THE OBSERVER'S HANDBOOK FOR 1951

PUBLISHED BY

The Royal Astronomical Society of Canada

C. A. CHANT, Editor
F. S. HOGG, Assistant Editor
DAVID DUNLAP OBSERVATORY

FORTY-THIRD YEAR OF PUBLICATION

TORONTO
3 Willcocks Street
Printed for the Society
By the University of Toronto Press
1950

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

The Society was incorporated in 1890 as The Astronomical and Physical Society of Toronto, assuming its present name in 1903.

For many years the Toronto organization existed alone, but now the Society is national in extent, having active Centres in Montreal and Quebec, P.Q.; Ottawa, Toronto, Hamilton, London, Windsor, and Guelph, Ontario; Winnipeg, Man.; Saskatoon, Sask.; Edmonton, Alta.; Vancouver and Victoria, B.C. As well as nearly 1400 members of these Canadian Centres, there are nearly 500 members not attached to any Centre, mostly resident in other nations, while some 300 additional institutions or persons are on the regular mailing list of our publications. The Society publishes a monthly "Journal" and a yearly "Observer's Handbook". Single copies of the Journal are 50 cents, and of the Handbook, 40 cents.

Membership is open to anyone interested in astronomy. Annual dues, $3.00; life membership, $40.00. Publications are sent free to all members or may be subscribed for separately. Applications for membership or publications may be made to the General Secretary, 3 Willcocks St., Toronto.

CALENDAR 1951

Jan.

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

Feb.

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

Mar.

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

April

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

May

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

June

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

July

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

Aug.

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

Sept.

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

Oct.

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

Nov.

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

Dec.

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

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CONTENTS

TABLES IN RECENT OBSERVER'S HANDBOOKS

PRINTED IN CANADA

PREFACE

The HANDBOOK for 1951 is the 43rd issue. During the past decade its circulation has increased from 1500 to 5500.

Four circular star maps 9 inches in diameter at a price of one cent each, and a set of four maps plotted on equatorial co-ordinates at a price of ten cents, are obtainable from the Director of University Extension, University of Toronto Toronto 5.

Celestial distances given herein are based on the standard value of 8″.80 for the sun's parallax, not on the more recent value 8″.790 determined by Sir Harold Jones. Among the recent additions are:

1. *Algol.* Olin J. Eggen's epoch 2432520.6303 and period 2.86731525d., as published in the *Astrophysical Journal,* 1948.

2. *Sun-spots.* A table of solar rotation numbers for observers of sun-spots, and an ephemeris for physical observations of the sun.

Mr. Charles E. Apgar, of Westfield, New Jersey, died on August 17th at the age of eighty-five. For a number of years this enthusiastic amateur astronomer had prepared the tables of Jupiter's satellites for the HANDBOOK. The editors regret the death of this loyal friend.

Dr. F. S. Hogg, the Assistant Editor, as in recent years, assumed the responsibility of preparing this volume and to him the chief credit of its success is due; but sincere thanks are tendered to all those whose names are mentioned in the book, especially to Miss Ruth J. Northcott and Professor J. F. Heard. Our deep indebtedness to the British *Nautical Almanac* and the *American Ephemeris* is thankfully acknowledged.

C. A. CHANT.

David Dunlap Observatory,
Richmond Hill, Ont., November, 1950.

ANNIVERSARIES AND FESTIVALS 1951

New Year's Day	Mon.	Jan. 1
Epiphany	Sat.	Jan. 6
Septuagesima Sunday		Jan. 21
Quinquagesima (Shrove Sunday)		Feb. 4
Ash Wednesday		Feb. 7
St. David	Thur.	Mar. 1
St. Patrick	Sat.	Mar. 17
Palm Sunday		Mar. 18
Good Friday		Mar. 23
Easter Sunday		Mar. 25
St. George	Mon.	Apr. 23
Rogation Sunday		Apr. 29
Ascension Day	Thur.	May 3
Pentecost (Whit Sunday)		May 13
Trinity Sunday		May 20
Empire Day (Victoria Day)	Thur.	May 24
Corpus Christi	Thur.	May 24
Birthday of the Queen Mother, Mary (1867)	Wed.	May 30
St. John Baptist (Mid-Summer Day)	Sun.	June 24
Dominion Day	Sun.	July 1
Birthday of Queen Elizabeth (1900)	Sat.	Aug. 4
Labour Day	Mon.	Sept. 3
St. Michael (Michaelmas Day)	Sat.	Sept. 29
Hebrew New Year (Rosh Hashanah)	Mon.	Oct. 1
All Saints' Day	Thur.	Nov. 1
Remembrance Day	Sun.	Nov. 11
St. Andrew	Fri.	Nov. 30
First Sunday in Advent		Dec. 2
Accession of King George VI (1936)	Tues.	Dec. 11
Birthday of King George VI (1895)	Fri.	Dec. 14
Christmas Day	Tues.	Dec. 25

Thanksgiving Day, Date set by Proclamation.

SYMBOLS AND ABBREVIATIONS

SIGNS OF THE ZODIAC

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

SUN, MOON AND PLANETS

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

ASPECTS AND ABBREVIATIONS

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

THE GREEK ALPHABET

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

THE CONFIGURATIONS OF JUPITER'S SATELLITES

In the Configurations of Jupiter's Satellites (pages 31, 33, etc.), O represents the disc of the planet, d signifies that the satellite is on the disc, * signifies that the satellite is behind the disc or in the shadow. Configurations are for an inverting telescope.

THE CONSTELLATIONS

Latin and English Names with Abbreviations

Andromeda, (*Chained Maiden*)	And	Andr
Antlia, *Air Pump*	Ant	Antl
Apus, *Bird of Paradise*	Aps	Apus
Aquarius, *Water-bearer*	Aqr	Aqar
Aquila, *Eagle*	Aql	Aqil
Ara, *Altar*	Ara	Arae
Aries, *Ram*	Ari	Arie
Auriga, (*Charioteer*)	Aur	Auri
Bootes, (*Herdsman*)	Boo	Boot
Caelum, *Chisel*	Cae	Cael
Camelopardalis, *Giraffe*	Cam	Caml
Cancer, *Crab*	Cnc	Canc
Canes Venatici, *Hunting Dogs*	CVn	CVen
Canis Major, *Greater Dog*	CMa	CMaj
Canis Minor, *Lesser Dog*	CMi	CMin
Capricornus, *Sea-goat*	Cap	Capr
Carina, *Keel*	Car	Cari
Cassiopeia, (*Lady in Chair*)	Cas	Cass
Centaurus, *Centaur*	Cen	Cent
Cepheus, (*King*)	Cep	Ceph
Cetus, *Whale*	Cet	Ceti
Chamaeleon, *Chamaeleon*	Cha	Cham
Circinus, *Compasses*	Cir	Circ
Columba, *Dove*	Col	Colm
Coma Berenices, *Berenice's Hair*	Com	Coma
Corona Australis, *Southern Crown*	CrA	CorA
Corona Borealis, *Northern Crown*	CrB	CorB
Corvus, *Crow*	Crv	Corv
Crater, *Cup*	Crt	Crat
Crux, (*Southern*) *Cross*	Cru	Cruc
Cygnus, *Swan*	Cyg	Cygn
Delphinus, *Dolphin*	Del	Dlph
Dorado, *Swordfish*	Dor	Dora
Draco, *Dragon*	Dra	Drac
Equuleus, *Little Horse*	Equ	Equl
Eridanus, *River Eridanus*	Eri	Erid
Fornax, *Furnace*	For	Forn
Gemini, *Twins*	Gem	Gemi
Grus, *Crane*	Gru	Grus
Hercules, (*Kneeling Giant*)	Her	Herc
Horologium, *Clock*	Hor	Horo
Hydra, *Water-snake*	Hya	Hyda
Hydrus, *Sea-serpent*	Hyi	Hydi
Indus, *Indian*	Ind	Indi
Lacerta, *Lizard*	Lac	Lacr
Leo, *Lion*	Leo	Leon
Leo Minor, *Lesser Lion*	LMi	LMin
Lepus, *Hare*	Lep	Leps
Libra, *Scales*	Lib	Libr
Lupus, *Wolf*	Lup	Lupi
Lynx, *Lynx*	Lyn	Lync
Lyra, *Lyre*	Lyr	Lyra
Mensa, *Table* (*Mountain*)	Men	Mens
Microscopium, *Microscope*	Mic	Micr
Monoceros, *Unicorn*	Mon	Mono
Musca, *Fly*	Mus	Musc
Norma, *Square*	Nor	Norm
Octans, *Octant*	Oct	Octn
Ophiuchus, *Serpent-bearer*	Oph	Ophi
Orion, (*Hunter*)	Ori	Orio
Pavo, *Peacock*	Pav	Pavo
Pegasus, (*Winged Horse*)	Peg	Pegs
Perseus, (*Champion*)	Per	Pers
Phoenix, *Phoenix*	Phe	Phoe
Pictor, *Painter*	Pic	Pict
Pisces, *Fishes*	Psc	Pisc
Piscis Australis, *Southern Fish*	PsA	PscA
Puppis, *Poop*	Pup	Pupp
Pyxis, *Compass*	Pyx	Pyxi
Reticulum, *Net*	Ret	Reti
Sagitta, *Arrow*	Sge	Sgte
Sagittarius, *Archer*	Sgr	Sgtr
Scorpius, *Scorpion*	Scr	Scor
Sculptor, *Sculptor*	Scl	Scul
Scutum, *Shield*	Sct	Scut
Serpens, *Serpent*	Ser	Serp
Sextans, *Sextant*	Sex	Sext
Taurus, *Bull*	Tau	Taur
Telescopium, *Telescope*	Tel	Tele
Triangulum, *Triangle*	Tri	Tria
Triangulum Australe, *Southern Triangle*	TrA	TrAu
Tucana, *Toucan*	Tuc	Tucn
Ursa Major, *Greater Bear*	UMa	UMaj
Ursa Minor, *Lesser Bear*	UMi	UMin
Vela, *Sails*	Vel	Velr
Virgo, *Virgin*	Vir	Virg
Volans, *Flying Fish*	Vol	Voln
Vulpecula, *Fox*	Vul	Vulp

The 4-letter abbreviations are intended to be used in cases where a maximum saving of space is not necessary.

MISCELLANEOUS ASTRONOMICAL DATA

Units of Length

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

Units of Time

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

The Earth

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

Earth's Orbital Motion

Solar parallax $=$ 8."80; constant of aberration $=$ 20."47
Annual general precession $=$ 50."26; obliquity of ecliptic $=$ 23° 26′ 50″ (1939)
Orbital velocity $=$ 18.5 miles/sec.; parabolic velocity at ⊕ $=$ 26.2 miles/sec

Solar Motion

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

The Galactic System

North pole of galactic plane R.A. 12*h* 40*m*, Dec. $+ 28°$ (1900)
Centre, 325° galactic longitude, $=$ R.A. 17*h* 24*m*, Dec. $-30°$
Distance to centre $=$ 10,000 parsecs; diameter $=$ 30,000 parsecs.
Rotational velocity (at sun) $=$ 262 km./sec.
Rotational period (at sun) $= 2.2 \times 10^{8}$ years
Mass $= 2 \times 10^{11}$ solar masses

Extragalactic Nebulae

Red shift $= +530$ km./sec./megaparsec $= +101$ miles /sec./million l.y.

Radiation Constants

Velocity of light $=$ 299,774 km./sec. $=$ 186,271 miles/sec.
Solar constant $=$ 1.93 gram calories/square cm./minute
Light ratio for one magnitude $=$ 2.512; log ratio $=$ 0.4000
Radiation from a star of zero apparent magnitude $= 3 \times 10^{-6}$ meter candles
Total energy emitted by a star of zero absolute magnitude $= 5 \times 10^{25}$ horsepower

Miscellaneous

Constant of gravitation, $G = 6.670 \times 10^{-8}$ c.g.s. units
Mass of the electron, $m = 9.035 \times 10^{-28}$ gm.; mass of the proton $= 1.662 \times 10^{-24}$ gm
Planck's constant, $h = 6.55 \times 10^{-27}$ erg. sec.
Loschmidt's number $= 2.705 \times 10^{19}$ molecules/cu. cm. of gas at N.T.P.
Absolute temperature $= T°\,K = T°C + 273° = 5/9\,(T°\,F + 459°)$

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

1951 EPHEMERIS OF THE SUN AT 0h GREENWICH CIVIL TIME

Date 1951	Apparent R.A.	Corr. to Sun-dial	Apparent Dec.
	h m s	m s	° ′
Jan. 1	18 42 27	+03 06	−23 05.4
4	18 55 41	+04 30	−22 49.9
7	19 08 52	+05 52	−22 30.3
10	19 21 59	+07 09	−22 06.7
13	19 35 01	+08 21	−21 39.2
16	19 47 57	+09 28	−21 07.9
19	20 00 47	+10 28	−20 33.0
22	20 13 31	+11 22	−19 54.6
25	20 26 07	+12 09	−19 12.9
28	20 38 37	+12 49	−18 28.0
31	20 50 59	+13 21	−17 40.1
Feb. 3	21 03 14	+13 47	−16 49.3
6	21 15 22	+14 05	−15 55.9
9	21 27 23	+14 16	−15 00.0
12	21 39 16	+14 20	−14 01.9
15	21 51 03	+14 17	−13 01.6
18	22 02 42	+14 07	−11 59.5
21	22 14 16	+13 50	−10 55.7
24	22 25 43	+13 28	−09 50.4
27	22 37 05	+13 00	−08 43.7
Mar. 2	22 48 22	+12 27	−07 35.9
5	22 59 34	+11 50	−06 27.0
8	23 10 43	+11 09	−05 17.3
11	23 21 48	+10 24	−04 07.0
14	23 32 50	+09 37	−02 56.2
17	23 43 49	+08 46	−01 45.2
20	23 54 46	+07 54	−00 34.0
23	00 05 42	+07 00	+00 37.1
26	00 16 37	+06 05	+01 48.0
29	00 27 32	+05 10	+02 58.5
Apr. 1	00 38 27	+04 16	+04 08.5
4	00 49 23	+03 22	+05 17.9
7	01 00 20	+02 30	+06 26.4
10	01 11 19	+01 39	+07 33.9
13	01 22 21	+00 51	+08 40.3
16	01 33 25	+00 06	+09 45.4
19	01 44 32	−00 37	+10 48.9
22	01 55 43	−01 16	+11 50.9
25	02 06 57	−01 51	+12 51.1
28	02 18 16	−02 22	+13 49.5
May 1	02 29 39	−02 48	+14 45.8
4	02 41 08	−03 10	+15 39.9
7	02 52 41	−03 26	+16 31.7
10	03 04 20	−03 37	+17 21.0
13	03 16 03	−03 43	+18 07.7
16	03 27 52	−03 44	+18 51.7
19	03 39 45	−03 41	+19 32.8
22	03 51 44	−03 32	+20 10.8
25	04 03 47	−03 18	+20 45.8
28	04 15 55	−03 00	+21 17.6
31	04 28 07	−02 37	+21 46.1
Jun. 3	04 40 23	−02 11	+22 11.2
6	04 52 43	−01 41	+22 32.8
9	05 05 06	−01 07	+22 50.9
12	05 17 31	−00 32	+23 05.3
15	05 29 58	+00 05	+23 16.1
18	05 42 26	+00 43	+23 23.2
21	05 54 54	+01 22	+23 26.6
24	06 07 23	+02 01	+23 26.2
27	06 19 51	+02 39	+23 22.2
30	06 32 17	+03 16	+23 14.4

Date 1951	Apparent R.A.	Corr. to Sun-dial	Apparent Dec.
	h m s	m s	° ′
Jul. 3	06 44 43	+03 52	+23 03.0
6	06 57 05	+04 25	+22 48.0
9	07 09 25	+04 55	+22 29.3
12	07 21 41	+05 21	+22 07.2
15	07 33 53	+05 43	+21 41.7
18	07 46 00	+06 01	+21 12.9
21	07 58 02	+06 13	+20 40.8
24	08 10 00	+06 21	+20 05.6
27	08 21 52	+06 24	+19 27.4
30	08 33 40	+06 22	+18 46.2
Aug. 2	08 45 22	+06 14	+18 02.3
5	08 56 58	+06 01	+17 15.7
8	09 08 29	+05 42	+16 26.6
11	09 19 55	+05 18	+15 35.1
14	09 31 15	+04 49	+14 41.4
17	09 42 31	+04 15	+13 45.6
20	09 53 41	+03 36	+12 47.8
23	10 04 47	+02 52	+11 48.2
26	10 15 50	+02 05	+10 46.9
29	10 26 48	+01 14	+09 44.1
Sep. 1	10 37 44	+00 20	+08 39.8
4	10 48 37	−00 37	+07 34.3
7	10 59 27	−01 36	+06 27.7
10	11 10 16	−02 38	+05 20.2
13	11 21 02	−03 41	+04 11.8
16	11 31 48	−04 44	+03 02.8
19	11 42 34	−05 49	+01 53.3
22	11 53 19	−06 52	+00 43.5
25	12 04 06	−07 55	−00 26.7
28	12 14 54	−08 57	−01 36.8
Oct. 1	12 25 44	−09 57	−02 46.9
4	12 36 37	−10 54	−03 56.8
7	12 47 32	−11 48	−05 06.2
10	12 58 31	−12 39	−06 15.0
13	13 09 33	−13 26	−07 23.1
16	13 20 40	−14 09	−08 30.3
19	13 31 52	−14 47	−09 36.3
22	13 43 10	−15 19	−10 41.2
25	13 54 33	−15 45	−11 44.6
28	14 06 04	−16 04	−12 46.4
31	14 17 40	−16 17	−13 46.5
Nov. 3	14 29 24	−16 23	−14 44.6
6	14 41 16	−16 21	−15 40.5
9	14 53 14	−16 13	−16 34.1
12	15 05 20	−15 56	−17 25.1
15	15 17 33	−15 33	−18 13.5
18	15 29 54	−15 01	−18 58.9
21	15 42 23	−14 22	−19 41.4
24	15 54 59	−13 36	−20 20.6
27	16 07 42	−12 42	−20 56.5
30	16 20 32	−11 42	−21 28.8
Dec. 3	16 33 28	−10 35	−21 57.5
6	16 46 30	−09 23	−22 22.4
9	16 59 36	−08 07	−22 43.3
12	17 12 47	−06 46	−23 00.2
15	17 26 01	−05 22	−23 13.0
18	17 39 17	−03 55	−23 21.7
21	17 52 36	−02 26	−23 26.2
24	18 05 55	−00 56	−23 26.4
27	18 19 15	+00 33	−23 22.4
30	18 32 33	+02 02	−23 14.2

SOLAR AND SIDEREAL TIME

In practical astronomy three different kinds of time are used, while in ordinary life we use a fourth.

1. *Apparent Time*—By apparent noon is meant the moment when the sun is on the meridian, and apparent time is measured by the distance in degrees that the sun is east or west of the meridian. Apparent time is given by the sun-dial.

2. *Mean Time*—The interval between apparent noon on two successive days is not constant, and a clock cannot be constructed to keep apparent time. For this reason *mean time* is used. The length of a mean day is the average of all the apparent days throughout the year. The *real sun* moves about the ecliptic in one year; an imaginary *mean sun* is considered as moving uniformly around the celestial equator in one year. The difference between the times that the real sun and the mean sun cross the meridian is the *equation of time*. Or, in general, *Apparent Time—Mean Time = Equation of Time*. This is the same as *Corr-ction to Sun-dial* on page 7, with the sign reversed.

3. *Sidereal Time*—This is time as determined from the stars. It is sidereal noon when the Vernal Equinox or First of Aries is on the meridian. In accurate time-keeping the moment when a star is on the meridian is observed and the corresponding mean time is then computed with the assistance of the Nautical Almanac. When a telescope is mounted equatorially the position of a body in the sky is located by means of the sidereal time.

4. *Standard Time*—In everyday life we use still another kind of time. A moment's thought will show that in general two places will not have the same mean time; indeed, difference in longitude between two places is determined from their difference in time. But in travelling it is very inconvenient to have the time varying from station to station. For the purpose of facilitating transportation the system of *Standard Time* was introduced in 1883. Within a certain belt approximately 15° wide, all the clocks show the same time, and in passing from one belt to the next the hands of the clock are moved forward or backward one hour.

In Canada we have seven standard time belts, as follows;—Newfoundland Time, 3h. 30m. slower than Greenwich; 60th meridian or Atlantic Time, 4h.; 75th meridian or Eastern Time, 5h.; 90th meridian or Central Time, 6h.; 105th meridian or Mountain Time, 7h.; 120th meridian or Pacific Time, 8h.; and 135th meridian or Yukon Time, 9h. slower than Greenwich.

The boundaries of the time belts are shown on the map on page 9.

Daylight Saving Time is the standard time of the next zone eastward. It is adopted in many places between certain specified dates during the summer.

MAP OF STANDARD TIME ZONES

Revisions: Newfoundland Time is 3h. 30m. slower than Greenwich Time.
The "panhandle" region of Alaska, containing such towns as Juneau and Skagway, is on 120th meridian (Pacific) Time, instead of Yukon Time.

JULIAN CALENDAR, 1951

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

Jan. 1	3648	May 1	3768	Sep. 1	3891
Feb. 1	3679	Jun. 1	3799	Oct. 1	3921
Mar. 1	3707	Jul. 1	3829	Nov. 1	3952
Apr. 1	3738	Aug. 1	3860	Dec. 1	3982

The Julian Day commences at noon. Thus J.D. 2,433,648 = Jan. 1.5 G.C.T.

TIMES OF SUNRISE AND SUNSET

In the tables on pages 11 to 16 are given the times of sunrise and sunset for places in latitudes 32°, 36°, 40°, 44°, 46°, 48°, 50°, and 52°. The times are given in Local Mean Time, and in the table below are given corrections to change from Local Mean to Standard Time for the cities and towns named.

The time of sunrise and sunset at a given place, in local mean time, varies from day to day, and depends principally upon the declination of the sun. Variations in the equation of time, the apparent diameter of the sun and atmospheric refraction at the points of sunrise and sunset also affect the final result. These quantities, as well as the solar declination, do not have precisely the same values on corresponding days from year to year, and so the table gives only approximately average values. The times are for the rising and setting of the upper limb of the sun, and are corrected for refraction. It must also be remembered that these times are computed for the sea horizon, which is only approximately realised on land surfaces.

The Standard Times for Any Station

In order to find the time of sunrise and sunset for any place on any day, first 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 time of sunrise and sunset for the proper latitude, on the desired day, and apply the correction to get the Standard Time.

CANADIAN CITIES AND TOWNS						AMERICAN CITIES		
	Lat.	Cor.		Lat.	Cor.		Lat.	Cor.
Belleville	44	+ 09	Peterborough	44	+ 13	Atlanta	34	+ 37
Brandon	50	+ 40	Port Arthur	48	+ 57	Baltimore	39	+ 06
Brantford	43	+ 21	Prince Albert	53	+ 03	Birmingham	34	− 13
Calgary	51	+ 36	Prince Rupert	54	+ 41	Boston	42	− 16
Charlottetown	46	+ 13	Quebec	47	− 15	Buffalo	43	+ 15
Chatham	42	+ 29	Regina	50	− 02	Chicago	42	− 10
Cornwall	45	− 01	St. Catharines	43	+ 17	Cincinnati	39	+ 38
Dawson	64	+ 18	St. Hyacinthe	46	− 09	Cleveland	42	+ 26
Edmonton	54	+ 34	Saint John, N.B.	45	+ 24	Dallas	33	+ 27
Fort William	48	+ 57	St. John's, Nfld.	48	+ 01	Denver	40	00
Fredericton	46	+ 26	St. Thomas	43	+ 25	Detroit	42	+ 32
Galt	43	+ 21	Sarnia	43	+ 30	Fairbanks	65	− 10
Glace Bay	46	00	Saskatoon	52	+ 07	Indianapolis	40	− 15
Granby	45	− 09	Sault Ste. Marie	47	+ 37	Juneau	58	+ 58
Guelph	44	+ 21	Shawinigan Falls	47	− 09	Kansas City	39	+ 18
Halifax	45	+ 15	Sherbrooke	45	− 13	Los Angeles	34	− 07
Hamilton	43	+ 19	Stratford	43	+ 24	Louisville	38	− 17
Hull	45	+ 03	Sudbury	47	+ 24	Memphis	35	00
Kingston	44	+ 06	Sydney	46	+ 01	Milwaukee	43	− 09
Kitchener	43	+ 22	Timmins	48	+ 26	Minneapolis	45	+ 13
London	43	+ 25	Toronto	44	+ 18	New Orleans	30	00
Medicine Hat	50	+ 23	Three Rivers	46	− 10	New York	41	− 04
Moncton	46	+ 19	Trail	49	− 09	Omaha	41	+ 24
Montreal	45	− 06	Truro	45	+ 13	Philadelphia	40	+ 01
Moose Jaw	50	+ 02	Vancouver	49	+ 12	Pittsburgh	40	+ 20
Niagara Falls	43	+ 16	Victoria	48	+ 14	Portland	46	+ 11
North Bay	46	+ 18	Windsor	42	+ 32	St. Louis	39	+ 01
Oshawa	44	+ 15	Winnipeg	50	+ 29	San Francisco	38	+ 10
Ottawa	45	+ 03	Woodstock	43	+ 23	Seattle	48	+ 09
Owen Sound	45	+ 24	Yellowknife	63	+ 37	Washington	39	+ 08

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 11 the time of sunrise on February 12 for latitude 45° is 7.07; add 24 min. and we get 7.31 (Eastern Standard Time).

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

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

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

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

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

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

BEGINNING OF MORNING AND ENDING OF EVENING TWILIGHT

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

TIMES OF MOONRISE AND MOONSET, 1951. (Local Mean Time)

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

Date	Latitude 35° Moon Rise	Set	Latitude 40° Moon Rise	Set	Latitude 45° Moon Rise	Set	Latitude 50° Moon Rise	Set	Latitude 52° Moon Rise	Set
Mar.	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
1	01 42	11 10	02 01	10 51	02 25	10 27	02 54	09 57	03 09	09 42
2	02 49	12 12	03 08	11 53	03 33	11 29	04 04	10 57	04 19	10 42
3	03 47	13 22	04 05	13 04	04 28	12 42	04 56	12 14	05 11	12 00
4	04 36	14 36	04 51	14 19	05 10	14 02	05 34	13 39	05 47	13 28
5	05 15	15 46	05 27	15 34	05 41	15 21	05 59	15 06	06 08	14 58
6	05 48	16 55	05 57	16 48	06 06	16 40	06 18	16 30	06 25	16 25
7 ●	06 17	18 00	06 22	17 58	06 27	17 54	06 34	17 48	06 36	17 48
8	06 43	19 04	06 44	19 05	06 46	19 05	06 47	19 08	06 47	19 08
9	07 08	20 07	07 06	20 11	07 03	20 17	07 00	20 23	06 57	20 26
10	07 34	21 08	07 28	21 17	07 21	21 26	07 12	21 38	07 08	21 43
11	08 01	22 09	07 51	22 21	07 40	22 35	07 27	22 53	07 20	23 01
12	08 31	23 11	08 18	23 25	08 03	23 44	07 44	— —	07 36	— —
13	09 05	— —	08 50	— —	08 31	— —	08 07	00 06	07 55	00 71
14	09 45	00 10	09 27	00 28	09 06	00 49	08 37	01 17	08 24	01 30
15 ☽	10 32	01 07	10 12	01 27	09 48	01 50	09 17	02 21	09 02	02 36
16	11 24	02 01	11 04	02 21	10 41	02 44	10 10	03 15	09 55	03 30
17	12 22	02 49	12 03	03 07	11 42	03 29	11 14	03 58	11 00	04 12
18	13 23	03 30	13 07	03 46	12 49	04 05	12 26	04 30	12 14	04 42
19	14 28	04 06	14 13	04 19	13 59	04 35	13 41	04 54	13 33	05 04
20	15 30	04 38	15 21	04 47	15 11	04 59	14 59	05 13	14 53	05 20
21	16 34	05 06	16 29	05 13	16 24	05 20	16 17	05 29	16 14	05 33
22	17 39	05 33	17 39	05 36	17 38	05 39	17 37	05 42	17 36	05 44
23 ⊕	18 45	06 00	18 49	05 58	18 53	05 57	18 57	05 55	19 00	05 54
24	19 55	06 27	20 02	06 23	20 11	06 16	20 21	06 09	20 27	06 06
25	21 06	06 57	21 18	06 48	21 31	06 38	21 49	06 25	21 56	06 19
26	22 19	07 33	22 35	07 20	22 54	07 05	23 17	06 46	23 29	06 37
27	23 33	08 15	23 51	07 59	— —	07 39	— —	07 14	— —	07 02
28	— —	09 05	— —	08 47	00 14	08 23	00 42	07 54	00 57	07 40
29	00 42	10 06	01 02	09 46	01 26	09 21	01 57	08 50	02 13	08 35
30 ☾	01 43	11 13	02 02	10 54	02 26	10 31	02 55	10 02	03 10	09 48
31	02 33	12 24	02 50	12 08	03 11	11 48	03 36	11 23	03 48	11 10
Apr.										
1	03 15	13 34	03 29	13 22	03 45	13 07	04 04	12 50	04 14	12 41
2	03 49	14 45	03 59	14 35	04 11	14 24	04 25	14 13	04 31	14 06
3	04 19	15 48	04 25	15 44	04 32	15 38	04 41	15 32	04 45	15 29
4	04 45	16 51	04 48	16 51	04 51	16 50	04 55	16 49	04 56	16 48
5	05 10	17 53	05 09	17 56	05 08	17 59	05 07	18 04	05 06	18 06
6 ●	05 35	18 54	05 31	19 01	05 26	19 09	05 19	19 19	05 16	19 23
7	06 02	19 56	05 54	20 06	05 44	20 18	05 32	20 33	05 28	20 40
8	06 31	20 57	06 19	21 11	06 05	21 28	05 49	21 47	05 42	21 57
9	07 04	21 58	06 48	22 15	06 31	22 35	06 09	23 00	06 00	23 06
10	07 41	22 57	07 23	23 16	07 03	23 38	06 37	— —	06 24	— —
11	08 24	23 52	08 05	— —	07 43	— —	07 13	00 07	06 58	00 22
12	09 14	— —	08 54	00 12	08 31	00 35	08 01	01 05	07 45	01 21
13	10 09	00 41	09 51	01 01	09 28	01 26	08 59	01 53	08 45	02 08
14 ☽	11 09	01 25	10 52	01 43	10 32	02 03	10 07	02 29	09 55	02 41
15	12 10	02 03	11 57	02 17	11 40	02 35	11 20	02 56	11 10	03 06
16	13 12	02 35	13 02	02 47	12 50	03 01	12 36	03 17	12 28	03 24
17	14 15	03 05	14 09	03 13	14 02	03 22	13 52	03 33	13 48	03 39
18	15 20	03 32	15 16	03 36	15 13	03 41	15 10	03 47	15 08	03 50
19	16 25	03 58	16 26	03 59	16 28	04 00	16 30	04 01	16 31	04 01
20	17 34	04 25	17 39	04 22	17 45	04 18	17 53	04 14	17 57	04 13
21 ⊕	18 45	04 55	18 54	04 48	19 06	04 39	19 20	04 30	19 27	04 25
22	20 00	05 28	20 14	05 17	20 30	05 04	20 51	04 48	21 01	04 41
23	21 16	06 09	21 33	05 54	21 55	05 36	22 21	05 14	22 34	05 03
24	22 29	06 58	22 49	06 39	23 12	06 18	23 43	05 50	23 59	05 37
25	23 35	07 57	23 55	07 37	— —	07 13	— —	06 42	— —	06 27
26	— —	09 04	— —	08 44	00 18	08 21	00 49	07 51	01 04	07 36
27	00 31	10 15	00 48	09 58	01 09	09 38	01 36	09 12	01 49	09 00
28 ☾	01 15	11 27	01 30	11 13	01 47	10 57	02 08	10 38	02 18	10 26
29	01 52	12 36	02 03	12 26	02 16	12 15	02 31	12 01	02 38	11 54
30	02 23	13 41	02 30	13 35	02 38	13 29	02 48	13 21	02 53	13 17

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

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

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

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

THE PLANETS FOR 1951

By C. A. Chant

THE SUN

During the present sun-spot cycle there has been remarkable activity on the sun. The maximum occurred about March 26, 1947, and the activity is still notable. In 1950 the sun was seldom without spots on its surface and they were often accompanied by striking auroral displays. Very probably this condition will continue throughout 1951.

MERCURY

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

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

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

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

Maximum Elongations of Mercury during 1951

Elong. East—Evening Star			Elong. West—Morning Star		
Date	Distance	Mag.	Date	Distance	Mag.
Apr. 5	19°	−0.2	Jan. 23	25°	+0.1
Aug. 3	27°	+0.6	May 22	25°	+0.8
Nov. 28	22°	+0.5	Sept. 16	18°	−0.1

The most favourable elongations to observe are: in the evening, April 5; in the morning, Sept. 16. At these times Mercury is about 80 million miles from the earth and in a telescope looks like a half-moon about 7″ in diameter.

VENUS

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

On Jan. 1, 1951, Venus is an evening star. It crosses the meridian about an hour after the sun, but as its declination is almost 23° S. it is not well placed for observers in the northern hemisphere. It is separating from the sun and on June 25 reaches greatest elong. E., 45° 25′. Then it moves in towards the sun. It attains greatest brilliancy, stellar mag. −4.2, on July 29 and reaches inferior conjunction with the sun on Sept. 3. The planet now becomes a morning star, rapidly separating from the sun. On Oct. 10 it attains greatest brilliancy, stellar mag. −4.3; and reaches greatest elong. W., 46° 39′, on Nov. 14. It will be a morning star the rest of the year.

In the month of February the planets Venus, Mars and Jupiter have close conjunctions with each other and with the moon. For details consult page 32, the Sky for February, and the map of the path of Mars.

With the exception of the sun and moon, Venus is the brightest object in the sky. Its brilliance is largely due to the dense clouds which cover the surface of the planet. They reflect well the sun's light; but they also prevent the astronomer from detecting any solid object on the surface of the body. If such could be observed it would enable him to determine the planet's rotation period. It is probably around 30 days.

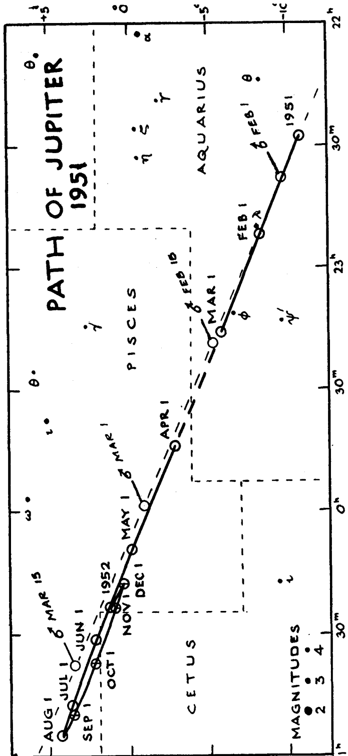
MARS

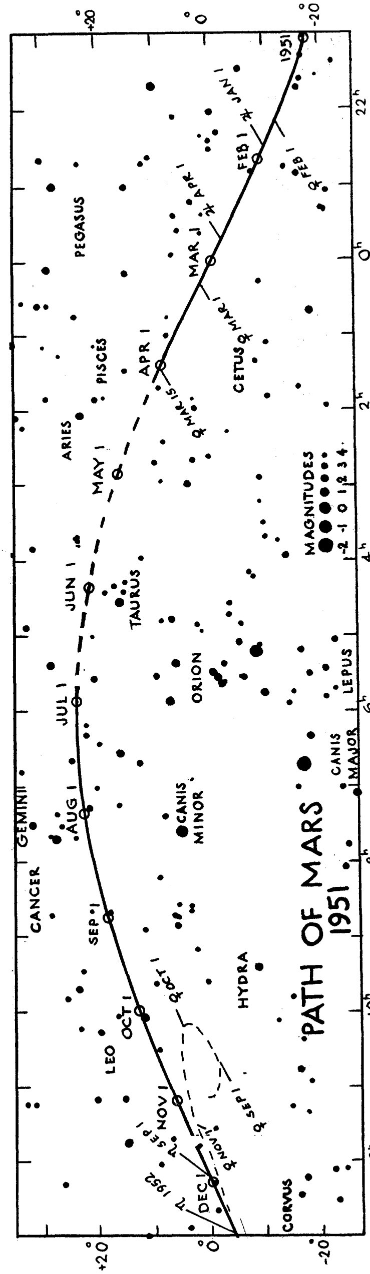
The orbit of Mars is outside that of the earth and consequently its planetary phenomena are quite different from those of the two inferior planets discussed above. Its mean distance from the sun is 141 million miles and the eccentricity of its orbit is 0.093, and a simple computation shows that its distance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

The sidereal, or true mechanical, period of revolution of Mars is 687 days; and the synodic period (for example, the interval from one opposition to the next one) is 780 days. This is the average value; it may vary from 764 to 810 days. The planet was in opposition on Mar. 23, 1950; the next opposition is on May 1, 1952; and the next close opposition is on Sept. 10, 1956. For its position among the stars see the map.

JUPITER

Jupiter is the giant of the family of the sun. Its mean diameter is 87,000 miles and its mass is 2½ times that of all the rest of the planets combined! Its mean distance is 483 million miles and the revolution period is 11.9 years. This


PATH OF JUPITER
1951
PISCES
AQUARIUS
CETUS
MAGNITUDES
2 3 4


PATH OF MARS
1951
PEGASUS
PISCES
ARIES
TAURUS
ORION
LEPUS
CANIS MAJOR
CANIS MINOR
GEMINI
CANCER
HYDRA
LEO
CORVUS
CETUS
MAGNITUDES
-2 -1 0 1 2 3 4

planet is known to possess 11 satellites, two of them discovered in 1938 (see p. 59). Not so long ago it was generally believed that the planet was still cooling down from its original high temperature, but from actual measurements of the radiation from it to the earth it has been deduced that the surface is at about −200° F. The spectroscope shows that its atmosphere is largely ammonia and methane.

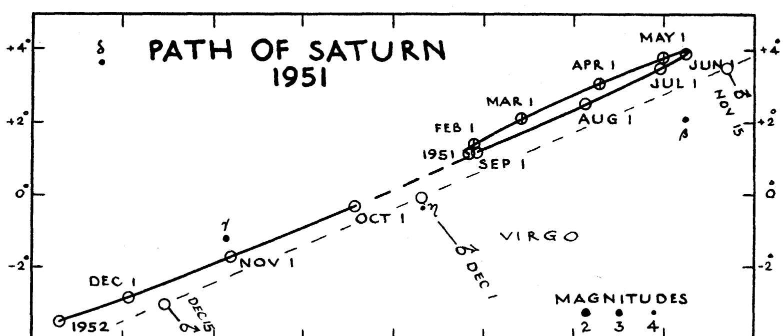
Jupiter is a fine object for the telescope. Many details of the surface as well as the flattening of the planet, due to its short rotation period, are visible, and the phenomena of its satellites provide a continual interest.

On Jan. 1, 1951, Jupiter crosses the meridian at 3.45 p.m. and is an evening star in the constellation Aquarius (see map). The sun moves over to the planet and they are in conjunction on March 11, and Jupiter becomes a morning star. It then separates from the sun until Oct. 2 when it comes to opposition and is on the meridian at midnight. At this time its distance from the earth is 366,800,000 mi. (see p. 45) and its stellar magnitude −2.5. On Dec. 31 it crosses the meridian at about 5.45 p.m.

SATURN

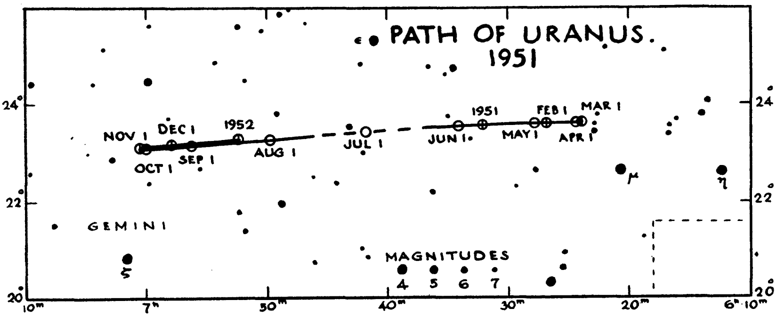
Saturn was the outermost planet known until modern times. In size it is a good second to Jupiter. In addition to its family of nine satellites, this planet has a unique system of rings, and it is one of the finest of celestial objects in a good telescope. The plane of the rings makes an angle of 27° with the plane of the planet's orbit, and twice during the planet's revolution period of 29½ years the rings appear to open out widest; then they slowly close in until, midway between the maxima, the rings are presented edgewise to the sun or the earth, at which times they are invisible. The rings were edgewise in 1937 and 1950, and at maximum in 1944. For the next few years they will be gradually opening out.

The planet is in the constellation Virgo (see map). On March 20 it is in opposition to the sun and is visible all night. Its stellar magnitude then is +0.7, slightly less bright than Rigel. On June 17 it is in quadrature with the sun and is on the meridian at sunset. On Sept. 29 it is in conjunction with the sun. On Dec. 19, it is in close conjunction with Mars (see p. 53).



URANUS

Uranus was discovered in 1781 by Sir William Herschel by means of a 6¼-in. mirror-telescope made by himself. The object did not look just like a star and he observed it again four days later. It had moved amongst the stars, and he assumed it to be a comet. He could not believe that it was a new planet. How-

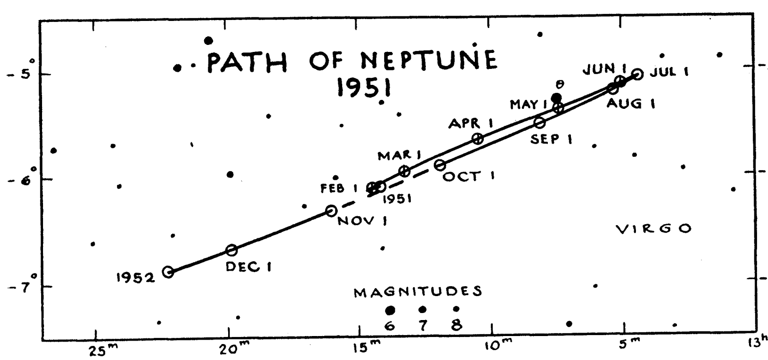


ever, computation later showed that it was a planet nearly twice as far from the sun as Saturn. Its period of revolution is 84 years and it rotates on its axis in about 11 hours. Its five satellites are visible only in a large telescope. The fifth satellite was discovered by G. P. Kuiper in 1948 at the McDonald Observatory (see p. 59).

As shown by the chart, Uranus in 1951 is still in Gemini. It was in opposition to the sun on Dec. 29, 1950, but as its synodic period is 369.66 days there will be no opposition in 1951; it will occur on Jan. 3, 1952.

NEPTUNE

Neptune was discovered in 1846 after its existence in the sky had been predicted from independent calculations by Leverrier in France and Adams in England. This discovery was a crowning demonstration of the correctness of Newton's law of gravitation. It caused a sensation at the time. The planet's



distance from the sun is 2800 million miles and its period of revolution is 165 years. A satellite was discovered in 1846, soon after the planet. A second satellite was discovered by G. P. Kuiper at the McDonald Observatory on May 1, 1949. Its magnitude is about 19.5, its period about 2 years, and diameter about 200 miles. It is named Nereid.

During 1951 Neptune is still in the constellation Virgo. It is in opposition to the sun on April 8. Its stellar magnitude is +7.7 and hence it is too faint for the naked eye. In the telescope it shows a greenish tint and a diameter of $2''.5$. It is in conjunction with the sun on Oct. 13.

PLUTO

Pluto, the most distant known planet, was discovered at the Lowell Observatory in 1930. Its mean distance from the sun is 3666 million miles and its revolution period is 248 years. It appears as a 15th mag. star in the constellation Cancer. It is in opposition to the sun on Feb. 8, 1951, at which time its astrometric position is R.A. $9^h\ 36^m.\ 0$, Dec. $+23°\ 32'$.

ECLIPSES, 1951

In 1951 there will be the least possible number of eclipses, *two*, both of the sun. Both of these eclipses are annular.

I. *An Annular Eclipse of the Sun,* March 7, 1951. Visible in Canada and the United States only as a slight partial eclipse at sunset from southern Ontario, and from the southern and eastern states. The central path starts between Australia and New Zealand, crosses the South Pacific, Pitcairn Island, Nicaragua and Costa Rica, and ends in the Caribbean Sea at sunset. The maximum duration of the annular phase will be 1 min. 38 sec. The G.C.T. of conjunction in right ascension will be March 7th, 20h 38m 37.5s.

II. *An Annular Eclipse of the Sun,* September 1, 1951, visible as a partial eclipse at sunrise from eastern Canada and the United States, and briefly as an annular eclipse of the rising sun from eastern Virginia. The central path starts at sunrise in Virginia, crosses the North Atlantic Ocean, French West Africa, The Gold Coast, Gulf of Guinea, the Congo, Northern Rhodesia, Mozambique, and ends in Madagascar at sunset. The duration along the central line of the path is remarkably constant, ranging from 2 min. 33 sec. to 2 min. 43 sec. The G.C.T. of conjunction in right ascension will be September 1st, 12h 42m 1.6s.

THE SKY MONTH BY MONTH

By J. F. Heard

THE SKY FOR JANUARY, 1951

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

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

The Sun—During January the sun's R.A. increases from 18h 42m to 20h 55m and its Decl. changes from 23° 05′ S. to 17° 23′ S. The equation of time changes from —3m 06s to —13m 31s. The earth is in perihelion or nearest the sun on the 1st. For changes in the length of the day, see p. 11.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 18.

Mercury on the 15th is in R.A. 18h 10m, Decl. 20° 46′ S. and transits at 10.34. After inferior conjunction on the 1st it is a morning star, coming to greatest western elongation on the 23rd at which time it may be seen low in the south-east just before sunrise.

Venus on the 15th is in R.A. 20h 47m, Decl. 19° 26′ S. and transits at 13.13. It is an evening star very low in the south-west at sunset. In a telescope it appears nearly fully illuminated.

Mars on the 15th is in R.A. 21h 47m, Decl. 14° 31′ S. and transits at 14.12. It is in Capricornus and Aquarius and may be seen low in the south-west after sunset.

Jupiter on the 15th is in R.A. 22h 38m, Decl. 9° 45′ S. and transits at 15.01. It is prominent in the south-west for a few hours after sunset.

For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 54.

Saturn on the 15th is in R.A. 12h 12m, Decl. 1° 12′ N. and transits at 4.36. It is in Virgo west of Spica, rising about midnight. On the 13th it is stationary in R.A. and begins to retrograde, or move westward among the stars. The rings are "thin" this year, their plane being within a few degrees of the line of sight.

Uranus on the 15th is in R.A. 6h 30m, Decl. 23° 36′ N. and transits at 22.50

Neptune on the 15th is in R.A. 13h 15m, Decl. 6° 08′ S. and transits at 5.38.

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

ASTRONOMICAL PHENOMENA MONTH BY MONTH

By Ruth J. Northcott

	d	h	m	JANUARY 75th Meridian Civil Time	Min. of Algol	Config. of Jupiter's Sat. 19h 00m
	d	h	m		h m	
Mon.	1	0	11	☾ Last Quarter		40213
		15		☌ ☿ ☉ Inferior		
		19	41	☌ ♆ ☾ ♆ 4° 25′ N.		
		23		⊕ in Perihelion. Dist. from ☉, 91, 345,000 mi.		
Tue.	2	22		♀ in Aphelion		14023
Wed.	3			Quadrantid meteors	15 22	23014
Thur.	4					32104
Fri.	5					30124
Sat.	6	8		Moon in Perigee. Dist. from ⊕, 223,500 mi.	12 12	3024*
		19	08	☌ ☿ ☾ ☿ 8° 12′ N.		
Sun.	7	15	10	● New Moon		21034
Mon.	8	2		☿ Greatest Hel. Lat. N.		0134*
		13	27	☌ ♀ ☾ ♀ 2° 38′ N.		
Tue.	9	21	14	☌ ♂ ☾ ♂ 1° 36′ N.	09 01	10234
Wed.	10	8		□ ♆ ☉		23041
Thur.	11	2	31	☌ ♃ ☾ ♃ 0° 13′ N.		32140
Fri.	12	10		☿ Stationary in R.A.	05 50	34012
Sat.	13	0		♄ Stationary in R.A.		43102
Sun.	14	19	23	☽ First Quarter		d4203
Mon.	15				02 39	4013*
Tue.	16					41023
Wed.	17				23 29	42031
Thur.	18	9		Moon in Apogee. Dist. from ⊕, 252,000 mi.		34210
Fri.	19					3012*
Sat.	20	20	38	☌ ♅ ☾ ♅ 4° 34′ S.	20 18	31024
Sun.	21	16		♆ Stationary in R.A.		20134
Mon.	22	23	47	○ Full Moon		2034*
Tue.	23	18		☿ Greatest elongation W., 24° 31′	17 07	10234
Wed.	24					20314
Thur.	25	11		♀ Greatest Hel. Lat. S.		32104
Fri.	26				13 57	30214
Sat.	27	18	29	☌ ♄ ☾ ♄ 3° 58′ N.		31042
Sun.	28					2401*
Mon.	29	1	49	☌ ♆ ☾ ♆ 4° 43′ N.	10 46	42103
Tue.	30	10	13	☾ Last Quarter		41023
Wed.	31	12		☿ in ☋		40213

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

THE SKY FOR FEBRUARY, 1951

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

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

The Sun—During February the sun's R.A. increases from 20h 55m to 22h 45m and its Decl. changes from 17° 23′ S. to 7° 59′ S. The equation of time changes from −13m 31s to a maximum of −14m 20s on the 12th and then to −12m 39s at the end of the month. For changes in the length of the day, see p. 11.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 18.

Mercury on the 15th is in R.A. 20h 43m, Decl. 19° 52′ S. and transits at 11.08. It is a morning star but poorly placed for observation.

Venus on the 15th is in R.A. 23h 17m, Decl. 6° 08′ S. and transits at 13.40. It is an evening star seen low in the west just after sunset. There is an occultation on the 7th, in the evening in eastern Canada, in the afternoon in western Canada. Conjunction with Jupiter is on the 11th and with Mars on the 15th. See Mars.

Mars on the 15th is in R.A. 23h 19m, Decl. 5° 20′ S. and transits at 13.41. It is in Aquarius and Pisces and may be seen for a short time after sunset low in the south-west. Conjunction with Jupiter is on the 7th and with Venus on the 15th. These are close conjunctions and the closeness and relative positions of these three planets at this time will be most interesting.

Jupiter on the 15th is in R.A. 23h 04m, Decl. 7° 05′ S. and transits at 13.25. It is very low in the south-west at sunset, setting soon after. See also Venus and Mars.

For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 54.

Saturn on the 15th is in R.A. 12h 09m, Decl. 1° 43′ N. and transits at 2.31. It is in Virgo west of Spica, rising in the late evening and visible the rest of the night.

Uranus on the 15th is in R.A. 6h 25m, Decl. 23° 39′ N. and transits at 20.44.

Neptune on the 15th is in R.A. 13h 14m, Decl. 6° 03′ S. and transits at 3.36.

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

				FEBRUARY 75th Meridian Civil Time	Min. of Algol	Config. of Jupiter's Sat. 18h 45m
	d	h	m		h m	
Thur.	1			. . . .	07 35	42310
Fri.	2			. . . .		43021
Sat.	3	10		Moon in Perigee. Dist. from ⊕, 226,800 mi..		43102
Sun.	4	10	09	☌ ☿ ☾ ☿ 3° 53′ N.	04 24	4201*
Mon.	5			. . . .		2103*
Tue.	6	2	54	● New Moon.		d0243
Wed.	7	14		☌ ♂ ♃ ♂ 0° 10′ N.	01 14	01234
		17	11	☌ ♀ ☾ ♀ 0° 36′ S..		
Thur.	8	0	07	☌ ♃ ☾ ♃ 0° 30′ S..		23104
		0	34	☌ ♂ ☾ ♂ 0° 21′S..		
		1		☍ ♇ ☉		
Fri.	9			. . . .	22 03	3014*
Sat.	10	19		☿ in Aphelion.		31024
Sun.	11	10		☌ ♀ ♃ ♀ 0° 26′ S..		23014
Mon.	12			. . . .	18 52	21034
Tue.	13	15	55	☽ First Quarter.		01423
Wed.	14			. . . .		4023*
Thur.	15	5		Moon in Apogee. Dist. from ⊕, 251,400 mi..	15 42	42130
		23		☌ ♀ ♂ ♀ 0° 35′ S..		
Fri.	16			. . . .		43201
Sat.	17	2	48	☌ ♅ ☾ ♅ 4° 42′ S..		43102
Sun.	18			. . . .	12 31	43201
Mon.	19			. . . .		42103
Tue.	20			. . . .		40123
Wed.	21	16	12	○ Full Moon.	09 20	41023
Thur.	22			. . . .		
Fri.	23	22	19	☌ ♄ ☾ ♄ 4° 03′ N.		
Sat.	24			. . . .	06 10	
Sun.	25	6	58	☌ ♆ ☾ ♆ 4° 50′ N.		
Mon.	26			. . . .		
Tue.	27			. . . .	02 59	
Wed.	28	17	59	☾ Last Quarter.		

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

Jupiter being near the sun, phenomena of the satellites are not given from February 22nd to May 1st.

THE SKY FOR MARCH, 1951

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

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

The Sun—During March the sun's R.A. increases from 22h 45m to 0h 38m and its Decl. changes from 7° 59′ S. to 4° 09′ N. The equation of time changes from −12m 39s to −4m 16s. On the 21st at 5.26 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. There is an annular eclipse of the sun on the 7th. For changes in the length of the day, see p. 12.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 19.

Mercury on the 15th is in R.A. 23h 51m, Decl. 2° 16′ S. and transits at 12.26. It is in superior conjunction on the 11th and is too close to the sun for observation until the end of the month when it becomes a good evening star.

Venus on the 15th is in R.A. 1h 23m, Decl. 8° 17′ N. and transits at 13.56. It is an evening star seen low in the west after sunset.

Mars on the 15th is in R.A. 0h 38m, Decl. 3° 31′ N. and transits at 13.10. It is in Pisces, very low in the west at sunset.

Jupiter on the 15th is in R.A. 23h 29m, Decl. 4° 28′ S. and transits at 12.00. It is too near the sun for observation. Conjunction is on the 11th.

For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 54.

Saturn on the 15th is in R.A. 12h 02m, Decl. 2° 33′ N. and transits at 0.34. It is in Virgo west of Spica rising in the early evening and visible all night. Opposition is on the 20th.

Uranus on the 15th is in R.A. 6h 24m, Decl. 23° 40′ N. and transits at 18.53.

Neptune on the 15th is in R.A. 13h 12m, Decl. 5° 49′ S. and transits at 1.44

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

MARCH

75th Meridian Civil Time

	d	h	m		Min. of Algol h m
Thur.	1			....	23 48
Fri.	2	2		Moon in Perigee. Dist. from ⊕, 229,800 mi..	
Sat.	3	3		☿ Greatest Hel. Lat. S.............	
Sun.	4			....	20 38
Mon.	5			....	
Tue.	6			....	
Wed.	7	10	22	☌ ☿ ☾ ☿ 1° 30′ S.	
				Annular eclipse of ☉. See p. 29...............	17 27
		15	50	🌑 New Moon.....................	
		22	02	☌ ♃ ☾ ♃ 1° 12′ S..............	
Thur.	8			....	
Fri.	9	4	36	☌ ♂ ☾ ♂ 2° 23′ S............	
Sat.	10	1	01	☌ ♀ ☾ ♀ 3° 24′ S...............	14 16
Sun.	11	5		☌ ☿ ♃ ☿ 0° 37′ S...............	
		5		☌ ☿ ☉ Superior.................	
		12		☌ ♃ ☉...........................	
Mon.	12			....	
Tue.	13			....	11 06
Wed.	14	6		♅ Stationary in R.A...............	
Thur.	15	1		Moon in Apogee. Dist. from ⊕, 251,200 mi..	
		12	40	🌓 First Quarter..................	
Fri.	16	10	35	☌ ♅ ☾ ♅ 4° 45′ S..............	07 55
Sat.	17			....	
Sun.	18			....	
Mon.	19			....	04 44
Tue.	20	5		☍ ♄ ☉ Dist. from ⊕, 788,600,000 mi.	
Wed.	21	5	26	☉ enters ♈. Spring commences. Long. of ☉, 0°	
Thur.	22	3		☿ in ☊..........................	01 33
		18		♀ in ☊..........................	
Fri.	23	2	54	☌ ♄ ☾ ♄ 3° 53′ N..............	
		5	50	🌕 Full Moon.....................	
Sat.	24	13	23	☌ ♆ ☾ ♆ 4° 47′ N..............	22 22
Sun.	25			....	
Mon.	26	4		☌ ☿ ♂..........................	
		18		□ ♅ ☉..........................	
		19		☿ in Perihelion...................	
Tue.	27	4		Moon in Perigee. Dist. from ⊕, 228,600 mi..	19 12
Wed.	28			....	
Thur.	29			....	
Fri.	30	0	35	☾ Last Quarter....................	16 01
Sat.	31			....	

Explanation of symbols and abbreviations on p. 4, of time on p. 8.
Jupiter being near the sun, phenomena of the satellites are not given from February 22 to May 1.

THE SKY FOR APRIL, 1951

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

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

The Sun—During April the sun's R.A. increases from 0h 38m to 2h 30m and its Decl. changes from 4° 09′ N. to 14° 46′N. The equation of time changes from —4m 16s to +2m 48s, being zero on the 15th; that is, the apparent sun changes from being east of the mean sun to being west of it. For changes in the length of the day, see p. 12.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 19.

Mercury on the 15th is in R.A. 2h 21m, Decl. 17° 14′ N. and transits at 12.48. It is at greatest eastern elongation on the 5th; around about this time it is a splendid evening star, being 18° above the western horizon at sunset. However, it rapidly approaches the sun and by the 24th it is in inferior conjunction.

Venus on the 15th is in R.A. 3h 48m, Decl. 21° 14′ N. and transits at 14.20. It is a good evening star prominent in the western sky in the early evening.

Mars on the 15th is in R.A. 2h 05m, Decl. 12° 29′ N. and transits at 12.35. It is too close to the sun for observation.

Jupiter on the 15th is in R.A. 23h 56m, Decl. 1° 34′ S. and transits at 10.25. It is too near the sun for easy observation.

For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 54.

Saturn on the 15th is in R.A. 11h 53m, Decl. 3° 28′ N. and transits at 22.19. It is in Virgo west of Spica, well up in the east at sunset and visible all night.

Uranus on the 15th is in R.A. 6h 26m, Decl. 23° 38′ N. and transits at 16.53.

Neptune on the 15th is in R.A. 13h 09m, Decl. 5° 30′ S. and transits at 23.35.

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

APRIL

75th Meridian Civil Time

	d	h	m		Min. of Algol h m
Sun.	1			....	
Mon.	2			....	12 50
Tue.	3			....	
Wed.	4	18	35	☌ ♃ ☾ ♃ 1° 56′ S..............	
Thur.	5	15		☿ Greatest elongation E., 19° 12′....	09 39
Fri.	6	1		☿ Greatest Hel. Lat. N............	
		5	52	● New Moon....................	
Sat.	7	7	25	☌ ♂ ☾ ♂ 3° 54′ S..............	
		21	26	☌ ☿ ☾ ☿ 1° 01′ S...............	
Sun.	8	15		☍ ♆ ☉ Dist. from ⊕, 2,722,000,000 mi...	06 28
Mon.	9	7	53	☌ ♀ ☾ ♀ 3° 57′ S..............	
Tue.	10			....	
Wed.	11	20		Moon in Apogee. Dist. from ⊕, 251,600 mi..	03 18
Thur.	12	19	22	☌ ♅ ☾ ♅ 4° 39′ S..............	
Fri.	13				
Sat.	14	7	55	☽ First Quarter..................	00 07
		17		☿ Stationary in R.A.................	
Sun.	15			....	
Mon.	16			....	20 56
Tue.	17			....	
Wed.	18			....	
Thur.	19	3		☌ ☿ ♂ ☿ 2° 51′ N..............	17 45
		9	13	☌ ♄ ☾ ♄ 3° 42′ N..............	
Fri.	20	21	42	☌ ♆ ☾ ♆ 4° 43′ N..............	
Sat.	21	16	30	○ ......Full Moon.....................	
				Lyrid meteors.........................	
Sun.	22			....	14 34
Mon.	23	18		Moon in Perigee. Dist. from ⊕, 225,200 mi..	
Tue.	24	23		☌ ☿ ☉ Inferior..................	
Wed.	25	9		♀ in Perihelion..................	11 23
Thur.	26			....	
Fri.	27			....	
Sat.	28	7	17	☾ Last Quarter..................	08 12
Sun.	29	11		☿ in ☋.........................	
Mon.	30			....	

Explanation of symbols and abbreviations on p. 4, of time on p. 8.
Jupiter being near the sun, phenomena of the satellites are not given from February 22 to May 1.

THE SKY FOR MAY, 1951

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

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

The Sun—During May the sun's R.A. increases from 2h 30m to 4h 32m and its Decl. changes from 14° 46′ N. to 21° 55′ N. The equation of time changes from +2m 48s to a maximum of +3m 45s on the 15th and then to +2m 37s at the end of the month. For changes in the length of the day, see p. 13.

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

Mercury on the 15th is in R.A. 1h 56m, Decl. 8° 31′ N. and transits at 10.27. It is a morning star, reaching greatest western elongation on the 22nd, but this is an unfavourable elongation.

Venus on the 15th is in R.A. 6h 20m, Decl. 25° 43′ N. and transits at 14.53. It is a prominent evening star dominating the western sky.

Mars on the 15th is in R.A. 3h 32m, Decl. 19° 13′ N. and transits at 12.03. It is too close to the sun for observation. Conjunction is on the 22nd.

Jupiter on the 15th is in R.A. 0h 20m, Decl. 0° 56′ N. and transits at 8.51. It is a prominent morning star low in the east before sunrise.

For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 54.

Saturn on the 15th is in R.A. 11h 48m, Decl. 3° 57′ N. and transits at 20.16. It is in Virgo about half-way between Spica and Regulus. It is well up in the southern sky at sunset and sets after midnight. On the 29th it is stationary in R.A. and resumes direct, or eastward, motion.

Uranus on the 15th is in R.A. 6h 30m, Decl. 23° 35′ N. and transits at 15.00.

Neptune on the 15th is in R.A. 13h 06m, Decl. 5° 14′ S. and transits at 21.34.

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

				MAY 75th Meridian Civil Time	Min. of Algol	Config of Jupiter's Sat. 4h 15m
	d	h	m		h m	
Tue.	1	10		♂ in ☊	05 01	32104
Wed.	2	13	03	☌ ♃ ☾ ♃ 2° 42′ S.		20314
Thur.	3					10234
Fri.	4			Eta Aquarid Meteors	01 50	02134
		17	07	☌ ☿ ☾ ☿ 5° 13′ S.		
Sat.	5	20	35	● New Moon		21034
Sun.	6	7	52	☌ ♂ ☾ ♂ 4° 38′ S.	22 39	3014*
Mon.	7	6		☿ Stationary in R.A.		3024*
Tue.	8					d3204
Wed.	9	12		Moon in Apogee. Dist. from ⊕, 252,200 mi.	19 28	23041
		12	08	☌ ♀ ☾ ♀ 2° 44′ S.		
		18		☿ in Aphelion		
Thur.	10	4	27	☌ ♅ ☾ ♅ 4° 27′ S.		41023
Fri.	11					40213
Sat.	12				16 17	42103
Sun.	13					4301*
Mon.	14	0	32	☽ First Quarter		43102
Tue.	15				13 06	d4320
Wed.	16	16	58	☌ ♄ ☾ ♄ 3° 41′ N.		42301
Thur.	17	0		☌ ♀ ♅ ♀ 2° 05′ N.		41023
		6		♀ Greatest Hel. Lat. N.		
Fri.	18	7	00	☌ ♆ ☾ ♆ 4° 45′ N.	09 55	04123
Sat.	19					21034
Sun.	20					23014
Mon.	21	0	45	○ Full Moon	06 44	31024
		23		Moon in Perigee. Dist. from ⊕, 222,700 mi.		
Tue.	22	9		☌ ♂ ☉		d3014
		12		☿ Greatest elongation W., 25° 24′		
Wed.	23					2304*
Thur.	24				03 33	10234
Fri.	25					01243
Sat.	26					21043
Sun.	27	15	17	☾ Last Quarter	00 22	d4201
Mon.	28					43102
Tue.	29	20		♄ Stationary in R.A.	21 11	43021
Wed.	30	2		☿ Greatest Hel. Lat. S.		4230*
		5	22	☌ ♃ ☾ ♃ 3° 30′ S.		
Thur.	31					d4023

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

THE SKY FOR JUNE, 1951

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

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

The Sun—During June the sun's R.A. increases from 4h 32m to 6h 36m and its Decl. changes from 21° 55′ N. to 23° 27′ N. at the solstice on the 22nd and then to 23° 11′ N. at the end of the month. The equation of time changes from +2m 29s to −3m 28s, being zero on the 14th; that is, the apparent sun changes from being west of the mean sun to being east of it. For changes in the length of the day, see p. 13.

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

Mercury on the 15th is in R.A. 4h 37m, Decl. 21° 26′ N. and transits at 11.10. It is poorly placed for observation all month. Superior conjunction is on the 25th.

Venus on the 15th is in R.A. 8h 44m, Decl. 20° 19′ N. and transits at 15.15. It is a good evening star dominating the western sky. Greatest eastern elongation is on the 25th. At this time it appears like a half-moon in the telescope.

Mars on the 15th is in R.A. 5h 03m, Decl. 23° 16′ N. and transits at 11.33. It is too close to the sun for observation.

Jupiter on the 15th is in R.A. 0h 40m, Decl. 2° 58′ N. and transits at 7.08. It rises shortly after midnight and dominates the eastern sky the rest of the night.

For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 54.

Saturn on the 15th is in R.A. 11h 48m, Decl. 3° 50′ N. and transits at 18.15. It is in Virgo about half-way between Spica and Regulus. It is well past the meridian at sunset and sets before midnight.

Uranus on the 15th is in R.A. 6h 38m, Decl. 23° 29′ N. and transits at 13.05.

Neptune on the 15th is in R.A. 13h 05m, Decl. 5° 04′ S. and transits at 19.31.

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

	d	h	m	JUNE 75th Meridian Civil Time	Min. of Algol	Config. of Jupiter's Sat. 3h 30m
	d	h	m		h m	
Fri.	1			....	18 00	4O123
Sat.	2	15	51	☌ ☿ ☾ ☿ 7° 28′ S..............		421O3
Sun.	3			....		2O31*
Mon.	4	5	58	☌ ♂ ☾ ♂ 4° 41′ S..............	14 48	31O42
		11	40	● New Moon....................		
Tue.	5	20		Moon in Apogee. Dist. from ⊕, 252,600 mi..		3O214
Wed.	6	13	32	☌ ♅ ☾ ♅ 4° 16′ S..............		321O4
Thur.	7			....	11 37	O314*
Fri.	8	12	58	☌ ♀ ☾ ♀ 1° 04′ S..............		O234*
Sat.	9			....		21O34
Sun.	10			....	08 26	2O134
Mon.	11			....		31O24
Tue.	12	13	52	☽ First Quarter..................		34O21
Wed.	13	1	30	☌ ♄ ☾ ♄ 3° 52′ N..............	05 15	3421O
Thur.	14	15	52	☌ ♆ ☾ ♆ 4° 56′ N..............		4O1**
Fri.	15			....		4O23*
Sat.	16			....	02 04	d42O3
Sun.	17	16		□ ♄ ☉..............................		42O13
Mon.	18	3		☿ in ♌..........................	22 52	431O2
Tue.	19	7	36	○ Full Moon....................		34O12
		9		Moon in Perigee. Dist. from ⊕, 221,800 mi..		
		10		☌ ☿ ♂ ☿ 0° 16′ S..............		
Wed.	20			....		3214O
Thur.	21			....	19 41	2O14*
Fri.	22	0	25	☉ enters ♋, Summer commences. Long. of ☉, 90°		1O234
		18		☿ in Perihelion..................		
Sat.	23			....		ddO34
Sun.	24			....	16 30	2O134
Mon.	25	9		☌ ☿ ☉ Superior................		13O24
		12		♀ Greatest elongation E., 45° 25′....		
Tue.	26	1	21	☾ Last Quarter..................		3O124
		19	34	☌ ♃ ☾ ♃ 4° 14′ S..............		
Wed.	27			....	13 18	321O4
Thur.	28	5		☌ ☿ ♅ ☿ 1° 10′ N..............		23O14
Fri.	29	7		♆ Stationary in R.A..............		14O32
Sat.	30			....	10 07	4O213

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

THE SKY FOR JULY, 1951

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

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

The Sun—During July the sun's R.A. increases from 6h 36m to 8h 41m and its Decl. changes from 23° 11′ N. to 18° 17′ N. The equation of time changes from −3m 28s to a maximum of −6m 24s on the 27th and then to −6m 17s at the end of the month. On the 4th the earth is in aphelion or farthest from the sun. For changes in the length of the day, see p. 14.

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

Mercury on the 15th is in R.A. 8h 57m, Decl. +18° 47′ N. and transits at 13.31. It is poorly placed for observation all month.

Venus on the 15th is in R.A. 10h 29m, Decl. 9° 14′ N. and transits at 14.59. It is an evening star seen low in the west. About the 5th it is interestingly close to Regulus. Greatest brilliancy is on the 29th when it reaches stellar magnitude −4.2.

Mars on the 15th is in R.A. 6h 32m, Decl. 23° 58′ N. and transits at 11.03. It is too close to the sun for easy observation.

Jupiter on the 15th is in R.A. 0h 52m, Decl. 4° 05′ N. and transits at 5.22. It rises before midnight and dominates the eastern and southern sky the rest of the night.

For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 54.

Saturn on the 15th is in R.A. 11h 54m, Decl. 3° 07′ N. and transits at 16.22. It is in Virgo west of Spica, well down in the south-west at sunset and setting a few hours later.

Uranus on the 15th is in R.A. 6h 46m, Decl. 23° 21′ N. and transits at 11.15.

Neptune on the 15th is in R.A. 13h 05m, Decl. 5° 06′ S. and transits at 17.33.

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

	d	h	m	JULY 75th Meridian Civil Time	Min. of Algol h m	Config. of Jupiter's Sat. 2h 45m
Sun.	1			....		4203*
Mon.	2	4		☌ ♅ ☉		d4102
		23		Moon in Apogee. Dist. from ⊕, 252,600 mi..		
Tue.	3	0		☿ Greatest Hel. Lat. N.............	06 56	43012
		2	34	☌ ♂ ☾ ♂ 4° 11′ S..		
		22	39	☌ ♅ ☾ ♅ 4° 10′ S..		
Wed.	4	2	48	● New Moon....................		43120
		16		⊕ in Aphelion. Dist. from ☉, 94,459,000 mi.		
Thur.	5	2	40	☌ ☿ ☾ ☿ 1° 56′ S..		43201
		10		□ ♃ ☉		
Fri.	6			....	03 45	41032
Sat.	7			....		40123
Sun.	8	3	27	☌ ♀ ☾ ♀ 0° 34′ S..		21043
Mon.	9	15		□ ♆ ☉	00 33	d034*
Tue.	10	10	36	☌ ♄ ☾ ♄ 4° 09′ N..		30124
Wed.	11	23	27	☌ ♆ ☾ ♆ 5° 10′ N..	21 22	31204
		23	56	◐ First Quarter..................		
Thur.	12	7		♀ in ♉..........................		32014
Fri.	13			....		10324
Sat.	14			....	18 10	01234
Sun.	15			....		21043
Mon.	16			....		4013*
Tue.	17	18		Moon in Perigee. Dist. from ⊕, 222,600 mi..	14 59	4302*
Wed.	18	14	17	○ Full Moon....................		43120
Thur.	19	18		☌ ♂ ♅ ♂ 0° 26′ N..		43201
Fri.	20			....	11 48	41032
Sat.	21			....		40123
Sun.	22			....		42103
Mon.	23			....	08 36	42013
Tue.	24	7	19	☌ ♃ ☾ ♃ 4° 47′ S..		3042*
Wed.	25	13	59	☾ Last Quarter..................		d3104
Thur.	26	11		☿ in ♉..........................	05 25	32014
Fri.	27			....		13024
Sat.	28			Delta Aquarid meteors..................		01234
Sun.	29	1		♀ Greatest brilliancy.............	02 13	21034
Mon.	30	7		Moon in Apogee. Dist. from ⊕, 252,200 mi..		20134
Tue.	31	8	02	☌ ♅ ☾ ♅ 4° 09′ S..	23 02	31024
		22	39	☌ ♂ ☾ ♂ 3° 15′ S..		

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

THE SKY FOR AUGUST, 1951

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

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

The Sun—During August the sun's R.A. increases from 8h 41m to 10h 38m and its Decl. changes from 18° 17′ N. to 8° 40′ N. The equation of time changes from −6m 17s to −0m 20s. For changes in the length of the day, see p. 14.

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

Mercury on the 15th is in R.A. 10h 59m, Decl. 2° 40′ N. and transits at 13.26. It is an evening star, being at greatest eastern elongation on the 3rd but the elongation is unfavourable. Inferior conjunction is on the 31st.

Venus on the 15th is in R.A. 11h 08m, Decl. 0° 43′ S. and transits at 13.34. It is an evening star but very low in the west by sunset.

Mars on the 15th is in R.A. 8h 00m, Decl. 21° 34′ N. and transits at 10.29. It is in Gemini and Cancer. It rises about two hours before the sun and is not at all prominent.

Jupiter on the 15th is in R.A. 0h 54m, Decl. 4° 08′ N. and transits at 3.22. Rising a few hours after sunset, it is very prominent the rest of the night. On the 4th it is stationary in R.A. and begins to retrograde, that is, move westward among the stars.

For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 54.

Saturn on the 15th is in R.A. 12h 04m, Decl. 1° 56′ N. and transits at 14.31. It is in Virgo west of Spica, well down in the west at sunset and setting soon after.

Uranus on the 15th is in R.A. 6h 53m, Decl. 23° 13′ N. and transits at 9.20.

Neptune on the 15th is in R.A. 13h 06m, Decl. 5° 19′ S. and transits at 15.33.

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

					Min. of Algol	Config. of Jupiter's Sat. 2h 00m
				AUGUST 75th Meridian Civil Time		
	d	h	m		h m	
Wed.	1			....		d3042
Thur.	2	17	39	● New Moon....................		32401
Fri.	3	14		☿ Greatest elongation E., 27° 19′....	19 51	4102*
Sat.	4	16		♃ Stationary in R.A..............		40123
Sun.	5	1	45	☌ ☿ ☾ ☿ 2° 01′ S................		41203
		15	54	☌ ♀ ☾ ♀ 3° 41′ S................		
		17		☿ in Aphelion..................		
Mon.	6	20	37	☌ ♄ ☾ ♄ 4° 27′ N...............	16 39	42013
Tue.	7			....		41302
Wed.	8	6	01	☌ ♆ ☾ ♆ 5° 21′ N...............		43012
Thur.	9			....	13 28	3240*
Fri.	10	7	22	☽ First Quarter..................		3104*
		19		♀ Stationary in R.A..............		
Sat.	11			....		01324
Sun.	12			Perseid meteors........................	10 16	12034
		20		☌ ♇ ☉.....................................		
Mon.	13			....		20134
Tue.	14	23		Moon in Perigee. Dist. from ⊕, 225,000 mi..		d1024
Wed.	15	17		♀ in Aphelion..................	07 05	30124
Thur.	16	16		☿ Stationary in R.A..............		3204*
		21	59	○ Full Moon....................		
Fri.	17			....		32104
Sat.	18			....	03 53	40132
Sun.	19			....		41203
Mon.	20	15	58	☌ ♃ ☾ ♃ 5° 01′ S...............		42013
Tue.	21			....	00 42	41032
Wed.	22			....		43012
Thur.	23			....	21 31	43210
Fri.	24	5	20	☾ Last Quarter..................		d4320
Sat.	25			....		40132
Sun.	26	1		☿ Greatest Hel. Lat. S.............	18 19	d1403
		22		Moon in Apogee. Dist. from ⊕, 251,600 mi..		
Mon.	27	17	45	☌ ♅ ☾ ♅ 4° 08′ S...............		20143
Tue.	28			....		10234
Wed.	29	18	56	☌ ♂ ☾ ♂ 1° 52′ S...............	15 08	30124
Thur.	30			....		32104
Fri.	31	3		☌ ☿ ☉ Inferior..................		32014

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

THE SKY FOR SEPTEMBER, 1951

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

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

The Sun—During September the sun's R.A. increases from 10h 38m to 12h 26m and its Decl. changes from 8° 40′ N. to 2° 47′ S. The equation of time changes from −0m 20s to +9m 57s, the apparent sun passing to the west of the mean sun on the 2nd. On the 23rd at 15.38 E.S.T. the sun crosses the equator moving southward, enters the sign of Libra, and autumn commences. There is an annular eclipse of the sun on the 1st. For changes in the length of the day, see p. 15.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 22. The full moon of September 15th is the Harvest Moon

Mercury on the 15th is in R.A. 10h 22m, Decl. 10° 21′ N. and transits at 10.50. It is a morning star and near the time of greatest western elongation on the 16th it may be seen in the east near Regulus just before sunrise.

Venus on the 15th is in R.A. 10h 12m, Decl. 2° 32′ N. and transits at 10.37. Early in the month it is too close to the sun for observation, being in inferior conjunction on the 3rd. By the end of the month it may be seen as a morning star low in the east just before sunrise.

Mars on the 15th is in R.A. 9h 21m, Decl. 16° 43′ N. and transits at 9.48. It is in Cancer and Leo, rising a few hours before the sun; not prominent.

Jupiter on the 15th is in R.A. 0h 45m, Decl. 3° 03′ N. and transits at 1.11. It rises shortly after sunset and is prominent all night.

For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 54.

Saturn on the 15th is in R.A. 12h 17m, Decl. 0° 30′ N. and transits at 12.42. It is too close to the sun for observation. Conjunction is on the 29th.

Uranus on the 15th is in R.A. 6h 59m, Decl. 23° 07′ N. and transits at 7.24.

Neptune on the 15th is in R.A. 13h 10m, Decl. 5° 41′ S. and transits at 13.34.

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

	d	h	m	SEPTEMBER 75th Meridian Civil Time	Min. of Algol h m	Config. of Jupiter's Sat. 1h 15m
Sat.	1			Annular eclipse of ☉, see p. 29............	11 56	O324*
		0	48	☌ ☿ ☾ ☿ 4° 39′ S................		
		7	27	☌ ♀ ☾ ♀ 9° 23′ S................		
		7	49	● New Moon....................		
Sun.	2					1O234
Mon.	3	8	16	☌ ♄ ☾ ♄ 4° 43′ N................		2O143
		10		☌ ♀ ☉ Inferior.................		
Tue.	4	12	54	☌ ♆ ☾ ♆ 5° 25′ N................	08 45	14O23
Wed.	5			....		43O12
Thur.	6			....		4312O
Fri.	7	4		♀ Greatest Hel. Lat. S............	05 33	432O1
Sat.	8	13	16	☽ First Quarter..................		41O2*
		20		☿ Stationary in R.A..............		
Sun.	9			....		d4O23
Mon.	10			....	02 22	42O13
Tue.	11	15		Moon in Perigee. Dist. from ⊕, 228,200 mi..		41O3*
Wed.	12	8		☌ ☿ ♀ ☿ 8° 21′N................	23 11	3O412
Thur.	13			....		312O4
Fri.	14	2		☿ in ☊........................		32O14
Sat.	15	7	38	○ Full Moon....................	19 59	13O24
Sun.	16	11		☿ Greatest elongation W., 17° 53′...		dO234
		21	04	☌ ♃ ☾ ♃ 4° 54′ S................		
Mon.	17			....		2O134
Tue.	18	17		☿ in Perihelion..................	16 48	12O34
Wed.	19			....		3O124
Thur.	20			....		312O4
Fri.	21			....	13 36	324O1
Sat.	22	23	13	☾ Last Quarter..................		413O2
Sun.	23	2		♀ Stationary in R.A..............		4O123
		15	38	☉ enters ♎, Autumn commences. Long. of ☉, 180°........................		
		16		Moon in Apogee. Dist. from ⊕, 251,200 mi..		
Mon.	24	3	24	☌ ♅ ☾ ♅ 4° 03′ S................	10 25	42O3*
Tue.	25			....		421O3
Wed.	26			....		43O12
Thur.	27	15	32	☌ ♂ ☾ ♂ 0° 01′ S................	07 14	d431O
		23	40	☌ ♀ ☾ ♀ 7° 07′ S................		
Fri.	28	23		☿ Greatest Hel. Lat. N............		324O1
Sat.	29	6		☌ ♄ ☉..............................		31O24
Sun.	30	3	31	☌ ☿ ☾ ☿ 3° 46′ N................	04 02	O1324
		20	57	● New Moon.....................		
		21	59	☌ ♄ ☾ ♄ 5° 00′ N................		

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

THE SKY FOR OCTOBER, 1951

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

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

The Sun—During October the sun's R.A. increases from 12h 26m to 14h 22m and its Decl. changes from 2° 47′ S. to 14° 06′ S. The equation of time changes from +9m 57s to +16m 20s. For changes in the length of the day, see p. 15.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 22. The full moon of October 14th is the Hunter's Moon.

Mercury on the 15th is in R.A. 13h 22m, Decl. 7° 43′ S. and transits at 11.53. It is in superior conjunction on the 13th and it is too near the sun all month for observation.

Venus on the 15th is in R.A. 10h 38m, Decl. 5° 48′ N. and transits at 9.06. It is a morning star prominent in the eastern sky before sunrise. At this time it has a crescent shape when seen in the telescope.

Mars on the 15th is in R.A. 10h 34m, Decl. 10° 33′ N. and transits at 9.02. It is in Leo, passing within a degree of Regulus on the 3rd and moving east of it. It is fainter than Regulus, being of stellar magnitude 1.9.

Jupiter on the 15th is in R.A. 0h 30m, Decl. 1° 31′ N. and transits at 22.54 Already risen at sunset, it dominates the sky all night. Opposition is on the 2nd.

For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 54.

Saturn on the 15th is in R.A. 12h 31m, Decl. 0° 57′ S. and transits at 10.57. It is too close to the sun for easy observation.

Uranus on the 15th is in R.A. 7h 01m, Decl. 23° 04′ N. and transits at 5.28.

Neptune on the 15th is in R.A. 13h 14m, Decl. 6° 06′ S. and transits at 11.40.

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

				OCTOBER 75th Meridian Civil Time	Min. of Algol	Config. of Jupiter's Sat. 23h 45m
	d	h	m		h m	
Mon.	1	21	30	☌ ♆ ☾ ♆ 5° 26′ N.		d2034
Tue.	2	23		☍ ♃ ☉ Dist. from ⊕, 366,800,000 mi.		03124
Wed.	3				00 51	31024
Thur.	4					32014
Fri.	5				21 40	31024
Sat.	6	1		☌ ☿ ♄ ☿ 0° 35′ S.		40312
Sun.	7	2		Moon in Perigee. Dist. from ⊕, 229,900 mi.		42103
		19		□ ♅ ☉		
		19	00	☽ First Quarter		
Mon.	8				18 28	42013
Tue.	9					4032*
Wed.	10	14		♀ Greatest brilliancy		43102
Thur.	11				15 17	43201
Fri.	12	2		♃ Greatest Hel. Lat. S.		4310*
Sat.	13	5		☌ ♆ ☉		40312
		10		☌ ☿ ☉ Superior		
		11		☌ ☿ ♆ ☿ 0° 40′ S.		
		23	18	☌ ♃ ☾ ♃ 4° 36′ S.		
Sun.	14	19	51	🌕 Full Moon	12 06	12403
Mon.	15					20143
Tue.	16					10324
Wed.	17				08 54	31024
Thur.	18					32014
Fri.	19					31204
Sat.	20	16		♅ Stationary in R.A.	05 43	0124*
Sun.	21	12		Moon in Apogee. Dist. from ⊕, 251,300 mi.		12034
		12	10	☌ ♅ ☾ ♅ 3° 52′ S.		
Mon.	22			Orionid meteors		20413
		10		☿ in ☋		
		18	55	☾ Last Quarter		
Tue.	23				02 32	41023
Wed.	24					d4302
Thur.	25				23 21	43201
Fri.	26	11	49	☌ ♂ ☾ ♂ 2° 05′ N.		43120
		18	24	☌ ♀ ☾ ♀ 0° 02′ S.		
Sat.	27					4012*
Sun.	28	13	23	☌ ♄ ☾ ♄ 5° 22′ N.	20 10	d4103
Mon.	29	8	18	☌ ♆ ☾ ♆ 5° 30′ N.		42013
Tue.	30	8	54	● New Moon		41023
Wed.	31	6	55	☌ ☿ ☾ ☿ 3° 58′ N.	16 58	30142

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

THE SKY FOR NOVEMBER, 1951

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

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

The Sun—During November the sun's R.A. increases from 14h 22m to 16h 25m and its Decl. changes from 14° 06′ S. to 21° 39′ S. The equation of time changes from +16m 20s to a maximum of +16m 23s on the 4th and then to +11m 20s at the end of the month. For changes in the length of the day, see p. 16.

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

Mercury on the 15th is in R.A. 16h 31m, Decl. 24° 10′ S. and transits at 13.00. It is an evening star but even at greatest eastern elongation on the 28th it is poorly placed for observation.

Venus on the 15th is in R.A. 12h 21m, Decl. 0° 57′ S. and transits at 8.48. It is a morning star prominent in the south-eastern sky before sunrise. Greatest western elongation on the 14th. There is a close conjunction with Saturn on the morning of the 21st.

Mars on the 15th is in R.A. 11h 43m, Decl. 3° 33′ N. and transits at 8.09. It moves from Leo to Virgo during the month, rising shortly after midnight.

Jupiter on the 15th is in R.A. 0h 19m, Decl. 0° 27′ N. and transits at 20.42. It is well up in the east at sunset and sets several hours before dawn. On the 30th it is stationary in R.A. and resumes direct, or eastward, motion among the stars.

For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 55.

Saturn on the 15th is in R.A. 12h 44m, Decl. 2° 17′ S. and transits at 9.08 It is in Virgo west of Spica, rising a few hours before the sun. There is a close conjunction with Venus on the morning of the 21st.

Uranus on the 15th is in R.A. 7h 00m, Decl. 23° 07′ N. and transits at 3.25.

Neptune on the 15th is in R.A. 13h 18m, Decl. 6° 30′ N. and transits at 9.43.

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

				NOVEMBER 75th Meridian Civil Time	Min. of Algol	Config. of Jupiter's Sat. 22h 00m
	d	h	m		h m	
Thur.	1	17		☿ in Aphelion....................		3204*
Fri.	2	8		Moon in Perigee. Dist. from ⊕, 227,200 mi..		32104
		9		♂ Greatest Hel. Lat. N.............		
		11		♀ in ☊........................		
Sat.	3			....	13 47	30124
Sun.	4			....		10234
Mon.	5			....		20134
Tue.	6	1	59	☽ First Quarter..................	10 36	1034*
Wed.	7			....		30124
Thur.	8			....		32104
Fri.	9			....	07 25	d3420
Sat.	10	0	59	☌ ♃ ☾ ♃ 4° 22′ S................		43012
Sun.	11			....		41023
Mon.	12			....	04 14	42013
Tue.	13	10	52	○ Full Moon.....................		4103*
Wed.	14	4		♀ Greatest elongation W., 46° 39′...		d4012
Thur.	15			....	01 03	43120
Fri.	16			Leonid meteors.........................		32401
Sat.	17	19	14	☌ ♅ ☾ ♅ 3° 39′ S...............	21 52	3042*
Sun.	18	8		Moon in Apogee. Dist. from ⊕, 251,900 mi..		10234
Mon.	19			....		20134
Tue.	20			....	18 41	12034
Wed.	21	2		♃ in Perihelion..................		03124
		5		☌ ♀ ♄ ♀ 0° 38′ S...............		
		15	01	☾ Last Quarter..................		
Thur.	22	1		☿ Greatest Hel. Lat. S.............		31204
Fri.	23			....	15 30	32014
Sat.	24	6	26	☌ ♂ ☾ ♂ 4° 09′ N..............		3024*
Sun.	25	4	58	☌ ♄ ☾ ♄ 5° 51′ N...............		41032
		12	49	☌ ♀ ☾ ♀ 5° 47′ N..............		
		20	19	☌ ♆ ☾ ♆ 5° 43′ N..............		
Mon.	26			....	12 19	42013
Tue.	27			....		41203
Wed.	28	6		☿ Greatest elongation E., 21° 40′....		40312
		20	00	● New Moon.....................		
Thur.	29	11		☌ ♀ ♆ ♀ 0° 32′ N..............	09 08	d4310
Fri.	30	8		Moon in Perigee. Dist. from ⊕, 223,900 mi..		43201
		8	43	☌ ☿ ☾ ☿ 2° 22′ N..............		
		14		♃ Stationary in R.A...............		

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

THE SKY FOR DECEMBER, 1951

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

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

The Sun—During December the sun's R.A. increases from 16h 25m to 18h 41m and its Decl. changes from 21° 39′ S. to 23° 27′ S. at the solstice on the 22nd and then to 23° 06′ S. at the end of the month. The equation of time changes from +11m 20s to zero on the 25th and then to −3m 00s at the end of the month. For changes in the length of the day, see p. 16.

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

Mercury on the 15th is in R.A. 17h 48m, Decl. 22° 11′ S. and transits at 12.10. It is in inferior conjunction on the 16th but by the end of the month it is a fairly good morning star which might be seen low in the south-east just before sunrise.

Venus on the 15th is in R.A. 14h 26m, Decl. 11° 49′ S. and transits at 8.55. It is a morning star prominent in the south-eastern sky before sunrise.

Mars on the 15th is in R.A. 12h 45m, Decl. 3° 02′ S. and transits at 7.13. It is in Virgo just west of Spica, rising shortly after midnight. It has brightened appreciably and ends the year with stellar magnitude 1.3. See Saturn.

Jupiter on the 15th is in R.A. 0h 19m, Decl. 0° 34′ N. and transits at 18.44. It is prominently placed in the south-east at sunset and sets shortly after midnight.

For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 55.

Saturn on the 15th is in R.A. 12h 53m, Decl. 3° 12′ S. and transits at 7.20. It is in Virgo west of Spica, rising soon after midnight. Mars, moving eastward, overtakes Saturn on the 19th and passes within a degree south of it. At this time Saturn may be distinguished from Mars by its being slightly brighter.

Uranus on the 15th is in R.A. 6h 56m, Decl. 23° 13′ N. and transits at 1.23.

Neptune on the 15th is in R.A. 13h 21m, Decl. 6° 48′ S. and transits at 7.48.

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

				DECEMBER 75th Meridian Civil Time	Min. of Algol	Config. of Jupiter's Sat. 21h 00m
	d	h	m		h m	
Sat.	1			....		43102
Sun.	2			....	05 57	d4032
Mon.	3			....		2403*
Tue.	4			....		21043
Wed.	5	11	20	☽ First Quarter..................	02 46	01324
Thur.	6	7		♀ in Perihelion..................		31024
Fri.	7	5	26	☌ ♃ ☾ ♃ 4° 26′ S..............	23 35	32014
		6		☿ Stationary in R.A..............		
Sat.	8	19		♂ in Aphelion....................		3104*
Sun.	9			....		0124*
Mon.	10			....	20 24	2034*
Tue.	11	1		☿ in ☊..........................		21043
Wed.	12			Geminid meteors.........................		40123
Thur.	13	4	30	● Full Moon.....................	17 13	41302
Fri.	14			....		43201
Sat.	15	0	24	☌ ♅ ☾ ♅ 3° 32′ S..............		4310*
		16		☿ in Perihelion..................		
		22		Moon in Apogee. Dist. from ⊕, 252,400 mi..		
Sun.	16	22		☌ ☿ ☉ Inferior................	14 02	43012
Mon.	17			....		42103
Tue.	18			....		d4203
Wed.	19	8		☌ ♂ ♄ ♂ 0° 40′ S..............	10 51	40123
Thur.	20			....		13042
Fri.	21	9	37	☾ Last Quarter..................		32014
Sat.	22	11	01	☉ enters ♑, Winter commences. Long. of ☉, 270°..............................	07 40	31204
		18	27	☌ ♄ ☾ ♄ 6° 23′ N..............		
		21	37	☌ ♂ ☾ ♂ 5° 50′ N..............		
Sun.	23	7	26	☌ ♆ ☾ ♆ 6° 01′ N..............		30124
Mon.	24			....		12034
Tue.	25	8	48	☌ ♀ ☾ ♀ 7° 44′ N..............	04 29	d2034
		23		☿ Greatest Hel. Lat. N............		
Wed.	26			....		0234*
Thur.	27	0	35	☌ ☿ ☾ ☿ 7° 56′ N..............		d1024
		3		☿ Stationary in R.A..............		
		22		□ ♃ ☉..............................		
		23		♀ Greatest Hel. Lat. N............		
Fri.	28	6	43	● New Moon.....................	01 19	32041
		18		Moon in Perigee. Dist. from ⊕, 221,900 mi..		
Sat.	29			....		34120
Sun.	30			....	22 08	43012
Mon.	31			....		d4103

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

JANUARY

d	h	m	Sat.	Phen.
1	17	41	II	ER
2	19	07	IV	OD
3	18	10	III	Se
6	18	44	I	OD
7	18	19	I	Te
	19	19	I	Se
8	20	20	II	ER
10	18	22	III	Te
	18	54	III	SI
11	19	11	IV	Se
14	18	03	I	TI
	18	59	I	SI
15	18	14	II	OD
	18	26	I	ER
17	19	19	III	TI
19	19	49	IV	OR
24	18	23	II	Te
29	19	18	I	OD
	18	55	I	Te
31	18	21	II	TI

FEBRUARY

d	h	m	Sat.	Phen.
4	18	34	III	OD
6	18	40	I	TI
7	18	40	I	ER
15	18	20	III	Se

Jupiter being near the sun, phenomena of the Satellites are not given from February 22 to May 1.

MAY

d	h	m	Sat.	Phen.
7	4	17	I	ED
8	3	52	I	Se
9	4	30	III	ER
15	3	32	I	SI
16	3	59	I	OR
24	3	15	I	Te
27	4	16	III	TI
29	2	47	II	SI
31	2	50	II	OR
	3	00	I	TI
	4	02	I	Se

JUNE

d	h	m	Sat.	Phen.
3	3	28	III	SI
7	3	42	I	SI
14	2	52	II	ED
	3	03	III	OD
15	2	46	I	ED
16	2	17	I	Se
	2	45	II	Te
	3	35	I	Te
21	1	34	III	ED
23	1	58	I	SI
	2	42	II	Se
	2	48	II	TI
	3	19	I	TI
	4	11	I	Se
24	2	47	I	OR
30	2	35	II	SI
	3	52	I	SI

JULY

d	h	m	Sat.	Phen.
1	1	03	I	ED
2	1	18	III	TI
	1	54	I	Te
	2	43	II	OR
	3	52	III	Te
8	2	58	I	ED
9	0	14	I	SI
	1	37	I	TI
	2	25	III	Se
	2	26	I	Se
	3	47	I	Te
10	1	04	I	OR
15	1	53	IV	SI
	2	12	IV	Se
16	2	08	I	SI
	2	27	II	ED
	3	29	I	TI
	3	33	III	SI
	4	20	I	Se
17	2	57	I	OR
	23	51	II	Se
	23	59	II	TI
18	0	07	I	Te
	2	34	II	Te
20	1	51	III	OR
23	4	01	I	SI
24	1	15	I	ED
	23	46	II	SI
	23	49	I	TI
25	0	42	I	Se
	1	59	I	Te
	2	29	II	Se
	2	32	II	TI
	23	17	I	OR
26	23	32	II	OR
27	0	32	III	ER
	3	13	III	OD
31	3	09	I	ED

AUGUST

d	h	m	Sat.	Phen.
1	0	23	I	SI
	1	39	I	TI
	2	24	II	SI
	2	35	I	Se
	3	49	I	Te
2	1	07	I	OR
3	1	41	III	ED
	1	59	II	OR
	4	32	III	ER
6	23	01	III	Te
8	2	17	I	SI
	3	28	I	TI
	4	29	I	Se
	23	32	I	ED
9	2	57	I	OR
	22	57	I	Se
	23	27	II	ED
10	0	05	I	Te
	4	23	II	OR
11	23	16	II	Te
13	22	23	III	Se
14	0	20	III	TI
	2	38	III	Te
15	4	10	I	SI
16	1	27	I	ED
	4	45	I	OR
	22	39	I	SI
	23	43	I	TI
17	0	51	I	Se
	1	53	I	Te
	2	02	II	ED
	23	12	I	OR
18	23	07	II	TI
	23	39	II	Se
19	1	40	II	Te
20	23	36	III	SI
21	2	23	III	Se
	3	53	III	TI
23	3	21	I	ED
24	0	33	I	SI
	1	29	I	TI
	2	45	I	Se
	3	40	I	Te
	4	37	II	ED
	21	50	I	ED
25	0	59	I	OR
	21	14	I	Se
	22	06	I	Te
	23	34	II	SI
26	1	29	II	TI
	2	16	II	Se
	4	02	II	Te
27	22	15	II	OR
28	3	38	III	SI
31	2	27	I	SI
	3	15	I	TI
	4	39	I	Se
	21	14	III	OD
	23	31	III	OR
	23	44	I	ED

SEPTEMBER

d	h	m	Sat.	Phen.
1	2	45	I	OR
	20	55	I	SI
	21	42	I	TI
	23	08	I	Se
	23	52	I	Te
2	2	11	II	SI
	3	48	II	TI
	4	53	II	Se
	21	11	I	OR
3	20	29	II	ED
4	0	32	II	OR
7	4	21	I	SI
	5	00	I	TI
	21	48	III	ED
8	0	34	III	ER
	0	37	III	OD
	1	39	I	ED
	2	53	III	OR
	4	30	I	OR
	22	49	I	SI
	23	26	I	TI
9	1	02	I	Se
	1	37	I	Te
	4	49	II	SI
	20	08	I	ED
	22	56	I	OR
10	20	03	I	Te
	23	05	II	ED
11	2	48	II	OR
12	20	48	II	Se
	21	47	II	Te
15	1	50	III	ED
	3	34	I	ED
16	0	43	I	SI
	1	10	I	TI
	2	56	I	Se
	3	21	I	Te
	22	03	I	ED
17	0	40	I	OR
	19	36	I	TI
	21	25	I	Se
	21	47	I	Te
18	1	40	II	ED
	5	03	II	OR
	19	41	III	Te
19	20	44	II	SI
	21	29	II	TI
	23	25	II	Se
20	0	03	II	Te
23	2	38	I	SI
	2	54	I	TI
	4	50	I	Se
	5	05	I	Te
	23	58	I	ED
24	2	24	I	OR
	21	06	I	SI
	21	20	I	TI
	23	19	I	Se
	23	31	I	Te
25	4	16	II	ED
	20	40	III	TI
	20	50	I	OR
	22	24	III	Se
	22	57	III	Te
26	23	22	II	SI
	23	43	II	TI
27	2	02	II	Se
	2	18	II	Te
28	20	24	II	OR
30	4	32	I	SI
	4	37	I	TI

OCTOBER

d	h	m	Sat.	Phen.
1	1	52	I	ED
	4	08	I	OR
	23	01	I	SI
	23	03	I	TI
2	1	14	I	Se
	1	14	I	Te
	20	21	I	ED
	22	34	I	ER
	23	44	III	SI
	23	54	III	TI
3	2	14	III	Te
	2	26	III	Se
	19	40	I	Te
	19	42	I	Se
4	1	58	II	TI
	1	59	II	SI
	4	32	II	Te
	4	39	II	Se
5	20	03	II	OD
	22	50	II	ER
8	3	40	I	OD
9	0	47	I	TI
	0	56	I	SI
	2	58	I	Te
	3	08	I	Se
	22	06	I	OD
10	0	29	I	ER
	3	09	III	TI
	3	46	III	SI
	19	12	I	TI
	19	24	I	SI
	21	24	I	Te
	21	37	I	Se
11	4	12	II	TI
	4	36	II	SI
	18	58	I	ER
12	22	17	II	OD
13	1	26	II	ER
	20	38	III	ER
14	19	55	II	Te
	20	34	II	Se
16	2	30	I	TI
	2	51	I	SI
	23	50	I	OD
17	2	24	I	ER
	20	56	I	TI
	21	19	I	SI
	23	08	I	Te
	23	32	I	Se
18	18	17	I	OD
	20	53	I	ER
19	18	01	I	Se
20	0	31	II	OD

d	h	m	Sat.	Phen.
	4	02	II	ER
	20	12	III	OD
21	0	39	III	ER
	19	35	II	TI
	20	33	II	SI
	22	10	II	Te
	23	11	II	Se
24	1	34	I	OD
	22	41	I	TI
	23	15	I	SI
25	0	53	I	Te
	1	27	I	Se
	20	01	I	OD
	22	48	I	ER
26	19	19	I	Te
	19	56	I	Se
27	2	47	II	OD
	23	31	III	OD
28	2	01	III	OR
	2	02	III	ED
	21	51	II	TI
	23	10	II	SI
29	0	28	II	Te
	1	47	II	Se
30	19	57	II	ER
31	3	20	I	OD
	18	30	III	Se

NOVEMBER

d	h	m	Sat.	Phen.
1	0	27	I	TI
	1	10	I	SI
	2	38	I	Te
	21	46	I	OD
2	0	44	I	ER
	18	53	I	TI
	19	39	I	SI
	21	05	I	Te
	21	51	I	Se
3	19	12	I	ER
4	2	54	III	OD
5	0	10	II	TI
	1	47	II	SI
	2	47	II	Te
6	18	14	II	OD
	22	35	II	ER
7	18	59	III	Te
	19	55	III	SI
	22	31	III	Se
8	2	13	I	TI
	17	42	II	Se
	23	33	I	OD
9	2	39	I	ER
	20	40	I	TI
	21	34	I	SI
	22	52	I	Te
	23	46	I	Se
10	18	00	I	OD
	21	08	I	ER
11	18	15	I	Se
12	2	30	II	TI
13	20	35	II	OD
14	1	12	II	ER
	19	56	III	TI
	22	30	III	Te
	23	57	III	SI
15	17	43	II	SI
	18	19	II	Te
	20	19	II	Se
16	1	21	I	OD
	22	28	I	TI
	23	30	I	SI
17	0	40	I	Te
	1	42	I	Se
	19	48	I	OD
	23	03	I	ER
18	17	59	I	SI
	19	08	I	Te
	20	10	I	Se
19	17	32	I	ER
20	22	59	II	OD
21	23	30	III	TI
22	18	06	II	TI
	20	20	II	SI
	20	43	II	Te
	22	55	II	Se
24	0	18	I	TI
	1	26	I	SI
	21	37	I	OD
25	0	58	I	ER
	18	12	III	ED
	18	46	I	TI
	19	55	I	SI
	20	46	III	ER
	20	57	I	Te
	22	06	I	Se
26	19	27	I	ER
28	1	25	II	OD
29	20	32	II	TI
	22	57	II	SI
	23	10	II	Te

DECEMBER

d	h	m	Sat.	Phen.
1	19	47	II	ER
	23	28	I	OD
2	19	52	III	OR
	20	37	I	TI
	21	50	I	SI
	22	14	III	ED
	22	49	I	Te
3	0	02	I	Se
	0	47	III	ER
	17	56	I	OD
	21	23	I	ER
4	18	31	I	Se
6	23	01	II	TI
8	22	25	II	ER
9	20	57	III	OD
	22	29	I	TI
	23	41	III	OR
	23	46	I	S1
10	0	41	I	Te
	17	26	II	Se
	19	48	I	OD
	23	18	I	ER
11	18	15	I	SI
	19	09	I	Te
	20	26	I	Se
12	17	47	I	ER
13	18	39	III	Se
15	19	43	II	OD
17	17	27	II	Te
	17	29	II	SI
	20	02	II	Se
	21	42	I	OD
18	18	51	I	TI
	20	11	I	SI
	21	03	I	Te
	22	22	I	Se
19	19	42	I	ER
20	17	23	III	Te
	20	13	III	SI
	22	41	III	Se
22	22	19	II	OD
24	17	24	II	TI
	20	02	II	Te
	20	06	II	SI
	22	38	II	Se
	23	36	I	OD
25	20	46	I	TI
	22	07	I	SI
	22	59	I	Te
26	18	05	I	OD
	21	38	I	ER
27	17	28	I	Te
	18	39	III	TI
	18	47	I	Se
	21	24	III	Te
31	20	00	II	TI
	22	39	II	Te
	22	42	II	SI

E—eclipse, O—occultation, T—transit, S—shadow, D—disappearance, R—reappearance, I—ingress, e—egress; 75th Meridian Civil Time. (For other times see p. 8.)

LUNAR OCCULTATIONS

Prepared by J. F. Heard

When the moon passes between the observer and a star that star is said to be occulted by the moon and the phenomenon is known as a lunar occultation The passage of the star behind the east limb of the moon is called the immersion and its appearance from behind the west limb the emersion. As in the case of eclipses, the times of immersion and emersion and the duration of the occultation are different for different places on the earth's surface. The tables given below, adapted from the 1951 Nautical Almanac, give the times of immersion or emersion or both for occultations of stars of magnitude 4.5 or brighter visible at Toronto and at Montreal and also at Vancouver and Calgary, at night. Emersions at the bright limb of the moon are given only in the case of stars brighter than magnitude 3.5. The terms a and b are for determining corrections to the times of the phenomena for stations within 300 miles of the standard stations. Thus if λ_0, ϕ_0, be the longitude and latitude of the standard station and λ, ϕ, the longitude and latitude of the neighbouring station then for the neighbouring station we have—

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

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

LUNAR OCCULTATIONS VISIBLE AT TORONTO AND MONTREAL, 1951

Date	Star	Mag.	I or E	Age of Moon	Toronto E.S.T.	Toronto a	Toronto b	Toronto P	Montreal E.S.T.	Montreal a	Montreal b	Montreal P
				d	h m	m	m	°	h m	m	m	°
Jan. 17	η Tau	3.0	I	10.1	17 10.4	—	—	135	Graze	...	...	...
17	η Tau	3.0	E	10.1	17 35.2	—	—	173	Graze	...	...	...
Feb. 7	Venus	-3.3	I	1.6	17 58.8	−1.3	−2.8	107	18 00.4	−1.0	−2.7	106
7	Venus	-3.3	E	1.6	18 40.7	+0.3	+2.1	184	Low	.....	.....	.....
Apr. 9	20 Tau	4.0	I	3.5	Sun	.....	.....	.....	18.41.5	−0.3	−3.3	129
Jun. 7	κ Gem	3.7	I	3.3	20 45.0	+0.4	−2.0	135	20 39.4	+0.4	−1.8	126
10	α Leo	1.3	I	6.3	20 14.5	−0.5	−2.3	143	20 13.4	−0.5	−2.1	133
10	α Leo	1.3	E	6.3	21 19.3	−0.6	−1.7	286	21 18.8	−0.4	−1.9	294
23	δ Cap	3.0	E	18.6	0 42.6	−1.1	+1.4	258	0 52.3	−1.3	+1.3	257
Aug. 16	δ Cap	3.0	E	14.2	21 04.4	−1.0	+1.8	225	21 13.8	−1.1	+1.7	224
18	λ Aqr	3.8	I	15.4	3 48.6	−1.1	−0.2	65	3 54.3	−1.0	−0.5	68
18	λ Aqr	3.8	E	15.4	4 53.4	−0.5	+0.3	222	Sun	.....	.....	.....
24	q Tau	4.4	I	21.4	0 44.6	−0.2	+1.6	79	0 49.3	−0.4	+1.6	83
24	20 Tau	4.0	I	21.4	1 07.9	−1.2	+0.6	120	1 17.1	—	—	129
24	20 Tau	4.0	E	21.4	1 45.6	+0.7	+3.3	192	1 47.1	—	—	182
24	q Tau	4.4	E	21.4	1 46.9	−0.3	+2.1	233	1 52.8	−0.3	+2.3	228
Oct. 7	τ Sgr	3.4	I	6.9	19 33.6	−1.5	−0.2	68	19 40.9	−1.3	−0.5	72
11	λ Aqr	3.8	I	11.0	20 45.2	0.0	+2.6	358	20 50.6	−0.3	+2.0	7
17	η Tau	3.0	E	17.0	Low	.....	.....	.....	19 16.8	+1.2	+2.7	185
25	α Leo	1.3	I	24.4	5 54.9	−1.3	−0.8	135	6 01.6	−1.4	−0.5	123
25	α Leo	1.3	E	24.4	7 15.1	−1.8	−0.5	293	7 23.2	−1.5	−1.2	307
Dec. 15	κ Gem	3.7	I	17.2	20 11.0	—	—	29	20 11.7	+1.0	+4.1	32
15	κ Gem	3.7	E	17.2	20 35.0	—	—	343	20 39.6	−1.4	−1.9	340

LUNAR OCC LTATIONS VISIBLE AT VANCOUVER AND CALGARY, 1951

Date	Star	Mag.	I or E	Age of Moon	Vancouver P.S.T.	Vancouver a	Vancouver b	Vancouver P	Calgary M.S.T.	Calgary a	Calgary b	Calgary P
				d	h m	m	m	°	h m	m	m	°
Jan. 11	ϕ Aqr	4.4	I	4.2	17 37.6	−1.6	−0.6	82	18 50.1	−1.4	−1.4	93
Feb. 7	Venus	-3.3	I	1.6	14 07.1	−0.6	+1.4	20	15 15.5	−0.8	+0.8	32
7	Venus	-3.3	E	1.6	15 16.8	−1.7	−0.6	262	16 29.2	−1.2	−0.6	251
13	q Tau	4.4	I	7.9	22 52.1	−0.6	−1.3	80	23 55.6	−0.5	−1.0	68
13-14	20 Tau	4.0	I	7.9	23 13.0	−0.2	−2.2	108	0 11.9	−0.1	−1.8	96
May 14	ρ Leo	3.8	I	9.2	22 28.5	−0.7	−1.9	124	23 31.8	−0.6	−1.9	113
July 30	136 Tau	4.5	E	26.1	Low	.....	.....	.....	2 43.9	+0.5	+1.5	253
Aug. 11	τ Scr	2.9	I	9.2	20 11.3	−1.6	−0.3	77	Low	.....	.....	.....
18	λ Aqr	3.8	I	15.4	No occ.	.....	.....	.....	1 38.9	—	—	338
18	λ Aqr	3.8	E	15.4	No occ.	.....	.....	.....	1 57.0	—	—	308
23	q Tau	4.4	E	21.4	Low	.....	.....	.....	23 53.0	0.0	+1.3	284
23-24	20 Tau	4.0	E	21.4	23 08.9	+0.3	+1.5	255	0 08.8	+0.2	+1.7	249
Oct. 10	ι Aqr	4.4	I	10.1	18 58.8	−1.6	+1.0	96	20 16.1	−2.0	+0.3	107
20	136 Tau	4.5	I	19.3	0 04.6	—	—	145	Graze	.....	.....	.....
20	136 Tau	4.5	E	19.3	0 37.9	—	—	200	Graze	.....	.....	.....
25	α Leo	1.3	I	24.4	2 21.2	−0.2	+0.6	121	3 24.9	−0.4	+0.7	120
25	α Leo	1.3	E	24.4	3 24.5	−0.5	+1.1	286	4 31.6	−0.8	+0.8	291

METEORS AND METEORITES

By Peter M. Millman

A meteor or "shooting star" appears when one of the larger particles comprising the dust of space happens to encounter the earth's atmosphere at high velocity. In general the particle is completely vapourized high in the upper atmosphere but occasionally it is large enough so that a portion reaches the earth's surface, and this solid lump of iron or stone is known as a meteorite. The study of meteors and meteorites contributes a large amount of valuable information concerning the nature and origin of the universe and there are many intriguing problems in this field awaiting solution. The amateur can do work of lasting value here, as the large and very expensive instrumental equipment required for most astronomical research is not needed for the study of meteors.

For any given observation point there is no way of predicting in advance just where the next meteor will appear, in other words, it is chiefly a matter of chance whether it appears north, south, east, west, or directly overhead. Taking an overall average for the whole year and all parts of the night a single observer with an unobstructed view of the sky will see 10 meteors per hour on a clear moonless night. This statement must be qualified by the fact that meteors are roughly twice as numerous during the second half of the night as they are during the first, and their rate of appearance is approximately doubled for the second half of the year as compared with the first six months. There is also a great variation in meteor frequency from one night to the next. The observed meteors range in brightness all the way from those only visible in fairly large telescopes up to great fireballs exceeding the full moon in luminosity. The frequency of meteors increases approximately in inverse proportion to their brightness.

In addition to the stray so-called "sporadic" meteors which appear on any night of the year, there are various swarms of meteors, each swarm moving along in its particular elliptical orbit about the sun. In most cases these meteor orbits are found to correspond closely with those of certain comets. When the earth encounters such a swarm of meteors the apparent paths, when projected backwards in the sky, all seem to meet in a point, a result of perspective. This point indicates the direction from which the meteors are coming and is called the "radiant". The meteor shower is commonly called after the constellation in which the radiant is located. The best known meteor showers are listed in the accompanying table which has been compiled from various sources. Of these showers the Perseids and Geminids are the most consistent. Some, such as the Leonids, Giacobinids, and Bielids, have provided spectacular displays in certain years and in others have been almost or totally absent. The Bielids have scarcely been observed at all since the 19th century; the Giacobinids were first observed in 1933. The hourly number listed in the table is the approximate number of meteors which are likely to be seen in one hour by a single observer on a clear moonless night at the shower maximum in a normal year.

Amateur cooperation assists greatly in the scientific study of meteors. Visual observations may be divided into two types:

(a) *Systematic programs.* These may be carried out either by a single observer or by groups of observers. In this case the sky is observed continuously for a period of time and the numbers of meteors seen, their brightness, colour, position, and other characteristics recorded. Plotting the observations on a star map is more important when the program is carried out in cooperation with another party observing some distance away.

(b) *The chance observation of a bright meteor or fireball.* Any meteor markedly brighter than Jupiter (mag. −2) should be carefully recorded and the observation forwarded to some observatory where meteor records are being kept. In this case it is very important to note the position of the meteor in the sky, as well as

Continued on page 80.

PRINCIPAL ELEMENTS OF THE SOLAR SYSTEM

ORBITAL ELEMENTS (1944, Dec. 31, 12^{h})

Planet	Mean Distance from Sun (a)		Period	Eccentricity	Inclination	Long. of Node	Long. of Perihelion	Mean Long. of Planet
	⊕ = 1	millions of miles	(P)	(e)	(i)	(☊)	(π)	
					°	°	°	°
Mercury.......	.387	36.0	88.0days	.206	7.0	47.6	76.5	120.5
Venus.........	.723	67.2	224.7	.007	3.4	76.1	130.7	36.0
Earth..........	1.000	92.9	365.3	.017	....	.....	101.9	99.8
Mars..........	1.524	141.5	687.0	.093	1.9	49.1	334.9	267.4
Jupiter........	5.203	483.3	11.86yrs.	.048	1.3	99.8	13.3	164.4
Saturn.........	9.54	886.	29.46	.056	2.5	113.1	91.8	97.1
Uranus........	19.19	1783.	84.0	.047	0.8	73.7	169.7	76.8
Neptune.......	30.07	2793.	164.8	.009	1.8	131.1	44.1	184.0
Pluto..........	39.46	3666.	247.7	.249	17.1	109.5	223.4	158.3

PHYSICAL ELEMENTS

Object	Symbol	Mean Diameter miles	Mass ⊕ = 1	Density water = 1	Axial Rotation	Mean Surface Gravity ⊕ = 1	Albedo Bond's	Magnitude at Opposition or Elongation
Sun........	☉	864,000	332,000	1.4	$24^{d}.7$ (equatorial)	27.9		− 26.7
Moon.......	☾	2,160	.0123	3.3	$27^{d}\ 7.7^{h}$	.16	.07	− 12.6
Mercury....	☿	3,010	.056	3.8	88^{d}	.27	.07	0±
Venus......	♀	7,580	.82	4.9	30^{d} ?	.85	.59	− 4±
Earth......	⊕	7,918	1.00	5.5	$23^{h}\ 56^{m}$	1.00	.29	
Mars.......	♂	4,220	.108	4.0	$24^{h}\ 37^{m}$	.38	.15	− 2±
Jupiter.....	♃	87,000	318.	1.3	$9^{h}\ 50^{m}\pm$	2.6	.56?	− 2±
Saturn......	♄	72,000	95.	.7	$10^{h}15^{m}\pm$	1.2	.63?	0±
Uranus.....	♅	31,000	14.6	1.3	$10^{h}.8\pm$	.9	.63?	+ 5.7
Neptune....	♆	33,000	17.2	1.3	16^{h} ?	1.0	.73?	+ 7.6
Pluto.......	♇	4,000?	.8 ?					+ 14

SATELLITES OF THE SOLAR SYSTEM

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

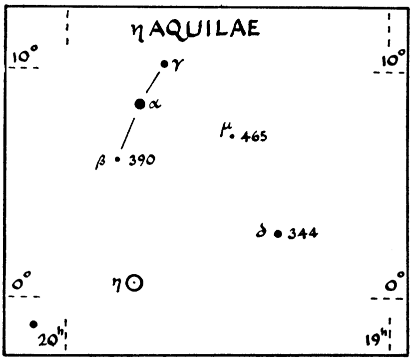
***As seen from the sun.**

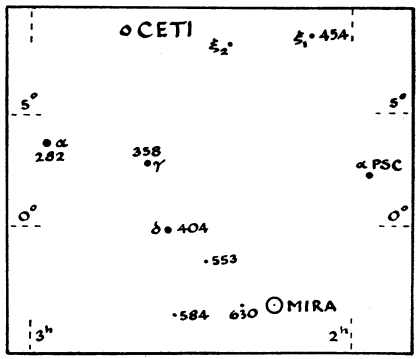
Satellites Io, Europa, Ganymede, Callisto are usually denoted I, II, III, IV respectively, in order of distance from the planet.

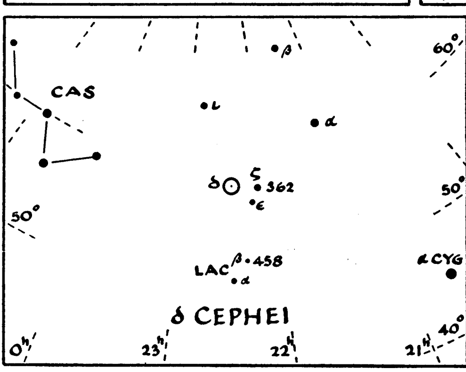
VARIABLE STARS

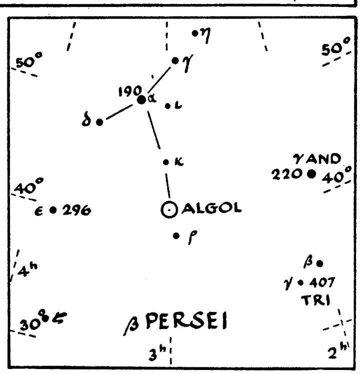
Much pleasure may be derived from the estimation of the brightness of variable stars. Maps of the fields of four bright variable stars are given below. In each case the magnitudes of several suitable comparison stars are given. These magnitudes are given as magnitudes, tenths and hundredths, with the decimal point omitted. Thus a star 362 is of magnitude 3.62. To determine the brightness of the variable at any time, carefully estimate the brightness as some fraction of the interval between two comparison stars, one brighter and one fainter than the variable. The result may then be expressed in magnitudes and tenths. Record the magnitude and time of observation. When a number of observations have been made, a graph may be plotted showing the magnitude estimate as ordinates against the date (days and tenths of a day) as abscissae. Such studies of naked-eye estimates of brightness will at once reveal the differences in variation between the different kinds of variable. For each short period variable the observations made on any one cycle may be carried forward one, two or any number of periods to form a combined light curve.

For the two cepheids, good mean curves may be readily found by observing the variables once a night on as many nights as possible. For Algol, which changes rapidly for a few hours before and after minimum, estimates should be made at quarter or half hour intervals around the times of minimum as tabulated on pages 31-53. Mira may be observed for a couple of months as it rises from the naked-eye limit to 2nd or 3rd magnitude maximum and fades again.









REPRESENTATIVE BRIGHT VARIABLE STARS

Name	Design.	Max.	Min.	Sp.	Period	Type	Date	Discoverer
η Aql	194700	3.7	4.4	G4	7.17652	Cep	1784	Pigott
N Aql	184300	-0.2	10.9	Q	Irr.	Nova	1918	Bower
ε Aur	045443	3.3	4.1	F5p	9833.	Ecl	1821	Fritsch
δ Cep	222557	3.6	4.3	G0	5.36640	Cep	1784	Goodricke
U Cep	005381	6.8	9.2	A0	2.49293	Ecl	1880	W. Ceraski
ο Cet[1]	0214*03*	2.0	10.1	M5e	331.8	LPV	1596	Fabricius
RR Cet	012700	8.4	9.0	F0	0.55304	Clus	1906	Oppolzer
R CrB	154428	5.8	13.8	cG0e	Irr.	RCrB	1795	Pigott
χ Cyg	194632	4.2	14.0	M7e	412.9	LPV	1686	Kirch
P Cyg	201437a	3.5	6.0	B1qk	Irr.	Nova	1600	Blaeu
SS Cyg	213843	8.1	12.0	Pec.	Irr.	SSCyg	1896	Wells
XX Cyg	200158	11.4	12.1	A	0.13486	Clus	1904	L. Ceraski
ζ Gem	065820	3.7	4.1	cG1	10.15353	Cep	1847	Schmidt
η Gem	060822	3.3	4.2	M2	235.58	LPV	1865	Schmidt
R Gem	070122a	6.5	14.3	Se	370.1	LPV	1848	Hind
U Gem	074922	8.8	13.8	Pec.	Irr.	SSCyg	1855	Hind
α Her	171014	3.1	3.9	M5	Irr.	SemiR	1795	W. Herschel
R Hya	1324*22*	3.5	10.1	M7e	414.7	LPV	1670	Montanari
R Leo	094211	5.0	10.5	M7e	310.3	LPV	1782	Koch
β Lyr	184633	3.4	4.3	B5e	12.92504	Ecl	1784	Goodricke
RR Lyr	192242	7.2	8.0	A5	0.56685	Clus	1901	Fleming
α Ori[2]	054907	0.2	1.2	M2	2070. Irr.	SemiR	1840	J. Herschel
U Ori	054920	5.4	12.2	M7e	376.9	LPV	1885	Gore
β Per[3]	030140	2.3	3.5	B8	2.86731	Ecl	1669	Montanari
ρ Per	025838	3.3	4.1	M4	Irr.	Irr.	1854	Schmidt
R Sge	200916	8.6	10.4	cG7	70.84	SemiR	1859	Baxendell
R Sct	1842*05*	4.5	9.0	K5e	141.5	SemiR	1795	Pigott
λ Tau	035512	3.8	4.1	B3	3.95294	Ecl	1848	Baxendell
RV Tau	044126	9.4	12.5	K0	78.60	SemiR	1905	L. Ceraski
SU Tau	054319	9.5	15.4	G0e	Irr.	RCrB	1908	Cannon
α UMi[4]	012288	2.3	2.4	cF7	3.96858	Cep	1911	Hertzsprung
N Her	180445	1.5	14.0	Q	Irr.	Nova	1934	Prentice
N Lac	221255	2.2	—	Q	Irr.	Nova	1936	Peltier

[1]οCet (Mira); [2]αOri (Betelgeuse); [3]βPer (Algol); [4]αUMi (Polaris).

The designation (Harvard) gives the 1900 position of the variable; here the first two figures give the hours, and the next two figures the minutes of R.A., while the last two figures give the declination in degrees, italicised for southern declinations. Thus the position of the fourth star of the list, δ Cep (222557) is R.A. 22h 25m, Dec. + 57°. The period is in days and decimals of a day. The type is based on the classification of Gaposchkin and Gaposchkin's comprehensive text-book, *Variable Stars*. The abbreviations here used are: Ecl, Eclipsing Binaries; LPV, Long Period Variables; Semi R, Semiregular; Cep, Cepheids; Clus, cluster type; Nova; SS Cyg and R Cr B, irregular variables of which SS Cygni and R Coronae Borealis are prototypes; and Irr, other irregular variables.

DOUBLE AND MULTIPLE STARS

A number of the stars which appear as single to the unaided eye may be separated into two or more components by field glasses or a small telescope. Such objects are spoken of as *double* or *multiple stars*. With larger telescopes pairs which are still closer together may be resolved, and it is found that, up to the limits of modern telescopes, over ten per cent. of all the stars down to the ninth magnitude are members of double stars.

The possibility of resolving a double star of any given separation depends on the diameter of the telescope objective. Dawes' simple formula for this relation is $d''=4.5/A$, where d is the separation, in seconds of arc, of a double star that can be just resolved, and A is the diameter of the objective in inches. Thus a one-inch telescope should resolve a double star with a distance of $4''.5$ between its components, while a ten-inch telescope should resolve a pair $0''.45$ apart. It should be noted that this applies only to stars of comparable brightness. If one star is markedly brighter than its companion, the glare from the brighter makes it impossible to separate stars as close as the formula indicates. This formula may be applied to the observation of double stars to test the quality of the seeing and telescope.

It is obvious that a star may appear double in one of two ways. If the components are at quite different distances from the observer, and merely appear close together in the sky the stars form an *optical* double. If, however, they are in the same region of space, and have common proper motion, or orbital motion about one another, they form a *physical* double. An examination of the probability of stars being situated sufficiently close together in the sky to appear as double shows immediately that almost all double stars must be physical rather than optical.

Double stars which show orbital motion are of great astrophysical importance, in that a careful determination of their elliptical orbits and parallaxes furnishes a measure of the gravitational attraction between the two components, and hence the mass of the system.

In the case of many unresolvable close doubles, the orbital motion may be determined by means of the spectroscope. In still other doubles, the observer is situated in the orbital plane of the binary, and the orbital motion is shown by the fluctuations in light due to the periodic eclipsing of the components. Such doubles are designated as *spectroscopic* binaries and *eclipsing* variables.

The accompanying table provides a list of double stars, selected on account of their brightness, suitability for small telescopes, or particular astrophysical interest. The data are taken chiefly from Aitken's *New General Catalogue of Double Stars*, and from the Yale *Catalogue of Bright Stars*. Successive columns give the star, its 1950 equatorial coordinates, the magnitudes and spectral classes of its components, their separation, in seconds of arc, and the approximate distance of the double star in light years. The last column gives, for binary stars of well determined orbits, the period in years, and the mean separation of the components in astronomical units. For stars sufficiently bright to show colour differences in the telescope used, the spectral classes furnish an indication of the colour. Thus O and B stars are bluish white, A and F white, G yellow, K orange and M stars reddish.

A good reference work in the historical, general, and mathematical study of double stars is Aitken's *The Binary Stars*.

REPRESENTATIVE DOUBLE STARS

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

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

THE BRIGHTEST STARS†

Their Magnitudes, Types, Proper Motions, Distances and Radial Velocities

The accompanying table contains the principal facts regarding 259 stars brighter than apparent magnitude 3.51 which it is thought may be of interest to our amateur members. The various columns should be self-explanatory but some comments may be in order.

The first column gives the name of the star and if it is preceded by the sign || such means that the star is a visual double and the combined magnitude is entered in the fourth column. Besides the 48 thus indicated there are 12 others on the list with faint companions but for these it is not thought that there is any physical connection. In the case of the 20 stars variable in light this fourth column shows their maximum and minimum magnitudes. The 19 first magnitude stars are set up in bold face type.

In the fifth column are given the types as revised at various observatories—principally at our own, but omitting the *s* and *n* designations descriptive of the line character. The annual proper motion follows in the next column and this may not necessarily be correct to the third decimal place.

The parallaxes are taken from the Yale Catalogue of Stellar Parallaxes 1935, the mean of the trigonometric and spectroscopic being adopted. The few negative trigonometric parallaxes were adjusted by Dyson's tables before being combined with the spectroscopic. The distance is given also in light years in the eighth column as to the lay mind that seems a fitting unit. The absolute magnitudes in the ninth column are the magnitudes the stars would have if all were at a uniform distance of 32.6 light years ($\pi = 0.''1$). At that distance the sun would appear as a star of magnitude 4.8.

The radial velocities in the last column have been taken from Vol. 18 of the Lick Publications. An asterisk * following the velocity means that such is variable. In these cases the velocity of the system, if known, is given; otherwise a mean velocity for the observations to date is set down.

Of the 259 stars or star systems here listed 146 are south and 113 north of the equator. This is to be expected from the fact that the northern half of the sky includes less of the Milky Way than the southern.

The number in each spectral class, apart from the one marked peculiar, is as follows: O, 3; B, 74; A, 55; F, 22; G, 43, K, 42 and M, 19. The B-stars are intrinsically luminous and appear in this list out of all proportion to their total number. The stars in Classes A and K are by far the most numerous but the revision of types throws many originally labelled K back into the G group.

From the last column we see that 98 velocities are starred, indicating that 38 per cent of the bright stars, or at least one in every three, are binary in character. For visual binaries the proportion has usually been listed as one in nine. Our list shows one in six but it is only natural to expect that we would observe a higher proportion among the nearby stars, such as these are on the average.

Other relationships can be established from the list if our amateur members care to study it.

†This feature of the HANDBOOK, first appearing in the 1925 edition, was prepared and frequently revised by the late Dr. W. E. Harper (1878-1940).

Star	R.A. 1950	Decl. 1950	Mag.	Type	Ann. Proper Motion	Parallax	Distance in Light Years	Abs. Mag.	Rad. Vel.
	h m	° ′			″	″			km./sec.
α Andr.......	0 6	+28 49	2.2	A1	.217	.034	96	−0.1	−13.0*
β Cass........	6	+58 52	2.4	F2	.561	.080	41	1.9	+11.4
γ Pegs........	11	+14 54	2.9	B2	.015	.005	652	−3.6	+ 5.0*
β Hydi.......	23	−77 32	2.9	G0	2.243	.162	21	4.0	+22.8
α Phoe........	24	−42 35	2.4	G5	.448	.040	81	0.4	+74.6*
δ Andr........	37	+30 35	3.5	K3	.167	.026	125	0.6	− 7.1*
α Cass........	38	+56 16	2.2–2.8	G8	.062	.018	181	−1.5	− 3.8
β Ceti........	41	−18 16	2.2	G7	.233	.052	63	0.8	+13.1
‖γ Cass........	54	+60 27	2.2	B0e	.031	.035	93	−0.1	− 6.8
‖β Phoe........	1 04	−46 59	3.4	G4	.043	.020	163	−0.1	− 1.2
β Andr........	07	+35 21	2.4	M0	.219	.041	79	0.5	+ 0.1
δ Cass........	23	+59 59	2.8–2.9	A3	.308	.050	65	1.3	+ 6.8
γ Phoe........	26	−43 34	3.4	M1	.223	.008	407	−2.1	+25.7*
α **Erid**........	36	−57 29	0.6	B9	.093	.046	71	−1.1	+19
‖α U. Min......	49	+89 02	2.3–2.4	F7	.043	.008	407	−3.4	−17.4*
ε Cass........	51	+63 25	3.4	B5	.043	.011	296	−1.4	− 8.1
β Arie........	52	+20 34	2.7	A3	.150	.066	49	1.8	− 0.6*
α Hydi.......	57	−61 49	3.0	A7	.255	.080	41	2.5	+ 7.0*
|γ Andr........	2 01	+42 05	2.3	K0	.073	.020	163	−1.2	−11.7
α Arie........	04	+23 14	2.2	K2	.242	.045	72	0.5	−14.3
β Tria........	07	+34 45	3.1	A6	.161	.029	112	0.4	+10.4*
‖o Ceti........	17	− 3 12	1.7–9.6	M6e	.239	.013	251	−2.7	+57.8*
‖θ Erid........	56	−40 30	3.4	A2	.068	.032	102	0.9	+11.9*
α Ceti........	3 00	+ 3 54	2.8	M1	.080	.018	181	−0.9	−25.7
γ Pers........	01	+53 19	3.1	F9	.012	.017	192	−0.7	+ 1.0*
ρ Pers........	02	+38 39	3.3–4.1	M6	.176	.024	136	0.3	+28.2
β Pers........	05	+40 46	2.1–3.2	B8	.011	.033	99	−0.3	+ 5.7*
α Pers........	21	+49 41	1.9	F4	.041	.017	192	−2.0	− 2.4
δ Pers........	39	+47 38	3.1	B5	.047	.012	272	−1.5	−10. *
‖η Taur........	45	+23 57	3.0	B5p	.053	.014	233	−1.3	+10.3
γ Hydi........	48	−74 24	3.2	M3	.124	.008	407	−2.3	+16.0
ζ Pers........	51	+31 44	2.9	B1	.023	.008	407	−2.6	+20.9
‖ε Pers........	54	+39 52	3.0	B2	.041	.006	543	−3.1	− 6 *
γ Erid........	56	−13 39	3.2	M0	.133	.012	272	−1.6	+61.7
λ Taur........	58	+12 21	3.8–4.2	B3	.015	.008	407	−2.2	+13.0*
α Reti......	4 14	−62 36	3.4	G5	.070	.016	204	−0.6	+35.6

αU. Min., *Polaris:* R.A. 1h 49.5m; Dec. + 89° 02′ (1951)

Star	R.A. 1950	Decl. 1950	Mag.	Type	Ann. Proper Motion	Parallax	Distance in Light Years	Abs. Mag.	Rad. Vel.
	h m	° ′			″	″			km./sec.
α **Taur**.......	4 33	+16 24	1.1	K8	.205	.060	54	0.0	+54.1
α Dora.......	33	−55 09	3.5	A0p	......	..	.....	......	+25.6
π^3 Orio........	47	+ 6 52	3.3	F5	.474	.124	26	3.8	+24.6
ι Auri........	54	+33 05	2.9	K4	.030	.020	163	−0.6	+17.6
ε Auri........	58	+43 45	3.1-3.8	F2	.015	.006	543	−2.7	−4.1 *
η Auri........	5 03	+41 10	3.3	B3	.082	.013	251	−1.1	+ 7.8
ε Leps........	03	−22 26	3.3	K5	.074	.016	204	−0.7	+ 1.0
β Erid........	05	− 5 09	2.9	A1	.117	.055	59	1.6	− 7
μ Leps........	11	−16 16	3.3	A0p	.053	.020	163	−0.2	+27.7
‖β **Orio**........	12	− 8 15	0.3	B8p	.005	.006	543	−5.8	+23.6*
‖α **Auri**........	13	+45 57	0.2	G1	.439	.078	42	−0.3	+30.2
‖η Orio........	22	− 2 26	3.4	B0	.009	.006	543	−2.7	+19.5*
γ Orio........	22	+ 6 18	1.7	B2	.019	.015	217	−2.4	+18.0
β Taur........	23	+28 34	1.8	B8	.180	.028	116	−1.0	+ 8.0
β Leps........	26	−20 48	3.0	G2	.095	.018	181	−0.7	−13.5
‖δ Orio........	29	− 0 20	2.4-2.5	B0	.006	.007	466	−3.4	+19.9*
α Leps........	31	−17 51	2.7	F6	.006	.012	272	−2.1	+24.7
ι Orio........	33	− 5 56	2.9	O8	.007	.021	155	−0.5	+21.5*
ε Orio........	34	− 1 14	1.8	B0	.004	.008	407	−3.7	+25.8
ζ Taur........	35	+21 07	3.0	B3e	028	.010	326	−2.0	+16.4*
‖ζ Orio........	38	− 1 58	1.8	B0	.012	.011	296	−3.0	+18.8
α Colm.......	38	−34 06	2.8	B8	.036	.022	148	−0.6	+34.6
κ Orio........	45	− 9 41	2.2	B0	.009	.006	543	−3.9	+20.1
β Colm.......	49	−35 47	3.2	K0	.397	.026	125	0.3	+89.4
α **Orio**........	52	+ 7 24	0.5-1.1	M2	.032	.012	272	−4.1	+21.0*
β Auri........	56	+44 57	2.1-2.2	A0p	.046	.052	63	0.7	−18.1*
‖θ Auri........	56	+37 13	2.7	A1	.106	.029	112	0.0	+28.6
η Gemi.......	6 12	+22 31	3.2-4.2	M2	.062	.014	233	−1.1	+21.4*
ζ C Maj......	18	−30 02	3.1	B3	.012	.013	251	−0.7	+33.1*
μ Gemi.......	20	+22 32	3.2	M3	.129	.016	204	−0.8	+54.8
β C Maj......	20	−17 56	2.0	B1	.003	.014	233	−2.3	+34.4*
α **Cari**........	23	−52 40	−0.9	F0	.022	.005	652	−7.4	+20.5
γ Gemi.......	35	+16 27	1.9	A2	.066	.050	65	0.4	−11.3*
ν Pupp.......	36	−43 09	3.2	B8	.021	.023	148	0.0	+28.2*
ε Gemi.......	41	+25 12	3.2	G9	.020	.009	362	−2.0	+ 9.9
ξ Gemi.......	42	+12 57	3.4	F5	.230	.054	60	2.1	+25.1
‖α **C Maj**......	43	−16 39	−1.6	A2	1.315	.386	8	1.3	− 7.5*
α Pict........	48	−61 53	3.3	A5	271	.....	.....	......	+20.6

Star	R.A. 1950	Decl. 1950	Mag.	Type	Ann. Proper Motion	Parallax	Distance in Light Years	Abs. Mag.	Rad. Vel.
	h m	° ′			″	″			km./sec.
τ Pupp..	6 49	−50 33	2.8	G8	.091	.025	130	−0.2	+36.4*
‖ε C Maj......	57	−28 54	1.6	B1	.005	.010	326	−3.4	+27.4
ζ Gemi.......	7 01	+20 39	3.7–4.3	G0p	.007	.005	652	−2.8	+ 6.7*
o^2 C Maj......	01	−23 45	3.1	B5p	.006	.007	466	−2.7	+48.6
δ C Maj......	06	−26 19	2.0	G4p	.003	.006	543	−4.1	+34 3*
L^2 Pupp.......	12	−44 33	3.4–6.2	M5e	.332	.018	181	−0.3	+53 0
π Pupp.......	15	−37 00	2.7	K5	.004	.018	181	−1.0	+15.8
η C Maj......	22	−29 12	2.4	B5p	.007	.012	272	−2.2	+40.4
β C Min......	24	+ 8 23	3.1	B8	.063	.022	148	−0.2	+23 *
σ Pupp.......	28	−43 12	3.3	M0	.191	.016	204	−0.7	+88.1*
α_1 Gemi.......	31	+32 00	2.0	A2	.201	.074	44	1.4	+ 6.0*
α_2 Gemi.......	31	+32 00	2.8	A0	.209	.074	44	2.2	− 1.2*
‖**α C Min**......	37	+5 21	0.5	F5	1.242	.316	10	3.0	− 3.0*
β Gemi.......	42	+28 09	1.2	G9	.623	.105	31	1.3	+ 3.3
ξ Pupp.......	47	−24 44	3.5	K1	.004	.006	543	−2.6	+ 3.7*
ζ Pupp.......	8 02	−39 52	2.3	O8	.032	.004	815	−4.7	−24.
ρ Pupp.......	05	−24 10	2.9	F6	.097	.025	130	−0.1	+46.6
‖γ Velr.........	08	−47 12	2.2	OW9	.002	.....	.....	......	+ 3.5
‖ε Cari........	21	−59 21	1.7	K0	.030	.010	326	−3.3	+11.5
o U Maj......	26	+60 53	3.5	G2	.166	014	233	−0.8	+19.8
‖δ Velr........	43	−54 32	2.0	A0	.093	.030	109	−0.6	+ 2.2
‖ε Hyda.......	44	+ 6 36	3.5	F9	.193	012	272	−1.1	+36.8*
ζ Hyda.......	53	+ 6 08	3.3	G7	.101	.026	125	0.3	+22.6
‖ι U Maj......	56	+48 14	3.1	A4	.500	.060	54	2.0	+12.6
λ Velr........	9 06	−43 14	2.2	K4	.024	.016	204	−1.8	+18.4
β Cari........	13	−69 31	1.8	A0	.192	.....	.....	......	− 5.
ι Cari........	16	−59 04	2.2	F0	.023	.....	.....	......	+13.3
α Lync.......	18	+34 36	3.3	K8	.214	022	148	0.0	+37.4
κ Velr........	21	−54 48	2.6	B3	.017	.017	192	−1.2	+21.7*
α Hyda.......	25	− 8 26	2.2	K4	.036	.018	181	−1.5	− 4.4
θ U Maj......	30	+51 54	3.3	F7	1.096	.072	45	2.6	+15.8
N Velr........	30	−56 49	3.4–4.2	K5	.038	.022	148	0.1	−13.9
ε Leon........	43	+24 00	3.1	G0	.045	.009	362	−2.1	+ 5.1
‖υ Cari........	46	−64 50	3.1	F0	.019	.....	.....	......	+13.6
α Leon.......	10 06	+12 13	1.3	B6	.244	.046	71	−0.4	+ 2.6
q Cari........	15	−61 05	3.4	K5	.043	.014	233	−0.9	+ 8.6

Star	R.A. 1950	Decl. 1950	Mag.	Type	Ann. Proper Motion	Parallax	Distance in Light Years	Abs. Mag.	Rad. Vel.
	h m	° ′				″	″		km./sec
‖γ Leo	10 17	+20 06	2.3	G8	.347	.024	136	−0.8	−36.8
μ U Maj	19	+41 45	3.2	K4	.082	.031	105	0.7	−20.3*
θ Cari	41	−64 08	3.0	B0	.022	.007	466	−2.8	+24. *
η Cari	43	−59 25	1.0–7.4	Pec	.007	.....	.....	......	−25.0
‖μ Velr	45	−49 09	2.8	G5	.079	.033	99	0.4	+ 6.9
ν Hyda	47	−15 56	3.3	K3	.218	020	163	−0.2	− 1.0
β U Maj	59	+56 39	2.4	A3	.089	.045	72	0.7	−12.1*
α U Maj	11 01	+62 01	2.0	G5	.137	036	91	−0.2	− 8.6*
ψ U Maj	07	+44 46	3.2	K0	067	035	93	0.9	− 3.6
δ Leon	11	+20 47	2.6	A2	208	058	56	1.4	−23.2
θ Leon	12	+15 42	3.4	A2	.103	025	130	0 4	+ 7.8
λ Cent	33	−62 45	3.3	B9	.045	031	105	0.8	+ 7.9
β Leon	47	+14 51	2.2	A2	.507	084	39	1.8	− 2.3
γ U Maj	51	+53 58	2.5	A0	.095	035	93	0.2	-11.1
δ Cent	12 06	−50 27	2.9	B3e	.040	015	217	−1.2	+ 9.
ε Corv	08	−22 30	3.2	K2	.063	024	136	0.1	+ 4.9
δ Cruc	12	−58 28	3.1	B3	.045	017	192	−0 7	+26.4
δ U Maj	13	+57 19	3.4	A0	.113	050	65	1 9	−12.
γ Corv	13	−17 16	2.8	B8	.159	.024	136	−0.3	− 4.2*
α^1 Cruc	24	−62 49	1.6	B1	.048	022	148	−1.7	−12.2*
α^2 Cruc	24	−62 49	2.1	B3	.048	022	148	−1.2	+ 0.3*
‖δ Corv	27	−16 14	3.1	A0	.249	.026	125	0.2	+ 8.7
γ Cruc	28	−56 50	1.5	M4	.270	....	.....	......	+21.3
β Corv	32	−23 07	2.8	G5	.059	027	121	0.0	− 7.7
α Musc	34	−68 52	2.9	B5	.040	.015	217	−1.2	+18.
‖γ Cent	39	−48 41	2.4	A0	.200	.032	102	−0.1	− 7.5
‖γ Virg	39	− 1 10	2.9	F0	.561	080	41	2.4	−19.6
‖β Musc	43	−67 50	3.3	B3	.039	.011	296	−1.5	+42. *
β Cruc	45	−59 25	1.5	B1	.054	.007	466	−4.3	−20 *
ε U Maj	52	+56 14	1.7	A2	.117	.067	49	0.8	−11.9*
‖α^2 C. Ven	54	+38 35	2.8	A1	.233	.030	109	0.2	− 3.5
ε Virg	13 00	+11 14	3 0	G6	.270	.037	88	0.8	−14.0
γ Hyda	16	−22 54	3.3	G7	.085	.028	116	0.5	− 5.4
ι Cent	18	−36 27	2.9	A2	.351	.049	67	1 4	+ 0.1
‖ζ^1 U. Maj	22	+55 11	2.4	A2p	.131	.042	78	0.5	− 9.9*
α Virg	23	−10 54	1.2	B2	.051	.018	181	−2.5	+ 1.6*
ζ Virg	32	− 0 20	3.4	A2	.285	.038	86	1.3	−13.1

Star	R.A. 1950	Decl. 1950	Mag.	Type	Ann. Proper Motion	Parallax	Distance in Light Years	Abs. Mag.	Rad. Vel.
	h m	° ′			″	″			km./sec.
ε Cent........	13 37	−53 13	2.6	B2	.039	.012	272	−2.0	− 5 6
η U. Maj......	46	+49 34	1.9	B3	.116	.015	217	−2.2	−10 9
μ Cent	47	−42 13	3.3	B3e	.026	.009	362	−1.9	+12.6
ζ Cent........	52	−47 02	3.1	B3	.080	.013	251	−1.3	*
η Boot........	52	+18 39	2.8	G1	.370	.100	33	2.8	− 0.2*
β Cent.......	14 00	−60 08	0.9	B3	.039	.026	125	−2.0	−12. *
π Hyda.......	04	−26 26	3.5	K3	.164	.037	88	1.3	+27.2
θ Cent........	04	−36 07	2.3	G8	.745	.056	58	1.0	+ 1.3
α Boot.......	13	+19 26	0.2	K0	2.287	.102	32	0.2	− 5 1
γ Boot........	30	+38 32	3.0	A3	.182	.063	52	2.0	−35.5
η Cent........	32	−41 56	2.6	B3	.046	.012	272	−2.0	− 0 2*
||**α Cent**.......	36	−60 38	0.1	G0	3.682	.768	4	4.5	−22.2*
α Circ........	38	−64 46	3.4	F0	.308	.063	52	2.4	+ 7.4
α Lupi........	39	−46 10	2.9	B2	.033	.009	362	−2.3	+ 7.3*
||ε Boot........	43	+27 17	2.7	G8	.045	.019	172	−0.9	−16.4
||α² Libr........	48	−15 47	2.9	F1	.128	.056	58	1.6	−10. *
β U Min......	51	+74 22	2.2	K4	.028	.030	109	−0.4	+16 9
β Lupi........	55	−42 56	2.8	B3	.067	.012	272	−1.8	− 0.3*
κ Cent........	56	−41 54	3.4	B2	.034	.011	296	−1.4	+ 9.1*
σ Libr........	15 01	−25 05	3.4	M4	.091	.020	163	−0.1	− 4.3
ζ Lupi........	09	−51 55	3.5	G5	.125	.027	121	0.7	− 9.7
γ Tr. Au......	14	−68 30	3.1	A0	.064	...	.....	.....	0.
β Libr........	14	− 9 12	2.7	B8	.100	.015	217	−1.4	−37. *
δ Lupi........	18	−40 28	3.4	B3	.031	.012	272	−1.2	+ 1.6
γ U. Min......	21	+72 01	3.1	A2	.016	.022	148	−0.2	− 3.9*
ι Drac........	24	+59 08	3.5	K3	.010	.030	109	0.9	−11.1
|γ Lupi........	32	−41 00	3.0	B3	.038	.013	251	−1.4	+ 6.
α Cor. B......	33	+26 53	2.3	A0	.160	.054	60	1.0	+ 1.0*
α Serp........	42	+ 6 35	2.8	K3	.142	.043	76	1.0	+ 3.0
β Tr. Au......	51	−63 17	3.0	F0	.436	.096	34	2.9	− 0.3
π Scor........	56	−25 58	3.0	B3	.037	.012	272	−1.6	− 3.0*
δ Scor........	57	−22 29	2.5	B1	.039	.011	296	−2.3	−16. *
||β Scor........	16 03	−19 40	2.8	B3	.029	.016	204	−1.2	− 9.3*
δ Ophi........	12	− 3 34	3.3	K8	.159	.030	109	0.7	−19.8
ε Ophi........	16	− 4 34	3.3	G9	.088	.031	105	0.8	−10.3
|σ Scor........	18	−25 28	3.1	B1	.033	.009	362	−2.1	− 0.4*
||η Drac........	23	+61 38	2.9	G5	.062	.038	86	0.8	−14.3

Star	R.A. 1950	Decl. 1950	Mag.	Type	Ann. Proper Motion	Parallax	Distance in Light Years	Abs. Mag.	Rad. Vel.
	h m	° ′			″	″			km./sec
‖α **Scor**	16 26	−26 19	1.2	M1	.032	.019	172	−2.4	− 3.2*
β Herc	28	+21 36	2.8	G4	.104	.020	163	−0.7	−25.8*
τ Scor	33	−28 07	2.9	B1	.037	.009	362	−2.3	+ 0.6
ζ Ophi	34	−10 28	2.7	B0	.023	.008	407	−2.8	−19. *
‖ζ Herc	39	+31 42	3.0	G0	.601	.105	31	3.1	−70.8*
α Tr. Au	43	−68 56	1.9	K5	.031	.025	130	−1.1	− 3.7
ε Scor	47	−34 12	2.4	G9	.665	.038	86	0.3	− 2.5
μ¹ Scor	48	−37 58	3.1	B3p	.030	.011	296	−1.7	*
ζ Arae	54	−55 55	3.1	K5	.046	.028	116	0.3	− 6.0
κ Ophi	55	+ 9 27	3.1–4.0	K3	.290	.042	78	1.2	−55.6
‖η Ophi	17 08	−15 40	2.6	A2	.095	.047	69	1.0	− 1.0
η Scor	08	−43 11	3.4	A7	.294	.066	49	2.5	−28.4
ζ Drac	09	+65 47	3.2	B8	.023	028	116	0.4	−14.1
‖α¹ Herc	12	+14 27	3.1–3.9	M7	.030	.008	407	−2.4	−32.5
δ Herc	13	+24 54	3.2	A2	.164	.036	91	1.0	−39. *
π Herc	13	+36 52	3.4	K3	.021	.018	181	−0.3	−25.7
θ Ophi	19	−24 57	3.4	B2	.031	.008	407	−2.1	− 3.6
β Arae	21	−55 29	2.8	K1	.036	.023	142	−0.4	− 0.4
υ Scor	27	−37 15	2.8	B3	.042	.010	326	−2.2	+18. *
α Arae	28	−49 50	3.0	B3e	.090	.015	217	−1.1	− 2.2
β Drac	29	+52 20	3.0	G0	.012	.007	466	−2.8	−20.1
λ Scor	30	−37 04	1.7	B2	.036	.016	204	−2.3	0. *
α Ophi	33	+12 35	2.1	A0	.264	.060	54	1.0	+15. *
θ Scor	34	−42 58	2.0	F0	.012	.024	136	−1.1	+ 1.4
κ Scor	39	−39 00	2.5	B3	.028	.009	362	−2.7	−10. *
β Ophi	41	+ 4 35	2.9	K2	.157	.030	109	0.3	−11.9
ι¹ Scor	44	−40 06	3.1	F8	.004	.008	407	−2.4	−27.6*
‖μ Herc	44	+27 45	3.5	G5	.817	114	28	3.8	−16.1
G Scor	46	−37 02	3.2	K2	.069	.029	112	0.5	+24.7
ν Ophi	56	− 9 46	3.5	G7	.118	.022	148	0.2	+12.4
γ Drac	55	+51 30	2.4	K5	.026	.026	125	−0.5	−27.8
γ Sgtr	18 03	−30 26	3.1	K0	.202	.030	109	0.5	+22.3*
η Sgtr	14	−36 47	3.2	M4	.216	.030	109	0.6	+ 0.5
δ Sgtr	18	−29 51	2.8	K4	.052	.033	99	0.4	−20.0
η Serp	19	− 2 55	3.4	G9	.898	.050	65	1.9	+ 8.9
ε Sgtr	21	−34 25	2.0	A0	.139	.020	163	−1.5	−10.8
λ Sgtr	25	−25 27	2.9	K1	.196	.036	91	0.7	−43.3
α **Lyra**	35	+38 44	0.1	A1	.348	.140	23	0.8	−13.8

Star	R.A. 1950	Decl. 1950	Mag.	Type	Ann. Proper Motion	Parallax	Distance in Light Years	Abs. Mag.	Rad. Vel.
	h m	° ′			″	″			km./sec.
φ Sgtr........	18 43	−27 03	3.3	B8	.150	.015	217	−0.8	+21.5*
‖β Lyra........	48	+33 18	3.4–4.1	B2p	.011	.006	543	−2.7	−19.0*
σ Sgtr........	52	−26 22	2.1	B3	.067	.021	155	−1.3	−10.7
γ Lyra........	57	+32 37	3.3	B9p	.008	.016	204	−0.7	−21.5*
‖ζ Sgtr........	59	−29 57	2.7	A2	.019	.035	93	0.4	+22.1
ζ Aqil........	19 03	+13 47	3.0	A0	.103	.038	86	0.9	−25. *
τ Sgtr........	04	−27 45	3.4	K0	.268	.036	91	1.2	+45.4*
π Sgtr........	07	−21 06	3.0	F2	.041	.017	192	−0.8	− 9.8
δ Drac........	13	+67 34	3.2	G8	.135	.028	116	0.4	+24.8
δ Aqil........	23	+ 3 01	3.4	A3	.267	.052	63	2.0	−32.3*
‖β¹ Cygn.......	29	+27 51	3.2	K0	.010	.010	326	−1.8	−23.9*
‖δ Cygn.......	43	+45 00	3.0	A1	.067	.023	116	0.2	−20.
γ Aqil........	44	+10 29	2.8	K3	.018	.018	181	−0.9	− 2.0
α **Aqil**........	48	+ 8 44	0.9	A2	.659	.184	18	2.2	−26.1
θ Aqil........	20 09	− 0 58	3.4	A0	.035	.018	181	−0.3	−28.6*
‖β Capr........	18	−14 56	3.2	F8	.042	.022	148	−0.1	−19.0*
γ Cygn.......	20	+40 06	2.3	F8	.006	.008	407	−3.2	− 7.6
α Pavo.......	22	−56 54	2.1	B3	.087	.014	233	−2.2	+ 1.8*
α Indi........	34	−47 28	3.2	G2	.072	.034	96	0.9	− 1.1
α **Cygn**.......	40	+45 06	1.3	A2p	.004	.002	1630	−7.2	− 6.3*
ε Cygn.......	44	+33 47	2.6	G7	.485	.040	81	0.6	−10.5*
ζ Cygn.......	21 11	+30 01	3.4	G6	.061	.018	181	−0.3	+16.9*
α Ceph.......	17	+62 22	2.6	A2	.163	.076	43	2.0	− 8.
β Ceph.......	28	+70 20	3.3–3.4	B1	.013	.006	543	−2.8	− 7.2
β Aqar........	29	− 5 48	3.1	G1	.020	.008	407	−2.4	+ 6.7
ε Pegs........	42	+ 9 39	2.5	K2	.028	.014	233	−1.8	+ 5.2
δ Capr........	44	−16 21	3.0	A3	.395	.062	53	2.0	− 6.4*
γ Grus........	51	−37 36	3.2	B8	.114	.020	163	−0.3	− 2.1
α Aqar........	22 03	− 0 34	3.2	G0	.019	.006	543	−2.9	+ 7.6
α Grus........	05	−47 12	2.2	B5	.202	.036	91	0.0	+11.8
α Tucn.......	15	−60 31	2.9	K5	.088	.019	172	−0.7	+42.2*
β Grus........	40	−47 09	2.2	M6	.131	.010	326	−2.8	+ 1.6
η Pegs........	41	+29 58	3.1	G1	.039	.016	204	−0.9	+ 4.4*
α **Psc. A**......	55	−29 53	1.3	A3	.367	.118	28	1.7	+ 6.5
β Pegs........	23 01	+27 49	2.6	M3	.235	.020	163	−0.9	+ 8.6
α Pegs........	02	+14 56	2.6	A0	.077	.033	99	0.2	− 4. *
γ Ceph.......	37	+77 21	3.4	K1	.167	.062	53	2.4	−42.0

STAR CLUSTERS

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

N.G.C.	M	Con.	α 1950 h m	δ ° ′	Cl.	Diam. ′	Mag. B.S.	No.	Int. mag.	Dist. l.y.
869		h Per	02 15.5	+56 55	Op	30	7			4,300
884		χPer	02 18.9	+56 53	Op	30	7			4,300
1039	34	Per	02 38.3	+42 35	Op	30	9	80		1,500
Pleiades	45	Tau	03 44.5	+23 58	Op	120	4.2	250		490
Hyades		Tau	04 17	+15 30	Op	400	4.0	100		120
1912	38	Aur	05 25.3	+35 48	Op	18	9.7	100		2,800
2099	37	Aur	05 49.0	+32 33	Op	24	9.7	150		2,700
2168	35	Gem	06 05.7	+24 21	Op	29	9.0	120		2,700
2287	41	C Ma	06 44.9	−20 42	Op	32	9	50		1,300
2632	44	Cnc	08 37.2	+20 10	Op	90	6.5	350		490
5139		ωCen	13 23.7	−47 03	Gl	23	12.9		3	22,000
5272	3	C Vn	13 39.9	+28 38	Gl	10	14.2		4.5	40,000
5904	5	Ser	15 15.9	+02 16	Gl	13	14.0		3.6	35,000
6121	4	Scr	16 20.5	−26 24	Gl	14	13.9		5.2	24,000
6205	13	Her	16 39.9	+36 33	Gl	10	13.8		4.0	34,000
6218	12	Oph	16 44.6	−01 51	Gl	9	14.0		6.0	36,000
6254	10	Oph	16 54.5	−04 02	Gl	8	14.1		5.4	36,000
6341	92	Her	17 15.6	+43 12	Gl	8	13.9		5.1	36,000
6494	23	Sgr	17 54.0	−19 01	Op	27	10.2	120		2,200
6611	16	Ser	18 16.0	−13 48	Op	8	10.6	55		6,700
6656	22	Sgr	18 33.3	−23 57	Gl	17	12.9		3.6	22,000
7078	15	Peg	21 27.6	+11 57	Gl	7	14.3		5.2	43,000
7089	2	Aqr	21 30.9	−01 04	Gl	8	14.6		5.0	45,000
7092	39	Cyg	21 30.5	+48 13	Op	32	6.5	25		1,000
7654	52	Cas	23 22.0	+61 19	Op	13	11.0	120		4,400

GALACTIC NEBULAE

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

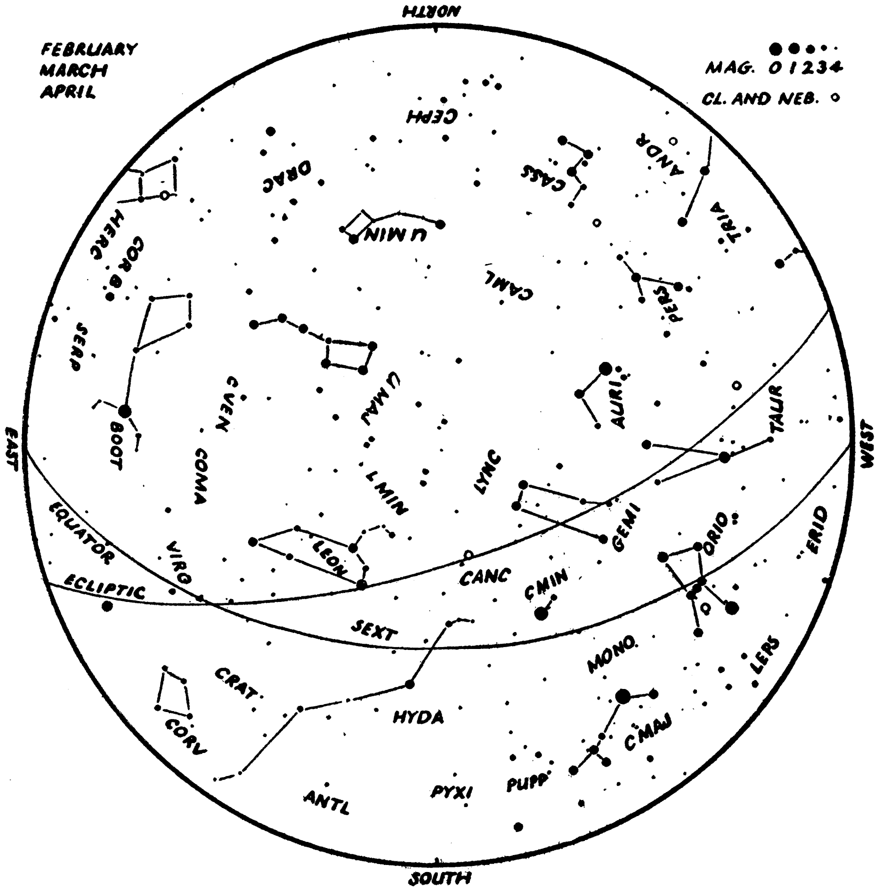
N.G.C.	M	Con	α 1950 h m	δ ° ′	Cl	Size ′	m n	m *	Dist. l.y.	Name
650	76	Per	01 38.3	+51 20	Pl	1.5	11	17	15,000	
1952	1	Tau	05 31.5	+21 59	Pl	6	11	16	10,000	Crab
1976	42	Ori	05 32.5	−05 25	Dif	30			1,800	Orion
B33		Ori	05 38.0	−02 29	Drk	4			300	Horsehead
2261		Mon	06 36.4	+08 47	Dif	2				Hubble's var
2392		Gem	07 26.2	+21 02	Pl	0.3	8	10	2,800	
2440		Pup	07 39.6	−18 05	Pl	0.9	11	16	8,600	
3587	97	UMa	11 11.8	+55 17	Pl	3.3	11	14	12,000	Owl
		Cru	12 48	−63	Drk	300			300	Coalsack
6210		Her	16 42.4	+23 54	Pl	0.3	10	12	5,600	
B72		Oph	17 20.5	−23 36	Drk	20			400	S nebula
6514	20	Sgr	17 59.3	−23 02	Dif	24			3,200	Trifid
B86		Sgr	17 59.9	−27 52	Drk	5				
6523	8	Sgr	18 00.6	−24 23	Dif	50			3,600	Lagoon
6543		Dra	17 58.6	+66 38	Pl	0.4	9	11	3,500	
6572		Oph	18 10.2	+06 50	Pl	0.2	9	12	4,000	
B92		Sgr	18 12.7	−18 15	Drk	15				
6618	17	Sgr	18 18.0	−16 12	Dif	26			3,000	Horseshoe
6720	57	Lyr	18 52.0	+32 58	Pl	1.4	9	14	5,400	Ring
6826		Cyg	19 43.5	+50 24	Pl	0.4	9	11	3,400	
6853	27	Vul	19 57.4	+22 35	Pl	8	8	13	3,400	Dumb-bell
6960		Cyg	20 43.6	+30 32	Dif	60				Network
7000		Cyg	20 57.0	+44 07	Dif	100				N. America
7009		Aqr	21 01.4	−11 34	Pl	0.5	8	12	3,000	
7662		And	23 23.4	+42 12	Pl	0.3	9	13	3,900	

EXTRA-GALACTIC NEBULAE

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

N.G.C.	M	Con	α 1950 h m	δ ° ′	Cl	Dimens. ′ ′	Mag.	Distance l.y.	Vel. km/sec
221	32	And	00 39.9	+40 36	E	3×3	8.8	800,000	− 185
224	31	And	00 40.0	+41 00	Sb	160×40	5.0	800,000	− 220
SMC		Tuc	00 53	−72 38	I	220×220	1.5	100,000	+ 170
598	33	Tri	01 31.0	+30 24	Sc	60×40	7.0	700,000	− 70
LMC		Dor	05 21	−69 27	I	430×530	0.5	90,000	+ 280
3031	81	UMa	09 51.5	+69 18	Sb	16×10	8.3	2,400,000	− 30
3034	82	UMa	09 51.8	+69 58	I	7× 2	9.0	2,600,000	+ 290
3368	96	Leo	10 44.1	+12 05	Sa	7× 4	10.0	5,700,000	+ 940
3623	65	Leo	11 16.3	+13 22	Sb	8× 2	9.9	5,000,000	+ 800
3627	66	Leo	11 17.6	+13 16	Sb	8× 2	9.1	4,300,000	+ 650
4258		CVn	12 16.5	+47 34	Sb	20× 6	8.7	4,600,000	+ 500
4374	84	Vir	12 22.5	+13 09	E	3× 2	9.9	6,000,000	+1050
4382	85	Com	12 22.9	+18 28	E	4× 2	10.0	3,700,000	+ 500
4472	49	Vir	12 27.2	+08 16	E	5× 4	10.1	5,700,000	+ 850
4565		Com	12 33.9	+26 16	Sb	15× 1	11.0	7,600,000	+1100
4594		Vir	12 37.4	−11 20	Sa	7× 2	9.2	7,200,000	+1140
4649	60	Vir	12 41.1	+11 50	E	4× 3	9.5	7,500,000	+1090
4736	94	CVn	12 48.6	+41 24	Sb	5× 4	8.4	3,000,000	+ 290
4826	64	Com	12 54.3	+21 57	Sb	8× 4	9.2	1,300,000	+ 150
5005		CVn	13 08.6	+37 20	Sc	5× 2	11.1	6,600,000	+ 900
5055	63	CVn	13 13.6	+42 18	Sb	8× 3	9.6	3,600,000	+ 450
5194	51	CVn	13 27.8	+47 27	Sc	12× 6	7.4	3,000,000	+ 250
5236	83	Hya	13 34.2	−29 36	Sc	10× 8	8	2,900,000	+ 500
6822		Sgr	19 42.4	−14 53	I	20×10	11	1,000,000	− 150
7331		Peg	22 34.8	+33 59	Sb	9× 2	10.4	5,200,000	+ 500

STAR MAP I

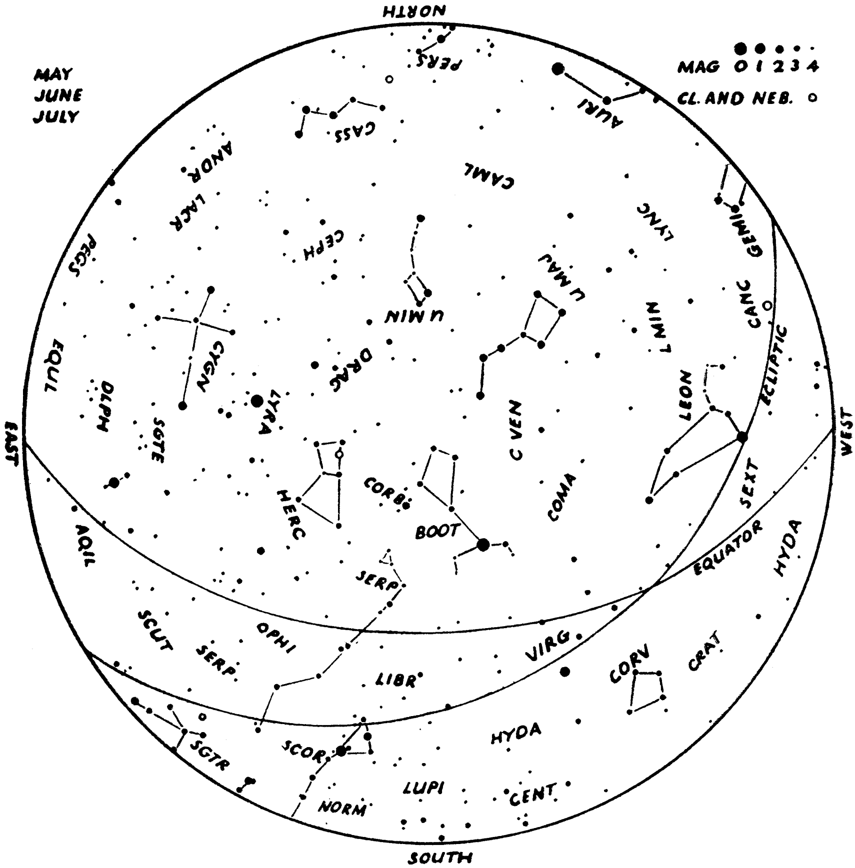


The above map represents the evening sky at

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

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

STAR MAP 2

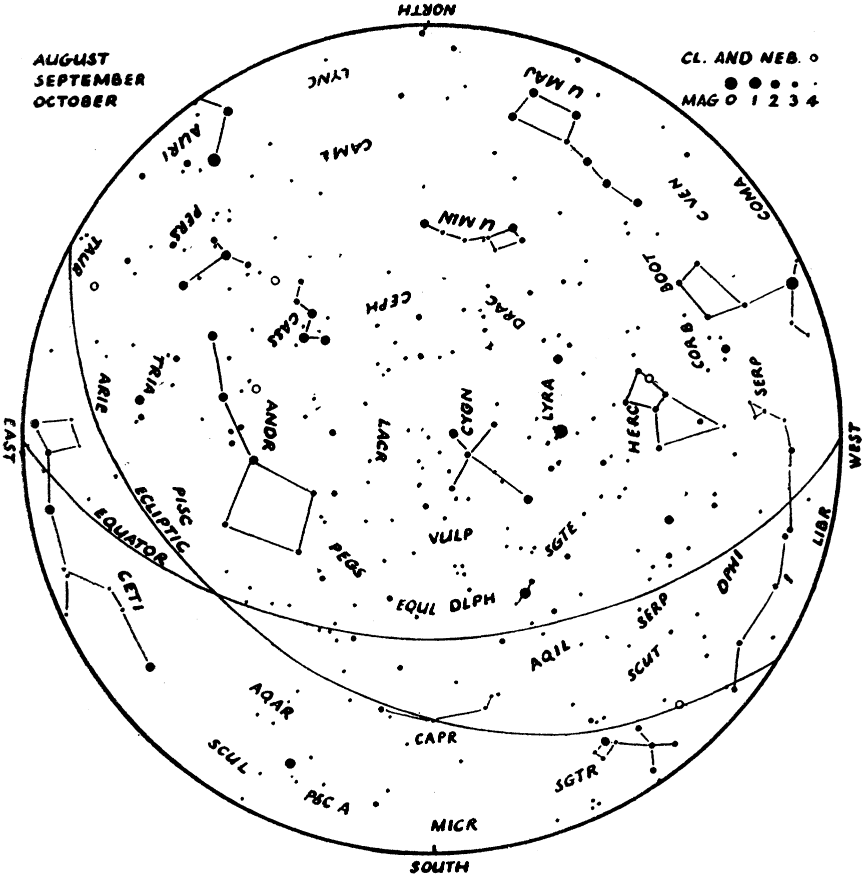


The above map represents the evening sky at

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

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

STAR MAP 3

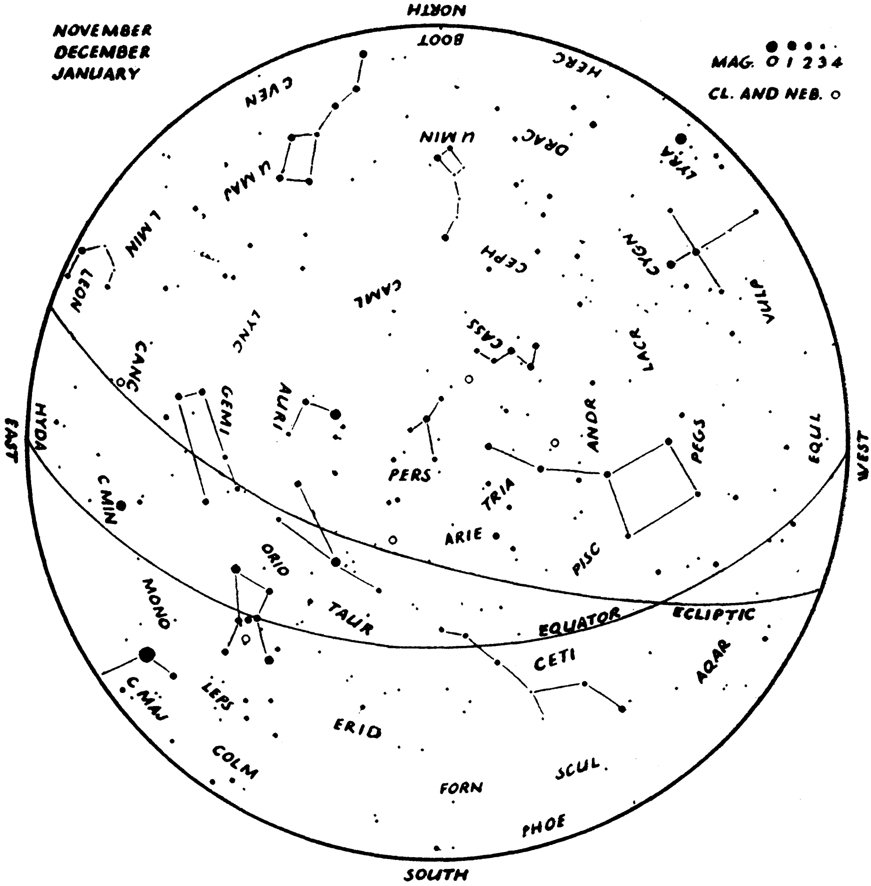


The above map represents the evening sky at

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

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

STAR MAP 4



The above map represents the evening sky at

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

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

Date		P	B_0	L_0	Date		P	B_0	L_0
		°	°	°			°	°	°
Jan.	1	+ 2.39	−3.02	66.78	Jul.	5	− 1.23	+3.30	145.07
	6	− 0.04	−3.59	0.93		10	+ 1.04	+3.82	78.90
	11	− 2.46	−4.14	295.09		15	+ 3.29	+4.32	12.73
	16	− 4.84	−4.65	229.25		20	+ 5.49	+4.79	306.57
	21	− 7.15	−5.12	163.41		25	+ 7.65	+5.22	240.42
	26	− 9.38	−5.56	97.58		30	+ 9.73	+5.63	174.28
	31	−11.52	−5.95	31.74	Aug.	4	+11.73	+5.99	108.15
Feb.	5	−13.55	−6.29	325.92		9	+13.64	+6.31	42.04
	10	−15.45	−6.59	260.08		14	+15.44	+6.59	335.93
	15	−17.23	−6.83	194.25		19	+17.13	+6.82	269.84
	20	−18.86	−7.02	128.40		24	+18.70	+7.00	203.77
	25	−20.35	−7.17	62.55		29	+20.14	+7.13	137.71
Mar.	2	−21.68	−7.24	356.69	Sep.	3	+21.45	+7.22	71.66
	7	−22.86	−7.25	290.82		8	+22.62	+7.25	5.62
	12	−23.87	−7.22	224.94		13	+23.64	+7.23	299.60
	17	−24.72	−7.13	159.04		18	+24.51	+7.16	233.59
	22	−25.39	−6.99	93.12		23	+25.22	+7.03	167.59
	27	−25.90	−6.79	27.19		28	+25.76	+6.85	101.60
Apr.	1	−26.22	−6.55	321.23	Oct	3	+26.14	+6.63	35.62
	6	−26.37	−6.25	255.26		8	+26.34	+6.35	329.65
	11	−26.33	−5.92	189.27		13	+26.36	+6.02	263.69
	16	−26.11	−5.54	123.26		18	+26.19	+5.65	197.74
	21	−25.71	−5.12	57.23		23	+25.84	+5.24	131.79
	26	−25.13	−4.66	351.17		28	+25.29	+4.78	65.85
May	1	−24.36	−4.18	285.10	Nov.	2	+24.54	+4.29	359.92
	6	−23.40	−3.66	219.01		7	+23.59	+3.76	293.99
	11	−22.28	−3.12	152.91		12	+22.46	+3.20	228.07
	16	−20.98	−2.56	86.78		17	+21.12	+2.62	162.16
	21	−19.51	−1.98	20.64		22	+196.0	+2.02	96.25
	26	−17.90	−1.40	314.49		27	+179.1	+1.40	30.35
	31	−16.14	−0.80	248.34	Dec.	2	+16.05	+0.77	324.45
Jun.	5	−14.25	−0.19	182.16		7	+14.04	+0.13	258.56
	10	−12.25	+0.41	115.99		12	+11.90	−0.51	192.68
	15	−10.16	+1.01	49.81		17	+ 9.66	−1.15	126.80
	20	− 7.98	+1.60	343.62		22	+ 7.32	−1.78	60.93
	25	− 5.77	+2.18	277.43		27	+ 4.93	−2.39	355.07
	30	− 3.51	+2.75	211.25	Jan.	1	+ 2 50	−2.99	289 22

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

Carrington's Rotation Numbers—Greenwich date of commencement of synodic rotations.

No.	Commences	No.	Commences	No.	Commences
1301	1950 Dec. 9.74	1306	1951 Apr. 25.33	1311	1951 Sep. 8.43
1302	1951 Jan 6.07	1307	May 22.56	1312	Oct. 5.70
1303	Feb. 2.41	1308	Jun. 18.76	1313	Nov. 1.99
1304	Mar. 1.75	1309	Jul. 15.96	1314	Nov. 29.30
1305	Mar. 29.06	1310	Aug. 12.18	1315	Dec. 26.63

Continued from page 57.

all other features observed. Information equally important, but often forgotten, is the exact time and date of the phenomenon and an accurate description of where the observer was situated, given within 100 yds. if possible.

Skilled visual or photographic observations from two or more stations make possible the computation of meteor heights. Most meteors are visible in the range from 40 to 80 miles above the earth's surface and move with velocities ranging from 20 to 60 miles per second.

METEORS AND METEORITES

Many common terrestrial stones have mistakenly been thought to have a meteoric origin, and any supposed meteorite should be investigated carefully. Contrary to popular belief, meteorites do not contain valuable minerals in quantities sufficient to make them of commercial interest, but they have a definite scientific value. Meteorites are of two main types, iron and stone. The irons have specific gravity ranging from 7 to 8 and are amost entirely composed of metallic nickel-iron. The stones have a specific gravity ranging from 2 to 4 or greater and, with very few exceptions, contain metallic inclusions that are revealed on grinding or filing the specimen. A freshly fallen meteorite is covered by a smooth black fusion crust but oxidation removes this where the object has lain in the ground for any length of time. Any object whose history and structure indicate that it is of meteoric origin should be submitted to some authority for further study.

A more detailed discussion of both visual and photographic observations of meteors will be found in "General Instructions for Meteor Observing." Meteor observations for the United States may be sent to the American Meteor Society, Flower Observatory, Upper Darby, Pa.; those for Canada to the writer at the Dominion Observatory, Ottawa, Ont.

PRINCIPAL METEOR SHOWERS FOR THE NORTHERN HEMISPHERE

Shower	Approx. Radiant		Current Maximum Date	Spectacular Displays	Hourly Number (all meteors)	Duration (in days)	Abbreviations (for use in observing records)
	α	δ					
Quadrantids....	232°	+52°	Jan. 3		20	4	Q
Lyrids.........	280	+37	Apr. 21		10	4	Y
Eta Aquarids...	336	− 1	May 4		10	8	E
Delta Aquarids .	340	−17	July 28		20	12	D
Perseids........	47	+57	Aug. 12		50	25	P
Giacobinids.....	267	+55	Oct. 9	1933, 1946		1	J
Orionids.......	96	+15	Oct. 22		20	14	O
Taurids........	56	+16	Nov. 10?			30	T
Leonids........	152	+22	Nov. 16	1799, 1833, 1866, 1867	20	14	L
Bielids.........	25	+45	Nov. 27	1872, 1885			B
Geminids.......	110	+33	Dec. 12		30	14	G

TABLE OF PRECESSION FOR 50 YEARS

R.A.	Prec. in Dec.	Precession in Right Ascension $\delta = +85°$	+80°	+75°	+70°	+60°	+50°	+40°	+30°	+20°	+10°	0°	−10°	−20°	−30°	Prec. in Dec.	R.A.
h m	′	m	m	m	m	m	m	m	m	m	m	m	m	m	m	′	h m
0 00	+ 16.7	+ 2.56	+ 2.56	+ 2.56	+ 2.56	+ 2.56	+ 2.56	+ 2.56	+ 2.56	+ 2.56	+ 2.56	+ 2.56	+ 2.56	+ 2.56	+ 2.56	− 16.7	12 00
0 30	+ 16.6	+ 4.22	3.38	3.10	2.96	2.81	2.73	2.68	2.64	2.61	2.59	2.56	2.53	2.51	2.48	− 16.6	11 30
1 00	+ 16.1	+ 5.85	4.19	3.64	3.36	3.06	2.90	2.80	2.73	2.67	2.61	2.56	2.51	2.45	2.39	− 16.1	11 00
1 30	+ 15.4	+ 7.43	4.98	4.15	3.73	3.30	3.07	2.92	2.81	2.72	2.64	2.56	2.49	2.40	2.31	− 15.4	10 30
2 00	+ 14.5	+ 8.92	5.72	4.64	4.09	3.52	3.22	3.03	2.88	2.76	2.66	2.56	2.46	2.36	2.24	− 14.5	10 00
2 30	+ 13.2	+10.31	6.40	5.09	4.42	3.73	3.37	3.13	2.95	2.81	2.68	2.56	2.44	2.31	2.17	− 13.2	9 30
3 00	+ 11.8	+11.56	7.02	5.50	4.73	3.92	3.50	3.22	3.02	2.85	2.70	2.56	2.42	2.27	2.11	− 11.8	9 00
3 30	+ 10.2	+12.66	7.57	5.86	4.99	4.09	3.61	3.30	3.07	2.88	2.72	2.56	2.40	2.24	2.05	− 10.2	8 30
4 00	+ 8.3	+13.58	8.03	6.16	5.21	4.23	3.71	3.37	3.12	2.91	2.73	2.56	2.39	2.21	2.00	− 8.3	8 00
4 30	+ 6.4	+14.32	8.40	6.40	5.39	4.34	3.79	3.42	3.16	2.93	2.74	2.56	2.38	2.19	1.97	− 6.4	7 30
5 00	+ 4.3	+14.85	8.66	6.58	5.52	4.42	3.84	3.46	3.18	2.95	2.75	2.56	2.37	2.17	1.94	− 4.3	7 00
5 30	+ 2.2	+15.18	8.82	6.68	5.60	4.47	3.88	3.49	3.20	2.96	2.75	2.56	2.37	2.16	1.92	− 2.2	6 30
6 00	+ 0.0	+15.29	8.88	6.72	5.62	4.49	3.89	3.50	3.20	2.97	2 76	2.56	2.36	2.16	1.92	0.0	6 00
12 00	− 16.7	+ 2.56	+ 2.56	+ 2.56	+ 2.56	+ 2.56	+ 2.56	+ 2.56	+ 2.56	+ 2.56	+ 2.56	+ 2.56	+ 2.56	+ 2.56	+ 2.56	+ 16.7	24 00
12 30	− 16.6	+ 0.90	1.82	2.02	2.16	2.31	2.39	2.44	2.48	2.51	2.53	2.56	2.59	2.61	2.64	+ 16.6	23 30
13 00	− 16.1	− 0.73	+ 0.93	1.48	1.77	2.06	2.22	2.32	2.39	2.45	2.51	2.56	2.61	2.67	2.73	+ 16.1	23 00
13 30	− 15.4	− 2.31	+ 0.14	0.97	1.39	1.82	2.05	2.20	2.31	2.40	2.49	2.56	2.64	2.72	2.81	+ 15.4	22 30
14 00	− 14.5	− 3.80	− 0.60	+ 0.46	1.03	1.60	1.90	2.09	2.24	2.36	2.46	2.56	2.66	2.76	2.88	+ 14.5	22 00
14 30	− 13.2	− 5.19	− 1.28	+ 0.03	0.70	1.39	1.75	1.99	2.17	2.31	2.44	2.56	2.68	2.81	2.95	+ 13.2	21 30
15 00	− 11.8	− 6.44	− 1.90	− 0.38	+ 0.40	1.20	1.62	1.90	2.11	2.27	2.42	2.56	2.70	2.85	3.02	+ 11.8	21 00
15 30	− 10.2	− 7.54	− 2.45	− 0.74	+ 0.13	1.03	1.51	1.81	2.05	2.24	2.40	2.56	2.72	2.88	3.07	+ 10.2	20 30
16 00	− 8.3	− 8.46	− 2.91	− 1.04	− 0.09	+ 0.89	1.41	1.75	2.00	2.21	2.39	2.56	2.73	2.91	3.12	+ 8.3	20 00
16 30	− 6.4	− 9.20	− 3.27	− 1.28	− 0.27	+ 0 78	1.33	1.70	1.97	2.19	2.38	2.56	2.74	2.93	3.16	+ 6.4	19 30
17 00	− 4.3	− 9.73	− 3.54	− 1.45	− 0.40	+ 0.70	1.28	1.66	1.94	2.17	2.37	2.56	2.75	2.95	3.18	+ 4.3	19 00
17 30	− 2.2	−10.06	− 3.70	− 1.56	− 0.47	+ 0.65	1.25	1.63	1.92	2.16	2.37	2.56	2.75	2.96	3.20	+ 2.2	18 30
18 00	− 0.0	−10 17	− 3.75	− 1.60	− 0.50	+ 0.63	1.23	1.62	1.92	2.16	2.36	2.56	2.76	2.97	3.20	+ 0.0	18 00