the OBSERVER'S HANDBOOK 1976

sixty-eighth year of publication

the ROYAL ASTRONOMICAL SOCIETY
of CANADA

editor: JOHN R. PERCY

THE ORIGINS OF THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

In the mid-nineteenth century, in the bustling Lake Ontario port city of Toronto, there were no professional astronomers. However, many inhabitants of the city were keenly interested in sciences and current developments in them. King's College, which grew into the University of Toronto, had been started in 1842. In 1849 it had 36 undergraduates attending, and had graduated a total of 55 students in the three faculties of arts, law and medicine. The Toronto Magnetic Observatory had been established in 1840. Its early directors and observers were officers and soldiers in garrison. Some of them, such as Captain J. F. Lefroy, contributed much to the cultural life of the city. Out of this body of interest came the Canadian Institute established in 1849 "to promote those pursuits which are calculated to refine and exalt a people".

Besides holding weekly meetings, the Canadian Institute accumulated an outstanding library. There many hours were spent in study by Andrew Elvins who had come to Canada from Cornwall in 1844. In 1860 he moved to Toronto, with a population then of 44,000, and became chief cutter in a well known clothing store on King Street. While the Canadian Institute held discussion meetings of all sciences, Elvins wished to concentrate on astronomy. For this purpose he gathered together a few like-minded friends.

On December 1, 1868 The Toronto Astronomical Club met for the first time, at the Elvins' home, "having for its object the aiding of each other in the pursuit of astronomical knowledge". The thousands of meteor sightings of the Leonid showers made in Toronto in November 1867 and 1868 had doubtless encouraged the project. In May, 1869 the word "Club" was changed to "Society". Written records were kept for the first year, until the secretary moved away. After that, the group met only sporadically, but by the distribution of materials Elvins kept interest alive.

As the century wore on, Elvins, who lived till 1918, acquired more kindred spirits, some of them influential and prominent. As a result, on March 10, 1890 the organization was incorporated as The Astronomical and Astrophysical Society of Toronto. In May, 1900 chiefly through the efforts of one of the important early members George E. Lumsden, the name was changed to The Toronto Astronomical Society. On March 3, 1903 through legal application the name took on its current form, The Royal Astronomical Society of Canada. For many years the Society had its offices and library in the Canadian Institute buildings, and held meetings there.

Early in the 1890's, Dr. Clarence A. Chant of the University of Toronto became deeply interested in the Society. The impetus which he gave to it until his death in 1956 still lingers. During its first fifteen years the Society published annually volumes containing its Transactions and Annual Report. In 1907 Dr. Chant started The Journal of the Royal Astronomical Society of Canada, and this Handbook, called then "The Canadian Astronomical Handbook". It is a remarkable fact that at the time of his death Dr. Chant had been the Editor of both the Journal and the Handbook for exactly 50 years. During this period he received generous assistance from many of the Society's members. At times the Journal was published monthly, but currently it is bi-monthly.

The change of name in 1903 led immediately to the concept that the Society should not be limited to Toronto, but should become national in scope. The second Centre to be established was that of Ottawa in 1906, where the Dominion Observatory was being established. Now the Society has 18 Centres from sea to sea across Canada, as listed elsewhere in this Handbook. The growth in membership to nearly 3000 also shows its flourishing state.

HELEN SAWYER HOGG

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252 College Street, Toronto M5T 1R7, Canada

editor: JOHN R. PERCY

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

Incorporated 1890 – Royal Charter 1903 – Federally Incorporated 1968

The National Office of the Society is located at 252 College Street, Toronto, Ontario M5T 1R7; the business office, reading room and astronomical library are housed here.

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

Publications of the Society are free to members, and include the JOURNAL (6 issues per year) and the OBSERVER'S HANDBOOK (published annually in November). Annual fees of $12.50 ($7.50 for persons under 18 years) are payable October 1 and include the publications for the following calendar year.

INDEX

Algol, Minima/35–57, 98
Anniversaries, Festivals/3
Appulses/60
Asteroids/74–75
Calendar/Inside Back Cover
Clusters/106–107
Comets/80
Constellations/5
Coordinates/4
Delta Cephei/98, 109
Eclipses/59
Galaxies/108–109
Greek Alphabet/4
Impact Craters/81–82
Julian Day Calendar/11
Jupiter, General/29
Jupiter, Belts, Zones/79
Jupiter, Long. Central Meridian/76
Jupiter, Satellites, Configurations/ 35–57
Jupiter, Satellites, Phenomena/77–79
Mars, General/28
Mars, Long. Central Meridian/73
Mars, Map/73
Mercury/28
Messier's Catalogue/105
Meteors/80–81
Miscellaneous Ast. Data/6
Moon, Observation/32
Moon, Map/72
Moon, Rise and Set/22–27
Nebulae, Galactic/104
Neptune/31
Occultations, Grazing/68–71
Occultations, Lunar/61–66
Occultations, Planetary/60
Planets, General/28–31
Planets, Elements/8
Pluto/31
Precession/84
Radio Sources/110
Satellites, Solar System/9
Saturn/29
Saturn, Satellites/83
Sky Month By Month/33–57
Solar System, Elements/8
Solar System. Satellites/9
Star Maps/111–116
Stars, Brightest/86–96
Stars, Clusters/106–107
Stars, Double/97
Stars, Names/85
Stars, Nearest/102–103
Stars, Variable/98–101, 109
Sun, Ephemeris/7
Sun, Physical Observations/58
Sun, Rise and Set/14–20
Sun, Sunspots/59
Symbols, Terminology/4
Time, Correction to Sundial/7
Time, Radio Time Signals/11
Time, Solar, Sidereal etc./10
Time Zones, Map/12
Twilight/21
Uranus/29
Venus/28
Visiting Hours/13

THE OBSERVER'S HANDBOOK 1976

THE OBSERVER'S HANDBOOK for 1976 is the sixty-eighth edition. I wish to thank all those who assisted in its preparation: those whose names appear in the various sections, those mentioned below, and especially my editorial assistant, John F. A. Perkins.

There are several major changes in this year's HANDBOOK. You will notice that the HANDBOOK no longer carries advertisements. The decision to discontinue advertisements was made by the Council of the Society, in order for the HANDBOOK to qualify (under federal law) as a non-commercial publication. We thank our advertisers for their support over the years.

The pages which were previously occupied by advertisements have been used to ease the crowding of material in the various sections, and to accommodate new material. There is now a set of six new star maps, drawn by John Perkins, and two extra pages of material on variable stars, provided by Janet Mattei of the A.A.V.S.O. Dr. John F. Heard has expanded his descriptions of "The Sky Month By Month", and Dr. Helen S. Hogg has provided a capsule history of the Society, on the inside front cover.

My thanks go to Dr. Ian Halliday for revising the page of "Miscellaneous Astronomical Data", to Dr. Cecil Costain for providing information on standard time zones, to Drs. Donald MacRae, C. T. Bolton and R. F. Garrison for revising the section on "The Brightest Stars", and to many readers of the HANDBOOK for spotting errors and inaccuracies and for making helpful suggestions. Special thanks also go to Maude Towne and Isabel Williamson, who have calculated the tables of moonrise and moonset for many years and who are now retiring from this onerous but important task. The David Dunlap Observatory and Erindale College, University of Toronto, have once again provided financial, technical and moral support for the HANDBOOK.

Finally, my deep indebtedness to H.M. Nautical Almanac Office (particularly Leslie V. Morrison, Gordon E. Taylor and Superintendent Dr. G. A Wilkins) and to the *American Ephemeris* is gratefully acknowledged.

JOHN R. PERCY

ANNIVERSARIES AND FESTIVALS, 1976

New Year's Day	Thur.	Jan. 1
Epiphany	Tues.	Jan. 6
Accession of Queen Elizabeth (1952)	Fri.	Feb. 6
Septuagesima Sunday		Feb. 15
Quinquagesima (Shrove) Sunday		Feb. 29
St. David	Mon.	Mar. 1
Ash Wednesday		Mar. 3
St. Patrick	Wed.	Mar. 17
Palm Sunday		Apr. 11
First Day of Passover	Thur.	Apr. 15
Good Friday		Apr. 16
Easter Sunday		Apr. 18
Birthday of Queen Elizabeth (1926)	Wed.	Apr. 21
St. George	Fri.	Apr. 23
Rogation Sunday		May 23
Victoria Day	Mon.	May 24
Ascension Day	Thur.	May 27
Pentecost (Whit Sunday)		June 6
Trinity Sunday		June 13
Corpus Christi	Thur.	June 17
St. John Baptist (Mid-Summer Day)	Thur.	June 24
Dominion Day	Thur.	July 1
Birthday of Queen Mother Elizabeth (1900)	Wed.	Aug. 4
Labour Day	Mon.	Sept. 6
Jewish New Year (Rosh Hashanah)	Sat.	Sept. 25
St. Michael (Michaelmas Day)	Wed.	Sept. 29
Yom Kippur	Mon.	Oct. 4
Thanksgiving	Mon.	Oct. 11
All Saints' Day	Mon.	Nov. 1
Remembrance Day	Thur.	Nov. 11
First Sunday in Advent		Nov. 28
St. Andrew	Tues.	Nov. 30
Christmas Day	Sat.	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

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

CO-ORDINATE SYSTEMS AND TERMINOLOGY

Astronomical positions are usually measured in a system based on the *celestial poles* and *celestial equator*, the intersections of the earth's rotation axis and equatorial plane, respectively, and the infinite sphere of the sky. *Right ascension* (R.A. or α) is measured in hours (h), minutes (m) and seconds (s) of time, eastward along the celestial equator from the *vernal equinox. Declination* (Dec. or δ) is measured in degrees (°), minutes (′) and seconds (″) of arc, northward (N or +) or southward (S or −) from the celestial equator toward the N or S celestial pole. One hour of time equals 15 degrees.

Positions can also be measured in a system based on the *ecliptic*, the intersection of the earth's orbit plane and the infinite sphere of the sky. The sun appears to move eastward along the ecliptic during the year. *Longitude* is measured eastward along the ecliptic from the vernal equinox; *latitude* is measured at right angles to the ecliptic, northward or southward toward the N or S ecliptic pole. The *vernal equinox* is one of the two intersections of the ecliptic and the celestial equator; it is the one at which the sun crosses the celestial equator moving from south to north.

Objects are *in conjunction* if they have the same longitude or R.A., and are *in opposition* if they have longitudes or R.A.'s which differ by 180°. If the second object is not specified, it is assumed to be the sun. For instance, if a planet is "in conjunction", it has the same longitude as the sun. At *superior conjunction*, the planet is more distant than the sun; at *inferior conjunction*, it is nearer.

If an object crosses the ecliptic moving northward, it is at the *ascending node* of its orbit; if it crosses the ecliptic moving southward, it is at the *descending node*.

Elongation is the difference in longitude between an object and a second object (usually the sun). At conjunction, the elongation of a planet is thus zero.

THE CONSTELLATIONS

Latin Names with Pronunciations and Abbreviations

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

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

MISCELLANEOUS ASTRONOMICAL DATA

Units of Length

1 Angstrom unit	$= 10^{-8}$ cm	1 micrometre, μ	$= 10^{-4}$ cm $= 10^{4}$A.
1 inch	= exactly 2.54 centimetres	1 cm = 10 mm	= 0.39370 ... in
1 yard	= exactly 0.9144 metre	1 m $= 10^{2}$ cm	= 1.0936 .... yd
1 mile	= exactly 1.609344 kilometres	1 km $= 10^{5}$ cm	= 0.62137 ... mi

1 astronomical unit $= 1.4960 \times 10^{13}$ cm $= 1.496 \times 10^{8}$ km $= 9.2956 \times 10^{7}$ mi
1 light-year $= 9.461 \times 10^{17}$ cm $= 5.88 \times 10^{12}$ mi = 0.3068 parsecs
1 parsec $= 3.086 \times 10^{18}$ cm $= 1.917 \times 10^{13}$ mi = 3.262 l.y.
1 megaparsec $= 10^{6}$ parsecs

Units of Time

Sidereal day = $23h\ 56m\ 04.09s$ of mean solar time
Mean solar day = $24h\ 03m\ 56.56s$ of mean sidereal time
Synodic month = $29d\ 12h\ 44m\ 03s = 29^{d}.5306$ Sidereal month = $27d\ 07h\ 43m\ 12s = 27^{d}.3216$
Tropical year (ordinary) = $365d\ 05h\ 48m\ 46s = 365^{d}.2422$
Sidereal year = $365d\ 06h\ 09m\ 10s = 365^{d}.2564$
Eclipse year = $346d\ 14h\ 52m\ 52s = 346^{d}.6200$

The Earth

Equatorial radius, a = 6378.164 km = 3963.21 mi: flattening, $c = (a - b)/a = 1/298.25$
Polar radius, b = 6356.779 km = 3949.92 mi
1° of latitude $= 111.133 - 0.559 \cos 2\phi$ km $= 69.055 - 0.347 \cos 2\phi$ mi (at lat. ϕ)
1° of longitude $= 111.413 \cos\phi - 0.094 \cos 3\phi$ km $= 69.229 \cos\phi - 0.0584 \cos 3\phi$ mi
Mass of earth $= 5.976 \times 10^{24}$ kgm $= 13.17 \times 10^{24}$ lb
Velocity of escape from $\oplus$ = 11.2 km/sec = 6.94 mi/sec

Earth's Orbital Motion

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

Solar Motion

Solar apex, R.A. $18h\ 04m$, Dec. + 30°; solar velocity = 19.75 km/sec = 12.27 mi/sec

The Galactic System

North pole of galactic plane R.A. $12h\ 49m$, Dec. + 27.°4 (1950)
Centre of galaxy R.A. $17h\ 42.4m$, Dec. − 28° 55′ (1950) (zero pt. for new gal. coord.)
Distance to centre ~ 10,000 parsecs; diameter ~ 30,000 parsecs
Rotational velocity (at sun) ~ 250 km/sec
Rotational period (at sun) $\sim 2.46 \times 10^{8}$ years
Mass $\sim 1.4 \times 10^{11}$ solar masses

External Galaxies

Red Shift ~ + 75 km/sec/megaparsec ~ 14 miles/sec/million l.y.

Radiation Constants

Velocity of light, $c = 2.997925 \times 10^{10}$ cm/sec = 186,282.1 mi/sec
Frequency, $\nu = c/\lambda$; ν in Hertz (cycles per sec), c in cm/sec, λ in cm
Solar constant = 1.950 gram calories/square cm/minute $= 1.36 \times 10^{6}$ cgs units
Light ratio for one magnitude = 2.512 . . . ; log ratio = exactly 0.4
Stefan's constant $= 5.66956 \times 10^{-5}$ cgs units

Miscellaneous

Constant of gravitation, $G = 6.6727 \times 10^{-8}$ cgs units
Mass of the electron, $m = 9.1096 \times 10^{-28}$ gm: mass of the proton $= 1.6727 \times 10^{-24}$ gm
Planck's constant, $h = 6.6262 \times 10^{-27}$ erg sec
Absolute temperature $= T°$ K $= T°$ C + 273° = 5/9 ($T°$ F + 459°)

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

SUN—EPHEMERIS AND CORRECTION TO SUN-DIAL

Date	Apparent R.A. 0h E.T.	Apparent Dec. 0h E.T.	Corr. to Sun-dial 12h E.T
	h m s	° ′	m s
Jan. 1	18 42 10	−23 05.2	+ 3 16
4	18 55 25	−22 49.8	+ 4 40
7	19 08 36	−22 30.2	+ 6 01
10	19 21 43	−22 06.8	+ 7 17
13	19 34 44	−21 39.4	+ 8 29
16	19 47 40	−21 08.2	+ 9 34
19	20 00 30	−20 33.4	+10 33
22	20 13 14	−19 55.1	+11 26
25	20 25 51	−19 13.4	+12 12
28	20 38 21	−18 28.6	+12 51
31	20 50 44	−17 40.7	+13 23
Feb. 3	21 02 59	−16 50.0	+13 48
6	21 15 07	−15 56.7	+14 05
9	21 27 08	−15 00.9	+14 15
12	21 39 01	−14 02.8	+14 17
15	21 50 48	−13 02.7	+14 13
18	22 02 27	−12 00.7	+14 02
21	22 14 01	−10 56.9	+13 45
24	22 25 29	− 9 51.5	+13 22
27	22 36 51	− 8 44.9	+12 54
Mar. 1	22 48 09	− 7 37.0	+12 21
4	22 59 21	− 6 28.2	+11 43
7	23 10 30	− 5 18.5	+11 01
10	23 21 35	− 4 08.3	+10 16
13	23 32 37	− 2 57.5	+ 9 28
16	23 43 36	− 1 46.5	+ 8 37
19	23 54 33	− 0 35.4	+ 7 44
22	0 05 29	+ 0 35.7	+ 6 51
25	0 16 25	+ 1 46.6	+ 5 56
28	0 27 20	+ 2 57.2	+ 5 02
31	0 38 15	+ 4 07.2	+ 4 08
Apr. 3	0 49 12	+ 5 16.6	+ 3 15
6	1 00 09	+ 6 25.1	+ 2 23
9	1 11 08	+ 7 32.6	+ 1 32
12	1 22 10	+ 8 39.0	+ 0 44
15	1 33 13	+ 9 44.0	− 0 01
18	1 44 20	+10 47.6	− 0 43
21	1 55 31	+11 49.6	− 1 21
24	2 06 46	+12 49.9	− 1 55
27	2 18 05	+13 48.3	− 2 25
30	2 29 29	+14 44.6	− 2 50
May 3	2 40 58	+15 38.8	− 3 10
6	2 52 31	+16 30.6	− 3 26
9	3 04 09	+17 19.9	− 3 36
12	3 15 52	+18 06.7	− 3 42
15	3 27 41	+18 50.6	− 3 42
18	3 39 34	+19 31.8	− 3 38
21	3 51 33	+20 09.9	− 3 28
24	4 03 36	+20 45.0	− 3 13
27	4 15 45	+21 16.8	− 2 54
30	4 27 57	+21 45.3	− 2 30
June 2	4 40 14	+22 10.5	− 2 03
5	4 52 33	+22 32.1	− 1 33
8	5 04 56	+22 50.2	− 0 59
11	5 17 21	+23 04.7	− 0 24
14	5 29 47	+23 15.5	+ 0 13
17	5 42 15	+23 22.7	+ 0 52
20	5 54 44	+23 26.1	+ 1 31
23	6 07 12	+23 25.8	+ 2 10
26	6 19 41	+23 21.8	+ 2 48
29	6 32 08	+23 14.1	+ 3 25

Date	Apparent R.A. 0h E.T.	Apparent Dec. 0h E.T.	Corr. to Sun-dial 12h E.T
	h m s	° ′	m s
July 2	6 44 33	+23 02.7	+ 4 00
5	6 56 55	+22 47.7	+ 4 33
8	7 09 15	+22 29.2	+ 5 02
11	7 21 30	+22 07.1	+ 5 27
14	7 33 42	+21 41.7	+ 5 48
17	7 45 49	+21 12.9	+ 6 05
20	7 57 52	+20 40.8	+ 6 18
23	8 09 50	+20 05.7	+ 6 25
26	8 21 43	+19 27.5	+ 6 27
29	8 33 30	+18 46.4	+ 6 24
Aug. 1	8 45 12	+18 02.5	+ 6 15
4	8 56 48	+17 16.0	+ 6 01
7	9 08 19	+16 27.0	+ 5 41
10	9 19 45	+15 35.6	+ 5 16
13	9 31 05	+14 41.9	+ 4 46
16	9 42 20	+13 46.2	+ 4 11
19	9 53 31	+12 48.4	+ 3 31
22	10 04 37	+11 48.9	+ 2 47
25	10 15 40	+10 47.6	+ 1 59
28	10 26 39	+ 9 44.8	+ 1 08
31	10 37 34	+ 8 40.6	+ 0 13
Sept. 3	10 48 27	+ 7 35.2	− 0 44
6	10 59 17	+ 6 28.7	− 1 44
9	11 10 05	+ 5 21.2	− 2 46
12	11 20 51	+ 4 12.9	− 3 49
15	11 31 37	+ 3 03.9	− 4 53
18	11 42 23	+ 1 54.5	− 5 57
21	11 53 09	+ 0 44.6	− 7 01
24	12 03 55	− 0 25.5	− 8 04
27	12 14 43	− 1 35.7	− 9 05
30	12 25 33	− 2 45.7	−10 05
Oct. 3	12 36 25	− 3 55.5	−11 02
6	12 47 20	− 5 04.8	−11 56
9	12 58 18	− 6 13.6	−12 47
12	13 09 20	− 7 21.7	−13 34
15	13 20 27	− 8 28.8	−14 16
18	13 31 39	− 9 34.9	−14 52
21	13 42 57	−10 39.8	−15 23
24	13 54 21	−11 43.2	−15 48
27	14 05 51	−12 45.0	−16 07
30	14 17 27	−13 45.1	−16 19
Nov. 2	14 29 10	−14 43.1	−16 24
5	14 41 01	−15 39.0	−16 22
8	14 52 59	−16 32.6	−16 13
11	15 05 04	−17 23.7	−15 56
14	15 17 17	−18 12.1	−15 31
17	15 29 38	−18 57.6	−14 58
20	15 42 07	−19 40.1	−14 18
23	15 54 43	−20 19.4	−13 30
26	16 07 26	−20 55.4	−12 36
29	16 20 16	−21 27.7	−11 35
Dec. 2	16 33 11	−21 56.5	−10 28
5	16 46 12	−22 21.4	− 9 16
8	16 59 18	−22 42.4	− 7 59
11	17 12 29	−22 59.4	− 6 38
14	17 25 43	−23 12.4	− 5 13
17	17 38 59	−23 21.1	− 3 45
20	17 52 18	−23 25.7	− 2 16
23	18 05 38	−23 26.0	− 0 46
26	18 18 57	−23 22.1	+ 0 43
29	18 32 15	−23 14.0	+ 2 12

PRINCIPAL ELEMENTS OF THE SOLAR SYSTEM

MEAN ORBITAL ELEMENTS

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

These elements, for epoch 1960 Jan. 1.5 E.T., are taken from the *Explanatory Supplement to the American Ephemeris and Nautical Almanac.*

PHYSICAL ELEMENTS

Object	Equatorial Diameter km	Oblateness	Mass ⊕=1	Mean Density water =1	Surface Gravity ⊕=1	Rotation Period	Inclination of Equator to Orbit °	Albedo
☉ Sun	1,392,000	0	332,958	1.41	27.9	25^d–35^d†		
☾ Moon	3,476	0	0.0123	3.36	0.16	$27^d\,07^h\,43^m$	6.7	0.067
☿ Mercury	4,865	0	0.055	5.46	0.38	58^d16^h	<7	0.056
♀ Venus	12,110	0	0.815	5.23	0.90	243^d(retro.)	~179	0.76
⊕ Earth	12,756	1/298	1.000	5.52	1.00	$23^h\,56^m\,04^s$	23.4	0.36
♂ Mars	6,788	1/192	0.107	3.93	0.38	24 37 23	24.0	0.16
♃ Jupiter	143,000	1/16	318.0	1.33	2.64	9 50 30	3.1	0.73
♄ Saturn	121,000	1/10	95.2	0.69	1.13	10 14	26.7	0.76
⛢ Uranus	47,000	1/16	14.6	1.56	1.07	10 49	97.9	0.93
♆ Neptune	50,900	1/50	17.3	1.54	1.08	16	28.8	0.62
♇ Pluto	5,500?	?	0.11	5?	0.6?	$6^d9^h17^m$	?	0.14?

†Depending on latitude. For the physical observations of the sun, p. 58, the sidereal period of rotation is 25.38 m.s.d.

SATELLITES OF THE SOLAR SYSTEM

Name	Vis. Mag.	Diam. km	Mean Distance from Planet km/1000	arc sec	Revolution Period d	h	m	Orbit Incl. °	Discovery
SATELLITE OF THE EARTH									
Moon	−12.7	3476	384.5		27	07	43	18–29	
SATELLITES OF MARS									
Phobos	11.6	23	9.3	26	0	07	39	1.0	A. Hall, 1877
Deimos	12.7	13	23.5	63	1	06	18	1.3	A. Hall, 1877
SATELLITES OF JUPITER									
V Amalthea	13.0	(200)	180	59	0	11	57	0.4	E. Barnard 1892
I Io	5.0	3640	422	138	1	18	28	0	Galileo, 1610
II Europa	5.3	3100	671	220	3	13	14	0	Galileo, 1610
III Ganymede	4.6	5270	1,070	351	7	03	43	0	Galileo, 1610
IV Callisto	5.6	4990	1,885	618	16	16	32	0	Galileo, 1610
XIII Leda	20	< 10	10,206	3350	210	14		28.8	C. Kowal, 1974
VI Himalia	14.7	(150)	11,470	3765	250	14		27.6	C. Perrine, 1904
VII Elara	16.0	(50)	11,740	3850	259	16		24.8	C. Perrine, 1905
X Lysithea	18.8	< 20	11,850	3888	263	13		29.0	S. Nicholson, 1938
XII Ananke	18.3	< 20	21,200	6958	631	02		147	S. Nicholson, 1951
XI Carme	18.6	< 20	22,560	7404	692	12		164	S. Nicholson, 1938
VIII Pasiphae	18.1	< 20	23,500	7715	738	22		145	P. Melotte, 1908
IX Sinope	18.8	< 20	23,700	7779	758			153	S. Nicholson, 1914
SATELLITES OF SATURN									
Janus	14	(300)	160	26	0	17	59	0.0	A. Dollfus, 1966
Mimas	12.1	(400)	187	30	0	22	37	1.5	W. Herschel, 1798
Enceladus	11.8	(500)	238	38	1	08	53	0.0	W. Herschel, 1789
Tethys	10.3	(950)	295	48	1	21	18	1.1	G. Cassini, 1684
Dione	10.4	1100	378	61	2	17	41	0.0	G. Cassini, 1684
Rhea	9.7	1600	526	85	4	12	25	0.4	G. Cassini, 1672
Titan	8.4	5800	1,221	197	15	22	41	0.3	C. Huygens, 1655
Hyperion	14.2	(320)	1,481	239	21	06	38	0.4	G. Bond, 1848
Iapetus	11.0v	1500	3,561	575	79	07	56	14.7	G. Cassini, 1671
Phoebe	16.5	(200)	12,960	2096	550	11		150	W. Pickering, 1898
SATELLITES OF URANUS									
Miranda	16.5	(400)	128	9	1	09	56	0	G. Kuiper, 1948
Ariel	14.4	(1400)	192	14	2	12	29	0	W. Lassell, 1851
Umbriel	15.3	(1000)	267	20	4	03	38	0	W. Lassell, 1851
Titania	14.0	(1800)	438	33	8	16	56	0	W. Herschel, 1787
Oberon	14.2	(1600)	587	44	13	11	07	0	W. Herschel, 1787
SATELLITES OF NEPTUNE									
Triton	13.6	4000	354	17	5	21	03	160.0	W. Lassell, 1846
Nereid	18.7	(600)	5600	264	359	10		27.4	G. Kuiper, 1949

Apparent magnitude and mean distance from planet are at mean opposition distance. The inclination of the orbit is referred to the planet's equator; a value greater than 90° indicates retrograde motion.

Apparent magnitudes and most of the diameters are from data presented at the IAU Colloquium on Planetary Satellites, Cornell University, August 1974, as printed in *Astronomy* magazine. I thank Mr. R. T. Dickinson for providing this data. The diameters of the smaller satellites are very uncertain, because they depend on assumptions about the albedo of the satellite.

TIME

Any recurring event may be used to measure time. The various times commonly used are defined by the daily passages of the sun or stars caused by the rotation of the earth on its axis. The more uniform revolution of the earth about the sun, causing the return of the seasons, defines ephemeris time. The atomic second has been defined; atomic time has been maintained in various labs, and an internationally acceptable atomic time scale is under discussion.

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

If instead of the sun we use stars, we have *sidereal time*. The sidereal time is zero when the vernal equinox or first point of Aries is on the meridian. As the earth makes one more rotation with respect to the stars than it does with respect to the sun during a year, sidereal time gains on mean time $3^m\ 56^s$ per day or 2 hours per month. Right Ascension (R.A.) is measured east from the vernal equinox, so that the R.A. of a body on the meridian is equal to the sidereal time.

Sidereal time is equal to mean solar time plus 12 hours plus the R.A. of the fictitious mean sun, so that by observation of one kind of time we can calculate the other. Local Sidereal time may be found approximately from Standard or zone time (0 h at midnight) by applying the corrections for longitude (p. 14) and sundial (p. 7) to obtain apparent solar time, then adding 12 h and R.A. sun (p. 7). (Note that it is necessary to obtain R.A. of the sun and correction to sundial at the standard time involved.)

Local mean time varies continuously with longitude. The local mean time of Greenwich, now known as *Universal Time* (UT) is used as a common basis for timekeeping. Navigation and surveying tables are generally prepared in terms of UT. When great precision is required, UT1 and UT2 are used differing from UT by polar variation and by the combined effects of polar variation and annual fluctuation respectively.

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

In Canada and the United States there are 9 standard time zones as follows: Newfoundland (N), $3^h\ 30^m$ slower than Greenwich; 60th meridian or Atlantic (A), 4 hours; 75th meridian or Eastern (E), 5 hours; 90th meridian or Central (C), 6 hours; 105th meridian or Mountain (M), 7 hours; 120th meridian or Pacific (P), 8 hours; 135th meridian or Yukon (Y), 9 hours; 150th meridian or Alaska-Hawaii, 10 hours; and 165th meridian or Bering, 11 hours slower than Greenwich.

The mean solar second, defined as 1/86400 of the mean solar day, has been abandoned as the unit of time because random changes in the earth's rotation make it variable. The unit of time has been redefined twice within the past two decades. In 1956 it was defined in terms of Ephemeris Time (ET) as 1/31,556,925.9747 of the tropical year 1900 January 0 at 12 hrs. ET. In 1967 it was redefined as 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium 133 atom. Ephemeris Time is required in celestial mechanics, while the cesium resonator makes the unit readily available. The difference, ΔT, between UT and ET is measured as a small error in the observed longitude of the moon, in the sense ΔT = ET − UT. The moon's position is tabulated in ET, but observed in UT. ΔT was zero near the beginning of the century, but in 1976 will be about 47 seconds.

RADIO TIME SIGNALS

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

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

Radio time signals readily available in Canada include:

CHU Ottawa, Canada	3330, 7335, 14670 kHz
WWV Fort Collins, Colorado	2.5, 5, 10, 20, 25 MHz
WWVH Maui, Hawaii	2.5, 5, 10, 15 MHz.

JULIAN DAY CALENDAR, 1976

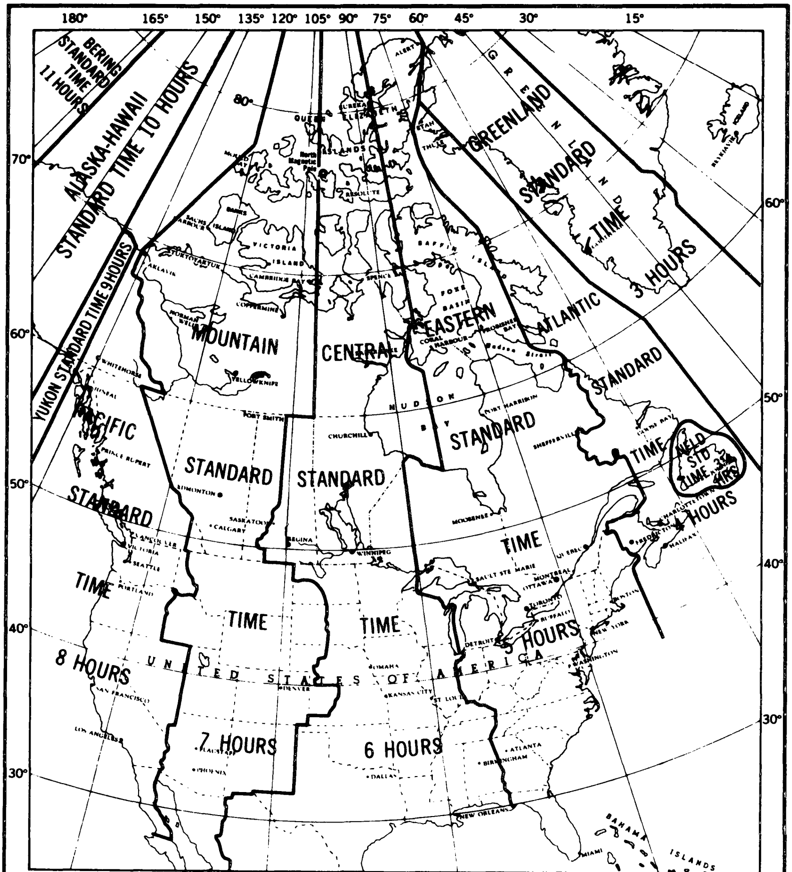
Jan. 1	2442779	May 1	2442900	Sept. 1	2443023
Feb. 1	2442810	June 1	2442931	Oct. 1	2443053
Mar. 1	2442839	July 1	2442961	Nov. 1	2443084
Apr. 1	2442870	Aug. 1	2442992	Dec. 1	2443114

The Julian day commences at noon, so that J.D. 2442779 = Jan. 1.5 U.T. 1976 = 12 hours U.T., Jan. 1, 1976.

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

This system was introduced in 1582 by Josephus Justus Scaliger under the name of the Julian period. The Julian period lasts 7980 years, and is the least common multiple of three cycles: the solar cycle of 28 Julian years, the lunar (or Metonic) cycle of 19 Julian years, and the Roman indiction cycle of 15 years. On Jan. 1, 4713 B.C., all three cycles began together. For more information, see "The Julian Period", by C. H. Cleminshaw in the *Griffith Observer*, April 1975

MAP OF STANDARD TIME ZONES



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

Note: Since the preparation of the above map, the standard time zones have been changed so that all parts of the Yukon Territory now observe Pacific Standard Time. The Yukon Standard Time Zone still includes a small part of Alaska, as shown on the above map.

VISITING HOURS AT SOME CANADIAN OBSERVATORIES

COMPILED BY MARIE LITCHINSKY

Burke-Gaffney Observatory, Saint Mary's University, Halifax, Nova Scotia B3H 3C3.
October-April: Saturday evenings 7:00 p.m.
May-September: Saturday evenings 9:00 p.m.

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

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

Dominion Radio Astrophysical Observatory, Penticton, B.C. V2A 6K3
Sunday, July and August only (2:00–5:00 p.m.).

PLANETARIUMS

The Calgary Centennial Planetarium, Mewata Park, Calgary, Alberta T2P 2M5
Winter: Wed.-Fri., 7:15 and 8:45 p.m. Sat.-Sun., 1:45 (children), 3:00, 7:15 and 8:45 p.m. (Closed Christmas Day, New Year's Day and Good Friday.)
Summer: Daily except Tues., 1:45 (children), 3:00, 4:15, 7:15 and 8:45 p.m.

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

H. R. MacMillan Planetarium, 1100 Chestnut Street, Vancouver, B.C. V6J 3J9.
Sept.-June: Tues.-Wed. 3:00 and 7:30 p.m.; Thurs. 7:30 p.m.; Fri. 7:30 and 9:00 p.m.; Weekends and Holidays, 1:00, 2:30, 4:00, 7:30 and 9:00 p.m.
July-August: Mornings (Tues. to Sat.) 11:30 a.m.
Afternoons (Tues. to Sun.) 1:00, 2:30, 4:00 p.m.
Evenings (Mon. to Sun.) 7:30 and 9:00 p.m.

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

McLaughlin Planetarium, 100 Queen's Park, Toronto, Ont. M5S 2C6.
Tues.-Sun. 1:30, 3:00 and 7:30 p.m. Holidays 1:30 and 3:00 p.m.
Theatre closed on Mondays, except on holidays.

McMaster University, School of Adult Education, GH-122, Hamilton, Ont.
Group reservations only.

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

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

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

TIMES OF RISING AND SETTING OF THE SUN AND MOON

The times of sunrise and sunset for places in latitudes ranging from 30° to 54° are given on pages 15 to 20, and of twilight on page 21. The times of moonrise and moonset for the 5 h meridian are given on pages 22 to 27. The times are given in Local Mean Time, and in the table below are given corrections to change from Local Mean Time to Standard Time for the cities and towns named.

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

The Standard Times for Any Station

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

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

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

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

L		Latitude 30° Sunrise	Latitude 30° Sunset	Latitude 35° Sunrise	Latitude 35° Sunset	Latitude 40° Sunrise	Latitude 40° Sunset	Latitude 44° Sunrise	Latitude 44° Sunset	Latitude 46° Sunrise	Latitude 46° Sunset	Latitude 48° Sunrise	Latitude 48° Sunset	Latitude 50° Sunrise	Latitude 50° Sunset	Latitude 54° Sunrise	Latitude 54° Sunset
		h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
January	**1**	6 56	17 11	7 08	16 59	7 22	16 45	7 35	16 31	7 42	16 24	7 51	16 16	7 59	16 08	8 19	15 47
	3	6 56	17 12	7 09	17 00	7 22	16 46	7 35	16 33	7 42	16 26	7 50	16 18	7 59	16 10	8 19	15 49
	5	6 57	17 14	7 09	17 02	7 22	16 48	7 35	16 35	7 42	16 28	7 50	16 20	7 58	16 12	8 18	15 52
	7	6 57	17 15	7 09	17 04	7 22	16 50	7 35	16 37	7 42	16 30	7 50	16 22	7 57	16 14	8 17	15 54
	9	6 57	17 17	7 09	17 05	7 22	16 52	7 34	16 39	7 41	16 32	7 49	16 24	7 56	16 17	8 16	15 57
	11	6 57	17 18	7 09	17 07	7 21	16 54	7 34	16 41	7 40	16 34	7 48	16 27	7 55	16 19	8 15	16 00
	13	6 57	17.20	7 08	17 09	7 21	16 56	7 33	16 44	7 40	16 37	7 47	16 29	7 54	16 22	8 14	16 03
	15	6 57	17 22	7 08	17 11	7 20	16 58	7 32	16 46	7 39	16 39	7 46	16 32	7 53	16 25	8 12	16 07
	17	6 57	17 23	7 07	17 13	7 19	17 00	7 31	16 49	7 37	16 42	7 44	16 35	7 51	16 28	8 10	16 10
	19	6 56	17 25	7 07	17 15	7 18	17 03	7 30	16 51	7 36	16 45	7 43	16 38	7 50	16 31	8 08	16 14
	21	6 56	17 27	7 06	17 17	7 17	17 05	7 28	16 54	7 35	16 48	7 41	16 41	7 48	16 34	8 05	16 18
	23	6 55	17 28	7 05	17 19	7 16	17 07	7 27	16 57	7 33	16 51	7 40	16 44	7 46	16 38	8 03	16 21
	25	6 54	17 30	7 04	17 21	7 15	17 10	7 25	16 59	7 31	16 54	7 38	16 47	7 44	16 41	8 00	16 25
	27	6 53	17 32	7 03	17 23	7 14	17 12	7 23	17 02	7 29	16 56	7 35	16 50	7 42	16 44	7 57	16 29
	29	6 52	17 34	7 02	17 25	7 12	17 14	7 22	17 05	7 27	16 59	7 33	16 53	7 39	16 47	7 54	16 33
	31	6 51	17 35	7 00	17 27	7 11	17 17	7 20	17 08	7 25	17 02	7 31	16 57	7 36	16 51	7 51	16 37
February	**2**	6 50	17 37	6 59	17 29	7 09	17 20	7 18	17 10	7 23	17 05	7 28	17 00	7 34	16 54	7 47	16 41
	4	6 49	17 39	6 57	17 31	7 07	17 22	7 16	17 13	7 20	17 08	7 26	17 03	7 31	16 58	7 44	16 45
	6	6 48	17 41	6 56	17 33	7 05	17 24	7 13	17 16	7 18	17 11	7 23	17 06	7 28	17 01	7 40	16 49
	8	6 47	17 42	6 54	17 35	7 03	17 27	7 11	17 19	7 15	17 14	7 20	17 09	7 25	17 04	7 36	16 53
	10	6 45	17 44	6 52	17 37	7 00	17 29	7 08	17 21	7 12	17 17	7 17	17 13	7 21	17 08	7 32	16 57
	12	6 43	17 45	6 50	17 39	6 58	17 31	7 05	17 24	7 09	17 20	7 14	17 16	7 18	17 11	7 28	17 01
	14	6 42	17 47	6 48	17 41	6 56	17 34	7 03	17 27	7 06	17 23	7 10	17 19	7 14	17 15	7 24	17 05
	16	6 40	17 48	6 46	17 43	6 53	17 36	6 59	17 29	7 03	17 26	7 07	17 22	7 11	17 18	7 19	17 09
	18	6 38	17 50	6 44	17 45	6 50	17 38	6 56	17 32	7 00	17 29	7 03	17 25	7 07	17 22	7 15	17 13
	20	6 36	17 52	6 42	17 47	6 47	17 40	6 53	17 35	6 56	17 32	7 00	17 29	7 03	17 25	7 11	17 17
	22	6 34	17 53	6 39	17 48	6 45	17 43	6 50	17 38	6 53	17 35	6 56	17 32	7 00	17 29	7 06	17 21
	24	6 32	17 55	6 37	17 50	6 42	17 45	6 47	17 40	6 50	17 38	6 53	17 35	6 56	17 32	7 02	17 25
	26	6 30	17 56	6 35	17 52	6 39	17 47	6 44	17 43	6 46	17 41	6 49	17 38	6 52	17 36	6 57	17 29
	28	6 28	17 57	6 32	17 54	6 36	17 50	6 40	17 46	6 43	17 44	6 45	17 41	6 48	17 39	6 53	17 33

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

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

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

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

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

TWILIGHT—BEGINNING OF MORNING AND ENDING OF EVENING

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

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

MOONRISE AND MOONSET, 1976; LOCAL MEAN TIME

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

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

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

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

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

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

THE PLANETS FOR 1976

MERCURY

Mercury is the smallest planet and the closest to the sun. Like our moon, it has very little atmosphere, and its surface is covered with impact craters. However, Mercury lacks the vast plains or *maria* which are so conspicuous on the moon. The orbit of Mercury is well within that of the earth, and the planet appears to move quickly (hence its name) from one side of the sun to the other, several times in the year. Its greatest elongation (angular distance from the sun) varies from 18° to 28°, and on such occasions it can be seen by the unaided eye for about two weeks. Despite its considerable brilliance it is always viewed in the twilight sky and one must look carefully to see it.

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

Date (U.T.)	Elong. East	Mag.	Date (U.T.)	Elong. West	Mag.
Jan. 7, 05^h	19°	−0.3	Feb. 16, 15^h	26°	+0.2
*Apr. 28, 02^h	21°	+0.4	June 15, 09^h	23°	+0.8
Aug. 26, 10^h	27°	+0.5	*Oct. 7, 16^h	18°	−0.1
Dec. 20, 10^h	20°	−0.3			

VENUS

Since the orbit of Venus lies within that of the earth, its apparent motion is like Mercury's but is much slower and more stately. At inferior conjunction, it comes within 50 million km of the earth, and its nearness and its reflective cloud layer make it the brightest of the planets. In size and structure, it is much like the earth, but it has a thick layer of clouds and a dense, hot atmosphere of carbon dioxide. It is visible to the unaided eye in the daytime, if one knows where to look. In a small telescope, it displays a series of phases like those of the moon.

Venus is easily identified by its great brilliance, though it is not as conspicuous in 1976 as in other years. It was at greatest elongation west (morning sky) late in 1975, and in 1976 it will gradually close in on the sun until mid-May, when it becomes too close to the sun for observation. From late July onwards, it is visible in the evening sky, reaching greatest elongation east in early 1977. Venus is in conjunction with Mars on September 10.

MARS

Since the orbit of Mars is outside that of the earth, its planetary phenomena are quite different from those of Mercury and Venus. At intervals of about 780 days (the synodic period), Mars can be seen in opposition to the sun. Its distance from earth is then smallest and (if Mars is at perihelion) can be as small as 56 million km. Such close approaches occur at intervals of 15 to 17 years; the most recent was in 1971.

The atmosphere of Mars is thin and consists mainly of carbon dioxide; some surface features are distinctly visible in a good telescope. Mariner spacecraft have photographed most of the surface. Much of it is covered by shallow impact craters, but there are also volcanoes, canyons and wind-swept deserts.

Mars—always conspicuous because of its reddish colour—is visible in the evening until early October, when it becomes too close to the sun for observation. On January 1, Mars is in Taurus, and has a magnitude of −1.2 and an apparent diameter of

30 arc sec. On April 7, at 20^h E.S T., it occults ε Gem (see "Planetary Appulses"). On the evening of May 5, still in Gemini, it makes a fine grouping with Saturn and the crescent moon. On May 11, at 21^h E.S.T., it is 1.3° N. of Saturn, the latter being the brighter. On July 5, at 13^h E.S.T., it is 0.7° N. of Regulus in Leo.

JUPITER

Jupiter, the giant of the sun's family, is a fine object for the telescope. Belts of clouds may be observed, interrupted by irregular spots which may be short-lived or persist for weeks. The "great red spot" has been visible for centuries. The flattening of the planet, due to its fast rotation, is conspicuous, and the phenomena of its satellites provide a continual interest. The four largest satellites are of great interest to professional astronomers, who are studying them as intensively as they studied the planets a few years ago.

In early 1976, Jupiter dominates the region of Pisces, in the evening sky. Conjunction occurs on April 27, after which Jupiter moves into the morning sky. In September and October, it is in Taurus, directly between the Hyades and the Pleiades. At opposition on November 18, it has a magnitude of −2.4 and an apparent diameter of about 95 arc sec. By the end of the year, it is visible in the evening sky, sharing the spotlight with Venus.

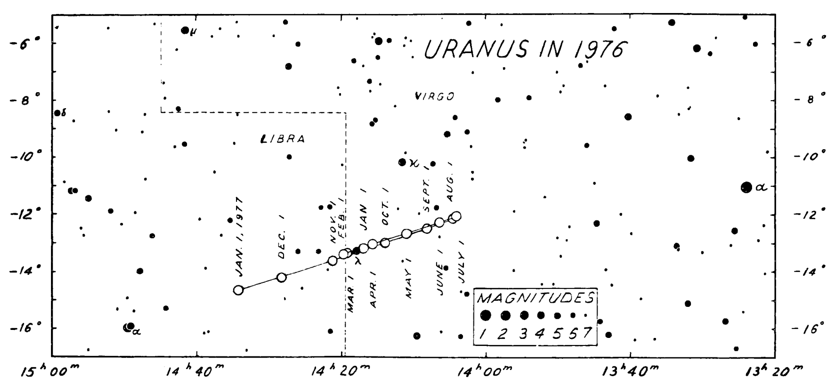
SATURN

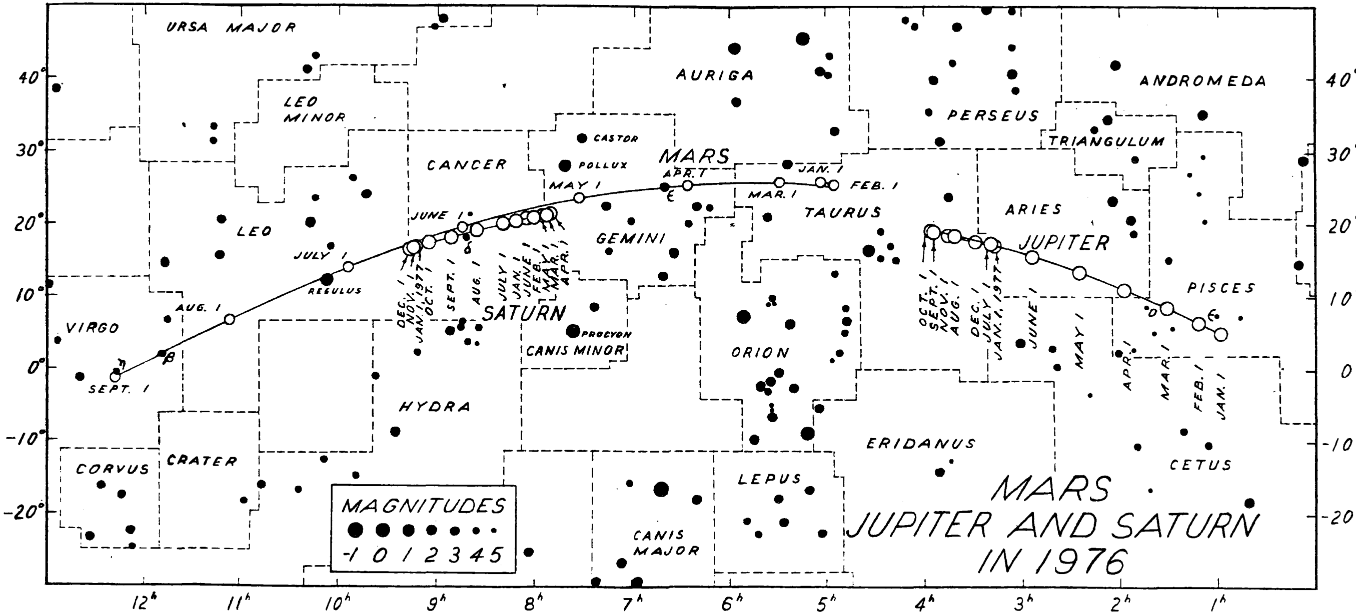
Saturn was the outermost planet known until modern times and, with its unique system of rings, is one of the finest of celestial objects in a good telescope. The plane of the rings makes an angle of 27° with the plane of the planet's orbit, and twice during the planet's revolution period of 29½ years,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

Saturn is at opposition on January 20, when its magnitude is −0.1 and its apparent diameter is 18.5 arc sec. Moving westward through Cancer, it enters Gemini in late winter. On the evening of May 5, it makes a fine grouping with Mars and the crescent moon, and on May 11, at 21^h E.S.T., it is 1.3° S. of Mars. Conjunction occurs on July 29, after which Saturn moves into the morning sky.

URANUS

Although Uranus at opposition can be seen with the unaided eye under a clear, dark sky, it was apparently unknown until 1781, when it was accidentally discovered




MARS
JUPITER AND SATURN
IN 1976
URSA MAJOR
LEO MINOR
LEO
CANCER
GEMINI
AURIGA
PERSEUS
ANDROMEDA
TRIANGULUM
ARIES
TAURUS
PISCES
VIRGO
CORVUS
CRATER
HYDRA
CANIS MINOR
CANIS MAJOR
ORION
LEPUS
ERIDANUS
CETUS
CASTOR
POLLUX
PROCYON
REGULUS
MARS
SATURN
JUPITER
MAGNITUDES
-1 0 1 2 3 4 5

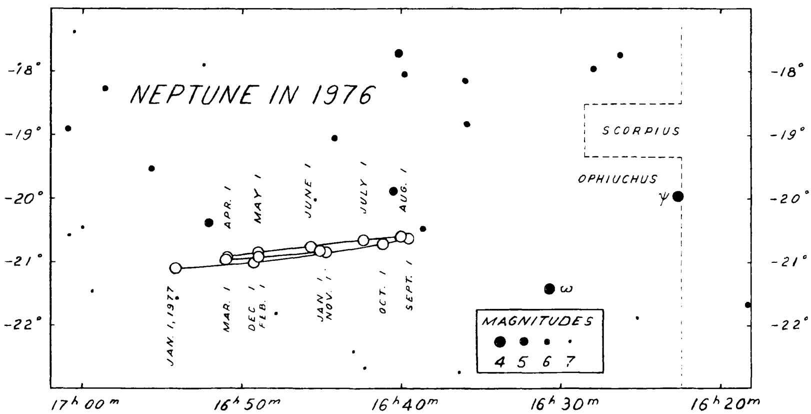
(telescopically) by William Herschel. It can easily be seen with binoculars, and in a telescope it shows a small, greenish, almost featureless disc. Jupiter, Saturn, Uranus and Neptune are rather similar in the sense that their interiors consist mainly of hydrogen and helium; their atmospheres consist of these same elements, and simple compounds of hydrogen.

Throughout most of 1976, Uranus is in Virgo and passes near λ Vir in early January, mid-March and mid-October (see map). At opposition on April 25, its magnitude is +5.7 and its apparent diameter is 3.9 arc sec.

NEPTUNE

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

In 1976, Neptune is far south on the ecliptic, in Ophiuchus (see map) and not well-placed for northern observers. At opposition on June 2 (E.S.T.), its magnitude is +7.7 and its apparent diameter is 2.5 arc sec.



PLUTO

Pluto, the most distant known planet, was discovered at the Lowell Observatory in 1930, as a result of an extensive search started two decades earlier by Percival Lowell. The faint star-like image was first detected by Clyde Tombaugh by comparing photographs taken on different dates. Little is known about the exact mass, radius and density of this planet. It varies in brightness with a period of 6.4 days, apparently due to its rotation.

At opposition on March 30, its astrometric position is R.A. (1950) $13^h04^m.5$, Dec. (1950) $+12°06'$, its apparent magnitude is +14, and its distance from earth is 4440 million km.

THE OBSERVATION OF THE MOON

During 1976 the ascending node of the moon's orbit moves from Libra into Virgo (☊ from 229° to 210°). See p. 61 for occultations of stars.

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

The sun's selenographic colongitude is numerically equal to the selenographic longitude of the sunrise terminator reckoned eastward from the mean centre of the disk. Its value increases at the rate of nearly 12.2° per day or about ½° per hour; it is approximately 270°, 0°, 90° and 180° at New Moon, First Quarter, Full Moon and Last Quarter respectively. (See the tabulated values for 0 h U.T. starting on p. 35.)

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

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

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

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

THE SKY MONTH BY MONTH

By John F. Heard

Introduction—In the monthly descriptions of the sky on the following pages, positions of the sun and planets are given for 0 h Ephemeris Time, which differs only slightly from Standard Time on the Greenwich meridian. The times of transit at the 75th meridian are given in *local mean time*; to change to Standard Time, see p. 14. Estimates of altitude are for an observer in latitude 45° N.

The Sun—The values of the equation of time are for noon E.S.T. on the first and last days of the month. For times of sunrise and sunset and for changes in the length of the day, see pp. 15–20. See also p. 7.

The Moon—Its phases, perigee and apogee times and distances, and its conjunctions with the planets are given in the "Astronomical Phenomena Month by Month" For times of moonrise and moonset, see pp. 22–27.

The Planets—Further information in regard to the planets, including Pluto, is found on pp. 28–31. For the configurations of Jupiter's satellites, see "Astronomical Phenomena Month by Month", and for their eclipses, see p. 77.

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

The configurations have been read from diagrams in the *American Ephemeris and Nautical Almanac*. Where two satellites are nearly coincident, it is difficult to tell the correct order of the satellites from the diagram. Such ambiguous cases are indicated by bold face type: thus **12**304 may actually be **13**204. An hour's observation usually reveals the correct configuration, because the apparent motion of the innermost satellites is much faster than that of the outermost. Also, the four satellites differ slightly in apparent magnitude.

Satellites move from east to west across the face of the planet, and from west to east behind it. Before opposition, shadows fall to the west, and after opposition, to the east.

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

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

and are rounded off to the nearest ten minutes.

THE SKY FOR JANUARY 1976

During this month which follows the winter solstice the days are lengthening as we know, but, as you may notice from a table of sunrise and sunset, the lengthening is not symmetrical; in Toronto, for example, sunrise gets earlier by about 14 minutes, but sunset gets later by about 35 minutes. The explanation? A hint: look at what is happening to the equation of time. Contrast the situation in February.

An hour after sunset at mid-month the summer triangle (Altair, Vega, Deneb) is sinking into the west and Orion, "pride of the winter skies", is rising in the east. Jupiter, Mars and Saturn, lined up between the meridian and the eastern horizon, trace out the ecliptic for us. Have a try at observing Mercury as an evening star early in the month. And if you are awake just before dawn on a clear night you will surely see Venus.

The bright asteroid Ceres is well placed for observation during January, moving through Taurus about halfway between the Pleiades and the Hyades. Look for it with binoculars, referring to the information on pp. 74–75

The Sun—During January the sun's R.A. increases from 18 h 42 m to 20 h 55 m and its Decl. changes from 23° 05′ S. to 17° 24′ S. The equation of time changes from −3 m 22 s to −13 m 25 s. The earth is at perihelion on the 4th at a distance of 147,102,000 km (91,405,000 miles) from the sun.

Mercury on the 1st is in R.A. 20 h 00 m, Decl. 22° 27′ S., and on the 15th is in R.A. 20 h 46 m, Decl. 16° 52′ S During the first half of the month it may be seen as an evening star very low in the south-west just after sunset. Greatest eastern elongation is on the 7th at which time Mercury is about 11 degrees above the south-western horizon at sunset. By the 23rd it is in inferior conjunction.

Venus on the 1st is in R.A. 15 h 51 m, Decl. 17° 52′ S., and on the 15th it is in R.A. 17 h 01 m, Decl. 21° 00′ S., mag. −3.6, and transits at 9 h 28 m. It is prominent in the south-eastern sky for nearly three hours before sunrise.

Mars on the 15th is in R.A. 4 h 53 m, Decl. 25° 43′ N., mag −0.7, and transits at 21 h 14 m. Now a month past opposition and closest approach, Mars has faded by nearly a magnitude but still outshines any nearby stars. In Taurus, it is well up in the east at sunset and sets about three hours before dawn. On the 20th it is stationary in right ascension and resumes eastward motion.

Jupiter on the 15th is in R.A. 1 h 04 m, Decl. 5° 29′ N., mag. −2.0, and transits at 17 h 26 m. In Pisces, it is nearly on the meridian at sunset and sets at about midnight.

Saturn on the 15th is in R.A. 8 h 09 m, Decl. 20° 26′ N., mag −0.1, and transits at 0 h 34 m. In Cancer, it rises about as the sun sets. Opposition is on the 20th.

Uranus on the 15th is in R.A. 14 h 19 m, Decl. 13° 19′ S., and transits at 6 h 39 m.

Neptune on the 15th is in R.A. 16 h 47 m, Decl. 20° 52′ S., and transits at 9 h 10 m.

1976	d	h	m	JANUARY E.S.T.	Min. of Algol h m	Config. of Jupiter's Sat. 19 h E.S.T.	Sun's Selen. Colong. 0 h U.T. °
Thur.	1	09	40	● New Moon		4O132	257.73
Fri.	2				5 50	31O4d	269.92[l]
Sat.	3	01		Mercury 7° S. of Moon		32O14	282.11
Sun.	4	02		Quadrantid meteors		3O24*	294.30
		06		Earth at perihelion			
Mon.	5				2 40	13O24	306.48[b]
Tues.	6					2O134	318.66
Wed.	7	00		Mercury greatest elong. E. (19°)	23 30	21O34	330.83
Thur.	8	07		Venus 7° N. of Antares		O1234	343.00
		12		Moon at apogee (404,410 km)			
Fri.	9	07		Jupiter 4° S. of Moon		13O24	355.17
		07	40	☽ First Quarter			
Sat.	10				20 20	32O41	7.33
Sun.	11			Mercury at ascending node		341O*	19.48
		23		Venus 0.4° N. of Neptune			
Mon.	12	21		Ceres 0.3° N. of Moon. Occ'n.		431O2	31.62
Tues.	13	00		Juno stationary	17 10	42O13	43.76
		15		Mercury stationary			
		22		Mars 5° N. of Moon			
Wed.	14					421O3	55.90
Thur.	15			Mercury at perihelion		4O123	68.03[l]
Fri.	16	23	47	○ Full Moon	14 00	41O32	80.16
Sat.	17	08		Saturn 5° N. of Moon		432O1	92.28
Sun.	18					341O*	104.41
Mon.	19				10 50	3O42d	116.54[b]
Tues.	20	06		Saturn at opposition		2O34*	128.66
		08		Moon at perigee (366,880 km)			
		10		Ceres stationary			
		15		Mars stationary			
Wed.	21	14		Pluto stationary		21O34	140.80
Thur.	22				7 40	O1234	152.94
Fri.	23	01		Mercury in inferior conjunction		1O324	165.09
		02		Spica 0.1° N. of Moon. Occ'n.[1]			
		18	04	☾ Last Quarter			
Sat.	24	02		Uranus 2° N. of Moon		32O14	177.24
Sun.	25				4 30	312O4	189.40
Mon.	26			Mercury at greatest hel. lat. N.		3O124	201.57
		16		Neptune 0.6° S. of Moon. Occ'n.			
Tues.	27					34O**	213.74
Wed.	28	03		Venus 2° S. of Moon	1 20	421O3	225.93
Thur.	29					4O123	238.11[l]
Fri.	30				22 00	41O32	250.30
Sat.	31	01	20	● New Moon		432O1	262.49

[l]Jan. 2, +4.81°; Jan. 15, −5.88°; Jan. 29, +4.86°.
[b]Jan. 5, −6.65°; Jan. 19, +6.54°.
[1]Visible in Central and S. America, S. Atlantic, S. Africa.

THE SKY FOR FEBRUARY 1976

An hour after sunset at mid-month the Great Square of Pegasus is "getting away" in the west; we won't see it easily after this month. Taurus with its brightest star Aldebaran and with the Pleiades is not far from the zenith. Near Aldebaran is Mars; identify them. Which is the brighter now? Watch how Mars' distance eastward from Aldebaran increases at an accelerating rate; by the end of April it will be near Castor and Pollux. South of Taurus is Orion, now best positioned for evening observing. Take a look at the centre star of Orion's sword with binoculars and admire the great Orion Nebula.

The Sun—During February the sun's R.A. increases from 20 h 55 m to 22 h 48 m and its Decl. changes from 17° 24′ S. to 7° 37′ S. The equation of time changes from −13 m 34 s to a maximum of −14 m 17 s on the 12th and then to −12 m 30 s at the end of the month.

Mercury on the 1st is in R.A. 19 h 41 m, Decl. 18° 13′ S., and on the 15th is in R.A. 20 h 05 m, Decl. 19° 44′ S. It is in greatest western elongation on the 16th, so at about this time it might be seen low in the south-east just before sunrise. However, this is an unfavourable elongation, Mercury being only about 9 degrees above the horizon at sunrise.

Venus on the 1st is in R.A. 18 h 30 m, Decl. 22° 19′ S., and on the 15th it is in R.A. 19 h 44 m, Decl. 21° 03′ S., mag. −3.4, and transits at 10 h 09 m. It rises about an hour and a half before the sun and is only about 12 degrees above the south-eastern horizon at sunrise.

Mars on the 15th is in R.A. 5 h 08 m, Decl. 25° 42′ N., mag. +0.2, and transits at 19 h 29 m. In Taurus, it is nearing the meridian at sunset and sets about three hours after midnight. Again it has faded by nearly a magnitude in the past month.

Jupiter on the 15th is in R.A. 1 h 21 m, Decl. 7° 21′ N., mag. −1.8, and transits at 15 h 42 m. In Pisces, it is well past the meridian at sunset and sets before midnight.

Saturn on the 15th is in R.A. 7 h 59 m, Decl. 20 ° 59′ N., mag 0.0, and transits at 22 h 17 m. In Cancer, it is well up in the east at sunset.

Uranus on the 15th is in R.A. 14 h 20 m, Decl. 13° 25′ S., and transits at 4 h 42 m.

Neptune on the 15th is in R.A. 16 h 50 m, Decl. 20° 57′ S., and transits at 7 h 12 m.

1976				FEBRUARY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 20 h E.S.T.	Sun's Selen. Colong. 0 h U.T.
	d	h	m		h m		°
Sun.	1					4312O	274.68[b]
Mon.	2				18 50	43O12	286.88
Tues.	3	13		Mercury stationary		4O**d	299.07
Wed.	4					241O3	311.25
Thur.	5	08		Moon at apogee (405,100 km)	15 40	O1243	323.44
		22		Jupiter 4° S. of Moon			
Fri.	6					1O324	335.61
Sat.	7					23O14	347.79
Sun.	8	05	05	☽ First Quarter	12 30	321O4	359.96
Mon.	9					3O124	12.12
Tues.	10	11		Mars 5° N. of Moon		13O24	24.27
		20		Uranus stationary			
Wed.	11				9 20	2O34d	36.42
Thur.	12					O143*	48.57[l]
Fri.	13	14		Saturn 5° N. of Moon		14O23	60.71
Sat.	14				6 10	423O1	72.84
Sun.	15	11	43	○ Full Moon		4321O	84.98[b]
Mon.	16	10		Mercury greatest elong. W. (26°)		43O12	97.11
		17		Juno 0.02° S. of Moon. Occ'n.			
Tues.	17	05		Moon at perigee (361,310 km)	3 00	431O2	109.24
Wed.	18			Mercury at descending node		42O13	121.38
Thur.	19			Venus at descending node	23 50	4O3**	133.52
		08		Spica 0.1° S. of Moon. Occ'n.[1]			
Fri.	20	08		Uranus 1° N. of Moon		41O23	145.66
Sat.	21					243O1	157.82
Sun.	22	03	16	☾ Last Quarter	20 40	321O4	169.98
		23		Neptune 0.9° S. of Moon. Occ'n.			
Mon.	23					3O124	182.15
Tues.	24					31O24	194.32[l]
Wed.	25				17 30	2O134	206.50
Thur.	26					21O34	218.69
Fri.	27	09		Venus 6° S. of Moon		1O234	230.89
		19		Mercury 7° S. of Moon			
Sat.	28			Mercury at aphelion	14 20	2O314	243.08[b]
Sun.	29	18	25	● New Moon		321O4	255.28

[l]Feb. 12, −7.07°; Feb. 24, +6.06°.
[b]Feb. 1, −6.56°; Feb. 15, +6.53°; Feb. 28, −6.60°.
[1]Visible in S. America.

THE SKY FOR MARCH 1976

This is the month of the vernal equinox. Notice that this happens on March 20 this year. Can you think of a reason why it is "early"? On this day the sun is on the equator and so we say that day and night are equal. Yet if you look at a table of sunrise and sunset for middle latitudes it will appear that the day is about 15 minutes longer than the night. This is partly because sunrise is defined as the moment when the sun's upper limb (rather than its centre) clears the horizon and partly because the refraction of the earth's atmosphere "lifts" the sun a bit. During March, the sunrise and sunset points move northward at the maximum rate. You can easily see this effect by observing the sunrise or sunset point over a period of two or three weeks.

The Sun—During March the sun's R.A. increases from 22 h 48 m to 0 h 42 m and its Decl. changes from 7° 37′ S. to 4° 30′ N. The equation of time changes from −12 m 18 s to −4 m 04 s. On the 20th at 6 h 50 m 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.

Mercury on the 1st is in R.A. 21 h 21 m, Decl. 17° 05′ S., and on the 15th is in R.A. 22 h 46 m, Decl. 10° 17′ S. It is too close to the sun for observation this month.

Venus on the 1st is in R.A. 21 h 01 m, Decl. 17° 29′ S., and on the 15th it is in R.A. 22 h 10 m, Decl. 12° 27′ S., mag. −3.3, and transits at 10 h 39 m. It rises barely an hour before the sun and is only about 9 degrees above the south-eastern horizon at sunrise.

Mars on the 15th is in R.A. 5 h 53 m, Decl. 25° 49′ N., mag. +0.8, and transits at 18 h 20 m. Moving from Taurus into Gemini, it is approximately on the meridian at sunset and sets a few hours after midnight. It now matches nearby Aldebaran in brightness.

Jupiter on the 15th is in R.A. 1 h 43 m, Decl. 9° 36′ N., mag. −1.6, and transits at 14 h 10 m. Moving from Pisces into Aries, it is well down in the west at sunset and sets within three hours.

Saturn on the 15th is in R.A. 7 h 53 m, Decl. 21° 17′ N., mag. +0.2, and transits at 20 h 18 m. Near the boundary between Cancer and Gemini, it is high in the eastern sky at sunset. 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. 14 h 18 m, Decl. 13° 16′ S., and transits at 2 h 46 m.

Neptune on the 15th is in R.A. 16 h 51 m, Decl. 20° 57′ S., and transits at 5 h 19 m.

1976				MARCH E.S.T.	Min. of Algol		Config. of Jupiter's Sat. 20 h E.S.T.	Sun's Selen. Colong. 0 h U.T.
	d	h	m		h	m		°
Mon.	1	08		Juno at opposition			34O21	267.49
Tues.	2				11	10	431O2	279.69
Wed.	3	23		Moon at apogee (406,000 km)			42O13	291.89
Thur.	4	15		Jupiter 3° S. of Moon			421O3	304.09
Fri.	5				8	00	4O23d	316.29
Sat.	6						4O13d	328.49
Sun.	7						4231O	340.68
Mon.	8	23	38	☽ First Quarter	4	50	34O21	352.86
Tues.	9	14		Mars 6 N. of Moon			314O2	5.04
Wed.	10						2O14*	17.21
Thur.	11	22		Saturn 5° N. of Moon	1	30	21O34	29.38[l]
Fri.	12						O1234	41.54
Sat.	13				22	20	O234*	53.70[b]
Sun.	14						231O4	65.85
Mon.	15	20		Neptune stationary			3O14*	78.00
		21	53	○ Full Moon				
Tues.	16	14		Moon at perigee (357,640 km)	19	10	31O24	90.14
Wed.	17	18		Spica 0.3° S. of Moon. Occ'n.			23O41	102.29
Thur.	18	15		Uranus 1° N. of Moon. Occ'n.			241O3	114.44
Fri.	19				16	00	4O123	126.59
Sat.	20			Mercury at greatest hel. lat. S.			41O23	138.75
		06	50	Equinox. Spring begins				
Sun.	21	05		Neptune 1° S. of Moon. Occ'n.[1]			423Od	150.92
Mon.	22	13	54	☾ Last Quarter	12	50	43O1*	163.09
Tues.	23						431O2	175.27[l]
Wed.	24						423O1	187.46
Thur.	25			Venus at aphelion	9	40	421O3	199.65
Fri.	26						O4123	211.85[b]
Sat.	27	13		Saturn stationary			1O234	224.06
Sun.	28	19		Venus 6° S. of Moon	6	30	23O14	236.27
Mon.	29						32O14	248.48
Tues.	30	12	08	● New Moon			31O24	260.70
		17		Pluto at opposition				
Wed.	31	05		Moon at apogee (406,510 km)	3	20	32O14	272.92

[l]Mar. 11, −7.93°; Mar. 23, +7.09°.
[b]Mar. 13, +6.61°; Mar. 26, −6.73°.
[1]Visible in N. America.

THE SKY FOR APRIL 1976

Notice in the section on eclipses that a partial eclipse of the sun on the 29th will be visible in some parts of North America. April–May and October–November are the eclipse seasons now, but 1976 is a poor eclipse year for North America.

Notice that the greatest eastern elongation of Mercury on the 27th is called a very favourable one. This is because the ecliptic east of the setting sun at this season in middle latitudes is nearly perpendicular to the horizon, so the altitude of Mercury at sunset is nearly as great as its angular distance from the sun (21°).

Mars, though a good deal fainter than before, should be identifiable. Watch it move rapidly eastward towards Saturn. Jupiter moves "into" the sun this month and we lose it for a while.

There is an occultation of ε Gem by Mars at almost exactly 20.00 E.S.T. on the 7th. This is visible over much of North America.

The Sun—During April the sun's R.A. increases from 0 h 42 m to 2 h 33 m and its Decl. changes from 4° 30′ N. to 15° 03′ N. The equation of time changes from −3 m 46 s to +2 m 51 s, being zero on the 15th. There is an annular eclipse of the sun on the 29th which is visible as a partial eclipse near the lower St. Lawrence, in the Atlantic provinces and the New England states.

Mercury on the 1st is in R.A. 0 h 41 m, Decl. 3° 08′ N., and on the 15th is in R.A. 2 h 25 m, Decl. 15° 43′ N. It is in superior conjunction on the 1st, and by the 27th it is in greatest eastern elongation, a very favourable one, at which time Mercury is nearly 19 degrees above the western horizon at sunset. During the last two weeks of the month it should be easy to see. On the evening of the 12th it is about 2° north of Jupiter which should facilitate locating it.

Venus on the 1st is in R.A. 23 h 29 m, Decl. 4° 55′ S., and on the 15th it is in R.A. 0 h 32 m, Decl. 1°51′ N., mag. −3.3, and transits at 11 h 00 m. It rises in the east just about half an hour before the sun.

Mars on the 15th is in R.A. 6 h 58 m, Decl. 24° 46′ N., mag. +1.3, and transits at 17 h 23 m. Moving rapidly through Gemini, it is now past the meridian at sunset and sets soon after midnight. It is no longer prominent among the nearby stars, but once located it will be interesting to watch it move eastward towards Saturn (see May).

Jupiter on the 15th is in R.A. 2 h 11 m, Decl. 12° 08′ N., mag. −1.6, and transits at 12 h 35 m. It is visible low in the west just after sunset early in the month, but by the 27th it is in conjunction with the sun.

Saturn on the 15th is in R.A. 7 h 54 m, Decl. 21° 17′ N., mag. +0.4, and transits at 18 h 17 m. In Cancer, it is close to the meridian at sunset and sets after midnight. See Mars.

Uranus on the 15th is in R.A. 14 h 14 m, Decl. 12° 53′ S., and transits at 0 h 40 m.

Neptune on the 15th is in R.A. 16 h 50 m, Decl. 20° 54 ′S., and transits at 3 h 16 m.

1976				APRIL E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 20 h E.S.T.	Sun's Selen. Colong. 0 h U.T.
	d	h	m		h m		°
Thur.	1	09		Jupiter 2° S. of Moon		21O34	285.14
		13		Mercury in superior conjunction			
Fri.	2					O1243	297.36
Sat.	3				0 10	1O423	309.57
Sun.	4					24O1d	321.79
Mon.	5				21 00	432O*	334.00
Tues.	6	22		Mars 7° N. of Moon		431O2	346.20
Wed.	7	14	02	☽ First Quarter		43O21	358.40
		19	56	Occultation of ε Gem by Mars			
Thur.	8			Mercury at ascending node	17 50	421O3	10.59[l]
		07		Saturn 6° N. of Moon			
Fri.	9						22.78
Sat.	10						34.96[b]
Sun.	11				14 40		47.14
Mon.	12			Mercury at perihelion			59.30
		13		Mercury 1.9° N. of Jupiter			
Tues.	13						71.47
Wed.	14			Mars at greatest hel. lat. N.	11 30		83.63
		02		Moon at perigee (356,940 km)			
		05		Spica 0.3° S. of Moon. Occ'n.[1]			
		06	49	○ Full Moon			
Thur.	15	01		Uranus 1° N. of Moon. Occ'n.			95.80
		16		Juno stationary			
Fri.	16			Venus at greatest hel. lat. S.			107.96
Sat.	17	14		Neptune 1° S. of Moon. Occ'n.	8 10		120.13
Sun.	18						132.30
Mon.	19						144.48
Tues.	20				5 00		156.67[l]
Wed.	21	02	14	☾ Last Quarter			168.86
		21		Lyrid meteors			
Thur.	22						181.06[b]
Fri.	23			Mercury at greatest hel. lat. N.	1 50		193.27
Sat.	24						205.49
Sun.	25	00		Uranus at opposition	22 40		217.71
Mon.	26						229.93
Tues.	27	07		Moon at apogee (406,400 km)			242.16
		15		Jupiter in conjunction with Sun			
		21		Mercury greatest elong. E. (21°)			
Wed.	28				19 30		254.39
Thur.	29	05	20	● New Moon. Eclipse of ⊙, pg. 59			266.62
		06		Pallas in conjunction with Sun			
Fri.	30	23		Mercury 4° N. of Moon			278.86

[l]Apr. 8, −8.01°; Apr. 20, +7.36°.
[b]Apr. 10, +6.75°; Apr. 22, −6.83°.
[1]Visible in Central and S. America.

THE SKY FOR MAY 1976

If you missed seeing Mercury last month look low in the west just after sunset early this month.

An hour after sunset at mid-month Gemini is sinking into the west. Identify Castor and Pollux and watch Saturn and Mars move eastward across the southerly extension of the line joining them, Mars moving more rapidly than Saturn and passing it within a degree and a half on the 11th.

The Sun—During May the sun's R.A. increases from 2 h 33 m to 4 h 36 m and its Decl. changes from 15° 03′ N., to 22° 02′ N. The equation of time changes from +2 m 59 s to a maximum of +3 m 42 s on the 15th and then to +2 m 20 s at the end of the month.

The Moon—There is a partial eclipse of the moon on the 13th but this is not visible in any part of North America.

Mercury on the 1st is in R.A. 3 h 52 m, Decl. 22° 57′ N., and on the 15th is in R.A. 4 h 01 m, Decl. 21° 03′ N. For the first week of the month it should be seen quite easily low in the west just after sunset, but by the 20th it is in inferior conjunction.

Venus on the 1st is in R.A. 1 h 45 m, Decl. 9° 27′ N., and on the 15th it is in R.A. 2 h 52 m, Decl. 15° 23′ N., mag. −3.4, and transits at 11 h 21 m. It is difficult to observe, rising just minutes before the sun at mid-month.

Mars on the 15th is in R.A. 8 h 07 m, Decl. 21° 56′ N., mag. +1.6, and transits at 16 h 34 m. Moving into Cancer, it is now well past the meridian at sunset and sets at about midnight. It is no longer prominent in brightness. Late on the 11th (at 21 h E.S.T.) Mars and Saturn are in conjunction, Mars being 1°.3 north.

Jupiter on the 15th is in R.A. 2 h 38 m, Decl. 14° 27′ N., mag −1.6, and transits at 11 h 05 m. In the latter part of the month it is easy to observe as a morning star rising to the north of east before the sun. On the morning of the 27th the proximity of Jupiter and the crescent moon will be a pretty sight.

Saturn on the 15th is in R.A. 8 h 01 m, Decl. 20° 58′ N., mag. +0.5, and transits at 16 h 26 m. In Cancer, it is well past the meridian at sunset and sets at about midnight. See Mars.

Uranus on the 15th is in R.A. 14 h 09 m, Decl. 12° 29′ S., and transits at 22 h 33 m.

Neptune on the 15th is in R.A. 16 h 48 m, Decl. 20° 49′ S., and transits at 1 h 15 m.

1976				MAY E.S.T.	Min. of Algol	Config. of Jupiter's Sat.	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Sat.	1				16 20		291.09
Sun	2						303.33
Mon	3						315.56
Tues.	4	23		η Aquarid meteors	13 10		327.79
		23		Mars 5° S. of Pollux			
Wed.	5	09		Mars 7° N. of Moon			340.01
		15		Saturn 6° N. of Moon			
Thur.	6						352.23[l]
Fri.	7	00	17	☽ First Quarter	10 00		4.44[b]
Sat.	8						16.64
Sun.	9	11		Mercury stationary			28.84
Mon.	10				6 50		41.03
Tues.	11	09		Venus 0.2° S. of Jupiter			53.22
		15		Spica 0.3° S. of Moon. Occ'n.			
		21		Mars 1.3° N. of Saturn			
Wed.	12	10		Uranus 1° N. of Moon Occ'n.			65.40
		12		Moon at perigee (359,170 km)			
Thur.	13	15	04	○ Full Moon. Eclipse of ☾, pg. 59.	3 40		77.58
Fri.	14	08		Vesta in conjunction with Sun			89.76
		23		Neptune 1° S. of Moon. Occ'n.[1]			
Sat.	15						101.94
Sun.	16			Mercury at descending node	0 30		114.12
Mon.	17						126.31
Tues.	18				21 10		138.50
Wed.	19						150.69[lb]
Thur.	20	07		Mercury in inferior conjunction			162.90
		16	22	☾ Last Quarter			
Fri.	21			Mars at aphelion	18 00		175.11
Sat.	22						187.33
Sun.	23						199.55
Mon.	24	19		Moon at apogee (405,600 km)	14 50		211.78
Tues.	25						224.01
Wed.	26			Mercury at aphelion			236.25
		23		Jupiter 0.8° S. of Moon. Occ'n.			
Thur.	27				11 40		248.49
Fri.	28	20	47	● New Moon			260.74
Sat.	29						272.99
Sun.	30				8 30		285.23
Mon.	31						297.48

[l]May 6, −7.26°; May 19, +7.01°.
[b]May 7, +6.82°; May 19, −6.79°.
[1]Visible in N. America.

THE SKY FOR JUNE 1976

The summer solstice is on the 21st, the sun being then at its farthest north of the equator at declination +23° 26′. So in middle northerly latitudes we have our longest day, the sun rising at about 60° east of north and setting about 60° west of north, and climbing to an altitude of about 68½° at mid-day (for latitude 45° N). It is a combination of the most direct rays and the longest daily sunlight that gives us the maximum heating effect at this time. (But why, then, does our hottest weather usually come a month or more later? Accumulation is the answer.)

Realizing that the full moon is always exactly opposite to the sun in the sky, what will be noteworthy about the diurnal path of the full moon this month?

The Sun—During June the sun's R.A. increases from 4 h 36 m to 6 h 40 m and its Decl. changes from 22° 02′ N. to 23° 07′ N. The equation of time changes from +2 m 11 s to −3 m 40 s, being zero on the 13th. The summer solstice is on the 21st at 1 h 24 m E.S.T.

Mercury on the 1st is in R.A. 3 h 34 m, Decl. 15° 27′ N., and on the 15th is in R.A. 3 h 59 m, Decl. 16° 53′ N. On the 15th it is in greatest western elongation and may be glimpsed low in the east just before sunrise. However, this is an unfavourable elongation, Mercury being only 11 degrees above the horizon at sunrise.

Venus on the 1st is in R.A. 4 h 17 m, Decl. 20° 53′ N., and on the 15th it is in R.A. 5 h 30 m, Decl. 23° 24′ N., mag. −3.5, and transits at 11 h 57 m. It is too close to the sun all month for easy observation, superior conjunction being on the 17th.

Mars on the 15th is in R.A. 9 h 19 m, Decl. 17° 02′ N., mag. +1.8, and transits at 15 h 44 m. Moving from Cancer into Leo, it is well down in the west at sunset and sets about three hours later.

Jupiter on the 15th is in R.A. 3 h 06 m, Decl. 16° 30′ N., mag. −1.6, and transits at 9 h 31 m. In Aries it rises to the north of east about two hours before the sun. It will be interesting to observe Jupiter relative to the crescent moon on the mornings of the 23rd and the 24th as the moon passes from a few degrees west of Jupiter to a few degrees east of him.

Saturn on the 15th is in R.A. 8 h 14 m, Decl. 20° 22′ N., mag. +0.5, and transits at 14 h 37 m. In Cancer, it is well down in the west at sunset and sets about two hours later.

Uranus on the 15th is in R.A. 14 h 05 m, Decl. 12° 09′ S., and transits at 20 h 27 m.

Neptune on the 15th is in R.A. 16 h 44 m, Decl. 20° 43′ S., and transits at 23 h 06 m.

1976			JUNE E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 4 h E.S.T.	Sun's Selen. Colong. 0 h U.T.
	d	h m		h m		°
Tues.	1	12	Mercury stationary			309.72
Wed.	2	01	Saturn 6° N. of Moon	5 20		321.96[l]
		20	Neptune at opposition			
		21	Mars 7° N. of Moon			
Thur.	3				31O24	334.20[b]
Fri.	4				32O4d	346.43
Sat.	5	07 20	☽ First Quarter	2 10	2O134	358.65
Sun.	6				1O234	10.87
Mon.	7			23 00	O2134	23.08
Tues.	8	00	Spica 0.4° S. of Moon. Occ'n.[1]		21O34	35.29
		17	Uranus 1° N. of Moon			
Wed.	9	14	Moon at perigee (363,550 km)		3O14*	47.48
Thur.	10			19 50	31O42	59.68
Fri.	11		Venus at ascending node		342O1	71.87
		08	Neptune 1° S. of Moon. Occ'n.			
		23 15	○ Full Moon			
Sat.	12				42O**	84.06
Sun.	13			16 30	41O23	96.24
Mon.	14				4O213	108.43
Tues.	15	04	Mercury greatest elong. W. (23°)		421O3	120.63
Wed.	16		Mercury at greatest hel. lat. S.	13 20	432O1	132.83[lb]
Thur.	17	23	Venus in superior conjunction		431O2	145.03
Fri.	18				342O1	157.24
Sat.	19	08 15	☾ Last Quarter	10 10	2O4**	169.45
Sun.	20				O234d	181.67
Mon.	21	01 24	Solstice. Summer begins		O1234	193.90
		12	Moon at apogee (404,590 km)			
Tues.	22	12	Mercury 3° N. of Aldebaran	7 00	21O34	206.13
Wed.	23	18	Jupiter 0.1° S. of Moon. Occ'n.		23O14	218.37
Thur.	24				31O24	230.61
Fri.	25	13	Vesta 0.8° S. of Moon. Occ'n.	3.50	3O14d	242.86
		17	Mercury 1° N. of Moon. Occ'n.			
		23	Pluto stationary			
Sat.	26				231O4	255.11
Sun.	27	09 50	● New Moon		O1243	267.36
Mon.	28			0 40	4O123	279.62
Tues.	29	13	Saturn 6° N. of Moon		421O3	291.87[l]
Wed.	30				423O1	304.12[b]

[l]June 2, −6.01°; June 16, +6.22°; June 29, −5.14°.
[b]June 3, +6.74°; June 16, −6.70°; June 30, +6.60°.
[1]Visible in Central and S. America.

THE SKY FOR JULY 1976

Early this month the earth is in aphelion; early in January it was at perihelion. The difference in distance from earth to sun between these two extremes is about 5,000,000 km or 3.3 per cent, which makes a difference in radiant heat received by the earth of nearly 7 per cent. Thus for the northern hemisphere the difference tends to warm our winters and cool our summers. However, the preponderance of large land masses in the northern hemisphere works the other way and tends to make our winters colder and summers hotter than those of the southern hemisphere.

The Sun—During July the sun's R.A. increases from 6 h 40 m to 8 h 45 m and its Decl. changes from 23° 07′ N., to 18° 02′ N. The equation of time changes from −3 m 51 s to a maximum of −6 m 27 s on the 26th and then to −6 m 18 s at the end of the month. The earth is in aphelion on the 3rd at a distance of 152,101,000 km (94,511,000 miles) from the sun.

Mercury on the 1st is in R.A. 5 h 30 m, Decl. 22° 27′ N., and on the 15th is in R.A. 7 h 36 m, Decl. 23° 06′ N. It is too close to the sun for observation, superior conjunction being on the 15th. However, a close conjunction with Venus on the 24th (at 9 h E.S.T., Mercury passing 0°.4 north) offers an interesting opportunity to locate Mercury in the twilight sky by observing Venus on the evenings of the 23rd and 24th in binoculars or by wide-field telescope.

Venus on the 1st is in R.A. 6 h 56 m, Decl. 23° 33′ N., and on the 15th it is in R.A. 8 h 10 m, Decl. 21° 16′ N., mag. −3.4, and transits at 12 h 39 m. It is an evening star now, and at mid-month it stands about 6 degrees above the north-western horizon at sunset.

Mars on the 15th is in R.A. 10 h 28 m, Decl. 10° 42′ N., mag. +1.9, and transits at 14 h 55 m. In Leo, it is well down in the west at sunset and sets within about two hours. On the evening of the 5th it is less than a degree north of Regulus.

Jupiter on the 15th is in R.A. 3 h 30 m, Decl. 17° 59′ N., mag. −1.8, and transits at 7 h 57 m. Moving into Taurus, it rises at about midnight. Between the mornings of the 21st and the 22nd the waning moon switches from west to east of Jupiter and in New Zealand an occultation will be visible.

Saturn on the 15th is in R.A. 8 h 29 m, Decl. 19° 34′ N., mag. +0.5, and transits at 12 h 54 m. It is too close to the sun for easy observation. On the 29th it is in conjunction with the sun.

Uranus on the 15th is in R.A. 14 h 04 m, Decl. 12° 05′ S., and transits at 18 h 28 m.

Neptune on the 15th is in R.A. 16 h 41 m, Decl. 20° 38′ S., and transits at 21 h 05 m.

1976				JULY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 4 h E.S.T.	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Thur.	1	09		Mars 6° N. of Moon		431O2	316.36
Fri.	2	23		Earth at aphelion		43O21	328.61
Sat.	3				18 10	4231O	340.84
Sun.	4	12	28	☽ First Quarter		4O213	353.07
Mon.	5			Mercury at ascending node		4O23*	5.30
		06		Spica 0.6° S. of Moon. Occ'n.			
		13		Mars 0.7° N. of Regulus			
		23		Uranus 1° N. of Moon. Occ'n.			
Tues.	6	21		Moon at perigee (368,370 km)	15 00	21O43	17.51
Wed.	7					2O314	29.72
Thur.	8	16		Neptune 1° S. of Moon. Occ'n.		31O24	41.92
Fri.	9			Mercury at perihelion	11 50	3O214	54.12
Sat.	10					231O4	66.32
Sun.	11	07		Uranus stationary		O134*	78.51
		08	09	○ Full Moon			
Mon.	12				8 40	O234*	90.70
Tues.	13					2O43d	102.89[b]
Wed.	14					2O413	115.08[l]
Thur.	15			Venus at perihelion	5 30	341O2	127.28
		10		Mercury in superior conjunction			
Fri.	16					43O21	139.48
Sat.	17					4321O	151.69
Sun.	18				2 20	42O31	163.90
Mon.	19	01	29	☾ Last quarter		41O23	176.12
		06		Moon at apogee (404,060 km)			
Tues.	20			Mercury at greatest hel. lat. N.	23 10	42O13	188.34
Wed.	21	12		Jupiter 0.5° N. of Moon. Occ'n.		42O13	200.57
Thur.	22					341O2	212.81
Fri.	23	19		Vesta 0.5° N. of Moon. Occ'n.	20 00	3O412	225.05
Sat.	24	09		Mercury 0.4° N. of Venus		321O4	237.29
Sun.	25	16	30	Appulse of Vesta and SAO 77347		23O14	249.54
		20		Ceres in conjunction with Sun			
Mon.	26	20	39	● New Moon	16 40	1O234	261.79[l]
Tues.	27					O134d	274.04[b]
Wed.	28	19		δ Aquarid meteors		2O34*	286.29
Thur.	29	09		Saturn in conjunction with Sun	13 30	31O24	298.54
		21		Mars 5° N. of Moon			
Fri.	30					3O124	310.78
Sat.	31	23		Moon at perigee (369,100 km)		321O4	323.02

[l]July 14, +5.37°; July 26, −5.25°.
[b]July 13, −6.58°; July 27, +6.51°.

THE SKY FOR AUGUST 1976

This month we have, on the 26th, a greatest eastern elongation of Mercury which normally results in a good opportunity to see Mercury as an evening star. (See, for example April.) But, whereas in April the ecliptic east of the setting sun was steep relative to the horizon, in August it is very oblique and, in addition, Mercury is about 4 degrees south of the ecliptic. Thus while Mercury on the 26th is 27 degrees east of the sun along the ecliptic, it is only about 6 degrees above the western horizon at sunset and so very low indeed when it is dark enough to see the planet. This is therefore a very unfavourable elongation.

The Sun—During August the sun's R.A. increases from 8 h 45 m to 10 h 41 m and its Decl. changes from 18° 02′ N. to 8° 19′ N. The equation of time changes from −6 m 15 s to −0 m 09 s.

Mercury on the 1st is in R.A. 9 h 53 m, Decl. 14° 20′ N., and on the 15th is in R.A. 11 h 12 m, Decl. 4° 44′ N. On the 26th it is in greatest eastern elongation, but this is a very unfavourable one, Mercury being scarcely 6 degrees above the western horizon at sunset.

Venus on the 1st is in R.A. 9 h 35 m, Decl. 15° 53′ N., and on the 15th it is in R.A. 10 h 41 m, Decl. 9° 51′ N., mag. −3.3, and transits at 13 h 08 m. It is an evening star standing about 8 degrees above the western horizon at sunset and setting within an hour.

Mars on the 15th is in R.A. 11 h 40 m, Decl. 3° 01′ N., mag. +1.9, and transits at 14 h 04 m. Moving from Leo into Virgo, it is now so low in the west at sunset as to be difficult to observe.

Jupiter on the 15th is in R.A. 3 h 49 m, Decl. 18° 58′ N., mag. −1.9, and transits at 6 h 13 m. In Taurus, it rises late in the evening. During the night of the 17th–18th it will be interesting to watch the moon overtake and pass Jupiter, being just 1° south of him at 04 hours E.S.T. In the southern part of South America this will be seen as an occultation.

Saturn on the 15th is in R.A. 8 h 45 m, Decl. 18° 37′ N., mag. +0.5, and transits at 11 h 09 m. It is now in the morning sky but too close to the sun for easy observation.

Uranus on the 15th is in R.A. 14 h 06 m, Decl. 12° 16′ S., and transits at 16 h 28 m.

Neptune on the 15th is in R.A. 16 h 40 m, Decl. 20° 37′ S., and transits at 19 h 01 m.

1976	d	h	m	AUGUST E.S.T.	Min. of Algol h m	Config. of Jupiter's Sat. 3 h E.S.T.	Sun's Selen. Colong. 0 h U.T. °
Sun.	1	11		Spica 0.8° S. of Moon. Occ'n.	10 20	42301	335.26
Mon.	2	05		Uranus 0.9° N. of Moon. Occ'n.		41023	347.49
		17	07	☽ First Quarter			
Tues.	3	01		Mercury 0.7° N. of Regulus		40213	359.71
Wed.	4	21		Neptune 1° S. of Moon	7 10	42103	11.92
Thur.	5					430*d	24.13
Fri.	6			Venus at greatest hel. lat. N.		43012	36.33
Sat.	7	11		Venus 1.1° N. of Regulus	4 00	34210	48.53
Sun.	8					23401	60.72
Mon.	9	18	44	☺ Full Moon		10423	72.91[b]
Tues.	10				0 50	02143	85.09[l]
Wed.	11	23		Perseid meteors		21034	97.28
Thur.	12			Mercury at descending node	21 40	014*d	109.47
Fri.	13					3024*	121.66
Sat.	14					31204	133.85
Sun.	15				18 20	23014	146.05
Mon.	16	01		Moon at apogee (404,400 km)		10324	158.25
Tues.	17	19	13	☾ Last Quarter		40213	170.46
Wed.	18	04		Jupiter 1° N. of Moon. Occ'n.[1]	15 10	42103	182.67
Thur.	19					42031	194.89
Fri.	20					43102	207.11
Sat.	21				12 00	430dd	219.34
Sun.	22			Mercury at aphelion		43201	231.58[l]
Mon.	23	03		Neptune stationary		41032	243.81
		18		Saturn 6° N. of Moon			
Tues.	24				8 50	40123	256.05[b]
Wed.	25	06	01	● New Moon		21403	268.30
Thur.	26	05		Mercury greatest elong. E. (27°)		20134	280.54
		19		Venus 5° N. of Moon			
Fri.	27	06		Mercury 0.5° N. of Moon. Occ'n.	5 40	31024	292.78
		10		Mars 4° N. of Moon			
		21		Moon at perigee (364,540 km)			
Sat.	28	18		Spica 1° S. of Moon. Occ'n.[2]		3024d	305.02
Sun.	29	12		Uranus 0.6° N. of Moon. Occ'n.		32014	317.25
Mon.	30				2 30	10324	329.48
Tues.	31	22	35	☽ First Quarter		01234	341.70

[l]Aug. 10, +5.06°; Aug. 22, −6.06°.
[b]Aug. 9, −6.55°; Aug. 24, +6.56°.
[1]Visible in S. America.
[2]Visible in N. America.

THE SKY FOR SEPTEMBER 1976

The autumnal equinox occurs on the 22nd. On that day if you are at latitude 44° N what is the meridian altitude of the sun? Is the interval from sunrise to sunset on the 22nd equal to the interval from sunset on the 22nd to sunrise on the 23rd? What two factors account for the inequality? Forgotten? See March.

Refer back to March relative to the rapid rate of change of the sunrise and sunset points at the time of the equinoxes.

An hour after sunset at mid-month we have Arcturus in the west, Antares in the south-west, and near the zenith we have the summer triangle of Altair, Vega and Deneb. Of these five famous stars can you find out from the Handbook which is the brightest, which the reddest, which the closest, which the most luminous (intrinsically)?

The Sun—During September the sun's R.A. increases from 10 h 41 m to 12 h 29 m and its Decl. changes from 8° 19′ N. to 3° 09′ S. The equation of time changes from +0 m 10 s to +10 m 09 s. On the 22nd at 15 h 48 m E.S.T. the sun crosses the equator moving southward, enters the sign of Libra and autumn commences.

Mercury on the 1st is in R.A. 1 h 14 m, Decl. 4° 51′ S., and on the 15th is in R.A. 12 h 15 m, Decl. 6° 05′ S. It is too close to the sun for observation until the end of the month, inferior conjunction being on the 22nd. However, by month's end it may be seen just before sunrise low in the east.

Venus on the 1st is in R.A. 11 h 59 m, Decl. 1° 26′ N., and on the 15th it is in R.A. 13 h 01 m, Decl. 5° 45′ S., mag. −3.3, and transits at 13 h 25 m. It is an evening star about 9 degrees above the western horizon at sunset and setting within an hour. On the evening of the 25th Venus and the crescent moon will make a pretty sight in the west. Also see Mars on this page.

Mars on the 15th is in R.A. 12 h 53 m, Decl. 5° 09′ S., mag. +1.9, and transits at 13 h 15 m. It is too close to the sun for easy observation, though on the evening of the 10th when it is in conjunction with Venus (passing 0°.4 south at 17 h E.S.T.) it would be interesting to locate Mars by observing Venus by binocular in the twilight sky.

Jupiter on the 15th is in R.A. 3 h 57 m, Decl. 19° 19′ N., mag. −2.1, and transits at 4 h 19 m. In Taurus, it rises about three hours after sunset. On the 19th it is stationary in right ascension and begins to retrograde, or move westward, among the stars.

Saturn on the 15th is in R.A. 9 h 00 m, Decl. 17° 40′ N., mag. +0.6, and transits at 9 h 22 m. In Cancer, it rises about three hours before the sun.

Uranus on the 15th is in R.A. 14 h 11 m, Decl. 12° 42′ S., and transits at 14 h 31 m.

Neptune on the 15th is in R.A. 16 h 40 m, Decl. 20° 39′ S., and transits at 17 h 00 m.

1976				SEPTEMBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 2 h E.S.T.	Sun's Selen. Colong. 0 h U.T.
	d	h	m		h m		°
Wed.	1	02		Neptune 2° S. of Moon	23 20	12O34	353.91
Thur.	2					2O134	6.12
Fri.	3					314O2	18.32
Sat.	4				20 00	34O21	30.51
Sun.	5	23		Mercury 5° S. of Venus		432O*	42.70[lb]
Mon.	6					41O3*	54.88
Tues.	7				16 50	4O123	67.06
Wed.	8	07	52	Full Moon. Harvest Moon.		412O3	79.24
		09		Mercury stationary			
Thur.	9					42O13	91.41
Fri.	10	17		Venus 0.4° N. of Mars	13 40	413O2	103.59
Sat.	11					3O421	115.77
Sun.	12			Mercury at greatest hel. lat. S.		321O4	127.95
		18		Moon at apogee (405,330 km)			
Mon.	13				10 30	3O4*d	140.13
Tues.	14	14		Jupiter 1° N. of Moon		O1324	152.32
Wed.	15					12O34	164.51
Thur.	16	12	20	Last Quarter	7 20	2O134	176.70
Fri.	17					13O24	188.91
Sat.	18					3O124	201.11
Sun.	19	16		Jupiter stationary	4 10	321O4	213.33[l]
		20		Venus 3° N. of Spica			
Mon.	20	10		Saturn 6° N. of Moon		342O1	225.54[b]
Tues.	21	20		Mercury in inferior conjunction		4O32*	237.77
Wed.	22	16	48	Equinox. Autumn begins	1 00	41O3d	249.99
Thur.	23	14	55	New Moon		42O13	262.22
Fri.	24	22		Moon at perigee (359,840 km)	21 40	41O32	274.45
Sat.	25	00		Mars 2° N. of Moon		43O12	286.68
		02		Spica 1° S. of Moon. Occ'n.			
		13		Venus 0.7° N. of Moon. Occ'n.			
		22		Uranus 0.3° N. of Moon. Occ'n.			
Sun.	26					4321O	298.91
Mon.	27	14		Mars 3° N. of Spica	18 30	342O1	311.13
Tues.	28	09		Neptune 2° S. of Moon		O432*	323.34
Wed	29					1O243	335.55
Thur.	30	05		Mercury stationary	15 20	2O134	347.75
		06	12	First Quarter			
		17		Venus 0.5° S. of Uranus			

[l]Sept. 5, +5.73°; Sept. 19, −6.94°.
[b]Sept. 5, −6.63°; Sept. 20, +6.73°.

THE SKY FOR OCTOBER 1976

I wonder how many astronomy enthusiasts ever rationalize the position and phase of the moon. Take this month, for example. We see from the preceding page that new moon was on Sept. 23 and first quarter on Sept. 30. Therefore on Oct. 1 the moon is 8 days old and about a day past first quarter. Where will we expect to see it that evening as the sun sets? Well, for one thing it will be near the ecliptic (the moon's orbit plane is tilted only about 5 degrees to the earth's orbit plane or ecliptic) and somewhat more than 90 degrees east of the sun, so about an hour east of the meridian. Will it be high or low in altitude? Well, since it is somewhat more than 90 degrees along (or nearly along) the ecliptic eastward of the sun, it must have declination about the same as the sun will have in three month's time, namely about Jan. 1, therefore nearly as far south as it ever is, i.e. about 23 degrees south. And this means its altitude as it approaches the meridian is very low, say in the neighbourhood of 20 degrees for those of us near latitude 44° N. This kind of mental gymnastics can deceive us by as much as the 5 degrees by which the moon's orbit is inclined to the earth's orbit, and in fact it did so in our example because the moon is almost exactly 5 degrees north of the ecliptic on the 1st so a more accurate altitude for the moon at sunset is 25 degrees.

The Sun—During October the sun's R.A. increases from 12 h 29 m to 14 h 25 m and its Decl. changes from 3° 09′ S. to 14° 24′ S. The equation of time changes from +10 m 28 s to +16 m 22 s. A total eclipse of the sun on the 23rd will not be visible in this hemisphere.

Mercury on the 1st is in R.A. 11 h 35 m, Decl. 2° 42′ N., and on the 15th is in R.A. 12 h 26 m, Decl. 0° 41′ S. Greatest western elongation is on the 7th, a favourable one, Mercury then standing about 17 degrees above the eastern horizon at sunrise. Thus until past mid-month Mercury will be easily found near the eastern horizon just before sunrise.

Venus on the 1st is in R.A. 14 h 14 m, Decl. 13° 29′ S., and on the 15th it is in R.A. 15 h 22 m, Decl. 19° 11′ S., mag. −3.4, and transits at 13 h 48 m. It is about 10 degrees above the south-western horizon at sunset and sets about an hour later.

Mars on the 15th is in R.A. 14 h 08 m, Decl. 12° 46′ S., mag. +1.8, and transits at 12 h 32 m. It is too close to the sun for easy observation.

Jupiter on the 15th is in R.A. 3 h 53 m, Decl. 19° 04′ N., mag. −2.3, and transits at 2 h 17 m. In Taurus, it rises about two hours after sunset and on the 11th will be about 1° north of the moon.

Saturn on the 15th is in R.A. 9 h 11 m, Decl. 16° 55′ N., mag. +0.6, and transits at 7 h 35 m. In Cancer, it rises about at midnight.

Uranus on the 15th is in R.A. 14 h 17 m, Decl. 13° 16′ S., and transits at 12 h 40 m.

Neptune on the 15th is in R.A. 16 h 43 m, Decl. 20° 46′ S., and transits at 15 h 05 m.

1976				OCTOBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 1 h E.S.T.	Sun's Selen. Colong. 0 h U.T.
	d	h	m		h m		°
Fri.	1			Mercury at ascending node		1O234	359.95
				Venus at descending node			
Sat.	2					3O124	12.14[lb]
Sun.	3				12 10	312O4	24.32
Mon.	4	12		Pluto in conjunction with Sun		32O14	36.49
Tues.	5			Mercury at perihelion		1O324	48.66
Wed.	6				9 00	O4123	60.83
Thur.	7	11		Mercury greatest elong. W. (18°)		24O13	72.99
		23	55	Full Moon			
Fri.	8					41O3*	85.15
Sat.	9				5 50	43O12	97.31
Sun.	10	07		Moon at apogee (406,140 km)		4312O	109.47
		07	58	Possible occ'n of SAO 153844 by Pallas			
Mon.	11	20		Jupiter 1° N. of Moon		432O1	121.64
Tues.	12				2 40	41O2*	133.80
Wed.	13					4O123	145.97
Thur.	14	18		Juno in conjunction with Sun	23 30	24O3*	158.14
Fri.	15			Mercury at greatest hel. lat. N.		1O43*	170.32
Sat.	16	03	59	Last Quarter		3O124	182.50
Sun.	17				20 10	312O4	194.69[lb]
Mon.	18	00		Saturn 6° N. of Moon		32O14	206.88
		17		Mars 0.4° S. of Uranus			
Tues.	19					1O24*	219.08
Wed.	20				17 00	O1234	231.29
Thur.	21	02		Orionid meteors		21O34	243.49
Fri.	22					2O43d	255.71
Sat.	23	00	10	New Moon. Eclipse of sun, pg. 59.	13 50	34O12	267.92
		08		Moon at perigee (357,150 km)			
Sun.	24					341Od	280.13
Mon.	25	08		Venus 4° S. of Moon		432O1	292.35
		19		Neptune 2° S. of Moon			
Tues.	26				10 40	413O2	304.55
Wed.	27	20		Venus 3° N. of Antares		4O123	316.76
Thur.	28					421O3	328.95
Fri.	29			Mars at descending node	7 30	42O3d	341.14
		17	05	First Quarter			
Sat.	30	14		Uranus in conjunction with Sun		43O12	353.32[lb]
Sun.	31	01		Venus 3° S. of Neptune		314O2	5.50

[l]Oct. 2, +6.96°; Oct. 17, −7.42°; Oct. 30, +7.80°.
[b]Oct. 2, −6.74°; Oct. 17, +6.83°; Oct. 30, −6.82°.

THE SKY FOR NOVEMBER 1976

Will the penumbral eclipse of the moon on the night of Nov. 6 be perceptible by eye? Textbooks say only if the moon passes within 700 miles of the umbra. Let us see if this eclipse meets this criterion. At the moon's distance the average diameter of the earth's umbral shadow is about 5700 miles, of the penumbral shadow about 10,000 miles; and the moon's diameter is 2160 miles. The Handbook's section on eclipses says that the magnitude of this penumbral eclipse is 0.86, meaning that at mid-eclipse this fraction of the moon's diameter is within the penumbra. This fraction of 2160 is 1952 miles. The difference between the umbral radius and the penumbral is $\frac{1}{2}(10{,}000 - 5700) = 2150$. Thus the edge of the moon comes within $2150 - 1952 = 198$ miles of the umbra. So the darkening of about one quarter of the moon's diameter should be perceptible. Draw a diagram of the event to scale and see if our conclusion looks reasonable.

The Sun—During November the sun's R.A. increases from 14 h 25 m to 16 h 29 m and its Decl. changes from 14° 24′ S. to 21° 47′ S. The equation of time changes from +16 m 23 s to a maximum of +16 m 24 s on the 3rd and then to +11 m 09 s at the end of the month.

The Moon—A penumbral eclipse of the moon will be visible in most of North America on the night of the 6th.

Mercury on the 1st is in R.A. 14 h 11 m, Decl. 12° 18′ S., and on the 15th is in R.A. 15 h 39 m, Decl. 20° 14′ S. Superior conjunction is on the 7th and the planet remains too close to the sun for observation all month.

Venus on the 1st is in R.A. 16 h 49 m, Decl. 23° 54′ S., and on the 15th it is in R.A. 18 h 03 m, Decl. 25° 25′ S., mag. −3.5, and transits at 14 h 27 m. It is quite prominent low in the south-western sky for about two hours after sunset.

Mars on the 15th is in R.A. 15 h 33 m, Decl. 19° 21′ S., mag. +1.6, and transits at 11 h 56 m. It is too close to the sun for observation, conjunction being on the 25th.

Jupiter on the 15th is in R.A. 3 h 38 m, Decl. 18° 17′ N., mag. −2.4, and transits at 0 h 00 m and 23 h 56 m (two transits on the same date!) In Taurus, it rises at about sunset and is visible all night. At about 20 hours on the 7th Jupiter passes 1° north of the moon. On the 18th Jupiter is at opposition.

Saturn on the 15th is in R.A. 9 h 18 m, Decl. 16° 32′ N., mag. +0.6, and transits at 5 h 39 m. Near the boundary between Cancer and Leo, it rises before midnight. On the 28th it is stationary in right ascension and begins to retrograde, or move westward, among the stars.

Uranus on the 15th is in R.A. 14 h 25 m, Decl. 13° 54′ S., and transits at 10 h 46 m.

Neptune on the 15th is in R.A. 16 h 47 m, Decl. 20° 54′ S., and transits at 13 h 07 m.

1976	d	h	m	NOVEMBER E.S.T.	Min. of Algol h m	Config. of Jupiter's Sat. 0 h E.S.T.	Sun's Selen. Colong. 0 h U.T. °
Mon.	1				4 20	32O14	17.67
Tues.	2					31O24	29.83
Wed.	3					O1324	41.99
Thur.	4			Venus at aphelion	1 10	21O34	54.14
				Taurid meteors			
Fri.	5					2O134	66.29
Sat.	6	10		Moon at apogee (406, 320 km)	22 00	O24*d	78.44
		18	15	Full Moon. Penumbral Eclipse of ☾, pp 54 and 59			
Sun.	7	04		Mercury in superior conjunction		31O24	90.58
		20		Jupiter 1° N. of Moon. Occ'n.			
Mon.	8			Mercury at descending node		32O41	102.73
Tues.	9				18 40	341O*	114.87
Wed.	10					4O312	127.02
Thur.	11					412O3	139.17
Fri.	12				15 30	42O13	151.32
Sat.	13					41O32	163.48[b]
Sun.	14	10		Saturn 6° N. of Moon		43O2d	175.64
		17	39	☾ Last Quarter			
Mon.	15				12 20	432O1	187.81[l]
Tues.	16	19		Leonid meteors*		3412O	199.99
Wed.	17					O4312	212.17
Thur.	18			Mercury at aphelion	9 10	12O43	224.35
		03		Jupiter at opposition			
Fri.	19	00		Spica 1° S. of Moon. Occ'n.		2O134	236.54
Sat.	20	01		Uranus 0.05° S. of Moon. Occ'n.		1O324	248.74
		20		Moon at perigee (357,490 km)			
Sun.	21	10	11	New Moon	6 00	3O124	260.94
Mon.	22	21		Vesta stationary		32O14	273.14
Tues.	23					312O4	285.34
Wed.	24	08		Venus 7° S. of Moon	2 50	O3142	297.53
		20		Mars in conjunction with Sun			
Thur.	25	10		Mercury 3° S. of Neptune		124O3	309.72
Fri.	26				23 40	42O13	321.91[b]
Sat.	27			Venus at greatest hel. lat. S.		41O32	334.09[l]
Sun.	28	02		Saturn stationary		43O12	346.26
		07	59	☽ First Quarter			
Mon.	29				20 30	432O*	358.43
Tues.	30					4312O	10.59

[l]Nov. 15, −7.21°; Nov. 27, +7.81°.

[b]Nov. 13, +6.78°; Nov. 26, −6.75°.

*The behaviour of this shower is rather unpredictable, but it is not expected to be conspicuous.

THE SKY FOR DECEMBER 1976

The winter solstice is on the 21st at 12.36 E.S.T. Let us also write down the dates and times of the vernal equinox, summer solstice and autumnal equinox, and let us also toss in the date and time of last year's winter solstice from the 1975 Handbook (Dec. 22 6.40 E.S.T.). Now let us calculate the intervals WS to VE, VE to SS, SS to AE and AE to WS. They are not equal, are they? Why not? Historical note: this is precisely how Hipparchus in the 2nd century B.C. calculated fairly accurately the time of the closest approach of the sun to the earth, although he believed that the sun moved around the earth on an eccentric circle, whereas we know that it is the earth which moves about the sun on an ellipse.

Look back to the note about the diurnal path of June's full moon and answer the same question about December's full moon.

The Sun—During December the sun's R.A. increases from 16 h 29 m to 18 h 46 m and its Decl. changes from 21° 47′ S. to 23° 02′ S. The equation of time changes from + 10 m 46 s to − 3 m 15 s, being zero on the 25th. The winter solstice occurs on the 21st at 12 h 36 m E.S.T.

Mercury on the 1st is in R.A. 17 h 24 m, Decl. 25° 16′ S., and on the 15th is in R.A. 18 h 54 m, Decl. 25° 02′ S. Greatest eastern elongation is on the 20th, but this is an unfavourable one, Mercury being only about 10 degrees above the south-western horizon at sunset.

Venus on the 1st is in R.A. 19 h 27 m, Decl. 24° 13′ S., and on the 15th it is in R.A. 20 h 38 m, Decl. 20° 48′ S., mag. − 3.7, and transits at 15 h 03 m. It is quite prominent in the south-western sky for about three hours after sunset

Mars on the 15th is in R.A. 17 h 05 m, Decl. 23° 18′ S., mag. + 1.6, and transits at 11 h 29 m. Though now in the morning sky it is too close to the sun for observation.

Jupiter on the 15th is in R.A. 3 h 23 m, Decl. 17° 28′ N., mag. − 2.3, and transits at 21 h 43 m. Moving from Taurus westward into Aries, it is now well up in the east at sunset and is visible until nearly dawn. At about 19 hours on the 4th Jupiter is less than a degree north of the moon.

Saturn on the 15th is in R.A. 9 h 17 m, Decl. 16° 39′ N., mag. + 0.4, and transits at 3 h 41 m. Near the boundary between Cancer and Leo, it rises in the late evening.

Uranus on the 15th is in R.A. 14 h 31 m, Decl. 14° 26′ S., and transits at 8 h 54 m.

Neptune on the 15th is in R.A. 16 h 51 m, Decl. 21° 03′ S., and transits at 11 h 14 m.

1976				DECEMBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 23 h E.S.T.	Sun's Selen. Colong. 0 h U.T.
	d	h	m		h m		°
Wed.	1					41O23	22.74
Thur.	2				17 20	24O13	34.89
Fri.	3	13		Moon at apogee (405,930 km)		1O234	47.04
Sat.	4	19		Jupiter 0.8° N. of Moon. Occ'n.[1]		3O124	59.18
Sun.	5	12		Neptune in conjunction with Sun	14 10	321O4	71.31
Mon.	6	13	15	○ Full Moon		32O4d	83.45
Tues.	7					3O124	95.58
Wed.	8				11 00	1O234	107.71
Thur.	9			Mercury at greatest hel. lat. S.		2O143	119.84
Fri.	10					1O43*	131.98
Sat.	11	16		Saturn 6° N. of Moon	7 40	43O12	144.12[b]
Sun.	12					4321O	156.26
Mon.	13	16		Geminid meteors		432O1	168.41[l]
Tues.	14	05	14	☾ Last Quarter	4 30	43O2*	180.56
Wed.	15					41O23	192.72
Thur.	16	09		Spica 1° S. of Moon. Occ'n.		42O13	204.89
Fri.	17	14		Uranus 0.3° S. of Moon. Occ'n.	1 20	41O3*	217.07
Sat.	18					43O12	229.25
Sun.	19	07		Moon at perigee (360, 950 km)	22 10	312O4	241.43
Mon.	20	05		Mercury greatest elong. E. (20°)		32O14	253.62
		21	08	● New Moon			
Tues.	21	12	36	Solstice. Winter begins		31O24	265.81
Wed.	22	06		Ursid meteors	19 00	1O234	278.00
		10		Mercury 6° S. of Moon			
Thur.	23					2O134	290.19[b]
Fri.	24	10		Venus 7° S. of Moon		12O34	302.38
Sat.	25	00		Pallas stationary	15 50	O124d	314.56[l]
Sun.	26					312O4	326.73
Mon.	27	17		Mercury stationary		32O41	338.90
Tues.	28			Mercury at ascending node	12 40	431O2	351.07
		02	48	☽ First Quarter			
Wed.	29					4O32d	3.23
Thur.	30					42O13	15.38
Fri.	31	04		Moon at apogee (405,100 km)	9 30	412O3	27.53

[l]Dec. 13, −6.23°; Dec. 25, +7.01°.
[b]Dec. 11, +6.65°; Dec. 23, −6.59°.
[1]Visible in S. America.

SUN—EPHEMERIS FOR PHYSICAL OBSERVATIONS, 1976

For 0 h U.T.

Date	P	B_0	L_0	Date	P	B_0	L_0
	°	°	°		°	°	°
Jan. 1	+ 2.44	−2.97	148.62	July 4	− 1.27	+3.25	226.94
6	+ 0.01	−3.55	82.77	9	+ 1.00	+3.78	160.77
11	− 2.40	−4.09	16.93	14	+ 3.24	+4.28	94.60
16	− 4.77	−4.61	311.09	19	+ 5.45	+4.75	28.44
21	− 7.08	−5.09	245.25	24	+ 7.60	+5.19	322.29
26	− 9.32	−5.52	179.42	29	+ 9.68	+5.59	256.15
31	−11.45	−5.92	113.59	Aug. 3	+11.68	+5.96	190.02
Feb. 5	−13.48	−6.27	47.76	8	+13.58	+6.28	123.90
10	−15.38	−6.56	341.92	13	+15.38	+6.56	57.80
15	−17.16	−6.81	276.09	18	+17.07	+6.80	351.71
20	−18.79	−7.00	210.24	23	+18.64	+6.99	285.63
25	−20.28	−7.14	144.39	28	+20.08	+7.13	219.57
Mar. 1	−21.61	−7.22	78.53	Sept. 2	+21.39	+7.21	153.52
6	−22.79	−7.25	12.67	7	+22.56	+7.25	87.48
11	−23.81	−7.22	306.78	12	+23.58	+7.23	21.46
16	−24.66	−7.14	240.88	17	+24.45	+7.16	315.44
21	−25.33	−7.00	174.97	22	+25.16	+7.04	249.44
26	−25.84	−6.81	109.04	27	+25.71	+6.87	183.46
31	−26.17	−6.57	43.09	Oct. 2	+26.09	+6.65	117.48
Apr. 5	−26.32	−6.28	337.12	7	+26.29	+6.37	51.50
10	−26.29	−5.95	271.13	12	+26.32	+6.05	345.54
15	−26.08	−5.57	205.12	17	+26.16	+5.68	279.59
20	−25.68	−5.15	139.08	22	+25.80	+5.27	213.64
25	−25.10	−4.70	73.03	27	+25.26	+4.82	147.70
30	−24.33	−4.22	6.96	Nov. 1	+24.52	+4.33	81.77
May 5	−23.38	−3.71	300.88	6	+23.58	+3.81	15.84
10	−22.26	−3.17	234.77	11	+22.44	+3.25	309.92
15	−20.97	−2.61	168.65	16	+21.12	+2.67	244.00
20	−19.51	−2.03	102.51	21	+19.61	+2.07	178.09
25	−17.90	−1.44	36.36	26	+17.92	+1.45	112.19
30	−16.15	−0.85	330.20	Dec. 1	+16.06	+0.82	46.30
June 4	−14.26	−0.24	264.03	6	+14.06	+0.18	340.41
9	−12.27	+0.36	197.86	11	+11.93	−0.46	274.52
14	−10.18	+0.96	131.67	16	+ 9.69	−1.10	208.64
19	− 8.02	+1.55	65.49	21	+ 7.37	−1.73	142.78
24	− 5.80	+2.14	359.31	26	+ 4.98	−2.34	76.91
29	− 3.54	+2.70	293.12	31	+ 2.56	−2.94	11.06

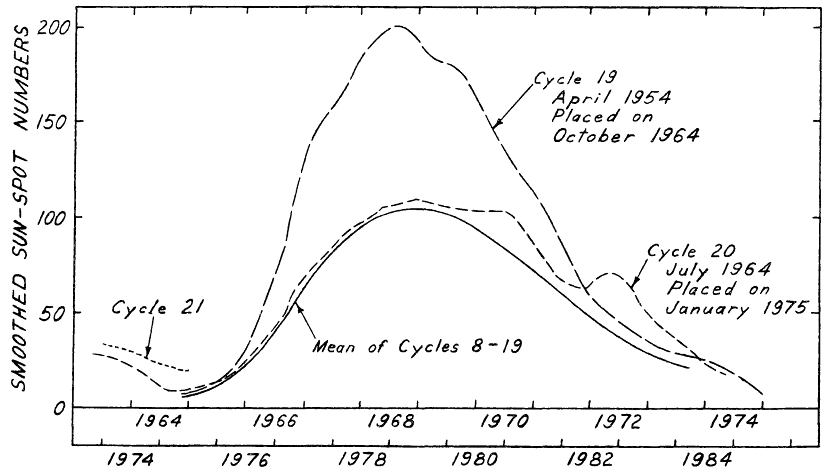
P—is the position angle of the axis of rotation, measured eastward from the north point on the disk, B_0 is the heliographic latitude of the centre of the disk, and L_0 is the heliographic longitude of the centre of the disk, from Carrington's solar meridian, measured in the direction of rotation.

Carrington's Rotation Numbers—Greenwich Date of Commencement of Synodic Rotation, 1976

No.	Commences	No.	Commences	No.	Commences
1637	Jan. 12.29	1642	May 27.75	1647	Oct. 10.90
1638	Feb. 8.63	1643	June 23.95	1648	Nov. 7.20
1639	Mar. 6.96	1644	July 21.15	1649	Dec. 4.51
1640	Apr. 3.27	1645	Aug. 17.37	1650	Dec. 31.84
1641	Apr. 30.53	1646	Sept. 13.63		

SUN-SPOTS

The diagram compares the sun-spot activity for cycles 19, 20 (immediately past) and 21 (beginning in 1975), with the mean of that for cycles 8 to 19. Sun-spot activity was expected to reach a minimum by the end of 1975. The first sun-spot of cycle 21 was observed by Waldmeier on Nov. 15, 1974 at solar latitude 37° N.



ECLIPSES DURING 1976

In 1976 there will be four eclipses, two of the sun and two of the moon.

1. *An annular eclipse of the sun* on April 29, beginning in mid Atlantic, tracking across north-west Africa, southern Asia and ending in China. It is visible as a partial eclipse along the shores of the St. Lawrence from about Montreal eastward and throughout the Atlantic provinces and the New England states. Mid-eclipse will be at about 5:30 a.m. A.S.T. in these regions and the duration will be about 40 minutes.

2. *A partial eclipse of the moon* on May 13, not visible in North America.

3. *A total eclipse of the sun* on October 23, beginning in east Africa, tracking across the Indian Ocean and the extreme southern part of Australia and ending in the south Pacific.

4. *A penumbral eclipse of the moon* on the night of Nov. 6, visible in part in North America except in the north-western section.

Moon enters penumbra..................	Nov. 6	15.46 E.S.T.
Middle of eclipse............................		18.01 E.S.T.
Moon leaves penumbra.......................		20.17 E.S.T.

Penumbral magnitude of eclipse 0.86

PLANETARY APPULSES AND OCCULTATIONS

A planetary appulse is a close approach of a star and a solar system object, as seen from the earth. According to Gordon E. Taylor, of H.M. Nautical Almanac Office, the following appulses will occur in 1976, and may be of interest to observers. The geocentric separation, in declination, is given in the sense planet *minus* star. The horizontal parallax is the angle subtended at the planet by the earth's equatorial radius. Times are given in U.T.; to get E.S.T., subtract 5 hours.

Planet	Date	UT of conjunction	Star Name or SAO No.	Vis. Mag.	Geocentric Separation	Horizontal Parallax
		h m			″	″
Venus	Jan. 21	22 39	185584	6.7	−13.1	7.2
	Feb. 4	14 01	187342	6.2	− 9.6	6.8
	Nov. 25	13 05	187562	6.4	−11.4	7.9
Mars	Mar. 10	22 04	77550	8.5	− 9.8	7.3
	Apr. 8	00 56	ε Gem	3.2	+ 2.0	5.9
Jupiter	Mar. 25	23 50	92688	7.0	−16.0	1.5
Neptune	Nov. 15	15 31	184653	8.7	− 1.3	0.3
Ceres	Nov. 3	16 05	99608	9.0	+ 1.8	2.9
Pallas	July 29	17 06	132592	8.5	+ 2.2	3.1
	Aug. 9	23 18	132996	9.0	+ 0.5	3.1
	Oct. 10	13 00	153844	8.9	+ 1.8	3.9
Juno	Feb. 27	01 47	118514	9.2	− 2.1	5.3
	Mar. 5	01 50	118449	6.3	+ 6.8	5.2
	Mar. 11	00 18	118410	7.6	+ 5.6	5.2
	Aug. 8	21 03	119163	8.3	− 4.2	2.4
Vesta	Mar. 10	20 24	110087	8.8	− 2.6	2.7
	July 17	08 53	94517	8.4	− 0.2	2.6
	July 25	21 32	77347	9.1	− 1.5	2.7

Three of the appulses give rise to observable occultations: that of SAO 77347 by Vesta is visible from western Australia, that of SAO 153844 by Pallas is possibly visible from part of western North America. Detailed predictions will be issued by Mr. Taylor at a later date. The occultation of ε Gem by Mars is widely visible, as follows:

Place	Disappearance		Reappearance		Altitude of	
	UT	P	UT	P	Star	Sun
Hawaii	$0^h52^m.2$	134°	$0^h56^m.3$	237°	47°	+52°
Palomar, Calif.	$0^h54^m.5$	115°	$0^h59^m.4$	256°	80°	+14°
Rothney, Alta.	$0^h54^m.6$	84°	$0^h59^m.6$	288°	64°	+13°
McDonald Obs., Texas	$0^h55^m.5$	119°	$1^h00^m.3$	253°	82°	+ 3°
Toronto, Ont.	$0^h56^m.6$	87°	$1^h01^m.7$	284°	59°	−12°
Washington, D.C.	$0^h56^m.9$	94°	$1^h02^m.0$	278°	59°	−16°
Bermuda	$0^h57^m.8$	98°	$1^h02^m.9$	273°	50°	−28°

OCCULTATIONS BY THE MOON

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

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

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

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

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

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

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

LUNAR OCCULTATIONS VISIBLE AT HALIFAX AND MONTREAL, 1976

Date	Z.C. No.	Mag.	I or E	Elong. of Moon	HALIFAX W. 63°6, N. 44°6 A.S.T.	a	b	P	MONTREAL W. 73°6, N. 45°5 E.S.T.	a	b	P
				°	h m	m	m	°	h m	m	m	°
Jan. 5	3290	7.3	I	51	Low				19 35.4	−1.0	−2.8	113
7	3512	5.8	I	72	17 26.3	−1.7	+0.9	57	Sun			
14	760	6.5	I	143	4 00.4	+0.2	−1.6	111	3 00.4	+0.1	−1.9	119
14	888	6.0	I	154	22 51.6	−1.8	−0.6	100	21 32.8	−1.8	−0.1	99
14/5	895	5.9	I	154	0 25.6	−1.4	−1.5	109	23 09.0	−1.6	−1.4	113
15	913	5.2	I	156	Graze				3 46.4	−0.9	+0.3	40
15	913	5.2	E	156	5 05.2	—	—	2	No occ.			
21	1688	6.3	E	235	No occ.				2 15.6	—	—	9
Feb. 6	299	6.3	I	76	Low				22 13.5	−0.5	+0.2	40
8	517	6.4	I	97	18 58.5	—	—	144	Sun			
10	798	6.4	I	120	18 31.4	−1.9	−0.3	115	Sun			
11/2	985	6.9	I	134	0 11.0	−0.4	−3.3	151	23 04.0	—	—	163
17	1623	5.4	E	202	1 26.6	−0.7	−2.2	342	0 16.6	−0.9	−1.4	329
18	1759	6.5	E	217	3 42.0	−0.6	−2.6	350	2 32.7	−0.9	−1.8	336
19	1888	6.2	E	231	2 42.8	−0.4	−2.2	349	1 35.5	−0.7	−1.2	335
22	2302	2.9	I	271	2 59.2	—	—	30	Low			
22	2302	2.9	E	271	3 19.4	—	—	357	Low			
22	2303	5.1	E	271	Graze				Low			
Mar. 5	374	6.1	I	56	21 26.9	−0.4	−0.2	50	20 21.4	−0.7	−0.3	53
8	760	6.5	I	90	21 51.0	—	—	29	20 32.7	−2.0	+1.5	40
10	1057	6.9	I	114	22 20.9	−1.0	−2.2	128	21 08.3	−1.1	−2.4	136
12	1309	5.7	I	138	18 50.7	−1.5	+3.5	52	Sun			
12	1318	5.7	I	139	20 58.3	−1.7	−0.5	111	19 42.3	−1.5	−0.2	115
16	1815	4.8	E	196	23 58.2	−1.7	+0.5	271	22 42.5	−1.6	+1.3	260
21	Nept.	7.7	E	254	07 04.3	−1.0	+0.9	213	05 51.9	−1.5	+0.7	221
Apr. 3	593	5.8	I	48	Low				21 18.3	+0.3	−1.9	116
5	862	7.5	I	71	21 43.0	—	—	176	No occ.			
5	863	6.7	I	71	21 52.0	—	—	169	No occ.			
7	1147	5.1	I	95	23 19.7	+0.1	−2.6	147	22 17.6	+0.1	−3.1	158
8	1256	7.1	I	106	19 22.5	−1.8	−0.5	103	Sun			
9	1384	7.4	I	120	No occ.				20 00.2	—	—	50
17	2343	6.4	E	220	2 17.0	−1.8	+0.3	266	1 00.3	−1.6	+0.8	261
17	2353	4.6	E	221	4 36.7	—	—	339	3 15.5	—	—	346
20	2826	4.0	I	260	4 19.9	—	—	16	3 07.6	—	—	11
20	2826	4.0	E	260	Sun				3 36.6	—	—	329
20	2828	6.0	E	260	Sun				3 37.9	−1.6	+2.5	204
24	3320	5.3	E	306	4 09.3	−0.7	+0.7	301	Low			
May 4	1106	3.6	I	65	22 28.3	+0.1	−1.7	116	21 27.0	−0.1	−2.0	123
5	1237	6.4	I	77	23 05.4	−0.3	−0.9	66	21 59.9	−0.6	−1.1	74
9	1587	6.0	I	117	Low				0 35.2	—	—	187
9	1705	7.5	I	130	23 26.2	−0.7	−2.4	156	22 17.1	−0.6	−2.6	167
10	1815	4.8	I	142	20 41.2	−1.4	−0.4	120	19 28.8	−1.0	−0.3	130
June 5	1662	6.3	I	98	21 59.2	−1.0	−1.5	101	20 46.3	−1.3	−1.4	107
7	1914	6.8	I	125	23 21.8	−1.2	−1.3	101	22 07.6	−1.4	−1.1	104
10	2192	6.2	I	153	0 34.7	—	—	28	Graze			
13	2828	6.0	E	206	23 07.6	−1.3	+1.9	231	Low			
July 2	1623	5.4	I	67	21 06.3	−0.9	−0.6	58	Sun			
5	2002	6.8	I	108	22 25.0	—	—	179	21 11.8	—	—	180
6	2136	6.8	I	121	22 44.8	−1.4	−1.6	122	21 29.1	−1.5	−1.3	121
7	2275	5.9	I	134	20 57.7	−1.9	+0.3	79	Sun			
8	2296	7.1	I	136	Low				0 15.8	−1.3	−2.1	132
9	2456	6.2	I	149	Low				0 38.6	−0.8	−0.2	52
14	3185	5.3	E	212	2 16.5	−2.1	+0.1	270	0 55.4	−2.1	+0.2	284
14	3187	6.2	E	213	2 37.2	−0.7	+2.3	194	1 29.2	−1.2	+1.8	211
Aug. 4	2394	6.5	I	117	22 12.0	−1.7	−1.7	126	20 53.7	−1.7	−1.2	120
6/7	2715	6.5	I	144	0 34.1	−1.0	−0.4	64	23 23.3	−1.1	+0.1	52
13	3515	6.2	E	217	Sun				2 46.0	−2.2	−0.4	273
28	1925	1.2	I	46	19 27.5	−0.7	−2.0	131	18 17.7	−0.9	−1.9	129
28	1925	1.2	E	46	Low				19 16.9	−0.6	−1.2	264
Sept. 3	2826	4.0	I	125	23 02.6	−1.2	−0.5	72	21 49.5	−1.3	0.0	59

Date	Z.C. No.	Mag.	I or E	Elong. of Moon	HALIFAX W. 63°6, N. 44°6				MONTREAL W. 73°6, N. 45°5			
					A.S.T.	a	b	P	E.S.T.	a	b	P
				°	h m	m	m	°	h m	m	m	°
Sept. 5	2968	6.2	I	139	Low				0 53.8	−0.6	−0.3	55
5	2969	3.2	I	139	Low				1 00.4	−0.6	−0.5	59
11	272	5.9	E	218	23 03.4	−0.6	+2.3	229	22 00.2	−0.4	+2.0	240
29	2611	6.8	I	82	20 15.2	−1.2	−0.6	71	19 02.4	−1.3	−0.1	61
Oct. 3	3184	7.1	I	132	23 26.8	−1.5	−0.9	84	22 11.1	−1.5	−0.1	69
3	3185	5.3	I	132	23 30.2	−1.7	−1.4	96	22 12.3	−1.7	−0.4	81
11	590	6.3	E	220	22 11.8	0.0	+2.7	218	21 14.3	+0.1	+2.2	230
15	1029	5.1	E	255	3 13.3	−1.5	+2.8	234	2 02.9	−1.1	+2.4	242
16	1147	5.1	E	267	2 32.2	−0.8	+3.0	233	1 28.3	−0.5	+2.4	242
28	2871	7.1	I	76	18 29.0	−1.5	+0.1	62	Sun			
30	3154	7.4	I	102	23 12.4	−0.4	+0.1	45	22 08.6	−0.4	+0.7	31
Nov. 2	3515	6.2	I	136	23 11.6	−1.4	+0.4	55	21 58.7	−1.3	+1.2	42
9	730	5.1	E	204	No occ.				5 46.5	—	—	346
9/0	832	4.7	E	213	0 12.1	—	—	195	23 11.4	−0.6	+3.8	214
11/2	1106	3.6	I	236	1 08.0	−1.4	−0.6	132	23 55.2	−1.1	+0.2	124
12	1106	3.6	E	236	2 14.9	−1.7	+2.2	244	1 01.9	−1.3	+2.1	249
13	1237	6.4	E	249	4 04.2	−2.1	+1.2	255	2 46.0	−1.8	+1.7	253
14	1359	5.1	E	262	Sun				5 16.6	−1.6	−1.2	305
26	3093	4.5	I	70	20 12.0	—	—	1	No occ.			
Dec. 2	272	5.9	I	137	17 12.2	−0.7	+1.8	72	Sun			
2	284	7.4	I	138	19 37.1	−1.6	+1.3	76	18 24.9	−1.1	+1.9	62
4	422	5.5	I	151	2 30.7	−1.0	+0.4	42	1 20.2	−1.2	+0.6	43
10	1309	5.7	E	229	22 55.4	−0.9	−1.9	340	21 43.0	—	—	359
11	1318	5.7	E	230	1 32.2	−1.7	+1.5	259	0 19.0	−1.2	+1.7	259
11	1332	5.7	E	232	Sun				5 57.1	−0.4	−3.1	338
26	3420	7.1	I	73	17 34.5	−0.5	+3.0	8	No occ.			
29/0	264	7.0	I	109	0 40.6	−0.3	−1.3	84	23 34.7	−0.6	−1.3	84
31	380	7.4	I	120	1 42.0	0.0	−2.4	118	0 38.3	−0.3	−2.8	121
31	469	7.3	I	129	18 47.8	−2.5	−0.8	124	17 28.1	−1.5	+0.7	106

LUNAR OCCULTATIONS VISIBLE AT TORONTO AND WINNIPEG, 1976

Date	Z.C. No.	Mag.	I or E	Elong. of Moon	TORONTO W. 79°4, N. 43°7				WINNIPEG W. 97°2, N. 49°9			
					E.S.T.	a	b	P	C.S.T.	a	b	P
				°	h m	m	m	°	h m	m	m	°
Jan. 5	3290	7.3	I	51	19 33.7	−1.4	−3.0	116	18 00.2	−1.3	−0.5	74
14	760	6.5	I	143	3 04.7	+0.1	−2.3	129	1 46.7	−0.4	−2.6	129
14	888	6.0	I	154	21 22.2	−1.8	0.0	104	20 01.4	−1.0	+1.6	77
14	895	5.9	I	154	23 01.8	−1.8	−1.6	122	21 26.8	−1.5	+0.2	102
15	913	5.2	I	156	3 41.6	−0.8	−0.3	56	2 20.7	−1.2	−0.3	59
21	1688	6.3	E	235	2 20.7	−0.5	−2.1	346	1 02.1	−0.3	−1.6	346
27	2509	6.0	E	315	6 20.5	−1.8	+2.5	225	No occ.			
Feb. 3	3494	4.6	I	42	19 58.6	−0.5	−1.9	98	18 37.2	−0.9	−0.7	69
5	186	7.1	I	65	22 02.4	0.0	−3.5	130	20 37.1	−0.8	−2.2	105
6	299	6.3	I	76	22 10.1	−0.6	−0.1	50	20 57.4	−1.0	+1.0	31
7	423	6.4	I	88	23 45.3	—	—	7	No occ.			
8	434	6.9	I	88	No occ.				0 15.5	0.0	−1.6	93
11	985	6.9	I	134	No occ.				21 26.2	—	—	167
16/7	1623	5.4	E	202	0 12.6	−1.1	−0.8	317	22 53.4	−0.7	−0.3	319
18	1759	6.5	E	217	2 29.6	−1.1	−1.3	323	1 06.0	−0.9	−0.4	316
19	1888	6.2	E	231	1 32.6	−0.9	−0.6	321	0 19.0	−0.4	0.0	318
Mar. 5	374	6.1	I	56	20 17.8	−0.8	−0.5	62	18 58.8	−1.2	+0.5	45
7	639	6.0	I	80	No occ.				23 08.3	+0.1	−2.6	130
8	760	6.5	I	90	20 19.4	−2.0	+0.8	53	18 56.0	—	—	32
10	1057	6.9	I	114	21 06.6	−1.1	−3.2	149	19 27.1	−1.5	−1.7	137
10/1	1072	6.2	I	115	0 28.5	−1.5	+0.5	44	23 01.5	−1.8	+0.4	51
12	1318	5.7	I	139	19 34.5	−1.4	−0.4	124	No occ.			
16	1815	4.8	E	196	22 29.7	−1.8	+2.3	244	21 21.6	−0.9	+2.3	248
17	1853	4.9	E	200	No occ.				5 30.2	−0.7	−1.3	269
21	Nept.	7.7	E	254	5 40.3	−1.9	+1.3	218	4 14.4	−1.9	+1.5	225

Date	Z.C. No.	Mag.	I or E	Elong. of Moon	TORONTO W. 79°.4, N. 43°.7 E.S.T.	a	b	P	WINNIPEG W. 97°.2, N. 49°.9 C.S.T.	a	b	P
				°	h m	m	m	°	h m	m	m	°
Apr. 2	466	7.3	I	38	No occ.				20 54.6	+0.1	−1.9	108
3	593	5.8	I	48	21 23.8	+0.3	−2.3	127	20 08.9	−0.3	−2.6	123
7	1147	5.1	I	95	22 26.4	—	—	177	No occ.			
9	1384	7.4	I	120	19 41.4	−2.3	+1.4	69	No occ.			
11	1528	6.6	I	136	2 26.4	−0.6	−0.4	55	1 06.0	−1.3	−0.5	57
11	1623	5.4	I	148	21 35.8	—	—	58	20 09.2	−1.7	+2.4	63
15	2182	6.3	E	206	23 18.4	−0.1	−1.5	344	No occ.			
16	2192	6.2	E	207	2 36.6	—	—	357	1 10.6	—	—	352
17	2343	6.4	E	220	0 48.8	−1.7	+1.3	253	No occ.			
17	2353	4.6	E	221	3 11.4	—	—	337	1 42.5	−0.6	−1.1	339
20	2826	4.0	I	260	2 51.5	—	—	21	No occ.			
20	2826	4.0	E	260	3 29.5	—	—	322	No occ.			
20	2828	6.0	E	260	3 23.3	—	—	198	No occ.			
May 4	1106	3.6	I	65	21 30.3	−0.1	−2.2	132	20 10.8	−0.5	−2.5	137
5	1237	6.4	I	77	21 58.2	−0.7	−1.2	84	20 33.6	−1.1	−1.2	90
9	1705	7.5	I	130	22 20.7	—	—	184	No occ.			
16	2591	6.5	E	215	No occ.				2 10.4	−1.5	−0.2	301
June 5	1662	6.3	I	98	20 41.2	−1.4	−1.4	116	No occ.			
7	1914	6.8	I	125	22 01.0	−1.5	−1.1	111	No occ.			
9	2192	6.2	I	153	23 04.2	—	—	38	21 32.9	—	—	42
July 6	2136	6.8	I	121	21 22.3	−1.6	−1.2	126	No occ.			
6	2147	7.0	I	122	No occ.				22 37.2	−1.3	−1.4	120
7/8	2296	7.1	I	136	0 11.7	−1.5	−2.0	132	22 36.4	−1.5	−0.9	116
7	2302	2.9	I	136	No occ.				23 46.7	−1.2	−1.1	97
7	2303	5.1	I	136	No occ.				23 46.8	−1.2	−1.1	96
8/9	2456	6.2	I	149	0 33.3	−1.1	0.0	51	23 16.2	—	—	25
13/4	3185	5.3	E	212	0 42.7	−2.0	+0.4	287	23 16.3	—	—	314
14	3187	6.2	E	213	1 18.8	−1.3	+1.9	214	0 07.5	−1.1	+1.7	237
Aug. 4	2394	6.5	I	117	20 45.2	−1.8	−1.0	123	No occ.			
6	2715	6.5	I	144	23 15.7	−1.3	+0.3	50	21 58.6	—	—	22
13	3515	6.2	E	217	2 33.1	−2.4	−0.2	276	No occ.			
18	577	6.0	E	272	No occ.				2 28.3	+0.1	+3.2	205
19	718	6.1	E	284	No occ.				3 53.8	−0.8	+1.7	257
28	1925	1.2	I	46	18 15.4	−1.1	−1.9	133	16 44.7	−1.2	−1.3	133
28	1925	1.2	E	46	19 15.2	−0.8	−1.1	261	17 50.1	−1.2	−1.0	268
Sept. 3	2826	4.0	I	125	21 40.8	−1.5	+0.3	57	20 20.5	−1.3	+1.4	33
4/5	2968	6.2	I	139	0 50.5	−0.7	−0.2	54	23 44.0	−0.1	+1.7	11
4/5	2969	3.2	I	139	0 57.4	−0.7	−0.3	58	23 48.4	−0.3	+1.3	17
5	2969	3.2	E	139	No occ.				0 33.0	−1.8	−2.5	302
11	272	5.9	E	218	21 54.5	−0.3	+2.0	241	No occ.			
15	658	4.2	I	252	No occ.				Graze			
17	943	6.2	E	276	No occ.				4 09.1	—	—	332
20	1332	5.7	E	313	No occ.				4 52.8	−0.6	−0.3	322
29	2611	6.8	I	82	18 54.0	−1.6	+0.1	61	No occ.			
29	2629	6.3	I	83	No occ.				20 30.1	−1.3	−1.2	99
Oct. 2	3051	7.0	I	119	No occ.				18 42.5	−1.6	+0.6	109
3	3184	7.1	I	132	22 01.5	−1.7	+0.3	66	20 42.0	−1.1	+1.5	34
3	3185	5.3	I	132	22 02.4	−1.9	−0.1	78	20 38.2	−1.3	+1.3	47
3	3187	6.2	I	132	No occ.				21 29.0	—	—	126
11	590	6.3	E	220	21 11.1	+0.2	+2.1	232	No occ.			
15	1029	5.1	E	255	1 52.9	−0.8	+2.5	239	0 53.7	−0.5	+1.5	269
16	1147	5.1	E	267	1 21.7	−0.3	+2.4	240	0 30.5	−0.1	+1.4	271
18	1397	5.5	E	294	No occ.				5 35.5	−1.2	+0.5	288
27	2731	6.5	I	64	No occ.				19 45.5	−0.1	+0.9	20
30	3154	7.4	I	102	22 04.4	−0.6	+0.9	30	No occ.			
31	3281	7.5	I	114	No occ.				21 03.5	−2.0	−1.0	103
Nov. 2	3515	6.2	I	136	21 48.4	−1.4	+1.6	39	No occ.			
4	98	6.2	I	149	3 30.2	−0.3	−0.5	60	2 20.1	−0.7	+0.3	38
9	730	5.1	E	204	5 56.5	−0.1	−3.7	325	4 21.7	—	—	337
9	832	4.7	E	213	23 01.8	−0.3	+3.8	213	22 10.6	−0.4	+2.0	250

					TORONTO W. 79°.4, N. 43°.7				WINNIPEG W. 97°.2, N. 49°.9			
Date	Z.C. No.	Mag.	I or E	Elong. of Moon	E.S.T.	a	b	P	C.S.T.	a	b	P
				°	h m	m	m	°	h m	m	m	°
Nov. 9	836	5.5	E	213	No occ.				22 47.3	−0.4	+2.7	229
11	1106	3.6	I	236	23 49.2	−0.9	+0.1	127	22 45.1	−0.2	+1.3	96
11/2	1106	3.6	E	236	0 51.1	−1.0	+2.4	244	23 48.9	−0.5	+1.4	273
13	1237	6.4	E	249	2 32.5	−1.6	+2.4	245	1 23.7	−0.8	+1.5	268
14	1359	5.1	E	262	5 08.6	−1.8	−0.6	294	3 40.2	−1.2	−0.1	302
24	2826	4.0	I	45	No occ.				18 16.6	−1.1	−1.2	94
25	2968	6.2	I	58	No occ.				19 34.3	−0.7	−0.5	61
25	2969	3.2	I	58	No occ.				19 41.1	−0.7	−0.6	64
30	64	6.6	I	118	No occ.				23 07.1	—	—	129
Dec. 2	284	7.4	I	138	18 15.4	−0.9	+2.0	60	17 21.3	−0.1	+2.6	30
3/4	422	5.5	I	151	1 11.7	−1.4	+0.4	51	23 55.3	−1.3	+3.0	21
9	1106	3.6	I	210	No occ.				6 32.7	−0.6	−1.6	97
9	1106	3.6	E	210	No occ.				7 36.3	−0.1	−1.9	293
10/1	1318	5.7	E	230	0 09.0	−1.0	+2.1	252	23 06.8	−0.4	+1.3	277
11	1332	5.7	E	232	5 58.4	−0.8	−2.6	325	4 25.8	−1.2	−1.9	320
24	3184	7.1	I	51	No occ.				19 40.6	−0.2	+0.7	25
24	3185	5.3	I	51	No occ.				19 36.3	−0.4	+0.1	39
24	3187	6.2	I	51	No occ.				20 07.3	−0.9	−2.3	109
29	252	7.4	I	108	No occ.				18 43.8	−2.1	−0.1	104
29	264	7.0	I	109	23 32.9	−0.8	−1.5	91	22 07.0	−1.3	−0.4	68
30	272	5.9	I	110	No occ.				0 25.3	−0.5	−1.3	82
30/1	380	7.4	I	120	0 42.1	−0.4	−3.7	133	23 08.0	−1.3	−2.2	110

LUNAR OCCULTATIONS VISIBLE AT EDMONTON AND VANCOUVER, 1976

					EDMONTON W. 113°.4, N. 53°.6				VANCOUVER W. 123°.1, N. 49°.2			
Date	Z.C. No.	Mag.	I or E	Elong. of Moon	M.S.T.	a	b	P	P.S.T.	a	b	P
				°	h m	m	m	°	h m	m	m	°
Jan. 3	3051	7.0	I	28	18 00.3	−1.5	−3.2	125	Sun			
9	241	6.9	I	97	No occ.				22 35.2	−0.9	+1.9	19
13/4	760	6.5	I	143	0 26.6	−0.9	−2.5	130	23 33.6	—	—	159
14	888	6.0	I	154	18 57.1	−0.4	+2.4	55	17 44.2	−0.2	+2.2	60
14	895	5.9	I	154	20 09.2	−1.0	+1.3	85	18 54.3	−0.8	+1.3	91
14/5	913	5.2	I	156	0 57.9	−1.4	0.0	63	23 43.8	−1.6	−0.3	84
20	1587	6.0	E	225	7 05.7	−1.0	−1.1	247	5 53.0	—	—	222
20	1688	6.3	E	235	23 53.5	−0.1	−1.4	348	Low			
22	1815	4.8	E	250	No occ.				2 07.7	−0.4	−1.0	337
25	2217	5.5	E	291	5 49.9	—	—	210	No occ.			
Feb. 2	3370	6.2	I	32	18 11.4	−0.8	−1.2	79	Sun			
5	186	7.1	I	65	19 13.3	−1.3	−1.2	88	18 04.0	−1.8	−1.2	97
6	299	6.3	I	76	19 48.5	—	—	9	18 26.2	−1.2	+2.4	25
7	423	6.4	I	88	No occ.				20 03.0	—	—	8
7	434	6.9	I	88	23 06.5	−0.4	−1.7	93	22 10.6	−0.6	−2.3	111
11	985	6.9	I	134	19 51.0	−1.4	−1.8	147	Graze			
16	1623	5.4	E	202	21 44.7	−0.4	0.0	322	Low			
17	1662	6.3	E	206	5 24.4	−0.5	−2.1	334	4 26.9	−0.8	−1.9	320
17	1759	6.5	E	217	23 53.5	−0.6	+0.2	311	22 45.5	−0.6	+0.7	291
Mar. 3	143	6.8	I	35	19 56.4	−0.5	+1.5	16	18 47.8	−0.6	+0.4	37
7	639	6.0	I	80	21 57.2	−0.3	−3.0	133	Graze			
7/8	654	6.0	I	81	0 07.1	−0.2	−0.9	58	23 09.8	−0.2	−1.2	76
9	796	6.8	I	93	Low				0 29.5	−0.3	−0.5	50
10	943	6.2	I	104	0 58.4	+0.1	−2.1	124	0 09.4	+0.1	−2.6	143
10	1072	6.2	I	115	21 34.7	−1.7	+0.7	58	20 16.0	−1.8	+0.2	81
11	1091	6.7	I	117	2 16.5	0.0	−1.7	105	1 24.2	0.0	−1.9	118
11	1212	7.1	I	129	No occ.				22 47.3	−2.0	+0.5	58
12	1332	5.7	I	141	No occ.				20 45.5	−1.9	+1.7	66
17	1853	4.9	E	200	4 10.7	−1.1	−1.1	269	3 01.5	−1.6	−0.5	257
21	Nept.	7.7	E	254	2 52.9	−1.7	+2.6	216	No occ.			

Date	Z.C. No.	Mag.	I or E	Elong. of Moon	EDMONTON W. 113°.4, N. 53°.6				VANCOUVER W. 123°.1, N. 49°.2			
					M.S.T.	a	b	P	P.S.T.	a	b	P
				°	h m	m	m	°	h m	m	m	°
Apr. 10	1528	6.6	I	136	23 40.7	−1.5	−0.5	70	22 28.0	−1.6	−0.6	91
12	1662	6.3	I	152	2 43.3	−0.8	−0.9	57	1 38.5	−1.1	−1.0	71
15/6	2192	6.2	E	207	0 01.1	−0.3	−0.6	338	22 57.3	−0.6	+0.1	315
21	2969	3.2	I	274	No occ.				3 01.8	—	—	6
21	2969	3.2	E	274	No occ.				3 26.3	—	—	327
May 7	1482	6.3	I	105	No occ.				22 53.5	−1.4	−0.3	53
9	1605	6.2	I	119	Low				0 59.2	—	—	182
10	1726	6.9	I	132	1 01.0	−0.5	−2.2	160	0 07.8	−0.3	−3.0	175
10	1727	7.1	I	132	No occ.				0 18.8	−1.3	−0.3	51
11	1853	4.9	I	146	1 03.2	−0.8	−1.6	127	0 01.2	−1.0	−1.7	137
14	2302	2.9	I	190	Sun				3 45.9	−0.9	−0.9	76
15/6	2591	6.5	E	215	0 50.4	−1.0	+0.5	303	23 38.3	−0.9	+0.8	291
17	2774	6.3	E	229	Sun				1 22.0	—	—	199
31	1091	6.7	I	37	Low				20 58.3	0.0	−1.2	77
July 5	2021	6.7	I	109	22 16.6	−1.2	−0.4	49	21 04.3	−1.6	−0.2	61
7	2302	2.9	I	136	22 22.4	−1.4	−0.4	91	21 09.2	−1.6	−0.1	99
7	2302	2.9	E	136	23 34.0	−1.2	−1.0	281	22 24.8	−1.5	−0.7	277
7	2303	5.1	I	136	22 22.6	−1.4	−0.4	91	21 09.3	−1.6	−0.1	98
8	2456	6.2	I	149	Graze				Sun			
18	146	4.4	I	260	Sun				2 26.4	−1.2	+1.3	93
18	146	4.4	E	260	Sun				3 34.2	−0.9	+2.3	216
Aug. 6/7	2733	6.4	I	145	0 07.0	−0.9	−0.2	49	22 56.5	−1.2	+0.3	49
18	577	6.0	E	272	1 37.7	0.0	+2.3	231	0 29.0	+0.2	+2.1	231
19	718	6.1	E	284	2 49.0	−0.5	+1.4	279	1 39.2	−0.3	+1.3	278
28	1925	1.2	I	46	15 23.1	−1.0	−0.8	141	14 19.7	−0.6	−1.5	162
28	1925	1.2	E	46	16 25.2	−1.5	−0.4	263	15 07.9	−2.1	+0.7	245
Sept. 13	422	5.5	E	232	3 53.3	−2.2	−2.3	309	2 38.7	−2.4	−1.2	301
14	658	4.2	I	252	23 51.5	−0.4	+1.0	120	22 44.6	−0.2	+0.8	121
14/5	658	4.2	E	252	0 39.5	0.0	+2.7	219	23 29.4	+0.3	+2.5	218
17	934	6.4	E	275	1 41.6	+0.5	+4.1	204	0 30.7	—	—	197
20	1332	5.7	E	313	3 41.5	−0.5	−1.8	348	No occ.			
27	2322	4.3	I	57	Low				18 30.3	−1.3	−1.6	120
28	2465	7.4	I	70	19 04.7	−1.6	−1.9	144	Sun			
29	2629	6.3	I	83	19 05.5	−1.4	−0.4	84	Sun			
Oct. 3	3184	7.1	I	132	19 34.9	−0.6	+2.5	10	Sun			
3	3185	5.3	I	132	19 26.4	−0.9	+1.9	28	18 07.9	−0.9	+2.3	29
3	3187	6.2	I	132	19 55.5	−1.5	+0.7	99	18 37.1	−1.4	+1.0	99
13	764	5.0	E	235	4 42.8	−1.6	+0.2	256	3 23.0	−1.7	+1.4	243
14	1029	5.1	E	255	23 53.4	−0.2	+1.1	289	Low			
18	1397	5.5	E	294	4 23.0	−0.7	+0.7	295	3 13.2	−0.5	+1.1	282
27	2733	6.4	I	64	18 43.0	—	—	149	Sun			
27	2745	6.9	I	65	Low				19 14.8	−0.9	−0.6	65
31	3281	7.5	I	114	19 34.6	−1.5	+0.6	78	18 16.0	−1.5	+1.1	76
Nov. 1/2	3420	7.1	I	127	0 55.0	−0.8	−2.1	103	23 54.9	−1.4	−2.6	112
3/4	98	6.2	I	149	1 12.2	−0.7	+1.9	16	23 56.7	−1.0	+1.6	27
9	730	5.1	E	204	No occ.				1 48.3	—	—	324
9	832	4.7	E	213	21 13.1	−0.1	+1.6	270	20 06.4	+0.1	+1.4	269
9	836	5.5	E	213	21 50.8	+0.2	+2.0	252	20 41.7	+0.1	+1.8	250
11	1106	3.6	E	236	22 47.3	−0.2	+1.1	292	Low			
12/3	1237	6.4	E	249	0 19.2	−0.4	+1.2	284	23 11.0	−0.1	+1.3	277
14	1359	5.1	E	262	2 24.6	−0.8	+0.1	311	1 16.2	−0.6	+0.6	297
24	2826	4.0	I	45	16 54.5	−1.2	−0.4	73	Sun			
25	2968	6.2	I	58	18 21.9	−0.7	+0.3	36	17 11.6	−1.0	+0.8	35
25	2969	3.2	I	58	18 28.0	−0.7	+0.1	40	17 17.9	−1.0	+0.6	39
25	2969	3.2	E	58	19 27.7	−1.1	−1.6	281	18 21.4	−1.5	−1.3	281
28	3366	6.6	I	95	21 08.9	−1.5	−1.7	104	19 58.8	−2.1	−1.5	106
30	64	6.6	I	118	21 30.2	−1.7	−0.9	97	20 14.9	−2.1	−0.5	99
Dec. 9	1106	3.6	I	210	5 13.3	−1.0	−1.6	104	4 10.5	−1.1	−1.9	122
9	1106	3.6	E	210	6 23.4	−0.6	−1.8	286	5 22.4	−1.1	−1.3	269
10	1318	5.7	E	230	22 06.6	−0.1	+1.0	294	Low			

Date	Z.C. No.	Mag.	I or E	Elong. of Moon	EDMONTON W. 113.°4, N. 53.°6 M.S.T.	a	b	P	VANCOUVER W. 123.°1, N. 49.°2 P.S.T.	a	b	P
				°	h m	m	m	°	h m	m	m	°
Dec. 11	1332	5.7	E	232	3 01.1	−1.1	−1.1	318	1 51.4	−1.4	−0.1	299
23	3051	7.0	I	38	18 19.7	−1.0	−1.5	97	17 14.3	−1.4	−1.3	98
24	3185	5.3	I	51	18 34.8	+0.1	+2.0	5	17 25.3	−0.1	+2.3	7
24	3187	6.2	I	51	18 45.9	−1.0	−1.0	83	17 38.2	−1.4	−0.8	84
28	132	6.9	I	98	19 01.4	−2.1	−1.1	113	17 42.7	−2.4	−0.5	113
29	252	7.4	I	108	17 21.1	−1.2	+1.5	79	Sun			
29	264	7.0	I	109	20 46.7	−1.3	+0.9	48	19 28.5	−1.5	+1.3	53
29	272	5.9	I	110	23 09.4	−0.9	−0.9	71	22 02.8	−1.3	−1.0	83
30	284	7.4	I	111	1 24.4	−0.3	0.0	38	0 21.5	−0.5	−0.5	56
30	380	7.4	I	120	21 38.4	−1.6	−0.8	93	20 24.1	−2.0	−0.6	100

NAMES OF OCCULTED STARS

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

Z.C. No.	Name	Z.C. No.	Name	Z.C. No.	Name	Z.C. No.	Name
64	116 B. Psc	796	352 B. Tau	1605	62 Leo	2509D	190 B. Oph
98	60 Psc	798	353 B. Tau	1623	69 Leo	2591	16 G. Sgr
132	169 B. Psc	832	119 Tau	1662	388 B. Leo	2611	−19° 4832
143	+8°158	836	120 Tau	1688D	431 B. Leo	2629D	39 G. Sgr
146	ε Psc	862	+18° 920	1705	−2° 3411	2715	89 G. Sgr
186D	222 B. Psc	863	127 Tau	1726	24 B. Vir.	2731	−18° 5079
241	281 B. Psc	888	+19°1110	1727	18 G. Vir.	2733	−19° 5182
252	+9°206	895	57 Ori	1759D	78 B. Vir	2745D	−18° 5115
264	300 B. Psc	913	64 Ori	1815	χ Vir	2774	173 B. Sgr
272	54 Cet	934	+18°1112	1853	ψ Vir	2826	ρ Sgr
284	+10°257	943	19 B. Gem	1888	50 Vir	2828	45 Sgr
299	12 H! Ari	985	+18°1214	1914	62 Vir	2871D	−17° 5699
374	29 Ari	1029	26 Gem	1925	α Vir	2927	337 B. Sgr
380	+13°411	1057	98 B. Gem	2002	607 B. Vir	2968D	16 B. Cap
422	σ Ari	1072	110 B. Gem	2021	672 B. Vir	2969	β Cap
423	124 B. Ari	1091	+17°1518	2136	47 B. Lib	3051	87 B. Cap
434	+15°414	1106D	λ Gem	2147	64 B. Lib	3093	ν Aqr
466	+15°447	1147	68 Gem	2182	26 Lib	3154	−10° 5696
469	+15°450	1212	+15° 1734	2192	28 Lib	3184	117 G. Cap
517	26 B. Tau	1237	+14° 1850	2217	11 H. Lib	3185	46 Cap
577	148 B. Tau	1256	+14° 1879	2275D	47 Lib	3187	47 Cap
590	162 B. Tau	1309	45 Cnc	2296	49 B. Sco	3281	162 B. Aqr
593	163 B. Tau	1318	50 Cnc	2302D	β Sco	3290	−5° 5790
639	85 H! Tau	1332	60 Cnc	2303D	56 B. Sco	3320	κ Aqr
654	234 B. Tau	1359	κ Cnc	2322D	ν Sco	3366	255 B. Aqr
658D	68 Tau	1384	+10° 1972	2343	58 G. Sco	3370	6 G. Psc
718	302 B. Tau	1397D	ω Leo	2353	ψ Oph	3420	−2° 5914
730	97 Tau	1482	14 Sex	2394	123 B. Sco	3494	λ Psc
760D	333 B. Tau	1528	84 B. Sex	2456	109 B. Oph	3512	22 Psc
764D	104 Tau	1587D	55 Leo	2465	−20° 4661	3515	25 Psc

GRAZING OCCULTATIONS OVER CANADA DURING 1976

BY L. V. MORRISON

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

Observers positioned on, or very near, one of these tracks will probably see the star disappear and reappear several times at the edge of features on the limb of the Moon. The recorded times of these events (to a precision of a second, if possible) are very valuable in the study of the shape and motion of the Moon currently being investigated at the Royal Greenwich Observatory and the U.S. Naval Observatory. Observers situated near to any of these tracks who are interested should write to Dr. David W. Dunham, Cincinnati Observatory, Observatory Place, Cincinnati, Ohio, 45208, U.S.A., at least two months before the event, giving their approximate latitude and longitude, and details of the event will be supplied.*

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

The numbering of the graze tracks differs slightly from that in previous years; there is no longer a continuous sequence. This arises from the method of preparing and editing the maps. It is easier and safer to preserve the original computer sequential numbering, even when certain tracks are later eliminated.

**Editor's Note*: A nominal fee is now charged for this service.

No.	Date	Name	Z.C.	Mag.	U.T.	%	L	No.	Date	Name	Z.C.	Mag.	U.T.	%	L
					h m								h m		
2	Jan. 6	−5° 5790	3290	7.3	0 57	19	S	21	Mar. 9	107 Tau	769	6.6	2 40	51	N
3	9	+9° 158	201	7.5	21 22	54	S	23	20	41 Lib	2233	5.5	3 43	76	S
4	10	π Psc	240	5.6	6 40	57	N	*24	20	47 Lib	2275	5.9	10 46	73	N
5	10	281 B. Psc	241	6.9	6 50	57	N	25	23	92 G. Sgr	2718	6.7	8 25	42	N
6	10	+13° 351	325	7.4	22 37	64	S	26	23	−19° 5182	2733	6.4	10 46	41	N
7	13	43 Tau	614	5.7	7 06	83	N	27	Apr. 5	312 B. Tau	736	6.2	3 36	26	N
8	22	−7° 3443	1809	6.9	9 07	67	S	*28	10	ω Leo	1397	5.5	5 21	77	N
9	24	2 G. Lib.	2063	6.7	7 10	45	S	29	20	ρ Sgr	2826	4.0	8 14	58	N
10	25	11 H. Lib	2217	5.5	12 36	32	S	30	20	45 Sgr	2828	6.0	7 51	58	S
11	Feb. 7	12 H^{1} Ari	299	6.3	2 51	38	N	*31	21	16 B. Cap	2968	6.2	11 06	47	N
11a	7	12 H^{1} Ari	299	6.3	3 23	38	N	†32	21	β Cap	2969	3.2	11 16	46	N
12	8	124 B. Ari	423	6.4	4 14	48	N	33	24	κ Aqr	3320	5.3	8 03	20	N
13	8	26 B. Tau	517	6.4	22 51	56	S	34	May 4	+18° 1214	985	6.9	3 08	20	N
14	10	282 B. Tau	691	6.6	3 27	68	N	†35	7	κ Cnc	1359	5.1	3 42	51	N
15	19	49 Vir	1884	5.3	5 46	81	S	36	8	14 Sex	1482	6.3	6 59	63	N
16	21	−17° 4273	2173	7.0	9 55	59	N	38	19	87 B. Cap	3051	7.0	9 33	64	S
17	22	58 G. Sco	2343	6.4	13 23	46	N	39	21	−5° 5790	3290	7.3	8 31	44	N
18	25	187 B. Sgr	2787	6.4	12 55	17	N	40	June 17	−7° 5727	3259	7.4	10 03	70	N
19	Mar. 6	29 Ari	374	6.1	1 40	22	N	41	18	6 G. Psc	3370	6.2	9 34	61	N
*20	9	333 B. Tau	760	6.5	1 11	50	N	43	23	+14° 469	413	6.8	8 33	16	N

No.	Date	Name	Z.C.	Mag.	U.T.	%	L	No.	Date	Name	Z.C.	Mag.	U.T.	%	L
					h m								h m		
44	June 23	σ Ari	422	5.5	10 08	16	S	67	Oct. 27	89 G. Sgr	2715	6.5	23 03	28	S
45	24	+16° 497	532	7.2	10 48	9	S	68	27	92 G. Sgr.	2718	6.7	23 28	28	S
46	July 6	607 B. Vir.	2002	6.8	2 08	65	S	69	28	−19° 5182	2733	6.4	1 43	29	S
†48	Aug. 1	α Vir	1925	1.2	15 27	35	S	70	Nov. 1	162 B. Aqr.	3281	7.5	3 26	70	S
49	17	145 B. Ari	450	6.6	8 33	57	N	72	18	28 Vir	1822	7.2	10 26	15	S
50	18	163 B. Tau	593	5.8	12 21	46	N	73	19	86 Vir	1971	5.8	13 10	7	S
51	20	119 Tau	832	4.7	6 20	29	S	75	25	ρ Sgr	2826	4.0	1 04	15	S
52	20	+18° 950	871	6.9	12 17	27	S	*76	28	231 B. Aqr.	3344	6.8	22 37	53	S
†53	28	α Vir	1925	1.2	22 43	15	S	*77	29	255 B. Aqr.	3366	6.6	4 23	55	S
54	Sept. 1	ψ Oph	2353	4.6	0 54	47	S	*78	Dec. 11	45 Cnc	1309	5.7	2 36	82	N
55	4	45 Sgr	2828	6.0	2 23	79	S	*79	13	36 Sex	1566	6.6	14 25	59	S
56	13	σ Ari	422	5.5	10 15	81	N	80	14	359 B. Leo	1649	6.3	6 17	52	N
†57	15	+17° 703	629	7.5	3 40	66	N	82	24	87 B. Cap	3051	7.0	1 52	11	S
58	15	+18° 629	643	6.7	5 16	65	N	83	24	10° 5714	3163	7.3	21 31	17	S
60	17	19 B. Gem	943	6.2	9 27	44	N	84	25	117 G. Cap	3184	7.1	1 54	19	N
61	17	+18° 1141	951	6.8	10 53	44	S	85	25	47 Cap	3187	6.2	2 28	19	S
62	19	+15° 1734	1212	7.1	10 35	24	N	86	29	169 B. Psc	132	6.9	1 57	57	S
63	29	−20° 4661	2465	7.4	2 21	33	S	87	29	ε Psc	146	4.4	6 08	58	N
65	Oct. 14	+18° 1040	904	7.1	10 39	70	N	88	30	+9° 206	252	7.4	0 58	66	S

NOTES ON DOUBLE STARS

Track 20: ZC 760 is the mean of the double star ADS 3672. The components are $7^{\mathrm{m}}.0$ and $7^{\mathrm{m}}.6$; separation $1''.2$ in p.a. 306°.

Track 24: ZC 2275 is the mean of the double star ADS 9834. The components are $6^{\mathrm{m}}.0$ and $8^{\mathrm{m}}.1$; separation $0''.5$ in p.a. 121°.

Track 28: ZC 1397 is the mean of the double star ADS 7390. The components are $5^{\mathrm{m}}.9$ and $6^{\mathrm{m}}.5$; separation $0''.5$ in p.a. 8°.

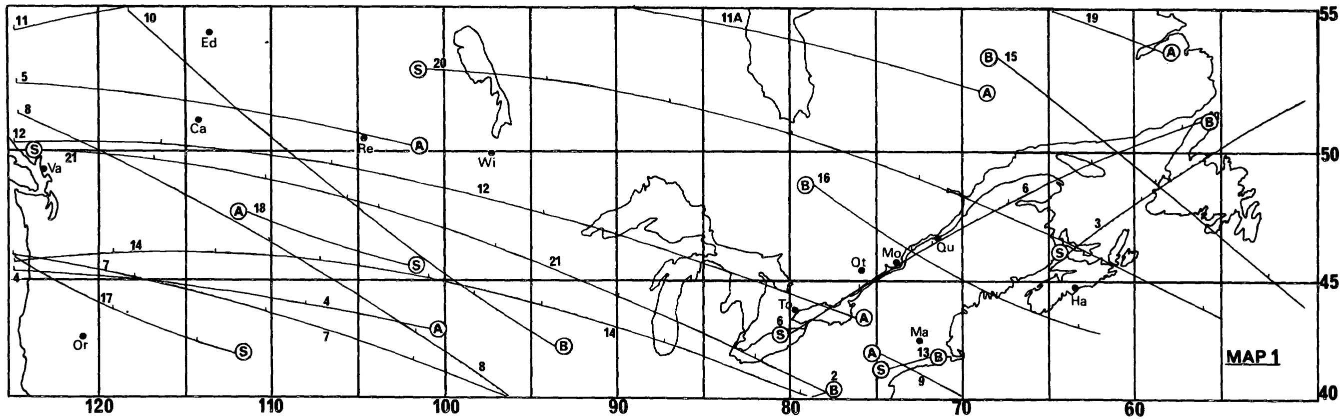
Track 31: ZC 2968 is the brighter component of the double star ADS 13717. The companion is 10th magnitude; separation $0''.8$ in p.a. 84°.

Track 76: ZC 3344 is the mean of the two brightest components of the system ADS 16270. These components are $7^{\mathrm{m}}.3$ and $7^{\mathrm{m}}.8$; separation $2''.4$ in p.a. 278°. A third component $8^{\mathrm{m}}.0$, has a separation of 49″ in p.a. 98°.

Track 77: ZC 3366 is the brighter component of the double star ADS 16392. The companion is 10th magnitude; separation $10''.4$ in p.a. 117°.

Track 78: ZC 1309 is the mean of a close double star. The components are both estimated to be $6^{\mathrm{m}}.4$ with separation $0''.05$.

Track 79: ZC 1566 is the mean of a possible close double star. The components are both estimated to be $7^{\mathrm{m}}.3$ with separation $0''.03$.


MAP 1
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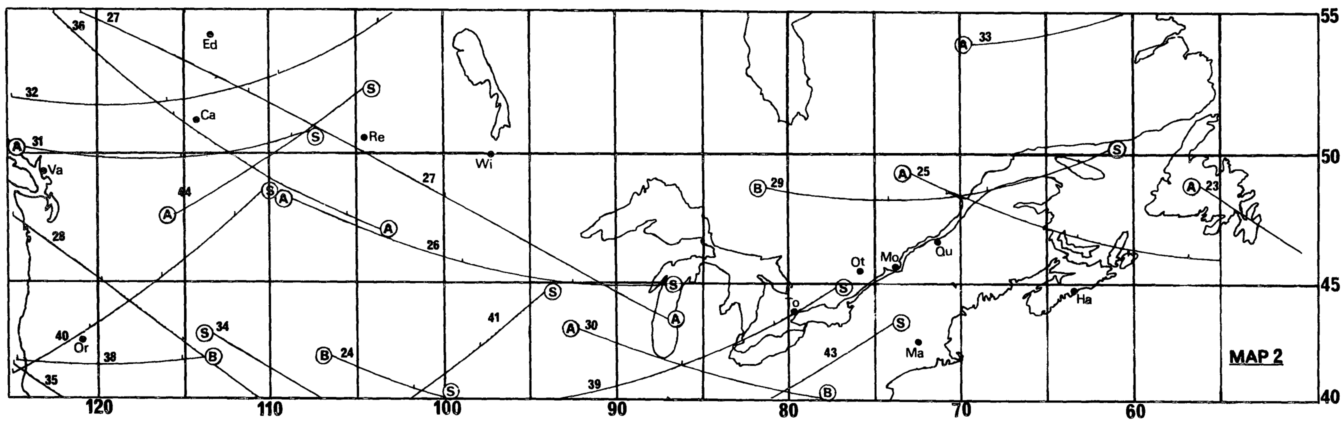
Map 1.


MAP 2
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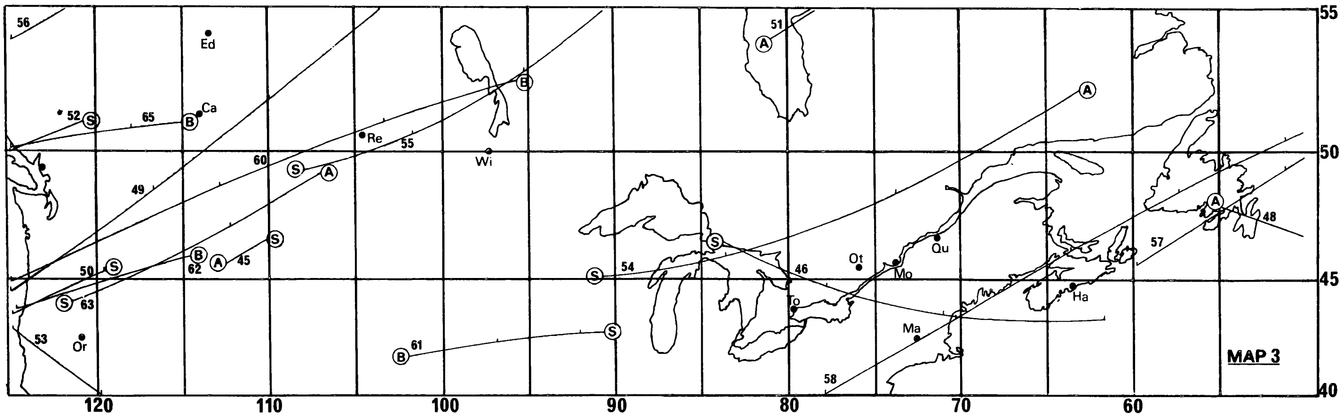
Map 2.


MAP 3
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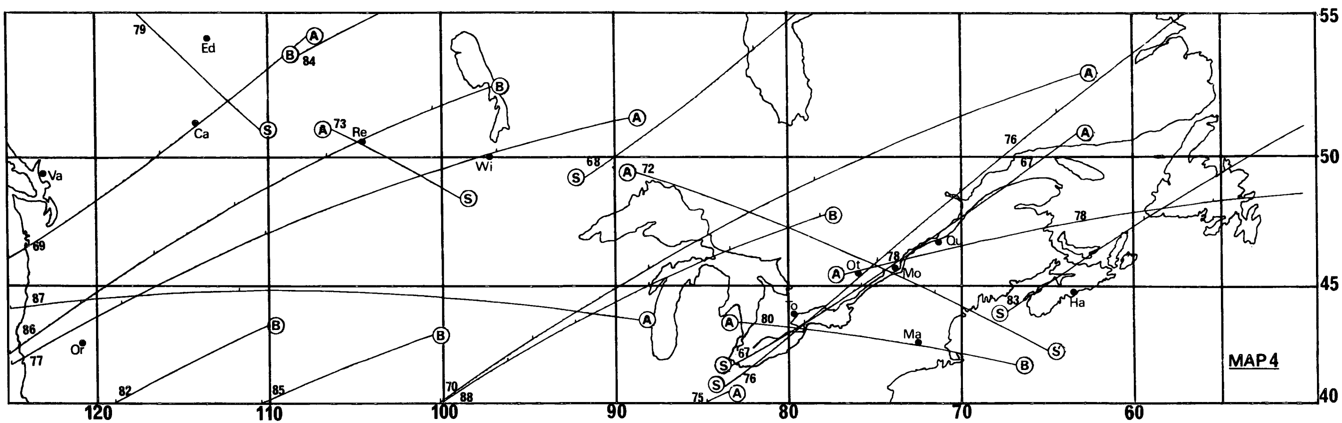
Map 3.


MAP 4
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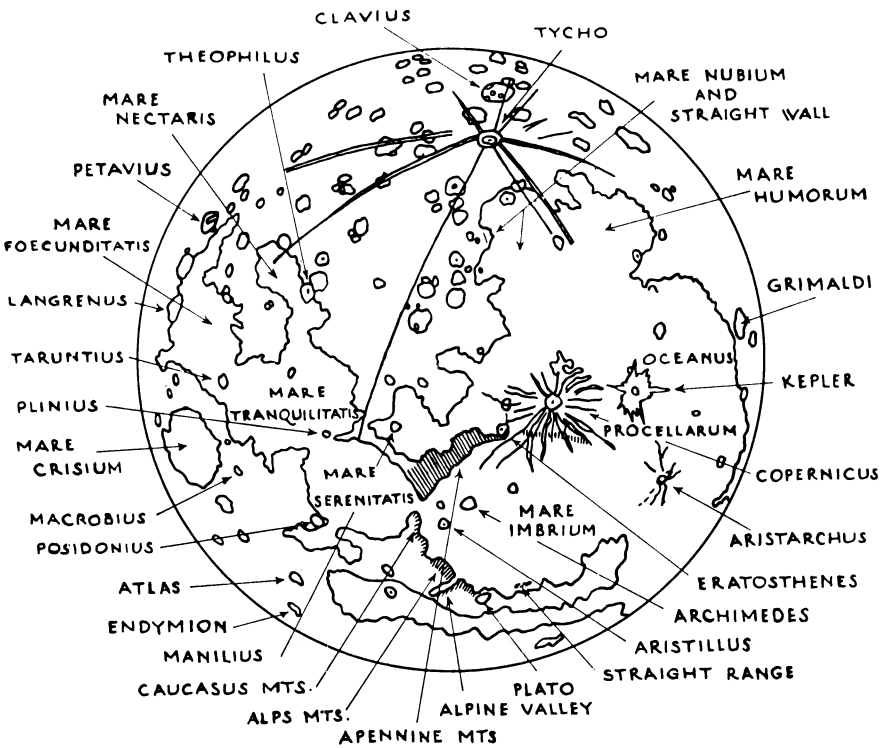
Map 4.

MAP OF THE MOON



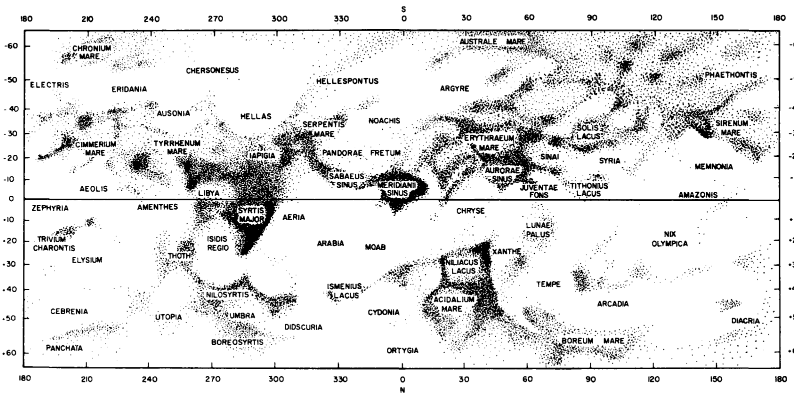
South appears at the top.

MARS—LONGITUDE OF THE CENTRAL MERIDIAN

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

Date	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
1	63.37	142.36	231.15	296.49	8.74	69.37	137.75	194.60
2	54.48	133.12	221.70	286.93	359.12	59.68	127.99	184.79
3	45.54	123.87	212.25	277.37	349.49	49.98	118.24	174.99
4	36.67	114.61	202.80	267.81	339.86	40.29	108.48	165.18
5	27.75	105.34	193.34	258.25	330.23	30.59	98.72	155.38
6	18.82	96.06	183.87	248.68	320.59	20.89	88.96	145.57
7	9.87	86.77	174.40	239.11	310.95	11.19	79.20	135.76
8	0.91	77.47	164.93	229.54	301.32	1.49	69.44	125.95
9	351.94	68.17	155.45	219.96	291.68	351.78	59.67	116.14
10	342.96	58.85	145.97	210.38	282.03	342.08	49.90	106.32
11	333.96	49.53	136.48	200.80	272.39	332.37	40.14	96.51
12	324.96	40.20	126.99	191.22	262.74	322.66	30.36	86.70
13	315.94	30.87	117.50	181.64	253.09	312.94	20.59	76.88
14	306.91	21.52	108.00	172.05	243.44	303.23	10.82	67.07
15	297.86	12.17	98.50	162.46	233.79	293.51	1.04	57.25
16	288.81	2.81	89.00	152.87	224.13	283.79	351.26	47.43
17	279.74	353.45	79.49	143.28	214.48	274.07	341.48	37.62
18	270.66	344.08	69.98	133.68	204.82	264.34	331.70	27.80
19	261.57	334.70	60.46	124.09	195.16	254.62	321.92	17.98
20	252.46	325.31	50.94	114.49	185.49	244.89	312.13	8.16
21	243.35	315.92	41.42	104.88	175.83	235.16	302.35	358.34
22	234.22	306.53	31.90	95.28	166.16	225.43	292.56	348.52
23	225.08	297.12	22.37	85.67	156.49	215.69	282.77	338.70
24	215.94	287.71	12.84	76.07	146.82	205.96	272.98	328.87
25	206.78	278.30	3.31	66.45	137.14	196.22	263.19	319.05
26	197.61	268.88	353.77	56.84	127.47	186.48	253.39	309.23
27	188.42	259.46	344.23	47.23	117.79	176.74	243.60	299.41
28	179.23	250.03	334.69	37.61	108.11	166.99	233.80	289.58
29	170.03	240.59	325.14	27.99	98.43	157.24	224.00	279.76
30	160.82		315.59	18.37	88.74	147.50	214.20	269.94
31	151.59		306.04		79.06		204.40	260.11

MAP OF MARS



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

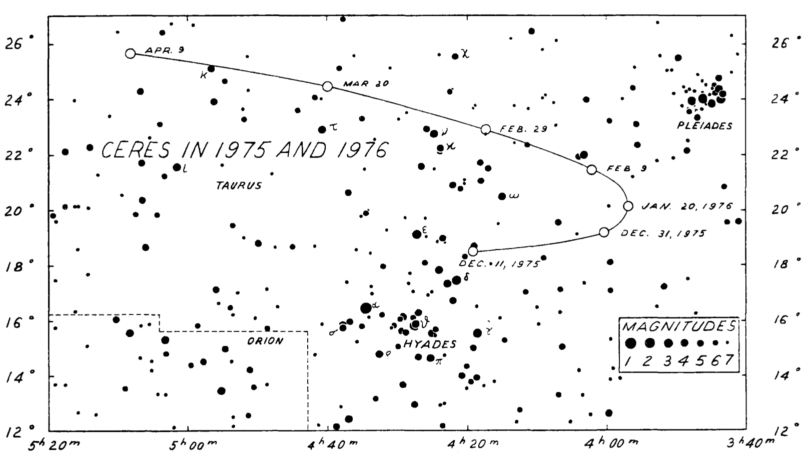
ASTEROIDS—EPHEMERIDES AT OPPOSITION, 1976

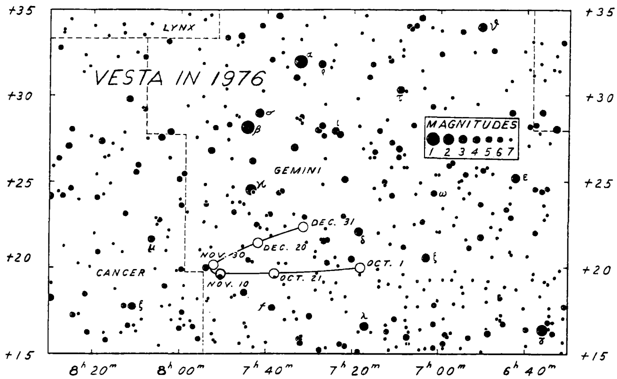
Only one of the four major asteroids—Juno—comes to opposition in 1976. Nevertheless, all four will be prominent at some time during the year. Early in 1976, Ceres will be bright, and moves through the region between the Hyades and the Pleiades (see map). Juno comes to opposition on March 1, mag. 8.7 in Sextans; by April it is near Regulus (see map). Pallas approaches opposition late in 1976, but is rather far south (in Pyxis) for northern observers (see map). Vesta also approaches opposition late in 1976, but is much brighter and more conspicuous than Pallas, as it moves in retrograde fashion through Gemini (see map).

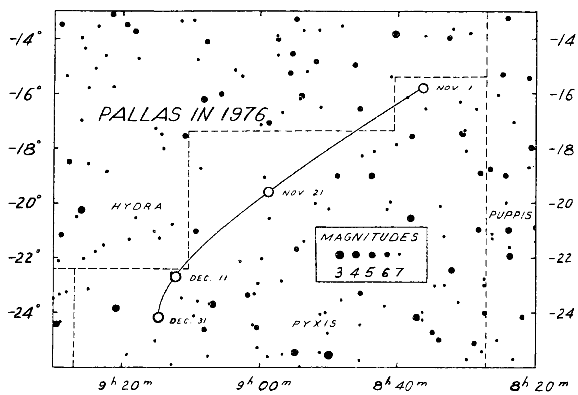
The following table lists the 1950 co-ordinates (for convenience in plotting on the *Atlas Coeli*) and the visual magnitudes of the four major asteroids on selected dates, at 0 h U.T.

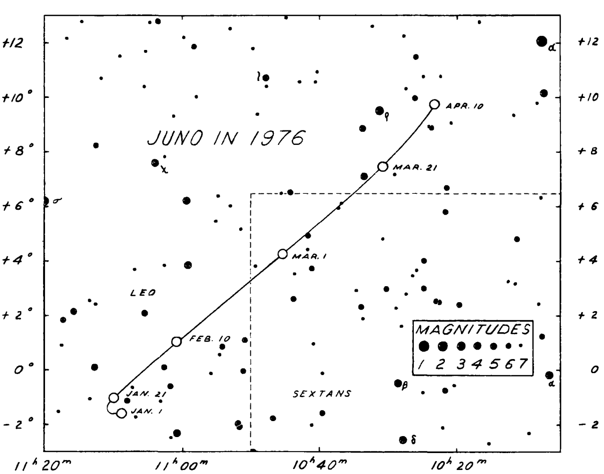
	CERES			JUNO			VESTA		
Date (0^h U.T.)	R.A. h m	Dec. ° ′	Mag.	R.A. h m	Dec. ° ′	Mag.	R.A. h m	Dec. ° ′	Mag.
Jan. 1	04 00.9	+19 08	6.9	11 07.5	−01 31	9.0	00 05.0	−07 12	7.5
11	03 56.7	+19 35	7.0	11 09.4	−01 24	9.0	00 16.4	−05 31	7.6
21	03 55.4	+20 07	7.1	11 08.7	−00 55	8.9	00 28.8	−03 48	7.7
31	03 56.9	+20 44	7.2	11 05.3	−00 04	8.9	00 42.0	−02 02	7.8
Feb. 10	04 01.1	+21 25	7.3	10 59.6	+01 10	8.8	00 55.9	−00 14	7.9
20	04 07.8	+22 09	7.4	10 52.3	+02 40	8.8	01 10.4	+01 34	8.0
Mar. 1	04 16.6	+22 54	7.5	10 44.1	+04 19	8.7	01 25.4	+03 21	8.1
11	04 27.2	+23 39	7.6	10 36.1	+06 00	8.8	01 40.8	+05 06	8.1
21	04 39.5	+24 23	7.7	10 29.4	+07 32	9.0	01 56.7	+06 49	8.2
31	04 53.3	+25 04	7.8	10 24.5	+08 50	9.2	02 12.8	+08 28	8.2
Apr. 10	05 08.2	+25 41	7.9	10 21.9	+09 50	9.4	02 29.4	+10 03	8.3

	CERES			PALLAS			VESTA		
	R.A. h m	Dec. ° ′	Mag.	R.A. h m	Dec. ° ′	Mag.	R.A. h m	Dec. ° ′	Mag.
Oct. 1	10 28.8	+17 08	8.0	07 48.6	−11 42	8.0	07 16.2	+20 01	7.6
11	10 45.8	+15 52	8.0	08 04.9	−13 36	8.0	07 27.2	+19 49	7.5
21	11 02.4	+14 37	7.9	08 20.1	−15 34	7.9	07 36.5	+19 40	7.4
31	11 18.4	+13 25	7.9	08 33.9	−17 34	7.7	07 43.8	+19 36	7.2
Nov. 10	11 33.8	+12 16	7.8	08 46.2	−19 31	7.6	07 48.8	+19 38	7.1
20	11 48.5	+11 14	7.7	08 56.6	−21 23	7.5	07 51.1	+19 50	7.0
30	12 02.5	+10 19	7.6	09 04.8	−23 05	7.4	07 50.5	+20 12	6.9
Dec. 10	12 15.5	+09 32	7.5	09 10.6	−24 31	7.3	07 46.8	+20 46	6.8
20	12 27.3	+08 57	7.4	09 13.6	−25 35	7.2	07 40.1	+21 29	6.7
30	12 37.8	+08 34	7.3	09 13.7	−26 07	7.0	07 30.9	+22 19	6.6




VESTA IN 1976
LYNX
GEMINI
CANCER
MAGNITUDES
1 2 3 4 5 6 7
DEC. 31
DEC. 20
NOV. 30
NOV. 10
OCT. 21
OCT. 1
+35
+30
+25
+20
+15
8h 20m
8h 00m
7h 40m
7h 20m
7h 00m
6h 40m


PALLAS IN 1976
HYDRA
PUPPIS
PYXIS
MAGNITUDES
3 4 5 6 7
NOV. 1
NOV. 21
DEC. 11
DEC. 31
-14°
-16°
-18°
-20°
-22°
-24°
9h 20m
9h 00m
8h 40m
8h 20m


JUNO IN 1976
LEO
SEXTANS
MAGNITUDES
1 2 3 4 5 6 7
APR. 10
MAR. 21
MAR. 1
FEB. 10
JAN. 21
JAN. 1
+12°
+10°
+8°
+6°
+4°
+2°
0°
-2°
11h 20m
11h 00m
10h 40m
10h 20m

JUPITER—LONGITUDE OF CENTRAL MERIDIAN

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

	SYSTEM I									
Day (0^h U.T.)	Jan.	Feb.	Mar.	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	°	°	°	°	°	°	°	°	°	°
1	174.9	23.8	275.9	20.6	72.7	284.5	138.6	197.1	55.7	116.6
2	332.7	181.5	73.6	178.3	230.5	82.3	296.5	355.1	213.7	274.6
3	130.4	339.2	231.2	336.0	28.2	240.2	94.4	153.1	11.8	72.6
4	288.2	136.9	28.8	133.7	186.0	38.0	252.3	311.1	169.8	230.6
5	85.9	294.5	186.5	291.4	343.8	195.9	50.3	109.1	327.9	28.6
6	243.6	92.2	344.1	89.1	141.6	353.7	208.2	267.1	125.9	186.6
7	41.4	249.9	141.8	246.9	299.3	151.6	6.1	65.1	283.9	344.6
8	199.1	47.5	299.4	44.6	97.1	309.4	164.0	223.1	82.0	142.5
9	356.8	205.2	97.1	202.3	254.9	107.3	322.0	21.1	240.0	300.5
10	154.5	2.9	254.7	0.0	52.7	265.1	119.9	179.1	38.1	98.5
11	312.2	160.5	52.3	157.7	210.5	63.0	277.8	337.1	196.1	256.4
12	110.0	318.2	210.0	315.5	8.3	220.8	75.8	135.1	354.1	54.4
13	267.7	115.8	7.6	113.2	166.0	18.7	233.7	293.2	152.2	212.4
14	65.4	273.5	165.3	270.9	323.8	176.6	31.7	91.2	310.2	10.3
15	223.1	71.1	322.9	68.7	121.6	334.4	189.6	249.2	108.3	168.3
16	20.8	228.8	120.5	226.4	279.4	132.3	347.6	47.2	266.3	326.2
17	178.5	26.5	278.2	24.1	77.2	290.2	145.5	205.2	64.3	124.2
18	336.2	184.1	75.8	181.9	235.0	88.1	303.5	3.2	222.4	282.1
19	133.9	341.8	233.5	339.6	32.8	245.9	101.4	161.3	20.4	80.0
20	291.6	139.4	31.1	137.4	190.6	43.8	259.4	319.3	178.4	238.0
21	89.3	297.1	188.8	295.1	348.5	201.7	57.4	117.3	336.5	35.9
22	247.0	94.7	346.4	92.9	146.3	359.6	215.3	275.4	134.5	193.8
23	44.7	252.4	144.0	250.6	304.1	157.5	13.3	73.4	292.5	351.7
24	202.4	50.0	301.7	48.4	101.9	315.4	171.3	231.4	90.5	149.6
25	0.1	207.7	99.3	206.1	259.7	113.3	329.2	29.4	248.6	307.5
26	157.8	5.3	257.0	3.9	57.5	271.2	127.2	187.5	46.6	105.4
27	315.4	163.0	54.6	161.6	215.4	69.1	285.2	345.5	204.6	263.3
28	113.1	320.6	212.2	319.4	13.2	227.0	83.2	143.5	2.6	61.2
29	270.8	118.3	9.9	117.2	171.0	24.9	241.2	301.6	160.6	219.1
30	68.5		167.5	274.9	328.8	182.8	39.1	99.6	318.6	17.0
31	226.2		325.2		126.7	340.7		257.7		174.9

	SYSTEM II									
Day (0^h U.T.)	Jan.	Feb.	Mar.	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	°	°	°	°	°	°	°	°	°	°
1	79.8	52.2	83.0	205.7	28.9	4.2	341.7	171.3	153.4	345.4
2	229.9	202.2	233.0	355.8	179.1	154.4	132.0	321.7	303.8	135.8
3	20.0	352.3	23.0	145.9	329.2	304.6	282.3	112.1	94.2	286.1
4	170.1	142.3	173.0	295.9	119.3	94.8	72.6	262.4	244.6	76.5
5	320.2	292.3	323.1	86.0	269.5	245.0	222.9	52.8	35.0	226.8
6	110.3	82.4	113.1	236.1	59.6	35.2	13.2	203.2	185.4	17.2
7	260.4	232.4	263.1	26.2	209.8	185.5	163.5	353.5	335.8	167.5
8	50.5	22.5	53.1	176.3	359.9	335.7	313.8	143.9	126.2	317.9
9	200.6	172.5	203.1	326.4	150.1	125.9	104.1	294.3	276.7	108.2
10	350.7	322.5	353.1	116.5	300.2	276.1	254.4	84.7	67.1	258.6
11	140.8	112.6	143.1	266.6	90.4	66.4	44.7	235.0	217.5	48.9
12	290.9	262.6	293.1	56.7	240.6	216.6	195.0	25.4	7.9	199.2
13	81.0	52.6	83.2	206.8	30.7	6.8	345.3	175.8	158.3	349.6
14	231.1	202.7	233.2	356.9	180.9	157.1	135.6	326.2	308.7	139.9
15	21.1	352.7	23.2	147.0	331.0	307.3	285.9	116.6	99.1	290.2
16	171.2	142.7	173.2	297.1	121.2	97.5	76.2	267.0	249.5	80.5
17	321.3	292.7	323.2	87.2	271.4	247.8	226.6	57.3	39.9	230.9
18	111.4	82.8	113.2	237.3	61.5	38.0	16.9	207.7	190.3	21.2
19	261.4	232.8	263.2	27.4	211.7	188.3	167.2	358.1	340.7	171.5
20	51.5	22.8	53.2	177.5	1.9	338.5	317.5	148.5	131.1	321.8
21	201.6	172.8	203.3	327.7	152.1	128.8	107.9	298.9	281.5	112.1
22	351.6	322.9	353.3	117.8	302.3	279.0	258.2	89.3	71.9	262.4
23	141.7	112.9	143.3	267.9	92.4	69.3	48.6	239.7	222.3	52.6
24	291.8	262.9	293.3	58.0	242.6	219.5	198.9	30.1	12.7	202.9
25	81.8	52.9	83.3	208.1	32.8	9.8	349.2	180.5	163.1	353.2
26	231.9	202.9	233.3	358.3	183.0	160.1	139.6	330.9	313.5	143.5
27	21.9	352.9	23.3	148.4	333.2	310.3	289.9	121.3	103.9	293.7
28	172.0	143.0	173.3	298.5	123.4	100.6	80.3	271.7	254.3	84.0
29	322.0	293.0	323.3	88.7	273.6	250.9	230.6	62.1	44.6	234.3
30	112.1		113.4	238.8	63.8	41.2	21.0	212.6	195.0	24.5
31	262.1		263.4		214.0	191.4		3.0		174.8

JUPITER—PHENOMENA OF THE BRIGHTEST SATELLITES 1976

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

The symbols are as follows: E—eclipse, O—occultation, T—transit, S—shadow, D—disappearance, R—reappearance, I—ingress, e—egress. Satellites move from east to west across the face of the planet, and from west to east behind it. Before opposition, shadows fall to the west, and after opposition to the east. Thus eclipse phenomena occur on the west side until November 18, and on the east thereafter.

JANUARY

d	h	m	Sat.	Phen.
2	18	53	III	Se
	18	58	II	TI
	21	35	II	Te
	21	38	II	SI
	22	57	I	OD
3	0	11	II	Se
	20	08	I	TI
	21	29	I	SI
	22	20	I	Te
	23	40	I	Se
4	18	45	II	ER
	20	57	I	ER
5	18	09	I	Se
6	0	59	III	OD
9	17	38	III	Te
	20	34	III	SI
	21	34	II	TI
	22	55	III	Se
10	0	11	II	Te
	0	15	II	SI
	0	52	I	OD
	22	04	I	TI
	23	25	I	SI
11	0	16	I	Te
	18	41	II	OR
	18	44	II	ED
	19	21	I	OD
	21	24	II	ER
	22	52	I	ER
12	17	54	I	SI
	18	45	I	Te
	20	05	I	Se
16	19	04	III	TI
	21	44	III	Te
17	0	12	II	TI
	0	37	III	SI
18	0	01	I	TI
	18	38	II	OD
	21	18	I	OD
	21	23	II	OR
	21	23	II	ED
19	0	03	II	ER
	18	31	I	TI
	19	50	I	SI
	20	43	I	Te
	22	01	I	Se
20	18	41	II	Se
	19	16	I	ER
23	23	15	III	TI
25	21	21	II	OD
	23	16	I	OD
26	20	29	I	TI
	21	47	I	SI
	22	41	I	Te
	23	57	I	Se
27	18	44	III	ED
	18	45	II	SI
	18	50	II	Te
	21	05	III	ER
	21	12	I	ER
	21	17	II	Se
28	18	26	I	Se

FEBRUARY

d	h	m	Sat.	Phen.
2	22	28	I	TI
2	23	43	I	SI
3	18	55	II	TI
	19	43	I	OD
	20	19	III	OR
	21	21	II	SI
	21	32	II	Te
	22	46	III	ED
	23	07	I	ER
4	18	12	I	SI
	19	10	I	Te
	20	22	I	Se
5	18	40	II	ER
10	21	39	II	TI
	21	43	I	OD
	21	54	III	OD
11	18	58	I	TI
	20	08	I	SI
	21	10	I	Te
	22	18	I	Se
12	19	31	I	ER
	21	19	II	ER
14	19	06	III	Se
18	20	58	I	TI
	22	04	I	SI
19	19	06	II	OD
	21	26	I	ER
20	18	43	I	Se
21	19	07	III	Te
	20	51	III	SI
26	20	13	I	OD
	21	56	II	OD
27	19	42	I	Te
	20	39	I	Se
28	19	10	II	Te
	20	52	III	TI
	21	00	II	Se

MARCH

d	h	m	Sat.	Phen.
4	22	14	I	OD
5	19	31	I	TI
	20	24	I	SI
	21	44	I	Te
6	19	20	II	TI
	19	46	I	ER
	21	03	II	SI
	21	57	II	Te
10	21	14	III	ER
12	21	33	I	TI
13	21	41	I	ER
15	21	13	II	ER
17	20	01	III	OD
20	20	47	I	OD
21	20	18	I	Te
	20	55	I	Se
22	19	57	II	OD

Jupiter being near the sun, phenomena are not given between Mar. 22 and June 16

JUNE

d	h	m	Sat.	Phen.
16	4	38	II	ED
18	3	06	II	Te
19	3	18	III	ED
19	3	48	I	ED
20	3	18	I	Se
	4	10	I	Te
25	3	20	II	TI
	4	00	II	Se
27	3	03	I	SI
	4	01	I	TI
28	3	21	I	OR
30	3	33	III	Te

JULY

d	h	m	Sat.	Phen.
2	4	03	II	SI
4	3	43	II	OR
	4	57	I	SI
5	5	21	I	OR
6	2	38	I	Te
7	3	29	III	Se
12	3	59	I	ED
13	2	28	I	TI
	3	28	I	Se
	4	36	I	Te
14	1	49	I	OR
	5	20	III	SI
18	2	23	III	OR
	4	16	II	ED
20	3	14	I	SI
	3	38	II	Te
	4	26	I	TI
	5	22	I	Se
21	3	48	I	OR
25	1	31	III	ER
	4	34	III	OD
27	1	13	II	SI
	3	47	II	Se
	3	50	II	TI
	5	08	I	SI
28	2	16	I	ED
	5	45	I	OR
29	0	52	I	TI
	1	11	II	OR
	1	44	I	Se
	3	00	I	Te
30	0	15	I	OR

AUGUST

d	h	m	Sat.	Phen.
1	3	22	III	ED
	5	31	III	ER
3	3	50	II	SI
4	4	11	I	ED
5	0	48	III	Te
	1	12	II	ER
	1	22	II	OD
	1	30	I	SI
	2	48	I	TI
	3	37	I	Se
	3	50	II	OR
	4	56	I	Te
6	2	11	I	OR
12	1	16	II	ED
	2	56	III	TI
	3	23	I	SI
	3	46	II	ER
	4	00	II	OD
	4	44	I	TI
	4	55	III	Te
12	5	31	I	Se
13	0	33	I	ED
	4	07	I	OR
	23	59	I	Se
14	1	04	II	Te
	1	19	I	Te
19	1	21	III	SI
	3	29	III	Se
	3	50	II	ED
	5	17	I	SI
20	2	27	I	ED
	6	02	I	OR
	23	45	I	SI
21	0	56	II	Se
	1	07	I	TI
	1	12	II	TI
	1	53	I	Se
	3	13	I	Te
	3	42	II	Te
22	0	31	I	OR
26	5	22	III	SI
27	4	22	I	ED
28	0	59	II	SI
	1	39	I	SI
	3	00	I	TI
	3	33	II	Se
	3	46	I	Se
	3	48	II	TI
	5	06	I	Te
	6	18	II	Te
	22	50	I	ED
29	2	24	I	OR
	23	35	I	Te
30	0	52	II	OR
	1	05	III	OD
	2	59	III	OR

SEPTEMBER

d	h	m	Sat.	Phen.
3	6	16	I	ED
4	3	32	I	SI
	3	36	II	SI
	4	52	I	TI
	5	40	I	Se
	6	10	II	Se
	6	23	II	TI
5	0	44	I	ED
	4	17	I	OR
	23	20	I	TI
	23	25	III	ED
6	0	08	I	Se
	0	46	II	ER
	0	56	II	OD
	1	26	I	Te
	1	34	III	ER
	3	22	II	OR
	5	00	III	OD
	22	44	I	OR
7	22	09	II	Te
11	5	26	I	SI
	6	13	II	SI
12	2	39	I	ED
	6	08	I	OR
	23	54	I	SI
13	0	50	II	ED
	1	10	I	TI
	2	02	I	Se

d	h	m	Sat.	Phen.
13	3	17	I	Te
	3	20	II	ER
	3	25	III	ED
	3	25	II	OD
	5	34	III	ER
	5	51	II	OR
14	0	36	I	OR
	22	06	II	Se
	22	10	II	TI
15	0	39	II	Te
16	22	34	III	TI
17	0	24	III	Te
19	4	33	I	ED
20	1	48	I	SI
	3	00	I	TI
	3	24	II	ED
	3	55	I	Se
	5	07	I	Te
	23	01	I	ED
21	2	26	I	OR
	21	27	I	TI
	22	10	II	SI
	22	24	I	Se
	23	34	I	Te
22	0	39	II	TI
	0	43	II	Se
	3	07	II	Te
23	21	20	III	SI
	21	29	II	OR
	23	29	III	Se
24	2	16	III	TI
	4	04	III	Te
26	6	27	I	ED
27	3	41	I	SI
	4	49	I	TI
	5	49	I	Se
	5	58	II	ED
28	0	56	I	ED
	4	14	I	OR
	22	10	I	SI
	23	16	I	TI
29	0	18	I	Se
	0	47	II	SI
	1	23	I	Te
	3	05	II	TI
	3	21	II	Se
	5	33	II	Te
	22	41	I	OR
30	23	52	II	OR

OCTOBER

d	h	m	Sat.	Phen.
1	1	20	III	SI
	3	30	III	Se
	5	53	III	TI
4	5	35	I	SI
	6	36	I	TI
	21	33	III	OR
5	2	50	I	ED
	6	02	I	OR
6	0	03	I	SI
	1	03	I	TI
	2	11	I	Se
	3	10	I	Te
	3	24	II	SI
	5	28	II	TI
	5	58	II	Se
	21	19	I	ED
7	0	29	I	OR
	20	40	I	Se
	21	36	I	Te
	21	49	II	ED
8	2	12	II	OR
	5	21	III	SI
9	21	07	II	Te
11	21	36	III	ER
	23	16	III	OD
12	1	02	III	OR
	4	45	I	ED
13	1	57	I	SI
	2	49	I	TI
	4	05	I	Se
	4	56	I	Te
	6	01	II	SI
	23	13	I	ED
14	2	15	I	OR
	20	25	I	SI
	21	15	I	TI
	22	34	I	Se
	23	23	I	Te
15	0	24	II	ED
	4	31	II	OR
	20	42	I	OR
16	20	58	II	TI
	21	53	II	Se
	23	27	II	Te
18	23	27	III	ED
19	1	37	III	ER
	2	42	III	OD
	4	27	III	OR
	6	39	I	ED
20	3	50	I	SI
	4	34	I	TI
	5	59	I	Se
	6	41	I	Te
21	1	08	I	ED
	4	01	I	OR
	22	19	I	SI
	23	00	I	TI
22	0	28	I	Se
	1	08	I	Te
	2	59	II	ED
	6	47	II	OR
	19	36	I	ED
	22	27	I	OR
23	19	34	I	Te
	21	56	II	SI
	23	16	II	TI
24	0	30	II	Se
	1	45	II	Te
25	19	55	II	OR
26	3	28	III	ED
	5	38	III	ER
	6	03	III	OD
27	5	44	I	SI
	6	18	I	TI
28	3	02	I	ED
	5	45	I	OR
29	0	13	I	SI
	0	44	I	TI
	2	22	I	Se
	2	52	I	Te
	5	33	II	ED
	19	31	III	Se
	19	34	III	TI
	21	20	III	Te
	21	31	I	ED
30	0	11	I	OR
	18	41	I	SI
	19	10	I	TI
	20	51	I	Se
	21	18	I	Te
31	0	33	II	SI
	1	33	II	TI
	3	07	II	Se
	4	01	II	Te

NOVEMBER

d	h	m	Sat.	Phen.
1	18	51	II	ED
	22	10	II	OR
2	7	28	III	ED
3	7	38	I	SI
4	4	57	I	ED
	7	29	I	OR
5	2	07	I	SI
	2	28	I	TI
	4	16	I	Se
	4	36	I	Te
	21	20	III	SI
	22	50	III	TI
	23	26	I	ED
	23	32	III	Se
6	0	37	III	Te
	1	55	I	OR
	20	35	I	SI
	20	54	I	TI
	22	45	I	Se
	23	02	I	Te
7	3	10	II	SI
	3	48	II	TI
	5	44	II	Se
	6	16	II	Te
	20	21	I	OR
8	21	26	II	ED
9	0	24	II	OR
10	19	03	II	Se
	19	24	II	Te
11	6	52	I	ED
12	4	01	I	SI
	4	11	I	TI
	6	11	I	Se
	6	19	I	Te
13	1	21	I	ED
	1	21	III	SI
	2	04	III	TI
	3	32	III	Se
	3	39	I	OR
	3	53	III	Te
	22	30	I	SI
	22	37	I	TI
14	0	39	I	Se
	0	45	I	Te
	5	47	II	SI
	6	02	II	TI
	19	49	I	ED
	22	05	I	OR
15	19	08	I	Se
	19	11	I	Te
16	0	01	II	ED
	2	37	II	OR
	17	41	III	ER
17	19	06	II	SI
	19	09	II	TI
	21	38	II	Te
	21	40	II	Se
19	5	54	I	TI
	5	56	I	SI
20	3	13	I	OD
	5	19	III	TI
	5	22	III	SI
	5	26	I	ER
	7	10	III	Te
	7	34	III	Se
21	0	20	I	TI
	0	24	I	SI
	2	29	I	Te
	2	34	I	Se
	21	39	I	OD
	23	55	I	ER
22	18	46	I	TI
	18	53	I	SI
	20	54	I	Te
	21	03	I	Se
23	2	23	II	OD
	5	09	II	ER
	18	24	I	ER
	19	03	III	OD
	21	42	III	ER
24	21	23	II	TI
	21	43	II	SI
	23	52	II	Te
25	0	16	II	Se
26	18	27	II	ER
27	4	57	I	OD
28	2	04	I	TI
	2	19	I	SI
	4	12	I	Te
	4	29	I	Se
	23	23	I	OD
29	1	50	I	ER
	20	30	I	TI
	20	48	I	SI
	22	38	I	Te
	22	58	I	Se
30	4	37	II	OD
	17	49	I	OD
	20	19	I	ER
	22	17	III	OD

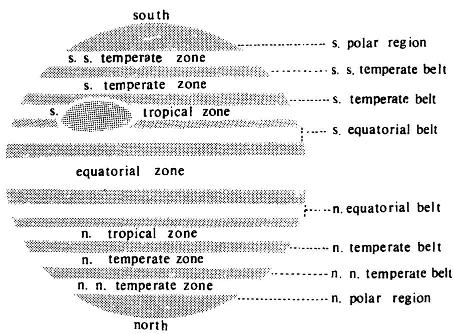
DECEMBER

d	h	m	Sat.	Phen.
1	1	44	III	ER
	17	26	I	Se
	23	38	II	TI
2	0	21	II	SI
	2	07	II	Te
	2	53	II	Se
3	17	44	II	OD
	21	03	II	ER
4	6	41	I	OD
5	3	48	I	TI
	4	14	I	SI
	5	57	I	Te
	6	24	I	Se
6	1	07	I	OD
	3	45	I	ER
	22	14	I	TI
	22	43	I	SI
7	0	23	I	Te
	0	52	I	Se
	19	33	I	OD
	22	14	I	ER
8	1	34	III	OD
	5	45	III	ER
	18	49	I	Te
	19	21	I	Se
9	1	54	II	TI
	2	58	II	SI
	4	24	II	Te
	5	30	II	Se
10	19	59	II	OD
	23	40	II	ER
11	17	25	III	SI
	19	38	III	Se
12	5	33	I	TI
	6	09	I	SI
	17	32	II	Te
	18	48	II	Se
13	2	52	I	OD
	5	40	I	ER
	23	59	I	TI
14	0	38	I	SI
	2	08	I	Te
	2	47	I	Se
	21	18	I	OD
15	0	09	I	ER
	4	54	III	OD
	18	26	I	TI
	19	06	I	SI
	20	34	I	Te
	21	16	I	Se
16	4	11	II	TI
	5	35	II	SI
	18	38	I	ER
17	22	16	II	OD
18	2	16	II	ER
	18	27	III	TI
	20	30	III	Te
	21	26	III	SI
	23	39	III	Se
19	18	53	II	SI
	19	51	II	Te
	21	25	II	Se
20	4	38	I	OD
21	1	45	I	TI

d	h m	Sat.	Phen.	d	h m	Sat.	Phen.	d	h m	Sat.	Phen.	d	h m	Sat.	Phen.
21	2 33	I	SI	23	17 31	I	OD	26	19 41	II	TI	29	17 51	III	ER
	3 54	I	Te		20 33	I	ER		21 30	II	SI		22 00	I	TI
	4 43	I	Se	24	17 40	I	Se		22 11	II	Te		22 57	I	SI
	23 05	I	OD	25	0 35	II	OD	27	0 01	II	Se	30	0 09	I	Te
22	2 04	I	ER		4 54	II	ER	28	3 32	I	TI		1 07	I	Se
	20 12	I	TI		21 52	III	TI		4 28	I	SI		19 19	I	OD
	21 02	I	SI		23 58	III	Te		18 13	II	ER		22 28	I	ER
	22 21	I	Te	26	1 27	III	SI	29	0 52	I	OD	31	18 36	I	Te
	23 12	I	Se		3 40	III	Se		3 59	I	ER		19 36	I	Se

JUPITER'S BELTS AND ZONES

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



COMETS IN 1976

By Brian G. Marsden

The following periodic comets are expected to be at perihelion during 1976:

Comet	Perihelion Date	Perihelion Distance	Period
Westphal	Jan. 3	1.26 A.U.	63.0 yr
Wolf	Jan. 25	2.50	8.4
Gunn	Feb. 10	2.44	6.8
Churyumov-Gerasimenko	Apr. 6	1.30	6.6
Harrington-Abell	Apr. 21	1.77	7.6
Tempel-Swift	May 25	1.60	6.4
Neujmin 2	June 18	1.28	5.4
d'Arrest	Aug. 12	1.16	6.2
Klemola	Aug. 20	1.77	11.0
Schaumasse	Sept. 5	1.21	8.2
Pons-Winnecke	Nov. 28	1.25	6.4

Comet Westphal faded out on its way in to perihelion in 1913, and it is doubtful whether it can be observed any more. Comet Wolf was recovered in May 1975 but will remain very faint. Comet Gunn, discovered in 1970, has been followed all the way around its orbit. Comets Churyumov-Gerasimenko and Klemola have been observed at only one previous perihelion passage, and thus the predictions, particularly in the case of Comet Klemola, are more uncertain than for the other comets listed here. Comet Harrington-Abell, which passed only 0.04 A.U. from Jupiter in 1974, will be faint. Comets Tempel-Swift and Neujmin 2 have been missing since 1908 and 1927, respectively, and it is extremely improbable that they will be observed in 1976.

Comet d'Arrest is making its most favourable return since its discovery in 1851 and will pass only 0.15 A.U. from the earth in August 1976. A brief ephemeris is:

Date	R.A. (1950)	Dec. (1950)	Mag.
July 1	$19^h00^m.0$	+22°04′	8.9
11	$19^h16^m.9$	+21°12′	
21	$19^h42^m.5$	+17°25′	7.5
31	$20^h22^m.0$	+ 8°43′	
Aug. 10	$21^h19^m.4$	− 6°25′	6.4
20	$22^h28^m.6$	−23°26′	
30	$23^h31^m.6$	−34°34′	7.1
Sept. 9	$0^h16^m.0$	−39°24′	
19	$0^h42^m.6$	−40°40′	8.5

Comets Schaumasse and Pons-Winnecke are badly placed for observation and it is doubtful that the former will be detectable, even with very large telescopes.

Any bright comets, other than d'Arrest, that may appear during 1976 will be completely unexpected.

METEORS, FIREBALLS AND METEORITES

By Peter M. Millman

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

Meteors are visible on any night of the year. At certain times of the year the earth encounters large numbers of meteors all moving together along the same orbit. Such a group is known as a meteor shower and the accompanying list gives the more important showers visible in 1976.

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

The radiant is the position among the stars from which the meteors of a given shower seem to radiate. The appearance of any very bright fireball should be reported immediately to the nearest astronomical group or other organization concerned with the collection of such information. Where no local organization exists, reports should be sent to Meteor Centre, National Research Council, Ottawa, Ontario, K1A 0R8. Free fireball report forms and instructions for their use, printed in either French or English, may be secured at the above address. If sounds are heard accompanying a bright fireball there is a possibility that a meteorite may have fallen. Astronomers must rely on observations made by the general public to track down such an object.

METEOR SHOWERS FOR 1976

	Shower Maximum			Radiant						
				Position at Max.		Daily Motion		Single Observer Hourly Rate		Normal Duration to 1/4 strength of Max.
Shower	Date	E.S.T.	Moon	R.A.	Dec.	R.A.	Dec.		Velocity	
		h		h m	°	m	°		km/sec	days
Quadrantids	Jan. 4	02	N.M.	15 28	+50	—	—	40	41	1.1
Lyrids	Apr. 22	21	L.Q.	18 16	+34	+4.4	0.0	15	48	2
η Aquarids	May 4	23	F.Q.	22 24	00	+3.6	+0.4	20	64	3
δ Aquarids	July 28	19	N.M.	22 36	−17	+3.4	+0.17	20	40	—
Perseids	Aug. 12	00	F.M.	03 04	+58	+5.4	+0.12	50	60	4.6
Orionids	Oct. 21	02	N.M.	06 20	+15	+4.9	+0.13	25	66	2
Taurids	Nov. 4	—	F.M.	03 32	+14	+2.7	+0.13	15	28	—
Geminids	Dec. 13	16	L.Q.	07 32	+32	+4.2	−0.07	50	35	2.6
Ursids	Dec. 22	06	N.M.	14 28	+76	—	—	15	34	2

CANADIAN METEORITE IMPACT SITES

BY P. BLYTH ROBERTSON

The search for ancient terrestrial meteorite craters, and investigations in the related fields of shock metamorphism and cratering mechanics, have been carried out since 1951 at the Earth Physics Branch (formerly Dominion Observatory) Department of Energy, Mines and Resources. Approximately 40 percent of the craters recognized in the world have been discovered in Canada. At large impact sites (greater than approximately 1500 m diameter) original meteoritic material is not recognizable. Extreme shock pressures and temperatures at impact vapourize or melt the meteorite and it becomes intimately mixed and disseminated in the melted target rocks. Hypervelocity impact craters are therefore identified by the presence of shock metamorphic effects, the characteristic suite of deformation in the target rocks produced by shock pressures exceeding approximately 75 kilobars. The twenty-three "confirmed" structures in the Table contain definitive evidence of shock metamorphism, and are listed in order of their discovery. The latter three of these features were recognized during 1974. The "possible" sites represent only a few of those under consideration but where definitive shock metamorphic effects have not been found. Craters where data have been obtained through diamond-drilling or geophysical surveys are marked "D" and "G", respectively, and "A" signifies those sites accessible by road. "Float" includes boulders and pebbles in glacial deposits.

Name	Lat.	Long.	Diam. (km)	Age ($\times 10^6$ years)	Surface Expression	Visible Geologic Featues	
A Confirmed sites							
New Quebec Crater, Que.	61°17′	73°40′	3	< 1	rimmed circular lake	raised rim	G
Brent, Ont.	46°05′	78°29′	4	450 ± 40	sediment-filled shallow depression	fracturing	A D G
Manicouagan, Que.	51°23′	68°42′	65	210 ± 4	circumferal lake, central elevation	impact melt	G
Clearwater Lake West, Que.	56°13′	74′30′	25	285 ± 30	island ring in circular lake	impact melt	D G
Clearwater Lake East, Que.	56°05′	74°07′	14.5	285 ± 30	circular lake	sedimentary float	D G
Holleford, Ont.	44°28′	76°38′	2	550 ± 50	sediment-filled shallow depression	sedimentary fill	A D G
Deep Bay, Sask.	56°24′	102°59′	9	100 ± 50	circular bay	sedimentary float	D G
Carswell, Sask.	58°27′	109°30′	30	485 ± 50	discontinuous circular ridge	weak shatter cones and breccia	G
Lac Couture, Que.	60°08′	75°18′	10	300 ± 50	circular lake	breccia float	
West Hawk Lake, Man.	49°46′	95°11′	3	150 ± 50	circular lake	none	
Pilot Lake, N.W.T.	60°17′	111°01′	5	300 ± 150	circular lake	fracturing, breccia float	A D G
Nicholson Lake, N.W.T.	62°40′	102°41′	12.5	300 ± 150	irregular lake with islands	breccia	G
Steen River, Alta.	59°31′	117°38′	13.5	95 ± 7	none, buried to 200 metres	none	D G
Sudbury, Ont.	46°36′	81°11′	100	1700 ± 200	elliptical basin	breccia, impact melt, shatter cones	A D G
Charlevoix, Que.	47°32′	70°18′	35	350 ± 25	semi-circular trough, central elevation	breccia float, shatter cones, impact melt	A G
Lake Mistastin, Labr.	55°53′	63°18′	20	40 ± 3	elliptical lake and central island	breccia, impact melt	
Lake St. Martin, Man.	51°47′	98°33′	24	225 ± 25	none, buried and eroded	impact melt	A D G
Lake Wanapitei, Ont.	46°44′	80°44′	8.5	37 ± 2	lake-filled, partly circular	breccia float	A G
Gow Lake, Sask.	56°27′	104°29′	5	> 150	lake and central island	breccia	G
Lac La Moinerie, Que.	57°26′	66°36′	8	> 150	lake-filled, partly circular	breccia float	
Haughton Dome, N.W.T.	75°22′	89°40′	18	< 400	shallow, ringed depression	shatter cones, breccia	
Slate Islands, Ont.	48°40′	87°00′	13	< 1100	islands are central uplift of submerged structure	shatter cones, breccia dikes	
Ile Rouleau (L. Mistassini) Que.	50°41′	73°53′	4	< 1000	island is central uplift of submerged structure.	shatter cones, breccia dikes	
B Possible sites							
Skeleton Lake, Ont.	45°15′	79°26′	4		lake-filled partly circular	breccia, sedimentary float	A G
Kakiattukallak Lake, Que.	57°42′	71°40′	6		circular lake	breccia float	
Meen Lake, N.W.T.	64°58′	87°41′	4		circular lake	breccia	
Charron Lake, Man.	52°44′	95°15′	5		circular lake	?	
Eagle Butte, Alta.	49°42′	110°30′	10		slight, buried and eroded	disturbed beds	A D
McIntosh Bay, Ont.	52°35′	94°05′	5		circular lake	?	
Poplar Bay (L. DuBonnet), Man.	50°23′	95°48′	3.5		circular lake	?	A G
Viewfield, Sask.	49°33′	103°04′	2.5		completely buried circular depression	?	A D G

SATURN AND ITS SATELLITES

BY TERENCE DICKINSON

Saturn, with its system of rings, is a unique sight through a telescope. There are three rings. The outer ring A has an outer diameter 169,000 miles. It is separated from the middle ring B by Cassini's gap, which has an outer diameter 149,000 miles, and an inner diameter 145,000 miles. The inner ring C, also known as the dusky or crape ring, has an outer diameter 112,000 miles and an inner diameter 93,000 miles. Evidence for a fourth, innermost ring has been found; this ring is very faint. Saturn exhibits a system of belts and zones with names and appearances similar to those of Jupiter (see diagram pg. 79).

Titan, the largest and brightest of Saturn's moons is seen easily in a 2-inch or larger telescope. At elongation Titan appears about 5 ring-diameters from Saturn. The satellite orbits Saturn in about 16 days and at magnitude 8.4* dominates the field around the ringed planet.

Rhea is considerably fainter than Titan at magnitude 9.8 and a good quality 3-inch telescope may be required to detect it. At elongation Rhea is about 2 ring-diameters from the centre of Saturn.

Iapetus is unique among the satellites of the solar system in that it is five times brighter at western elongation (mag. 10.1) than at eastern elongation (mag. 11.9). When brightest, Iapetus is located about 12 ring-diameters west of its parent planet. Of the remaining moons only Dione and Tethys are seen in "amateur"-sized telescopes.

*Magnitudes given are at mean opposition.

ELONGATIONS OF SATURN'S SATELLITES, 1976 (E.S.T.)

JANUARY

d	h	Sat.	Elong.
3	19.2	Rh	E
8	07.5	Rh	E
8	14.4	Ti	W
12	19.8	Rh	E
16	19.7	Ti	E
17	08.1	Rh	E
21	20.4	Rh	E
24	11.7	Ti	W
26	08.7	Rh	E
30	21.0	Rh	E

FEBRUARY

d	h	Sat.	Elong.
1	17.0	Ti	E
4	09.3	Rh	E
8	09.9	Ia	E
8	21.7	Rh	E
9	09.1	Ti	W
13	10.0	Rh	E
17	14.4	Ti	E
17	22.3	Rh	E
22	10.7	Rh	E
25	06.7	Ti	W
26	23.0	Rh	E

MARCH

d	h	Sat.	Elong.
2	11.4	Rh	E
4	12.2	Ti	E
6	23.7	Rh	E
11	12.1	Rh	E
12	04.8	Ti	W
16	00.5	Rh	E
18	03.8	Ia	W
20	10.4	Ti	E
20	12.9	Rh	E
25	01.3	Rh	E
28	03.3	Ti	W
29	13.8	Rh	E

APRIL

d	h	Sat.	Elong.
3	02.2	Rh	E
5	09.1	Ti	E
7	14.7	Rh	E
12	03.1	Rh	E
13	02.2	Ti	W
16	15.6	Rh	E
21	04.1	Rh	E
21	08.4	Ti	E
25	16.6	Rh	E
27	12.1	Ia	E
29	01.7	Ti	W
30	05.1	Rh	E

MAY

d	h	Sat.	Elong.
4	17.6	Rh	E
7	08.2	Ti	E
9	06.1	Rh	E
13	18.7	Rh	E
15	01.6	Ti	W
18	07.2	Rh	E
22	19.8	Rh	E
23	08.3	Ti	E
27	08.3	Rh	E
31	01.9	Ti	W
31	20.9	Rh	E

JUNE

d	h	Sat.	Elong.
5	09.4	Rh	E
6	07.5	Ia	W
8	08.8	Ti	E
9	22.0	Rh	E
14	10.6	Rh	E

Saturn being near the sun, elongations are not given between June 14 and August 25.

AUGUST

d	h	Sat.	Elong.
25	20.0	Rh	E
26	15.9	Ia	W
27	12.8	Ti	E
30	08.6	Rh	E

SEPTEMBER

d	h	Sat.	Elong.
3	21.2	Rh	E
4	06.2	Ti	W
8	09.8	Rh	E
12	13.4	Ti	E
12	22.3	Rh	E
17	10.9	Rh	E
20	06.7	Ti	W
21	23.4	Rh	E
26	12.0	Rh	E
28	13.8	Ti	E

OCTOBER

d	h	Sat.	Elong.
1	00.5	Rh	E
5	13.0	Rh	E
6	06.9	Ti	W
7	02.4	Ia	E
10	01.6	Rh	E
14	13.9	Ti	E
14	14.1	Rh	E
19	02.6	Rh	E
22	06.8	Ti	W
23	15.1	Rh	E
28	03.6	Rh	E
30	13.6	Ti	E

NOVEMBER

d	h	Sat.	Elong.
1	16.0	Rh	E
6	04.5	Rh	E
7	06.3	Ti	W
10	17.0	Rh	E
15	05.4	Rh	E
15	07.9	Ia	W
15	12.8	Ti	E
19	17.8	Rh	E
23	05.4	Ti	W
24	06.3	Rh	E
28	18.7	Rh	E

DECEMBER

d	h	Sat.	Elong.
1	11.6	Ti	E
3	07.1	Rh	E
7	19.5	Rh	E
9	03.9	Ti	W
12	07.9	Rh	E
16	20.2	Rh	E
17	09.9	Ti	E
21	08.6	Rh	E
25	02.0	Ti	W
25	19.1	Ia	E
25	21.0	Rh	E
30	09.3	Rh	E
33	07.8	Ti	E

TABLE OF PRECESSION FOR 50 YEARS

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

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

FINDING LIST OF NAMED STARS

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

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

THE BRIGHTEST STARS

BY DONALD A. MACRAE

The 286 stars brighter than apparent magnitude 3.55.

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

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

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

Type. The customary spectral (temperature) classification is given first. The Roman numerals are indicators of *luminosity class*. They are to be interpreted as follows: Ia—most luminous supergiants; Ib—less luminous supergiants; II—bright giants; III—normal giants; IV—subgiants; V—main sequence stars. Intermediate classes are sometimes used, e.g. Iab. Approximate absolute magnitudes can be assigned to the various spectral and luminosity class combinations. Other symbols used in this column are: p—a peculiarity; e—emission lines; v—the spectrum is variable; m—lines due to metallic elements are abnormally strong; f—the O-type spectrum has several broad emission lines; n or nn—unusually wide or diffuse lines. A composite spectrum, e.g. M1 Ib+B, shows up when a star is composed of two nearly equal but unresolved components. The table now includes accurate spectral and luminosity classes for most stars in the southern sky. These were provided by Dr. Robert Garrison of the Dunlap Observatory. A few types in italics and parentheses remain poorly defined. 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. The information on radial velocities was brought up-to-date in 1975 by Dr. C. T. Bolton of the Dunlap Observatory. Italics indicate an average value of a variable radial velocity.

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

Star	Right Ascension R.A. 1980	Declination Dec.	Visual Magnitude V	Colour Index $B–V$	Spectral Classification Type		Parallax π	Absolute Magnitude M_V	Distance light-years D	Proper Motion μ	Radial Velocity R		
	h m	° ′					″		l.y.	″	km/sec		
Sun			−26.73	+0.63	G2	V		+4.84					***Sun***
α And	00 07.3	+28 58	2.06	−0.08	B9p		0.024	−0.1	90	0.209	*−11.7*	Manganese star	***Alpheratz***
β Cas	08.1	+59 02	2.26v	+0.34	F2	IV	0.072	+1.6	45	0.555	+11.8	Var. R 0.ᵐ08, 0.10ᵈ	***Caph***
γ Peg	12.2	+15 04	2.84v	−0.23	B2	IV	−.004	−3.4	570	0.010	+04.1	β CMa type, R in V 2.83–2.85, 0.15ᵈ	
β Hyi	24.6	−77 22	2.78	+0.62	G1	IV	0.153	+3.7	21	2.255	+22.8		γ Peg = ***Algenib***
α Phe	25.3	−42 25	2.39	+1.08	*K0*	*III*	0.035	+0.1	93	0.442	*+74.6*		***Ankaa***
δ And *A*	38.2	+30 45	3.25:	+1.26	K3	III	0.024	−0.2	160	0.161	−07.3	B 12ᵐ 28″	
α Cas	39.4	+56 25	2.22	+1.18	K0	II–III	0.009	−1.1	150	0.058	−03.8	Var.?	***Schedar***
β Cet	42.6	−18 06	2.02	+1.03	K1	III	0.057	+0.8	57	0.234	+13.1		***Diphda***
η Cas *A*	47.9	+57 42	3.47	+0.56	G0	V	0.182	+4.8	18	1.221	+09.4	B 7.26ᵐ 12″	
γ Cas *A*	55.5	+60 36	2.5v	−0.16v	B0	IV:pe	0.034	−0.3:	96:	0.026	−06.8	Var. B 8.18ᵐ 2″	
β Phe *AB*	01 05.1	−46 50	3.30	+0.88	*G8*	*III*	0.017	+0.3	190	0.035	−01.1	A 4.1ᵐ B 4.1ᵐ 1″	
η Cet	07.6	−10 17	3.44	+1.16	K3	III	0.032	+1.0	102	0.250	+11.5		
β And	08.6	+35 31	2.02	+1.57	M0	III	0.043	+0.2	76	0.211	+00.3		***Mirach***
δ Cas	24.4	+60 08	2.67	+0.13	A5	V	0.029	+2.1	43	0.301	+06.7	Ecl.? R 0.08:ᵐ 759ᵈ	***Ruchbah***
γ Phe	27.5	−43 25	3.40	+1.56	K5	IIb–III	−.003	−4.6	1300	0.209	*+25.7*		
α Eri	37.0	−57 20	0.51	−0.16	B3	Vp	0.023	−2.3	118	0.098	+19		***Achernar***
τ Cet	43.2	−16 03	3.50	+0.72	G8	Vp	0.275	+5.70	12	1.921	−16.2		

Star	R.A. 1980	Dec.	V	$B–V$	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km/sec		
α Tri	01 52.0	+29 29	3.42	+0.50	F6 IV	0.050	+2.0	65	0.230	*−12.6*		
ε Cas	52.9	+63 34	3.37	−0.15	B3 IV:p	0.007	−2.7	520	0.038	−08.1		
β Ari	53.6	+20 43	2.65	+0.14	A5 V	0.063	+1.7	52	0.147	*−04.0*		*Sheratan*
α Hyi	58.1	−61 40	2.84	+0.28	F0 V		+2.9	31	0.265	+07		
γ And *A*	02 02.7	+42 14	2.14:	+1.16:	K3 II	0.005	−2.4	260	0.068	−11.7	*B* 5.4^m *C* 6.2^m *A–BC* 10″ *B–C* 0.5″	γ And = *Almach*
α Ari	06.1	+23 22	2.00	+1.15	K2 III	0.043	+0.2	76	0.241	−14.3		*Hamal*
β Tri	08.4	+34 54	3.00	+0.13	A5 III	0.012	−0.1	140	0.156	*+15.2*		
α UMi *A*	12.5	+89 11	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*
o Cet *A*	18.3	−03 04	2.0v		M5.5e–M9e	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*	42.2	+03 10	3.48	+0.11	A2 V	0.048	+2.0	68	0.203	−05.1	*A* 3.57^m *B* 6.23^m 3″	
θ Eri *AB*	57.5	−40 23	2.92	+0.13	A3 III	0.028	+1.7	65	0.061	*+11.9*	*A* 3.25^m *B* 4.36^m 8″	*Acamar*
α Cet	03 01.2	+04 00	2.54	+1.63	M2 III	0.003	−0.5	130	0.075	−25.9		*Menkar*
γ Per	03.3	+53 25	2.91:	+0.72:	G8 III: +A3:	0.011	+0.3	113	0.004	*+02.5*		
ρ Per	03.7	+38 45	3.5v		M4 II–III	0.008	−1.0	260	0.172	+28.2	Irr. *R* 3.2–3.8	
β Per	06.6	+40 52	2.06v	−0.07	B8 V	0.031	−0.5	105	0.006	*+06.0*	Ecl. *R* 2.06–3.28, 2.87^d	*Algol*
α Per	22.9	+49 47	1.80	+0.48	F5 Ib	0.029	−4.4	570	0.035	−02.4		*Mirfak*
δ Per	41.5	+47 44	3.03	−0.14	B5 III	0.007	−3.3	590	0.046	+02.8		
η Tau	46.3	+24 03	2.86	−0.09	B7 III	0.005	−3.2	541	0.050	+10.1	in Pleiades	*Alcyone*
γ Hyi	47.5	−74 18	3.30	+1.61	M2 III	−.001	−1.5	300	0.125	+16.0		
ζ Per *A*	52.7	+31 50	2.83	+0.13	B1 Ib	0.007	−6.1	1000	0.015	+20.6	*B* 9.36^m 13″	
ε Per *A*	56.5	+39 57	2.88	−0.17	B0.5 V	−.001	−3.7	680	0.036	*−01*	*B* 7.99^m 9″	
γ Eri	57.1	−13 34	2.96	+1.58	M0 III	0.003	−0.5	160	0.126	+61.7		
α Ret *A*	04 14.1	−62 32	3.33	+0.91	G9 III	0.008	−2.1	390	0.064	+35.6	*B* 12^m 49″	
ε Tau	27.5	+19 08	3.54	+1.02	K0 III	0.018	+0.1	160	0.118	+38.6		
θ² Tau	27.5	+15 49	3.42	+0.17	A7 III	0.025	+0.2	140	0.108	*+39.5*		
α Dor	33.5	−55 05	3.28	−0.08	A0 IIIp	0.011	−1.2	260	0.051	+25.6	Silicon star	
α Tau *A*	34.8	+16 28	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***
π³ Ori	48.3	+06 56	3.17	+0.45	F6 V	0.125	+3.65	26	0.468	+24.3		
ι Aur	55.7	+33 08	2.68:	+1.49	K3 II	0.015	−2.4	330	0.021	+17.5		

Star	R.A. 1980	Dec.	V	B–V	Type	π	M_V	D	μ	R	
	h m	° ′				″		l.y.	″	km/sec	
ε Aur	05 00.5	+43 48	3.0v	+0.50:	F0 Iap	0.004	−7.1	3400	0.008	*−01.4*	Ecl. *R* 0.81^m 9886^d
ε Lep	04.6	−22 24	3.21	+1.46	*K5 III*	0.006	−0.4	170	0.077	+01.0	
η Aur	05.1	+41 13	3.17	−0.18	B3 V	0.013	−2.1	370	0.077	+07.4	
β Eri	06.9	−05 06	2.79	+0.13	A3 III	0.042	+0.9	78	0.122	−08	
μ Lep	12.1	−16 13	3.29	−0.09	*B9 IIIp*	0.018	−2.1	390	0.049	+27.7	Manganese star
β Ori *A*	13.6	−08 13	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	15.2	+45 59	0.05	+0.80	G8 III: +F	0.073	−0.6	45	0.435	*+30.2*	***Capella***
η Ori *AB*	23.5	−02 24	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	24.0	+06 20	1.64	−0.23	B2 III	0.026	−4.2	470	0.015	+18.2	*Bellatrix*
β Tau	25.0	+28 36	1.65	−0.13	B7 III	0.018	−3.2	300	0.178	+08.0	*Elnath*
β Lep *A*	27.4	−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*	31.0	−00 19	2.20v	−0.20	O9.5 II	0.004	−6.1	1500	0.002	*+22.0*	Ecl. *R* 2.20–2.35 5.7^d, B 6.74^m 53″
α Lep	31.8	−17 51	2.58	+0.22	F0 Ib	0.002	−4.6	900	0.006	+24.7	
λ Ori *AB*	34.1	+09 55	3.40	−0.18	O8	0.006	−5.1	1800	0.006	+33.5	*A* 3.56^m *B* 5.54^m 4″ *C* 10.92^m 29″
ι Ori *AB*	34.5	−05 56	2.76	−0.24	O9 III	0.021	−6.1	2000	0.005	*+27.6*	*A* 2.78^m *B* 7.31^m 11″
ε Ori	35.2	−01 13	1.70	−0.19	B0 Ia	−.007	−6.8	1600	0.000	+26.1	*Alnilam*
ζ Tau	36.5	+21 08	3.07:	−0.13:	B2 III:p	−.002	−4.2	940	0.023	*+22.8*	Shell star
α Col *A*	39.0	−34 05	2.64	−0.11	*B8 Ve*	−.005	−0.6	140	0.026	+35	*B* 12^m 12″ *Phact*
ζ Ori *AB*	39.7	−01 57	1.79	−0.22	O9.5 Ib	0.022	−6.6	1600	0.004	+18.1	*A* 1.91^m *B* 4.05^m 3″ *Alnitak*
κ Ori	46.8	−09 41	2.06	−0.17	B0.5 Ia	0.009	−6.9	2100	0.004	+20.6	
β Col	50.2	−35 47	3.12	+1.16	K2 III	0.023	+0.0	140	0.402	+89.4	
α Ori	54.0	+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	58.0	+44 57	1.86	+0.06	A2 V	0.037	−0.3	88	0.051	*−18.2*	*Menkalinan*
θ Aur *AB*	58.4	+37 13	2.65v	−0.07	B9.5pv	0.018	+0.1	108	0.097	+29.3	Silicon star *A* 2.67^m *B* 7.14^m 3″, var., 1.4^d
η Gem *A*	06 13.7	+22 31	3.33v	+1.58	M3 III	0.013	−0.6	200	0.066	*+19.0*	*R* 0.27^m, *B* 6.70^m 1″
ζ CMa	19.6	−30 03	3.04	−0.18	B2.5 V	−.003	−2.4	390	0.004	*+32.2*	
μ Gem	21.7	+22 32	2.92v	+1.63	M3 III	0.021	−0.6	160	0.129	+54.8	*R* 0.14^m
β CMa	21.8	−17 56	1.96v	−0.24	B1 II–III	0.014	−4.8	750	0.004	*+33.7*	β CMa type variable, 0.25^d
α Car	23.5	−52 41	−0.72	+0.16	F0 Ib–II	0.018	−3.1	98	0.025	+20.5	***Canopus***
γ Gem	36.6	+16 25	1.93	0.00	A0 IV	0.031	−0.6	105	0.066	*−12.5*	*Alhena*

Star	R.A. 1980	Dec.	*V*	*B–V*	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km/sec		
ν Pup	06 37.1	−43 11	3.19	−0.10	*B7 III*		−3.2	620	0.010	+28.2		
ε Gem	42.7	+25 09	3.00	+1.39	G8 Ib	0.009	−4.6	1080	0.016	+09.9		
ξ Gem	44.2	+12 55	3.38	+0.43	F5 IV	0.051	+1.9	64	0.224	+25.3		
α CMa *A*	44.2	−16 42	−1.47	+0.01	A1 V	0.375	+1.45	8.7	1.324	*−07.6*	*B* 8.66^m 1976: 11″, p.a. 57°	***Sirius***
α Pic	48.2	−61 55	3.27	+0.21	A7 Vn		+2.1	57	0.272	+20.6		
τ Pup	49.5	−50 36	2.92	+1.21	*K0 III*		+0.1	124	0.079	*+36.4*		
ε CMa *A*	57.8	−28 57	1.48:	−0.18:	B2 II		−5.1	680	0.004	+27.4	*B* 7.5^m 8″	***Adhara***
σ² CMa	07 02.2	−23 48	3.02	−0.09	B3 Ia		−7.1	3400	0.000	+48.4		
δ CMa	07.6	−26 22	1.85	+0.65	F8 Ia	−.018	−7.1	2100	0.005	+34.3		
L_2 Pup	12.9	−44.37			(gM5e)	0.016	−3.1	650	0.342	+53.0	LP, *R* 3.4–6.2, 141^d	
π Pup	16.5	−37 04	2.70:	+1.63:	(gK4)	0.023	−0.3	140	0.008	+15.8		
η CMa	23.3	−29 15	2.46	−0.08	B5 Ia		−7.1	2700	0.008	+41.1		
β CMi	26.2	+08 20	2.91	−0.09	B7 V	0.020	−1.1	210	0.065	+22		
σ Pup *A*	28.6	−43 15	3.24	+1.49	K5 III	0.013	−0.4	180	0.195	*+88.1*	*B* 9.4^m 22″	
α Gem *A*	33.3	+31 56	1.97	+0.00:	A1 V	0.072	+1.3	45	0.199	+06.0	} 2″, *B–V* +0.02, *C* 9.08v^m 73″	***Castor***
α Gem *B*	33.3	+31 56	2.95	+0.07:	A5m	0.072	+2.3	45	0.199	*−01.2*	}	
α CMi *A*	38.2	+05 17	0.37	+0.41	F5 IV–V	0.288	+2.7	11.3	1.250	*−03.2*	*B* 10.7^m 4″	***Procyon***
β Gem	44.1	+28 05	1.16	+1.02	K0 III	0.093	+1.0	35	0.625	+03.3		***Pollux***
ξ Pup	48.4	−24 50	3.34	+1.23	G3 Ib	−.003	−4.6	1240	0.005	*+02.7*		
χ Car	56.2	−52 56	3.48	−0.18	B3 IVp		−2.1	430	0.039	+19.1		
ζ Pup	08 02.9	−39.57	2.23	−0.26	O5f		−7.1	2400	0.033	−24		
ρ Pup	06.7	−24 15	2.80v	+0.42	F6 IIp	0.031	+0.3:	105:	0.098	+46.6	Var. *R* 2.72–2.87, 0.14^d	
γ Vel *A*	08.9	−47 18	1.83	−0.26	WC8		−4.1	520	0.011	+35	*B* 4.31^m 41″	
ε Car	22.1	−59 26	1.90:	+1.30:	K3: III+B2:v		−3.1:	340	0.030	+11.5		***Avior***
ο UMa *A*	28.6	+60 47	3.37	+0.83	G5 III	0.004	+0.1	150	0.171	+19.8	*B* 15^m 7″	
δ Vel *AB*	44.2	−54 38	1.95	+0.05	A2 V	0.043	+0.2	76	0.086	+02.2	*A* 2.0^m *B* 5.1^m 3″ *CD* 10^m 69″	
ε Hya *ABC*	45.7	+06 30	3.39	+0.68	G0 comp.	0.010	+0.6	140	0.198	*+36.4*	*A*3.7^m*B*5.2^{m}0.2″15^y,*C*6.8^{m}3″*D*12^{m}20″	
ζ Hya	54.3	+06 02	3.11	+1.00	K0 II–III	0.029	−1.1	220	0.101	+22.8		
ι UMa *A*	57.9	+48 07	3.12	+0.19	A7 V	0.066	+2.2	49	0.505	+12.2	*BC* 10.8^m 4″	

Star	R.A. 1980	Dec.	V	$B–V$	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km/sec		
λ Vel	09 07.3	−43 21	2.24	+1.64:	K4 Ib–IIa	0.015	−4.6	750	0.026	+18.4		*Suhail*
a Car	10.5	−58 52	3.43	−0.17	B2 IV–V		−2.9	590	0.028	*+23.3*		
β Car	13.0	−69 38	1.67	+0.01	A1 III	0.038	−0.4	86	0.183	−05		*Miaplacidus*
ι Car	16.6	−59 11	2.25	+0.17	A9 Ib		−4.6	750	0.019	+13.3		
α Lyn	19.9	+34 29	3.17	+1.54	M0 III	0.021	−0.5	180	0.217	+37.6		
κ Vel	21.5	−54 56	2.49	−0.20	B2 IV–V	0.007	−3.4	470	0.012	*+21.9*		
α Hya	26.6	−08 35	1.98	+1.44	K4 III	0.017	−0.3	94	0.034	−04.3		*Alphard*
N Vel	30.6	−56 57	3.19	+1.56	K5 III	0.015	−0.4	170	0.036	−13.9		
θ UMa *A*	31.5	+51 46	3.12	+0.46	F6 IV	0.052	+1.8	63	1.094	+15.4	*B* 14^m 5″	
ε Leo	44.7	+23 51	2.99	+0.81	G0 II	0.002	−2.1	340	0.048	+05.0		
l Car	44.7	−62 26	4.1		G8 Ia	0.019	−5.5	2700	0.016	*+04.0*	Cep. max. 3.4^m min. 4.8^m, 35.52^d	
υ Car *AB*	46.6	−64 59	2.95	+0.26	A8 Ib	0.020	−2.1	340	0.012	+13.6	*A* 3.02^m *B* 6.03^m 5″	
α Leo *A*	10 07.3	+12 04	1.36	−0.11	B7 V	0.039	−0.7	84	0.248	+03.5	*B* 8.1^m 177″	***Regulus***
ω Car	13.2	−69 56	3.33	−0.08	B8 III		−1.5	300	0.029	*+04*		
ζ Leo	15.7	+23 31	3.46	+0.30	F0 III	0.009	+0.5	130	0.023	−15.0		
λ UMa	15.9	+43 01	3.45	+0.03	A2 IV	−.010	+0.1	150	0.170	+18.3		
q Car	16.4	−61 14	3.41v	+1.55	K3 Ib–II	0.018	−4.6	1300	0.023	+08.6	Var. *R* 3.38–3.44	
γ Leo *AB*	18.8	+19 57	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	21.1	+41 36	3.05	+1.55	M0 III	0.031	+0.5	105	0.086	*−20.5*		
p Car	31.4	−61 35	3.30v	−0.11	B4 Vne		−2.3	430	0.021	+26.0	Var. *R* 3.22–3.39	
θ Car	42.2	−64 17	2.74	−0.22	B0.5 Vp		−4.0	710	0.018	+24		
μ Vel *AB*	45.9	−49 19	2.67	+0.89	*G5 III*		+0.1	108	0.085	+06.9	*A* 2.7^m *B* 7.2^m 1″	
ν Hya	48.6	−16 05	3.12	+1.25	K3 III	0.022	−0.2	150	0.221	−01.0		
β UMa	11 00.6	+56 30	2.37	−0.03	A1 V	0.042	+0.5	78	0.087	−12.0		*Merak*
α UMa *AB*	02.5	+61 52	1.81	+1.06	K0 III	0.031	−0.7	105	0.138	−08.9	*A* 1.88^m *B* 4.82^m 1″	*Dubhe*
ψ UMa	08.6	+44 36	3.00	+1.14	K1 III		+0.0	130	0.072	−03.8		
δ Leo	13.0	+20 38	2.57	+0.13	A4 V	0.040	+0.6	82	0.201	−20.6		
θ Leo	13.2	+15 33	3.34	0.00	A2 V	0.019	+1.1	90	0.104	+07.8		
λ Cen	34.9	−62 54	3.15	−0.05	B9 III		−2.1	370	0.039	*−01*		
β Leo	48.0	+14 41	2.14	+0.09	A3 V	0.076	+1.5	43	0.511	−01		*Denebola*

Star	R.A. 1980	Dec.	V	$B–V$	Type		π	M_V	D	μ	R		
	h m	° ′					″		l.y.	″	km/sec		
γ UMa	11 52.7	+53 49	2.44	0.00	A0	V	0.020	+0.2	90	0.094	−12.9		*Phecda*
δ Cen	12 07.3	−50 36	2.59v	−0.11:	B2	IVne		−2.7	370	0.042	+09	Var. *R* 2.56–2.62	
ε Crv	09.1	−22 30	3.00	+1.33	K3	III		−0.2	140	0.069	+04.9		
δ Cru	14.1	−58 38	2.81v	−0.23	B2	IV		−3.4	570	0.041	+26.4	Var *R* 2.78–2.84	
δ UMa	14.4	+57 09	3.30	+0.07	A3	V	0.052	+1.9	63	0.106	−12.9		*Megrez*
γ Crv	14.8	−17 25	2.59	−0.10	B8	III		−3.1	450	0.163	−04.2		*Gienah*
α Cru *A*	25.4	−62 59	1.39	−0.25	B0.5	IV		−3.9	370	0.042	*−11.2*	} 5″, *C* 4.90^m 89″	***Acrux***
α Cru *B*	25.4	−62 59	1.86	−0.25	B1	V		−3.4	370	0.042	*−00.6*	}	
δ Crv *A*	28.8	−16 24	2.97	−0.04	B9.5	V:n	0.018	+0.1	124	0.255	+09	*B* 8.26^m 24″	
γ Cru	30.1	−57 00	1.69	+1.55	M4	III		−2.5	220	0.274	+21.3		*Gacrux*
β Crv	33.3	−23 17	2.66	+0.89	G5	III	0.027	+0.1	108	0.059	−07.7		
α Mus	36.0	−69 01	2.70v	−0.20	B2	IV–V		−2.9	430	0.037	+*10*	Var. *R* 2.66–2.73	
γ Cen *AB*	40.5	−48 51	2.17	+0.00	*A0*	*IV:*	0.006	−0.5	160	0.197	−07.5	*A* 2.9^m *B* 2.9^m 2″	
γ Vir *AB*	40.6	−01 20	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*	45.0	−68 00	3.06	−0.17:	B2	V		−2.1	470	0.041	+42	*A* 3.7^m *B* 4.0^m 1″	
β Cru	46.6	−59 35	1.28v	−0.25	B0.5	III		−4.6	490	0.049	+20.0	β CMa var., 0.25^d:	***Beta Crucis***
ε UMa	53.2	+56 04	1.79v	−0.03	A0pv		0.008	+0.2	68	0.113	−09.3	Chromium-europium star	*Alioth*
α CVn *A*	55.1	+38 26	2.90v	−0.10	B9.5pv		0.023	+0.1	118	0.238	*−03.3*	Silicon-europium star. *B* 5.61^m 20″	*Cor Caroli*
ε Vir	13 01.2	+11 05	2.83	+0.93	G9	II–III	0.036	+0.6	90	0.274	−14.0		
γ Hya	17.8	−23 04	2.98	+0.92	G8	III	0.021	+0.3	113	0.086	−05.4		
ι Cen	19.5	−36 36	2.76	+0.05	*A2*	*V*	0.046	+1.1	71	0.351	+00.1		
ζ UMa *A*	23.1	+55 02	2.26	+0.02	A2	V	0.037	+0.1	88	0.127	*−05.6*	*B* 3.94^m 14″ (Alcor, 708″)	*Mizar*
α Vir	24.1	−11 03	0.91v	−0.24	B1	V	0.021	−3.3	220	0.054	+*01.0*	Ecl. *R* 0.91–1.01, 4.0^d, β CMa var.,	***Spica***
ζ Vir	33.7	−00 30	3.37	+0.10	A3	Vn	0.035	+1.1	93	0.287	−13.2		
ε Cen	38.6	−53 22	2.33v	−0.23	B1	III		−3.9	570	0.033	+05.6	β CMa var., 0.17^d	
η UMa	46.8	+49 25	1.87	−0.20	B3	V	0.004	−2.1	210	0.123	−10.9		*Alkaid*
ν Cen	48.3	−41 35	3.42	−0.22	B2	IV		−3.4	750	0.037	+*09.0*		
μ Cen	48.4	−42 23	3.12v	−0.13:	B2	V:pne		−2.7	470	0.032	+12.6	Var. *R* 3.08–3.17	
η Boo	53.8	+18 30	2.69	+0.59	G0	IV	0.102	+2.7	32	0.370	+*01.0*		
ζ Cen	54.3	−47 12	2.56	−0.23:	B2.5	IV		−3.4	520	0.076	+*06.5*		

Star	R.A. 1980	Dec.	V	$B-V$	Type		π	M_V	D	μ	R		
	h m	° ′					″		l.y.	″	km/sec		
β Cen *AB*	14 02.4	−60 16	0.63v	−0.23:	B1	III	0.016	−5.2	490	0.035	*−12*	*A* 0.7^m *B* 3.9^m 1″, β CMa var.	***Hadar***
π Hya	05.3	−26 35	3.25	+1.13	K2	III	0.039	+1.2	84	0.156	+27.2		
θ Cen	05.5	−36 17	2.04	+1.03	K0	III–IV	0.059	+0.9	55	0.738	+01.3		*Menkent*
α Boo	14.8	+19 17	−0.06	+1.23	K2	IIIp	0.090	−0.3	36	2.284	−05.2		***Arcturus***
γ Boo	31.3	+38 24	3.05	+0.19	A7	III	0.016	+0.2	118	0.186	−35.5		
η Cen	34.2	−42 04	2.39v	−0.21	B1.5	V:ne		−3.0	390	0.049	−00.2	Var, *R* 2.33–2.45	
α Cen *A*	38.4	−60 46	0.01	+0.68	G2	V	.751	+4.39	4.3	3.676	−24.6	18″	***Rigil Kentaurus***
α Cen *B*	38.4	−60 46	1.40:	+0.73:	K1	V		+5.8	4.3		−20.7		
α Lup	40.7	−47 19	2.32v	−0.22	B1	V		−3.3	430	0.033	*+07.3*	β CMa var., 0.26^d	
α Cir *AB*	40.9	−64 53	3.18	+0.25	A8	p	0.049	+1.6	66	0.308	+07.4	Strontium star. *A* 3.19^m *B* 8.61^m 16″	
ε Boo *AB*	44.1	+27 09	2.37	+0.96	K1:	III: +A	0.013	+0.0	103	0.051	−16.5	*A* 2.47^m *B* 5.04^m 3″	
α Lib *A*	49.8	−15 54	2.76	+0.15	A3m		0.049	+1.2	66	0.130	−10	*B* 5.15^m 231″	*Zubenelgenubi*
β UMi	50.8	+74 14	2.07	+1.47	K4	III	0.031	−0.5	105	0.033	+16.9		*Kochab*
β Lup	57.3	−43 03	2.69	−0.23	B2	IV		−3.4	540	0.066	−00.3		
κ Cen	57.8	−42 01	3.15	−0.21	B2	V		−2.7	470	0.033	+09.1		
β Boo	15 01.2	+40 28	3.48	+0.95	G8	III	0.022	+0.3	140	0.059	−19.9		
σ Lib	02.9	−25 12	3.31	+1.65	M4	III	0.056	+2.0:	58:	0.089	−04.3		
ζ Lup *A*	10.8	−52 01	3.42	+0.90:	*K0*	*III*	0.036	+1.2	90	0.135	−09.7	*B* 7.8^m 71″	
δ Boo *A*	14.7	+33 24	3.47	+0.95	G8	III	0.028	+0.3	140	0.148	−12.2	*B* 7.84^m 105″	
β Lib	15.9	−09 18	2.61	−0.11	B8	V	−.012	−0.6	140	0.101	−35.2		
γ TrA	17.1	−68 36	2.89	+0.01	A0	IV	0.005	+0.2	113	0.067	−06	Europium star	
δ Lup	20.1	−40 34	3.21v	−0.23	B2	IV		−3.4	680	0.032	+02	β CMa var., 0.165^d	
γ UMi	20.8	+71 54	3.04	+0.06	A3	II–III	−.005	−1.5	270	0.026	*−03.9*		
ι Dra	24.5	+59 02	3.28	+1.18	K2	III	0.032	+0.8	102	0.012	−11.0		
γ Lup *AB*	33.8	−41 06	2.80	−0.22	B2	Vn		−2.7	570	0.037	*+06*	*A* 3.5^m *B* 3.7^m 1″	
α CrB	33.8	+26 47	2.23v	−0.02	A0	V	0.043	+0.4	76	0.154	*+01.7*	Ecl. *R* 0.11^m, 17.4^d	*Alphecca*
α Ser	43.3	+06 29	2.65	+1.17	K2	III	0.046	+1.0	71	0.139	+02.9		
β TrA	53.4	−63 22	2.84	+0.28:	F0	IV	0.078	+2.3	42	0.448	−00.3		
π Sco	57.6	−26 04	2.92	−0.19	B1	V	0.005	−3.3	570	0.034	*−03*		
η Lup *AB*	58.8	−38 21	3.40	−0.23	B2	V		−2.7	570	0.042	+07	*A* 3.47^m *B* 7.70^m 15″	
δ Sco	59.2	−22 34	2.34	−0.13	B0	V		−4.0	590	0.032	−14		*Dschubba*

Star	R.A. 1980	Dec.	V	$B-V$	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km/sec		
β Sco *AB*	16 04.3	−19 45	2.65	−0.09	B0.5 V	0.004	−3.7	650	0.027	*−01.0*	*A* 2.78^{m} *B* 5.04^{m} 1″, *C* 4.93^{m} 14″	
δ Oph	13.3	−03 37	2.72	+1.59	M1 III	0.029	−0.5	140	0.156	−19.9		
ε Oph	17.2	−04 39	3.22	+0.97	G9 III	0.036	+1.0	90	0.089	−10.3		
σ Sco *A*	20.0	−25 32	2.86v	+0.14	B1 III		−4.4	570	0.030	*+02.5*	β CMa *R* 2.82–2.90, 0.25^{d}, *B* 8.49^{m} 20″	
η Dra *A*	23.7	+61 33	2.71	+0.92	G8 III	0.043	+0.9	76	0.062	−14.3	*B* 8.7^{m} 6″	
α Sco *A*	28.2	−26 23	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	29.3	+21 32	2.78	+0.92	G8 III	0.017	+0.3	103	0.105	*−25.5*		
τ Sco	34.6	−28 10	2.85	−0.25	B0 V		−4.0	750	0.030	−00.7		
ζ Oph	36.1	−10 31	2.57	+0.00	O9.5 V	−.007	−4.3	520	0.022	*−19*		
ζ Her *AB*	40.6	+31 38	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	42.2	+38 58	3.46	+0.92	G7 III–IV	0.053	+2.1	62	0.097	+08.3		
α TrA	46.5	−68 60	1.93	+1.43	K2 Ib	0.024	−0.1	82	0.044	−03.6		*Atria*
ε Sco	48.8	−34 16	2.28	+1.16	K2.5 III	0.049	+0.7	66	0.664	−02.5		
μ¹ Sco	50.5	−38 01	2.99v	−0.20	B1.5 V		−3.0	520	0.033	*−25*	Ecl. *R* 2.99–3.09, 1.4^{d}	
κ Oph	56.8	+09 25	3.18	+1.15	K2 III	0.026	−0.1	150	0.293	−55.6		
ζ Ara	56.9	−55 57	3.12	+1.61	K4 III	0.036	+0.9	90	0.042	−06.0		
ζ Dra	17 08.7	+65 44	3.20	−0.12	B6 III	0.017	−3.2	620	0.026	−14.1		
η Oph *AB*	09.3	−15 42	2.43	+0.06	A2.5 V	0.047	+1.4	69	0.097	−00.9	*A* 3.0^{m} *B* 3.4^{m} 1″	*Sabik*
η Sco	10.7	−43 13	3.33	+0.38	*F2 III*	0.063	+2.3	52	0.293	−28.4		
α Her *AB*	13.8	+14 24	3.10v	+1.41	M5 II	−.007	−2.3	410	0.032	−33.1	*A* 3.2^{m} $\pm$ 0.3 *B* 5.4^{m} 5″	*Ras-Algethi*
δ Her	14.2	+24 51	3.14	+0.09	A3 IV	0.034	+0.8	96	0.164	−41		
π Her	14.3	+36 49	3.13	+1.43	K3 II	0.020	−2.4	410	0.029	−25.7		
θ Oph	20.8	−24 59	3.29v	−0.22	B2 IV		−3.4	710	0.025	*−03.6*	β CMa var., 0.14^{d}	
β Ara	23.6	−55 31	2.90:	+1.45:	K1.5 Ib	0.026	−4.6	1030	0.035	−00.4		
γ Ara *A*	23.8	−56 22	3.32	−0.16:	B1 Ib		−3.3	680	0.017	−04	*B* 10^{m} 18″	
υ Sco	29.4	−37 16	2.71	−0.22	B2 IV		−3.4	540	0.039	*+07*		
β Dra *A*	29.9	+52 20	2.77	+0.96	G2 II	0.009	−2.1	310	0.019	−20.0	*B* 11.49^{m} 4″	
α Ara	30.3	−49 52	2.95	−0.18:	B2.5 V		−2.4	390	0.083	*−02*		
λ Sco	32.3	−37 05	1.60v	−0.24	B1 V		−3.3	310	0.031	00	β CMa var., 0.21^{d}	*Shaula*
α Oph	34.0	+12 35	2.09	+0.16	A5 III	0.056	+0.8	58	0.260	+12.7		*Rasalhague*
θ Sco	35.9	−42 59	1.86	+0.39	*F0 Ib*	0.020	−4.6	650	0.012	+01.4		

Star	R.A. 1980	Dec.	V	$B-V$	Type	π	M_V	D	μ	R	
	h m	° ′				″		l.y.	″	km/sec	
κ Sco	17 41.1	−39 01	2.39v	−0.21	B1.5 III		−3.4	470	0.031	*−10*	β CMa var., 0.20^d
β Oph	42.5	+04 35	2.77	+1.16	K2 III	0.023	−0.1	124	0.160	−12.0	
μ Her *A*	45.7	+27 45	3.42	+0.75	G5 IV	0.108	+3.6	30	0.811	−15.6	*BC* 9.78^m 33″
ι¹ Sco	46.2	−40 06	3.02	+0.49	F2 Ia	0.013	−7.1	3400	0.004	*−27.6*	
G Sco	48.4	−37 02	3.21	+1.18	K2 III	0.032	+0.7	102	0.064	+24.7	
γ Dra	56.1	+51 29	2.21	+1.52	K5 III	0.017	−0.4	108	0.026	−27.6	*Eltanin*
ν Oph	58.0	−09 47	3.32	+1.00	G9 III	0.015	+0.2	140	0.118	+12.4	
γ Sgr	18 04.5	−30 26	2.97	+1.00	*K0 III*	0.018	+0.1	124	0.200	*+22.1*	
η Sgr *A*	16.3	−36 47	3.12	+1.55	M3.5 III	0.038	+1.1:	86:	0.218	+00.5	*B* 10^m 4″
δ Sgr	19.7	−29 50	2.71	+1.39	K2 III	0.039	+0.7	84	0.050	−20.0	
η Ser	20.2	−02 54	3.23	+0.94	K0 III–IV	0.054	+1.9	60	0.894	+08.9	
ε Sgr	22.9	−34 24	1.81	−0.02	B9.5 III	0.015	−1.1	124	0.135	−11	*Kaus Australis*
λ Sgr	26.7	−25 27	2.80	+1.05	*K2 III*	0.046	+1.1	71	0.194	−43.3	
α Lyr	36.2	+38 46	0.04	0.00	A0 V	0.123	+0.5	26.5	0.345	−13.9	*Vega*
φ Sgr	44.4	−27 01	3.20	−0.11	*B8 III*		−3.1	590	0.052	+21.5	
β Lyr *A*	49.4	+33 21	3.38v	−0.05:	Bpe	−.011	−4.6	1300	0.007	*−17.8*	Ecl. *R* 3.38–4.36, 12.9^d, *B* 7.8^m 46″
σ Sgr	54.0	−26 19	2.12:	−0.21	B2 V		−2.7	300	0.059	−11	*Nunki*
ξ² Sgr	56.5	−21 07	3.51	+1.18:	K1 III	0.006	+0.0	160	0.035	−19.9	
γ Lyr	58.2	+32 40	3.25	−0.05	B9 III	0.011	−2.1	370	0.007	−21.5	
ζ Sgr *AB*	19 01.3	−29 54	2.61	+0.08	*A2 IV*	0.020	+0.1	140	0.020	+22	*A* 3.3^m *B* 3.5^m < 1″
ζ Aql *A*	04.5	+13 50	2.99	+0.01	A0 V:nn	0.036	+0.8	90	0.101	−26.3	*B* 12^m 5″
λ Aql	05.2	−04 55	3.44	−0.10	B9: V:n	0.025	−0.1	160	0.092	−14	
τ Sgr	05.7	−27 42	3.30	+1.18	K1 III	0.038	+1.2	86	0.261	*+45.4*	
π Sgr *ABC*	08.6	−21 03	2.89	+0.35	F2 II–III	0.016	−0.7	250	0.040	−09.8	*A* 3.7^m *B* 3.8^m *C* 6.0^m < 1″
δ Dra	12.5	+67 38	3.06	+1.00	G9 III	0.028	+0.2	124	0.130	+24.8	
δ Aql	24.5	+03 04	3.38	+0.31	F0 IV	0.062	+2.3	53	0.267	*−29.9*	
β Cyg *A*	29.9	+27 55	3.07	+1.12	K3 II:+B:	0.004	−2.4	410	0.009	−24.0	*B* 5.11^m 35″ *Albireo*
δ Cyg *AB*	44.3	+45 05	2.87	−0.03	B9.5 III	0.021	−1.7	270	0.060	−21	*A* 2.91^m *B* 6.44^m 2″
γ Aql	45.3	+10 33	2.72	+1.52	K3 II	0.006	−2.4	340	0.012	−02.1	
α Aql	49.8	+08 49	0.77	+0.22	A7 IV–V	0.198	+2.2	16.5	0.658	−26.3	*Altair*

Star	R.A. 1980	Dec.	V	B–V	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km/sec		
θ Aql	20 10.3	−00 52	3.24	−0.07	B9.5 III	0.008	−1.7	330	0.034	*−27.3*		
β Cap *A*	19.9	−14 51	3.06	+0.76	comp.	0.005	+0.1	130	0.039	−18.9	Type gK0: + late B; *B* 5.97^m 205″	
γ Cyg	21.5	+40 11	2.22	+0.66	F8 Ib	−.006	−4.6	750	0.001	−07.5		
α Pav	24.1	−56 48	1.95	−0.20	B2.5 V		−2.9	310	0.087	*+02.0*		*Peacock*
α Ind	36.2	−47 21	3.11	+1.00	*K0 III*	0.039	+1.1	84	0.082	−01.1		
α Cyg	40.7	+45 12	1.26	+0.09	A2 Ia	−.013	−7.1	1600	0.003	*−04.6*		***Deneb***
β Pav	43.2	−66 17	3.45	+0.16	A7 III	0.026	−0.1	160	0.046	+09.8		
η Cep	44.9	+61 45	3.41	+0.92	K0 IV	0.071	+2.7	46	0.825	−87.3		
ε Cyg	45.4	+33 53	2.46	+1.03	K0 III	0.044	+0.7	74	0.481	*−10.3*		
ζ Cyg	21 12.1	+30 08	3.19	+1.00	G8 II	0.021	−2.2	390	0.056	+17.4		
α Cep	18.2	+62 31	2.44	+0.24	A7 IV–V	0.063	+1.4	52	0.156	−10		*Alderamin*
β Cep	28.4	+70 28	3.15v	−0.22v	B2 III	0.005	−4.2	980	0.014	*−03.1*	β CMa *R* 3.14–3.16, 0.19^d	
β Aqr	30.5	−05 40	2.86	+0.82	G0 Ib	0.000	−4.6	1030	0.017	+06.5		
ε Peg *A*	43.2	+09 48	2.38	+1.55	K2 Ib	−.005	−4.6	780	0.025	+04.7	*B* 11^m 82″	*Enif*
δ Cap	45.9	−16 13	2.92v	+0.29	A6m	0.065	+2.0	50	0.392	*−00.2*	Var. *R* 2.88–2.95	
γ Gru	52.7	−37 27	3.00	−0.10	B8 III	0.008	−3.1	540	0.102	−02.1		
α Aqr	22 04.7	−00 25	2.93	+0.96	G2 Ib	0.003	−4.6	1080	0.016	+07.5		
α Gru	06.9	−47 04	1.76	−0.14	B7 IV	0.051	+0.3:	64:	0.194	+11.8		*Al Na'ir*
ζ Cep	10.1	+58 06	3.36	+1.59	K1 Ib	0.019	−4.6	1240	0.015	*−18.4*		
α Tuc	17.1	−60 21	2.87	+1.40	K4 III	0.019	+1.5	62	0.079	*+42.2*		
δ Cep *A*	28.5	+58 19	3.96v	+0.66v	F5–G2 Ib	0.005	−4.0	1300	0.012	*−16.8*	Cep. *R* 3.51–4.42, 5.4^d *B* 6.19^m 41″	
ζ Peg	40.5	+10 44	3.40	−0.08:	B8 V	−.004	−0.6	210	0.077	+07		
β Gru	41.5	−46 59	2.17v	+1.59	M5 III	0.003	−2.5	280	0.134	+01.6	Var. *R* 2.11–2.23	
η Peg	42.1	+30 07	2.95	+0.85	G8 II: + F?	−.002	−2.2	360	0.027	*+04.3*		
δ Aqr	53.6	−15 56	3.28	+0.08	A3 V	0.039	+1.2	84	0.047	+18.0		
α PsA	56.5	−29 44	1.15	+0.10	A3 V	0.144	+2.0	22.6	0.367	+06.5		***Fomalhaut***
β Peg	23 02.8	+27 58	2.5 v	+1.67	M2 II–III	0.015	−1.5	210	0.234	+08.7	Var. *R* 2.4–2.7	*Scheat*
α Peg	03.8	+15 05	2.50	−0.03	B9.5 III	0.030	−0.1	109	0.071	−03.5		*Markab*
γ Cep	38.5	+77 30	3.20	+1.02	K1 IV	0.064	+2.2	51	0.168	−42.4		

DOUBLE AND MULTIPLE STARS

BY CHARLES E. WORLEY

Many stars can be separated into two or more components by use of a telescope. The larger the aperture of the telescope, the closer the stars which can be separated under good seeing conditions. With telescopes of moderate size and average optical quality, and for stars which are not unduly faint or of large magnitude difference, the minimum angular separation is given by 4.6/D, where D is the diameter of the telescope's objective in inches.

The following lists contain some interesting examples of double stars. The first list presents pairs whose orbital motions are very slow. Consequently, their angular separations remain relatively fixed and these pairs are suitable for testing the performance of small telescopes. In the second list are pairs of more general interest, including a number of binaries of short period for which the position angles and separations are changing rapidly.

In both lists the columns give, successively: the star designation in two forms; its right ascension and declination for 1975; the combined visual magnitude of the pair and the individual magnitudes; the apparent separation and position angle for 1976.0; and the period, if known.

Many of the components are themselves very close visual or spectroscopic binaries. (Other double stars appear in the table of The Brightest Stars and of The Nearest Stars.)

Star		A.D.S.	R.A. 1975.0 h	m	Dec. 1975.0 °	′	Magnitudes comb.	A	B	P.A. 1976.0 °	Sep. ″	P (app.) years
λ	Cas	434	00	30.4	+54	24	4.9	5.5	5.8	181	0.6	640
α	Psc	1615	02	00.7	+02	39	4.0	4.3	5.3	284	1.8	720
33	Ori	4123	05	29.9	+03	16	5.7	6.0	7.3	27	1.8	—
OΣ	156	5447	06	46.0	+18	13	6.1	6.8	7.0	246	0.5	1100
Σ	1338	7307	09	19.4	+38	18	5.8	6.5	6.7	249	1.0	400
35	Com	8695	12	52.1	+21	23	5.1*	5.2	7.4	159	1.0	500
Σ	2054	10052	16	23.5	+61	45	5.6	6.0	7.2	355	1.1	—
ε¹	Lyr†	11635	18	43.5	+39	38	5.1	5.4	6.5	356	2.7	1200
ε²	Lyr†	11635	18	43.5	+39	38	4.4	5.1	5.3	85	2.3	600
π	Aql	12962	19	47.5	+11	44	5.6	6.0	6.8	110	1.4	—
OΣ	500	16877	23	36.3	+44	18	5.9	6.4	7.1	355	0.5	—
η	Cas	671	00	47.4	+57	42	3.5*	3.5	7.2	305	11.8	480
Σ	186	1538	01	54.5	+01	44	6.0	6.8	6.8	56	1.3	160
γ	And AB	1630	02	02.1	+42	15	2.1*	2.1	5.1	64	9.8	—
γ	And BC	1630	02	02.1	+42	15	5.1	5.5	6.3	109	0.5	61
OΣ	65	2799	03	48.9	+25	31	5.2	5.8	6.2	205	0.7	62
α	CMa	5423	06	44.1	−16	40	−1.4	−1.4	8.5	57	11.1	50
α	Gem	6175	07	33.0	+31	56	1.6	2.0	2.8	108	2.0	420
ζ	Cnc AB	6650	08	10.8	+17	44	5.0	5.6	5.9	303	0.9	60
ζ	Cnc AC	6650	08	10.8	+17	44	5.2	5.4	7.3	83	5.9	1150
σ²	UMa	7203	09	08.2	+67	14	4.8*	4.8	8.2	5	3.1	1100
γ	Leo	7724	10	18.6	+19	59	1.8	2.1	3.4	123	4.3	620
ξ	UMa	8119	11	16.8	+31	41	3.8	4.3	4.8	113	3.1	60
γ	Vir	8630	12	40.4	−01	19	2.8	3.5	3.5	300	4.2	170
ζ	Boo	9343	14	39.9	+13	50	3.8	4.5	4.5	306	1.1	125
ξ	Boo	9413	14	50.2	+19	13	4.5	4.7	6.8	335	7.2	150
ζ	Her	10157	16	40.4	+31	39	2.8	2.9	5.5	171	1.2	35
τ	Oph	11005	18	01.6	−08	11	4.7	5.2	5.9	276	1.9	280
70	Oph	11046	18	04.2	+02	32	4.0	4.2	6.0	359	1.9	88
δ	Cyg	12880	19	44.2	+45	03	2.9*	2.9	6.3	234	2.2	830
4	Aqr	14360	20	50.1	−05	54	6.0	6.4	7.2	10	0.9	150
τ	Cyg	14787	21	13.7	+37	56	3.7	3.8	6.4	162	0.9	50
μ	Cyg	15270	21	43.0	+28	38	4.5	4.8	6.1	295	1.8	500
ζ	Aqr	15971	22	27.5	−00	10	3.6	4.3	4.5	236	1.8	850
Σ	3050	17149	23	58.2	+33	35	5.8	6.5	6.7	303	1.5	350

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

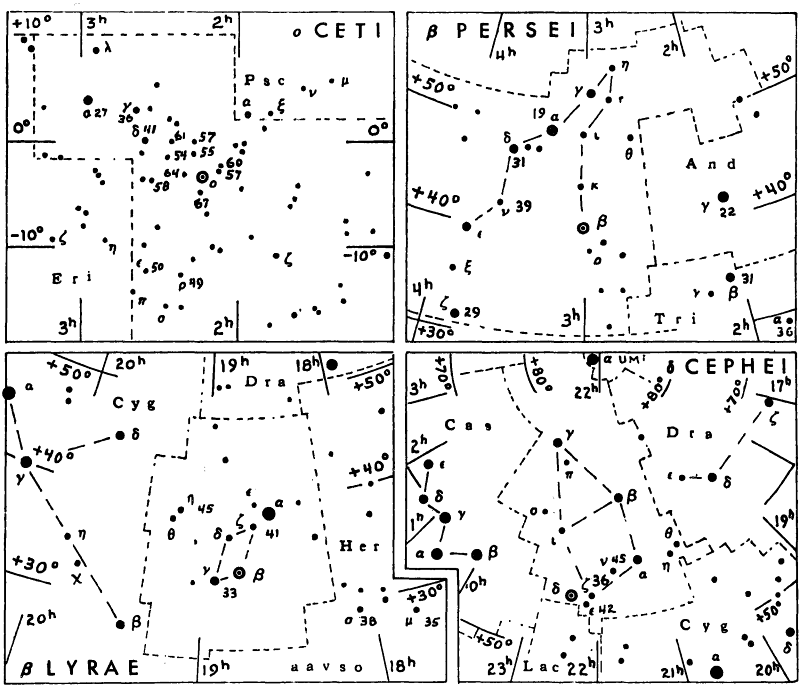
(*Editor's Note* The co-ordinates of the stars in this table, which was extensively revised in 1975, are referred to the equinox of 1975, rather than to that of 1980, which is used elsewhere in this book.)

VARIABLE STARS

By Janet Mattei

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

In the tables the first column, the Harvard designation of the star, gives the 1900 position: the first four figures give the hours and minutes of R.A., the last two figures give the Dec. in degrees, italicised for southern declinations. The column headed *Max.* gives the mean maximum magnitude. The *Period* is in days. The *Epoch* gives the predicted date of the *earliest* maximum occurring this year; by adding the period to this epoch other dates of maximum may be found. The list of long-period variables has been prepared by the American Association of Variable Star Observers and includes the variables with maxima brighter than mag. 8.0, and north of Dec. −20°. These variables may reach maximum two or three weeks before or after the listed epoch and may remain at maximum for several weeks. The second table contains stars which are representative of other types of variable. The data are taken from "The General Catalogue of Variable Stars" by Kukarkin and Parenago and for eclipsing binaries from *Rocznik Astronomiczny Obserwatorium Krakowskiego*, 1975, International Supplement.



LONG-PERIOD VARIABLE STARS

Variable	Max. m	Per d	Epoch 1976	Variable	Max. m	Per d	Epoch 1976
001755 T Cas	7.8	445	Feb. 1	142539 V Boo	7.9	258	July 5
001838 R And	7.0	409	Dec. 19	143227 R Boo	7.2	223	July 7
021143 W And	7.4	397	Dec. 8	151731 S CrB	7.3	361	Jan. 21
0214*03* o Cet	3.4	332	Jan. 28	154639 V CrB	7.5	358	Oct. 15
0228*13* U Cet	7.5	235	Mar. 4	154615 R Ser	6.9	357	Aug. 31
023133 R Tri	6.2	266	Jan. 29	160625 RU Her	8.0	484	July 24
043065 T Cam	8.0	374	Oct. 24	162119 U Her	7.5	406	June 20
0455*14* R Lep	6.8	432	June 27	1621*12* V Oph	7.5	298	Aug. 3
050953 R Aur	7.7	459	Nov. 30	163266 R Dra	7.6	245	Jan. 30
054920 U Ori	6.3	372	Aug. 30	164715 S Her	7.6	307	Mar. 8
0617*02* V Mon	7.0	335	May 1	1702*15* R Oph	7.9	302	Jan. 5
065355 R Lyn	7.9	379	Apr. 23	171723 RS Her	7.9	219	Aug. 1
070122aR Gem	7.1	370	July 1	180531 T Her	8.0	165	Feb. 11
070310 R CMi	8.0	338	Sept. 2	181136 W Lyr	7.9	196	Apr. 29
072708 S CMi	7.5	332	Apr. 26	183308 X Oph	6.8	334	Jan. 1
081112 R Cnc	6.8	362	Jan. 7	190108 R Aql	6.1	300	May 9
081617 V Cnc	7.9	272	June 12	1910*17* T Sgr	8.0	392	June 2
084803 S Hya	7.8	257	July 19	1910*19* R Sgr	7.3	269	Feb. 18
0850*08* T Hya	7.8	288	Mar. 26	193449 R Cyg	7.5	426	Apr. 9
093934 R LMi	7.1	372	Feb. 29	194048 RT Cyg	7.3	190	Apr. 1
094211 R Leo	5.8	313	May 27	194632 χ Cyg	5.2	407	June 28
103769 R UMa	7.5	302	Apr. 21	201647 U Cyg	7.2	465	—
1214*18* R Crv	7.5	317	Jan. 8	2044*05* T Aqr	7.7	202	June 21
122001 SS Vir	6.8	355	Dec. 13	210868 T Cep	6.0	390	July 29
123160 T UMa	7.7	257	Jan. 9	213753 RU Cyg	8.0	234	Apr. 6
123307 R Vir	6.9	146	Jan. 24	230110 R Peg	7.8	378	Feb. 21
123961 S UMa	7.8	226	Feb. 26	230759 V Cas	7.9	228	July 21
131546 V CVn	6.8	192	Jan. 24	231508 S Peg	8.0	319	Oct. 17
1327*06* S Vir	7.0	378	Jan. 17	2338*15* R Aqr	6.5	387	Jan. 2
134440 R CVn	7.7	328	May 24	235350 R Cas	7.0	431	—
142584 R Cam	7.9	270	Apr. 11	2357*15* W Cet	7.6	351	Mar. 12

OTHER TYPES OF VARIABLE STARS

Variable	Max. m	Min. m	Type	Sp. Cl.	Period d	Epoch 1976 E.S.T.
005381 U Cep	6.7	9.8	Ecl.	B8+gG2	2.49302	Jan. 1.29*
025838 ρ Per	3.3	4.0	Semi R	M4	33–55, 1100	—
030140 β Per	2.1	3.3	Ecl.	B8+G	2.86731	Jan. 2.22*
035512 λ Tau	3.5	4.0	Ecl.	B3	3.952952	Jan. 3.92*
060822 η Gem	3.1	3.9	Semi R	M3	233.4	—
061907 T Mon	6.4	8.0	δ Cep	F7–K1	27.0205	Jan. 6.43
065820 ζ Gem	4.4	5.2	δ Cep	F7–G3	10.15172	Jan. 3.20
154428 R Cr B	5.8	14.8	R Cr B	cFpep		—
171014 α Her	3.0	4.0	Semi R	M5	50–130, 6 yrs.	—
1842*05* R Sct	6.3	8.6	RVTau	G0e-K0p	144	—
184633 β Lyr	3.4	4.3	Ecl.	B8	12.931163	Jan. 3.34*
192242 RR Lyr	6.9	8.0	RR Lyr	A2–F1	0.5668223	Jan. 1.21
194700 η Aql	4.1	5.2	δ Cep	F6–G4	7.176641	Jan. 2.75
222557 δ Cep	4.1	5.2	δ Cep	F5–G2	5.366341	Jan. 4.70

*Minimum.

BRIEF DESCRIPTION OF VARIABLE TYPES

Variables can be divided into three main classes; pulsating, eruptive and eclipsing binary stars as recommended by Commission 27 of the International Astronomical Union at its 12th General Assembly in Hamburg in 1964. A very brief and general description about the major types of variables in each class is given below.

I. *Pulsating Variables*

Cepheids: Variables that pulsate periodically with periods 1 to 70 days. They have high luminosity with amplitudes of light variations ranging from 0.1 to 2^m. Some of the group are located in open clusters, and they obey the well known period-luminosity relation. They are of F spectral class at maximum and G–K at minimum. The later their spectral class the greater is the period of light variation. Typical representative: δ Cephei.
RR Lyrae Type: Pulsating, giant variables with periods ranging from $0\overset{d}{.}05$ to $1\overset{d}{.}2$ and amplitude of light variation between 1 and 2^m. They are usually of A spectral class. Typical representative: RR Lyrae.
RV Tauri Type: Supergiant variables with light curves of alternating deep and shallow minima. The periods, defined as the interval between two deep minima, range from 30 to 150 days. The amplitude of light variations goes up to 3^m. Many show long term variations of 500 to 9000 days in their mean magnitude. Generally the spectral classes range from G to K. Typical representative: R Scuti.
Long period—Mira Ceti variables: Giant variables that vary with amplitudes from 2.5 to 5^m and larger with well defined periodicity, ranging from 80 to 1000 days. They show characteristic emission spectra of late spectral classes of Me, Ce and Se. Typical representative: ο Ceti (Mira).
Semiregular Variables: Giants and supergiants showing appreciable periodicity accompanied by intervals of irregularities of light variation. The periods range from 30 to 1000 days with amplitudes not exceeding 1 to 2^m, in general. Typical representative: R Ursae Minoris.
Irregular Variables: Stars that show no periodicity or only a trace of it at times. Typical representative: ω Canis Majoris.

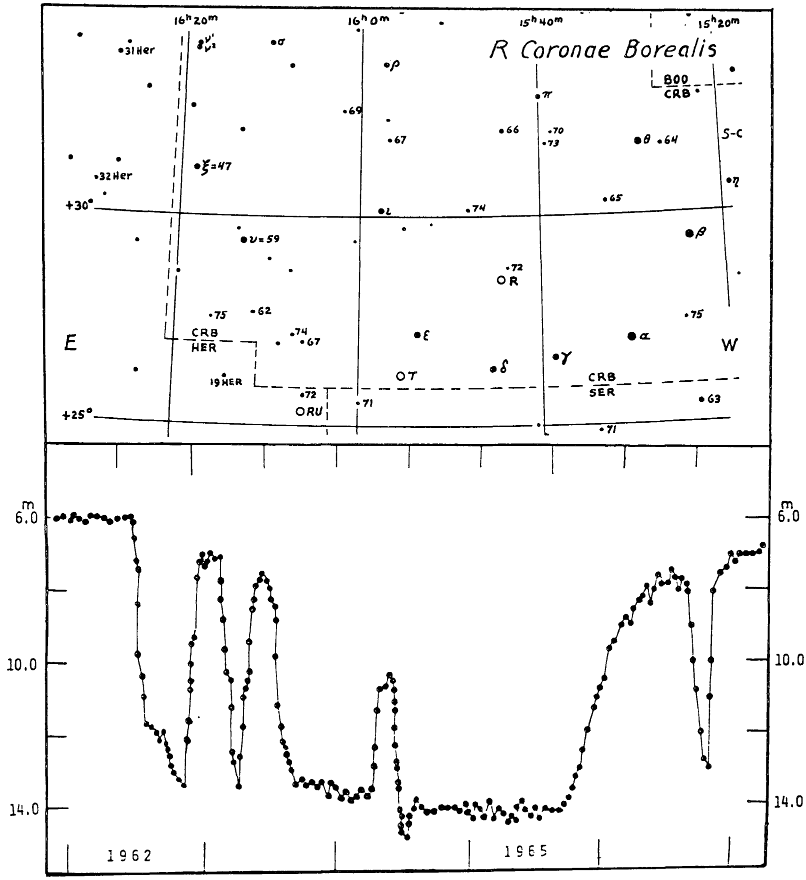
II. *Eruptive Variables*

Novae: Hot, dwarf stars with sudden increase in brightness, from 7 to 16^m in amplitude, in a matter of 1 to several to hundreds of days. After the outburst the brightness decreases slowly until its initial brightness is reached in several years or decades. Near the maximum brightness, spectra similar to A or F giants are usually observed. Typical representative: CP Puppis (Nova 1942).
Supernovae: Novae in a much larger scale, with sudden increase in brightness up to 20^m or more. The general appearance of their light curve is similar to novae. Typical representative: CM Tauri (central star of the Crab Nebula).
R Coronae Borealis Type: High luminosity variables with slow, non-periodic drops in brightness of amplitudes from about 1 to 9^m. The duration of minima varies from some dozen to several hundreds of days. Members of this type are of F to K and R spectral class. Typical representative: R Coronae Borealis.
U Geminorum Type: Dwarf novae that have long intervals of apparent quiesence at minimum with sudden rises to maximum. The range of outburst is from 2 to 6^m in light variations and ten to thousands of days between outbursts depending upon the star. It is a well established fact that most of the members are spectroscopic binaries with periods in order of hours. Typical representative: SS Cygni.
Z Camelopardalis Type: Variables similar to U Gem stars in their physical and spectroscopic properties. They show cyclical variations with intervals of constant brightness for several cycles, approximately one third of the way from maximum to minimum. Typical representative: Z Camelopardalis.

III. *Eclipsing Binaries*

Binary systems of stars with the orbital plane lying close to the line of sight of the observer. The components periodically eclipse each other, causing variations in the apparent brightness of the system, as is seen and recorded by the observer. The period of the eclipses coincides with the period of the orbital motion of the components. Typical representative: β Persei (Algol).

Editor's Note: In cooperation with the A.A.V.S.O., we plan to introduce one or two new variables to our readers each year. The following finding chart and light curve are for R CrB. Normally, it is $6^m_.0$, but suddenly and unpredictably it may fade as much as 10 magnitudes, then slowly return to normal. It is an easy variable star to observe with binoculars.



THE NEAREST STARS

By Alan H. Batten

The accompanying table is similar to one that has been published in the HANDBOOK for several years. Like its predecessors, it is based on the work of Professor van de Kamp who has studied many of the nearest stars and published a revised list of them in 1969 in the *Publications of the Astronomical Society of the Pacific*. Since that list was published, four new stars have been found to have parallaxes of about 0″.190 or greater and are therefore within the distance limit of about seventeen light years (or just over five parsecs) which has been arbitrarily set as the limit for this table. One of them, G158–27, has been included in the HANDBOOK since 1972; the other three, L725–32, B.D. −15° 6290, and B.D. 44° 2051, appear for the first time in the 1976 HANDBOOK. New determinations of the parallaxes of some of the stars in this list have also been published in the last few years. They have not been used because van de Kamp's discussion made use of all the data available for each star, and the inclusion of new data from single observatories for just a few stars would destroy the homogeneity of his list. The reader should remember, however, that new results may affect the order of stars in the list, and that the parallaxes of the new stars included will be relatively uncertain until more observations are available. The latest determination of the parallax of Stein 2051A and B is 0″.179 and if this value is confirmed the stars should be dropped from the list.

Measuring the distances of stars is one of the most difficult and important jobs of an observational astronomer. As the earth travels around the sun each year, the directions of the nearer stars seem to change very slightly compared with those of more distant background stars. This change is called *annual parallax*; even for the nearest star it is less than one second of arc—the angle subtended by a penny about 2.5 miles away. That explains the difficulty of the task, and why results from different observatories are often slightly different. Parallax measurements are important because all our knowledge of the luminosities of stars, and hence of the structures of both the stars and the Galaxy, depends on the relatively few stellar distances that can be directly and accurately measured. The distances are so vast that new units are needed to describe them. Often we talk of *light-years*—the distance (nearly ten million million km or six million million miles) that light travels in a year—but in their own calculations astronomers use *parsecs*. One parsec is the distance of a star that has an annual parallax of one second of arc, and is equal to about 3.26 light years. The distance in parsecs is the reciprocal of the parallax expressed (as in the table) in seconds of arc.

The table gives the name and position of each star, the annual parallax π, the distance D in light-years, the spectral type, the proper motion μ in seconds of arc per year (that is the apparent motion of the star across the sky each year—nearby stars usually have large proper motions), the total space velocity W in km/sec (if known), the visual apparent magnitude and the luminosity in visible light in terms of that of the sun. In column 6, *wd* stands for white dwarf, and *e* indicates the presence of emission lines in the spectrum. Very few stars in our neighbourhood are brighter than the sun, and there are no very luminous or very hot stars at all. Most stars in this part of the galaxy are small, cool, and insignificant objects; we shall probably never be sure we have found them all.

The newest list contains 63 stars, including the Sun, thirty-one of which are single. There are eleven double-star systems and two triple systems. Earlier lists have emphasized the unseen companions believed to be associated with seven of the stars or systems. Recent work has called the reality of some of these into question—especially that of the supposed planetary companion of Barnard's star. The suspected companions are still indicated by asterisks in the table, but the evidence for several of them is no longer as clear as it appeared to be some years ago.

THE NEAREST STARS

Name	1980 α	1980 δ	π	D	Sp.	μ	W	m	L
	h m	° ′	″	l.y.		″	km/sec		
Sun					G2			−26.8	1.0
α Cen A	14 38	−60 46	0.760	4.3	G2	3.68	32	0.1	1.3
B					K5			1.5	0.36
C	14 28	−62 36			M5*e*			11.0	0.00006
Barnard's*	17 56	+04 36	.552	5.9	M5	10.30	140	9.5	0.00044
Wolf 359	10 56	+07 10	.431	7.6	M6*e*	4.84	55	13.5	0.00002
Lal. 21185*	11 03	+36 07	.402	8.1	M2	4.78	103	7.5	0.0052
Sirius A	6 44	−16 42	.377	8.6	A1	1.32	18	−1.5	23.
B					*wd*			7.2	0.008
Luy. 726–8A	1 37	−18 04	.365	8.9	M6*e*	3.35	52	12.5	0.00006
B					M6*e*			13.0	0.00004
Ross 154	18 49	−23 50	.345	9.4	M5*e*	0.74	12	10.6	0.0004
Ross 248	23 40	+44 04	.317	10.3	M6*e*	1.82	86	12.2	0.00011
ε Eri	03 32	−09 32	.305	10.7	K2	0.97	22	3.7	0.30
Luy. 789–6	22 38	−15 28	.302	10.8	M6	3.27	79	12.2	0.00012
Ross 128	11 47	+00 58	.301	10.8	M5	1.40	26	11.1	0.00033
61 Cyg A	21 06	+38 38	.292	11.2	K5	5.22	106	5.2	0.083
B*					K7			6.0	0.040
ε Ind	22 03	−56 52	.291	11.2	K5	4.67	86	4.7	0.13
Procyon A	07 39	+05 17	.287	11.4	F5	1.25	21	0.3	7.6
B					*wd*			10.8	0.0005
Σ 2398 A	18 42	+59 36	.284	11.5	M3.5	2.29	39	8.9	0.0028
B					M4			9.7	0.0013
Groom. 34 A	00 18	+43 54	.282	11.6	M1	2.91	52	8.1	0.0058
B					M6			11.0	0.00040
Lacaille 9352	23 05	−35 59	.279	11.7	M2	6.87	117	7.4	0.012
τ Ceti	01 43	−16 03	.273	11.9	G8	1.92	37	3.5	0.44
BD+5°1668*	07 27	+05 27	.266	12.2	M4	3.73	71	9.8	0.0014
L725–32	01 11	−17 06	.262	12.4	M5*e*	1.31		11.5	0.0003
Lacaille 8760	21 16	−38 58	.260	12.5	M1	3.46	67	6.7	0.025
Kapteyn's	05 11	−44 59	.256	12.7	M0	8.79	292	8.8	0.0040
Kruger 60 A	22 27	+57 36	.254	12.8	M4	0.87	31	9.7	0.0017
B					M6			11.2	0.00044
Ross 614 A	06 28	−02 48	.249	13.1	M5*e*	0.97	30	11.3	0.0004
B					?			14.8	0.00002
BD−12°4523	16 30	−12 36	.249	13.1	M5	1.18	38	10.0	0.0013
van Maanen's	00 48	+05 19	.234	13.9	*wd*F	2.98	270	12.4	0.00017
Wolf 424 A	12 33	+09 09	.229	14.2	M6*e*	1.87	39	12.6	0.00014
B					M6*e*			12.6	0.00014
CD−37°15492	00 04	−37 27	.225	14.5	M3	6.09	130	8.6	0.0058
G158 27	00 06	−07 38	.224	14.6		2.1		13.8	0.00005
Groom. 1618	10 10	+49 33	.217	15.0	M0	1.45	40	6.6	0.040
CD−46°11540	17 28	−46 53	.216	15.1	M4	1.15		9.4	0.0030
CD−49°13515	21 32	−49 11	.214	15.2	M3	0.78		8.7	0.0058
CD−44°11909	17 37	−44 17	.213	15.3	M5	1.14		11.2	0.00063
Luy. 1159–16	01 59	+13 00	.212	15.4	(M7)	2.08		12.3	0.00023
Lal. 25372	13 44	+15 01	.208	15.7	M3.5	2.30	55	8.5	0.0076
AOe 17415–6*	17 37	+68 22	.207	15.7	M3.5	1.31	34	9.1	0.0044
CC 658	11 44	−64 42	.206	15.8	*wd*	2.69		11.0	0.0008
Ross 780	22 52	−14 22	.206	15.8	M5	1.17	28	10.2	0.0016
o^2 Eri A	04 14	−07 41	.205	15.9	K0	4.08	104	4.4	0.33
B					*wd*A			9.9	0.0027
C					M4*e*			11.2	0.00063
BD−15°6290	22 52	−14 22	.205	15.9	M5	1.16		10.2	0.0016
BD+20°2465*	10 19	+19 58	.202	16.1	M4.5	0.49	15	9.4	0.0036
BD+44°2051	11 05	+43 36	.199	16.4	M2*e*	4.40		8.8	0.0063
Altair	19 49	+08 49	.196	16.6	A7	0.66	31	0.8	10.
70 Oph A	18 05	+02 31	.195	16.7	K1	1.13	29	4.2	0.44
B					K6			6.0	0.083
AC+79°3888	11 46	+78 47	.194	16.8	M4	0.87	121	11.0	0.0009
BD+43°4305*	22 46	+44 14	.193	16.9	M5*e*	0.84	21	10.1	0.0021
Stein 2051 A	04 30	+58 57	.192	17.0	(M5)	2.37		11.1	0.0008
B					*wd*			12.4	0.0003

*Star may have an unseen component.

GALACTIC NEBULAE

BY RENÉ RACINE

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

NGC	M	Con	α 1980 δ		Type	Size ′	S mag. sq″	m *	Dist. 10^3 l.y.	Remarks
			h m	° ′						
650/1	76	Per	01 40.9	+51 28	Pl	1.5	20	17	15	
IC348		Per	03 43.2	+32 07	Ref	3	21	8	0.5	Nebulous cluster
1435		Tau	03 46.3	+24 01	Ref	15	20	4	0.4	Merope nebula
1535		Eri	04 13.3	−12 48	Pl	0.5	17	12		
1952	1	Tau	05 33.3	+22 05	SN	5	19	16v	4	"Crab" + pulsar
1976	42	Ori	05 34.3	−05 25	HII	30	18	4	1.5	Orion nebula
1999		Ori	05 35.5	−06 45	PrS	1		10v	1.5	
ζ Ori		Ori	05 39.8	−01 57	Comp	2°			1.5	Incl. "Horsehead"
2068	78	Ori	05 45.8	+00 02	Ref	5	20		1.5	
IC443		Gem	06 16.4	+22 36	SN	40			2	
2244		Mon	06 31.3	+04 53	HII	50	21	7	3	Rosette neb.
2247		Mon	06 32.1	+10 20	PrS	2	20	9	3	
2261		Mon	06 38.0	+08 44	PrS	2		12v	4	Hubble's var. neb.
2392		Gem	07 28.0	+20 57	Pl	0.3	18	10	10	Clown face neb.
3587	97	UMa	11 13.6	+55 08	Pl	3	21	13	12	Owl nebula
ρOph		Oph	16 24.4	−23 24	Comp	4°			0.5	Bright + dark neb.
θOph		Oph	17 20.7	−24 59	Comp	5°				Incl. "S" neb.
6514	20	Sgr	18 01.2	−23 02	HII	15	19		3.5	Trifid nebula
6523	8	Sgr	18 02.4	−24 23	HII	40	18		4.5	Lagoon nebula
6543		Dra	17 58.6	+66 37	Pl	0.4	15	11	3.5	
6611	16	Ser	18 17.8	−13 48	HII	15	19	10	6	
6618	17	Sgr	18 19.7	−16 12	HII	20	19		3	Horseshoe neb.
6720	57	Lyr	18 52.9	+33 01	Pl	1.2	18	15	5	Ring nebula
6826		Cyg	19 44.4	+50 28	Pl	0.7	16	10	3.5	
6853	27	Vul	19 58.6	+22 40	Pl	7	20	13	3.5	Dumb-bell neb.
6888		Cyg	20 11.6	+38 21	HII	15				
γCyg		Cyg	20 21.5	+40 12	Comp	6°				HII + dark neb.
6960/95		Cyg	20 44.8	+30 38	SN	150			2.5	Cygnus loop
7000		Cyg	20 58.2	+44 14	HII	100	22		3.5	N. America neb.
7009		Aqr	21 03.0	−11 28	Pl	0.5	16	12	3	Saturn nebula
7023		Cep	21 01.4	+68 05	Ref	5	21	7	1.3	
7027		Cyg	21 06.4	+42 09	Pl	0.2	15	13		
7129		Cep	21 42.5	+65 00	Ref	3	21	10	2.5	Small cluster
7293		Aqr	22 28.5	−20 54	Pl	13	22	13		Helix nebula
7662		And	23 25.0	+42 25	Pl	0.3	16	12	4	

MESSIER'S CATALOGUE OF DIFFUSE OBJECTS

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

M	NGC	Con	α 1980	δ	m_V	Type
1	1952	Tau	5 33.3	+22 01	11.3	DN*
2	7089	Aqr	21 32.4	−00 54	6.27	GC*
3	5272	CVn	13 41.3	+28 29	6.22	GC*
4	6121	Sco	16 22.4	−26 27	6.07	GC*
5	5904	Ser	15 17.5	+02 11	5.99	GC*
6	6405	Sco	17 38.9	−32 11	6	OC*
7	6475	Sco	17 52.6	−34 48	5	OC*
8	6523	Sgr	18 02.4	−24 23		DN*
9	6333	Oph	17 18.1	−18 30	7.58	GC
10	6254	Oph	16 56.0	−04 05	6.40	GC*
11	6705	Sct	18 50.0	−06 18	7	OC*
12	6218	Oph	16 46.1	−01 55	6.74	GC*
13	6205	Her	16 41.0	+36 30	5.78	GC*
14	6402	Oph	17 36.5	−03 14	7.82	GC
15	7078	Peg	21 29.1	+12 05	6.29	GC*
16	6611	Ser	18 17.8	−13 48	7	OC*
17	6618	Sgr	18 19.7	−16 12	7	DN*
18	6613	Sgr	18 18.8	−17 09	7	OC
19	6273	Oph	17 01.3	−26 14	6.94	GC
20	6514	Sgr	18 01.2	−23 02		DN*
21	6531	Sgr	18 03.4	−22 30	7	OC
22	6656	Sgr	18 35.2	−23 55	5.22	GC*
23	6494	Sgr	17 55.7	−19 00	6	OC*
24	6603	Sgr	18 17.3	−18 27	6	OC
25	4725†	Sgr	18 30.5	−19 16	6	OC*
26	6694	Sct	18 44.1	−09 25	9	OC
27	6853	Vul	19 58.8	+22 40	8.2	PN*
28	6626	Sgr	18 23.2	−24 52	7.07	GC
29	6913	Cyg	20 23.3	+38 27	8	OC
30	7099	Cap	21 39.2	−23 15	7.63	GC
31	224	And	0 41.6	+41 09	3.7	G-Sb*
32	221	And	0 41.6	+40 45	8.5	G-E*
33	598	Tri	1 32.8	+30 33	5.9	G-Sc*
34	1039	Per	2 40.7	+42 43	6	OC
35	2168	Gem	6 07.6	+24 21	6	OC*
36	1960	Aur	5 35.0	+34 05	6	OC
37	2099	Aur	5 51.5	+32 33	6	OC*
38	1912	Aur	5 27.3	+35 48	6	OC
39	7092	Cyg	21 31.5	+48 21	6	OC
40	—	UMa	—	—		2 stars
41	2287	CMa	6 46.2	−20 43	6	OC*
42	1976	Ori	5 34.4	−05 24		DN*
43	1982	Ori	5 34.6	−05 18		DN
44	2632	Cnc	8 38.8	+20 04	4	OC*
45	—	Tau	3 46.3	+24 03	2	OC*
46	2437	Pup	7 40.9	−14 46	7	OC*
47	2422	Pup	7 35.6	−14 27	5	OC
48	2548	Hya	8 12.5	−05 43	6	OC
49	4472	Vir	12 28.8	+08 07	8.9	G-E*
50	2323	Mon	7 02.0	−08 19	7	OC
51	5194	CVn	13 29.0	+47 18	8.4	G-Sc*
52	7654	Cas	23 23.3	+61 29	7	OC
53	5024	Com	13 12.0	+18 17	7.70	GC
54	6715	Sgr	18 53.8	−30 30	7.7	GC
55	6809	Sgr	19 38.7	−31 00	6.09	GC*
56	6779	Lyr	19 15.8	+30 08	8.33	GC
57	6720	Lyr	18 52.9	+33 01	9.0	PN*
58	4579	Vir	12 36.7	+11 56	9.9	G-SBb
59	4621	Vir	12 41.0	+11 47	10.3	G-E
60	4649	Vir	12 42.6	+11 41	9.3	G-E
61	4303	Vir	12 20.8	+04 36	9.7	G-Sc
62	6266	Sco	16 59.9	−30 05	7.2	GC
63	5055	CVn	13 14.8	+42 08	8.8	G-Sb*
64	4826	Com	12 55.7	+21 48	8.7	G-Sb*
65	3623	Leo	11 17.8	+13 13	9.6	G-Sa
66	3627	Leo	11 19.1	+13 07	9.2	G-Sb
67	2682	Cnc	8 50.0	+11 54	7	OC*
68	4590	Hya	12 38.3	−26 38	8.04	GC
69	6637	Sgr	18 30.1	−32 23	7.7	GC
70	6681	Sgr	18 42.0	−32 18	8.2	GC
71	6838	Sge	19 52.8	+18 44	6.9	GC
72	6981	Aqr	20 52.3	−12 39	9.15	GC
73	6994	Aqr	20 57.8	−12 44		OC
74	628	Psc	1 35.6	+15 41	9.5	G-Sc
75	6864	Sgr	20 04.9	−21 59	8.31	GC
76	650	Per	1 40.9	+51 28	11.4	PN*
77	1068	Cet	2 41.6	−00 04	9.1	G-Sb
78	2068	Ori	5 45.8	+00 02		DN
79	1904	Lep	5 23.3	−24 32	7.3	GC
80	6093	Sco	16 15.8	−22 56	7.17	GC
81	3031	UMa	9 54.2	+69 09	6.9	G-Sb*
82	3034	UMa	9 54.4	+69 47	8.7	G-Irr*
83	5236	Hya	13 35.9	−29 46	7.5	G-Sc*
84	4374	Vir	12 24.1	+13 00	9.8	G-E
85	4382	Com	12 24.3	+18 18	9.5	G-SO
86	4406	Vir	12 25.1	+13 03	9.8	G-E
87	4486	Vir	12 29.7	+12 30	9.3	G-Ep
88	4501	Com	12 30.9	+14 32	9.7	G-Sb
89	4552	Vir	12 34.6	+12 40	10.3	G-E
90	4569	Vir	12 35.8	+13 16	9.7	G-Sb
91	—	—	—	—		M58?
92	6341	Her	17 16.5	+43 10	6.33	GC*
93	2447	Pup	7 43.6	−23 49	6	OC
94	4736	CVn	12 50.1	+41 14	8.1	G-Sb*
95	3351	Leo	10 42.8	+11 49	9.9	G-SBb
96	3368	Leo	10 45.6	+11 56	9.4	G-Sa
97	3587	UMa	11 13.7	+55 08	11.1	PN*
98	4192	Com	12 12.7	+15 01	10.4	G-Sb
99	4254	Com	12 17.8	+14 32	9.9	G-Sc
100	4321	Com	12 21.9	+15 56	9.6	G-Sc
101	5457	UMa	14 02.5	+54 27	8.1	G-Sc*
102	—	—	—	—		M101?
103	581	Cas	1 31.9	+60 35	7	OC

†Index Catalogue Number.

STAR CLUSTERS

By T. Schmidt-Kaler

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

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

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

Open Clusters

NGC	α 1980 δ h m	° ′	P	D	m	r	Sp	Remarks
188	00 42.0	+85 14	9.3	14	14.6	1.55	F2	oldest known
752	01 56.6	+37 35	6.6	45	9.6	0.38	A5	
869	02 17.6	+57 04	4.3	30	9.5	2.15	B1	h Per
884	02 21.0	+57 02	4.4	30	9.5	2.48	B0	χ Per, M supergiants
Perseus	03 21	+48 32	2.3	240	5	0.17	B1	moving cl., α Per
Pleiades	03 45.9	+24 04	1.6	120	4.2	0.125	B6	M45, best known
Hyades	04 19	+15 35	0.8	400	*1.5*	0.040	A2	moving cl. in Tau*
1912	05 27.3	+35 49	7.0	18	9.7	1.41	B5	
1976/80	05 34.4	−05 24	2.5	50	*5.5*	0.41	O5	Trapezium, very young
2099	05 51.1	+32 32	6.2	24	9.7	1.28	B8	M37
2168	06 07.6	+24 21	5.6	29	9.0	0.87	B5	M35
2232	06 25.5	−04 44	4.1	*20*	*7*	0.49	B3	
2244	06 31.3	+04 53	5.2	27	*8.0*	1.62	O5	Rosette, very young
2264	06 39.9	+09 54	4.1	30	*8.0*	0.72	O8	S Mon
2287	06 46.2	−20 43	5.0	32	*8.8*	0.66	B4	M41
2362	07 18.0	−24 54	3.8	7	9.4	1.64	O9	τ CMa
2422	07 34.7	−14 27	4.3	30	9.8	0.48	B3	

*Basic for distance determination.

NGC	α 1980 δ		P	D	m	r	Sp	Remarks
	h m	° ′						
2437	07 40.9	−14 46	6.6	27	10.8	1.66	B8	M46
2451	07 44.7	−37 55	3.7	37	6	0.30	B5	
2516	07 58.0	−60 51	3.3	50	10.1	0.37	B8	
2546	08 11.8	−37 35	5.0	45	7	0.84	B0	
2632	08 39.0	+20 04	3.9	90	7.5	0.158	A0	Praesepe, M44
IC2391	08 39.7	−52 59	2.6	45	3.5	0.15	B4	
IC2395	08 40.4	−48 07	4.6	20	10.1	0.90	B2	
2682	08 49.3	+11 54	7.4	18	10.8	0.83	F2	M67, old cl.
3114	10 02.0	−60 01	4.5	37	7	0.85	B5	
IC2602	10 42.6	−64 17	1.6	65	6	0.15	B1	θ Car
Tr 16	10 44.4	−59 36	6.7	10	10	2.95	O5	η Car and Nebula
3532	11 05.5	−58 33	3.4	55	8.1	0.42	B8	
3766	11 35.2	−61 30	4.4	12	8.1	1.79	B1	
Coma	12 24.1	+26 13	2.9	300	5.5	0.08	A1	Very sparse cl.
4755	12 52.4	−60 13	5.2	12	7	2.10	B3	κ Cru, "jewel box"
6067	16 11.7	−54 10	6.5	16	10.9	1.45	B3	G and K supergiants
6231	16 52.6	−41 46	8.5	16	7.5	1.77	O9	O supergiants, WR-stars
Tr 24	16 55.6	−40 38	8.5	60	*7.3*	1.60	O5	
6405	17 38.8	−32 12	4.6	26	8.3	0.45	B4	M6
IC4665	17 45.7	+05 44	5.4	50	7	0.33	B8	
6475	17 52.6	−34 48	3.3	50	7.4	0.23	B5	M7
6494	17 55.7	−19 01	5.9	27	10.2	0.44	B8	M23
6523	18 01.9	−24 23	5.2	45	*7*	1.56	O5	M8, Lagoon neb. and very young cl. NGC6530
6611	18 17.8	−13 48	6.6	8	10.6	1.69	O7	M16, nebula
IC4725	18 30.5	−19 16	6.2	35	9.3	0.60	B3	M25, Cepheid, U Sgr
IC4756	18 38.3	+05 26	5.4	50	8.5	0.44	A3	
6705	18 50.0	−06 18	6.8	12.5	12	1.70	B8	M11, very rich cl.
Mel 227	20 08.2	−79 23	5.2	60	*9*	0.24	B9	
IC1396	21 38.3	+57 25	5.1	60	*8.5*	0.71	O6	Tr 37
7790	23 57.4	+61	7.1	4.5	11.7	3.16	B1	C Ceph: CEa, CEb, CF Cas

Globular Clusters

NGC	M	α 1980 δ		B	D	Sp	m	N	r	V
		h m	° ′							
104	47 Tuc	00 23.1	−72 11	4.35	*44*	G3	13.54	11	5	−24
1851		05 13.3	−40 02	7.72:	*11.5*	F7		3	14.0	+309
2808		09 11.5	−64 42	7.4	*18.8*	F8	15.09	4	9.1	+101
5139	ω Cen	13 25.6	−47 12	4.5	*65.4*	F7	13.01	165	5.2	+230
5272	3	13 41.3	+28 29	6.86	9.3	F7	14.35	189	10.6	−153
5904	5	15 17.5	+02 10	6.69	10.7	F6	14.07	97	8.1	+49
6121	4	16 22.4	−26 28	7.05	22.6	*G0*	13.21	43	4.3	+65
6205	13	16 41.0	+36 30	6.43	12.9	F6	13.85	10	6.3	−241
6218	12	16 46.1	−01 55	7.58	21.5	F8	14.07	1	7.4	−16
6254	10	16 56.0	−04 05	7.26	16.2	G1	14.17	3	6.2	+71
6341	92	17 16.5	+43 10	6.94	12.3	F1	13.96	16	7.9	−118
6397		17 39.2	−53 40	6.9	*19*	F5	12.71	3	2.9	+11
6541		18 06.5	−43 45	7.5	*23.2*	F6	13.45	1	4.0	−148
6656	22	18 35.1	−23 56	6.15	26.2	F7	13.73	24	3.0	−144
6723		18 58.3	−36 39	7.37	11.7	G4	14.32	19	7.4	−3
6752		19 09.1	−60 01	6.8	*41.9*	F6	13.36	1	5.3	−39
6809	55	19 38.8	−30 59	6.72	21.1	F5	13.68	6	6.0	+170
7078	15	21 29.1	+12 05	6.96	9.4	F2	14.44	103	10.5	−107
7089	2	21 32.4	−00 55	6.94	6.8	F4	14.77	22	12.3	−5

EXTERNAL GALAXIES

By S. van den Bergh

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

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

The Brightest Galaxies

NGC or name	M	α 1980 δ		Type	m_{pg}	Dimensions	Distance millions of l.y.
		h m	° ′			′ ′	
55		00 14.0	−39 20	Sc or Ir	7.9	30×5	7.5
205		00 39.2	+41 35	E6p	8.89	12×6	2.1
221	32	00 41.6	+40 46	E2	9.06	3.4×2.9	2.1
224	31	00 41.6	+41 10	Sb I–II	4.33	163×42	2.1
247		00 46.1	−20 51	S IV	9.47	21×8.4	7.5
253		00 46.6	−25 24	Sep	7.0:	22×4.6	7.5
SMC		00 52.0	−72 56	Ir IV or IV–V	2.86	216×216	0.2
300		00 54.0	−37 48	Sc III–IV	8.66	22×16.5	7.5
598	33	01 32.8	+30 33	Sc II–III	6.19	61×42	2.4
Fornax		02 38.7	−34 36	dE	9.1:	50×35	0.4
LMC		05 23.7	−69 46	Ir or Sc III–IV	0.86	432×432	0.2
2403		07 34.9	+65 39	Sc III	8.80	22×12	6.5
2903		09 31.0	+21 36	Sb I–II	9.48	16×6.8	19.0
3031	81	09 53.9	+69 09	Sb I–II	7.85	25×12	6.5
3034	82	09 54.4	+69 47	Scp:	9.20	10×1.5	6.5
4258		12 18.0	+47 25	Sbp	8.90	19×7	14.0
4472	49	12 28.8	+08 06	E4	9.33	9.8×6.6	37.0
4594	104	12 38.8	−11 31	Sb	9.18	7.9×4.7	37.0
4736	94	12 50.0	+41 13	Sbp II:	8.91	13×12	14.0
4826	64	12 55.8	+21 48	?	9.27	10×3.8	12.0:
4945		13 04.1	−49 22	Sb III	8.0	20×4	—
5055	63	13 14.8	+42 08	Sb II	9.26	8.0×3.0	14.0
5128		13 24.2	−42 54	E0p	7.87	23×20	—
5194	51	13 29.0	+47 18	Sc I	8.88	11×6.5	14.0
5236	83	13 36.0	−29 46	Sc I–II	7.0:	13×12	8.0:
5457	101	14 02.4	+54 26	Sc I	8.20	23×21	14.0
6822		19 43.8	−14 49	Ir IV–V	9.21	20×10	1.7

Name	NGC	α 1980 δ h m	° ′	m_{pg}	$(m - M)_{pg}$	M_{pg}	Type	Dist. thous. of l.y.
M31	224	00 41.6	+41 10	4.33	24.65	−20.3	Sb I–II	2,100
Galaxy		—	—	—	—	?	Sb or Sc	—
M33	598	01 32.8	+30 33	6.19	24.70	−18.5	Sc II–III	2,400
LMC		05 23.7	−69 46	0.86	18.65	−17.8	Ir or SBc III–IV	160
SMC		00 52.0	−72 56	2.86	19.05	−16.2	Ir IV or IV–V	190
NGC	205	00 39.2	+41 35	8.89	24.65	−15.8	E6p	2,100
M32	221	00 41.6	+40 46	9.06	24.65	−15.6	E2	2,100
NGC	6822	19 43.8	−14 49	9.21	24.55	−15.3	Ir IV–V	1,700
NGC	185	00 37.8	+48 14	10.29	24.65	−14.4	E0	2,100
IC1613		01 04.0	+02 01	10.00	24.40	−14.4	Ir V	2,400
NGC	147	00 32.0	+48 14	10.57	24.65	−14.1	dE4	2,100
Fornax		02 38.7	−34 36	9.1:	20.6:	−12:	dE	430
And I		00 44.4	+37 56	13.5:	24.65	−11:	dE	2,100
And II		01 15.3	+33 20	13.5:	24.65	−11:	dE	2,100
And III		00 34.3	+36 24	13.5:	24.65	−11:	dE	2,100
Leo I		10 07.4	+12 24	11.27	21.8:	−10:	dE	750:
Sculptor		00 58.9	−33 49	10.5	19.70	−9.2:	dE	280:
Leo II		11 12.4	+22 16	12.85	21.8:	−9:	dE	750:
Draco		17 19.8	+57 56	—	19.50	?	dE	260
Ursa Minor		15 08.5	+67 11	—	19.40	?	dE	250

MAXIMA OF DELTA CEPHEI

A finding chart for this famous pulsating variable is given on p. 98. The magnitudes (minus decimal point) of non-variable comparison stars are marked; the magnitude of δ Cep can be estimated relative to these. Observation of this star, or of Algol, is a good introduction to serious variable star observing, and is a good project for the amateur or student.

Times given are E.S.T., rounded off to the nearest 10 minutes, and are based on the ephemeris J.D. (max) = 2436075.445 + 5.366341 E.

Date	Time	Date	Time	Date	Time	Date	Time
Jan. 5	15ʰ50ᵐ	Apr. 5	21ʰ20ᵐ	July 6	2ʰ50ᵐ	Oct. 5	8ʰ20ᵐ
11	0 40	11	6 10	11	11 40	10	17 10
16	9 30	16	15 00	16	20 30	16	1 50
21	18 20	21	23 50	22	5 10	21	10 40
27	3 00	27	8 30	27	14 00	26	19 30
Feb. 1	11 50	May 2	17 20	Aug. 1	22 50	Nov. 1	4 20
6	20 40	8	2 10	7	7 40	6	13 00
12	5 30	13	11 00	12	16 20	11	21 50
17	14 10	18	19 40	18	1 10	17	6 40
22	23 00	24	4 30	23	10 00	22	15 30
28	7 50	29	13 20	28	18 50	28	0 10
Mar. 4	16 40	June 3	22 10	Sept. 3	3 30	Dec. 3	9 00
10	1 25	9	6 50	8	12 20	8	17 50
15	10 10	14	15 40	13	21 00	14	2 40
20	19 00	20	0 30	19	6 00	19	11 20
26	3 50	25	9 20	24	14 40	24	20 10
31	12 40	30	18 00	29	23 30	30	5 00

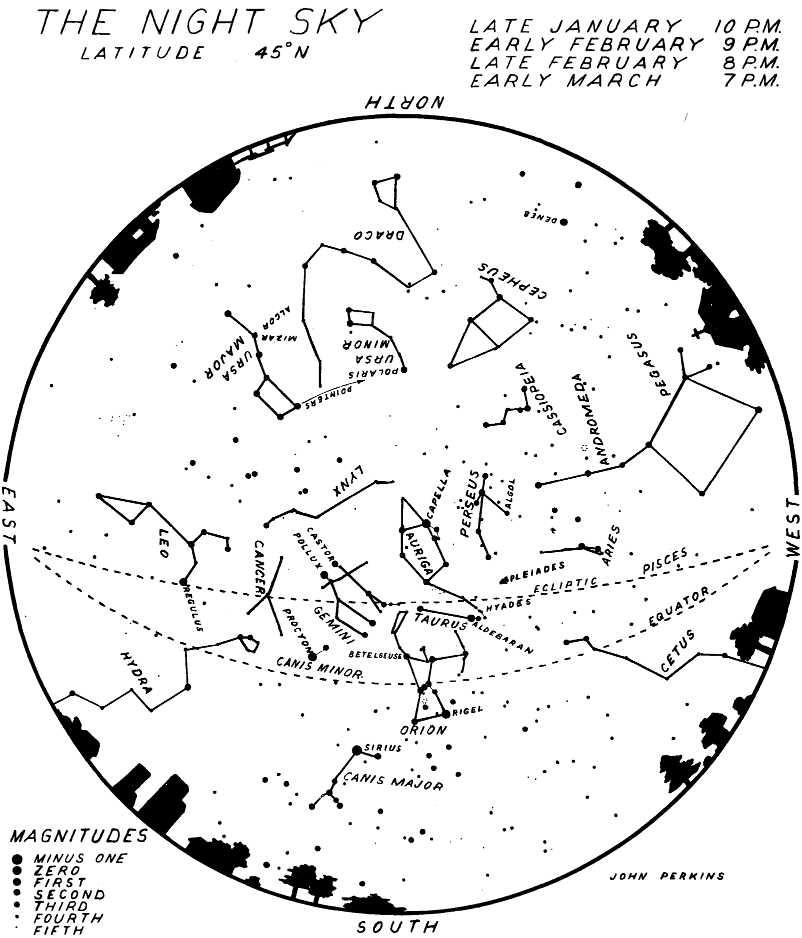
RADIO SOURCES

By John Galt

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

Name	α (1980) h m	δ ° ′	Remarks
Tycho's s'nova	00 24.6	+64 01	Remnant of supernova of 1572
Andromeda gal.	00 41.5	+41 09	Closest normal spiral galaxy
IC 1795, W3	02 23.9	+62 01	Multiple HII region, OH emission
PKS 0237–23	02 39.1	−23 14	Quasar with large red shift Z = 2.2
NGC 1275, 3C 84	03 18.5	+41 26	Seyfert galaxy, radio variable
Fornax A	03 21.6	−37 15	10th mag. SO galaxy
CP 0328	03 31.3	+54 29	Pulsar, period = 0.7145 sec., H abs'n.
Crab neb, M1*	05 33.2	+22 00	Remnant of supernova of 1054
NP 0532	05 33.2	+22 00	Radio, optical & X-ray pulsar
V 371 Orionis	05 32.7	+01 54	Red dwarf, radio & optical flare star
Orion neb, M42	05 34.3	−05 24	HII region, OH emission, IR source
IC 443	06 16.1	+22 36	Supernova remnant (date unknown)
Rosette neb	06 30.9	+04 53	HII region
YV CMa	07 22.2	−20 42	Optical var. IR source, OH, H_2O emission
3C 273	12 28.0	+02 10	Nearest, strongest quasar
Virgo A, M87*	12 29.8	+12 30	EO galaxy with jet
Centaurus A	13 24.2	−42 55	NGC 5128 peculiar galaxy
3C 295	14 10.7	+52 18	21st mag. galaxy, 4,500,000,000 light years
Scorpio X-1	16 18.8	−15 35	X-ray, radio optical variable
3C 353	17 19.5	−00 58	Double source, probably galaxy
Kepler's s'nova	17 27.6	−21 16	Remnant of supernova of 1604
Galactic nucleus	17 44.3	−28 56	Complex region OH, NH_3 em., H_2CO abs'n.
Omega neb, M17	18 19.3	−16 10	HII region, double structure
W 49	19 09.4	+09 05	HII region s'nova remnant, OH emission
CP 1919	19 20.8	+21 50	First pulsar discovered, P = 1.337 sec.
Cygnus A*	19 58.7	+40 41	Strong radio galaxy, double source
Cygnus X	20 21.9	+40 19	Complex region
NML Cygnus	20 45.8	+40 02	Infrared source, OH emission
Cygnus loop	20 51.4	+29 36	S'nova remnant (Network nebula)
N. America	20 54.4	+43 59	Radio shape resembles photographs
3C 446	22 24.7	−05 04	Quasar, optical mag. & spectrum var.
Cassiopeia A*	23 22.5	+58 42	Strongest source, s'nova remnant
Sun*			Continuous emission & bursts
Moon			Thermal source only
Jupiter*			Radio bursts controlled by Io

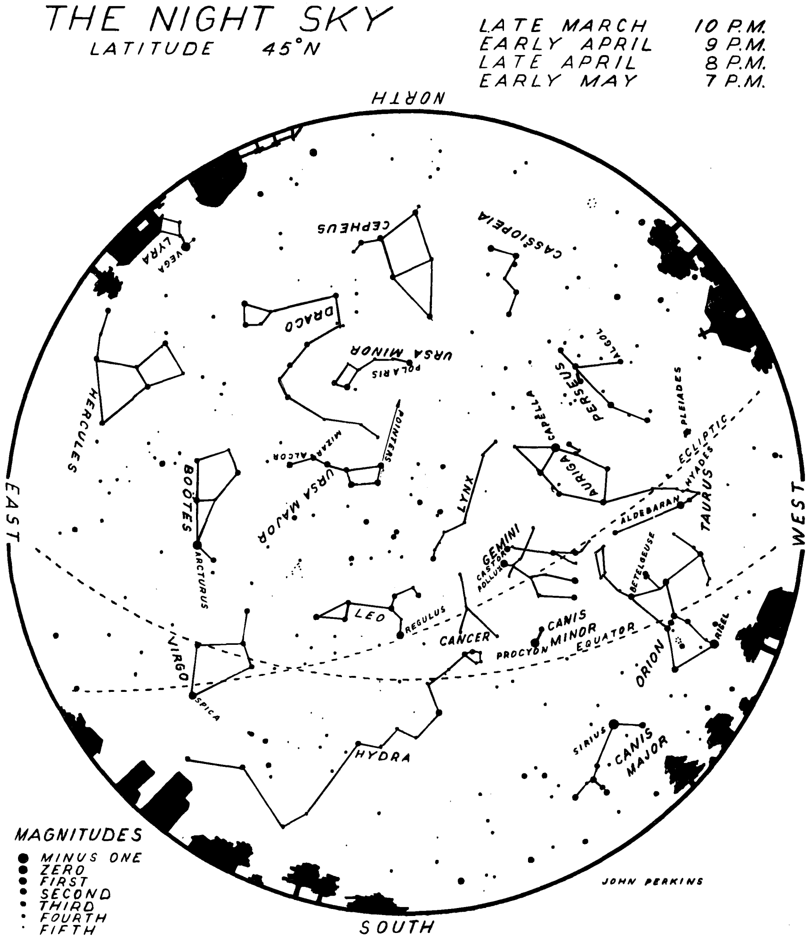
*Could be detected with amateur radio telescopes.



The above map represents the evening sky on the dates and times shown. For earlier (or later) dates, add (or subtract) two hours per month. For instance, the map represents the early morning sky in late October at 4 a.m. The map is drawn for latitude 45° N. but is useful for latitudes several degrees north or south of this.

The centre of the map is the *zenith*, the point directly overhead; the circumference of the map is the *horizon*. To identify the stars, hold the map in front of you so that the part of the horizon which you are facing (north, for instance) is downward.

The north celestial *pole* is near the star Polaris. The celestial *equator* is also marked. The sun, moon and planets are always found near the *ecliptic*.



The above map represents the evening sky on the dates and times shown. For earlier (or later) dates, add (or subtract) two hours per month. For instance, the map represents the early morning sky in late December at 4 a.m. The map is drawn for latitude 45° N, but is useful for latitudes several degrees north or south of this.

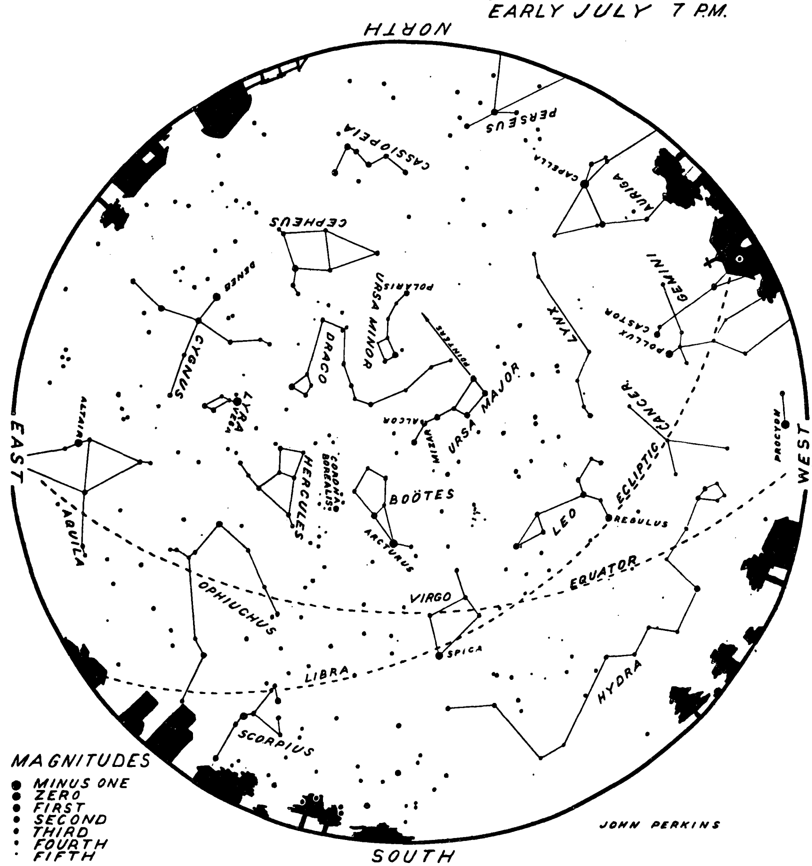
The centre of the map is the *zenith*, the point directly overhead; the circumference of the map is the *horizon*. To identify the stars, hold the map in front of you so that the part of the horizon which you are facing (north, for instance) is downward.

The north celestial *pole* is near the star Polaris. The celestial *equator* is also marked. The sun, moon and planets are always found near the *ecliptic*.

THE NIGHT SKY

LATITUDE 45°N

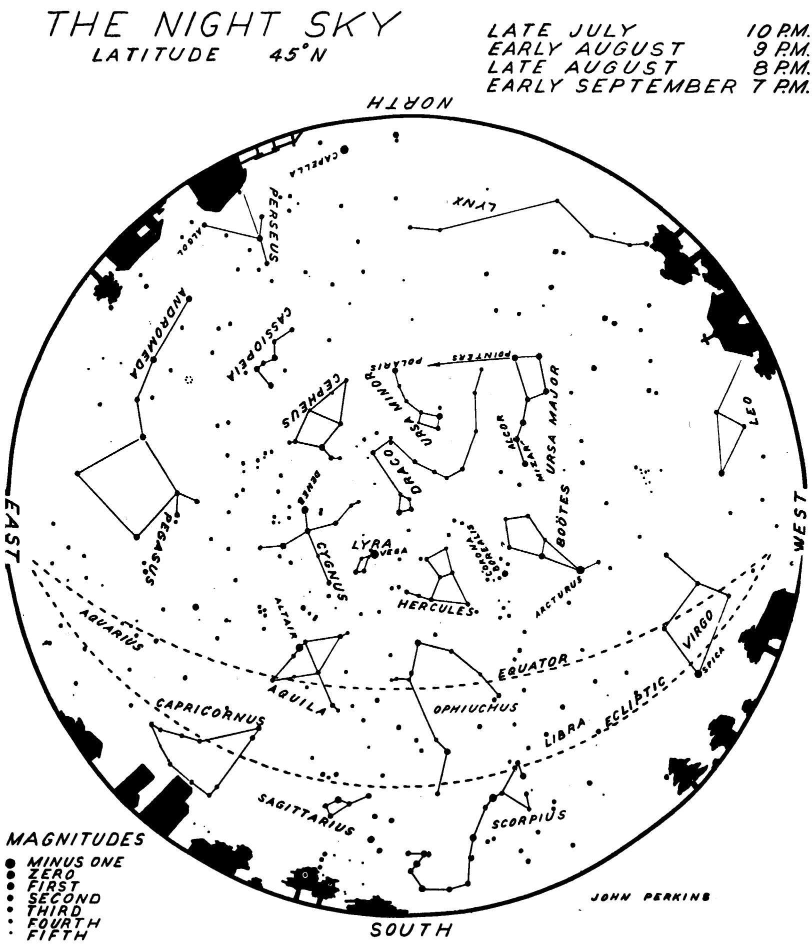
LATE MAY	10 P.M.
EARLY JUNE	9 P.M.
LATE JUNE	8 P.M.
EARLY JULY	7 P.M.



The above map represents the evening sky on the dates and times shown. For earlier (or later) dates, add (or subtract) two hours per month. For instance, the map represents the early morning sky in late February at 4 a.m. The map is drawn for latitude 45° N, but is useful for latitudes several degrees north or south of this.

The centre of the map is the *zenith*, the point directly overhead; the circumference of the map is the *horizon*. To identify the stars, hold the map in front of you so that the part of the horizon which you are facing (north, for instance) is downward.

The north celestial *pole* is near the star Polaris. The celestial *equator* is also marked. The sun, moon and planets are always found near the *ecliptic*.



The above map represents the evening sky on the dates and times shown. For earlier (or later) dates, add (or subtract) two hours per month. For instance, the map represents the early morning sky in late April at 4 a.m. The map is drawn for latitude 45° N, but is useful for latitudes several degrees north or south of this.

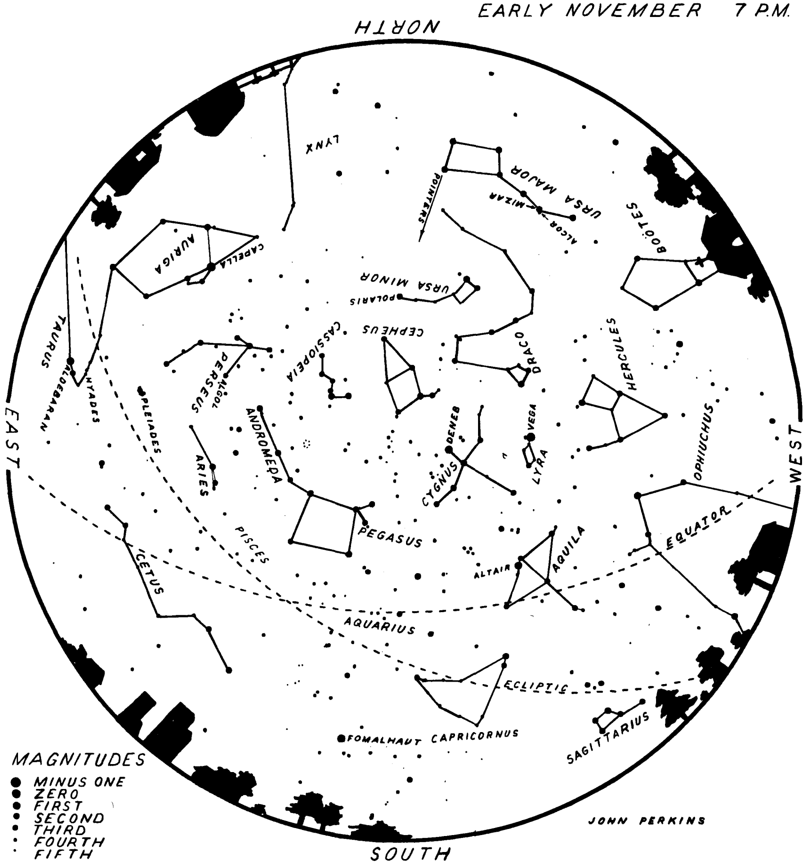
The centre of the map is the *zenith*, the point directly overhead; the circumference of the map is the *horizon*. To identify the stars, hold the map in front of you so that the part of the horizon which you are facing (north, for instance) is downward.

The north celestial *pole* is near the star Polaris. The celestial *equator* is also marked. The sun, moon and planets are always found near the *ecliptic*.

THE NIGHT SKY

LATITUDE 45° N

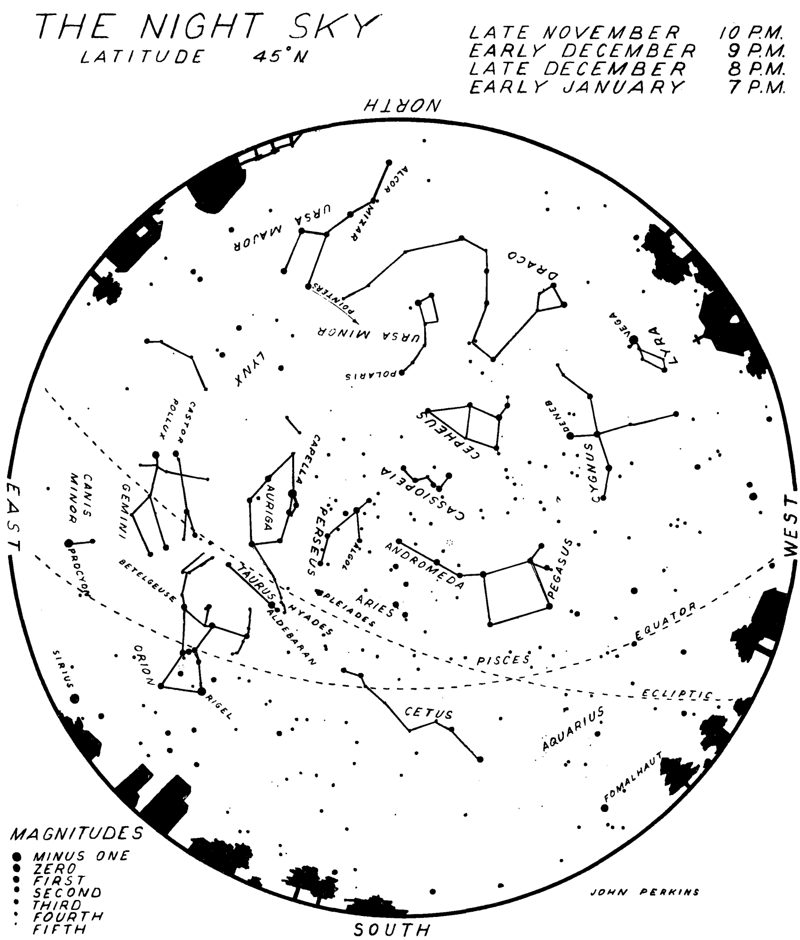
LATE SEPTEMBER	10 P.M.
EARLY OCTOBER	9 P.M.
LATE OCTOBER	8 P.M.
EARLY NOVEMBER	7 P.M.



The above map represents the evening sky on the dates and times shown. For earlier (or later) dates, add (or subtract) two hours per month. For instance, the map represents the early morning sky in late June at 4 a.m. The map is drawn for latitude 45° N, but is useful for latitudes several degrees north or south of this.

The centre of the map is the *zenith*, the point directly overhead; the circumference of the map is the *horizon*. To identify the stars, hold the map in front of you so that the part of the horizon which you are facing (north, for instance) is downward.

The north celestial *pole* is near the star Polaris. The celestial *equator* is also marked. The sun, moon and planets are always found near the *ecliptic*.



The above map represents the evening sky on the dates and times shown. For earlier (or later) dates, add (or subtract) two hours per month. For instance, the map represents the early morning sky in late August at 4 a.m. The map is drawn for latitude 45° N, but is useful for latitudes several degrees north or south of this.

The centre of the map is the *zenith*, the point directly overhead; the circumference of the map is the *horizon*. To identify the stars, hold the map in front of you so that the part of the horizon which you are facing (north, for instance) is downward.

The north celestial *pole* is near the star Polaris. The celestial *equator* is also marked. The sun, moon and planets are always found near the *ecliptic*.

CALENDAR 1976

January

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

February

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

March

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

April

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

May

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

June

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

July

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

August

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

September

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

October

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

November

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

December

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

CALENDAR 1977

January

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

February

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

March

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

April

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

May

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

June

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

July

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

August

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

September

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

October

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

November

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

December

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