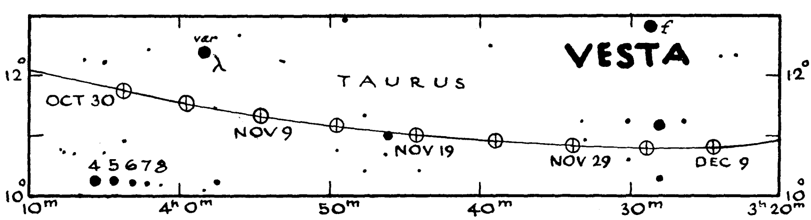
Opp. Nov. 12 in Cet Mag. 7.5

Oct.	23	3^h	35.7^m	+9°53′
	28	3	31.9	+9 46
Nov.	2	3	27.7	+9 39
	7	3	23.2	+9 33
	12	3	18.4	+9 29
	17	3	13.6	+9 26
	22	3	08.9	+9 26
	27	3	04.4	+9 27
Dec.	2	3	00.2	+9 31

VESTA (No. 4)

Opp. Nov. 19 in Tau Mag. 7.0

Oct.	30	4^h	03.7^m	+11°44′
Nov.	4	3	59.4	+11 32
	9	3	54.6	+11 20
	14	3	49.5	+11 10
	19	3	44.2	+11 01
	24	3	38.9	+10 54
	29	3	33.8	+10 50
Dec.	4	3	28.9	+10 48
	9	3	24.5	+10 49



Jupiter being near the sun, phenomena of the satellites are not given before March 19th.

MARCH

d	h	m	Sat.	Phen.
30	4	39	I	Se

APRIL

d	h	m	Sat.	Phen.
5	4	21	IV	Te
6	4	18	I	SI
10	4	00	II	Te
12	3	59	III	ED
15	4	12	I	Te
17	3	48	II	TI
	4	00	II	Se
22	3	51	I	TI
23	3	16	III	TI
	3	28	I	OR
24	3	47	II	SI
26	3	29	II	OR

MAY

d	h	m	Sat.	Phen.
7	3	38	I	ED
8	3	03	I	Se
10	3	07	II	ED
15	2	41	I	SI
17	2	28	IV	OR
18	3	26	III	ER
19	3	20	II	TI
23	1	54	I	ED
24	2	30	I	Te
28	2	46	II	OR
29	2	03	III	Te
31	0	57	I	SI
	2	03	I	TI
	3	13	I	Se

JUNE

d	h	m	Sat.	Phen.
1	1	41	I	OR
5	1	22	III	Se
	2	06	III	TI
7	2	50	I	SI
9	0	35	I	Te
11	2	17	IV	Te
	2	43	II	ED
12	1	50	III	SI
13	0	44	II	Se
	2	37	II	Te
15	2	04	I	ED
16	0	05	I	TI
	1	29	I	Se
	2	22	I	Te
	23	42	I	OR
19	2	42	IV	ER
20	0	29	II	SI
	2	05	II	TI
23	1	06	I	SI
	1	51	I	TI
	2	29	III	OR
24	1	28	I	OR
27	3	03	II	SI
29	1	23	II	OR
	23	49	III	ED
30	3	00	I	SI

JULY

d	h	m	Sat.	Phen.
1	0	20	I	ED
	3	13	I	OR
	23	46	I	Se
2	0	20	I	Te
5	23	49	II	ED
6	1	22	IV	OR
7	22	38	II	Te
8	2	14	I	ED
	23	23	I	SI
	23	47	I	TI
9	1	40	I	Se
	2	04	I	Te
	23	23	I	OR
10	22	48	III	Te
13	2	25	II	ED
14	0	43	IV	SI
	3	18	IV	TI
	22	01	II	TI
15	0	22	II	Se
	0	53	II	Te
16	1	17	I	SI
	1	31	I	TI
	22	37	I	ED
17	1	06	I	OR
	21	46	III	SI
	22	03	I	Se
	22	14	I	Te
	22	30	III	TI
18	1	20	III	Se
	2	05	III	Te
22	0	05	II	SI
	0	15	II	TI
	2	57	II	Se
	3	06	II	Te
23	3	11	I	SI
	3	15	I	TI
	21	18	II	OR
24	0	31	I	ED
	2	50	I	OR
	21	40	I	SI
	21	41	I	TI
	23	58	I	Se
	23	58	I	Te
25	1	46	III	SI
	1	47	III	TI
	21	17	I	ER
29	2	27	II	TI
	2	40	II	SI
30	20	39	II	OD
	21	58	IV	Te
	23	19	IV	Se
	23	51	II	ER
31	2	16	I	OD
	23	25	I	TI
	23	35	I	SI

AUGUST

d	h	m	Sat.	Phen.
1	1	42	I	Te
	1	53	I	Se
	20	42	I	OD
	23	11	I	ER
4	23	24	III	ER
6	22	55	II	OD
7	2	29	II	ER
8	1	09	I	TI
	1	23	IV	OD
	1	30	I	SI
	20	41	II	Te
	21	24	II	Se
	22	26	I	OD
9	1	06	I	ER
	21	53	I	Te
	22	17	I	Se
11	22	00	III	OD
14	1	12	II	OD
15	20	05	II	TI
	21	08	II	SI
	22	56	II	Te
	23	59	II	Se
16	0	11	I	OD
	21	20	I	TI
	21	54	I	SI
	23	38	I	Te
17	0	12	I	Se
	21	29	I	ER
19	1	21	III	OD
22	21	23	III	Se
	22	22	II	TI
	23	43	II	SI
23	1	13	II	Te
	23	06	I	TI
	23	49	I	SI
24	1	24	I	Te
	20	23	I	OD
	20	28	IV	OR
	21	04	II	ER
	22	45	IV	ED
	23	23	I	ER
25	19	51	I	Te
	20	36	I	Se
29	21	48	III	SI
	22	03	III	Te
30	0	41	II	TI
31	0	53	I	TI
	22	09	I	OD
	23	42	II	ER

SEPTEMBER

d	h	m	Sat.	Phen.
1	20	13	I	SI
	21	38	I	Te
	22	31	I	Se
	22	41	IV	TI
2	19	47	I	ER
5	21	59	III	TI
7	21	24	II	OD
	23	57	I	OD
8	21	09	I	TI
	22	09	I	SI
	23	26	I	Te
9	0	26	I	Se
	19	27	III	ER
	21	02	II	Se
	21	42	I	ER
10	21	29	IV	ER
14	23	50	II	OD
15	22	58	I	TI
16	0	04	I	SI
	19	50	III	ED
	20	13	I	OD
	20	47	II	SI
	21	26	II	Te
	23	28	III	ER
	23	37	I	ER
	23	37	II	Se
17	19	43	I	Te
	20	51	I	Se
23	19	01	III	OD
	21	02	II	TI
	22	03	I	OD
	22	37	III	OR
	23	22	II	SI
24	19	17	I	TI
	20	29	I	SI
	21	34	I	Te
	22	46	I	Se
25	20	01	I	ER
	20	57	II	ER
30	22	47	III	OD

OCTOBER

d	h	m	Sat.	Phen.
1	21	09	I	TI
	22	25	I	SI
2	21	56	I	ER
3	19	11	I	Se
4	21	29	III	Se
5	19	29	IV	SI
9	20	16	I	OD
	20	38	II	OD
10	18	49	I	SI
	19	48	I	Te
	21	06	I	Se
11	20	11	III	Te
	20	41	II	Se
	21	54	III	SI
13	21	24	IV	OR
17	19	26	I	TI
	20	45	I	SI
	21	43	I	Te
18	20	15	I	ER
	20	26	II	SI
	20	36	III	TI
	20	40	II	Te
20	18	12	II	ER
22	18	24	IV	Se
	19	34	III	ER
24	21	22	I	TI
25	18	34	I	OD
	20	27	II	TI
26	18	08	I	Te
	19	27	I	Se
27	20	50	II	ER
29	18	13	III	OR
	19	56	III	ED

NOVEMBER

d	h	m	Sat.	Phen.
2	17	48	I	TI
	19	06	I	SI
	20	05	I	Te
3	17	54	II	OD
	18	34	I	ER
5	17	46	II	Se
	18	43	III	OD
7	19	42	IV	TI
9	19	46	I	TI
10	20	29	I	ER
11	17	48	I	Se
12	17	55	II	Te
	20	22	II	Se
16	18	02	III	SI
17	18	55	I	OD
18	18	31	I	Te
	19	43	I	Se
19	17	47	II	TI
21	18	04	II	ER
24	19	46	IV	Te
25	18	14	I	TI
	19	22	I	SI
26	18	49	I	ER

DECEMBER

d	h	m	Sat.	Phen.
3	17	23	I	OD
4	18	04	I	Se
5	18	19	II	OD
7	17	30	II	Se
11	17	42	I	SI
14	18	17	II	Te
18	18	46	I	TI
	19	37	I	SI
19	19	03	I	ER
21	18	13	II	TI
22	17	47	III	Se
23	17	53	II	ER
26	17	56	I	OD
27	17	35	I	Te
	18	19	I	Se
28	19	21	IV	Se
29	18	10	III	SI
	18	59	III	Te

E—eclipse, O—occultation, T—transit, S—shadow, D—disappearance, R—reappearance, I—ingress, e—egress; **E.S.T.** (For other times see p. 10.)

The phenomena are given for latitude 45° N., for Jupiter one hour above the horizon, and the sun one hour below the horizon.

EPHEMERIS FOR THE PHYSICAL OBSERVATIONS OF THE SUN, 1961
For 0h U.T.

Date	P	B_0	L_0	Date	P	B_0	L_0
	°	°	°		°	°	°
Jan. 1	+ 2.12	−3.07	91.61	July 5	− 0.98	+3.34	169.87
6	− 0.31	−3.64	25.76	10	+ 1.29	+3.86	103.70
11	− 2.72	−4.18	319.92	15	+ 3.53	+4.36	37.53
16	− 5.09	−4.69	254.08	20	+ 5.74	+4.83	331.37
21	− 7.39	−5.16	188.25	25	+ 7.88	+5.26	265.22
26	− 9.62	−5.60	122.42	30	+ 9.95	+5.66	199.08
31	−11.74	−5.98	56.58	Aug. 4	+11.94	+6.02	132.95
Feb. 5	−13.75	−6.32	350.75	9	+13.83	+6.33	66.84
10	−15.64	−6.61	284.92	14	+15.62	+6.61	0.74
15	−17.40	−6.85	219.08	19	+17.30	+6.83	294.66
20	−19.02	−7.03	153.24	24	+18.85	+7.01	228.58
25	−20.49	−7.16	87.39	29	+20.28	+7.14	162.52
Mar. 2	−21.80	−7.23	21.52	Sept. 3	+21.57	+7.22	96.47
7	−22.96	−7.25	315.65	8	+22.72	+7.25	30.44
12	−23.95	−7.21	249.77	13	+23.72	+7.23	324.42
17	−24.78	−7.12	183.87	18	+24.58	+7.15	258.41
22	−25.44	−6.97	117.95	23	+25.27	+7.02	192.41
27	−25.92	−6.77	52.01	28	+25.79	+6.84	126.42
Apr. 1	−26.23	−6.52	346.06	Oct. 3	+26.15	+6.60	60.44
6	−26.35	−6.23	280.08	8	+26.33	+6.32	354.47
11	−26.30	−5.89	214.09	13	+26.33	+5.99	288.51
16	−26.06	−5.50	148.08	18	+26.14	+5.62	222.56
21	−25.64	−5.08	82.04	23	+25.77	+5.20	156.61
26	−25.03	−4.62	15.99	28	+25.19	+4.74	90.67
May 1	−24.24	−4.13	309.91	Nov. 2	+24.43	+4.24	24.74
6	−23.27	−3.62	243.82	7	+23.46	+3.71	318.82
11	−22.12	−3.08	177.71	12	+22.30	+3.16	252.90
16	−20.81	−2.51	111.59	17	+20.95	+2.57	186.98
21	−19.33	−1.93	45.45	22	+19.41	+1.97	121.07
26	−17.70	−1.34	339.30	27	+17.70	+1.35	55.17
31	−15.92	−0.75	273.13	Dec. 2	+15.82	+0.71	349.27
June 5	−14.03	−0.14	206.96	7	+13.80	+0.07	283.39
10	−12.02	+0.46	140.78	12	+11.65	−0.57	217.51
15	− 9.92	+1.06	74.60	17	+ 9.40	−1.20	151.63
20	− 7.74	+1.65	8.42	22	+ 7.06	−1.83	85.76
25	− 5.51	+2.23	302.24	27	+ 4.67	−2.45	19.90
30	− 3.25	+2.80	236.05				

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

CARRINGTON'S ROTATION NUMBERS—GREENWICH DATE OF COMMENCEMENT OF SYNODIC ROTATIONS, 1961

No.	Commences	No.	Commences	No.	Commences
1436	Jan. 7.96	1441	May 24.44	1446	Oct. 7.58
1437	Feb. 4.30	1442	June 20.64	1447	Nov. 3.88
1438	Mar. 3.63	1443	July 17.84	1448	Dec. 1.19
1439	Mar. 30.94	1444	Aug. 14.06	1449	Dec. 28.51
1440	Apr. 27.21	1445	Sept. 10.31		

ECLIPSES, 1961

In 1961 there will be four eclipses, two of the sun and two of the moon.

I. *A Total Eclipse of the Sun* on February 15. This eclipse will be visible partially in all of Europe and North Africa and most of Asia; the path of totality begins off the east coast of France and sweeps across Southern Europe and Russia and ends in Siberia.

II. *A Partial Eclipse of the Moon* in the morning of March 2, visible generally in the Pacific Ocean, Australasia, and Asia. The beginning will be visible in North America except the extreme eastern part, but the ending will be visible only in the extreme north-western corner of North America. Generally speaking, over the eastern part of the continent the moon will have set and the sun risen before the moon is well into the umbra.

moon enters umbra	06h 52m E.S.T.
middle of eclipse	08h 29m E.S.T.
moon leaves umbra	10h 05m E.S.T.
magnitude of eclipse	0.806

III. *An Annular Eclipse of the Sun* on August 11. The central line commences in Brazil and sweeps across the South Atlantic and Antarctica and ends in the Indian Ocean. The partial phase will be visible generally in the South Atlantic and South Indian Oceans and in South Africa.

IV. *A Partial Eclipse (nearly total) of the Moon* on the night of August 25, visible generally in North and South America.

moon enters umbra	20h 36m E.S.T.
middle of eclipse	22h 09m E.S.T.
moon leaves umbra	23h 42m E.S.T.
magnitude of eclipse	0.992

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PLANETARY APPULSES AND OCCULTATIONS

The close approach of a planet to a star is of interest to observers. Surprisingly few observable appulses of planets and stars of 9th magnitude or brighter occur during a year. An even rarer occurrence is the observable occultation of a star by a planet.

The following details have been kindly supplied by Mr. Gordon E. Taylor and the British Astronomical Association. The data include the E.S.T. of conjunction of the planet and star, the magnitude of the star, the angular separation of the star and planet as seen from the centre of the earth (geocentric separation), and the horizontal parallax of the planet. The geocentric separation is in the sense dec. of planet minus dec. of star.

Planet	Date	Conj. E.S.T.	Star	Mag.	Geoc. Sepn.	Hor. Par.
		h m			"	"
Venus	May 14	21 33	Z.C.136	6.3	+20	21
Mars	Jan. 13*	23 29	B.D.+27°1049	8.8	+19	14
	Jan. 21	10 18	B.D.+27°1006	8.0	+20	13
	Feb. 19*	4 58	B.D.+26°1079	7.5	−27	10
	Apr. 25	11 09	B.D.+23°1825	8.7	+23	6
	June 21*	20 51	B.D.+14°2166	8.6	−10	4
	July 28	13 10	B.D.+6°2429	8.9	− 2	4
	Aug. 14*	18 34	B.D.+1°2633	7.7	−11	4
	Sept. 4*	20 01	B.D.−3°3360	8.0	+10	4
Jupiter	Feb. 6	11 28	B.D.−21°5471	8.8	−52	1
	Feb. 8	14 49	B.D.−21°5482	8.7	+38	1
	Feb. 9	22 17	B.D.−21°5494	8.6	−50	1
	Feb. 19	2 39	B.D.−21°5546	8.8	−38	1
	Mar. 15	2 12	B.D.−20°5836	7.3	+25	2
	Mar. 15	22 16	B.D.−20°5844	8.5	+12	2
	Mar. 23	12 25	B.D.−20°5880	7.8	+15	2
	June 27	15 37	B.D.−19°5850	8.7	−12	2
	Dec. 8	3 51	B.D.−19°5852	7.9	+14	2

*These phenomena may be observed in some parts of North America; the others occur in daylight or when the objects are below the horizon.

No occultations by planets are predicted to be visible from North America during 1961.

LUNAR OCCULTATIONS

When the moon passes between the observer and a star that star is said to be occulted by the moon and the phenomenon is known as a lunar occultation. The passage of the star behind the east limb of the moon is called the immersion and its re-appearance from behind the west limb the emersion. As in the case of eclipses, the times of immersion and emersion and the duration of the occultation are different for different places on the earth's surface. The tables given below, adapted from data supplied by the British Nautical Almanac Office and give the times of immersion or emersion or both for occultations visible at Toronto, Montreal, Edmonton and Vancouver. Stars of magnitude 5.3 or brighter are included as well as daytime occultations of very bright stars and planets. Since an occultation at the bright limb of the moon is difficult to observe the predictions are limited to phenomena occurring at the dark limb.

The terms a and b are for determining corrections to the times of the phenomena for stations within 300 miles of the standard stations. Thus if λ_0, ϕ_0, be the longitude and latitude of the standard station and λ, ϕ, the longitude and latitude of the neighbouring station then for the neighbouring station we have:

Standard Time of phenomenon = Standard Time of phenomenon at the standard station $+a(\lambda-\lambda_0)+b(\phi-\phi_0)$

where $\lambda-\lambda_0$ and $\phi-\phi_0$ are expressed in degrees. The quantity P is the position angle of the point of contact on the moon's disk reckoned from the north point towards the east.

LUNAR OCCULTATIONS VISIBLE AT TORONTO AND MONTREAL, 1961

Date	Star	Mag.	I or E	Age of Moon	Toronto E.S.T.	a	b	P	Montreal E.S.T.	a	b	P
				d	h m	m	m	°	h m	m	m	°
Jan. 10	74 Vir	4.8	E	22.9	3 30.9	−1.3	+1.1	275	3 39.8	−1.3	+0.5	287
Jan. 26	γ Tau	3.9	I	9.3	1 05.0	−0.4	−1.7	101	1 04.1	−0.3	−1.5	92
Feb. 18	89 Psc	5.3	I	3.6	18 35.2	—	—	130	18 37.7	−1.4	−3.4	124
Mar. 8	γ Lib	4.0	I	21.0	Low	...	...	...	0 44.6	−0.3	−0.3	144
Mar. 8	γ Lib	4.0	E	21.0	1 29.5	−1.6	+2.5	241	1 42.3	−1.5	+1.6	256
Mar. 21	θ^1 Tau	4.0	I	5.2	20 10.3	−1.0	−1.8	104	20 12.7	−0.8	−1.5	95
Mar. 21	θ^2 Tau	3.6	I	5.2	20 20.5	−0.8	−3.1	128	20 19.6	−0.7	−2.5	118
Mar. 21	264 B.Tau	4.8	I	5.3	21 20.1	−0.8	−0.4	61	21 23.7	−0.7	−0.2	51
Mar. 22	111 Tau	5.1	I	6.3	22 40.4	—	—	156	22 31.8	+0.2	−3.1	139
Apr. 21	74 Gem	5.2	I	6.9	22 43.2	—	—	30	No occ.	...	...	...
May 15	α Tau	1.1	I	1.2	17 32.6	−0.7	−1.5	96	17 33.5	−0.5	−1.3	87
May 15	α Tau	1.1	E	1.2	18 36.4	−0.4	−0.9	255	18 35.8	−0.1	−1.2	265
June 4	42 Cap	5.3	E	20.6	2 11.0	−1.2	+1.4	254	2 21.0	−1.3	+1.2	257
July 9	α Tau	1.1	I	26.2	4 50.7	—	—	5	4 53.8	—	—	9
July 9	α Tau	1.1	E	26.2	5 13.4	—	—	323	5 22.3	—	—	318
July 23	24 Sco	5.0	I	11.4	23 38.5	−1.1	+0.1	48	23 43.7	−0.8	−0.1	47
July 29	μ Cap	5.2	E	16.4	0 10.4	−1.6	+0.8	262	0 21.1	−1.6	+0.6	261
Aug. 4	5 Tau	4.3	I	22.6	3 59.3	−1.2	+1.4	84	Sun	...	...	...
Aug. 5	γ Tau	3.9	I	23.6	2 37.4	+0.1	+2.4	36	2 41.8	0.0	+2.5	38
Aug. 5	γ Tau	3.9	E	23.6	3 29.0	−1.0	+0.9	289	3 36.9	−1.2	+0.9	287
Aug. 5	α Tau	1.1	I	23.9	12 32.2	−0.8	0.0	51	12 37.1	−0.8	+0.4	39
Aug. 5	α Tau	1.1	E	23.9	13 25.0	0.0	−2.3	300	13 19.4	+0.3	−2.8	312
Sept. 21	μ Cap	5.2	I	12.0	20 37.1	−1.5	+1.1	64	20 47.8	−1.5	+0.9	65
Sept. 27	μ Cet	4.4	I	17.1	0 08.8	−0.9	+2.0	51	0 18.2	−1.1	+1.8	54
Sept. 27	μ Cet	4.4	E	17.1	1 20.3	−1.7	+0.9	260	1 31.7	−1.7	+0.8	258
Sept. 28	θ^1 Tau	4.0	E	19.1	22 19.4	−0.1	+1.2	278	22 22.7	−0.2	+1.3	276
Sept. 28	θ^2 Tau	3.6	E	19.1	22 21.3	+0.1	+1.5	256	22 24.4	−0.1	+1.6	255
Sept. 28	264B. Tau	4.8	E	19.1	23 10.0	−0.8	+0.4	304	23 15.8	−0.9	+0.5	302
Sept. 29	α Tau	1.1	I	19.2	1 07.7	−0.5	+2.6	41	1 16.3	−0.7	+2.5	43
Sept. 29	α Tau	1.1	E	19.2	2 11.1	−1.8	+0.4	284	2 22.5	−1.9	+0.2	283
Sept. 30	115 Tau	5.3	E	20.1	0 41.6	−0.6	+1.4	270	0 48.4	−0.8	+1.4	269
Oct. 4	o^1 Cnc	5.2	E	24.3	3 40.5	−0.4	+2.0	253	3 47.5	−0.7	+2.0	255
Oct. 7	σ Leo	4.1	E	27.4	5 12.0	−0.4	−0.8	329	5 12.7	−0.5	−1.2	336
Oct. 17	ρ Cap	5.0	I	8.2	18 33.3	—	—	9	18 44.0	—	—	9
Nov. 3	χ Leo	4.7	E	24.6	4 39.2	−0.9	+0.8	287	4 46.1	−1.1	+0.4	295
Nov. 20	μ Cet	4.4	I	12.7	19 32.5	−0.7	+1.9	57	19 40.4	−0.9	+1.8	60
Nov. 22	α Tau	1.1	I	14.7	19 56.9	−0.4	+1.5	84	20 02.5	−0.6	+1.4	86
Nov. 22	α Tau	1.1	E	14.7	20 59.6	−0.6	+1.9	242	21 07.1	−0.7	+2.0	240
Nov. 23	115 Tau	5.3	E	15.6	Low	...	...	...	18 59.3	+0.5	+2.4	212
Nov. 23	119 Tau	4.7	E	15.7	21 25.4	−1.2	+0.1	305	21 33.4	−1.4	+0.2	303
Nov. 26	ζ Cnc	5.1	E	18.7	Low	...	...	...	21 36.5	−0.1	+1.1	283
Nov. 29	ν Leo	5.2	E	20.9	1 57.5	−1.0	+1.6	264	2 06.8	−1.2	+1.4	270
Dec. 20	75 Tau	5.3	I	12.3	3 04.5	−0.6	−1.6	98	3 05.2	−0.5	−1.3	89
Dec. 20	264B. Tau	4.8	I	12.4	No occ.	...	...	...	4 20.7	+0.7	−4.3	151
Dec. 28	σ Leo	4.1	I	20.5	No occ.	...	...	...	6 15.5	—	—	180
Dec. 28	σ Leo	4.1	E	20.5	No occ.	...	...	...	6 53.4	—	—	235

Date	Star	Mag.	I or E	Age of Moon	Edmonton				Vancouver			
					M.S.T.	a	b	P	P.S.T.	a	b	P
				d	h m	m	m	°	h m	m	m	°
Jan. 22	ν Psc	4.7	I	6.2	17 32.0	−1.7	+0.1	96	Sun	...	...	...
Jan. 25	γ Tau	3.9	I	9.3	22 19.3	−1.3	−0.6	80	21 06.1	−1.7	−0.5	90
Jan. 26	71 Tau	4.6	I	9.5	2 10.9	+0.2	−2.9	134	No occ.	...	...	...
Jan. 26	θ^1 Tau	4.0	I	9.5	Low	...	...	...	2 13.9	−0.1	−1.1	76
Jan. 26	θ^2 Tau	3.6	I	9.5	Low	...	...	...	2 15.8	0.0	−1.6	97
Feb. 3	59 Leo	5.1	E	17.5	3 54.3	−2.1	+0.4	241	No occ.	...	...	...
Mar. 9	24 Sco	5.0	E	22.2	5 02.5	−1.3	+0.2	289	3 47.4	−1.3	+0.8	275
Mar. 14	Mercury	0.7	I	27.5	13 37.1	−1.3	−1.8	109	12 28.1	−1.7	−1.4	107
Mar. 14	Mercury	0.7	E	27.5	14 28.3	−0.2	+0.3	209	13 23.0	−0.4	+0.7	208
Mar. 22	111 Tau	5.1	I	6.3	19 46.8	−1.2	−3.2	137	No occ.	...	...	...
Apr. 4	γ Lib	4.0	I	18.7	Sun	...	...	...	4 51.7	−1.6	0.0	53
Apr. 26	59 Leo	5.1	I	11.1	1 22.2	−0.2	−2.6	158	0 34.3	—	—	179
May 15	α Tau	1.1	I	1.2	14 44.1	−1.4	0.0	72	13 28.2	−1.7	+0.2	81
May 15	α Tau	1.1	E	1.2	15 59.3	−1.2	−1.1	269	14 48.9	−1.5	−0.3	257
June 21	γ Vir	2.9	E	8.9	No occ.	...	...	...	20 29.2	−0.5	−2.8	348
June 22	74 Vir	4.8	I	10.0	22 35.9	−0.8	−2.0	145	21 36.1	−0.8	−2.3	160
June 30	π Cap	5.2	E	17.2	2 39.7	−0.8	+1.3	198	1 23.9	—	—	196
June 30	ρ Cap	5.0	E	17.2	Sun	...	...	...	2 40.1	−1.5	−0.3	271
July 23	24 Sco	5.0	I	11.4	20 51.5	—	—	31	Sun	...	...	...
Aug. 4	5 Tau	4.3	I	22.6	2 02.6	+0.1	+2.3	37	0 55.1	+0.2	+2.1	37
Aug. 4	5 Tau	4.3	E	22.6	2 53.8	−0.7	+1.3	285	1 43.0	−0.4	+1.2	287
Aug. 5	71 Tau	4.6	E	23.7	Sun	...	...	...	3 35.9	−0.3	+2.2	233
Aug. 5	θ^2 Tau	3.6	I	23.8	Sun	...	...	...	3 50.4	−0.6	+1.8	74
Aug. 5	θ^1 Tau	4.0	I	23.8	Sun	...	...	...	3 53.3	−0.4	+2.2	53
Aug. 5	α Tau	1.1	I	23.9	10 01.0	—	—	21	8 38.3	−1.4	+2.0	37
Aug. 5	α Tau	1.1	E	23.9	10 39.9	—	—	320	9 39.5	−1.5	−2.4	300
Aug. 23	π Cap	5.2	I	12.8	23 26.3	—	—	140	22 12.1	—	—	140
Aug. 23/24	ρ Cap	5.0	I	12.9	0 04.0	−1.1	−0.2	65	22 51.5	−1.4	+0.3	64
Sept. 5	74 Gem	5.2	E	25.1	Sun	...	...	...	3 56.1	+0.4	+4.3	208
Oct. 26	γ Tau	3.9	I	16.6	2 37.7	−1.9	−2.0	128	1 25.3	—	—	137
Oct. 26	γ Tau	3.9	E	16.6	3 23.9	−1.1	+2.6	203	2 00.4	—	—	191
Oct. 28	71 Ori	5.2	E	18.7	Graze	...	...	...	5 27.1	−1.3	−3.0	316
Nov. 16	χ Aqr	5.1	I	8.8	21 55.8	−1.2	−0.8	85	20 44.2	−1.5	−0.3	84
Nov. 20	μ Cet	4.4	I	12.7	17 50.6	+0.3	+2.7	9	Low	...	...	...
Nov. 22	α Tau	1.1	I	14.7	18 16.6	+0.4	+1.9	43	Low	...	...	...
Nov. 22	α Tau	1.1	E	14.7	19 01.9	−0.1	+1.2	289	17 57.1	+0.1	+1.0	290
Nov. 29	α Leo	1.3	I	21.1	No occ.	...	...	...	3 46.1	—	—	51
Nov. 29	α Leo	1.3	E	21.1	No occ.	...	...	...	4 29.7	—	—	348
Dec. 17	ξ^2 Cet	4.3	I	10.1	16 53.2	−0.4	+1.7	77	Sun	...	...	...
Dec. 18	μ Cet	4.4	I	10.4	2 33.0	−0.3	−0.9	67	1 32.9	−0.6	−1.2	81
Dec. 18	5 Tau	4.3	I	11.2	22 31.1	—	—	140	Graze	...	...	...
Dec. 19	γ Tau	3.9	I	12.2	19 14.0	−0.8	+1.2	101	18 01.7	−0.6	+1.3	99
Dec. 19/20	75 Tau	5.3	I	12.3	0 16.8	−1.3	0.0	71	23 01.2	−1.6	+0.3	79
Dec. 20	264B. Tau	4.8	I	12.4	1 40.9	−1.0	−3.9	138	No occ.	...	...	...
Dec. 20	α Tau	1.1	I	12.5	4 15.8	−0.2	−1.8	99	3 21.1	−0.4	−2.4	118
Dec. 20	α Tau	1.1	E	12.5	5 12.7	−0.1	−1.0	248	4 13.0	−0.5	−0.3	230
Dec. 24	ζ Cnc	5.1	E	16.5	6 05.9	−0.8	−1.5	272	5 00.0	−1.4	−0.7	253

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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 10 to 45 miles per second they become luminous and appear as meteors or fireballs and, if large enough to avoid complete vapourization, in rare cases they may fall to the earth as meteorites.

Meteors are visible on any night of the year. At certain times of the year the earth encounters large numbers of meteors all moving together along the same orbit. Such a group is known as a meteor shower and the accompanying list gives the most important showers visible in 1961.

On the average an observer sees 7 meteors per hour which are not associated with any recognized shower. These have been included in the hourly rates listed in the table. The radiant is the position among the stars from which the meteors of a given shower seem to radiate. The appearance of any very bright fireball should be reported immediately to the nearest astronomical group or organization. If sounds are heard accompanying such a phenomenon there is a possibility that a meteorite may have fallen and the astronomers must rely on observations made by the general public to track it down.

Meteor Showers for 1961

Shower	Shower Maximum			Radiant				Single Observer Hourly Rate	Normal Duration to $\frac{1}{4}$ strength of Max.
	Date	E.S.T.	Moon	Position at Max. α	δ	Daily Motion α	δ		
				°	°	°	°		(days)
Quadrantids	Jan. 3	06^h	F.M.	232	+50			40	0.6
Lyrids	Apr. 21	23	F.Q.	274	+34	+1.1	0.0	15	2.3
η Aquarids	May 4	23	L.Q.	336	00	+0.9	+0.4	20	18
δ Aquarids	July 29	08	F.M.	339	−17	+0.85	+0.17	20	20
Perseids	Aug. 12	03	N.M.	046	+58	+1.35	+0.12	50	5.0
Orionids	Oct. 20	14	F.M.	095	+15	+1.23	+0.13	25	8
Taurids	Nov. 5	15	N.M.	053	+14	+0.67	+0.13	15	(30)
Leonids	Nov. 16	13	F.Q.	152	+22	+0.70	−0.42	15	4
Geminids	Dec. 13	08	F.Q.	113	+32	+1.05	−0.07	50	6.0
Ursids	Dec. 22	13	F.M.	217	+76			15	2.2

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FINDING LIST OF NAMED STARS

Name		R.A.	Name		R.A.
Acamar	θ Eri	02	Fomalhaut	α PsA	22
Achernar	α Eri	01	Gacrux	γ Cru	12
Acrux	α Cru	12	Gienah	γ Crv	12
Adhara	ϵ CMa	06	Hadar	β Cen	14
Al Na'ir	α Gru	22	Hamal	α Ari	02
Albireo	β Cyg	19	Kaus Australis	ϵ Sgr	18
Alcyone	η Tau	03	Kochab	β UMi	14
Aldebaran	α Tau	04	Markab	α Peg	23
Alderamin	α Cep	21	Megrez	δ UMa	12
Algenib	γ Peg	00	Menkar	α Cet	03
Algol	β Per	03	Menkent	θ Cen	14
Alioth	ϵ UMa	12	Merak	β UMa	10
Alkaid	η UMa	13	Miaplacidus	β Car	09
Almach	γ And	02	Mira	o Cet	02
Alnilam	ϵ Ori	05	Mirach	β And	01
Alphard	α Hya	09	Mirfak	α Per	03
Alphecca	α CrB	15	Mizar	ζ UMa	13
Alpheratz	α And	00	Nunki	σ Sgr	18
Altair	α Aql	19	Peacock	α Pav	20
Ankaa	α Phe	00	Phecda	γ UMa	11
Antares	α Sco	16	Polaris	α UMi	01
Arcturus	α Boo	14	Pollux	β Gem	07
Atria	α TrA	16	Procyon	α CMi	07
Avior	ϵ Car	08	Ras-Algethi	α Her	17
Bellatrix	γ Ori	05	Rasalhague	α Oph	17
Betelgeuse	α Ori	05	Regulus	α Leo	10
Canopus	α Car	06	Rigel	β Ori	05
Capella	α Aur	05	Rigil Kentaurus	α Cen	14
Caph	β Cas	00	Sabik	η Oph	17
Castor	α Gem	07	Scheat	β Peg	23
Deneb	α Cyg	20	Schedar	α Cas	00
Denebola	β Leo	11	Shaula	λ Sco	17
Diphda	β Cet	00	Sirius	α CMa	06
Dubhe	α UMa	11	Spica	α Vir	13
Elnath	β Tau	05	Suhail	λ Vel	09
Eltanin	γ Dra	17	Vega	α Lyr	18
Enif	ϵ Peg	21	Zubenelgenubi	α Lib	14

THE BRIGHTEST STARS

By Donald A. MacRae

The 286 stars brighter than apparent magnitude 3.55.

Star. If the star is a visual double the letter A indicates that the data are for the brighter component. The brightness and separation of the second component B are given in the last column. Sometimes the double is too close to be conveniently resolved and the data refer to the combined light, AB; in interpreting such data the magnitudes of the two components must be considered.

Visual Magnitude (V). These magnitudes are based on *photoelectric observations*, with a few exceptions, which have been adjusted to match the yellow colour-sensitivity of the eye. The photometric system is that of Johnson and Morgan in *Ap. J.*, vol. 117, p. 313, 1953. It is as likely as not that the true magnitude is within 0.03 mag. of the quoted figure, on the average. Variable stars are indicated with a "v". The type of variability, range, R, in magnitudes, and period in days are given.

Colour index ($B-V$). The blue magnitude, B, is the brightness of a star as observed photoelectrically through a blue filter. The difference $B-V$ is therefore a measure of the colour of a star. The table reveals a close relaton between $B-V$ and spectral type. Some of the stars are slightly reddened by interstellar dust. The probable error of a value of $B-V$ is only 0.01 or 0.02 mag.

Type. The customary spectral (temperature) classification is given first. The Roman numerals are indicators of *luminosity class*. They are to be interpreted as follows: Ia—most luminous supergiants; Ib—less luminous supergiants; II—bright giants; III—normal giants; IV—subgiants; V—main sequence stars. Intermediate classes are sometimes used, e.g. Iab. Approximate absolute magnitudes can be assigned to the various spectral and luminosity class combinations. Other symbols used in this column are: p—a peculiarity; e—emission lines; v—the spectrum is variable; m—lines due to metallic elements are abnormally strong; f—the O-type spectrum has several broad emission lines; n or nn—unusually wide or diffuse lines. A composite spectrum, e.g. M1 Ib+B, shows up when a star is composed of two nearly equal but unresolved components. In the far southern sky, spectral types in italics were provided through the kindness of Prof. R. v. d. R. Woolley, Australian Commonwealth Observatory. Types in parentheses are less accurately defined (g—giant, d—dwarf, c-exceptionally high luminosity). All other types were very kindly provided especially for this table by Dr. W. W. Morgan, Yerkes Observatory.

Parallax (π). From "General Catalogue of Trigonometric Stellar Parallaxes" by Louise F. Jenkins, Yale Univ. Obs., 1952.

Absolute visual magnitude (M_V), and *distance in light-years* (D). If π is greater than 0.030″ the distance corresponds to this trigonometric parallax and the absolute magnitude was computed from the formula $M_V = V + 5 + 5 \log \pi$. Otherwise a generally more accurate absolute magnitude was obtained from the luminosity class. In this case the formula was used to *compute* π and the distance corresponds to this "spectroscopic" parallax. The formula is an expression of the inverse square law for decrease in light intensity with increasing distance. The effect of absorption of light by interstellar dust was neglected, except for three stars, ζ Per, σ Sco and ζ Oph, which are significantly reddened and would therefore be about a magnitude brighter if they were in the clear.

Annual proper motion (μ), and *radial velocity* (R). From "General Catalogue of Stellar Radial Velocities" by R. E. Wilson, Carnegie Inst. Pub. 601, 1953. Italics indicate an average value of a variable radial velocity.

The star names are given for all the officially designated navigation stars and a few others. Throughout the table, a *colon* (:) indicates an uncertainty.

We are indebted to Dr. Daniel L. Harris, Yerkes Observatory, particularly for his compilation of the photometric data from numerous sources.

Star	Right Ascension	Declination	Visual Magnitude	Colour Index	Spectral Classification		Parallax	Absolute Magnitude	Distance light-years	Proper Motion	Radial Velocity		
Star	R.A. 1960	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 06.3	+28 52	2.06	−0.08	B9p		0.024	−0.1	90	0.209	*−11.7*	Manganese star	*Alpheratz*
β Cas	07.0	+58 56	2.26	+0.34	F2	IV	0.072	+1.6	45	0.555	+11.8		*Caph*
γ Peg	11.2	+14 58	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	23.7	−77 29	2.78	+0.62	*G1*	*IV*	0.153	+3.7	21	2.255	+22.8		γ Peg = *Algenib*
α Phe	24.3	−42 31	2.39	+1.08	*K0*	*III*	0.035	+0.1	93	0.442	*+74.6*		*Ankaa*
δ And *A*	37.2	+30 39	3.25:	+1.26	K3	III	0.024	−0.2	160	0.161	−07.3	*B* 12^m 28″	
α Cas	38.2	+56 19	2.16	+1.18	K0	II–III	0.009	−1.1	150	0.058	−03.8	Var.?	*Schedar*
β Cet	41.6	−18 12	2.02	+1.03	K1	III	0.057	+0.8	57	0.234	+13.1		*Diphda*
η Cas *A*	46.7	+57 36	3.47	+0.56	G0	V	0.182	+4.8	18	1.221	+09.4	*B* 7.26^m 9″	
γ Cas *A*	54.3	+60 30	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 04.3	−46 56	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	06.6	−10 24	3.47	+1.16	K3	III	0.032	+1.0	102	0.250	+11.5		
β And	07.5	+35 25	2.02	+1.57	M0	III	0.043	+0.2	76	0.211	+00.3		*Mirach*
δ Cas	23.2	+60 02	2.67	+0.13	A5	V	0.029	+2.1	43	0.301	+06.7	Ecl.? *R* $0.08{:}^m$ 759^d	
γ Phe	26.6	−43 31	3.44	+1.56	*K5*	*Ib*	−.003	−4.6	1300	0.209	*+25.7*		
α Eri	36.2	−57 26	0.51	−0.16	*B5*	*IV:*	0.023	−2.3	118	0.098	+19		***Achernar***
τ Cet	42.2	−16 09	3.50	+0.72	G8	Vp	0.275	+5.70	12	1.921	−16.2		

Star	R.A. 1960	Dec.	V	$B-V$	Type	π	M_V	D	μ	R	
	h m	° ′				″		l.y.	″	km./sec.	
α Tri	01 50.8	+29 23	3.45	+0.46	F6 IV	0.050	+2.0	65	0.230	*−12.6*	
ϵ Cas	51.5	+63 28	3.33	−0.15	B3 IV: p	0.007	−2.7	520	0.038	−08.1	
β Ari	52.4	+20 37	2.68	+0.14	A5 V	0.063	+1.7	52	0.147	*−01.9*	
α UMi *A*	55.5	+89 05	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 Hyi	57.5	−61 46	2.84	+0.28	*F0 V*		+2.9	31	0.265	+07	
γ And *A*	02 01.4	+42 08	2.14:	+1.16:	K3 II	0.005	−2.4	260	0.068	−11.7	γ And = *Almach* *B* 5.4^m *C* 6.2^m *A–BC* 10″ *B–C* 0.7″
α Ari	04.9	+23 16	2.00	+1.15	K2 III	0.043	+0.2	76	0.241	−14.3	*Hamal*
β Tri	07.2	+34 48	3.00	+0.13	A5 III	0.012	−0.1	140	0.156	*+09.9*	
o Cet *A*	17.3	−03 09	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*	41.2	+03 04	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*	56.7	−40 28	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 00.2	+03 56	2.54	+1.63	M2 III	0.003	−0.5	130	0.075	−25.9	*Menkar*
γ Per	01.9	+53 21	2.91:	+0.72:	G8III: +A3:	0.011	+0.3	113	0.004	*+02.5*	
ρ Per	02.6	+38 41	3.5v		M4 II–III	0.008	−1.0	260	0.172	+28.2	Irr. *R* 3.2–3.8
β Per	05.6	+40 48	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	21.5	+49 43	1.80	+0.48	F5 Ib	0.029	−4.4	570	0.035	−02.4	*Mirfak*
δ Per	40.1	+47 40	3.03	−0.14	B5 III	0.007	−3.3	590	0.046	−09	
η Tau	45.1	+23 59	2.86	−0.09	B7 III	0.005	−3.2	541	0.050	+10.1	in Pleiades *Alcyone*
γ Hyi	47.8	−74 22	3.30	+1.61	*M2 II–III*	−.001	−1.5	300	0.125	+16.0	
ζ Per *A*	51.6	+31 46	2.83	+0.13	B1 Ib	0.007	−6.1	1000	0.015	+20.6	*B* 9.36^m 13″
ϵ Per *A*	55.2	+39 54	2.88	−0.17	B0.5 V	−.001	−3.7	680	0.036	−01	*B* 7.99^m 9″
γ Eri	56.2	−13 37	3.01	+1.58	M0 III	0.003	−0.5	160	0.126	+61.7	
α Ret *A*	04 13.9	−62 34	3.33	+0.91	*G6 II*	0.008	−2.1	390	0.064	+35.6	*B* 12^m 49″
ϵ Tau	26.3	+19 06	3.54	+1.02	K0 III	0.018	+0.1	160	0.118	+38.6	
θ^2 Tau	26.4	+15 47	3.42	+0.17	A7 III	0.025	+0.2	140	0.108	*+39.5*	
α Dor	33.1	−55 08	3.28	−0.08	*A0 IIIp*	0.011	−1.2	260	0.051	+25.6	Silicon star
α Tau *A*	33.6	+16 26	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	47.7	+06 54	3.17	+0.45	F6 V	0.125	+3.65	26	0.468	+24.3	
ι Aur	54.4	+33 06	2.64:	+1.49	K3 II	0.015	−2.4	330	0.021	+17.5	

α UMi, *Polaris:* R.A. 1 h 56.4 m; Dec. +89° 05′ (1961).

Star	R.A. 1960	Dec.	V	$B-V$	Type		π	M_V	D	μ	R	
	h m	° ′					″		l.y.	″	km./sec.	
ϵ Aur	04 59.1	+43 46	3.0v	+0.50:	F0	Iap	0.004	−7.1	3400	0.008	*−02.5*	Ecl. R 0.81^m 9886^d
η Aur	05 03.7	+41 11	3.17	−0.18	B3	V	0.013	−2.1	370	0.077	+07.4	
ϵ Lep	03.8	−22 25	3.21	+1.46	*K5*	*III*	0.006	−0.4	170	0.077	+01.0	
β Eri	05.9	−05 08	2.79	+0.13	A3	III	0.042	+0.9	78	0.122	−08	
μ Lep	11.1	−16 15	3.29	−0.09	*B9*	*IIIp*	0.018	−2.1	390	0.049	+27.7	Manganese star
β Ori *A*	12.6	−08 15	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	13.7	+45 58	0.05	+0.80	G8III: +F		0.073	−0.6	45	0.435	*+30.2*	**Capella**
η Ori *AB*	22.5	−02 26	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	23.0	+06 19	1.64	−0.23	B2	III	0.026	−4.2	470	0.015	+18.2	*Bellatrix*
β Tau	23.8	+28 35	1.65	−0.13	B7	III	0.018	−3.2	300	0.178	+08.0	*Elnath*
β Lep *A*	26.5	−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*	30.0	−00 20	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	31.0	−17 51	2.58	+0.22	F0	Ib	0.002	−4.6	900	0.006	+24.7	
λ Ori *AB*	32.9	+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*	33.5	−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	34.2	−01 14	1.70	−0.19	B0	Ia	−.007	−6.8	1600	0.000	+26.1	*Alnilam*
ζ Tau	35.3	+21 07	3.07:	−0.13:	B2	III: p	−.002	−4.2	940	0.023	*+24.3*	Shell star
α Col *A*	38.2	−34 06	2.64	−0.11	*B8*	*Ve*	−.005	−0.6	140	0.026	+35	B 12^m 12″
ζ Ori *AB*	38.7	−01 58	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	45.9	−09 41	2.06	−0.17	B0.5	Ia	0.009	−6.9	2100	0.004	+20.6	
β Col	49.5	−35 47	3.12	+1.16		(gK1)	0.023	+0.0	140	0.402	+89.4	
α Ori	53.0	+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	56.6	+44 57	1.86	+0.06	A2	V	0.037	−0.3	88	0.051	*−18.2*	
θ Aur *AB*	57.0	+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 12.5	+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	18.8	−30 03	3.04	−0.18	B2.5	V	−.003	−2.4	390	0.004	*+32.2*	
μ Gem	20.5	+22 32	2.92v	+1.63	M3	III	0.021	−0.6	160	0.129	+54.8	R 0.14^m
β CMa	20.9	−17 56	1.96	−0.24	B1	II–III	0.014	−4.8	750	0.004	*+33.7*	β CMa type variable
α Car	23.1	−52 40	−0.72	+0.16	F0	Ib–II	0.018	−3.1	98	0.025	+20.5	**Canopus**
γ Gem	35.4	+16 26	1.93	0.00	A0	IV	0.031	−0.6	105	0.066	*−12.5*	

Star	R.A. 1960	Dec.	V	$B-V$	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
ν Pup	06 36.5	−43 10	3.19	−0.10	*B7 III*		−3.2	620	0.010	+28.2		
ϵ Gem	41.5	+25 10	3.00	+1.39	G8 Ib	0.009	−4.6	1080	0.016	+09.9		
ξ Gem	43.0	+12 56	3.38	+0.43	F5 IV	0.051	+1.9	64	0.224	+25.3		
α CMa *A*	43.4	−16 40	−1.42	+0.01	A1 V	0.375	+1.45	8.7	1.324	*−07.6*	*B* 8.66^m 1960: 9″, $\theta = 90°$	***Sirius***
α Pic	47.8	−61 54	3.27	+0.21	*A5 V*		+2.1	57	0.272	+20.6		
τ Pup	48.9	−50 34	2.97	+1.17	*K0 III*		+0.1	124	0.079	*+36.4*		
ϵ CMa *A*	57.1	−28 55	1.48:	−0.18:	B2 II		−5.1	680	0.004	+27.4	*B* 7.5^m 8″	***Adhara***
o^2 CMa	07 01.4	−23 46	3.02	−0.09	B3 Ia		−7.1	3400	0.000	+48.4		
δ CMa	06.8	−26 20	1.85	+0.65	F8 Ia	−.018	−7.1	2100	0.005	+34.3		
L_2 Pup	12.3	−44 34			(gM5e)	0.016	−3.1	650	0.342	+53.0	LP, *R* 3.4–6.2, 141^d	
π Pup	15.7	−37 01	2.81	+1.56:	(gK4)	0.023	−0.3	140	0.008	+15.8		
η CMa	22.5	−29 13	2.46	−0.08	B5 Ia		−7.1	2700	0.008	+41.1		
β CMi	25.0	+08 22	2.91	−0.09	B7 V	0.020	−1.1	210	0.065	+22		
σ Pup *A*	28.0	−43 13	3.28	+1.49	(gK5)	0.013	−0.4	180	0.195	*+88.1*	*B* 9.4^m 22″	
α Gem *A*	32.0	+31 59	1.97	+0.00:	A1 V	0.072	+1.3	45	0.199	+06.0	5″, $B-V$+0.02, *C* $9.08v^m$ 73″	*Castor*
α Gem *B*	32.0	+31 59	2.95	+0.07:	A5m	0.072	+2.3	45	0.199	−01.2		
α CMi *A*	37.2	+05 20	0.37	+0.41	F5 IV–V	0.288	+2.7	11.3	1.250	−03.2	*B* 10.7^m 5″	***Procyon***
β Gem	42.9	+28 07	1.16	+1.02	K0 III	0.093	+1.0	35	0.625	+03.3		***Pollux***
ξ Pup	47.6	−24 45	3.34	+1.23	G3 Ib	−.003	−4.6	1240	0.005	*+02.7*		
χ Car	55.8	−52 52	3.48	−0.18	(B3)		−2.1	430	0.039	+19.1		
ζ Pup	08 02.2	−39 53	2.23	−0.26	O5f		−7.1	2400	0.033	−24		
ρ Pup	05.8	−24 11	2.80v	+0.42	F6 IIp	0.031	+0.3:	105:	0.098	+46.6	Var. *R* 2.72–2.87	
γ Vel *A*	08.3	−47 14	1.88	−0.26	*WC7*		−4.1	520	0.011	+35	*B* 4.31^m 41″	
ϵ Car	21.7	−59 23	1.97	+1.14:	(K0 + B)		−3.1:	340	0.030	+11.5		***Avior***
o UMa *A*	27.0	+60 51	3.37	+0.83	G5 III	0.004	+0.1	150	0.171	+19.8	*B* 15^m 7″	
δ Vel *AB*	43.6	−54 34	1.95	+0.05	*A0 V*	0.043	+0.2	76	0.086	+02.2	*A* 2.0^m *B* 5.1^m 3″ *CD* 10^m 69″	
ϵ Hya *ABC*	44.7	+06 34	3.39	+0.68	G0 comp.	0.010	+0.6	140	0.198	*+36.4*	*A* 3.7^m*B*5.2^m0.2″15^y, *C*6.8^m3″*D*12^m20″	
ζ Hya	53.3	+06 06	3.11	+1.00	K0 II–III	0.029	−1.1	220	0.101	+22.8		
ι UMa *A*	56.5	+48 12	3.12	+0.19	A7 V	0.066	+2.2	49	0.505	+12.2	*BC* 10.8^m 7″	

Star	R.A. 1960	Dec.	V	$B-V$	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
λ Vel	09 06.5	−43 16	2.24	+1.64:	*K5 Ib*	0.015	−4.6	750	0.026	+18.4		*Suhail*
a Car	09.9	−58 48	3.43	−0.17	*B3 IV*		−2.9	590	0.028	+*23.3*		
β Car	12.8	−69 33	1.67	+0.01	*A0 III*	0.038	−0.4	86	0.183	−05		*Miaplacidus*
ι Car	16.0	−59 06	2.25	+0.17	*F0 Ib*		−4.6	750	0.019	+13.3		
α Lyn	18.6	+34 34	3.17	+1.54	M0 III	0.021	−0.5	180	0.217	+37.6		
κ Vel	20.9	−54 50	2.45	−0.15	*B2 IV*	0.007	−3.4	470	0.012	+*21.9*		
α Hya	25.6	−08 29	1.98	+1.44	K4 III	0.017	−0.3	94	0.034	−04.3		*Alphard*
N Vel	30.0	−56 51	3.19	+1.56	(gK5)	0.015	−0.4	170	0.036	−13.9		
θ UMa *A*	30.2	+51 52	3.19	+0.46	F6 IV	0.052	+1.8	63	1.094	+15.4	*B* 14^m 5″	
ε Leo	43.6	+23 58	2.99	+0.81	G0 II	0.002	−2.1	340	0.048	+05.0		
l Car	44.1	−62 19	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*	46.1	−64 53	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 06.2	+12 10	1.36	−0.11	B7 V	0.039	−0.7	84	0.248	+03.5	*B* 8.1^m 177″	***Regulus***
ω Car	12.8	−69 50	3.33	−0.08	*B8.5 IV*		−1.5	300	0.029	+04		
ζ Leo	14.5	+23 37	3.46	+0.30	F0 III	0.009	+0.5	130	0.023	−15.0		
λ UMa	14.7	+43 07	3.45	+0.03	A2 IV	−.010	+0.1	150	0.170	+18.3		
q Car	15.8	−61 08	3.41v	+1.55	*K5 Ib*	0.018	−4.6	1300	0.023	+08.6	Var. *R* 3.38–3.44	
γ Leo *AB*	17.8	+20 03	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	20.0	+41 42	3.05	+1.55	M0 III	0.031	+0.5	105	0.086	−*20.5*		
p Car	30.6	−61 29	3.30v	−0.11	*B5 IVpe*		−2.3	430	0.021	+26.0	Var. *R* 3.22–3.39	
θ Car	41.5	−64 11	2.74	−0.22	*B0 Vp*		−4.0	710	0.018	+24		
μ Vel *AB*	45.0	−49 12	2.67	+0.89	*G5 III*		+0.1	108	0.085	+06.9	*A* 2.7^m *B* 7.2^m 2″	
ν Hya	47.6	−15 59	3.12	+1.25	K3 III	0.022	−0.2	150	0.221	−01.0		
β UMa	59.4	+56 36	2.37	−0.03	A1 V	0.042	+0.5	78	0.087	−12.0		*Merak*
α UMa *AB*	11 01.3	+61 58	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	07.4	+44 43	3.00	+1.14	K1 III		+0.0	130	0.072	−03.8		
δ Leo	12.0	+20 45	2.57	+0.13	A4 V	0.040	+0.6	82	0.201	−20.6		
θ Leo	12.1	+15 39	3.34	0.00	A2 V	0.019	+1.1	90	0.104	+07.8		
λ Cen	33.9	−62 48	3.15	−0.05	*B9 III*		−2.1	370	0.039	+07.9		
β Leo	47.0	+14 48	2.14	+0.09	A3 V	0.076	+1.5	43	0.511	−00.1		*Denebola*

Star	R.A. 1960	Dec.	V	$B-V$	Type		π	M_V	D	μ	R		
	h m	° ′					″		l.y.	″	km./sec.		
γ UMa	11 51.7	+53 55	2.44	0.00	A0	V	0.020	+0.2	90	0.094	−12.9		*Phecda*
δ Cen	12 06.3	−50 30	2.59v	−0.15:	*B2*	*Ve*		−2.7	370	0.042	+09	Var. *R* 2.56–2.62	
ε Crv	08.1	−22 24	3.04	+1.33	K3	III		−0.2	140	0.069	+04.9		
δ Cru	13.0	−58 32	2.81v	−0.23	*B2*	*IV*		−3.4	570	0.041	+26.4	Var. *R* 2.78–2.84	
δ UMa	13.5	+57 15	3.30	+0.07	A3	V	0.052	+1.9	63	0.106	−12.9		*Megrez*
γ Crv	13.7	−17 19	2.59	−0.10	B8	III		−3.1	450	0.163	−04.2		*Gienah*
α Cru *A*	24.4	−62 53	1.39	−0.25	*B1*	*IV*		−3.9	370	0.042	*−11.2*	} 5″, *C* 4.90^m 89″	**Acrux**
α Cru *B*	24.4	−62 53	1.86	−0.25	(B3)			−3.4	370	0.042	*−00.6*		
δ Crv *A*	27.8	−16 18	2.97	−0.04	B9.5	V: n	0.018	+0.1	124	0.255	+09	*B* 8.26^m 24″	
γ Cru	28.9	−56 53	1.69	+1.55	*M3*	*II*		−2.5	220	0.274	+21.3		*Gacrux*
β Crv	32.3	−23 11	2.66	+0.89	G5	III	0.027	+0.1	108	0.059	−07.7		
α Mus	34.8	−68 55	2.70v	−0.20	*B3*	*IV*		−2.9	430	0.037	+18	Var. *R* 2.66–2.73	
γ Cen *AB*	39.3	−48 44	2.17	+0.00	*A0*	*IV:*	0.006	−0.5	160	0.197	−07.5	*A* 2.9^m *B* 2.9^m 1″	
γ Vir *AB*	39.6	−01 14	2.76	+0.34	F0	V	0.101	+3.5	32	0.567	−19.7	*A* 3.50^m *B* 3.52^m 4″	
β Mus *AB*	43.8	−67 53	3.06	−0.17:	*B3*	*V*		−2.1	470	0.041	+42	*A* 3.7^m *B* 4.0^m 1″	
β Cru	45.4	−59 28	1.28	−0.25	*B0*	*III*		−4.6	490	0.049	+20.0		***Beta Crucis***
ε UMa	52.3	+56 11	1.79	−0.03	A0pv		0.008	+0.2	68	0.113	−09.3	Chromium-europium star	*Alioth*
α CVn *A*	54.2	+38 32	2.90	−0.10	B9.5pv		0.023	+0.1	118	0.238	*−03.3*	Silicon-europium star. *B* 5.61^m 20″	
ε Vir	13 00.2	+11 10	2.86	+0.93	G9	II–III	0.036	+0.6	90	0.274	−14.0		
γ Hya	16.7	−22 58	2.98	+0.92	G8	III	0.021	+0.3	113	0.086	−05.4		
ι Cen	18.3	−36 30	2.76	+0.05	*A2*	*V*	0.046	+1.1	71	0.351	+00.1		
ζ UMa *A*	22.3	+55 08	2.26	+0.02	A2	V	0.037	+0.1	88	0.127	*−09.0*	*B* 3.94^m 14″	*Mizar*
α Vir	23.1	−10 57	0.91v	−0.24	B1	V	0.021	−3.3	220	0.054	*+01.0*	Ecl. *R* 0.91–1.01, 4.0^d	***Spica***
ζ Vir	32.7	−00 24	3.40	+0.10	A3	Vn	0.035	+1.1	93	0.287	−13.2		
ε Cen	37.3	−53 16	2.33	−0.23	*B1*	*IV*		−3.9	570	0.033	+05.6		
η UMa	46.0	+49 31	1.87	−0.20	B3	V	0.004	−2.1	210	0.123	−10.9		*Alkaid*
ν Cen	47.1	−41 29	3.42	−0.22	B2	IV		−3.4	750	0.037	*+09.0*		
μ Cen	47.2	−42 17	3.12v	−0.13:	B2	V: pne		−2.7	470	0.032	+12.6	Var. *R* 3.08–3.17	
η Boo	52.8	+18 36	2.69	+0.59	G0	IV	0.102	+2.7	32	0.370	*−00.1*		
ζ Cen	53.0	−47 06	2.56	−0.23:	*B2*	*IV*		−3.4	520	0.076	*+06.5*		

Star	R.A. 1960	Dec.	V	$B-V$	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
β Cen *AB*	14 01.0	−60 11	0.63	−0.23:	*B1 II:*	0.016	−5.2	490	0.035	*−12*	*A* 0.7ᵐ *B* 3.9ᵐ 1″	***Hadar***
π Hya	04.1	−26 29	3.25	+1.13	K2 III	0.039	+1.2	84	0.156	+27.2		
θ Cen	04.3	−36 10	2.04	+1.03	K0 III–IV	0.059	+0.9	55	0.738	+01.3		*Menkent*
α Boo	13.8	+19 23	−0.06	+1.23	K2 IIIp	0.090	−0.3	36	2.284	−05.2		***Arcturus***
γ Boo	30.5	+38 29	3.05	+0.19	A7 III	0.016	+0.2	118	0.186	−35.5		
η Cen	33.0	−41 59	2.39v	−0.21	B1.5 V:ne		−3.0	390	0.049	−00.2	Var. *R* 2.33–2.45	
α Cen *A*	36.9	−60 40	0.01	+0.68	*G2 V*	.751	+4.39	4.3	3.676	−24.6	18″	***Rigil Kentaurus***
α Cen *B*	36.9	−60 40	1.40:	+0.73:	(dK1)		+5.8	4.3		−20.7		
α Cir *AB*	39.2	−64 48	3.18	+0.25	*F0 Vp*	0.049	+1.6	66	0.308	+07.4	Strontium star. *A* 3.19ᵐ *B* 8.61ᵐ 16″	
α Lup	39.3	−47 13	2.32	−0.22	B1 V		−3.3	430	0.033	+07.3		
ε Boo *AB*	43.2	+27 14	2.37	+0.96	K1: III: + A	0.013	+0.0	103	0.051	−16.5	*A* 2.47ᵐ *B* 5.04ᵐ 3″	
α Lib *A*	48.5	−15 50	2.76	+0.15	A3m	0.049	+1.2	66	0.130	−10	*B* 5.15ᵐ 231″	*Zubenelgenubi*
β UMi	50.8	+74 19	2.04	+1.47	K4 III	0.031	−0.5	105	0.033	+16.9		*Kochab*
β Lup	55.9	−42 58	2.69	−0.23	B2 IV		−3.4	540	0.066	−00.3		
κ Cen	56.5	−41 57	3.15	−0.21	B2 V		−2.7	470	0.033	+09.1		
β Boo	15 00.4	+40 33	3.48	+0.95	G8 III	0.022	+0.3	140	0.059	−19.9		
σ Lib	01.7	−25 08	3.31	+1.65	M4 III	0.056	+2.0:	58:	0.089	−04.3		
ζ Lup *A*	09.4	−51 57	3.42	+0.90:	*K0 III*	0.036	+1.2	90	0.135	−09.7	*B* 7.8ᵐ 71″	
δ Boo *A*	13.9	+33 28	3.47	+0.95	G8 III	0.028	+0.3	140	0.148	−12.2	*B* 7.84ᵐ 105″	
β Lib	14.8	−09 14	2.61	−0.11	B8 V	−.012	−0.6	140	0.101	−35.2		
γ TrA	15.1	−68 32	2.94	−0.01	*A0 Vp*	0.005	+0.2	113	0.067	00	Europium star	
δ Lup	18.7	−40 30	3.24	−0.23	B2 IV		−3.4	680	0.032	+02		
γ UMi	20.8	+71 59	3.08	+0.06	A3 II-III	−.005	−1.5	270	0.026	*−03.9*		
ι Dra	24.0	+59 06	3.28	+1.18	K2 III	0.032	+0.8	102	0.012	−11.0		
γ Lup *AB*	32.5	−41 02	2.80	−0.22	B2 Vn		−2.7	570	0.037	+06	*A* 3.5ᵐ *B* 3.7ᵐ 1″	
α CrB	33.0	+26 51	2.23v	−0.02	A0 V	0.043	+0.4	76	0.154	*+01.7*	Ecl. *R* 0.11ᵐ, 17.4ᵈ	*Alphecca*
α Ser	42.3	+06 33	2.65	+1.17	K2 III	0.046	+1.0	71	0.139	+02.9		
β TrA	51.6	−63 19	2.87	+0.28:	*F2 V*	0.078	+2.3	42	0.448	−00.3		
π Sco	56.4	−26 00	2.92	−0.19	B1 V	0.005	−3.3	570	0.034	*−03*		
η Lup *AB*	57.5	−38 17	3.45	−0.23	B2 V		−2.7	570	0.042	+07	*A* 3.47ᵐ *B* 7.70ᵐ 15″	
δ Sco	58.0	−22 51	2.34	−0.13	B0 V		−4.0	590	0.032	−14		

Star	R.A. 1960	Dec.	V	$B-V$	Type	π	M_V	D	μ	R	
	h m	° ′				″		l.y.	″	km./sec.	
β Sco *AB*	16 03.1	−19 42	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	12.2	−03 36	2.72	+1.59	M1 III	0.029	−0.5	140	0.156	−19.9	
ϵ Oph	16.2	−04 36	3.22	+0.97	G9 III	0.036	+1.0	90	0.089	−10.3	
σ Sco *A*	18.8	−25 30	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*	23.4	+61 36	2.71	+0.92	G8 III	0.043	+0.9	76	0.062	−14.3	*B* 8.7^m 6″
α Sco *A*	26.9	−26 21	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	28.5	+21 35	2.78	+0.92	G8 III	0.017	+0.3	103	0.105	*−25.5*	
τ Sco	33.4	−28 08	2.85	−0.25	B0 V		−4.0	750	0.030	−00.7	
ζ Oph	35.0	−10 29	2.57	+0.00	O9.5 V	−.007	−4.3	520	0.022	−19	
ζ Her *AB*	39.8	+31 40	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	41.5	+39 00	3.46	+0.92	G7 III–IV	0.053	+2.1	62	0.097	+08.3	
α TrA	44.4	−68 57	1.93	+1.43	*K2 III*	0.024	−0.1	82	0.044	−03.6	*Atria*
ϵ Sco	47.6	−34 13	2.28	+1.16	*K2 III–IV*	0.049	+0.7	66	0.664	−02.5	
μ^1 Sco	49.2	−37 59	2.99v	−0.20	B1.5 V		−3.0	520	0.033	*−25*	Ecl. *R* 2.99–3.09, 1.4^d
ζ Ara	55.3	−55 56	3.16	+1.61	(gK5)	0.036	+0.9	90	0.042	−06.0	
κ Oph	55.8	+09 26	3.18	+1.15	K2 III	0.026	−0.1	150	0.293	−55.6	
η Oph *AB*	17 08.1	−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*
ζ Dra	08.7	+65 46	3.20	−0.12	B6 III	0.017	−3.2	620	0.026	−14.1	
η Sco	09.3	−43 11	3.33	+0.38	*F2 III*	0.063	+2.3	52	0.293	−28.4	
α Her *AB*	12.8	+14 26	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	13.4	+24 53	3.14	+0.09	A3 IV	0.034	+0.8	96	0.164	−41	
π Her	13.7	+36 51	3.13	+1.43	K3 II	0.020	−2.4	410	0.029	−25.7	
θ Oph	19.6	−24 58	3.29	−0.22	B2 IV		−3.4	710	0.025	−03.6	
β Ara	22.0	−55 30	2.90	+1.45:	*K3 Ib*	0.026	−4.6	1030	0.035	−00.4	
γ Ara *A*	22.0	−56 21	3.32	−0.16	*B1 V*		−3.3	680	0.017	−04	*B* 10^m 18″
υ Sco	28.0	−37 16	2.71	−0.22	*B2 IV*		−3.4	540	0.039	*+18*	
α Ara	28.7	−49 51	2.95	−0.18:	B2.5 V		−2.4	390	0.083	*−02*	
β Dra *A*	29.5	+52 20	2.77	+0.96	G2 II	0.009	−2.1	310	0.019	−20.0	*B* 11.49^m 4″
λ Sco	30.9	−37 05	1.60	−0.24	B1 V		−3.3	310	0.031	00	*Shaula*
α Oph	33.1	+12 35	2.09	+0.16	A5 III	0.056	+0.8	58	0.260	+12.7	*Rasalhague*
θ Sco	34.4	−42 58	1.86	+0.39	*F0 Ib*	0.020	−4.6	650	0.012	+01.4	

Star	R.A. 1960	Dec.	V	$B-V$	Type	π	M_V	D	μ	R	
	h m	° ′				″		l.y.	″	km./sec.	
κ Sco	17 39.7	−39 01	2.39	−0.21	*B2 IV*		−3.4	470	0.031	−10	
β Oph	41.5	+04 35	2.77	+1.16	K2 III	0.023	−0.1	124	0.160	−12.0	
ι¹ Sco	44.8	−40 07	2.99	+0.49	F2 Ia	0.013	−7.1	3400	0.004	−*27.6*	
μ Her *A*	44.9	+27 45	3.42	+0.75	G5 IV	0.108	+3.6	30	0.811	−15.6	*BC* 9.78ᵐ 33″
G Sco	47.1	−37 02	3.21	+1.18	(gK1)	0.032	+0.7	102	0.064	+24.7	
γ Dra	55.7	+51 30	2.21	+1.52	K5 III	0.017	−0.4	108	0.026	−27.6	*Eltanin*
ν Oph	56.8	−09 46	3.32	+1.00	G9 III	0.015	+0.2	140	0.118	+12.4	
γ Sgr	18 03.2	−30 26	2.97	+1.00	*K0 III*	0.018	+0.1	124	0.200	+*22.1*	
η Sgr *A*	14.9	−36 47	3.17	+1.55	*M3 II*	0.038	+1.1:	86:	0.218	+00.5	*B* 10ᵐ 4″
δ Sgr	18.4	−29 51	2.71	+1.39	*K2 III*	0.039	+0.7	84	0.050	−20.0	
η Ser	19.2	−02 55	3.23	+0.94	K0 III–IV	0.054	+1.9	60	0.894	+08.9	
ε Sgr	21.5	−34 24	1.81	−0.02	*B9 IV*	0.015	−1.1	124	0.135	−11	*Kaus Australis*
λ Sgr	25.5	−25 27	2.80	+1.05	*K2 III*	0.046	+1.1	71	0.194	−43.3	
α Lyr	35.6	+38 45	0.04	0.00	A0 V	0.123	+0.5	26.5	0.345	−13.9	***Vega***
φ Sgr	43.2	−27 02	3.20	−0.11	*B8 III*		−3.1	590	0.052	+21.5	
β Lyr *A*	48.6	+33 19	3.38v	−0.05:	Bpe	−.011	−4.6	1300	0.007	−*19.2*	Ecl. *R* 3.38–4.36, 12.9ᵈ, *B* 7.8ᵐ 46″
σ Sgr	52.8	−26 21	2.12	−0.21	B2 V		−2.7	300	0.059	−11	*Nunki*
ξ² Sgr	55.3	−21 10	3.51	+1.18:	(gK1)	0.006	+0.0	160	0.035	−19.9	
γ Lyr	57.4	+32 38	3.25	−0.05	B9 III	0.011	−2.1	370	0.007	−21.5	
ζ Sgr *AB*	19 00.1	−29 56	2.61	+0.08	*A2 IV*	0.020	+0.1	140	0.020	+22	*A* 3.3ᵐ *B* 3.5ᵐ 1″
ζ Aql *A*	03.6	+13 48	2.99	+0.01	A0 V:nn	0.036	+0.8	90	0.101	−26.3	*B* 12ᵐ 5″
λ Aql	04.1	−04 57	3.44	−0.07	B9: V:n	0.025	−0.1	160	0.092	−14	
τ Sgr	04.4	−27 44	3.30	+1.18	(gK1)	0.038	+1.2	86	0.261	+*45.4*	
π Sgr *ABC*	07.4	−21 05	2.89	+0.35	F2 II–III	0.016	−0.7	250	0.040	−09.8	*A* 3.7ᵐ *B* 3.8ᵐ *C* 6.0ᵐ < 1″
δ Dra	12.6	+67 35	3.06	+1.00	G9 III	0.028	+0.2	124	0.130	+24.8	
δ Aql	23.5	+03 02	3.38	+0.31	F0 IV	0.062	+2.3	53	0.267	−*29.9*	
β Cyg *A*	29.1	+27 52	3.07	+1.12	K3 II: + B:	0.004	−2.4	410	0.009	−24.0	*B* 5.11ᵐ 35″ *Albireo*
δ Cyg *AB*	43.7	+45 02	2.87	−0.03	B9.5 III	0.021	−1.7	270	0.060	−21	*A* 2.91ᵐ *B* 6.44ᵐ 2″
γ Aql	44.4	+10 31	2.67	+1.48	K3 II	0.006	−2.4	340	0.012	−02.1	
α Aql	48.8	+08 46	0.77	+0.22	A7 IV, V	0.198	+2.2	16.5	0.658	−26.3	***Altair***

Star	R.A. 1960	Dec.	V	$B-V$	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
θ Aql	20 09.2	−00 56	3.31	−0.07	B9.5 III	0.008	−1.7	330	0.034	*−27.3*		
β Cap *A*	18.8	−14 55	3.06	+0.76	comp.	0.005	+0.1	130	0.039	−18.9	Type gK0: + late B; *B* 5.97^m 205″	
γ Cyg	20.8	+40 08	2.22	+0.66	F8 Ib	−.006	−4.6	750	0.001	−07.5		
α Pav	22.5	−56 52	1.95	−0.20	*B3 IV*		−2.9	310	0.087	*+02.0*		*Peacock*
α Ind	34.8	−47 26	3.11	+1.00	*K0 III*	0.039	+1.1	84	0.082	−01.1		
α Cyg	40.1	+45 08	1.26	+0.09	A2 Ia	−.013	−7.1	1600	0.003	−04.6		***Deneb***
β Pav	41.4	−66 21	3.45	+0.16	*A5 III*	0.026	−0.1	160	0.046	+09.8		
η Cep	44.5	+61 41	3.41	+0.92	K0 IV	0.071	+2.7	46	0.825	−87.3		
ε Cyg	44.6	+33 49	2.46	+1.03	K0 III	0.044	+0.7	74	0.481	*−10.3*		
ζ Cyg	21 11.2	+30 04	3.25:		G8 II	0.021	−2.2	390	0.056	+17.4		
α Cep	17.6	+62 25	2.44	+0.24	A7 IV, V	0.063	+1.4	52	0.156	−10		*Alderamin*
β Cep	28.2	+70 23	3.15v	−0.22v	B2 III	0.005	−4.2	980	0.014	−08.2	β CMa *R* 3.14–3.16, 0.19^d	
β Aqr	29.5	−05 45	2.86	+0.82	G0 Ib	0.000	−4.6	1030	0.017	+06.5		
ε Peg *A*	42.2	+09 41	2.31	+1.55	K2 Ib	−.005	−4.6	780	0.025	+04.7	*B* 11^m 82″	*Enif*
δ Cap	44.8	−16 19	2.92v	+0.29	A6m	0.065	+2.0	50	0.392	*−06.3*	Var. *R* 2.88–2.95	
γ Gru	51.5	−37 33	3.03	−0.10	*B8 III:*	0.008	−3.1	540	0.102	−02.1		
α Aqr	22 03.7	−00 31	2.96	+0.96	G2 Ib	0.003	−4.6	1080	0.016	+07.5		
α Gru	05.7	−47 09	1.76	−0.14	*B5 V*	0.051	+0.3:	64:	0.194	+11.8		*Al Na'ir*
ζ Cep	09.5	+58 00	3.31	+1.55	K1 Ib	0.019	−4.6	1240	0.015	*−18.4*		
α Tuc	15.8	−60 28	2.87	+1.40	*K3 III–IV*	0.019	+1.5	62	0.079	*+42.2*		
δ Cep *A*	27.7	+58 13	3.96v	+0.66v	F5–G2 Ib	0.005	−4.0	1300	0.012	*−16.8*	Cep. *R* 3.51–4.42, 5.4^d, *B* 6.19^m 41″	
ζ Peg	39.5	+10 37	3.40:	−0.08:	B8 V	−.004	−0.6	210	0.077	+07		
β Gru	40.3	−47 06	2.17v	+1.59	*M3 II*	0.003	−2.5	280	0.134	+01.6	Var. *R* 2.11–2.23	
η Peg	41.1	+30 01	2.95	+0.85	G8 II: + F?	−.002	−2.2	360	0.027	*+04.3*		
δ Aqr	52.5	−16 02	3.28	+0.08	A3 V	0.039	+1.2	84	0.047	+18.0		
α PsA	55.4	−29 50	· 19	+0.10	A3 V	0.144	+2.0	22.6	0.367	+06.5		***Fomalhaut***
β Peg	23 01.8	+27 52	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	02.8	+14 59	2.50	−0.03	B9.5 III	0.030	−0.1	109	0.071	−03.5		*Markab*
γ Cep	37.7	+77 25	3.20	+1.02	K1 IV	0.064	+2.2	51	0.168	−42.4		

TABLE OF PRECESSION FOR 50 YEARS

R.A.	Prec. in Dec.	Precession in Right Ascension δ = +85°	+80°	+75°	+70°	+60°	+50°	+40°	+30°	+20°	+10°	0°	−10°	−20°	−30°	Prec. in Dec.	R.A.
h m	′	m	m	m	m	m	m	m	m	m	m	m	m	m	m	′	h m
0 00	+16.7	+ 2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	−16.7	12 00
0 30	+16.6	+ 4.22	3.38	3.10	2.96	2.81	2.73	2.68	2.64	2.61	2.59	2.56	2.53	2.51	2.48	−16.6	11 30
1 00	+16.1	+ 5.85	4.19	3.64	3.36	3.06	2.90	2.80	2.73	2.67	2.61	2.56	2.51	2.45	2.39	−16.1	11 00
1 30	+15.4	+ 7.43	4.98	4.15	3.73	3.30	3.07	2.92	2.81	2.72	2.64	2.56	2.49	2.40	2.31	−15.4	10 30
2 00	+14.5	+ 8.92	5.72	4.64	4.09	3.52	3.22	3.03	2.88	2.76	2.66	2.56	2.46	2.36	2.24	−14.5	10 00
2 30	+13.2	+10.31	6.40	5.09	4.42	3.73	3.37	3.13	2.95	2.81	2.68	2.56	2.44	2.31	2.17	−13.2	9 30
3 00	+11.8	+11.56	7.02	5.50	4.73	3.92	3.50	3.22	3.02	2.85	2.70	2.56	2.42	2.27	2.11	−11.8	9 00
3 30	+10.2	+12.66	7.57	5.86	4.99	4.09	3.61	3.30	3.07	2.88	2.72	2.56	2.40	2.24	2.05	−10.2	8 30
4 00	+ 8.3	+13.58	8.03	6.16	5.21	4.23	3.71	3.37	3.12	2.91	2.73	2.56	2.39	2.21	2.00	− 8.3	8 00
4 30	+ 6.4	+14.32	8.40	6.40	5.39	4.34	3.79	3.42	3.16	2.93	2.74	2.56	2.38	2.19	1.97	− 6.4	7 30
5 00	+ 4.3	+14.85	8.66	6.58	5.52	4.42	3.84	3.46	3.18	2.95	2.75	2.56	2.37	2.17	1.94	− 4.3	7 00
5 30	+ 2.2	+15.18	8.82	6.68	5.60	4.47	3.88	3.49	3.20	2.96	2.75	2.56	2.37	2.16	1.92	− 2.2	6 30
6 00	+ 0.0	+15.29	8.88	6.72	5.62	4.49	3.89	3.50	3.20	2.97	2.76	2.56	2.36	2.16	1.92	0.0	6 00
12 00	−16.7	+ 2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+2.56	+16.7	24 00
12 30	−16.6	+ 0.90	1.82	2.02	2.16	2.31	2.39	2.44	2.48	2.51	2.53	2.56	2.59	2.61	2.64	+16.6	23 30
13 00	−16.1	− 0.73	+0.93	1.48	1.77	2.06	2.22	2.32	2.39	2.45	2.51	2.56	2.61	2.67	2.73	+16.1	23 00
13 30	−15.4	− 2.31	+0.14	0.97	1.39	1.82	2.05	2.20	2.31	2.40	2.49	2.56	2.64	2.72	2.81	+15.4	22 30
14 00	−14.5	− 3.80	−0.60	+0.46	1.03	1.60	1.90	2.09	2.24	2.36	2.46	2.56	2.66	2.76	2.88	+14.5	22 00
14 30	−13.2	− 5.19	−1.28	+0.03	0.70	1.39	1.75	1.99	2.17	2.31	2.44	2.56	2.68	2.81	2.95	+13.2	21 30
15 00	−11.8	− 6.44	−1.90	−0.38	+0.40	1.20	1.62	1.90	2.11	2.27	2.42	2.56	2.70	2.85	3.02	+11.8	21 00
15 30	−10.2	− 7.54	−2.45	−0.74	+0.13	1.03	1.51	1.81	2.05	2.24	2.40	2.56	2.72	2.88	3.07	+10.2	20 30
16 00	− 8.3	− 8.46	−2.91	−1.04	−0.09	+0.89	1.41	1.75	2.00	2.21	2.39	2.56	2.73	2.91	3.12	+ 8.3	20 00
16 30	− 6.4	− 9.20	−3.27	−1.28	−0.27	+0.78	1.33	1.70	1.97	2.19	2.38	2.56	2.74	2.93	3.16	+ 6.4	19 30
17 00	− 4.3	− 9.73	−3.54	−1.45	−0.40	+0.70	1.28	1.66	1.94	2.17	2.37	2.56	2.75	2.95	3.18	+ 4.3	19 00
17 30	− 2.2	−10.06	−3.70	−1.56	−0.47	+0.65	1.25	1.63	1.92	2.16	2.37	2.56	2.75	2.96	3.20	+ 2.2	18 30
18 00	− 0.0	−10.17	−3.75	−1.60	−0.50	+0.63	1.23	1.62	1.92	2.16	2.36	2.56	2.76	2.97	3.20	+ 0.0	18 00

THE NEAREST STARS

By R. M. Petrie and Jean K. McDonald

Perhaps the most difficult problem in observational astronomy is the determination of the distances to the stars. The reason, of course, is that the distances are so enormous as to require the measurement of vanishingly small angular displacements. As the earth goes in its orbit around the sun the stars show a small change in their positions and it is this small apparent movement which is called the annual parallax. If we can measure the parallax we can at once calculate the distance to the star concerned.

Astronomers speak of stellar distances in terms of light-years or, alternatively, parsecs. A light-year is the distance light travels in one year with its speed of 186,000 miles per second. If we know the parallax in seconds of arc we obtain the distance in light-years by dividing 3.26 by the parallax. Thus the star Sirius, which has an annual parallax of 0.″375, is 8.7 light-years distant. The reciprocal of the parallax gives the distance in parsecs; Sirius is 2.7 parsecs from the sun.

The apparent motion, per year, of a star across the sky, called proper motion, is a good indication of a star's distance. Obviously, the nearer stars will appear to move more rapidly than their more distant fellows and this fact has many times been instrumental in the discovery of nearby stars.

The table accompanying this note lists, in order of distance, all known stars within sixteen light-years. Including the sun it contains fifty-five stars, but it does not contain the unseen companions of double and multiple stars entered in the table. The table is taken from a paper by Professor van de Kamp, published in 1953. In addition to the name and position for each star, the table gives spectral type, Sp.; parallax, π; distance in light-years, D; proper motion in second of arc per year, μ; total velocity with respect to the sun in km./sec., R; apparent visual magnitude, m; and finally, luminosity in terms of the sun, L. In column four, *wd* indicates a white dwarf, and *e* indicates an emission-line star.

The stars within sixteen light-years form an important astronomical table because the annual parallaxes are large enough to be well determined. This means that we have accurate knowledge of the distances, speeds, and luminosities of these stars. Furthermore this sample is probably quite representative of the stellar population in our part of the galaxy, and as such is well worth our study.

It is interesting to note that most of the stars are cool red dwarfs, of type M. This must be the most populous of all the stellar varieties. Only ten of these nearby stars are bright enough to be seen with the unaided eye (magnitude less than five). Only three stars, Sirius, Altair, and Procyon, are brighter than the sun while the great majority are exceedingly faint. Not one giant star is contained in the list nor is there a B-type star. This is a consequence of the extreme rarity of very hot and very bright stars. One may conclude that stars brighter than the sun are very scarce.

Another striking fact is the prevalence of double and multiple stars, there being sixteen such systems if we count unseen components. Obviously double and multiple stars are quite common in the stellar population, and must be explained by any acceptable theory of stellar formation and evolution.

THE NEAREST STARS

Star	1950				Sp.	π	D	μ	R	m	L
	α		δ								
	h	m	°	′		″	l.y.	″	km./sec.		
Sun					G0					-26.9	1.0
α Cen A	14	36	−60	38	G0	0.760	4.3	3.68	34	0.3	1.0
B					K5					1.7	0.28
C	14	26	−62	28	M5*e*					11	0.000052
Barnard's *	17	55	+ 4	33	M5	.545	6.0	10.30	141	9.5	0.00040
Wolf 359	10	54	+ 7	20	M6*e*	.421	7.7	4.84	56	13.5	0.000017
Luy. 726-8A	1	36	−18	13	M6*e*	.410	7.9	3.35	48	12.5	0.00004
B					M6*e*					13.0	0.00003
Lal. 21185*	11	01	+36	18	M2	.398	8.2	4.78	103	7.5	0.0048
Sirius A	6	43	−16	39	A0	.375	8.7	1.32	18	−1.6	23.
B					*wd*					7.1	0.008
Ross 154	18	47	−23	53	M5*e*	.351	9.3	0.67	10	10.6	0.00036
Ross 248	23	39	+43	55	M6*e*	.316	10.3	1.58	84	12.2	0.00010
ϵ Eri	3	31	− 9	38	K2	.303	10.8	0.97	21	3.8	0.25
Ross 128	11	45	+ 1	07	M5	.298	10.9	1.40	26	11.1	0.00030
61 Cyg* A	21	05	+38	30	K6	.293	11.1	5.22	106	5.6	0.052
B					M0					6.3	0.028
Luy. 789-6	22	36	−15	37	M6	.292	11.2	3.27	80	12.2	0.00012
Procyon A	7	37	+ 5	21	F5	.288	11.3	1.25	20	0.5	5.8
B					*wd*					10.8	0.00044
ϵ Ind	22	00	−57	00	K5	.285	11.4	4.67	87	4.7	0.12
Σ 2398 A	18	42	+59	33	M4	.280	11.6	2.29	38	8.9	0.0028
B					M4					9.7	0.0013
Groom. 34 A	0	16	+43	44	M2*e*	.278	11.7	2.91	51	8.1	0.0058
B					M4*e*					10.9	0.00044
τ Ceti	1	42	−16	12	G4	.275	11.8	1.92	37	3.6	0.36
Lac. 9352	23	03	−36	09	M2	.273	11.9	6.87	118	7.2	0.013
BD +50°1668	7	25	+ 5	29	M4	.263	12.4	3.73	72	10.1	0.0010
Lacaille 8760	21	14	−39	04	M1	.255	12.8	3.46	68	6.6	0.028
Kapteyn's	5	10	−45	00	M0	.251	13.0	8.79	275	9.2	0.0025
Kruger 60 A	22	26	+57	27	M4	.249	13.1	0.87	29	9.9	0.0013
B					M5*e*					11.4	0.00033
Ross 614 A	6	27	− 2	47	M5*e*	.248	13.1	0.97	30	10.9	0.00052
B					?					14.8	0.000016
BD−12°4523	16	28	−12	32	M5	.244	13.4	1.24	27	10.0	0.0013
van Mannen's	0	46	+ 5	10	*wd*F	.236	13.8	2.98	64	12.3	0.00016
Wolf 424 A	12	31	+ 9	18	M6*e*	.223	14.6	1.87	40	12.6	0.00014
B					M6*e*					12.6	0.00014
Groom. 1618	10	08	+49	42	K5	.222	14.7	1.45	41	6.8	0.030
CD−37°15492	0	02	−37	36	M3	.219	14.9	6.09	134	8.6	0.0058
CD−46°11540	17	25	−46	51	M4	.213	15.3	1.15		9.7	0.0023
BD+20°2465*	10	17	+20	07	M4*e*	.211	15.4	0.49	15	9.5	0.0028
CD−44°11909	17	34	−44	16	M5	.209	15.6	1.14		11.2	0.00058
CD−49°13515	21	30	−49	13	M3	.209	15.6	0.78		9	0.0044
AOe 17415-6	17	37	+68	23	M3	.206	15.8	1.31	34	9.1	0.0040
Ross 780	22	50	−14	31	M5	.206	15.8	1.12	28	10.2	0.0014
Lal. 25372	13	43	+15	10	M2	.205	15.9	2.30	55	8.6	0.0063
CC 658	11	43	−64	33	*wd*	.203	16.0	2.69		11	0.0008
o^2 Eri A	4	13	− 7	44	K0	.200	16.3	4.08	105	4.5	0.30
B					*wd*A					9.2	0.0040
C					M5*e*					11.0	0.0008
70 Oph A	18	03	+ 2	31	K1	.199	16.4	1.13	28	4.2	0.40
B					K5					5.9	0.083
Altair	19	48	+ 8	44	A5	.198	16.5	0.66	31	0.9	8.3
BD+43°4305	22	45	+44	05	M5*e*	.198	16.5	0.84	20	10.2	0.0016
AC 79°3888	11	44	+78	57	M4	0.196	16.6	0.87	121	11.0	0.0008

*Star has an unseen component.

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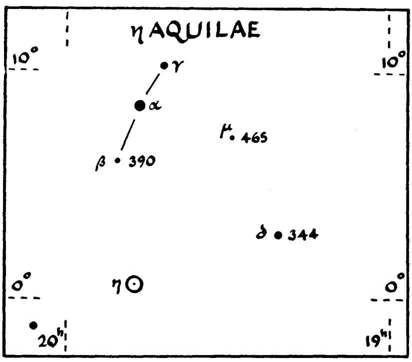
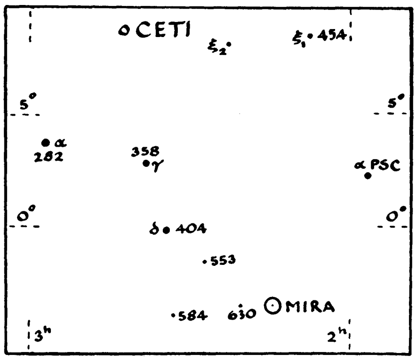
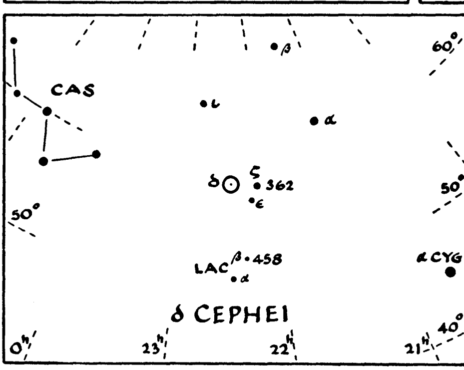
VARIABLE STARS

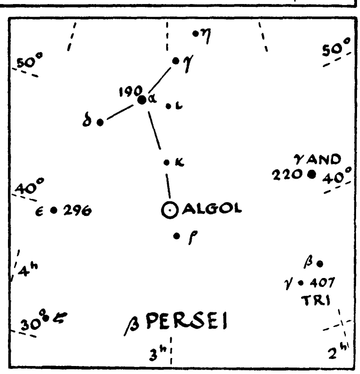
Maps of the fields of four bright variable stars are given below. In each case the magnitudes of several suitable comparison stars are given. Note that the decimal points are omitted: a star 362 is of mag. 3.62. Use two comparison stars, one brighter and one fainter than the variable, and estimate the brightness of the variable in terms of these two stars. Record the date and time of observation. When a number of observations have been made, a graph may be plotted showing the magnitude estimate as ordinates against the date (days and tenths of a day) as abscissae. Each type of variable has a distinctive shape of light curve.

In the tables the first column, the Harvard designation of the star, gives the 1900 position: the first four figures give the hours and minutes of R.A., the last two figures give the Dec. in degrees, italicised for southern declinations. The column headed *Max.* gives the mean maximum magnitude. The *Period* is in days. The *Epoch* gives the predicted date of the *earliest* maximum occurring this year; by adding the period to this epoch other dates of maximum may be found. The list of long-period variables has been prepared by the American Association of Variable Star Observers and includes the variables with maxima brighter than mag. 8.0, and north of Dec. −20°. These variables may reach maximum two or three weeks before or after the listed epoch and may remain at maximum for several weeks. The second table contains stars which are representative of other types of variable. The data are taken from "The General Catalogue of Variable Stars" by Kukarkin and Parenago and for eclipsing binaries from *Rocznik Astronomiczny Obserwatorium Krakowskiego*, 1959, International Supplement.









LONG-PERIOD VARIABLE STARS

Variable		Max. m	Per. d	Epoch 1961
001755	T Cas	7.8	445	May 9
001838	R And	7.0	409	Mar. 30
021143	W And	7.4	397	Nov. 11
0214*03*	*o* Cet	3.4	332	June 12
0228*13*	U Cet	7.5	235	May 21
023133	R Tri	6.2	266	June 18
043065	T Cam	8.0	374	Sept. 17
0455*14*	R Lep	6.8	432	Mar. 4
050953	R Aur	7.7	459	...
054920a	U Ori	6.3	372	May 28
0617*02*	V Mon	7.0	335	Oct. 9
065355	R Lyn	7.9	379	Oct. 29
070122a	R Gem	7.1	370	Apr. 10
070310	R CMi	8.0	338	Nov. 19
072708	S CMi	7.5	332	Aug. 13
081112	R Cnc	6.8	362	Mar. 20
081617	V Cnc	7.9	272	July 11
084803	S Hya	7.8	257	May 22
0850*08*	T Hya	7.8	288	July 9
093934	R LMi	7.1	372	...
094211	R Leo	5.8	313	Feb. 4
103769	R UMa	7.5	302	June 9
1214*18*	R Crv	7.5	317	Mar. 9
122001	SS Vir	6.8	355	June 29
123160	T UMa	7.7	257	June 9
123307	R Vir	6.9	146	Mar. 20
123961	S UMa	7.8	226	Apr. 23
131546	V CVn	6.8	192	May 1
1327*06*	S Vir	7.0	378	Sept. 5
134440	R CVn	7.7	328	Jan. 26
142584	R Cam	7.9	270	June 9
142539	V Boo	7.9	258	Jan. 17
143227	R Boo	7.2	223	Mar. 12
151731	S CrB	7.3	361	May 2
154639	V CrB	7.5	358	Feb. 9
154615	R Ser	6.9	357	Feb. 27
160625	RU Her	8.0	484	Nov. 29
162119	U Her	7.5	406	Oct. 30
1621*12*	V Oph	7.5	298	Feb. 15
163266	R Dra	7.6	245	Apr. 9
164715	S Her	7.6	307	Apr. 5
1702*15*	R Oph	7.9	302	Jan. 6
171723	RS Her	7.9	219	June 8
180531	T Her	8.0	165	Mar. 29
181136	W Lyr	7.9	196	Mar. 20
183308	X Oph	6.8	334	June 24
190108	R Aql	6.1	300	Apr. 25
1910*17*	T Sgr	8.0	392	Mar. 11
1910*19*	R Sgr	7.3	269	May 7
193449	R Cyg	7.5	426	Feb. 7
194048	RT Cyg	7.3	190	Feb. 22
194632	χ Cyg	5.2	407	Nov. 21
200938	RS Cyg	7.2	418	...
201647	U Cyg	7.2	465	Dec. 14
2044*05*	T Aqr	7.7	202	Jan. 7
210868	T Cep	6.0	390	Dec. 2
213753	RU Cyg	8.0	234	July 4
230110	R Peg	7.8	378	July 29
230759	V Cas	7.9	228	May 7
231508	S Peg	8.0	319	Jan. 3
2338*15*	R Aqr	6.5	387	Feb. 27
235350	R Cas	7.0	431	Dec. 2
2357*15*	W Cet	7.6	351	July 29

OTHER TYPES OF VARIABLE STARS

Variable		Max. m	Min. m	Type	Sp. Cl.	Period d	Epoch 1961 E.S.T.
005381	U Cep	6.8	9.8	Ecl	B8+gG2	2.49295	Jan. 2.01*
025838	ρ Per	3.2	3.8	SemiR	M4	33–55	
035512	λ Tau	3.5	4.0	Ecl	B3	3.952952	Jan. 3.15*
060822	η Gem	3.1	3.9	SemiR	M3	233.4	Jan. 4*
061907	T Mon	5.8	6.8	δ Cep	F7–K1	27.0205	Jan. 25.51
065820	ζ Gem	3.7	4.1	δ Cep	F7–G3	10.15172	Jan. 10.03
154428	R CrB	5.8	14	R CrB	cG0ep		
171014	α Her	3.0	4.0	SemiR	M5		
1842*05*	R Sct	5.0	8.4	RVTau	G0–M5	144	
184633	β Lyr	3.4	4.3	Ecl	B8p	12.931163	Jan. 10.97*
192242	RR Lyr	7.3	8.1	RR Lyr	A2–F0	0.56683735	Jan. 1.19
194700	η Aql	3.7	4.4	δ Cep	F6–G4	7.176641	Jan. 4.79
222557	δ Cep	3.8	4.6	δ Cep	F5–G2	5.366341	Jan. 4.66

*Minima

REPRESENTATIVE DOUBLE STARS

Star		α 1950	δ	Mag. and Spect.	d	D	Remarks
		h m	° ′		″	L.Y.	
π	And	00 34.2	+33 27	4.4B3; 8.5	36	470	†
η	Cas	00 46.0	+57 33	3.6F8; 7.2M0	8	18	526y; 66AU
α	UMi	01 48.8	+89 02	var. F8; 8.8	19	407	Polaris
γ	Ari	01 50.8	+19 03	4.8A0; 4.8A0	8.3	150	
α	Pis	01 59.4	+02 31	5.2A2; 4.3A2	2.4	130	††
γ	And	02 00.8	+42 05	2.3K0; 5.4A0; 6.6	10, 0.7	410	56y; 23AU
6	Tri	02 09.5	+30 04	5.4G4; 7.0F3	3.6	330	††
η	Per	02 47.0	+55 41	3.9K0; 8.5	28	540	
32	Eri	03 51.8	−03 06	5.0G5; 6.3A	6.7	300	
β	Ori	05 12.1	−08 15	0.3B8; 7.0	9	540	†
θ	Ori	05 32.8	−05 25	5.4;6.8; 6.8; 7.9; O	13, 17	540	Trapezium
β	Mon	06 26.4	−07 00	4.7B2; 5.2; 5.6	7, 25	470	†
12	Lyn	06 41.8	+59 30	5.3A2; 6.2; 7.4	1.7, 8	180	†
α	CMa	06 43.0	−16 39	−1.6A0; 8.5F	11	9	50y; 20AU
δ	Gem	07 17.1	+22 05	3.5F0; 8.0M0	6.8	58	†
α	Gem	07 31.4	+32 00	2.0A0; 2.8A0; 9M10	4, 70	47	340y; 79AU
ζ	Cnc	08 09.3	+17 48	5.6G0; 6.0; 6.2	1, 5	78	60y; 21AU
γ	Leo	10 17.2	+20 06	2.6K0; 3.8G5	4	160	400y
ξ	UMa	11 15.5	+31 48	4.4G0; 4.9G0	2	25	††60y; 20AU
ι	Leo	11 21.3	+10 48	4.1F3; 6.8F3	2	69	
γ	Vir	12 39.1	−01 10	3.6F0; 3.7F0	6	34	171y; 42AU
α	CVn	12 53.7	+38 35	2.9A0; 5.4A0	20	140	††
ζ	UMa	13 21.9	+55 11	2.4A2; 4.0A2	14	78	††
π	Boo	14 38.4	+16 38	4.9A0; 5.1A0	6	360	†
ε	Boo	14 42.8	+27 17	2.7K0; 5.1A0	3	220	
ξ	Boo	14 49.1	+19 18	4.8G5; 6.7	3	22	151y; 31AU
δ	Ser	15 32.4	+10 42	4.2F0; 5.2F0	4	170	
ξ	Sco	16 01.6	−11 14	5.1F3; 4.8; 7G7	1, 7	84	44.7y; 19AU
α	Her	17 12.4	+14 27	var.M5; 5.4G	5	540	†
δ	Her	17 13.0	+24 54	3.2A0; 8.1G2	11	100	† Optical
ε	Lyr	18 42.7	+39 37	5.1, 6.0A3; 5.1, 5.4A5	3, 2	200	Pairs 207″
β	Cyg	19 28.7	+27 51	3.2K0; 5.4B9	34	410	†
α	Cap	20 14.9	−12 40	3.8G5; 4.6G0	376		Optical
γ	Del	20 44.3	+15 57	4.5G5; 5.5F8	10	110	
61	Cyg	21 04.6	+38 30	5.6K5; 6.3K5	23	11	
β	Cep	21 28.1	+70 20	var.B1; 8.0A3	14	540	†
ζ	Aqr	22 26.2	−00 17	4.4F2; 4.6F1	3	140	
δ	Cep	22 27.3	+58 10	var.G0; 7.5A0	41	650	
8	Lac	22 33.6	+39 23	5.8B3; 6.5B5	22	1100	†
σ	Cas	23 56.5	+55 29	5.1B2; 7.2B3	3	820	

† or ††, one, or two of the components are themselves very close visual double or more generally, spectroscopic binaries.

STAR CLUSTERS

The star clusters for this observing list have been selected to include the more conspicuous members of the two main classes—open clusters and globular clusters. Most of the data are from Shapley's *Star Clusters* and from Trumpler's catalogue in Lick Bulletin No. 420. In the following table *N.G.C.* indicates the serial number of the cluster in the New General Catalogue of Clusters and Nebulae; *M*, its number in Messier's catalogue; *Con.*, the constellation in which it is located; α and δ, its right ascension and declination; *Cl.*, the kind of cluster, *Op* for open or galactic and *Gl* for globular; *Diam.*, the apparent diameter in minutes of arc; *Mag. B.S.*, the magnitude of the fifth brightest star in the case of open clusters, the mean of the 25 brightest for globulars; *No.*, the number of stars in the open clusters down to the limiting magnitudes of the photographs on which the particular clusters were studied; *Int. mag.*, the total apparent magnitude of the globular clusters; and *Dist.*, the distance in light years.

N.G.C.	M	Con.	α 1960 h m	δ ° ′	Cl.	Diam. ′	Mag. B.S.	No.	Int. mag.	Dist l.y.
869		h Per	02 16.2	+56 58	Op	30	7			4,300
884		χPer	02 19.6	+56 56	Op	30	7			4,300
1039	34	Per	02 39.4	+42 37	Op	30	9	80		1,500
Pleiades	45	Tau	03 45.1	+23 59	Op	120	4.2	250		490
Hyades		Tau	04 18	+15 31	Op	400	4.0	100		120
1912	38	Aur	05 26.0	+35 48	Op	18	9.7	100		2,800
2099	37	Aur	05 49.7	+32 33	Op	24	9.7	150		2,700
2168	35	Gem	06 06.4	+24 21	Op	29	9.0	120		2,700
2287	41	C Ma	06 45.3	−20 42	Op	32	9	50		1,300
2632	44	Cnc	08 37.8	+20 07	Op	90	6.5	350		490
5139		ωCen	13 24.3	−47 16	Gl	23	12.9		3	22,000
5272	3	C Vn	13 40.4	+28 35	Gl	10	14.2		4.5	40,000
5904	5	Ser	15 16.5	+02 13	Gl	13	14.0		3.6	35,000
6121	4	Sco	16 21.2	−26 26	Gl	14	13.9		5.2	24,000
6205	13	Her	16 40.2	+36 32	Gl	10	13.8		4.0	34,000
6218	12	Oph	16 45.2	−01 53	Gl	9	14.0		6.0	36,000
6254	10	Oph	16 55.0	−04 03	Gl	8	14.1		5.4	36,000
6341	92	Her	17 15.9	+43 11	Gl	8	13.9		5.1	36,000
6494	23	Sgr	17 54.6	−19 01	Op	27	10 2	120		2,200
6611	16	Ser	18 16.6	−13 48	Op	8	10.6	55		6,700
6656	22	Sgr	18 34.0	−23 57	Gl	17	12.9		3 6	22,000
7078	15	Peg	21 28.0	+11 59	Gl	7	14.3		5.2	43,000
7089	2	Aqr	21 31.4	−01 00	Cl	8	14.6		5.0	45,000
7092	39	Cyg	21 30.8	+48 15	Op	32	6.5	25		1,000
7654	52	Cas	23 22.4	+61 23	Op	13	11.0	120		4,400

GALACTIC NEBULAE

The galactic nebulae here listed have been selected to include the most readily observable representatives of planetary nebulae such as the Ring Nebula in Lyra, diffuse bright nebulae like the Orion nebula and dark absorbing nebulosities such as the Coal Sack. These objects are all located in our own galactic system. The first five columns give the identification and position as in the table of clusters. In the *Cl* column is given the classification of the nebula, planetary nebulae being listed as *Pl*, diffuse nebulae as *Dif*, and dark nebulae as *Drk*. *Size* indicates approximately the greatest apparent diameter in minutes of arc; and *m n* is the magnitude of the planetary nebula and *m* * is the magnitude of its central star. The distance is given in light years, and the name of the nebula is added for the better known objects.

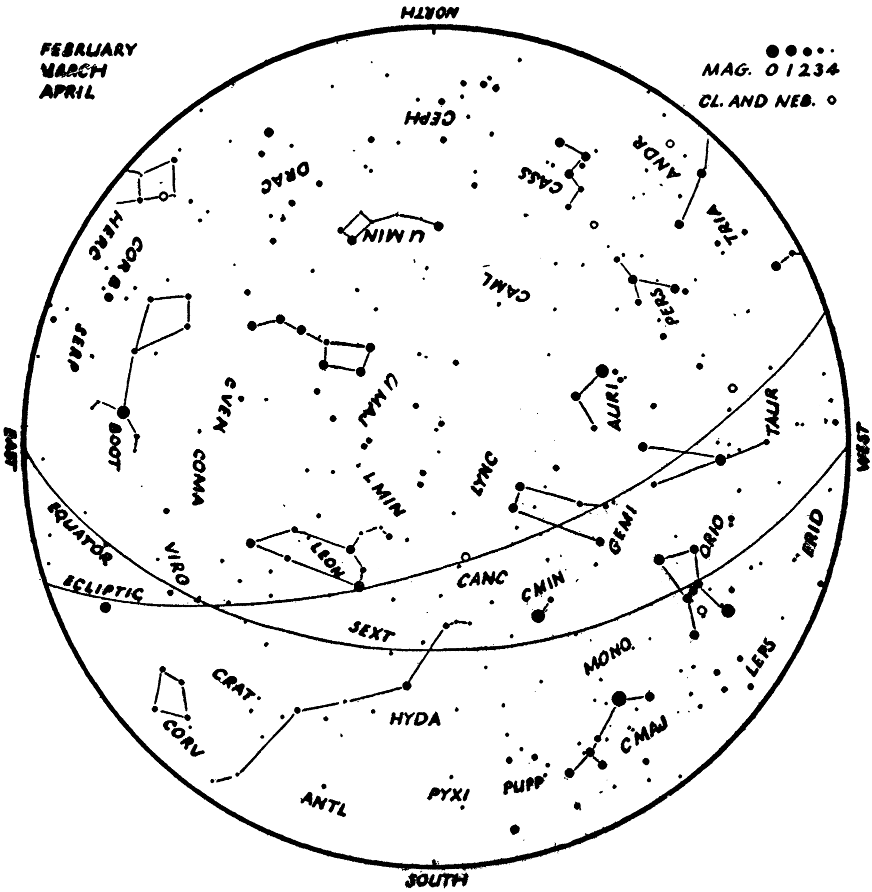
N.G.C.	M	Con	α 1960 h m	δ ° ′	Cl	Size ′	m n	m *	Dist. l.y.	Name
650	76	Per	01 39.7	+51 22	Pl	1.5	11	17	15,000	
1952	1	Tau	05 32.1	+22 00		6	11	16	4,100	Crab
1976	42	Ori	05 33.3	−05 25	Dif	30			1,800	Orion
B33		Ori	05 38.9	−02 29	Drk	4			300	Horsehead
2261		Mon	06 37.0	+08 46	Dif	2				Hubble's var.
2392		Gem	07 26.8	+21 00	Pl	0.3	8	10	2,800	
2440		Pup	07 40.1	−18 07	Pl	0.9	11	16	8,600	
3587	97	UMa	11 12.5	+55 14	Pl	3.3	11	14	12,000	Owl
		Cru	12 49	−63	Drk	300			300	Coalsack
6210		Her	16 42.8	+23 52	Pl	0.3	10	12	5,600	
B72		Oph	17 21.2	−23 35	Drk	20			400	S nebula
6514	20	Sgr	18 00.0	−23 02	Dif	24			3,200	Trifid
B86		Sgr	18 00.5	−27 53	Drk	5				
6523	8	Sgr	18 01.2	−24 23	Dif	50			3,600	Lagoon
6543		Dra	17 58.6	+66 37	Pl	0.4	9	11	3,500	
6572		Oph	18 10.2	+06 50	Pl	0.2	9	12	4,000	
B92		Sgr	18 13.2	−18 15	Drk	15				
6618	17	Sgr	18 18.5	−16 12	Dif	26			3,000	Horseshoe
6720	57	Lyr	18 52.1	+32 59	Pl	1.4	9	14	5,400	Ring
6826		Cyg	19 43.7	+50 26	Pl	0.4	9	11	3,400	
6853	27	Vul	19 57.9	+22 36	Pl	8	8	13	3,400	Dumb-bell
6960		Cyg	20 44.0	+30 34	Dif	60				Network
7000		Cyg	20 57.4	+44 10	Dif	100				N. America
7009		Aqr	21 02.0	−11 32	Pl	0.5	8	12	3,000	
7662		And	23 24.0	+42 19	Pl	0.3	9	13	3,900	

EXTERNAL GALAXIES

Among the hundreds of thousands of systems far beyond our own galaxy relatively few are readily seen in small telescopes. The following list contains a selection of the closer brighter objects of this kind. The first five columns give the catalogue numbers, constellation and position on the celestial sphere. In the column *Cl*, *E* indicates an elliptical nebula, *I* an irregular object, and *Sa*, *Sb*, *Sc* spiral nebulae, in which the spiral arms become increasingly dominant compared with the nucleus as we pass from *a* to *c*. The remaining columns give the apparent magnitude of the nebula, its distance in light years and the radial velocity in kilometers per second. As these objects have been selected on the basis of ease of observation, the faint, very distant objects which have spectacularly large red shifts, corresponding to large velocities of recession, are not included.

N.G.C.	M	Con	α 1960 h m	δ ° ′	Cl	Dimens. ′ ′	Mag.	Distance millions of l.y.	Vel. km / sec
221	32	And	00 40.5	+40 39	E	3×3	8.8	1.6	− 185
224	31	And	00 40.5	+41 03	Sb	160×40	5.0	1.6	− 220
SMC		Tuc	00 53	−72 35	I	220×220	1.5	0.17	+ 170
598	33	Tri	01 31.6	+30 28	Sc	60×40	7.0	1.4	− 70
LMC		Dor	05 21	−69 26	I	430×530	0.5	0.17	+ 280
3031	81	UMa	09 52.4	+69 16	Sb	16×10	8.3	4.8	− 30
3034	82	UMa	09 52.7	+69 53	I	7× 2	9.0	5.2	+ 290
3368	96	Leo	10 44.6	+12 02	Sa	7× 4	10.0	11.4	+ 940
3623	65	Leo	11 16.8	+13 19	Sb	8× 2	9.9	10.0	+ 800
3627	66	Leo	11 18.2	+13 13	Sb	8× 2	9.1	8.6	+ 650
4258		CVn	12 17.0	+47 32	Sb	20× 6	8.7	9.2	+ 500
4374	84	Vir	12 23.0	+13 06	E	3× 2	9.9	12.0	+1050
4382	85	Com	12 23.4	+18 25	E	4× 2	10.0	7.4	+ 500
4472	49	Vir	12 27.8	+08 13	E	5× 4	10.1	11.4	+ 850
4565		Com	12 34.4	+26 12	Sb	15× 1	11.0	15.2	+1100
4594		Vir	12 37.9	−11 24	Sa	7× 2	9.2	14.4	+1140
4649	60	Vir	12 41.7	+11 46	E	4× 3	9.5	15.0	+1090
4736	94	CVn	12 49.0	+41 20	Sb	5× 4	8.4	6.0	+ 290
4826	64	Com	12 54.8	+21 54	Sb	8× 4	9.2	2.6	+ 150
5005		CVn	13 09.0	+37 16	Sc	5× 2	11.1	13.2	+ 900
5055	63	CVn	13 14.0	+42 14	Sb	8× 3	9.6	7.2	+ 450
5194	51	CVn	13 28.2	+47 24	Sc	12× 6	7.4	6.0	+ 250
5236	83	Hya	13 34.8	−29 40	Sc	10× 8	8	5.8	+ 500
6822		Sgr	19 42.7	−14 52	I	20×10	11	2.0	− 150
7331		Peg	22 35.2	+34 12	Sb	9× 2	10.4	10.4	+ 500

STAR MAP I

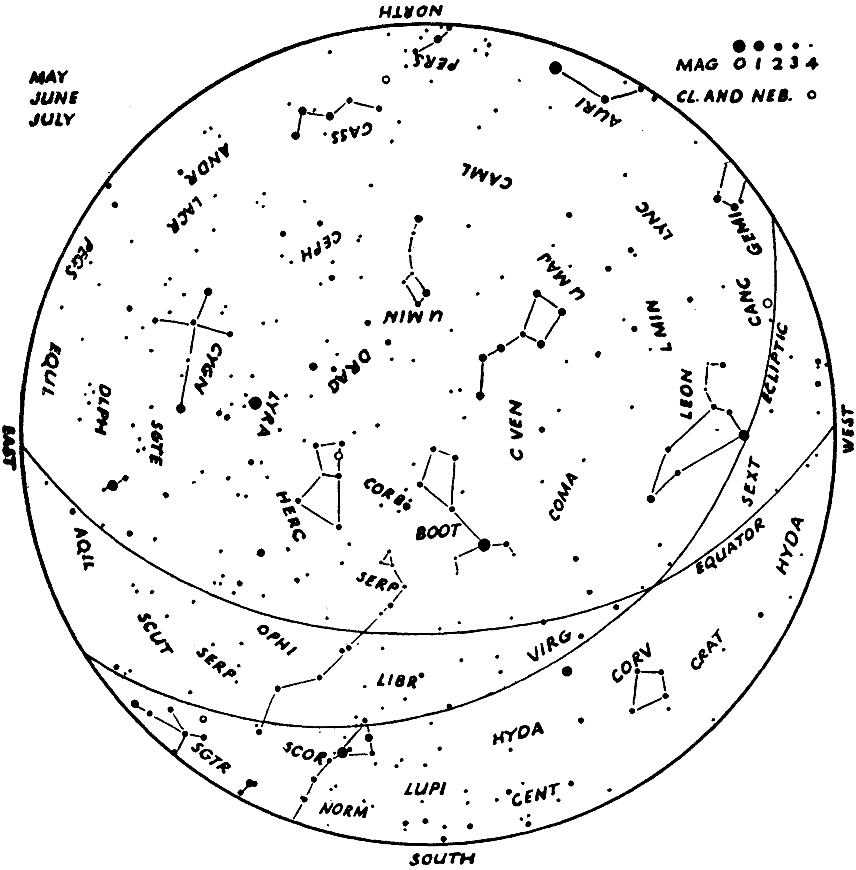


The above map represents the evening sky at

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

The centre of the map is the zenith, the circumference the horizon. To identify the stars hold the map so that the part of the horizon you are facing is down.

STAR MAP 2

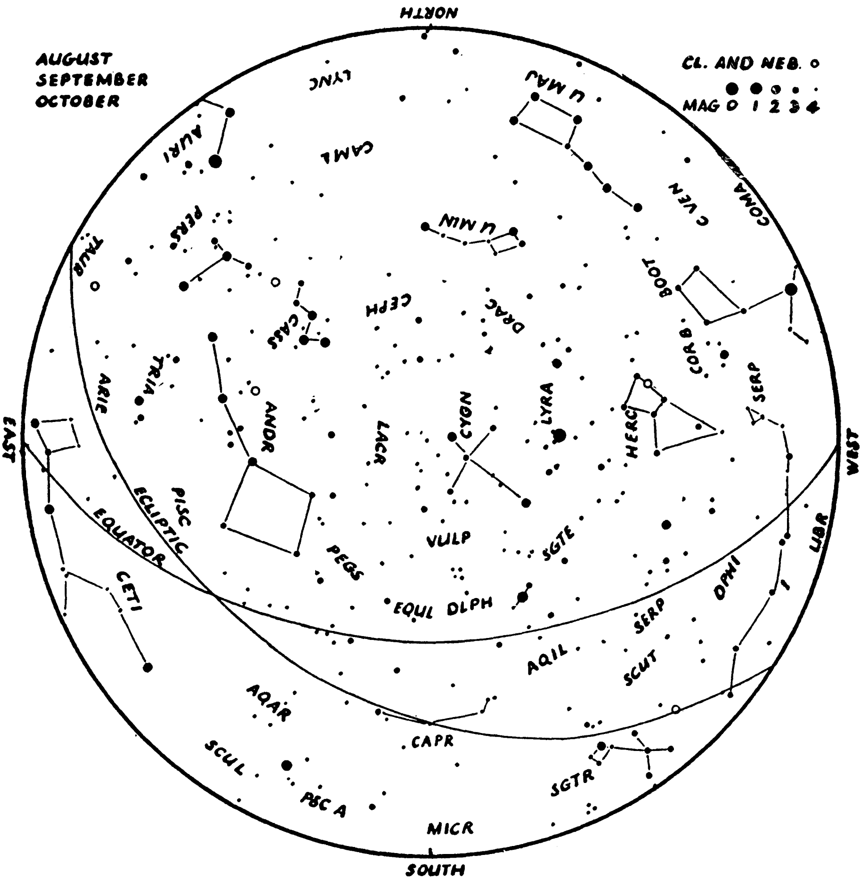


The above map represents the evening sky at

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

The centre of the map is the zenith, the circumference the horizon. To identify the stars hold the map so that the part of the horizon you are facing is down.

STAR MAP 3

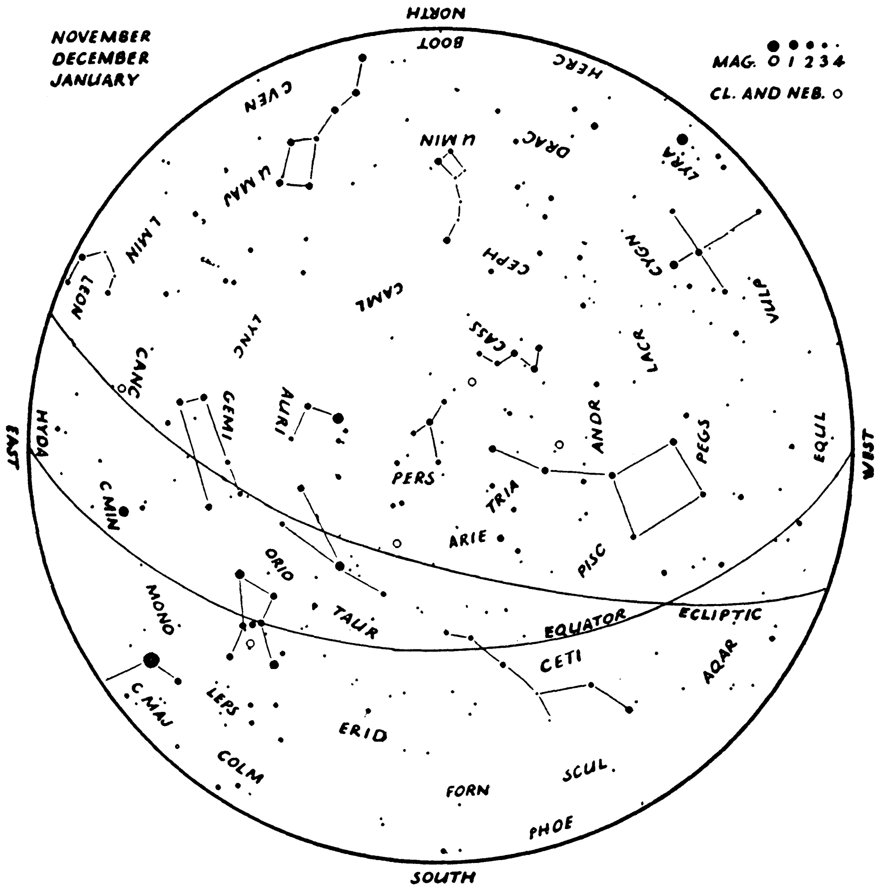


The above map represents the evening sky at

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

The centre of the map is the zenith, the circumference the horizon. To identify the stars hold the map so that the part of the horizon you are facing is down.

STAR MAP 4

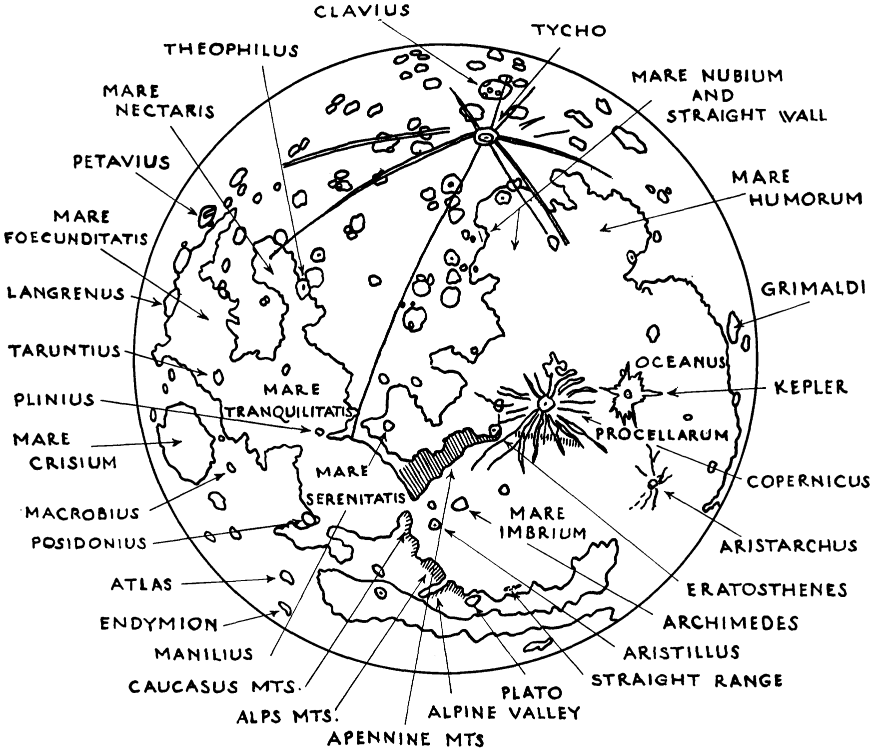


The above map represents the evening sky at

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

The centre of the map is the zenith, the circumference the horizon. To identify the stars hold the map so that the part of the horizon you are facing is down.

MAP OF THE MOON



South appears at the top

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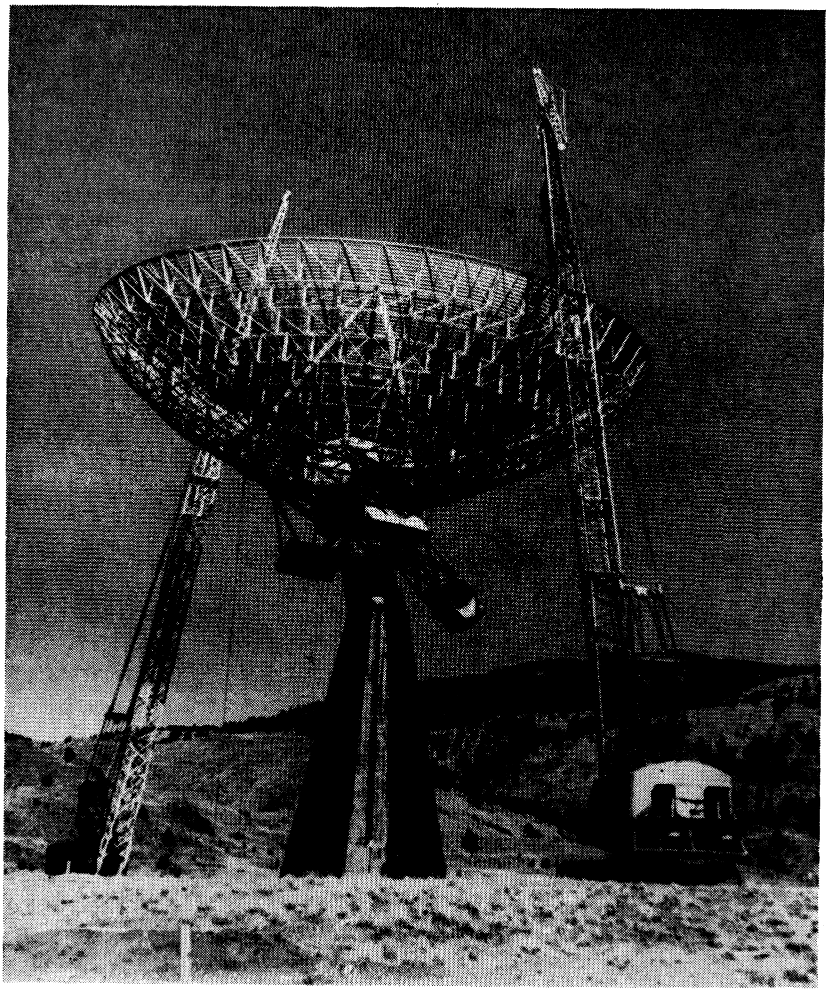

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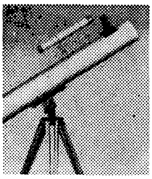

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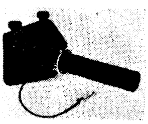

This model uses rolls of No. 127 film. Picture area will be a circle 1-9/16" in diameter. The advantage of this model is the ease of using roll film. With each camera you get a piece of ground glass. Before loading film in camera, you focus the telescope. Then lock it in this position. For positions other than infinity, you can scribe a mark on your tube.

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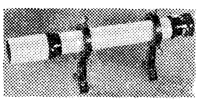

Has crosshairs for exact locating. You focus by sliding objective mount in and out. Base fits any diameter tube—an important advantage. Has 3 centering screws for aligning with main telescope. 20-mm. diam. objective. Weighs less than ½ pound.

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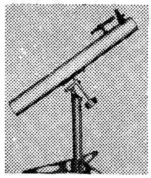

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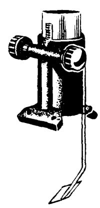

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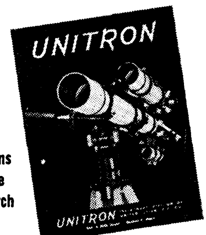

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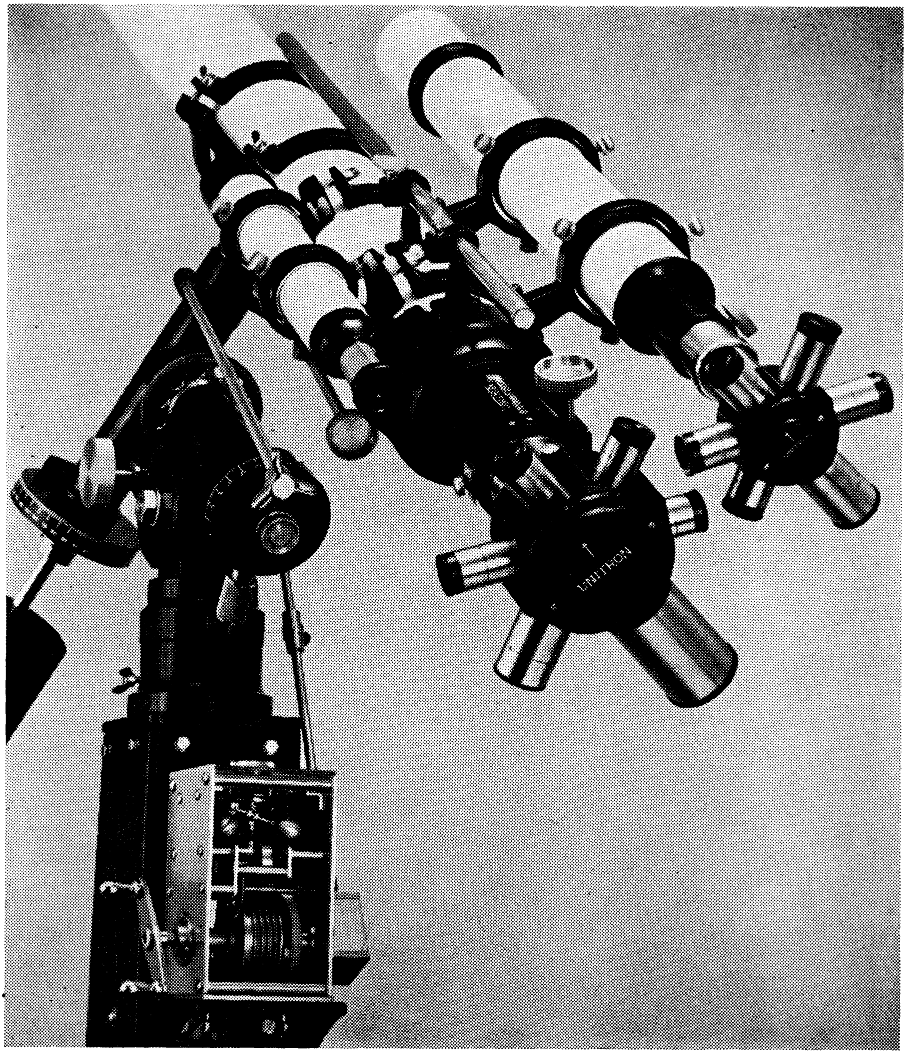

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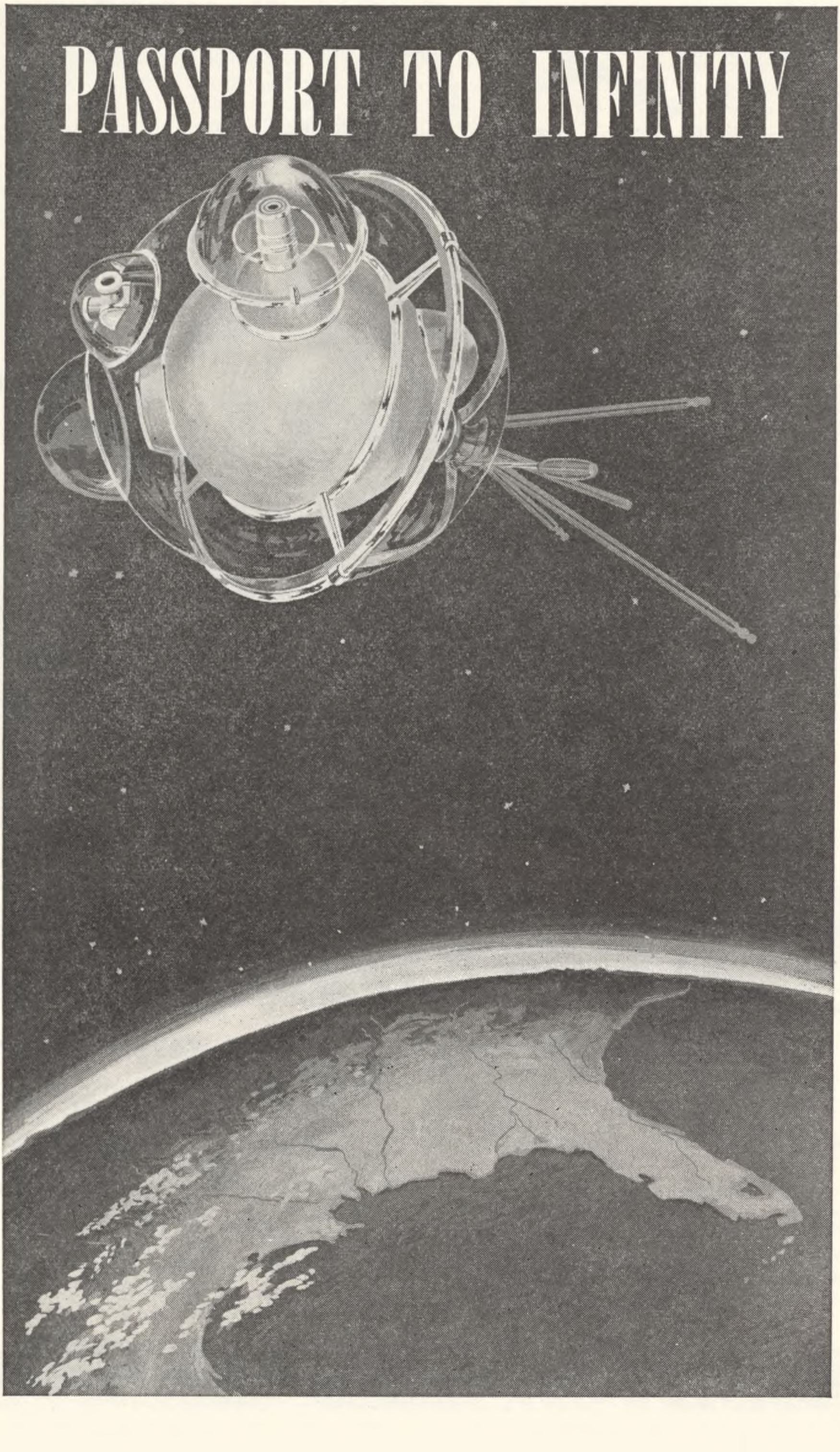
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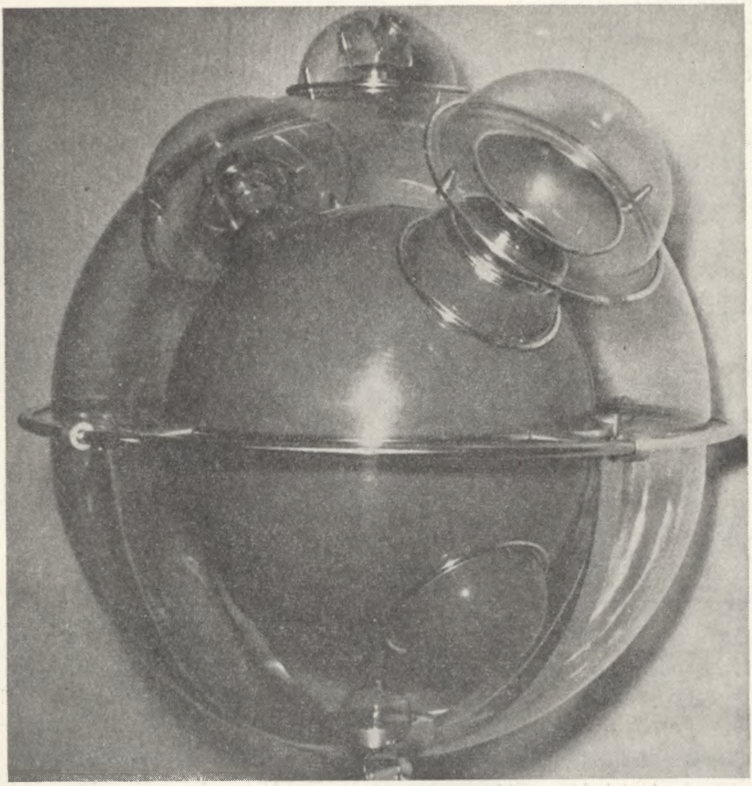

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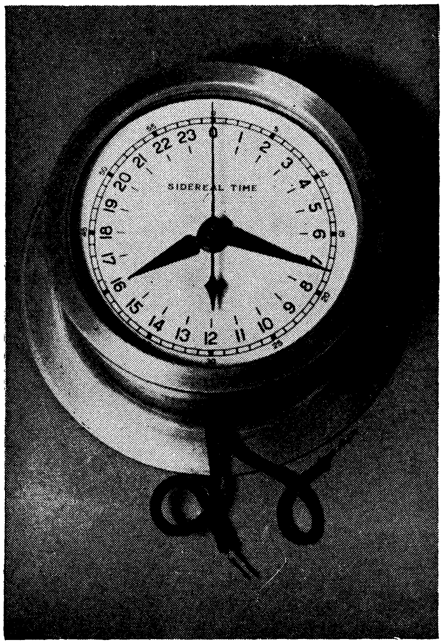

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Jan.

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	....	....	....	....

Feb.

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	....	....	....	....

Mar.

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	....	....	....	....	....

Aug.

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	....	....

Sept.

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

Oct.

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	....	....	....	....

Nov.

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	....	....

Dec.

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	....	....	....	....	....	....

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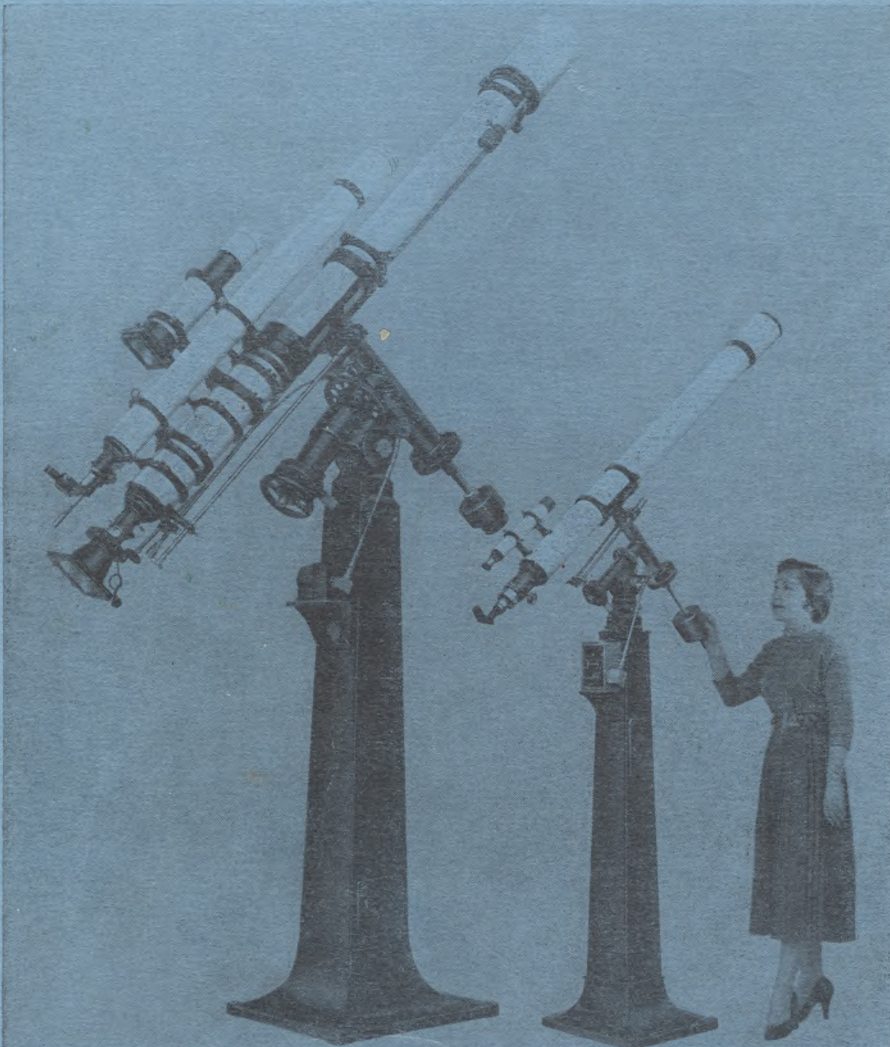

UNITRON'S 6" Refractor on left, 4" on right

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