THE HANDBOOK

OF THE

BRITISH ASTRONOMICAL ASSOCIATION

1949

1948 NOVEMBER

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CONTENTS

British Astronomical Association

HANDBOOK FOR 1949

TWENTY-EIGHTH YEAR OF PUBLICATION

PREFACE

In spite of increasing interest in astronomical matters, and the rapid growth in membership of the Association, there remains a deplorable lack of observations of occultations. In an attempt to stimulate interest in this important work, this number of the *Handbook* contains a reprint of the article on observing occultations, which first appeared in 1943. It is to be hoped that these notes may do something to remedy the present position. There is nothing difficult in timing an occultation, yet the results are of the utmost value.

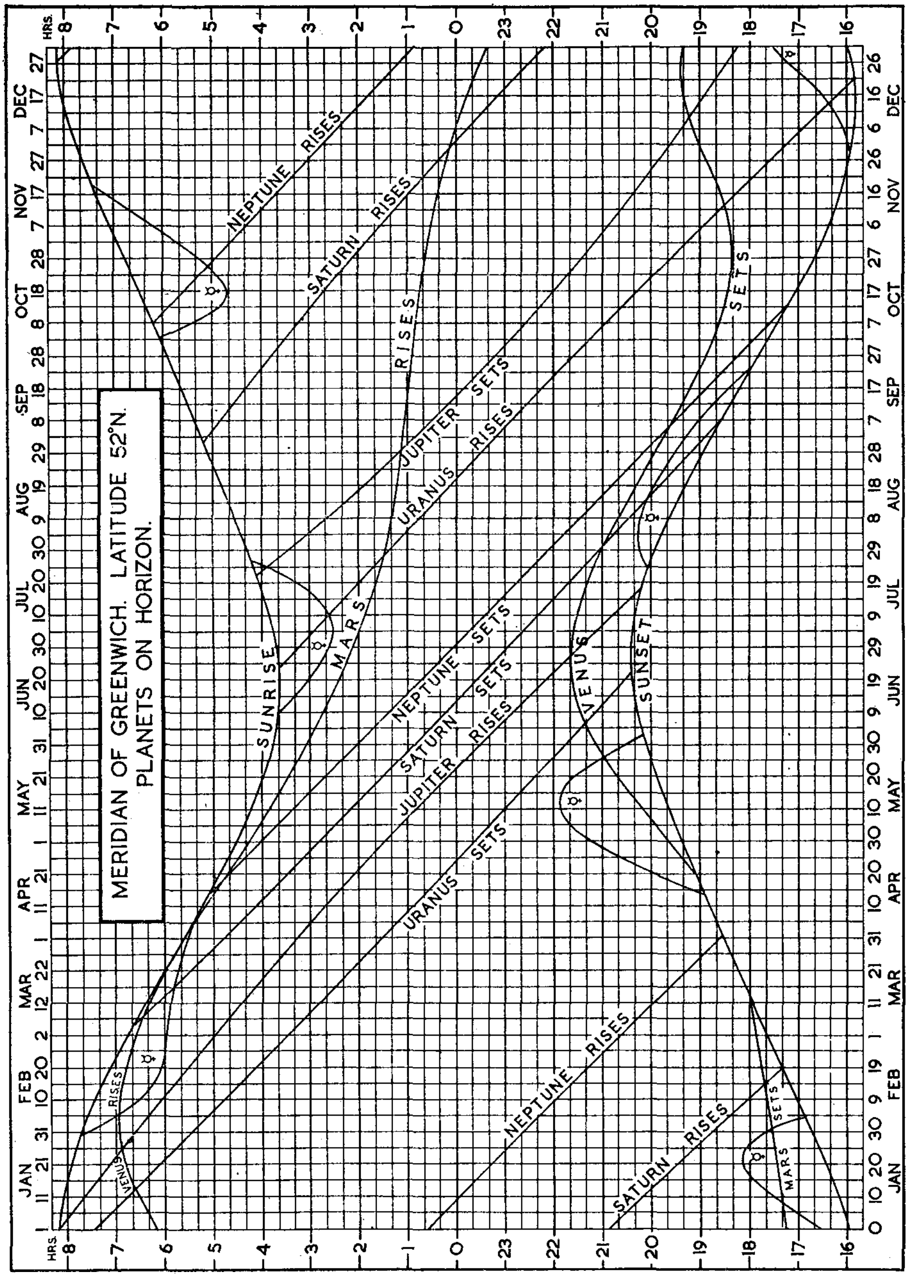
The passage of the ring-plane of Saturn through the Earth and Sun in September 1950 will not be observed, since Saturn at that time is near conjunction. There is, however, an increasing number of phenomena of Saturn's satellites at such times, and details will be found in these pages. Reports of observations of any of these phenomena will be welcomed. It also happems that the plane of the orbits of Jupiter's satellites is presented edge-on to the Earth in 1950, so that there is a possibility of eclipses and occultations of one satellite by another. Mr. D. A. Appleby has investigated the circumstances in 1949, but finds only one such phemonenon—an occultation of I by III on December 19^{d} $20^{h}\cdot 6$. Both satellites will be in transit at the time, and the occultation is not likely to be seen.

The notes on comets are due to Dr. G. Merton, whose labours throughout the Session ensure that these notes are as accurate and as up-to-date as possible. A great deal of computing has to be done to make these pages complete, and there is often little to show for so much effort. In this connection, the work of P. Brown on comet magnitudes must be mentioned particularly as being of great value. The friendly co-operation of Dr. Paul Herget and of Miss L. Oterma in supplying notes on comets is much appreciated.

The cordial thanks of the Association are due to the Astronomer-Royal and to the Superintendent of the Nautical Almanac Office; to Dr. L. J. Comrie for advice and criticism; to W. M. Witchell for the Magnetic Elements, to J. P. M. Prentice for the Meteor Diary, and to Mr. Arthur Burnet for his work on possible occultations of stars by planets. The work of all members of the Computing Section is gratefully acknowledged, and in addition to those whose names appear elsewhere in this issue, the work of J. K. Openshaw in assisting with the production of tabulated matter has been particularly helpful. The diagrams in this issue are the work of Miss E. C. M. Phillips (Planets, Precession, Saturn), D. W. Millar (Planetary Diagram) and G. Newell (Iapetus, Neptune, Uranus) while the Director, with some misgivings, drew the path of Pluto.

J. G. PORTER
Director, Computing Section.

13 CLEAVE ROAD
GILLINGHAM
KENT.


MERIDIAN OF GREENWICH. LATITUDE 52°N.
PLANETS ON HORIZON.
HRS.
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
NEPTUNE RISES
SATURN RISES
RISES
JUPITER SETS
URANUS RISES
MARS
SUNRISE
NEPTUNE SETS
SATURN SETS
JUPITER RISES
URANUS SETS
VENUS
SUNSET
SETS
MARS
RISES
VENUS

VISIBILITY OF PLANETS

The diagram on the opposite page shows the times for the actual rising and setting of the Sun and planets.

Since dates change at midnight, the dates at the top of the diagram differ by one day from those at the foot; each vertical line followed upwards represents the succession of phenomena in the course of one night. The name of the planet is always written on the side of the curve on which observation is possible. Thus on the night of Oct. 17-18, Uranus rises at $20^h\ 15^m$, while Jupiter sets at $22^h\ 00^m$; Mars rises at $0^h\ 44^m$, Saturn at $2^h\ 40^m$, and Mercury about $1\frac{3}{4}$ hours before the Sun.

The diagram has been drawn for a place on the meridian of Greenwich in latitude + 52°, but may be adapted for any place in the British Isles by applying two corrections as follows:—

(1) *Add* the longitude, expressed in time measure, if *west* of Greenwich; this applies to both rising and setting times.

(2) *Add* the correction from the following table for *setting* times, and *subtract* this correction for *rising*.

Thus rising time = time from diagram + longitude − correction
setting time = time from diagram + longitude + correction.

Example: Glasgow, $0^h\ 17^m$ W., 55° 53′ N. Date: Oct. 18.
Saturn rises at $2^h\ 40^m$ from diagram.
Dec. of Saturn (p. 34) = + 7°; correct = + 6^m.
Saturn rises at Glasgow $2^h\ 40^m + 17^m - 6^m = 2^h\ 51^m$.

Dec. \ Lat.	50°	51°	52°	53°	54°	55°	56°	57°	58°
+ 24°	− 12	− 6	0	+ 6	+ 12	+ 19	+ 27	+ 35	+ 44
+ 20	8	4	0	5	10	15	21	27	33
+ 16	6	3	0	3	7	11	15	20	24
+ 12	5	3	0	2	5	8	11	14	17
+ 8	3	− 2	0	2	4	5	7	9	11
+ 4	− 1	0	0	+ 1	+ 2	+ 3	+ 4	+ 5	+ 6
0	0	0	0	0	0	0	0	0	0
− 4	+ 1	0	0	− 1	− 2	− 3	− 4	− 4	− 5
− 8	2	+ 1	0	2	3	5	7	8	10
− 12	4	2	0	2	5	7	10	13	16
− 16	6	3	0	3	6	10	14	18	22
− 20	8	4	0	4	9	14	19	24	30
− 24	+ 11	+ 6	0	− 5	− 11	− 18	− 25	− 32	− 40

TIME RECKONING

Universal Time (U.T., Greenwich Mean Time beginning at midnight) is used generally by astronomers, and therefore in the *Handbook* and *Journal.*

Greenwich Mean Astronomical Time (G.M.A.T.) or Greenwich Mean Time beginning at noon, was in use before 1925 January 1, and all astronomical records prior to that date must be understood to refer to this system. This method of reckoning time has the advantage of avoiding the change of date at midnight, and is therefore used by observers of planets, meteors, etc. To convert U.T. to G.M.A.T., subtract twelve hours, and to convert G.M.A.T. to U.T., add twelve hours.

Equation of Time is the correction to be applied to mean time to give apparent (or sun-dial) time. This is the sense in which the equation of time is now used, although the reverse definition is sometimes given in textbooks.

Equation of Time = Apparent Time − Mean Time.
= Hour angle of true Sun − H.A. Mean Sun.
= R.A. Mean Sun − R.A. True Sun.

Sidereal Time is the hour angle of the First Point of Aries. We have

Sidereal Time = R.A. of a heavenly body + H.A. of that body,

hence the sidereal time is the R.A. of any heavenly body which happens to be in transit across the meridian at the moment. In particular,

Sidereal time at Mean Noon = R.A. Mean Sun.
= R.A. True Sun + Equation of Time.

The Sidereal Time at any other time of day may be obtained by adding to the Sidereal Time at Noon the sidereal equivalent of the mean time interval. For ordinary purposes, where an error of a few seconds is neglibigle, this may be done by adding to the mean time interval one 360th part of itself—and this is easily done by dividing by 6, and writing the hours in the minutes column, and the minutes in the seconds column. The sum of the mean time interval and its correction is the required sidereal interval. The following example will make this clear.

Required the sidereal time at $22^h\ 40^m$ on 1949 Feb. 18.

	h	m	s		h	m
Interval from noon =	10	40	0			
Divide by 6		1	47			
Sum	10	41	47	=	10	41·8
R.A. Sun at Noon					22	6·5
Equation of Time						−14·1
Sum = Sidereal Time					8	34·2

The local sidereal time is then obtained by subtracting the longitude if west, adding if east. The hour angle of a star is found by subtracting the star's R.A. from the local S.T.

Hour angle = G.S.T. − longitude − R.A.

The Solar Year is regarded as beginning at the moment when the Sun's mean longitude is 280°. This moment is called the beginning of the *Besselian fictitious year*, and is represented by the notation 1947·0, 1950·0, etc. In 1949, the Besselian year commences on January $0^d{\cdot}681$.

The Julian Date, in which the day begins at noon, is used in accurate computing work.

1949	J.D.	1949	J.D.	1949	J.D.
Jan. 0·5	243 2917	May 0·5	243 3037	Sept. 0·5	243 3160
Feb. 0·5	243 2948	June 0·5	243 3068	Oct. 0·5	243 3190
Mar. 0·5	243 2976	July 0·5	243 3098	Nov. 0·5	243 3221
Apr. 0·5	243 3007	Aug. 0·5	243 3129	Dec. 0·5	243 3251

Example: 1949 April $17^d\ 21^h\ 35^m$ = J.D. 2433024·39931

THE SUN, 1949

The tables on pages 6 and 7 give the values, **at mean noon** and at four-day intervals, of certain quantities which may be used in observations of the Sun, and in time measurement.

The R.A. and Dec. of the Sun and the Equation of Time (E) are given to $0^m·1$ and 1′. The Sun's true longitude is given to two decimal places, with differences, for the use of observers of meteors, zodiacal light, etc., as a measure of time.

The last three columns on pages 6 and 7 give

P = the position angle of the N. end of the axis of rotation, + if east of the north point of the disk, – if west.

B_0 = the heliographic latitude of the centre of the disk.

L_0 = the heliographic longitude of the centre of the disk.

The values of P and B_0 at any other time may be interpolated directly from the main table, while the value of L_0 may be obtained by use of the critical table below, bearing in mind the fact that L_0 *decreases* with time. The rate of decrease may be assumed to be 13°·2 per day, and although this is not strictly true, the resultant error should amount to less than 0°·2, which is less than the possible errors of measurement. Hence to obtain the value of L_0 at any other time, add 13°·2 for each day before, and subtract 13°·2 for each day after a date in the main table. Similarly add the appropriate angle from the critical table if before noon, and subtract if after noon.

The heliographical longitude and latitude of a spot may be conveniently estimated by the method described in *Journal*, **53**, 63, 1943.

Variation of L_0 with Time

h m	°	h m	°	h m	°	h m	°
0 00		1 44		3 33		5 22	
	0·0		1·0		2·0		3·0
05		54		44		33	
	0·1		1·1		2·1		3·1
16		2 05		54		44	
	0·2		1·2		2·2		3·2
27		16		4 05		54	
	0·3		1·3		2·3		3·3
38		27		16		6 05	
	0·4		1·4		2·4		3·4
49		38		27		16	
	0·5		1·5		2·5		3·5
1 00		49		38		27	
	0·6		1·6		2·6		3·6
11		3 00		49		38	
	0·7		1·7		2·7		3·7
22		11		5 00		49	
	0·8		1·8		2·8		3·8
33		22		11		7 00	
	0·9		1·9		2·9		3·9
44		33		22		11	
	1·0		2·0		3·0		4·0
1 54		3 44		33		7 22	

In critical cases ascend.

The dates of commencement of the synodic rotations, in continuation of Carrington's (Greenwich Photo-Heliographic) series, are as follows:

Rotation No.	Commences		d	Rotation No.	Commences		d
1275	1948	Dec.	30·63	1282	1949	July	9·55
1276	1949	Jan.	26·97	1283		Aug.	5·76
1277		Feb.	23·21	1284		Sept.	2·00
1278		Mar.	22·63	1285		Sept.	29·27
1279		Apr.	18·91	1286		Oct.	26·56
1280		May	16·14	1287		Nov.	22·86
1281		June	12·35	1288		Dec.	20·18

The sidereal period of rotation of the Sun used in physical ephemerides is 25·38 mean solar days, after Carrington; the mean synodic rotation period is $27^d·2753$.

The Sun at *Noon*

Date	R.A.		Dec^n.	*E*	True Long. 1950·0		*P*	B_0	L_0
	h m		° ′	m	°		°	°	°
Jan. 1	18 46.8	17·7	− 23 01	− 3.6	280.79	4.07	+ 1.9	− 3.1	335·3
5	19 04·5	17·5	22 37	5·5	284·86	4.08	0.0	3·6	282·7
9	19 22·0	17·3	22 07	7·2	288·94	4·08	− 2·0	4·0	230·0
13	19 39·3	17·2	21 29	8·8	293·02	4·07	3·9	4·4	177·3
17	19 56·5	17·0	20 45	10·2	297·09	4·07	5·8	4·8	124·6
21	20 13·5	16·8	− 19 55	− 11·4	301·16	4·07	− 7·6	− 5·2	72·0
25	20 30·3	16·6	18 58	12·4	305·23	4.06	9·4	5·6	19·3
29	20 46·9	16·3	17 56	13·2	309·29	4·06	11·1	5·9	326·6
Feb. 2	21 03·2	16·2	16 49	13·8	313·35	4·06	12·7	6·2	274·0
6	21 19·4	15·9	15 38	14·2	317·41	4·05	14·3	6·4	221.3
10	21 35·3	15·7	− 14 22	− 14·4	321·46	4·04	− 15·8	− 6·6	168·6
14	21 51·0	15·5	13 02	14·3	325·50	4·04	17·2	6·8	116·0
18	22 06·5	15·4	11 39	14·1	329·54	4·03	18·5	7·0	63·3
22	22 21·9	15·2	10 13	13·6	333·57	4·02	19·8	7·1	10·6
26	22 37·1	15·0	8 44	13·0	337·59	4·02	20·9	7·2	317·9
Mar. 2	22 52·1	14·9	− 7 13	− 12·3	341·61	4·01	− 21·9	− 7·2	265·2
6	23 07·0	14·8	5 41	11·4	345·62	4·00	22·9	7·2	212·5
10	23 21·8	14·7	4 07	10·4	349·62	3·98	23·7	7·2	159·8
14	23 36·5	14·6	2 33	9·4	353·60	3·98	24·4	7·2	107·1
18	23 51·1	14·6	− 0 58	8·2	357·58	3·98	25·0	7·1	54·4
22	0 05·7	14·5	+ 0 37	− 7·0	1·56	3·98	− 25·5	− 7·0	1·7
26	0 20·2	14·6	2 11	5·8	5·52	3·96	25·9	6·8	308·9
30	0 34·8	14·5	3 45	4·6	9·48	3·94	26·2	6·6	256·1
Apr. 3	0 49·3	14·6	5 18	3·4	13·42	3·94	26·3	6·4	203·4
7	1 3·9	14·7	6 49	2·2	17·36	3·93	26·4	6·1	150·6
11	1 18·6	14·8	+ 8 18	− 1·1	21·29	3·91	− 26·3	− 5·8	97·8
15	1 33·4	14·8	9 45	− 0·1	25·20	3·91	26·1	5·5	45·0
19	1 48·2	14·9	11 09	+ 0.9	29·11	3·90	25·8	5·2	352·1
23	2 03·1	15·1	12 31	1·7	33·01	3·90	25·4	4·8	299·3
27	2 18·2	15·2	13 49	2·4	36·91	3·88	24·8	4·5	246·5
May 1	2 33·4	15·4	+ 15 04	+ 2·9	40·79	3·88	− 24·2	− 4·1	193·6
5	2 48·8	15·5	16 14	3·4	44·67	3·87	23·4	3·7	140·7
9	3 04·3	15·6	17 21	3·6	48·54	3·86	22·5	3·2	87·8
13	3 19·9	15·8	18 22	3·8	52·40	3·85	21·5	2·8	34·9
17	3 35·7	15·9	19 19	3·7	56·25	3·85	20·4	2·3	342·0
21	3 15·6	16·1	+ 20 11	+ 3·6	60·10	3·85	− 19·2	− 1·9	289·1
25	4 07·7	16·3	20 57	3·2	63·95	3·84	17·9	1·4	236·2
29	4 24·0	16·3	21 37	2·8	67·79	3·83	16·5	0·9	183·3
June 2	4 40·3	16·4	22 11	2·2	71·62	3·83	15·0	− 0·4	130.3
6	4 56·7	16·6	22 39	1·5	75·45	3·82	13·5	0·0	77·4
10	5 13·3	16·6	+ 23 01	+ 0·8	79·27	3·82	− 11·8	+ 0·5	24·5
14	5 29·9	16·6	23 16	0·0	83·09	3·82	10·2	1·0	331·5
18	5 46·5	16·6	23 25	− 0·9	86·91	3·82	8·4	1·5	278·6
22	6 3·1	16·6	23 27	1·8	90·73	3·82	6·7	2·0	225·6
26	6 19·7	16·6	23 22	2·6	94·54	3·81	4·9	2·4	172·7
30	6 36·3	16·6	+ 23 11	− 3·5	98·36	3·81	− 3·1	+ 2·9	119·7

The Sun at *Noon*

Date	R.A.		Decⁿ.	E	True Long. 1950·0		P	B_0	L_0
	h m		° ′	m	°		°	°	°
July 4	6 52·9	16·4	+ 22 53	− 4·2	102·17	3·82	− 1·2	+ 3·3	66·8
8	7 09·3	16·3	22 29	4·9	105·99	3·81	+ 0·6	3·7	13·8
12	7 25·6	16·3	21 59	5·4	109·80	3·81	2·4	4·1	320·9
16	7 41·9	16·0	21 23	5·9	113·61	3·82	4·2	4·5	268·0
20	7 57·9	16·0	20 41	6·2	117·43	3·82	5·9	4·9	215·0
24	8 13·9	15·8	+ 19 53	− 6·4	121·25	3·82	+ 7·6	+ 5·2	162·1
28	8 29·7	15·6	19 01	6·4	125·07	3·83	9·3	5·5	109·2
Aug. 1	8 45·3	15·4	18 03	6·2	128·90	3·83	10·9	5·8	56·3
5	9 00·7	15·3	17 00	5·9	132·73	3·83	12·5	6·1	3·4
9	9 16·0	15·2	15 53	5·4	136·56	3·84	14·0	6·4	310·5
13	9 31·2	15·0	+ 14 42	− 4·8	140·40	3·84	+ 15·4	+ 6·6	257·6
17	9 46·2	14·8	13 27	4·0	144·24	3·85	16·8	6·8	204·8
21	10 01·0	14·8	12 09	3·1	148·09	3·86	18·1	6·9	151·9
25	10 15·8	14·6	10 47	2·1	151·95	3·86	19·3	7·1	99·1
29	10 30·4	14·5	9 23	− 0·9	155·81	3·87	20·4	7·1	46·2
Sept. 2	10 44·9	14·5	+ 7 57	+ 0·3	159·68	3·88	+ 21·4	+ 7·2	353·4
6	10 59·4	14·4	6 28	1·6	163·56	3·88	22·4	7·2	300·5
10	11 13·8	14·3	4 58	3·0	167·44	3·90	23·2	7·2	247·7
14	11 28·1	14·4	3 26	4·4	171·34	3·90	24·0	7·2	194·9
18	11 42·5	14·3	1 54	5·8	175·24	3·91	24·7	7·1	142·1
22	11 56·8	14·4	+ 0 21	+ 7·2	179·15	3·92	+ 25·2	+ 7·0	89·3
26	12 11·2	14·5	− 1 13	8·6	183·07	3·93	25·7	6·9	36·5
30	12 25·7	14·5	2 46	10·0	187·00	3·93	26·0	6·7	343·7
Oct. 4	12 40·2	14·6	4 19	11·2	190·93	3·95	26·2	6·5	290·9
8	12 54·8	14·7	5 52	12·4	194·88	3·95	26·4	6·3	238·2
12	13 09·5	14·8	− 7 23	+ 13·5	198·83	3·97	+ 26·4	+ 6·0	185·4
16	13 24·3	15·0	8 52	14·4	202·80	3·97	26·2	5·7	132·6
20	13 39·3	15·2	10 19	15·2	206·77	3·99	26·0	5·4	79·9
24	13 54·5	15·4	11 44	15·8	210·76	3·99	25·6	5·1	27·1
28	14 09·9	15·5	13 06	16·2	214·75	4·00	25·1	4·7	334·4
Nov. 1	14 25·4	15·8	− 14 25	+ 16·4	218·75	4·00	+ 24·5	+ 4·3	281·6
5	14 41·2	16·0	15 40	16·4	222·75	4·01	23·8	3·9	228·9
9	14 57·2	16·2	16 51	16·2	226·76	4·03	22·9	3·4	176·1
13	15 13·4	16·4	17 57	15·7	230·79	4·03	21·9	3·0	123·4
17	15 29·8	16·7	18 59	15·0	234·82	4·04	20·8	2·5	70·7
21	15 46·5	16·9	− 19 55	+ 14·1	238·86	4·05	+ 19·6	+ 2·0	18·0
25	16 03·4	17·1	20 45	13·0	242·91	4·05	18·3	1·5	325·2
29	16 20·5	17·2	21 29	11·7	246·96	4·05	16·8	1·0	272·5
Dec. 3	16 37·7	17·4	22 06	10·2	251·01	4·06	15·3	+ 0·5	219·8
7	16 55·1	17·6	22 37	8·6	255·07	4·06	13·6	0·0	167·1
11	17 12·7	17·7	− 23 01	+ 6·8	259·13	4·07	+ 11·9	− 0·5	114·4
15	17 30·4	17·7	23 16	4·9	263·20	4·07	10·1	1·0	61·7
19	17 48·1	17·8	23 25	2·9	267·27	4·08	8·3	1·5	9·0
23	18 05·9	17·7	23 26	+ 0·9	271·35	4·08	6·4	2·0	316·3
27	18 23·6	17·7	23 20	− 1·1	275·43	4·07	4·5	2·5	263·6
31	18 41·3		− 23 06	− 3·0	279·50		+ 2·5	− 3·0	210·9

ECLIPSES, 1949

In 1949 there will be four eclipses, two of the Sun and two of the Moon. There are no penumbral eclipses of the Moon during the year.

1. *Total eclipse of the Moon,* April 13, visible at Greenwich. The moon is at the decending node, and almost at perigee.

	h m		h m
Moon enters penumbra	1 31·6	leaves	6 50·3
Moon enters umbra	2 27·7	leaves	5 54·1
Total eclipse begins	3 28·0	ends	4 53·8
Middle of eclipse	4 10·9	magnitude	1·432
First contact of umbra	$P = 131°$	last contact	$P = 283°$
Sun rises at Greenwich	$5^h\ 10^m$	Moon sets	$5^h\ 16^m$.

2. *Partial eclipse of the Sun,* April 28, visible at Greenwich.

	Mag.	Begins	P	Middle	Ends	P
		h m	°	h m	h m	°
Edinburgh	0·45	6 28	272	7 25	8 25	26
Greenwich	0·41	6 21	275	7 15	8 14	23
Plymouth	0·43	6 18	274	7 13	8 11	25

3. *Total eclipse of the Moon.* October 6-7, visible at Greenwich. The Moon is at the ascending node, and almost at apogee.

	d h m		d h m
Moon enters penumbra	6 23 50·1	leaves	7 06 02·7
Moon enters umbra	7 01 04·7	leaves	4 48·1
Total eclipse begins	2 19·5	ends	3 33·2
Middle of eclipse	2 56·4	magnitude	1·228
First contact of umbra	$P = 42°$	last contact	$P = 260°$
Sun rises at Greenwich	$6^h\ 10^m$.	Moon sets	$6^h\ 24^m$.

4. *Partial eclipse of the Sun,* October 21, invisible at Greenwich, visible in New Zealand and parts of Australia.

	Mag.	Begins	P	Middle	Ends	P
		h m	°	h m	h m	°
Melbourne	0·73	19 35	283	20 26	21 20	138
Sydney	0·64	19 29	279	20 19	21 12	145
Wellington	0·51	19 46	275	20 39	21 36	157

In 1932 there were five eclipses. The fifth eclipse was a small partial eclipse of the Sun at the Moon's descending node in September, and was the last of a series which has now moved off the Earth at the north pole.

P = position angle of the point of contact, measured from the north point of the disk.

THE MOON, 1949

Lunation	New Moon	First Quarter	Full Moon	Last Quarter
	d h m	d h m	d h m	d h m
322		Jan. 7 11 51	Jan. 14 21 59	Jan. 21 14 07
323	Jan. 29 02 42	Feb. 6 08 05	Feb. 13 09 08	Feb. 20 00 43
324	Feb. 27 20 55	Mar. 8 00 42	Mar. 14 19 03	Mar. 21 13 10
325	Mar. 29 15 11	Apr. 6 13 01	Apr. 13 04 08	Apr. 20 03 27
326	Apr. 28 08 02	May 5 21 33	May 12 12 51	May 19 19 22
327	May 27 22 24	June 4 03 27	June 10 21 45	June 18 12 29
328	June 26 10 02	July 3 08 08	July 10 07 41	July 18 06 01
329	July 25 19 33	Aug. 1 12 57	Aug. 8 19 33	Aug. 16 22 59
330	Aug. 24 03 59	Aug. 30 19 16	Sept. 7 09 59	Sept. 15 14 29
331	Sept. 22 12 21	Sept. 29 04 18	Oct. 7 02 52	Oct. 15 04 06
332	Oct. 21 21 23	Oct. 28 17 04	Nov. 5 21 09	Nov. 13 15 47
333	Nov. 20 07 29	Nov. 27 10 01	Dec. 5 15 13	Dec. 13 01 48
334	Dec. 19 18 55	Dec. 27 06 31		

The lunation numbers are a continuation of Brown's series (E. W. Brown, "The Motion of the Moon, 1923—1931", *M.N.*, **93**, 603), of which No. 1 commenced on 1923 January 16. These numbers are always quoted in any reference to occultation observations, and may be recommended as a convenient system of reference in any lunar observations.

Perigee			Apogee		
Date	Diam.	H.P.	Date	Diam.	H.P.
d h	′ ″	′ ″	d h	′ ″	′ ″
Jan. 17 03	32 54	60 22	Jan 5 08	29 31	54 10
Feb. 14 10	33 20	61 09	Feb. 2 02	29 27	54 03
Mar. 14 21	33 30	61 28	Mar. 1 12	29 24	53 57
Apr. 12 09	33 22	61 14	Mar. 28 13	29 24	53 56
May 10 15	33 00	60 34	Apr. 24 22	29 26	54 01
June 7 07	32 33	59 45	May 22 14	29 31	54 09
July 2 22	32 19	59 19	June 19 08	29 34	54 16
July 29 01	32 38	59 53	July 17 02	29 34	54 15
Aug. 25 21	33 04	60 41	Aug. 13 20	29 31	54 09
Sept. 23 04	33 23	61 16	Sept. 10 11	29 26	54 01
Oct. 21 15	33 27	61 24	Oct. 7 17	29 25	53 58
Nov. 19 02	33 14	61 00	Nov. 3 18	29 26	54 00
Dec. 17 07	32 47	60 10	Dec. 1 06	29 29	54 06
			Dec. 29 00	29 32	54 12

H.P. = Horizontal parallax.

The distance of the Moon from the Earth in miles may be found by dividing 817,500,000 by the H.P. in seconds of arc.

LIBRATION

The following table gives the dates of maximum libration of the Moon. The headings of the columns show the *limb* which is exposed to view by libration, and if the age of the Moon is taken into account, observers will be able to select dates most suitable for observation of objects near the limb.

North			East			South			West		
Date		Age	Date		Age	Date		Age	Date		Age
		d			d			d			d
Jan.	1	New	Jan.	11	11·6	Jan.	15	15·6	Jan.	24	24·6
Jan.	28	28·6	Feb.	9	10·9	Feb.	12	13·9	Feb.	21	22·9
Feb.	24	25·9	Mar.	9	9·1	Mar.	11	11·1	Mar.	21	21·1
Mar.	24	24·1	Apr.	6	7·4	Apr.	7	8·4	Apr.	18	19·4
Apr.	20	21·4	May	3	4·7	May	4	5·7	May	17	18·7
May	17	18·7	May	30	2·1	June	1	4·1	June	13	16·6
June	13	16·1	June	26	New	June	28	New	July	11	14·6
July	11	14·6	July	23	26·6	July	25	New	Aug.	6	11·2
Aug.	7	12·2	Aug.	20	25·2	Aug.	21	26·2	Sept.	2	8·8
Sept.	3	9·8	Sept.	17	23·8	Sept.	17	24·3	Sept.	30	7·5
Sept.	30	7·5	Oct.	15	22·5	Oct.	15	22·5	Oct.	28	6·1
Oct.	27	5·1	Nov.	12	21·1	Nov.	11	20·1	Nov.	25	4·7
Nov.	24	3·7	Dec.	10	19·7	Dec.	8	17·7	Dec.	23	3·2
Dec.	21	New									

THE OBSERVATION OF OCCULTATIONS

The observation of occultations is a straightforward matter well within the reach of all amateurs, and it is a fact of some concern that the number of observations of this kind has shown a considerable decrease within recent years. With the object of reviving interest in the subject, the following notes have been compiled, principally from the experiences of Messrs. Addey, Eldridge, Green, Ogilvie and Saxton, to whom due acknowledgements and thanks are offered.

For the purpose of timing an occultation, it is necessary to have a clock or chronometer which can be relied upon to keep a constant rate, at least for a few hours between two wireless signals. It is also necessary, when at the telescope, either to be able to listen to the ticks of a clock, or to use some kind of chronograph. The best method is probably to use a chronograph, and a simple form of this instrument has been described by Mr. W. T. Hay in *Journal*, **43**, 80. The eye-and-ear method is, however, quite successful, although it entails the estimation of fractions of a second. An audible seconds transmission from a master clock can easily be contrived from an old bell movement, and gives a loud tick which makes counting easy. The favourite method with most observers, however, is to use a stop-watch, and the following details refer principally to this method.

The Telescope.—It is not necessary to have a large instrument, nor need it be mounted equatorially. Indeed, it is likely that it will be found more convenient to leave the telescope stationary. Use the full aperture available, with a fairly low power. This has many advantages, especially if the star is faint, or earth-shine is present. The diameter of the field should be known, so that the time for a star to drift across the field can be estimated. A few minutes before the occultation is due, take up a *comfortable* position at the telescope, and note the direction in which the star drifts across the field. About a minute before time, adjust the telescope so that the star is just on the edge of the field, and so placed that it will drift across a diameter. Thus with an eyepiece magnifying, say, 52 diameters, having a field of diameter 35′, the star will take about two minutes to drift across the field, and the occultation will take place near the centre. This method gives at least some small sense of anticipation of the phenomenon, which is entirely lacking in other methods. To lessen the strain of waiting, it is also a good plan to count seconds from the moment the star has been moved to the edge of the field.

Timing.—The actual timing is done by starting the stop-watch at the instant the star disappears, and the watch is at once taken to the clock. A definite second (some seconds in advance) is decided upon, and the rhythm of the clock-ticks is picked up, and as the seconds hand of the clock jumps to the second decided upon, the stop-watch is stopped. The clock-time at which the watch is stopped, less the reading of the stop-watch, is the time of occultation. By applying to this time the clock-error, the G.M.T. of the occultation is determined.

Alternatively, the stop-watch may be taken to the phone, and the accurate time obtained from the speaking clock. Here again the time given by TIM, less the time on the stop-watch, is the correct time of the observation. It is not really satisfactory to let the stop-watch run until a wireless time-signal is obtained, because no stop-watch has a regular rate over long periods.

Errors.—The clock or chronometer should be checked as often as possible against the wireless time-signals, and the error plotted against G.M.T. on squared paper, so that the error at any time may be determined. The error should be counted as negative if the clock is fast, positive if it is slow. The rate of the stop-watch should also be known, at least for the short time taken to walk from the telescope to the clock. It is quite common for a stop-watch to go appreciably faster when fully wound. Generally speaking, if this method is followed, the error due to the stop-watch is too small to be noticed.

The most important error to correct in this work is that due to personal equation. There is always a time-lag in starting a stop-watch or chronograph when a star suddenly vanishes, or any other event occurs which cannot be precisely anticipated. There is no appreciable lag in timing any particular second on the clock, or the last of the six "pips" on the wireless, because these can be anticipated. The lag in timing an occultation is least when the event occurs at the dark limb of the Moon illuminated by earth-shine. It is not easy to get a good estimate of one's personal equation in this respect, but one method suggested is to get a friend to switch off an electric light on the exact tick of some particular second of the clock. The observer, some distance away, out of hearing of either the light-switch or the clock, then records the phenomenon exactly as if it were an occultation, and the result is compared with the friend's record of the time of the occurrence. It is difficult to give any definite figure for this error, but it is suggested that 0·3 second would be quite a reasonable allowance. If this error be counted negative, then we have

G.M.T. of occultation = Clock-time = stop-watch time
+ clock-error
+ personal equation.

Finally, do not abandon the observation because clouds are drifting across the sky, until the time of occultation is definitely past. And do not keep all your results until the end of the year—send them along in good time, please!

LUNAR OCCULTATIONS, 1949

Details are given in the following lists of the more readily observable occultations visible at eight stations. Complete lists for stars down to magnitude 7·5 are given each year in the *Nautical Almanac.*

Ph. is the Phase—whether disappearance (D) or reappearance (R).

P is the position angle of the star, measured to the east from the north point of the Moon.

The time of occultation at a place $\Delta\lambda$ degrees *west* and $\Delta\phi$ degrees *north* of a place for which prediction is given may be found from

$$\text{predicted time} + a.\Delta\lambda + b.\Delta\phi$$

in which the coefficients *a* and *b* are given in the table in minutes. If the observer is *east* of the given place, then $\Delta\lambda$ is taken as negative; similarly $\Delta\phi$ is negative if the observer is *south* of a place for which a prediction is given.

For distances up to 300 miles the error will not usually exceed 2 minutes.

Example: Observer at Liverpool, 53° 24′ N., 3°·1 W.

Occultation of 37 Capricorni on October 29.
Observer is 1°·9 N. and 3°·1 W. of Greenwich.
Correction to Greenwich time $= +3{\cdot}1\,(-2{\cdot}3) + 1{\cdot}9\,(\;\;1{\cdot}0) = -9^{m}{\cdot}0$.
Approximate time $= 19^{h}\,51^{m}{\cdot}0 - 9^{m}{\cdot}0 = 19^{h}\,42^{m}{\cdot}0$.

The positions of the eight stations named are as follows:—

	Long.	Lat.		Long.	Lat.
	h m	° ′		h m	° ′
Greenwich	0 00·0	51 29 N.	Wellington	11 39·1 E.	41 17 S.
Edinburgh	0 12·7 W.	55 55 N.	Dunedin	11 22·0 E.	45 52 S.
Cape	1 13·9 E.	33 56 S.	Melbourne	9 39·9 E.	37 50 S.
Johannesburg	1 52·3 E.	26 11 S.	Sydney	10 04·8 E.	33 52 S.

The Pleiades.—The Moon passes close to the Pleiades each month during the year, and some of the stars in this group will be seen to be occulted by observers in the southern hemisphere:—

In New Zealand and Australia on September 13 and December 4.
In South Africa on October 10 and December 31.

OCCULTATIONS OF STARS BY PLANETS

Mr. Arthur Burnett has investigated the possibility of occultations of stars by planets during 1949, but reports that he has been unable to find a single case of such an occultation during the year. The Washington Zodiacal Catalogue of stars down to magnitude 7·0 was used, and was supplemented in the case of Jupiter and Saturn by the A. G. Zone Catalogues, stars down to magnitude 8·0 having been examined.

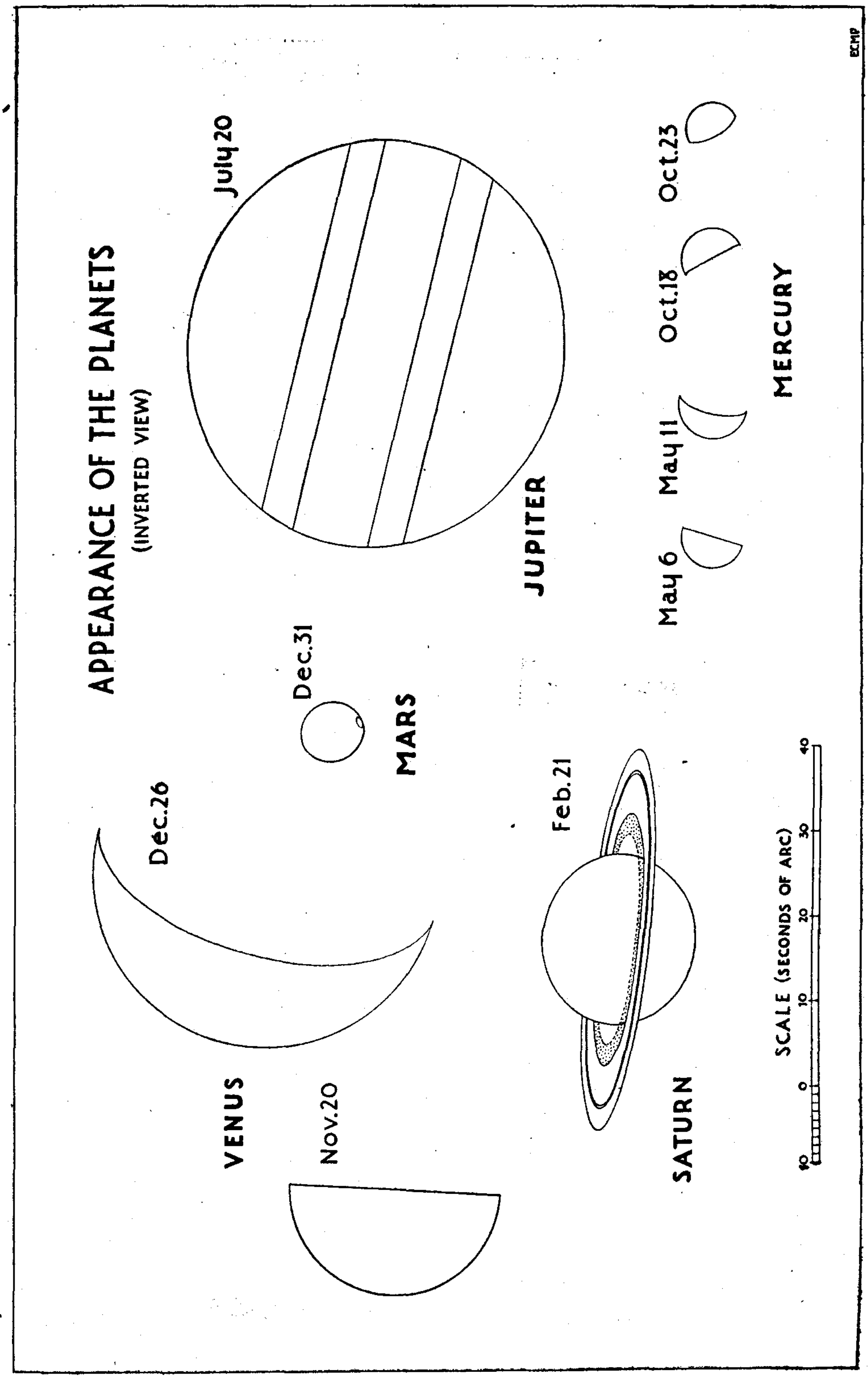
Date	Star	Mag.	Ph.	U.T.	*a*	*b*	*P*
	GREENWICH			h m	m	m	°
Jan. 11	32 Tauri	5·8	D	2 17·3	− 0·2	− 1·1	75
12	112B. Aurigæ	5·7	D	17 40·7	+ 0·2	+ 2·5	36
Feb. 3	*e* Piscium	5·7	D	21 13·4	− 0·4	− 2·2	97
15	η Virginis	4·0	D	22 47·1	− 0·2	− 1·1	164
15	η Virginis	4·0	R	23 34·3	− 1·2	+ 1·7	263
Mar. 5	δ Arietis	4·5	D	21 49·3	− 0·5	0·0	39
8	136 Tauri	4·5	D	20 21·8	− 1·4	− 0·6	86
Apr. 7	*c* Geminorum	5·4	D	0 31·4	+ 0·2	− 1·8	122
11	η Virginis	4·0	D	20 56·3	− 0·9	0·0	124
July 6	40B. Scorpii	5·4	D	22 44·7	− 1·3	− 1·0	114
Aug. 2	42 Libræ	5·1	D	20 58·2	− 1·3	− 1·2	115
Sept. 16	136 Tauri	4·5	R	0 05·3	+ 0·3	+ 1·8	242
Oct. 14	49 Aurigæ	5·0	R	0 43·3	− 0·8	+ 0·9	294
29	37 Capricorni	5·8	D	19 51·0	− 2·3	− 1·0	108
29	ε Capricorni	4·7	D	21 33·2	− 0·6	− 0·2	45
Nov. 3	ζ Piscium	5·6	D	20 30·4	...	...	349
Dec. 3	τ Arietis	5·2	D	22 53·6	− 1·8	− 0·2	89
6	136 Tauri	4·5	D	17 52·1	+ 0·4	+ 1·5	73
6	136 Tauri	4·5	R	18 46·7	0·0	+ 1·5	267
23	κ Capricorni	4·8	D	16 43·9	− 1·8	− 0·8	95
25	χ Aquarii	5·1	D	17 10·6	− 1·0	+ 1·0	39
31	104B. Tauri	5·5	D	19 18·0	− 0·5	+ 2·8	27
	EDINBURGH						
Jan. 11	32 Tauri	5·8	D	2 11·6	− 0·3	− 1·0	65
12	112B. Aurigæ	5·7	D	17 54·4	+ 0·5	+ 3·2	19
Feb. 3	*e* Piscium	5·7	D	21 04·2	− 0·4	− 1·5	80
15	η Virginis	4·0	D	22 43·4	− 0·3	− 0·2	149
15	η Virginis	4·0	R	23 37·5	− 0·8	+ 1·2	276
Mar. 5	δ Arietis	4·5	D	21 48·6	− 0·7	+ 0·7	23
8	136 Tauri	4·5	D	20 15·8	− 1·3	0·0	73
10	47 Geminorum	5·6	D	3 38·9	+ 0·1	− 1·0	61
Apr. 1	ρ Arietis	5·6	D	20 00·2	+ 0·3	− 3·8	131
7	*c* Geminorum	5·4	D	0 23·7	+ 0·1	− 1·8	120
11	η Virginis	4·0	D	20 54·2	− 0·9	+ 0·4	115
Sept. 16	136 Tauri	4·5	R	0 14·1	+ 0·2	+ 1·7	251
Oct. 14	49 Aurigæ	5·0	R	0 43·4	− 0·9	+ 0·5	311
29	37 Capricorni	5·8	D	19 41·9	− 1·7	− 0·4	96
Dec. 3	τ Arietis	5·2	D	22 49·6	− 1·4	+ 0·5	73
6	136 Tauri	4·5	D	18 00·2	+ 0·4	+ 1·6	65
6	136 Tauri	4·5	R	18 53·2	0·0	+ 1·4	277
23	κ Capricorni	4·8	D	16 36·2	− 1·4	− 0·4	84
25	χ Aquarii	5·1	D	17 12·4	− 0·7	+ 1·0	27
31	104B. Tauri	5·5	D	19 32·4	+ 0·2	+ 4·0	5

Date	Star	Mag.	Ph.	U.T.	*a*	*b*	*P*
	CAPE			h m	m	m	°
Jan. 19	γ Virginis	2·9	D	23 49·5	− 1·7	− 0·5	70
20	γ Virginis	2·9	R	0 26·8	+ 0·1	− 3·2	3
Feb. 10	ι Geminorum	3·9	D	23 07·4	− 1·7	+ 0·9	88
16	θ Virginis	4·4	D	20 48·2	− 0·2	− 1·5	115
Mar. 10	φ Geminorum	5·0	D	19 29·3	...	...	172
Apr. 4	β Tauri	1·8	D	15 37·1	− 2·2	+ 1·3	47
4	β Tauri	1·8	R	16 51·1	− 2·0	− 0·2	300
May 6	η Leonis	3·6	D	18 59·8	− 0·4	− 1·9	167
June 8	ι Libræ	4·7	D	19 15·8	− 1·8	− 1·1	104
Aug. 19	β Tauri	1·8	D	3 47·0	− 1·3	− 0·3	66
19	β Tauri	1·8	R	5 09·9	− 2·2	− 0·3	262
30	σ Scorpii	3·1	D	20 21·4	− 2·1	− 2·9	157
30	σ Scorpii	3·1	R	20 55·0	+ 0·3	+ 4·2	216
Sept. 29	τ Sagittarii	3·4	D	20 07·7	− 1·7	+ 0·8	95
29	τ Sagittarii	3·4	R	21 14·1	− 0·2	+ 2·2	229
Oct. 10	η Tauri	3·0	D	21 39·6	− 0·9	− 0·5	70
10	η Tauri	3·0	R	22 53·8	− 1·0	+ 0·4	228
Nov. 9	β Tauri	1·8	D	1 45·0	− 2·5	− 0·9	130
9	β Tauri	1·8	R	2 51·9	− 2·6	+ 2·2	223
14	η Leonis	3·6	D	1 41·0	− 1·2	− 1·4	99
14	η Leonis	3·6	R	2 53·5	− 1·5	− 1·8	314
30	ε Piscium	4·4	D	23 01·8	− 0·6	+ 3·0	13
	JOHANNESBURG						
Feb. 16	θ Virginis	4·4	D	20 41·2	− 0·6	− 1·0	95
Mar. 10	φ Geminorum	5·0	D	19 28·7	− 1·7	− 1·1	135
Apr. 4	β Tauri	1·8	D	16 20·2	...	...	22
4	β Tauri	1·8	R	16 58·1	...	...	334
May 6	η Leonis	3·6	D	18 59·5	− 1·4	− 0·7	126
Aug. 19	β Tauri	1·8	D	4 01·5	− 1·9	+ 0·3	63
19	β Tauri	1·8	R	5 33·4	− 2·8	0·0	268
30	σ Scorpii	3·1	D	20 25·2	− 1·3	− 0·8	133
30	σ Scorpii	3·1	R	21 15·2	+ 0·2	+ 2·1	236
Sept. 29	τ Sagittarii	3·4	D	20 27·9	− 1·1	+ 0·9	90
29	τ Sagittarii	3·4	R	21 30·4	+ 0·1	+ 1·8	233
30	*A* Sagittarii	5·0	D	16 53·5	...	...	132
Oct. 10	23 Tauri	4·2	D	21 01·4	− 0·9	− 0·1	66
10	η Tauri	3·0	D	21 48·1	− 1·3	0·0	68
10	η Tauri	3·0	R	23 10·6	− 1·6	+ 1·0	227
Nov. 9	β Tauri	1·8	D	2 04·0	− 2·3	0·0	109
9	β Tauri	1·8	R	3 28·6	− 1·9	+ 1·4	254
14	η Leonis	3·6	D	1 47·9	− 2·0	− 0·6	80
Dec. 31	17 Tauri	3·8	D	17 06·0	− 1·5	+ 0·4	60
31	20 Tauri	4·0	D	18 05·0	− 1·3	+ 1·4	36

Date	Star	Mag.	Ph.	U.T.	*a*	*b*	*P*
	WELLINGTON			h m	m	m	°
Jan. 10	τ Arietis	5·2	D	9 17·9	− 2·1	+ 0·7	80
20	θ Virginis	4·4	D	13 40·6	− 0·1	− 2·4	165
26	ϕ Sagittarii	3·3	D	16 28·4	− 1·1	+ 0·8	33
Feb. 11	ϕ Geminorum	5·0	D	8 12·2	− 1·8	− 2·1	143
Mar. 10	b^1 Geminorum	5·0	D	10 22·8	...	...	44
Mar. 10	b^2 Geminorum	5·1	D	10 26·3	− 1·7	+ 0·8	91
Apr. 8	ξ Cancri	5·2	D	11 26·5	+ 0·3	− 1·2	167
9	η Leonis	3·6	D	11 49·3	− 0·2	− 1·1	161
May 31	b^2 Geminorum	5·1	D	5 55·2	− 2·0	+ 1·9	63
June 30	η Leonis	3·6	D	6 34·0	− 2·4	+ 2·5	66
July 7	22 Scorpii	4·9	D	11 47·5	− 1·6	+ 3·7	48
22	β Tauri	1·8	R	19 41·2	− 2·5	− 1·9	304
Sept. 13	17 Tauri	3·8	D	14 44·6	− 1·6	− 0·4	72
13	20 Tauri	4·0	D	15 38·0	− 1·3	+ 0·6	45
13	*q* Tauri	4·4	D	15 48·8	...	...	355
13	17 Tauri	3·8	R	16 07·9	− 1·6	+ 0·6	231
13	20 Tauri	4·0	R	17 01·3	− 2·3	+ 0·4	263
Oct. 13	κ Aurigæ	4·4	D	16 13·4	− 1·9	0·0	68
Dec. 4	17 Tauri	3·8	D	9 32·6	− 1·7	− 0·4	74
4	16 Tauri	5·4	D	9 47·0	− 0·9	+ 0·6	36
4	20 Tauri	4·0	D	10 25·2	− 1·4	+ 0·6	45
4	*q* Tauri	4·4	D	10 34·6	...	...	357
	DUNEDIN						
Jan. 10	τ Arietis	5·2	D	9 06·7	− 1·9	+ 0·4	82
20	θ Virginis	4·4	D	13 52·1	+ 0·2	− 2·6	179
26	ϕ Sagittarii	3·3	D	16 26·5	− 0·2	− 0·6	55
Mar. 10	b^1 Geminorum	5·0	D	10 04·8	− 2·1	+ 1·1	63
10	b^2 Geminorum	5·1	D	10 16·9	− 1·5	+ 0·4	102
Apr. 9	η Leonis	3·6	D	11 58·3	...	...	191
May 31	b^2 Geminorum	5·1	D	5 40·7	− 1·6	+ 1·2	80
June 30	η Leonis	3·6	D	6 18·9	− 1·5	+ 0·9	92
July 7	22 Scorpii	4·9	D	11 28·8	− 1·7	+ 1·6	71
Sept. 13	17 Tauri	3·8	D	14 40·9	− 1·3	− 0·7	74
13	20 Tauri	4·0	D	15 31·2	− 1·1	+ 0·2	45
13	*q* Tauri	4·4	D	15 40·1	...	...	357
13	17 Tauri	3·8	R	16 00·0	− 1·3	+ 0·3	230
13	20 Tauri	4·0	R	16 51·0	− 2·0	+ 0·1	262
28	*X* Sagittarii	5·0	D	12 44·1	0·0	+ 0·8	114
Oct. 13	κ Aurigæ	4·4	D	16 06·5	− 1·6	− 0·4	72
Dec. 4	17 Tauri	3·8	D	9 28·3	− 1·4	− 0·7	76
4	16 Tauri	5·4	D	9 41·3	− 0·8	+ 0·3	38
4	20 Tauri	4·0	D	10 17·9	− 1·2	+ 0·2	46
4	*q* Tauri	4·4	D	10 26·0	...	...	359

Date	Star	Mag.	Ph.	U.T.	*a*	*b*	*P*
	MELBOURNE			h m	m	m	°
Mar. 8	β Tauri	1·8	D	9 27·4	...	...	23
8	β Tauri	1·8	R	10 09·7	...	...	326
10	b^1 Geminorum	5·0	D	9 14·0	− 1·9	− 0·1	66
10	b^2 Geminorum	5·1	D	9 28·7	− 2·1	− 0·8	107
28	MERCURY	− 0·5	D	5 49·8	− 1·1	+ 1·8	87
28	MERCURY	− 0·5	R	6 55·3	0·0	+ 2·7	204
Apr. 11	*b* Virginis	5·2	D	12 10·7	− 3·1	+ 0·4	73
May 4	ϕ Geminorum	5·0	D	10 14·1	− 0·6	− 0·2	136
July 7	22 Scorpii	4·9	D	10 41·6	− 2·9	+ 1·2	62
Sept. 13	17 Tauri	3·8	R	15 12·0	− 2·3	− 2·7	296
13	η Tauri	3·0	D	15 33·2	− 1·3	− 0·9	83
13	23 Tauri	4·2	R	15 56·3	− 0·5	+ 0·5	216
13	η Tauri	3·0	R	16 45·6	− 0·9	+ 0·7	218
28	*X* Sagittarii	5·0	D	12 54·9	+ 0·1	+ 1·8	63
Oct. 12	β Tauri	1·8	D	20 48·0	...	...	160
12	β Tauri	1·8	R	21 17·9	...	...	202
17	η Leonis	3·6	R	18 47·1	− 1·0	− 1·4	278
Dec. 4	η Tauri	3·0	D	10 19·9	− 1·4	− 1·0	84
4	η Tauri	3·0	R	11 32·0	− 0·9	+ 0·7	217

Date	Star	Mag.	Ph.	U.T.	*a*	*b*	*P*
	SYDNEY						
Mar. 10	b^1 Geminorum	5·0	D	9 28·7	− 2·4	+ 0·6	58
10	b^2 Geminorum	5·1	D	9 39·8	− 2·3	− 0·4	100
28	MERCURY	− 0·5	D	6 02·1	− 0·7	+ 1·7	88
28	MERCURY	− 0·5	R	7 04·9	+ 0·2	+ 2·6	207
May 4	ϕ Geminorum	5·0	D	10 18·5	− 0·8	+ 0·3	115
June 12	τ Sagittarii	3·4	D	16 41·4	...	...	136
12	τ Sagittarii	3·4	R	17 23·8	...	...	197
Sept. 13	17 Tauri	3·8	D	14 35·6	+ 1·0	+ 2·4	4
13	23 Tauri	4·2	D	14 52·5	− 1·3	− 0·9	84
13	17 Tauri	3·8	R	15 17·7	− 2·8	− 2·5	294
13	η Tauri	3·0	D	15 39·4	− 1·8	− 0·8	84
13	23 Tauri	4·2	R	16 03·0	− 0·7	+ 0·9	214
13	η Tauri	3·0	R	16 55·1	− 1·1	+ 1·1	214
28	*X* Sagittarii	5·0	D	13 00·7	+ 0·3	+ 1·7	61
Oct. 12	β Tauri	1·8	D	20 47·4	− 0·9	− 0·4	135
13	κ Aurigæ	4·4	D	15 46·8	...	...	22
Dec. 4	17 Tauri	3·8	D	9 20·1	+ 0·7	+ 2·1	8
4	23 Tauri	4·2	D	9 39·7	− 1·5	− 1·0	86
4	η Tauri	3·0	D	10 26·6	− 1·9	− 0·8	86
4	η Tauri	3·0	R	11 41·8	− 1·1	+ 1·1	214


APPEARANCE OF THE PLANETS
(INVERTED VIEW)
July 20
JUPITER
Oct.23
Oct.18
May 11
May 6
MERCURY
Dec.31
MARS
Dec.26
VENUS
Nov.20
Feb.21
SATURN
SCALE (SECONDS OF ARC)
10
0
10
20
30
40

MERCURY

Greatest Elongation E.	Inferior Conjunction	Greatest Elongation W.	Superior Conjunction
Jan. 18 (19°)	Feb. 2	Feb. 28 (27°)	Apr. 13
May 10 (22°)	June 3	June 28 (22°)	July 26
Sept. 7 (27°)	Oct. 3	Oct. 19 (18°)	Nov. 21

Observers in this country will be able to see Mercury as an evening star in the period May 5—15, and as a morning star about October 14—24.

In the southern hemisphere, the planet is well placed as an evening star in early September, and as a morning star at the end of February.

An occultation of Mercury by the Moon is visible in Australia on March 28.

Date	R.A.	Dec.	Ph.	Elong.
	Evening Star			
	h m	° ′		°
Jan. 1	19 33·8	− 23 53	94	11
6	20 08·1	22 14	89	14
11	20 40·0	20 01	80	17
16	21 07·0	17 23	65	18
21	21 24·8	14 50	44	18
26	21 27·6	− 13 05	20	14
	Morning Star			
Feb. 10	20 30·7	− 15 34	14	15
15	20 25·2	16 50	29	21
20	20 31·7	17 31	42	25
25	20 46·6	17 35	52	26
Mar 2	21 07·1	17 04	61	27
7	21 31·2	15 57	67	26
12	21 57·7	14 17	73	24
27	22 26·0	12 04	78	22
22	22 55·6	9 20	83	20
27	23 26·5	6 07	88	16
Apr. 1	23 58·8	− 2 25	92	12
	Evening Star			
Apr. 26	3 05·6	+ 18 58	81	14
May 1	3 41·9	21 52	66	18
6	4 13·1	23 43	50	21
11	4 37·8	24 37	36	22
16	4 54·7	24 40	24	21
21	5 03·2	24 01	14	18
26	5 03·1	+ 22 47	6	13

Date	R.A.	Dec.	Ph.	Elong.
	Morning Star			
	h m	° ′		°
June 15	4 30·7	+ 17 31	10	16
20	4 33·1	17 39	18	20
25	4 43·1	18 28	29	22
30	5 00·9	19 45	40	22
July 5	5 26·2	21 12	54	21
10	5 59·0	22 30	68	18
15	6 38·5	+ 23 14	83	14
	Evening Star			
Aug. 9	10 07·8	+ 13 04	90	14
14	10 40·2	9 28	85	17
19	11 09·5	5 50	80	21
24	11 36·0	+ 2 17	75	23
29	12 00·0	− 1 07	69	25
Sept. 3	12 21·4	4 15	63	27
8	12 39·8	7 01	56	27
13	12 54·2	9 14	47	26
18	13 03·0	10 42	36	24
23	13 03·9	− 11 01	23	20
	Morning Star			
Oct. 13	12 15·6	− 0 55	24	15
18	12 25·5	0 56	48	18
23	12 46·6	2 46	69	17
28	13 13·5	5 37	83	15
Nov. 2	13 43·0	− 8 52	92	12
	Evening Star			
Dec. 12	18 03·0	− 25 33	95	11
17	18 37·3	25 25	91	14
22	19 10·8	24 39	85	16
27	19 41·8	23 18	76	18
32	20 07·5	− 21 28	61	19

VENUS

Superior Conjunction April 16. Greatest Elongation E., Nov. 20 (47°).

Venus will not be a very conspicuous object in 1949. As an evening star in the autumn, she is well south of the equator, and remains low in the south-west. Greatest brilliancy occurs on December 26. There is a close approach to the young moon on August 26, which may be visible as an occultation in Eastern Canada.

Date	R.A.	Dec.	Mag.	Diam.	Ph.	Distance
	h m	° ′		″		Units
Sept. 3	12 59·6	− 6 10	− 3·4	13·6	79	1·236
13	13 43·3	11 07	3·5	14·4	76	1·169
23	14 28·1	15 41	3·6	15·3	73	1·101
Oct. 3	15 14·2	19 41	3·6	16·3	70	1·030
13	16 01·8	22 54	3·7	17·6	66	0·958
23	16 50·5	− 25 11	− 3·8	19·0	62	0·884
Nov. 2	17 39·6	26 25	3·9	20·8	58	0·809
12	18 27·7	26 32	4·0	22·9	54	0·734
22	19 13·4	25 36	4·1	25·5	49	0·659
Dec. 2	19 55·1	23 44	4·2	28·8	44	0·584
12	20 30·9	− 21 10	− 4·3	33·0	37	0·510
22	20 59·1	18 11	4·4	38·3	30	0·440
32	21 16·9	− 15 09	− 4·4	44·9	22	0·375

The Phase (Ph.) in these tables is the fraction of the area of the disk which is illuminated. It is also the fraction of the diameter, perpendicular to the line of cusps, lying in the visible portion of the disk. For convenience, it is given in these tables as a percentage. The elongation (Elong.) of a planet from the Sun is given in the case of Mercury only. The distance, where given, is expressed in astronomical units of 93,000,000 miles.

EARTH

Perihelion January 3 (91,400,000 miles) Aphelion July 2 (94,600,000 miles).

Spring Equinox March 20^d 23^h. Summer Solstice June 21^d 18^h.
Autumn Equinox Sept. 23 09. Winter Solstice Dec. 22 04.

Obliquity of the Ecliptic.

1949.0	$\epsilon = 23° 26' 45''\cdot30$	$\sin\epsilon = 0.397\,8833$	$\log\sin\epsilon = 9\cdot599\,7557$
		$\cos\epsilon = 0\cdot917\,4360$	$\log\cos\epsilon = 9\cdot962\,5758$
1950·0	$\epsilon = 23\ 26\ 44\cdot84$	$\sin\epsilon = 0\cdot397\,8812$	$\log\sin\epsilon = 9.599\,7534$
		$\cos\epsilon = 0\cdot917\,4369$	$\log\cos\epsilon = 9.962\,5762$

MARS

Conjunction March 17

Mars remains too close to the Sun to be visible in the first half of the year, but rises about two hours before the Sun at the end of July. The planet moves direct through Gemini, Cancer and Leo, passing close to *Regulus* at the end of October, and thence into Virgo at the end of the year. Opposition takes place in 1950 March.

There is a close conjunction of Mars with Saturn on the night of November 30, Mars being 0°·2 north of Saturn.

Date	R.A.	Dec.	Mag.	Diam.	*P*	*Q*	Ph.	Tilt	Distance
	h m	° ′		″	°	°		°	Units
Oct. 3	9 15·1	+ 17 16	+ 1·7	4·7	1	288	93	+ 18	1·987
13	9 38·8	15 31	1·6	4·9	4	290	93	20	1·919
23	10 01·6	13 41	1·6	5·1	8	291	92	21	1·845
Nov. 2	10 23·5	11 47	1·5	5·3	11	292	92	22	1·766
12	10 44·5	9 52	1·4	5·6	14	293	91	23	1·683
22	11 04·4	+ 7 59	+ 1·3	5·9	17	293	91	+ 23	1·595
Dec. 2	11 23·3	6 09	1·2	6·2	20	293	90	23	1·503
12	11 41·1	4 25	1·1	6·6	23	294	90	23	1·409
22	11 57·4	2 50	0·9	7·1	25	293	90	23	1·313
32	12 12·1	+ 1 26	+ 0·8	7·7	26	293	90	+ 23	1·216

P = Position angle of the axis of rotation, measured eastwards from the north point.

Q = Position angle of the point of greatest defect of illumination. The position angle of the line of cusps is $Q \pm 90°$.

Tilt = the tilt of the north pole of Mars towards (+) or away (−) from the Earth. These quantities will enable the disk to be sketched before observing.

The position of the north pole of Mars (1949·0) is:

α $21^h 11^m 08^s·9$ λ 355°·721
δ $+54° 39' 14''·4$ β +64·553

The obliquity of the Martian ecliptic is 23°·98.

JUPITER

Conjunction Jan. 1. Opposition July 20.

Jupiter is a morning star in the spring months and an evening star in the summer and early autumn. The planet is now moving north once more, and will be seen on the borders of Capricornus and Sagittarius. At its stationary point on May 20, Jupiter will be south of the two stars α and β Capricorni.

Date		R.A.	Dec.	Mag.	Polar Diam.	Equat. Diam.	Distance
		h m	° ′		″	″	Units
Apr.	21	20 12·3	− 20 12	− 1·8	36·3	38·9	5·070
May	1	20 15·5	20 04	1·9	37·4	40·1	4·911
	11	20 17·4	19 59	2·0	38·7	41·4	4·755
	21	20 18·0	19 59	2·0	39·9	42·7	4·608
	31	20 17·4	20 03	2·1	41·1	44·0	4·473
June	10	20 15·4	− 20 11	− 2·2	42·2	45·2	4·354
	20	20 12·3	20 23	2·2	43·2	46·3	4·255
	30	20 08·1	20 38	2·3	44·0	47·1	4·181
July	10	20 03·2	20 54	2·3	44·5	47·6	4·134
	20	19 57·9	21 11	2·3	44·7	47·8	4·115
	30	19 52·5	− 21 27	− 2·3	44·5	47·7	4·126
Aug.	9	19 47·5	21 41	2·3	44·1	47·3	4·166
	19	19 43·1	21 53	2·2	43·4	46·5	4·233
	29	19 39·8	22 01	2·2	42·5	45·5	4·325
Sept.	8	19 37·7	22 07	2·1	41·4	44·4	4·437
	18	19 36·9	− 22 09	− 2·1	40·3	43·1	4·567
	28	19 37·5	22 08	2·0	39·0	41·8	4·708
Oct.	8	19 39·4	22 03	2·0	37·8	40·5	4·858
	18	19 42·7	21 55	1·9	36·7	39·3	5·012
	28	19 47·1	− 21 44	− 1·8	35·6	38·1	5·165

The position of the north pole of Jupiter (1949.0) is:—

α $17^h 52^m 10^s\!\cdot\!5$ λ $247°\!\cdot\!078$
δ $+64° 33' 11''\!\cdot\!2$ β $+87\cdot842$

The obliquity of the Jovian ecliptic is 3°·07.

The north pole of the planet on the date of opposition is in position angle 347° and is tilted 1° away from the Earth.

The tables of longitudes on the following pages refer to the central meridian of the illuminated disk, the correction for phase having been applied. For the convenience of observers, alternative headings using G.M.A.T. beginning at noon are given. The brief tables of movement of the central meridian are based on mean daily synodic rotations of 877°·95 for System I, and 870°·30 for System II. More extended tables are given in the *Nautical Almanac* each year, and were also published in the *Handbook* for 1931, 1932 and 1933.

LONGITUDE OF CENTRAL MERIDIAN OF JUPITER

SYSTEM I

Month	March	April	May	June	July	Aug.	Sept.	Oct.
U.T.	24h	24h	24h	22h	21h	20h	19h	18h
G.M.A.T.	12	12	12	10	9	8	7	6
Day	°	°	°	°	°	°	°	°
1	313·7	165·9	222·3	5·8	29·8	212·1	31·8	50·2
2	111·5	323·7	20·3	163·8	187·8	10·1	189·7	207·9
3	269·3	121·6	178·2	321·8	345·8	168·1	347·6	5·7
4	67·1	279·4	336·1	119·8	143·9	326·1	145·5	163·5
5	224·9	77·3	134·0	277·8	301·9	124·1	303·3	321·3
6	22·6	235·1	292·0	75·8	99·9	282·1	101·2	119·0
7	180·4	33·0	89·9	233·8	258·0	80·1	259·1	276·8
8	338·2	190·9	247·8	31·8	56·0	238·1	56·9	74·5
9	136·0	348·7	45·8	189·8	214·1	36·0	214·8	232·3
10	293·8	146·6	203·7	347·8	12·1	194·0	12·7	30·0
11	91·6	304·5	1·7	145·8	170·1	352·0	170·5	187·8
12	249·4	102·3	159·6	303·9	328·2	149·9	328·3	345·5
13	47·2	260·2	317·6	101·9	126·2	307·9	126·2	143·3
14	205·0	58·1	115·5	259·9	284·2	105·8	284·0	301·0
15	2·8	216·0	273·5	57·9	82·3	263·8	81·9	98·8
16	160·6	13·8	71·4	215·9	240·3	61·8	239·7	256·5
17	318·4	171·7	229·4	13·9	38·3	219·7	37·6	54·2
18	116·2	329·6	27·3	172·0	196·4	17·6	195·4	212·0
19	274·0	127·5	185·3	330·0	354·4	175·6	353·2	9·7
20	71·9	285·4	343·3	128.0	152·4	333·5	151·0	167·4
21	229·7	83·3	141·2	286·0	310·5	131·5	308·8	325·1
22	27·5	241·2	299·2	84·1	108·5	289·4	106·6	122·8
23	185·3	39·1	97·2	242·1	266·5	87·3	264·4	280·6
24	343·2	197·0	255·1	40·1	64·5	245·2	62·2	78·3
25	141·0	354·9	53·1	198·2	222·5	43·1	220·0	236·0
26	298·8	152·8	211·1	356·2	20·6	201·1	17·8	33·7
27	96·7	310·7	9·1	154·2	178·6	358·9	175·6	191·4
28	254·5	108·6	167·1	312·3	336·6	156·8	333·4	349·1
29	52·3	266·5	325·0	110·3	134·6	314·7	131·2	146·8
30	210·2	64·4	123·0	268·3	292·6	112·6	289·0	304·5
31	8·0	...	281·0	...	90·6	270·5	...	102·2

Change of Longitude in Intervals of Mean Time

hr.	°	hr.	°	min.	°	min.	°	min.	°
1	36·6	6	219·5	10	6·1	1	0·6	6	3·7
2	73·2	7	256·1	20	12·2	2	1·2	7	4·3
3	109·7	8	292·7	30	18·3	3	1·8	8	4·9
4	146·3	9	329·2	40	24·4	4	2·4	9	5·5
5	182·9	10	5·8	50	30·5	5	3·0	10	6·1

System I applies to all objects situated on or between the north component of the south equatorial belt and the south component of the north equatorial belt.

LONGITUDE OF CENTRAL MERIDIAN OF JUPITER

System II

Month	March	April	May	June	July	Aug.	Sept.	Oct.
U.T.	24^h	24^h	24^h	22^h	21^h	20^h	19^h	18^h
G.M.A.T.	12	12	12	10	9	8	7	6
Day	°	°	°	°	°	°	°	°
1	120·3	95·9	283·4	191·0	346·4	292·4	236·0	25·8
2	270.4	246·1	73·7	341·4	136·8	82·8	26·3	176·0
3	60·6	36·3	224·0	131·8	287·2	233·2	176·5	326·1
4	210·7	186·5	14·3	282·1	77·6	23·5	326·7	116·3
5	0·9	336·7	164·6	72·5	228·0	173·9	117·0	266·4
6	151·0	127·0	314·9	222·9	18·4	324·2	267·2	56·5
7	301·2	277·2	105·2	13·2	168·8	114·6	57·4	206·7
8	91·3	67·4	255·5	163·6	319·2	265·0	207·7	356·8
9	241·5	217·7	45·8	314·0	109·6	55·3	357·9	146·9
10	31·7	7·9	196·1	104·4	260·0	205·7	148·1	297·0
11	181·8	158·1	346·4	254·8	50·4	356·0	298·3	87·2
12	332·0	308·4	136·7	45·1	200·8	146·3	88·6	237·3
13	122·2	98·6	287·1	195·5	351·2	296·7	238·8	27·4
14	272·3	248·9	77·4	345·9	141·6	87·0	29·0	177·5
15	62·5	39·1	227·7	136·3	292·0	237·3	179·2	327·6
16	212·7	189·4	18·0	286·7	82·4	27·6	329·4	117·7
17	2·9	339·6	168·4	77·1	232·9	178·0	119·6	267·8
18	153·1	129·9	318·7	227·5	23·3	328·3	269·8	57·9
19	303·2	280·1	109·0	17·9	173·7	118·6	60·0	208·0
20	93·4	70·4	259·3	168·3	324·1	268·9	210·2	358·1
21	243·6	220·6	49·7	318·7	114·5	59·2	0·4	148·2
22	33·8	10·9	200·0	109·0	264·9	209·5	150·6	298·3
23	184·0	161·2	350·4	259·4	55·2	359·8	300·7	88·4
24	334·2	311·5	140·7	49·8	205·6	150·1	90·9	238·5
25	124·4	101·7	291·1	200·2	356·0	300·4	241·1	28·6
26	274·6	252·0	81·4	350·6	146·4	90·7	31·3	178·6
27	64·8	42·3	231·7	141·0	296·8	240·9	181·4	328·7
28	215·0	192·6	22·1	291·4	87·2	31·2	331·6	118·8
29	5·2	342·8	172·5	81·8	237·6	181·5	121·7	268·9
30	155·4	133·1	322·8	232·2	27·9	331·7	271·9	59·0
31	305·6	...	113·2	...	178·3	122·0	...	209·0

Change of Longitude in Intervals of Mean Time

hr.	°	hr.	°	min.	°	min.	°	min.	°
1	36·3	6	217·6	10	6·0	1	0·6	6	3·6
2	72·5	7	253·8	20	12·1	2	1·2	7	4·2
3	108·8	8	290·1	30	18·1	3	1·8	8	4·8
4	145·1	9	326·4	40	24·2	4	2·4	9	5·4
5	181·3	10	2·6	50	30·2	5	3·0	10	6·0

System II applies to all objects situated north of the south component of the north equatorial belt or south of the north component of the south equatorial belt.

SATELLITES OF JUPITER

The following pages give the configurations of the four great satellites of Jupiter, as seen in an inverting telescope in the northern hemisphere. The column headed ♃ between heavy lines represents the body of the planet, and the figures 1 to 4 represent the satellites. A number between the heavy lines thus represents a transit of that satellite, and shadow transits are similarly represented by the letters *a*, *b*, *c* or *d* for the shadows of satellites 1, 2, 3 or 4 respectively. A missing number shows that a satellite is in eclipse or occulted. The aim has been to give the times of all visible eclipses, together with sufficient other information to enable the observer to identify the satellites and their shadows.

The column headed *Time* gives the time of eclipse (and certain other phenomena) to the nearest minute, but where the minutes are omitted, the configuration is merely intended as a general guide at about that hour. The times have been chosen to suit observers in S. Africa, Australia and New Zealand, as well as in this country. Observers in the southern hemisphere will have to invert these diagrams to obtain the correct orientation.

The column *Phen.* gives the phenomenon which occurs at the time stated. The configuration given then shows the position of the satellites immediately afterwards. The abbreviations used are

E = eclipse commences	F = eclipse finishes
D = disappearance by occultation	R = reappearance from occultation
T = transit commences	S = shadow transit commences

Observers should have no difficulty in identifying the satellites at any particular time, and the movements are clearly shown in the changes from line to line. Thus the identification of a missing satellite is made by glancing at the preceding and following lines, where the beginning or end of an eclipse or occultation will generally be found. At times near conjunction, this may be more difficult, as fewer phenomena are given during such restricted hours.

The satellites move from east to west (i.e., from the *f* to the *p* side) across the face of the planet, and from west to east behind it. Before opposition (July 20) the shadows fall to the west, and after opposition to the east. To make this clear the word *Shadow* is printed at the foot of the appropriate column.

Detailed notes on these phenomena will be found in the 1944 *Handbook*.

Jupiter without satellites: This unusual phenomenon occurs on March 4 and possibly on September 21, but unfortunately neither case is visible in this country. According to the late Major A. E. Levin (*Journal* **42**, 12) the phenomenon does not occur again until 1961.

On March 4, Jupiter will appear to have no satellites from $17^h\ 12^m$ until $17^h\ 20^m$, I being in transit, II and III in eclipse, and IV occulted.

On September 21, an eclipse of IV is timed to finish at $9^h\ 52^m\!\cdot\!9$, II being at that time in transit and III also eclipsed. An occultation of I is given for $9^h\ 53^m$, but as this time is to the nearest minute, there is a distinct possibility of the phenomenon taking place for at least a few seconds.

Date	Time	Phen.	*p* West	♃	*f* East
May	h m				
9	3		4	1	2 3
	15		4 1 2		3
	22 54	E 1	4 2		3
10	3		2 4		1 3
11	3 22	E 2	1		4 3
	17 22	E 1			2 3 4
12	3			3	1 2 4
	16		3	*a* 1	2 4
13	3		3 1	2	4
	11 51	E 1	3 2		4
	16		3 2		1 4
14	16 39	E 2	3 1		4
15	3		3 1		2 4
	15				1 2 4
16	3				1 3 2 4
	15		1	2	3 4
17	0 48	E 1	2		3 4
	15		2		1 4 3
18	3		2 1		4 3
	19 16	E 1			4 3 2
19	3			4	3 1 2
	15		4 3		1 2
20	3		3 4 1	*b*	2
	13 44	E 1	3 4 2		
21	3		4 3 2		1
	19 13	E 2	4 3 1		
22	3		4 3 1		2
	12 58	E 3	4		1 2
23	3		4		1 3 2
	15		4 1	*b*	2 3
24	2 41	E 1	4 2		3
	15		4 2		1 3
25	3		4 2	1	3
	21 10	E 1	4		2 3
26	3		4	*c*	3 1 2
	15		4 3		1 2
	23 04	E 4	3 1		2
27	2 47	F 4	3 1 4		2
	15 38	E 1	3 2		4
28	3		3 2		1 4
	15		3 2	*a* 1	4
	21 48	E 2	3 1		4
29	3		3 1		2 4
	16 57	E 3			1 2 4
30	3				3 1 2 4
	15		1		2 3 4
			Shadow		

Date	Time	Phen.	*p* West	♃	*f* East
May	h m				
31	3		2 1		3 4
	15		2		1 3 4
June					
1	11 05	E 2	1		3 4
	23 03	E 1			2 3 4
2	3				1 3 2 4
	14			3	1 2 4
3	2		3 1		2 4
	17 32	E 1	3 2		4
4	2		3 2		1 4
	17		3 2	1 4	
5	0 23	E 2	3 1 4		
	12		3 4		2
	20 56	E 3	4		1 2
6	14		4 1		3 2
7	2		4 1 2		3
	14		4 2		1 3
8	13 40	E 2	4 1		3
9	0 57	E 1	4		2 3
	15		4	3	1 2
10	2		4 3 1		2
	14		4 3 1 2		
	19 26	E 1	4 3 2		
11	2		4 3 2		1
12	2 58	E 2	3 4 1		
	13 54	E 1	3 4		2
	17 04	E 4	3		1 2
13	0 55	E 3			1 2
	14			1	4 3 2
14	2		1	2	4 3
	14		2		1 3 4
15	16 51	E 2	1		3 4
16	2 51	E 1			2 3 4
	14				1 3 2 4
17	2		3	*a* 1	2 4
	14		3 1	*b* 2	4
	21 20	E 1	3 2		4
18	2		3 2		1 4
19	2		3 2 1		4
	15 48	E 1	3		2 4
20	2		3		1 2 4
	14			*a* 1	3 2 4
21	3		1	*b d* 2	4 3
	10 17	Ė 1	2	4	3
	14		2 4		1 3
			Shadow		

Date	Time	Phen.	*p* West	♃	*f* East
June	h m				
22	14		4 2 1		3
	18 51	E 2	4 1		3
23	2		4 1		2 3
	14		4		1 3 2
24	2		4 3	*a*	1 2
	14		4 3 1	*b*	2
	23 14	E 1	4 3 2		
25	14		4 3 2		1
26	2		4 3 2 1		
	8 09	E 2	4 3 1		
	17 42	E 1	4 3		2
27	2		4 3		1 2
	8 53	E 3	4		1 2
	16		4	*a* 1	3 2
28	2		4 1		2 3
	12 11	E 1	4 2		3
29	2		2 4		1 3
	11 05	E 4	2	*a* 1	3
	21 26	E 2	1		4 3
30	2		1		2 4 3
	14				1 2 3 4
July					
1	1			*c* 3	1 2 4
	12		3 1		2 4
2	1 08	E 1	3 2		4
	12		3 2		1 4
3	0		3 2	*a* 1	4
	10 44	E 2	3 1		4
	19 36	E 1	3		2 4
4	0		3		1 2 4
	12 52	E 3			1 2 4
5	0		1		3 2 4
	14 05	E 1	2		3 4
6	0		2		1 3 4
	12		2	*a* 1	4 3
7	0 02	E 2	1		4 3
	12				1 2 4 3
8	0			4	3 1 2
	12		4 3 1		2
9	0		4 3 1 2		
	3 02	E 1	4 3 2		
	12		4 3 2		1
10	13 21	E 2	4 3 1		
	21 30	E 1	4 3		2
11	16 52	E 3	4		1 2
			Shadow		

Date	Time	Phen.	*p* West	♃	*f* East
July	h m				
12	0		4 1		3 2
	12		4 1 2		3
	15 59	E 1	4 2		3
13	0		4 2		1 3
	14		4 2	*a* 1	3
14	0		4 1 2		3
	2 39	E 2	4 1		3
	10 27	E 1	4		2 3
15	0		4		3 1 2
	12		4 1 3		2
16	0		3 1 4	*b* 2	
	12		3 2		4 1
17	0		3 2		1 4
	12		3 1 2		4
	15 57	E 2	3 1		4
	23 24	E 1	3		2 4
18	12		3		1 2 4
	20 52	E 3		*a* 1	2 4
19	1		1		3 2 4
	12		1	*b* 2	3 4
	17 53	E 1	2		3 4
20	0		2		1 3 4
			Shadow		

Opposition.—After this date, satellites are occulted on the *p* side, and reappear from eclipse on the *f* side.

Date	Time	Phen.	*p* West	♃	*f* East
21	0		1 2		3 4
	8 04	F 2	1		2 3 4
	14 38	F 1			1 2 3 4
22	0				1 3 2 4
	12		1	3 *c*	2 4
23	0		3 1		2 4
	9 07	F 1	3 2		1 4
24	0		3 2		1 4
	13		3 2 1	4	
	21 23	F 2	3 4 1		2
25	3 36	F 1	3 4		1 2
26	0		4 3	1 *a*	2
	14		4 1	2 *b*	3
	22 04	F 1	4 2		1 3
27	17		4 2	1 *a*	3
28	0		4 2 1		3
	10 42	F 2	4 1		2 3
	16 33	F 1	4		1 2 3
29	0		4		1 3 2
					Shadow

Date	Time	Phen.	*p* West	♃	*f* East
July	h m				
29	12		4	1 *a*	3 2
	15		4 1	3 *c*	2
30	0		4 3 1		2
	11 02	F 1	4 3 2		1
31	12		4 3 2 1		
Aug.					
1	0 01	F 2	4 3 1		2
	10		3 4		1 2
	22		3		1 2
2	3 21	F 4	1 3		4 2
	8 26	F 3	1		3 4 2
	23 59	F 1	2		1 3 4
3	22		2 1		3 4
4	10		1		3 4
	13 19	F 2	1		2 3 4
	18 27	F 1			1 2 3 4
5	22		1 3	*c*	2 4
6	10		3 2 1		4
	12 56	F 1	3 2		1 4
7	10		3 2 1	*a*	4
	22		3 1 2		4
8	2 38	F 2	3 1		2 4
	7 25	F 1	3		1 2 4
9	10		1		2 4
	12 26	F 3	1		3 2 4
	22		2 1		4 3
10	1 53	F 1	2		1 4 3
	10		2 4	*d*	1 3
	22		2 4	1 *a*	3
11	10		4 1 2		3
	15 57	F 2	4 1		2 3
	20 22	F 1	4		1 2 3
12	22		4 1	3	2
13	10		4 3 1 2	*b*	
	14 51	F 1	4 3 2		1
14	10		4 3 2	1 *a*	
	22		4 3 1 2		
15	9 19	F 1	4 3		1 2
16	10		4 1 3		2
	16 27	F 3	4 1		3 2
	22		4 1	2 *b*	3
17	9		4 2		1 3
	23		2 4	1 *a*	3
18	10 49	D 4	1 2		3
	14 58	R 4	1		4 3
					Shadow

Date	Time	Phen.	*p* West	♃	*f* East
Aug.	h m				
18	17 16	E 4	1		3
	21 31	F 4			4 2 3
	22 17	F 1			1 4 2 3
19	10				1 3 2 4
	22		1		3 2 4
20	10		1 3	2	4
	16 45	F 1	3 2		1 4
21	22		3 1 2		4
22	7 54	F 2	3 1		2 4
	11 14	F 1	3		1 2 4
23	10		3 1		2 4
	20 27	F 3	1		3 2 4
	23		1	2	3 4
24	10		2		1 3 4
25	10		2 1		4 3
	20		1		4 3
	21 13	F 2			2 4 3
26	0 11	F 1			1 2 4 3
	20			1 *a* 4	3 2
	22		1 4		3 2
27	10		4 1 3	*c*	2
	22		4 3 2		1
28	13		4 3 2	1	
	22		4 3 2 1		
29	10 32	F 2	4 3		2
	13 09	F 1	4 3		1 2
30	10		4 3 1	*a*	2
	20 41	R 3	4 1		3 2
	20 53	E 3	4 1		2
31	0 29	F 3	4 1		2 3
	7 37	F 1	4 2		1 3
Sept.					
1	9		4 2 1		3
	21		4 1		3
	23 51	F 2	4		2 3
2	9		4		1 2 3
	22		4	1 *a*	3 2
3	9		4 1	3	2
	20 35	F 1	3 2 4		1
4	11 21	E 4	3 2		1
	15 42	F 4	3 2	1 *a*	4
	21		3 2 1		4
5	9		3 1		4
	13 11	F 2	3		2 4
	15 04	F 1	3		1 2 4
6	9		3	1	2 4
					Shadow

Date	Time	Phen.	*p* West	♃	*f* East
Sept.	h m				
6	21		1		2 4
7	0 14	R 3	1		3 2 4
	0 53	E 3	1		2 4
	4 29	F 3	1	2	3 4
	9 32	F 1	2		1 3 4
8	9		2 1		3 4
	21		1 2		3 4
9	2 29	F 2			2 3 4
	4 01	F 1			1 2 3 4
	21				1 3 2 4
10	9		1		3 2 4
	21		3 2	*b*	4
	22 30	F 1	3 2		1 4
11	21		3 2 1		4
12	10		3 1 2	4	
	14		3 4		
	15 49	F 2	3 4		2
	16 59	F 1	3 4		1 2
	21		3 4	*d*	1 2
13	10		4 3		1 2
	21		4 1 3		2
14	8 03	D 1	4	2 *b*	
	8 30	F 3	4 2	*b*	3
	11 27	F 1	4 2		1 3
15	9		4 2 1		3
	21		4 1 2		3
16	9		4		1 2 3
	21		4		1 3 2
17	9		4 1		3 2
	21		4 3	2 *c*	
18	0 25	F 1	4 3 2		1
	21		4 3 2 1	*a*	
19	9		3 4 1 2		
	18 28	F 2	3 4 1		2
	18 54	F 1	3 4		1 2
20	21		1 3		2
	22 26	R 4	1 3		4 2
21	8 54	E 3	1	2	
	9 53	F 4	1	2	4
	9 53	D 1		2	4
	12 31	F 3	2	*b*	3 4
	13 22	F 1	2		1 3 4
22	9		2	1 *a*	3 4
	21		1 2		3 4
23	7 47	F 2			2 3 4
	7 51	F 1			1 2 3 4
					Shadow

Date	Time	Phen.	*p* West	♃	*f* East
Sept.	h m				
24	9		1		3 2 4
	21		1	3	2 4
	23		3	2 *c*	4
25	9		3 2		1 4
	22		3 2	1 *a*	4
26	9		3 2 1		4
	20 49	F 1	3 2		1 4
	21 06	F 2	3		2 1 4
27	9		3		1 2 4
	21		3 1		2 4
28	9		1		2 4
	12 55	E 3		2 *b*	4
	15 17	F 1	2	*b*	1 4
	21		2		4 1 3
29	9		2 4	1	3
	20		4 2 1		3
30	9 46	F 1	4		1 3
	10 25	F 2	4		2 1 3
21	21		4		1 2 3
Oct.					
1	7		4 1	*a*	2 3
	19		4 1		3 2
2	7		4 3 2		1
3	7		4 3 2 1		
	19		4 3 1		
	22 44	F 1	4 3		1
4	7		4 3		1 2
	19		4 3 1	*a*	2
5	16 55	E 3	4 2	*b*	
	17 12	F 1	4 2	*b*	1
	20 33	F 3	4 2		3 1
6	7		4 2		1 3
	19		2 4 1		3
7	11 28	D 4			3
	11 41	F 1			1 3
	13 04	F 2			2 1 3
	19				4 1 2 3
8	7			1 *a*	4 2 3
	19		1		3 2 4
9	7		2 3	*b c*	1 4
10	7		3 2 1		4
	19		3 1 2		4
11	7		3		2 1 4
	19		3	1	2 4
12	7		3 1		2 4
	16			2	4
					Shadow

Date	Time	Phen.	*p* West	♃	*f* East
Oct.	h m				
12	19 08	F 1	2	*b*	1 4
	19 10	R 3	2	*b*	3 1 4
	20 56	E 3	2		1 4
13	7		2		1 3 4
	19		2 1		3 4
14	13 36	F 1			1 4 3
	19				2 1 4 3
15	7				1 4 2 3
	19		1		4 3 2
16	7		4	23	
	8 05	F 1	4 2	3 *b*	1
	19		4 2 3		1
17	7		4 3 2 1		
	19		4 3 1 2		
18	7		4 3		2 1
	19		4 3		1 2
19	7		4 3 1		2
	19		4 3	2	
	21 03	F 1	4 2	*b*	1
20	7		4 2		1 3
	19		4 2 1		3
21	18 22	F 2	4		2 1 3
22	7		4		1 2 3
	19		4 1		2 3
23	8		4	2	3
	10 00	F 1	4	23 *b*	1
	19		2 3 4		1
24	7		3 2 1	*a*	
	9 48	R 4	3 2 1		4
	17 42	E 4	3 2 1		
25	7 41	F 2	3		2 1 4
	19		3		1 2 4
26	7		3 1		2 4
27	8 36	F 3	2		1 3 4
	19		2 1	*a*	3 4
28	7		2 1		3 4
	17 27	F 1			1 3 4
	21 00	F 2			2 1 3 4
29	7				1 2 3 4
	19		1		2 3 4
30	11 56	F 1		2	1 3 4
	19		2 3	*c*	1 4
31	7		3 2	1 *a*	4
	19		3 2 1		4
					Shadow

SATURN

Opposition Feb. 21. Conjunction Sept. 2.

At the beginning of the year, Saturn is an evening star in the southern part of Leo. At the stationary point on May 1, the planet will be near *Regulus*, and only about half a magnitude brighter than that star.

In November, as a morning star, Saturn will be found near σ Leonis. Mars will be in the same constellation, and there will be a close conjunction of the two planets on November 30 (Mars 0°·2 north of Saturn). The rings at this time are tilted only 1°·5 to the line of sight, and they will close completely in 1950. The narrow appearance of the rings accounts for the obvious decrease in brightness of the planet as seen by the naked eye.

Saturn may be seen close to the Moon on Nov. 15 and Dec. 12. The first of these conjunctions may be seen as an occultation in Canada.

Date	R.A.	Dec.	Mag.	Polar Diam.	Rings Major Axis	Rings Minor Axis	Dist.
	h m	° ′		″	″	″	Units
Jan. 1	10 33·6	+ 10 50	+ 0·7	17·2	43·3	5·6	8·664
21	10 30·3	11 13	0·6	17·7	44·5	6·1	8·431
Feb. 10	10 25·2	11 47	0·4	18·0	45·2	6·8	8·299
Mar. 2	10 19·1	12 23	0·4	18·0	45·3	7·4	8·289
22	10 13·6	12 54	0·5	17·8	44·7	7·8	8·401
Apr. 11	10 09·7	+ 13 15	+ 0·6	17·3	43·6	7·9	8·618
May 1	10 08·2	13 21	0·7	16·7	42·1	7·7	8·908
21	10 09·5	13 11	0·8	16·2	40·6	7·3	9·235
June 10	10 13·3	12 48	0·9	15·6	39·3	6·8	9·562
30	10 19·2	+ 12 13	+ 1·0	15·1	38·1	6·1	9·857
Nov. 1	11 12·9	+ 6 58	+ 1·2	15·0	37·8	1·8	9·917
21	11 19·0	6 24	1·2	15·5	39·0	1·3	9·628
Dec. 11	11 22·9	6 04	1·2	16·0	40·3	1·1	9·304
31	11 24·3	+ 6 01	+ 1·1	16·6	41·8	1·1	8·978

SATELLITES OF SATURN

Titan.—The position angles of this satellite are given at daily intervals after Eastern elongation.

TITAN at Eastern elongation		Time after E.Elong.	*P*	Time after E.Elong.	*P*
d h	d h	d	°	d	°
Jan. 9 07·8	May 16 15·7	0	84	8	263
25 05·7	June 1 15·0	1	80	9	259
Feb. 10 03·4	17 14·7	2	75	10	254
26 00·9		3	61	11	241
Mar. 13 22·5		4	327	12	161
29 20·2		5	279	13	103
Apr. 14 18·3	Dec. 10 16·8	6	271	14	92
30 16·8	26 15·7	7	266	15	87

Rhea.—Position angles are given at intervals of six hours after Eastern elongation.

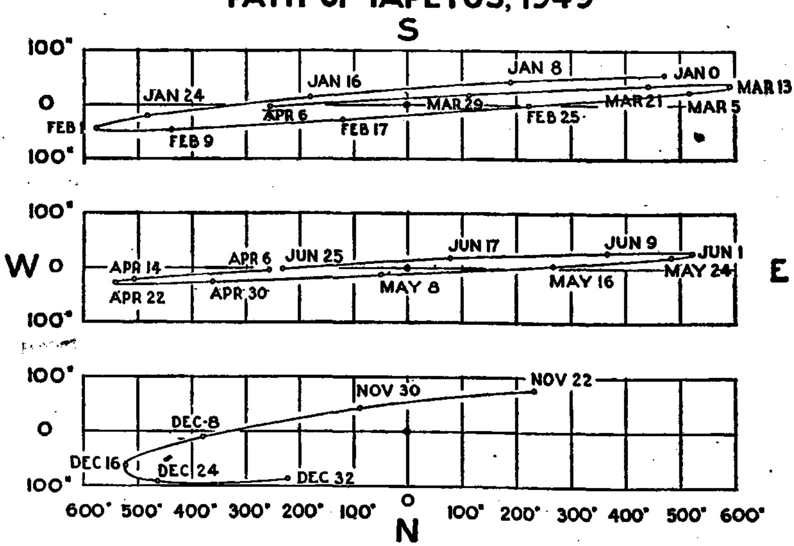
Rhea at Eastern elongation									Time after E.Elong.		P
	d	h		d	h		d	h	d	h	°
Jan.	3	17·5	Mar.	25	23·6	June	15	07·3	0	0	84
	8	05·9		30	11·9		19	19·8		6	81
	12	18·3	Apr.	4	00·3		24	08·4		12	76
	17	06·6		8	12·6		28	20·9		18	68
	21	19·0		13	01·0				1	0	42
	26	07·3		17	13·4					6	308
	30	19·6		22	01·8					12	280
Feb.	4	07·9		26	14·2					18	272
	8	20·3	May	1	02·6				2	0	267
	13	08·6		5	15·1					6	264
	17	21·0		10	03·5					12	261
	22	09·3		14	16·0	Dec.	4	04·1		18	256
	26	21·6		19	04·5		8	16·6	3	0	249
Mar.	3	09·9		23	16·9		13	05·0		6	224
	7	22·2		28	05·4		17	17·5		12	130
	12	10·6	June	1	17·9		22	05·9		18	100
	16	22·9		6	06·4		26	18·3	4	0	92
	21	11·3		10	18·8		31	06·8		6	84

Hyperion.—This satellite may be seen most easily when near conjunction with Titan. The most favourable dates in 1949 occur at the western elongations of both satellites on February 1, April 6 and June 9.

Iapetus.—The diagram below shows the path of this satellite to scale, the measurements being in seconds of arc. Iapetus is interesting because it is much brighter at western elongation (Jan. 30, April 19, Dec. 17).

For further details of these satellites see 1948 *Handbook*.

PATH OF IAPETUS, 1949



Saturn: Satellite Phenomena, 1949

The list which follows gives details of the times of eclipses, transits and occultations of Saturn's satellites, and has been computed by the methods described by Dr. L. J. Comrie (*B.A.A. Memoirs*, **30**, part 3).

Te = Tethys   Di = Dione   Rh = Rhea   TN = Titan

Eclipses and occultations:

In the case of Dione, both beginning (E_1) and end (E_2) of eclipse may be seen. In other cases, the beginning of eclipse (E_1) and end of occultation (O_2) are seen before opposition on February 21, and in December; and the beginning of occultation (O_1) and end of eclipse (E_2) after opposition (March to June).

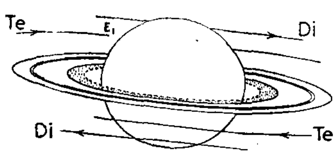
No eclipses of Titan take place during the year.

Transits and shadow-transits:

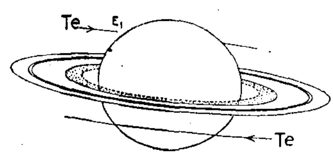
In the case of the December transits of Titan, both beginning (T_1) and end of the transit (T_2) are shown. In all other cases, only the beginning of transit (T) is given. Similarly, the beginning of shadow-transit (S) is given, there being no shadow-transits of Titan during 1949.

The duration of these transits and shadow-transits is, however, indicated at the foot of each column. The duration is given in minutes for the first of such transits in that column.

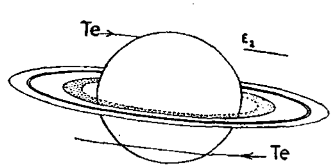
As a further measure of economy, no position angles are given, nor is the distance of an eclipsed satellite from the limb of the planet stated. The diagrams below have been drawn to indicate in a general way the changes in these phenomena that take place during the year.



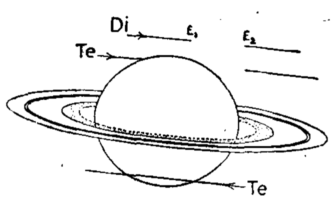
JANUARY



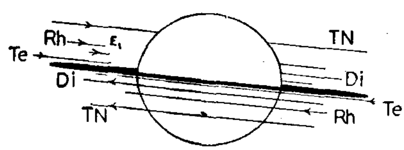
FEBRUARY



MARCH



MAY



DECEMBER

Jan.

d	h	m		
1	7	36	Di	T
	15	31	Te	S
	15	43	Te	T
2	14	09	Te	E_1
	16	31	Di	O_1
	16	41	Te	O_2
	17	58	Di	O_2
3	12	49	Te	S
	13	01	Te	T
4	1	17	Di	T
	11	27	Te	E_1
	13	59	Te	O_2
5	10	07	Te	S
	10	12	Di	O_1
	10	19	Te	T
	11	37	Di	O_2
6	8	45	Te	E_1
	11	16	Te	O_2
	18	58	Di	T
7	7	25	Te	S
	7	37	Te	T
8	3	54	Di	O_1
	5	16	Di	O_2
	6	04	Te	E_1
	8	34	Te	O_2
9	4	43	Te	S
	4	55	Te	T
	12	40	Di	T
10	3	23	Te	E_1
	5	52	Te	O_2
	21	35	Di	O_1
	22	54	Di	O_2
11	2	02	Te	S
	2	13	Te	T
12	0	41	Te	E_1
	3	09	Te	O_2
	6	22	Di	T
	23	20	Te	S
	23	31	Te	T
13	15	17	Di	O_1
	16	31	Di	O_2
	21	59	Te	E_1
14	0	27	Te	O_2
	20	38	Te	S
	20	49	Te	T

Te	S	98^m
Te	T	142
Di	T	88

Jan.

d	h	m		
15	0	04	Di	T
	19	18	Te	E_1
	21	44	Te	O_2
16	8	59	Di	O_1
	10	09	Di	O_2
	17	57	Te	S
	18	07	Te	T
17	16	36	Te	E_1
	17	46	Di	T
	19	01	Te	O_2
18	15	15	Te	S
	15	25	Te	T
19	2	41	Di	O_1
	3	46	Di	O_2
	13	54	Te	E_1
	16	18	Te	O_2
20	11	28	Di	T
	12	33	Te	S
	12	43	Te	T
21	11	12	Te	E_1
	13	35	Te	O_2
	20	23	Di	O_1
	21	22	Di	O_2
22	9	52	Te	S
	10	01	Te	T
23	5	11	Di	T
	8	31	Te	E_1
	10	53	Te	O_2
24	7	10	Te	S
	7	19	Te	T
	14	06	Di	O_1
	14	58	Di	O_2
25	5	49	Te	E_1
	8	10	Te	O_2
	22	55	Di	T
26	4	28	Te	S
	4	37	Te	T
27	3	08	Te	E_1
	5	27	Te	O_2
	7	50	Di	O_1
	8	32	Di	O_2
28	1	47	Te	S
	1	55	Te	T
	16	40	Di	T
29	0	26	Te	E_1

Te	S	104^m
Te	T	135
Di	T	71

Jan.

d	h	m		
29	2	44	Te	O_2
	23	05	Te	S
	23	13	Te	T
30	1	35	Di	O_1
	2	05	Di	O_2
	21	44	Te	E_1
31	0	01	Te	O_2
	10	29	Di	T
	20	24	Te	S
	20	31	Te	T
Feb.				
1	19	03	Te	E_1
	21	18	Te	O_2
2	17	42	Te	S
	17	49	Te	T
3	16	21	Te	E_1
	18	35	Te	O_2
4	15	01	Te	S
	15	07	Te	T
5	13	40	Te	E_1
	15	51	Te	O_2
6	12	19	Te	S
	12	25	Te	T
7	10	58	Te	E_1
	13	08	Te	O_2
8	9	37	Te	S
	9	43	Te	T
9	8	17	Te	E_1
	10	25	Te	O_2
10	6	56	Te	S
	7	01	Te	T
11	5	35	Te	E_1
	7	42	Te	O_2
12	4	14	Te	S
	4	19	Te	T
13	2	54	Te	E_1
	4	59	Te	O_2
14	1	33	Te	S
	1	37	Te	T
15	0	12	Te	E_1
	2	16	Te	O_2
	22	51	Te	S
	22	55	Te	T
16	21	31	Te	E_1
	23	32	Te	O_2

Te	S	110^m
Te	T	129
Di	T	13

Feb.

d	h	m		
17	20	10	Te	S
	20	13	Te	T
18	18	49	Te	E_1
	20	49	Te	O_2
19	17	28	Te	S
	17	31	Te	T
20	16	08	Te	E_1
	18	06	Te	O_2
21	14	47	Te	S
	14	49	Te	T
22	13	27	Te	E_1
	15	24	Te	E_2
23	12	06	Te	S
	12	07	Te	T
24	10	45	Te	E_1
	12	43	Te	E_2
25	9	24	Te	S
	9	26	Te	T
26	8	05	Te	O_1
	10	03	Te	E_2
27	6	43	Te	S
	6	44	Te	T
28	5	23	Te	O_1
	7	22	Te	E_2
Mar.				
1	4	01	Te	S
	4	02	Te	T
2	2	41	Te	O_1
	4	41	Te	E_2
3	1	20	Te	S
	1	20	Te	T
	23	59	Te	O_1
4	2	00	Te	E_2
	22	38	Te	S
	22	38	Te	T
5	21	17	Te	O_1
	23	20	Te	E_2
6	19	57	Te	T
	19	57	Te	S
7	18	36	Te	O_1
	20	39	Te	E_2
8	17	15	Te	T
	17	16	Te	S
9	15	54	Te	O_1
	17	58	Te	E_2

Te S 116^m
Te T 118

Mar.

d	h	m		
10	14	33	Te	T
	14	34	Te	S
11	13	12	Te	O_1
	15	17	Te	E_2
12	11	52	Te	T
	11	53	Te	S
13	10	31	Te	O_1
	12	37	Te	E_2
14	9	10	Te	T
	9	12	Te	S
15	7	49	Te	O_1
	9	56	Te	E_2
16	6	28	Te	T
	6	31	Te	S
17	5	07	Te	O_1
	7	15	Te	E_2
18	3	47	Te	T
	3	49	Te	S
19	2	26	Te	O_1
	4	34	Te	E_2
20	1	05	Te	T
	1	08	Te	S
	23	44	Te	O_1
21	1	54	Te	E_2
	22	24	Te	T
	22	27	Te	S
22	21	03	Te	O_1
	23	13	Te	E_2
23	19	42	Te	T
	19	45	Te	S
24	18	21	Te	O_1
	20	32	Te	E_2
25	17	00	Te	T
	17	04	Te	S
26	15	40	Te	O_1
	17	51	Te	E_2
27	14	19	Te	T
	14	23	Te	S
28	12	58	Te	O_1
	15	11	Te	E_2
29	11	37	Te	T
	11	42	Te	S
30	10	17	Te	O_1
	12	30	Te	E_2
31	8	56	Te	T
	9	00	Te	S

Te S 124^m
Te T 102

Apr.

d	h	m		
1	7	35	Te	O_1
	9	49	Te	E_2
2	6	14	Te	T
	6	19	Te	S
3	0	28	Di	E_1
	0	42	Di	E_2
	4	54	Te	O_1
	7	09	Te	E_2
4	3	33	Te	T
	3	38	Te	S
	9	14	Di	S
5	2	12	Te	O_1
	4	28	Te	E_2
	18	05	Di	E_1
	18	29	Di	E_1
6	0	52	Te	T
	0	57	Te	S
	23	31	Te	O_1
7	1	47	Te	E_2
	2	51	Di	S
	22	10	Te	T
	22	16	Te	S
8	11	44	Di	E_1
	12	15	Di	E_2
	20	49	Te	O_1
	23	07	Te	E_2
9	19	29	Te	T
	19	34	Te	S
	20	30	Di	S
10	18	08	Te	O_1
	20	26	Te	E_2
11	5	24	Di	E_1
	6	01	Di	E_2
	16	47	Te	T
	16	53	Te	S
12	14	10	Di	S
	15	26	Te	O_1
	17	45	Te	E_2
13	14	06	Te	T
	14	12	Te	S
	23	04	Di	E_1
	23	46	Di	E_2
14	12	45	Te	O_1
	15	05	Te	E_2
15	7	49	Di	S

Te S 130^m
Te T 85
Di S 14

Apr.

d	h	m		
15	11	24	Te	T
	11	31	Te	S
16	10	04	Te	O_1
	12	24	Te	E_2
	16	44	Di	E_1
	17	30	Di	E_2
17	8	43	Te	T
	8	50	Te	S
18	1	30	Di	S
	7	22	Te	O_1
	9	43	Te	E_2
19	6	02	Te	T
	6	09	Te	S
	10	24	Di	E_1
	11	15	Di	E_2
20	4	41	Te	O_1
	7	03	Te	E_2
	19	10	Di	S
21	3	20	Te	T
	3	28	Te	S
22	1	59	Te	O_1
	4	05	Di	E_1
	4	22	Te	E_2
	4	59	Di	E_2
23	0	39	Te	T
	0	47	Te	S
	12	51	Di	S
	23	18	Te	O_1
24	1	42	Te	E_2
	21	45	Di	E_1
	21	57	Te	T
	22	05	Te	S
	22	43	Di	E_2
25	20	37	Te	O_1
	23	01	Te	E_2
26	6	31	Di	S
	19	16	Te	T
	19	24	Te	S
27	15	26	Di	E_1
	16	27	Di	E_2
	17	55	Te	O_1
	20	20	Te	E_2
28	16	35	Te	T
	16	43	Te	S

Te	S	134^m
Te	T	79
Di	S	47

Apr.

d	h	m		
29	0	12	Di	S
	15	14	Te	O_1
	17	39	Te	E_2
30	9	07	Di	E_1
	10	11	Di	E_2
	13	53	Te	T
	14	02	Te	S
May				
1	12	32	Te	O_1
	14	59	Te	E_2
	17	53	Di	S
2	11	12	Te	T
	11	21	Te	S
3	2	48	Di	E_1
	3	55	Di	E_2
	9	51	Te	O_1
	12	18	Te	E_2
4	8	30	Te	T
	8	40	Te	S
	11	34	Di	S
5	7	09	Te	O_1
	9	37	Te	E_2
	20	30	Di	E_1
	21	39	Di	E_2
6	5	49	Te	T
	5	59	Te	S
7	4	28	Te	O_1
	5	14	Di	S
	6	57	Te	E_2
8	3	07	Te	T
	3	18	Te	S
	14	11	Di	E_1
	15	23	Di	E_2
9	1	46	Te	O_1
	4	16	Te	E_2
	22	56	Di	S
10	0	26	Te	T
	0	37	Te	S
	23	05	Te	O_1
11	1	36	Te	E_2
	7	52	Di	E_1
	9	07	Di	E_2
	21	44	Te	T
	21	56	Te	S

Te	S	137^m
Te	T	77
Di	S	62

May

d	h	m		
12	16	38	Di	S
	20	23	Te	O_1
	22	55	Te	E_2
13	19	03	Te	T
	19	14	Te	S
14	1	33	Di	E_1
	2	51	Di	E_2
	17	42	Te	O_1
	20	14	Te	E_2
15	10	19	Di	S
	16	21	Te	T
	16	33	Te	S
16	15	01	Te	O_1
	17	34	Te	E_2
	19	14	Di	E_1
	20	34	Di	E_2
17	13	40	Te	T
	13	52	Te	S
18	4	00	Di	S
	12	19	Te	O_1
	14	53	Te	E_2
19	10	59	Te	T
	11	11	Te	S
	12	56	Di	E_1
	14	18	Di	E_2
20	9	37	Te	O_1
	12	12	Te	E_2
	21	42	Di	S
21	8	17	Te	T
	8	30	Te	S
22	6	37	Di	E_1
	6	56	Te	O_1
	8	02	Di	E_2
	9	32	Te	E_2
23	5	36	Te	T
	5	49	Te	S
	15	23	Di	S
24	4	15	Te	O_1
	6	51	Te	E_2
25	0	19	Di	E_1
	1	45	Di	E_2
	2	54	Te	T
	3	08	Te	S
26	1	33	Te	O_1

Te	S	139^m
Te	T	80
Di	S	75

May

d	h	m		
26	4	10	Te	E_2
	9	04	Di	S
27	0	13	Te	T
	0	27	Te	S
	18	00	Di	E_1
	19	29	Di	E_2
	22	52	Te	O_1
28	1	30	Te	E_2
	21	31	Te	T
	21	46	Te	S
29	2	46	Di	S
	20	10	Te	O_1
	22	49	Te	E_2
30	11	41	Di	E_1
	13	12	Di	E_2
	18	50	Te	T
	19	05	Te	S
31	17	29	Te	O_1
	20	08	Te	E_2
	20	27	Di	S

June

d	h	m		
1	16	09	Te	T
	16	24	Te	S
2	5	23	Di	E_1
	6	56	Di	E_2
	14	47	Te	O_1
	17	28	Te	E_2
3	13	27	Te	T
	13	43	Te	S
	14	08	Di	S
4	12	06	Te	O_1
	14	47	Te	E_2
	23	05	Di	E_1
5	0	39	Di	E_2
	10	46	Te	T
	11	02	Te	S
6	7	50	Di	S
	9	25	Te	O_1
	12	06	Te	E_2
7	8	05	Te	T
	8	21	Te	S
	16	46	Di	E_1
	18	23	Di	E_2
8	6	44	Te	O_1
	9	26	Te	E_2

Te	S	143^m
Te	T	87
Di	S	86

June

d	h	m		
9	1	32	Di	S
	5	23	Te	T
	5	40	Te	S
10	4	02	Te	O_1
	6	45	Te	E_2
	10	27	Di	E_1
	12	06	Di	E_2
11	2	42	Te	T
	2	59	Te	S
	19	13	Di	S
12	1	21	Te	O_1
	4	04	Te	E_2
13	0	00	Te	T
	0	18	Te	S
	4	09	Di	E_1
	5	49	Di	E_2
	22	40	Te	O_1
14	1	24	Te	E_2
	12	55	Di	S
	21	19	Te	T
	21	36	Te	S
15	19	59	Te	O_1
	21	51	Di	E_1
	22	43	Te	E_2
	23	33	Di	E_2
16	18	38	Te	T
	18	55	Te	S
17	6	36	Di	S
	17	18	Te	O_1
	20	02	Te	E_2
18	15	32	Di	E_1
	15	57	Te	T
	16	14	Te	S
	17	16	Di	E_2
19	14	36	Te	O_1
	17	22	Te	E_2
20	00	18	Di	S
	13	16	Te	T
	13	33	Te	S
21	9	14	Di	E_1
	10	59	Di	E_2
	11	55	Te	O_1
	14	41	Te	E_2
22	10	35	Te	T
	10	52	Te	S

Te	S	145^m
Te	T	98
Di	S	97

June

d	h	m		
22	18	00	Di	S
23	9	14	Te	O_1
	12	00	Te	E_2
24	2	56	Di	E_1
	4	43	Di	E_2
	7	53	Te	T
	8	11	Te	S
25	6	33	Te	O_1
	9	19	Te	E_2
	11	41	Di	S
26	5	12	Te	T
	5	30	Te	S
	20	37	Di	E_1
	22	26	Di	E_2
27	3	52	Te	O_1
	6	38	Te	E_2
28	2	31	Te	T
	2	49	Te	S
	5	23	Di	S
29	1	11	Te	O_1
	3	58	Te	E_2
	14	19	Di	E_1
	16	09	Di	E_2
	23	50	Te	T
30	0	08	Te	S
	22	30	Te	O_1
	23	04	Di	S

Te	S	149^m
Te	T	111
Di	S	106

Dec.

d	h	m		
1	5	50	Di	S
	6	34	Di	T
	19	43	Te	S
	20	18	Te	T
2	14	46	Di	E_1
	18	23	Te	E_1
	18	47	Di	O_2
	21	56	Te	O_2
	22	21	Rh	E_1

Te	S	169^m
Te	T	178
Di	S	169
Di	T	197

Dec.

d	h	m		
3	2	56	Rh	O_2
	17	02	Te	S
	17	37	Te	T
	23	31	Di	S
4	0	16	Di	T
	15	41	Te	E_1
	19	15	Te	O_2
5	4	29	Rh	S
	5	21	Rh	T
	8	28	Di	E_1
	12	29	Di	O_2
	14	20	Te	S
	14	56	Te	T
6	13	00	Te	E_1
	14	33	TN	O_1
	16	34	Te	O_2
	17	13	Di	S
	17	58	Di	T
	19	15	TN	O_2
7	10	46	Rh	E_1
	11	39	Te	S
	12	15	Te	T
	15	24	Rh	O_2
8	2	09	Di	E_1
	6	11	Di	O_2
	10	18	Te	E_1
	13	52	Te	O_2
9	8	57	Te	S
	9	33	Te	T
	10	54	Di	S
	11	39	Di	T
	16	54	Rh	S
	17	49	Rh	T
10	7	37	Te	E_1
	11	11	Te	O_2
	19	50	Di	E_1
	23	53	Di	O_2
11	6	16	Te	S
	6	52	Te	T
	23	11	Rh	E_1
12	3	52	Rh	O_2
	4	36	Di	S
	4	55	Te	E_1
	5	21	Di	T
	8	29	Te	O_2

Te	S	169^m
Te	T	178
Di	S	170
Di	T	197
Rh	S	137
Rh	T	225

Dec.

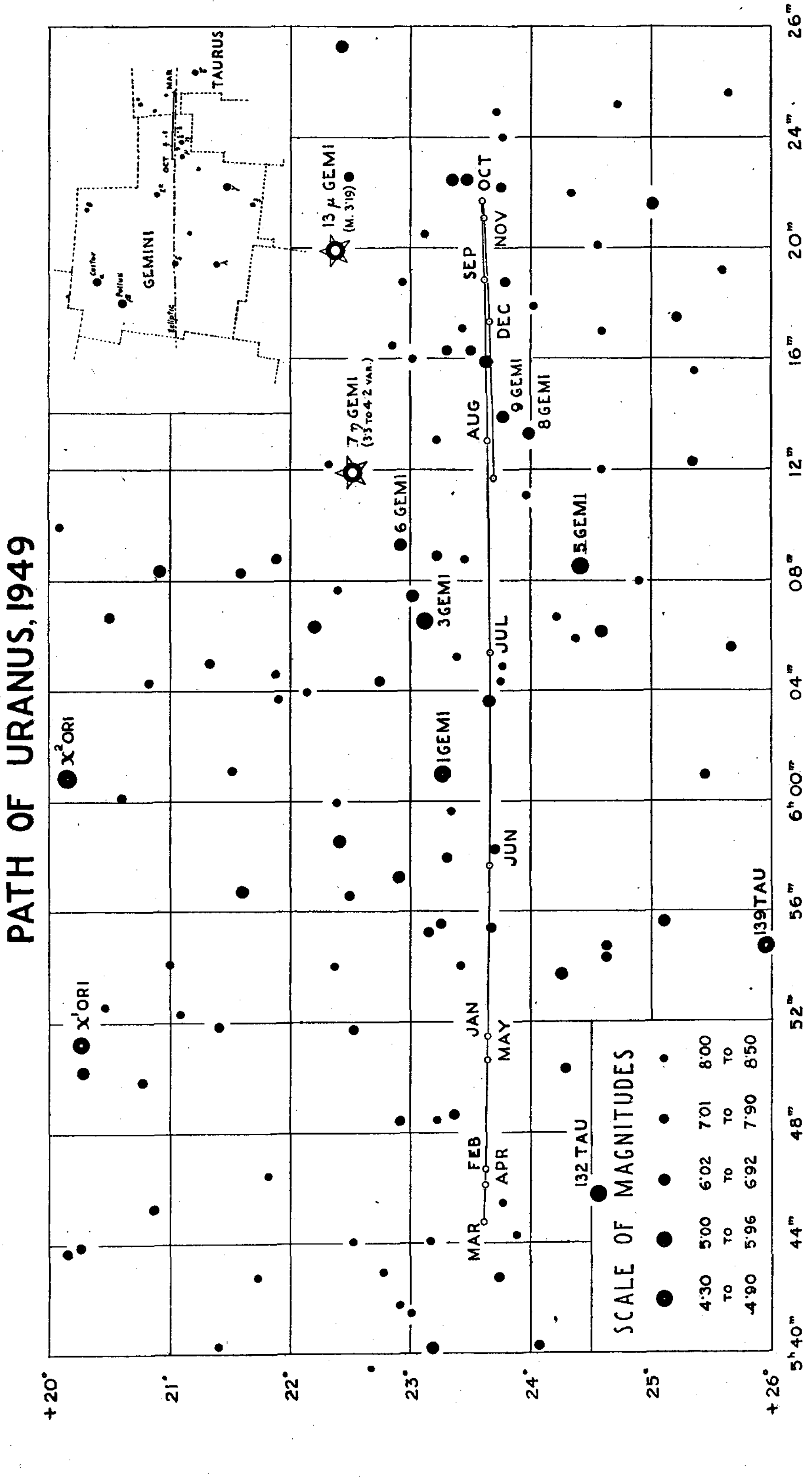
d	h	m		
13	3	35	Te	S
	4	11	Te	T
	13	31	Di	E_1
	17	35	Di	O_2
14	2	14	Te	E_1
	5	19	Rh	S
	5	48	Te	O_2
	6	16	Rh	T
	9	20	TN	T_1
	14	07	TN	T_2
	22	17	Di	S
	23	02	Di	T
15	0	53	Te	S
	1	29	Te	T
	23	32	Te	E_1
16	3	07	Te	O_2
	7	13	Di	E_1
	11	17	Di	O_2
	11	36	Rh	E_1
	16	19	Rh	O_2
	22	12	Te	S
	22	48	Te	T
17	15	59	Di	S
	16	44	Di	T
	20	51	Te	E_1
18	0	25	Te	O_2
	17	45	Rh	S
	18	42	Rh	T
	19	30	Te	S
	20	06	Te	T
19	0	54	Di	E_1
	4	58	Di	O_2
	18	09	Te	E_1
	21	44	Te	O_2
20	9	40	Di	S
	10	25	Di	T
	16	49	Te	S
	17	24	Te	T
21	0	02	Rh	E_1
	4	45	Rh	O_2
	15	28	Te	E_1
	18	35	Di	E_1
	19	02	Te	O_2
	22	40	Di	O_2
22	13	32	TN	O_1

Te	S	170^m
Te	T	178
Di	S	172
Di	T	199
Rh	S	148
Rh	T	225

Dec.

d	h	m		
22	14	07	Te	S
	14	43	Te	T
	18	32	TN	O_2
23	3	21	Di	S
	4	06	Di	T
	6	10	Rh	S
	7	08	Rh	T
	12	47	Te	E_1
	16	20	Te	O_2
24	11	26	Te	S
	12	01	Te	T
	12	17	Di	E_1
	16	21	Di	O_2
25	10	05	Te	E_1
	12	28	Rh	E_1
	13	39	Te	O_2
	17	11	Rh	O_2
	21	03	Di	S
	21	47	Di	T
26	8	44	Te	S
	9	20	Te	T
27	5	59	Di	E_1
	7	24	Te	E_1
	10	02	Di	O_2
	10	57	Te	O_2
	18	35	Rh	S
	19	33	Rh	T
28	6	03	Te	S
	6	38	Te	T
	14	44	Di	S
	15	28	Di	T
29	4	42	Te	E_1
	8	15	Te	O_2
	23	40	Di	E_1
30	0	53	Rh	E_1
	3	21	Te	S
	3	43	Di	O_2
	3	56	Te	T
	5	36	Rh	O_2
	8	12	TN	T_1
	13	03	TN	T_2
31	2	01	Te	E_1
	5	34	Te	O_2
	8	25	Di	S
	9	09	Di	T

Te	S	170^m
Te	T	178
Di	S	174
Di	T	199
Rh	S	156
Rh	T	226


PATH OF URANUS, 1949
GEMINI
TAURUS
Castor
Pollux
Ecliptic
13 μ GEMI
(M. 3·19)
7 η GEMI
(3·3 TO 4·2 VAR.)
9 GEMI
8 GEMI
6 GEMI
5 GEMI
3 GEMI
1 GEMI
χ² ORI
χ¹ ORI
139 TAU
132 TAU
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
SCALE OF MAGNITUDES
4·30 TO 4·90
5·00 TO 5·96
6·02 TO 6·92
7·01 TO 7·90
8·00 TO 8·50
+20°
21°
22°
23°
24°
25°
+26°
5h40m
44m
48m
52m
56m
6h00m
04m
08m
12m
16m
20m
24m
26m

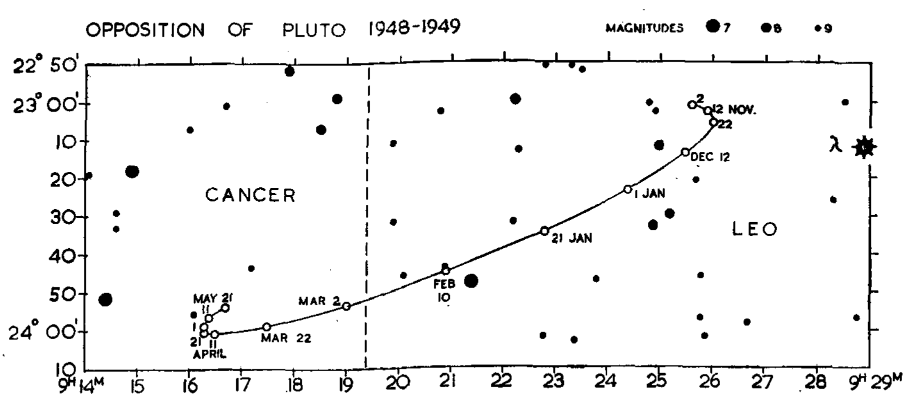
URANUS, NEPTUNE and PLUTO

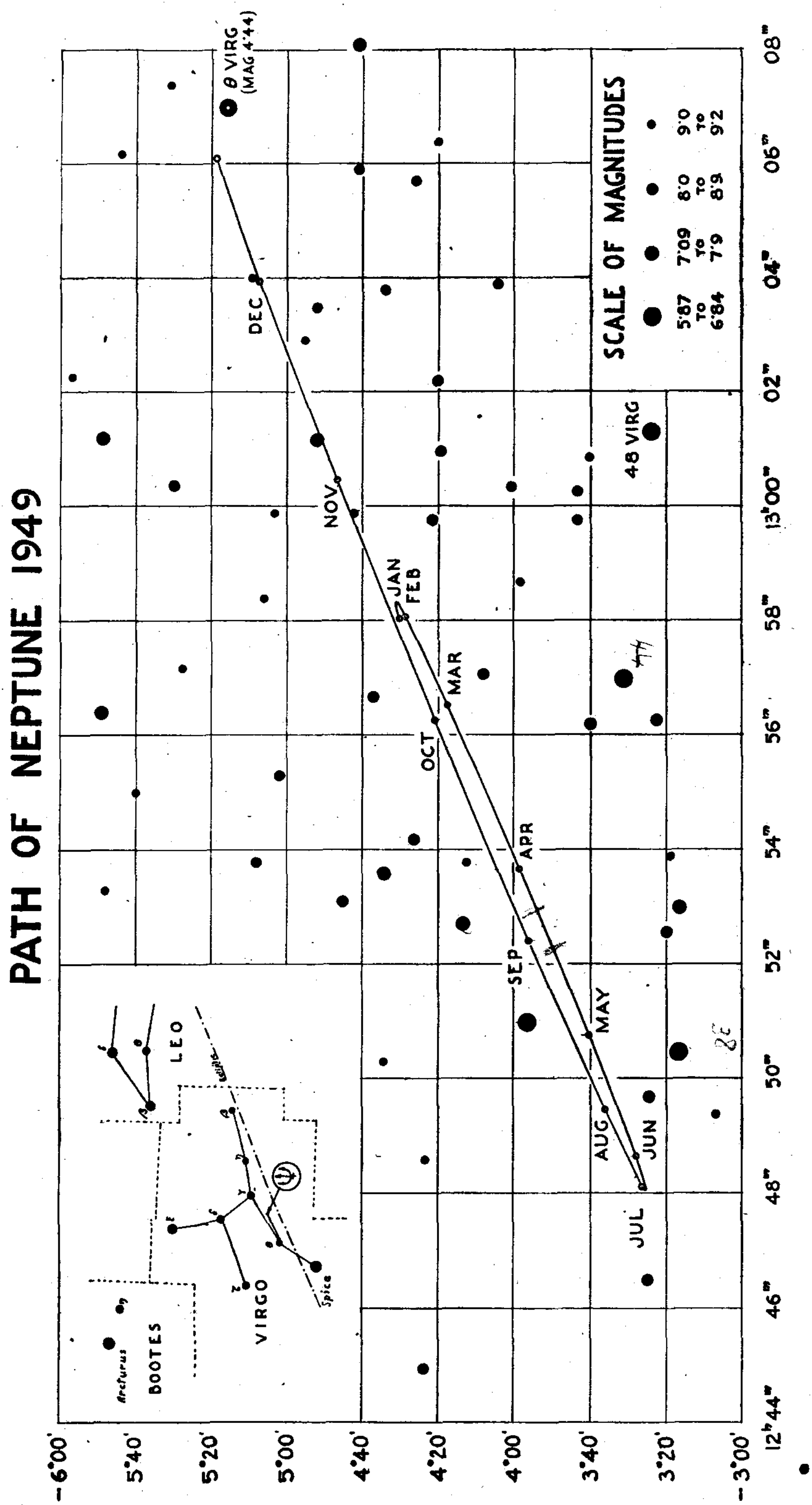
The paths of Uranus, Neptune and Pluto among the stars in 1949 are illustrated by diagrams showing the field as seen in an inverting telescope.

Uranus (page 42) moves from Taurus into Gemini, and will be found at the end of the year just north of μ and ν Geminorum. Opposition occurs on December 25, when Uranus will be 17·96 units from the Earth. The apparent diameter will then be 4″ and the magnitude 5·8. The planet is bright enough to be found without difficulty, and the diagram shows only stars brighter than magnitude 8·5. The small circles indicate positions on the first day of each month.

Neptune (page 44) is in Virgo, close to θ Virginis. Opposition is on April 3, the distance then being 29·29 units. The apparent diameter at opposition is 2″·5 and the magnitude 7·7. The diagram for Neptune is on a larger scale than that for Uranus, and shows stars down to magnitude 9·2.

Pluto moves from Leo into Cancer during the year. The diagram below is drawn from an ephemeris by J. G. Porter, and shows the position of the planet during the opposition period, together with all B.D. stars in the neighbourhood. The brightest star in the field is λ Leonis (magnitude 4·48). Opposition occurs on February 7, the distance being 35·6 units.




PATH OF NEPTUNE 1949
θ VIRG (MAG 4·44)
48 VIRG
SCALE OF MAGNITUDES
5·87 TO 6·84
7·09 TO 7·9
8·0 TO 8·9
9·0 TO 9·2
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
LEO
VIRGO
BOOTES
Arcturus
Spica
08ᵐ
06ᵐ
04ᵐ
02ᵐ
13ʰ00ᵐ
58ᵐ
56ᵐ
54ᵐ
52ᵐ
50ᵐ
48ᵐ
46ᵐ
12ʰ44ᵐ
−6°00'
5°40'
5°20'
5°00'
4°40'
4°20'
4°00'
3°40'
3°20'
−3°00'

ALGOL (β Persei)

Mean Place: R.A. $3^h\ 04^m\ 50^s$. Dec. + 40° 46′.

The following table of approximate U.T. of primary minima (geocentric) is based on an observation by Gaposchkin 1938 Dec. $5^d\ 2^h\ 17^m$ (heliocentric) (*P.A.*, **47**, 51, 1939) using the period of $2^d{\cdot}867318$ derived by Smart (*M.N.*, **97**, 402). It is believed that the predictions in the *Handbook* may well be an hour late if the data of a more recently observed epoch than that given above are reliable. For safety, observations should therefore begin at least two and a half hours before the times given below.

The total variation in brightness is from $2^m{\cdot}2$ to $3^m{\cdot}5$.

		h		d	h		d	h
Jan.	2	17·5	July	2	9·0	Oct.	2	3·0
	5	14·3		5	5·8		4	23·8
	8	11·1		8	2·7		7	20·6
	11	7·9		10	23·5		10	17·4
	14	4·7		13	20·3		13	14·2
	17	1·6		16	17·1		16	11·0
	19	22·4		19	13·9		19	7·8
	22	19·2		22	10·7		22	4·6
	25	16·0		25	7·5		25	1·4
	28	12·9		28	4·3		27	22·3
	31	9·7		31	1·1		30	19·1
Feb.	3	6·5	Aug.	2	21·9	Nov.	2	15·9
	6	3·3		5	18·8		5	12·7
	9	0·1		8	15·6		8	9·5
	11	21·0		11	12·4		11	6·3
	14	17·8		14	9·2		14	3·1
	17	14·6		17	6·0		17	0·0
	20	11·4		20	2·8		19	20·8
	23	8·3		22	23·6		22	17·6
	26	5·1		25	20·4		25	14·4
Mar.	1	1·9		28	17·2		28	11·2
	3	22·7		31	14·0	Dec.	1	8·0
	6	19·5	Sept.	3	10·9		4	4·9
	9	16·4		6	7·7		7	1·7
	12	13·2		9	4·5		9	22·5
	15	10·0		12	1·3		12	19·3
	18	6·8		14	22·1		15	16·1
	21	3·6		17	18·9		18	13·0
	24	0·5		20	15·7		21	9·8
	26	21·3		23	12·5		24	6·6
	29	18·1		26	9·3		27	3·4
				29	6·1		30	0·2

Computed by J. A. Bancroft-Wilson.

PERIODIC COMETS IN 1949

Comet Whipple, 1933 IV (= 1947g)

This comet was discovered at Harvard in 1933, and was seen again at its 1940 return. The orbit is of moderate eccentricity, and lies between the orbits of Mars and Jupiter, and Cunningham has suggested that the comet may be visible at opposition each year. A search by Jeffers at Lick on 1947 June 21 was successful, the comet being found close to the predicted place.

The ephemeris here given is a continuation of that in the 1948 *Handbook*, and is based on the elements predicted by Dr. C. Dinwoodie:—

T 1948 June 25·770 U.T.			
ω 190·1196	1950·0	*e*	0·355630
☊ 188·5963	1950·0	*a*	3·80018
i 10·2486	1950·0	*n*	0°·133045
q 2·44872		*P*	7·408 years

Equatorial constants for 1950·0:—

$$x = +3{\cdot}600823\,(\cos E - e) - 1{\cdot}131332 \sin E$$
$$y = +1{\cdot}156313 \qquad\qquad +3{\cdot}283115$$
$$z = +0{\cdot}371990 \qquad\qquad +0{\cdot}745768$$

Date 1949	R.A. 1950·0	Dec. 1950·0	*r*	*Δ*	Mag.
	h m	° ′			
Jan. 4	3 47·3	+ 6 57	2·738	1·985	14·3
12	3 47·6	7 18	2·759	2·087	
20	3 49·3	7 47	2·782	2·199	
28	3 52·5	8 21	2·805	2·317	
Feb. 5	3 56·9	8 58	2·828	2·440	
13	4 02·6	+ 9 37	2·851	2·567	15·1
21	4 09·3	10 18	2·875	2·696	
Mar. 1	4 16·9	10 58	2·900	2·826	
9	4 26·3	11 37	2·924	2·955	
17	4 34·4	12 15	2·949	3·084	
25	4 41·1	+ 12 51	2·975	3·209	15·7
Apr. 2	4 56·3	13 23	3·000	3·332	
10	5 04·9	13 52	3·026	3·451	
18	5 10·4	14 06	3·052	3·581	
26	5 21·8	+ 14 36	3·078	3·686	16·2

Ephemeris by H. Procter

Comet Schwassmann-Wachmann (2), 1929 I (= 1947 l)

by H. Q. Rasmusen

This comet was recovered by Van Biesbroeck on 1947 October 20. The observations which have been published suggest a correction to the following orbit of + 0·0208 day in *T*.

Epoch and osculation 1949 January 4·0 U.T.

T	1948 August 23·5770 U.T.		e	0·383651
M	20°·1512		a	3·49212
ω	358·1003	1950·0	n	0°·1510324
☊	125·0201	1950·0	P	6·526 years
i	3·7239	1950·0	q	2·15236

Equatorial constants for 1950·0:—

$$x = -1{\cdot}959030\cos(E-e) - 2{\cdot}664270\sin E$$
$$y = +2{\cdot}655171 \qquad\qquad -1{\cdot}739206$$
$$z = +1{\cdot}143320 \qquad\qquad -0{\cdot}526100$$

Date 1948/49	R.A. 1950·0	Dec. 1950·0	r	Δ	Mag.
	h m	° ′			
Dec. 3	12 16·1	+ 0 21	2·272	2·464	13·7
11	12 28·1	− 0 44	2·290	2·392	
19	12 39·4	1 42	2·310	2·317	
27	12 49·8	2 32	2·331	2·241	
Jan. 4	12 59·2	3 16	2·352	2·164	
12	13 07·4	− 3 50	2·375	2·086	13·5
20	13 14·4	4 15	2·398	2·010	
28	13 19·9	4 30	2·422	1·935	
Feb. 5	13 23·9	4 35	2·447	1·865	
13	13 26·2	4 30	2·473	1·800	
21	13 26·8	− 4 14	2·499	1·743	13·4
Mar. 1	13 25·6	3 48	2·526	1·695	
9	13 22·8	3 14	2·553	1·660	
17	13 18·5	2 34	2·581	1·638	
25	13 13·2	1 51	2·609	1·632	
Apr. 2	13 07·2	− 1 08	2·638	1·642	13·5
10	13 01·2	− 0 28	2·667	1.671	
18	12 55.6	+ 0 06	2.696	1.716	
26	12 50.7	0 32	2.725	1.778	
May 4	12 47.0	+ 0 48	2.755	1.855	13.9

Comet Forbes, 1929 II (= 1948e)

This comet was recovered by H. M. Jeffers at Lick on 1948 May 14 within 3′ of the position predicted by F. R. Cripps in last year's *Handbook*. Observations indicate that the comet is some two magnitudes fainter than was predicted. By mid-February it will be too close to the sun to be observed.

T 1948 September 16·11755 U.T.

ω	259°·741 } 1950·0	e	0·552735
☊	25·445 } 1950·0	a	3·454745
i	4·621 } 1950·0	n	0°·153490
q	1·545187	P	6·422 years

Equatorial constants for 1950·0:—

$$x = +0{\cdot}900237\,(\cos E - e) + 2{\cdot}777813 \sin E$$
$$y = -2{\cdot}940703 \qquad + 0{\cdot}709732$$
$$z = -1{\cdot}573882 \qquad + 0{\cdot}262778$$

Date 1949	R.A. 1950·0 (h m)	Dec. 1950·0 (° ′)	r	Δ	Mag.
Jan. 4	21 54·9	−15 03	1·892	2·498	17·6
12	22 14·3	13 06	1·935	2·593	
20	22 32·8	11 08	1·980	2·688	
28	22 50·7	9 10	2·026	2·782	
Feb. 5	23 07·9	− 7 13	2·073	2·875	18·5

Ephemeris by J. M. A. Danby and H. Procter

Comet Neujmin (2), 1916 II

By F. R. Cripps

This short-period comet has been seen at only one return—that of 1927—since its discovery in 1916.

Perturbations by Jupiter and Saturn have been applied to the elements given in the 1943 *Handbook*. The comet is less favourably placed than in 1943.

T	1948 October 9·054 U.T.			
ω	193°·739	1950·0	e	0·56415
☊	327·928	1950·0	a	3·09696
i	10·611	1950·0	n	0°·180843
q	1·34981		P	5·450 years

Equatorial constants for 1950·0:—

$$x = -2·933094\,(\cos E - e) - 0·781747\sin E$$
$$y = +0·957357 \qquad\qquad -2·011877$$
$$z = +0·267565 \qquad\qquad -1·371076$$

Date 1949		R.A. 1950·0	Dec. 1950·0	r	Δ	Variation for $\Delta T = +1$ day $\Delta\alpha$	$\Delta\delta$	Mag.
		h m	° ′			m	′	
Jan.	4	16 00·8	−28 07	1·642	2·266	−1·35	+4·5	15·1
	12	16 22·9	29 23	1·689	2·265	1·31	3·3	
	20	16 44·3	30 25	1·738	2·260	1·26	2·2	
	28	17 05·0	31 15	1·788	2·251	1·22	1·2	
Feb.	5	17 24·6	31 55	1·839	2·237	1·17	+0·3	
	13	17 43·2	−32 25	1·891	2·218	−1·12	−0·6	15·7
	21	18 00·6	32 48	1·943	2·194	1·08	1·3	
Mar.	1	18 16·7	33 05	1·996	2·165	1·04	2·0	
	9	18 31·3	33 17	2·050	2·130	1·01	2·6	
	17	18 44·4	33 28	2·103	2·092	0·98	3·2	
	25	18 55·9	−33 37	2·156	2·049	−0·97	−3·7	16·1
Apr.	2	19 05·6	33 47	2·210	2·003	0·96	4·2	
	10	19 13·4	33 59	2·263	1·956	0·96	4·7	
	18	19 19·1	34 13	2·316	1·907	0·99	5·1	
	26	19 22·7	34 30	2·369	1·860	1·02	5·5	
May	4	19 23·9	−34 50	2·421	1·815	−1·06	−5·7	16·3
	12	19 22·8	35 12	2·472	1·775	1·13	6·0	
	20	19 19·3	35 35	2·524	1·743	1·20	6·0	
	28	19 13·4	−35 57	2·575	1·721	−1·28	−6·0	16·5

Ephemeris by H. Cunliffe

Comet Neujmin (1), 1913 III

Discovered in 1913, this comet was seen again in 1931. The ephemeris below has been calculated from the elements by Prof. G. van Biesbroeck (*A.J.*, **44**, 116—117, 1935) which were based on his revision of the 1913—1931 revolution.

The reported recovery of this comet at Mount Wilson on 1948 May 6 has not been confirmed. It indicated a correction to the predicted value of T of −3·38 days, but this has not been applied in the following elements and ephemeris.

T	1948 December 19·1296 U.T.			
ω	346°·7345	1950·0	e	0·774568
☊	347·2207	1950·0	a	6·85091
i	15·0294	1950·0	n	0°·0549644
q	1·544414		P	17·932 years

Equatorial constants for 1950·0:—

$$x = +6.167101 (\cos E - e) + 1{\cdot}870655 \sin E$$
$$y = -2{\cdot}549391 \qquad + 3{\cdot}007456$$
$$z = -1{\cdot}549977 \qquad + 2{\cdot}496383$$

Date 1949	R.A. 1950·0	Dec. 1950·0	r	Δ	Variation for $\Delta T = +1$ day $\Delta\alpha$	$\Delta\delta$	Mag.
	h m	° ′			m	′	
Jan. 4	21 37·0	− 14 42	1·556	2·202	− 1·56	− 15·0	14·2
12	22 00·3	11 39	1·571	2·247	1·50	15·5	
20	22 22·9	8 33	1·592	2·298	1·44	15·8	
28	22 45·0	5 26	1·618	2·354	1·39	15·8	
Feb. 5	23 06·4	− 2 19	1·649	2·414	1·33	15·6	
13	23 27·3	+ 0 44	1·685	2·479	− 1·28	− 15·1	14·8
21	23 47·8	3 42	1·725	2·547	1·23	14·5	
Mar. 1	0 07·8	6 34	1·769	2·618	1·19	13·8	
9	0 27·4	9 19	1·816	2·692	1·15	13·0	
17	0 46·7	+ 11 56	1·865	2·767	− 1·11	− 12·2	15·5

Ephemeris by E. Longbottom

Comet Gale, 1927 VI

When this comet was discovered in 1927, the determination of its orbit proved difficult and uncertain, and the comet was only recovered in 1938 with the aid of five spaced search ephemerides by L. E. Cunningham. The prediction for this present return of the comet is based on a revision by F. R. Cripps of the perturbed orbit from 1927 to 1938, and its correction using some of the 1938 observations. The 1938—1949 perturbations were computed by the Rev. C. Dinwoodie, using the Cowell method, and starting from the elements as follows:

T	1938 June 18·47415 U.T.		e	0·760730
ω	209°·11622	1950·0	a	4·943741
☊	67·25374	1950·0	n	0°·0896645
i	11·72544	1950·0	P	10·992 years

Perturbations by Jupiter and Saturn, and by the inner planets where they were appreciable, were included. Independent work by F. R. Cripps using the

Encke method, and by W. E. Beart using Crommelin's tables with an unpublished modification of Crommelin's method due to Dr. G. Merton, led to almost identical results. Dr. Dinwoodie's predicted elements have been used for the following ephemeris:—

T	1949 April 25·847 U.T.	Epoch 1949 May 4.0 U.T.	
ω	209°·9951 (1950·0)	e	0·7646988
Ω	66·0791 (1950·0)	a	4·892694
i	11·4658 (1950·0)	n	0·0910714
q	1·15126	P	10·823 years

Equatorial constants for 1950·0:—

$$x = +0{\cdot}473109\,(\cos E - e) + 3{\cdot}085280 \sin E$$
$$y = -4{\cdot}251920 \qquad\qquad + 0{\cdot}542309$$
$$z = -2{\cdot}373984 \qquad\qquad - 0{\cdot}356439$$

Date 1949		R.A. 1950·0	Dec. 1950·0	r	Δ	Variation for $\Delta T = +1$ day $\Delta\alpha$	$\Delta\delta$	Mag.
		h m	° ′			m	′	
Jan.	4	14 47·0	− 7 40	1·860	2·107	− 1·53	+ 11·9	16·8
	12	15 07·6	9 22	1·787	1·971	1·70	12·7	16·5
	20	15 29·7	11 04	1·714	1·840	1·90	13·5	16·1
	28	15 53·4	12 46	1·644	1·715	2·12	14·2	15·6
Feb.	5	16 19·1	14 27	1·574	1·598	2·38	14·6	15·2
	13	16 47·0	− 16 03	1·507	1·490	− 2·66	+ 14·8	14·7
	21	17 17·2	17 34	1·443	1·392	2·96	14·5	14·3
Mar.	1	17 50·0	18 53	1·383	1·306	3·24	13·5	13·9
	9	18 25·1	19 56	1·327	1·234	3·50	11·7	13·5
	17	19 02·4	20 39	1·277	1·176	3·71	9·0	13·1
	25	19 41·3	− 20 55	1·234	1·132	− 3·80	+ 5·7	12·9
April	2	20 20·9	20 42	1·198	1·103	3·77	+ 1·8	12·6
	10	21 00·2	20 00	1·172	1·088	3·62	− 2·0	12·3
	18	21 38·2	18 52	1·156	1·085	3·35	5·5	12·3
	26	22 14·3	17 23	1·151	1·094	3·00	8·3	12·3
May	4	22 47·8	− 15 41	1·157	1·109	− 2·64	− 10·4	12·4
	12	23 18·6	13 52	1·173	1·130	2·29	11·9	12·5
	20	23 46·7	12 04	1·200	1·153	1·97	12·8	12·7
	28	0 12·0	10 20	1·235	1·178	1·70	13·3	13·0
June	5	0 34·8	8 43	1·279	1·200	1·47	13·6	13·2
	13	0 55·1	− 7 17	1·329	1·220	+ 1·29	− 13·8	13·5
	21	1 13·2	6 02	1·385	1·236	1·15	13·9	13·8
	29	1 29·0	5 00	1·445	1·248	1·03	14·1	14·1
July	7	1 42·5	4 12	1·510	1·255	0·95	14·3	14·4
	15	1 53·9	3 37	1·577	1·257	0·90	14·6	14·7
	23	2 02·9	− 3 15	1·646	1·254	− 0·89	− 15·0	15·0
	31	2 09·6	3 06	1·717	1·250	0·89	15·5	15·2
Aug.	8	2 13·8	3 09	1·789	1·243	0·92	16·0	15·5
	16	2 15·4	3 23	1·862	1·236	0·99	16·6	15·7
	24	2 14·5	− 3 46	1·936	1·231	− 1·07	− 17·1	15·9

Ephemeris by J. M. A. Danby

Comet Väisälä (1), 1939 IV

By Miss L. Oterma

This faint periodic comet was discovered at the beginning of 1939 by Y. Väisälä at Turku in Finland. At its next return, the comet will be less favourably placed than at its discovery, since it will not be at opposition; but it may be detected early in the summer of 1950, having passed perihelion in November 1949.

The following elements were obtained from the observations in 1939 from January 18 to April 22:—

Epoch 1939 March 18·0 U.T.			T	1939 April 26·0826 U.T.
M	356°·35780		e	0·6342393
ω	44·34494	1950·0	a	4·818176
☊	135·56344	1950·0	n	0°·0931923
i	11·27068	1950·0	P	10·576 years

The ephemeris for the coming apparition has been derived from the above orbit by applying to it the accurate special perturbations by Jupiter and Saturn. As a check, the perturbations were computed also by Miss H. Rantaseppä, whose calculations gave practically the same ephemeris as that which follows.

Epoch 1949 Feb. 13·0 U.T.				
T	1949 November 10·46 U.T.		e	0·635182
M	334°·6723		a	4·80254
ω	44·3322	1950·0	n	0·0936479
☊	135·4647	1950·0	P	10·525 years
i	11·2804	1950·0	q	1·75205

The magnitudes are photographic magnitudes according to the Mt. Wilson scale, based on the r^4 law. The uncertainty in the perihelion date (expected mean error) is estimated as ± 2·5 days.

Date 1949/50	R.A. 1950·0	Dec. 1950·0	r	Δ	Variation for ΔT = + 1 day $\Delta\alpha$	$\Delta\delta$	Mag.
	h m	° ′			m	′	
Jan. 4	4 32·6	+ 8 58	3·317	2·482	− 0·67	− 2·0	19·4
12	4 28·0	9 17	3·267	2·507			
20	4 24·6	9 42	3·216	2·544			
28	4 22·5	10 13	3·164	2·591			
Feb. 5	4 22·0	10 48	3·113	2·646			
13	4 23·1	+ 11 27	3·062	2·705	− 0·57	− 2·2	19·2
21	4 25·6	12 09	3·011	2·767			
Mar. 1	4 29·5	12 53	2·960	2·830			
9	4 34·8	13 38	2·908	2·891			
17	4 41·4	14 24	2·856	2·950			

Comet Väisälä—*continued*

Date 1949/50	R.A. 1950·0	Dec. 1950·0	r	Δ	Variation for $\Delta T = +1$ day: $\Delta\alpha$	$\Delta\delta$	Mag.
	h m	° ′			m	′	
Mar. 25	4 49·1	+ 15 08	2·804	3·005	− 0·57	− 2·3	19·0
Apr. 2	4 57·9	15 52	2·753	3·054			
10	5 07·8	16 34	2·702	3·098			
18	5 18·7	17 12	2·650	3·136			
26	5 30·4	17 48	2·599	3·167			
May 4	5 42·9	+ 18 20	2·548	3·192	− 0·69	− 2·2	18·8
12	5 56·3	+ 18 47	2·498	3·210			
Oct. 11	11 48·0	+ 5 08	1·780	2·662	− 1·38	+ 5·2	16·8
19	12 09·2	3 24	1·768	2·622			
27	12 30·5	+ 1 40	1·758	2·583			
Nov. 4	12 51·8	− 0 04	1·753	2·544			
12	13 13·2	− 1 45	1·752	2·508			
20	13 34·5	− 3 21	1·755	2·474	− 1·39	+ 5·5	16·6
28	13 55·7	4 52	1·762	2·441			
Dec. 6	14 16·8	6 16	1·772	2·410			
14	14 37·7	7 32	1·786	2·380			
22	14 58·2	8 40	1·804	2·348			
30	15 18·4	− 9 38	1·825	2·317	− 1·32	+ 4·8	16·6
Jan. 7	15 38·0	10 26	1·849	2·285			
15	15 57·0	11 04	1·876	2·252			
23	16 15·3	11 32	1·906	2·219			
31	16 32·8	− 11 51	1·939	2·183			

Comet du Toit, 1945c

This comet is interesting because of its short period, namely about 4½ years—only Encke's comet has a shorter period than this. Using a provisional orbit computed by L. E. Cunningham from observations in 1945 covering 58 days, T. A. Goodchild has computed the perturbations by Jupiter and Saturn during the revolution 1945—1949, and predicted the return to perihelion as 1949 November 10·6. Later information however indicates that a revision of the 1945 elements is necessary which may modify the prediction considerably. It is hoped to publish a revised prediction later in the *Journal*.

Comet Reinmuth (1), 1928 I

Discovered in 1928, this comet was also seen at its 1935 return, but not in 1942-3. The *Handbook* elements for 1935, however, have been found to contain a serious error in the value of the mean motion (and also in a and P) which led to a wrong prediction in 1942.

Predicted elements for 1935 by Kanda and Hirose, which have since come to hand, have been corrected by F. R. Cripps, using 4 observations 1934-35, as follows:—

T 1935 April 29·8732 U.T.	e	0·5037175
ω 8°·78852 } 1950·0	a	3·739425
☊ 125·17232 } 1950·0	n	0°·136300 (assumed)
i 8·06127 } 1950·0		

Independent confirmation was furnished by a correction of Foxell and Levin's elements by Dr. G. Merton. Cripps has computed the two revolutions to 1950 by Encke's method, including perturbations by Jupiter and Saturn. The comet made a close approach to Jupiter in 1937 June (0·7 A.U.).

T 1950 July 23·7442 U.T.		
ω 12°·8760 } 1950.0	e	0·476943
☊ 123·5994 } 1950.0	a	3·89499
i 8·3896 } 1950.0	n	0°·128217
q 2·03730	P	7·687 years

Equatorial constants for 1950·0:—

$$x = -2{\cdot}816437(\cos E - e) - 2{\cdot}327856 \sin E$$
$$y = +2{\cdot}415211 \qquad - 2{\cdot}452928$$
$$z = +1{\cdot}185489 \qquad - 0{\cdot}533059$$

Date 1949	R.A. 1950·0	Dec. 1950·0	r	Δ	Variation for $\Delta T = +1$ day $\Delta\alpha$	$\Delta\delta$	Mag.
	h m	° ′			m	′	
Oct. 3	4 07·2	+ 10 00	3·015	2·306	− 1·05	− 4·0	18·6
11	4 06·8	9 36	2·977	2·189	1·10	4·2	
19	4 04·9	9 10	2·940	2·084	1·16	4·4	18·3
27	4 01·5	8 43	2·902	1·993	1·21	4·6	
Nov. 4	3 56·8	8 16	2·864	1·917	1·25	4·7	18·0
12	3 50·9	+ 7 52	2·827	1·857	− 1·27	− 4·9	
20	3 44·4	7 31	2·789	1·815	1·28	5·0	17·7
28	3 37·5	7 17	2·752	1·792	1·28	5·0	
Dec. 6	3 30·9	7 11	2·715	1·786	1·26	5·1	17·6
14	3 25·1	7 14	2·678	1·796	1·21	5·0	
22	3 20·4	+ 7 27	2·642	1·822	− 1·17	− 5·0	17·5
30	3 17·2	+ 7 50	2·606	1·860	− 1·13	− 4·9	

Ephemeris by H. Cunliffe and T. A. Goodchild.

Comet Schwassmann-Wachmann (1), 1925 II

By Paul Herget

This is one of the most unusual comets known. Its orbit has the smallest eccentricity (0·135) of any known comet, and with an inclination of less than 10°, it lies entirely between the orbits of Jupiter and Saturn. The comet is also remarkable in its physical characteristics. It may suddenly increase its usual brightness (magnitude 16—17) by more than a hundredfold in the course of a few days, without any apparent cause.

The following elements are based upon observations from 1934 to 1944, and the mean residual of a single observation is 1″·3.

Epoch 1941 January 6·0 U.T.

M	350°·57422		e	0·13550705
ω	356·22129	1950·0	a	6·38853498
☊	322·00407	1950·0	n	0°·061038443
i	9·51654	1950·0	P	16·148 years
			q	5·5228435

The comet is observable at every opposition. The ephemeris given below for the opposition of 1949 February 3 includes accurate special perturbations by Jupiter and Saturn. The variations $\Delta\alpha$ and $\Delta\delta$ for + 1 day's change in T are + $0^m·21$ and − 1′·4 respectively during this period.

Date 1949	R.A. 1950·0	Dec. 1950·0	r	Δ
	h m	° ′		
Jan. 4	9 19·0	+ 17 32	7·209	6·368
14	9 15·4	17 44		
24	9 11·4	17 57	7·210	6·242
Feb. 3	9 07·1	18 11		
13	9 02·7	18 24	7·211	6·241
23	8 58·6	+ 18 35		
Mar. 5	8 55·0	18 43	7·212	6·362
15	8 52·0	18 48		
25	8 49·8	18 50	7·213	6·586
Apr. 4	8 48·6	18 48		
14	8 48·4	+ 18 43	7·213	6·878
24	8 49·1	18 34		
May 4	8 50·6	18 22	7·213	7·199
14	8 53·0	18 07		
24	8 56·2	+ 17 49	7·213	7·515

Comet Schwassmann-Wachmann (1), 1925 II—*continued*

Date 1949/50	R.A. 1950·0	Dec. 1950·0	*r*	Δ
	h m	° ′		
Oct. 31	10 20·8	+ 9 32	7·200	7·584
Nov. 10	10 24·1	9 07		
20	10 26·8	8 46	7·197	7·265
30	10 28·6	8 29		
Dec. 10	10 29·6	8 16	7·193	6·931
20	10 29·7	+ 8 09		
30	10 28·9	8 06	7·190	6·620
Jan. 9	10 27·2	8 09		
19	10 24·6	8 16	7·186	6·372
29	10 21·3	+ 8 27		

Comet Oterma, 1942 VII (= 1943a)

By Paul Herget

This faint comet was discovered in 1943 April by Miss L. Oterma at Turku in Finland. Its orbit is much smaller than that of Comet Schwassmann-Wachmann (1), but it shares with that comet the characteristic of having an orbit of exceptionally small eccentricity, as a result of which it has been observable throughout its whole orbit. This orbit lies between those of Mars and Jupiter, and resembles the orbits of the minor planets of the Hilda group. Observed magnitudes lie between 13 and 18, but no variations have been observed which are not due to changes in distance.

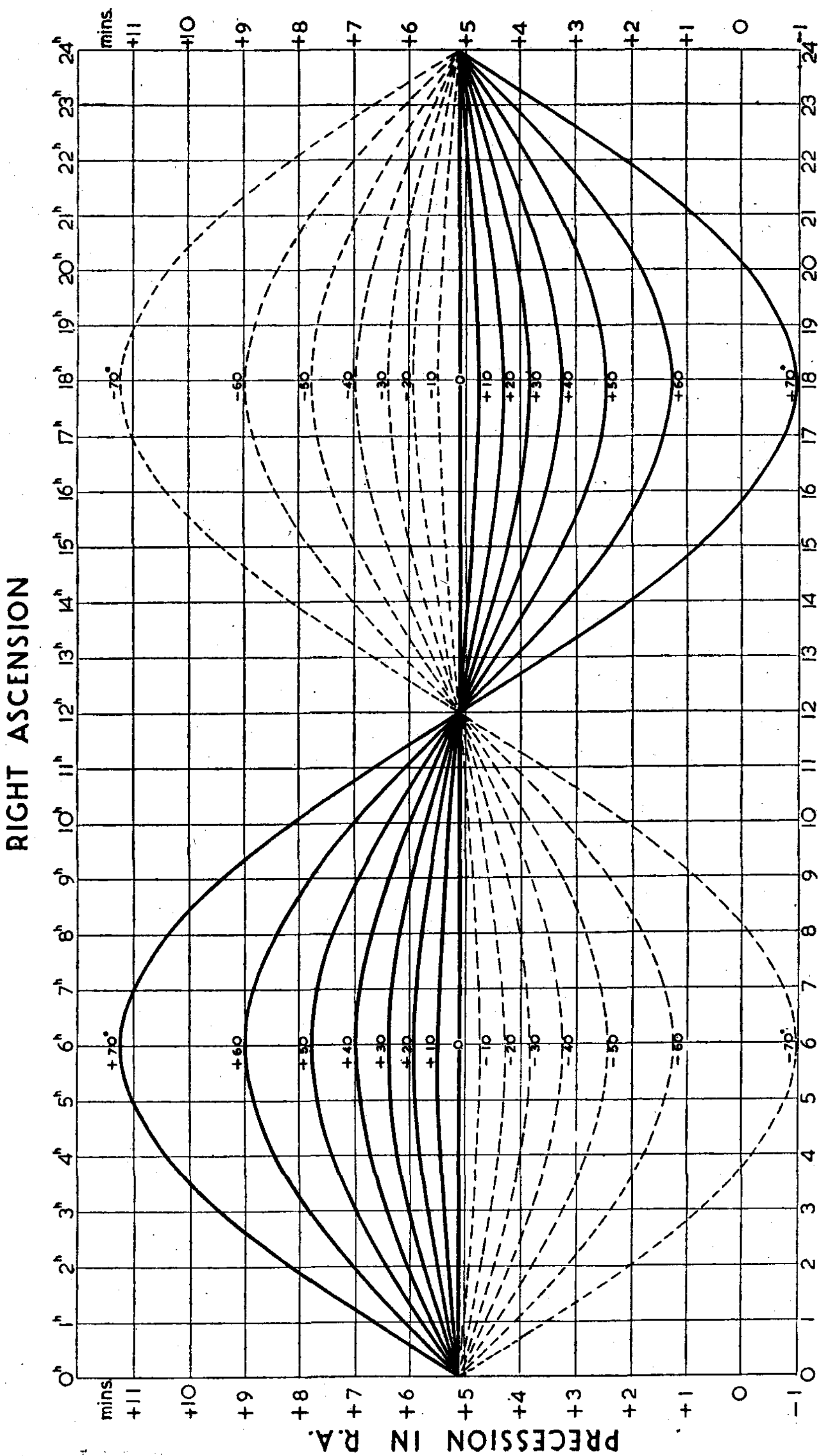
Preliminary calculations indicate that the comet experienced a close approach to Jupiter in 1937. In order to compute accurately the character of the orbit before this close approach, it is necessary to have accurate observations for the next few years extending as far along the orbit as possible on either side of opposition. Accurate special perturbations by Jupiter and Saturn have been applied to the definitive orbit for 1943-44.

Epoch 1943 October 3·0 U.T.

M	50°·8937		e	0·144425
ω	354·8058	1950·0	a	3·96181
☊	155·1708	1950·0	n	0°·124987
i	3·9899	1950·0	P	7·886 years
			q	3·38963

Date 1949/50		R.A. 1950·0	Dec. 1950·0	r	Δ	Variation for ΔT = + 1 day Δα	Δδ
		h m	° ′			m	′
Jan.	4	3 27·0	+ 13 47	3·850	3·151		
	14	3 25·8	13 54				
	24	3 26·3	14 07	3·825	3·389		
Feb.	3	3 28·7	14 28			+ 0·55	+ 1·8
	13	3 32·7	14 54	3·801	3·661		
	23	3 38·3	+ 15 24				
Mar.	5	3 45·2	15 57	3·776	3·934		
	15	3 53·4	16 32				
	25	4 02·6	+ 17 07	3·752	4·183		
Sept.	1	7 25·4	+ 19 04	3·575	4·173		
	11	7 37·8	18 36				
	21	7 49·0	18 07	3·556	3·917		
Oct.	1	7 59·0	17 37				
	11	8 07·9	17 07	3·538	3·627		
	21	8 15·7	+ 16 39				
	31	8 22·1	16 14	3·521	3·321		
Nov.	10	8 27·0	15 53			+ 0·71	− 1·8
	20	8 30·2	15 38	3·504	3·022		
	30	8 31·5	15 31				
Dec.	10	8 30·8	+ 15 31	3·489	2·759		
	20	8 28·0	15 40				
	30	8 23·6	15 56	3·475	2·567		
Jan.	9	8 17·6	16 20				
	19	8 10·7	+ 16 48	3·462	2·480		

Opposition 1950 Jan. 23.


RIGHT ASCENSION
PRECESSION IN R.A.
mins.
0h 1h 2h 3h 4h 5h 6h 7h 8h 9h 10h 11h 12h 13h 14h 15h 16h 17h 18h 19h 20h 21h 22h 23h 24h
+11 +10 +9 +8 +7 +6 +5 +4 +3 +2 +1 0 −1
+70° +60 +50 +40 +30 +20 +10 0 −10 −20 −30 −40 −50 −60 −70°

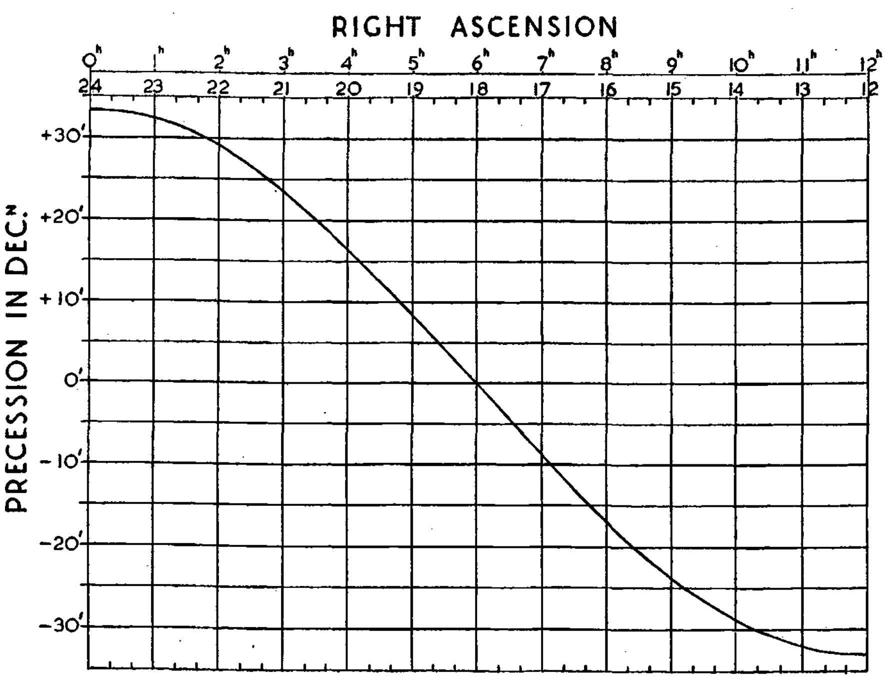
PRECESSION FOR 100 YEARS

Observers using a star catalogue in which the positions are given for one of the earlier equinoxes may apply corrections for precession by means of the two diagrams given here. These are arranged to give the corrections in right ascension and declination *for one hundred years* so that other intervals may be conveniently worked by proportion.

The diagram on the opposite page gives the correction in R.A. in minutes of time on the vertical axis. Curves are drawn for each 10° of declination—full lines for northern, and broken lines for southern declinations—and the R.A. is read along the horizontal axes. The diagram below gives the correction in declination. This is a function of the R.A. alone, and the correction is read on the vertical axis. *The corrections are always to be added algebraically.* Thus to correct the position of γ Centauri, the position of which in 1900 is given as $12^h\ 36^m{\cdot}0$, $-48°\ 25'$, we have to add on the correction for 49 years. It is sufficiently accurate to use one half of the correction from the diagrams, so that we have:—

	h	m	°	′
Position (1900)	12	36·0	−48	25
Half correction		+2·7		−16
Position (1949)	12	38·7	−48	41

In the same way, corrections can be made for any other interval, usually with an accuracy of one or two minutes of arc.



METEOR DIARY, 1949

1. **Scope of Diary.**—This Diary contains in Table I the conditions of observation of those streams for which moonlight conditions are favourable for visual observation, as in previous issues*, and in Table II brief details of other showers which in this year can only be effectively observed by radar technique.

2. **Time.**—All times in this Diary are expressed in G.M.A.T.; radar observers should note that in order to convert to U.T. the correction is + 12 hours. The longitude of the sun which is also used as a measure of time in meteor work is tabulated on pages 6 and 7.

3. **Latitude.**—The Diary is intended primarily for observers in England and is based on an assumed latitude of 52°. Observers in latitudes differing by more than 2° would need to compute the appropriate corrections, particularly in the figures for twilight.

4. **Explanation, Table I.**—The Table contains in all cases where the moon is favourable: (1) the radiant altitude; (2) the Moon's age and times of moonrise and moonset, where relevant; (3) times of twilight; (4) certain approximate data concerning the radiant and richness of each stream. These data include:

Radiant.—Very few of the major streams have point radiants of the classic type and the positions given are generally merely an approximate centre of an area of radiation.

Normal Limits.—The dates between which an observer may expect to obtain a radiant for the stream in about five or six hours of watching.

H.R. at maximum.—The expected hourly rate at maximum for one observer when the radiant is in the zenith. The rate given is a forecast for the year 1949, so far as this can be done; it bears no relation to the rates attained in other years. These hourly rates depend on the radiant altitude, and are to be diminished by the factors given in the critical table below. It is clearly useless to expect to see a good shower when the radiant is very low.

Critical Table for Hourly Rates

Altitude	Factor	Altitude	Factor
°		°	
0		27·4	
	0·1		0·6
2·6		34·5	
	0·2		0·7
8·6		42·5	
	0·3		0·8
14·5		52·2	
	0·4		0·9
20·7		65·8	
	0·5		1·0
27·4		90·0	

In critical cases, ascend.

Twilight.—This has been assumed to start and end when the Sun's upper limb is 12° below the horizon, which is the approximate limit for effective positional work. For statistical work the limits are somewhat narrower and will depend on the state of the sky.

Transit.—The times of transit of the radiants are given for the convenience of radar workers, and are expressed in hours of G.M.A.T.

* *Handbook*, **1945**, 37; **1946**, 42; **1947**, 42; **1948**, 50.

5. **Explanation, Table II.**—The quantities tabulated are:
(1) the name of the stream.
(2) the limits of observation, which here means the general limits of a detectable stream.
(3) the time of transit of the radiant, as in Table I.
(4) (5) the radiant and type of radiant structure, for which see Explanation to Table I.

6. **Notes on Individual Streams.**

The Quadrantids. Radar observations in 1948 January gave the very high H.R. at maximum 100.* The tabulated H.R. may therefore be too low.

The Perseids. The radiant type is now considered to be a large elliptical area, approximately 12° by 7°, within which the radiants of individual meteors are somewhat uniformly diffuse.

The 1935 Aurigids. A few meteors recorded by Prentice on 1948 Aug. 29 suggest that the stream discovered by Guth and Hoffmeister in 1935 may be returning.

The Orionids. If the suggested period of 16 years† is correct, there should be a perceptible increase in H.R. in 1949 over the 1943—1948 rates, particularly during the early stages Oct. 16-20.

The Leonids. Radar observations in 1947 November gave nearly zero results. The parent comet is in aphelion, and the tabulated H.R. may be too high.

The Bielids. Extensive visual and radar observations in 1946 and 1947 yielded nearly zero results,‡ and the stream must be considered as still missing.

The December Ursids. The stream recurred in 1947, its third annual appearance, and was successfully observed by radar.|| It is now clear that Bečvář's 1946 position is the correct one.

The Daylight Streams. The great daylight Pisces stream discovered by Clegg, Hughes and Lovell in 1947 has now been more fully investigated. The original observations are now published§ and further work has been done with more powerful apparatus at the 1948 return. In Table II the principal sub-centres have been listed, from information kindly supplied by Dr. Lovell.

Table I. Visual Work

The QUADRANTIDS

Data

Maximum	Jan. $3^d\ 0^h$.
Normal Limits	Jan. 2—3
H.R. at Max.	40
Radiant	$230° + 52°$
Type	Multiple centres
Transit	$20^h.5$
Conditions	Very favourable

* Lovell, privately communicated.
† Prentice, *Journal*, **51**, 167, 1941.
‡ Lovell and Prentice, *Journal*, **58**, 140, 1948.
|| Clegg, Hughes and Lovell, *Journal*, **58**, 134, 1948, Prentice *ibid* p. 140.
§ Clegg, Hughes and Lovell, *M.N.*, **107**, 369, 1947.

The QUADRANTIDS—*continued*

Radiant Altitude on January 3:

T	6^h	9^h	12^h	15^h	18^h
a	18°	14°	23°	42°	67°

Moon

Jan. 3 age 4^d sets $8^h\ 20^m$.

Twilight

Dusk $5^h\ 25^m$, Dawn $18^h\ 45^m$.

The LYRIDS

Data

Maximum	April 21
Normal Limits	April 20—22
H.R. at Max.	8
Radiant	271° + 33°
Type	Multiple centres
Transit	$16^h{\cdot}0$
Conditions	Very favourable

Radiant Altitude on April 21:

T	9^h	11^h	13^h	15^h
a	16°	33°	52°	68°

Moon

		d		h m
April 20	age	22	rises	14 51
21		23		15 14

Twilight

April 21 dusk $8^h\ 30^m$, dawn $15^h\ 25^m$.

The PERSEIDS

Data

Maximum	Aug. 11
Normal Limits	Aug. 4—16
H.R. at Max.	50
Radiant	44° + 58°
Type	Diffuse
Transit	$17^h{\cdot}6$
Conditions	Very unfavourable Full moon Aug. 8.

The GIACOBINIDS

Data

Maximum	Oct. 9
Radiant	262° + 54°

No stream is expected this year

The ORIONIDS

Data

Maximum	Oct. 19—20
Normal Limits	Oct. 15—25
H.R. at Max.	12
Radiant	96° + 15°
Type	Multiple Centres
Transit	$16^{h}\cdot4$
Conditions	Very favourable
Period	16 years ?
Next return	1951—55 (?)

Radiant Altitude on Oct. 20

T	11^h	13^h	15^h	17^h
a	17°	35°	49°	52°

Moon

Negligible

Twilight

Oct. 21, dawn $17^h\ 22^m$

The TAURIDS

Data

Maximum	Nov. 3—10
Normal Limits	Oct. 26—Nov. 22
H.R. at Max.	6
Radiant	55° + 15°
Type	Diffuse
Transit	$12^{h}\cdot6$
Conditions	Favourable, later stages

Radiant Altitude on November 11

T	7^h	9^h	11^h	13^h	15^h
a	18°	36°	50°	52°	41°

Moon

	age d		h	m
Nov. 11	age 21	rises	8	05
12	22		9	27
13	23		10	53
14	24		12	19

Twilight

Nov. 15	dusk $5^h\ 29^m$,	dawn $18^h\ 03^m$
23	5 20	18 14

The LEONIDS

Data

Maximum	Nov. 16
Normal Limits	Nov. 15—20
H.R. at Max.	6
Radiant	152° + 22°
Type	Sharp
Transit	$18^{h}\cdot5$
Period	33 years
Conditions	Very favourable
Next return	1965

Radiant Altitude on Nov. 16

T	11^h	13^h	15^h	17^h
a	5°	22°	40°	56°

Moon

Negligible

Twilight

Nov. 16 dusk $5^h\,28^m$, dawn $18^h\,03^m$

The GEMINIDS

Data

Maximum	Dec. 12
Normal Limits	Dec. 9—14
H.R. at Max.	60
Radiant	113° + 32°
Type	Multiple centres
Transit	$14^{h}\cdot0$
Conditions	Favourable

Radiant Altitude on December 12

T	5^h	7^h	9^h	11^h	13^h	15^h
a	2°	15°	32°	51°	66°	68°

Moon

		age (d)	rises (h)	(m)
Dec.	10	21	10	04
	11	22	11	28
	12	23	12	53
	13	24	14	19

Twilight

Dec. 13 dusk $5^h\,13^m$, dawn $18^h\,36^m$

The DECEMBER URSIDS

Data

Maximum	Dec. 22
Normal Limits	Dec. 22
H.R. at Max.	8 (?)
Radiant	$207° + 74°$
Type	Sharp
Transit	$19^h.7$
Conditions	Very favourable

Radiant Altitude

T	7^h	10^h	13^h	16^h
a	36	38	46	58

Moon

Negligible

Twilight

Dec. 22 dusk $5^h\ 15^m$, dawn $18^h\ 41^m$

Table II. Daylight and Moonlight Streams

Stream	Limits	Transit G.M.A.T.	Radiant	Type*
		h	° °	
η Aquarids	May 1—11	19·4	333 ± 0	CM
The Great Daylight Piscid Stream.				
Stream B	May 6—15	20·7	357 + 5	DM
,, C	May 5—14	22·5	26 + 25	M
,, D	May 30—June 14	22·2	49 + 30	M
,, E	June 2—13	22·8	57 + 15	M
,, F	June 23—July 10	21·9	68 + 35	
,, G	June 20—July 10	23·1	85 + 25	
,, H	July 12—18	22·5	90 + 18	
,, J	July 12—18	23·2	100 + 20	
,, K	July 12—18	24·6	122 + 13	
Perseids	August 4—16	17·6	44 + 58	DM

* C Multiple Centres D Diffuse M Moving

ASTRONOMICAL AND PHYSICAL CONSTANTS

Solar parallax	(*Paris Conference*, 1896)	$8''\cdot80$
Constant of nutation	(*Paris Conference*, 1896)	$9''\cdot21$
Constant of aberration	(*Paris Conference*, 1896)	$20''\cdot47$
Moon's equatorial horizontal parallax (*Brown*)		$3422''\cdot70$
Annual general precession (*Newcomb*)		$p = 50''\cdot2564 + 0''\cdot0222T$*
Annual precession in R.A. (*Newcomb*)		$m = 3^s\cdot07234 + 0^s\cdot00186T$
Annual precession in Dec. (*Newcomb*)		$n = 20''\cdot0468 - 0''\cdot0085\ T$
Obliquity of ecliptic (*Newcomb*)		$\epsilon = 23^\circ\cdot27'\ 08''\cdot26 - 46''\cdot85T$
Node of moving on fixed ecliptic (*Newcomb*)		$\Omega = 173^\circ\ 57'\cdot06 + 54'\cdot77T$
Speed of rotation of ecliptic (*Newcomb*)		$\pi = 0''\cdot4711 - 0''\cdot0007T$
Mean distance Earth to Sun†		149,500,000 km. = 92,900,000 miles
Mean distance Earth to Moon		384,400 km. = 238,900 miles

Length of the Year (*Newcomb*)	d	d
Tropical (equinox to equinox)	365·24219 879	$-$ 0·00000 614T
Sidereal‡	365·25636 042	+ 0·00000 011T
Anomalistic (perihelion to perihelion)	365·25964 134	+ 0·00000 304T
Eclipse § (*Brown*)	346·62003 1	+ 0·00003 2 T
Julian	365·25	

Length of the month (*Brown*)	d	d
Synodical (New Moon to New Moon)	29·53058 82	$-$ 0·00000 02T
Sidereal‡	27·32166 10	$-$ 0·00000 02T
Tropical (equinox to equinox)	27·32158 17	$-$ 0·00000 02T
Anomalistic (perigee to perigee)	27·55455 05	$-$ 0·00000 14T
Nodical (node to node)	27·21222 00	$\pm$ 0·00000 00T

Length of day (*Newcomb*)	
Mean solar	$24^h\ 03^m\ 56^s\cdot555 = 1^d\cdot00273\ 791$ sidereal time
Sidereal	$23^h\ 56^m\ 04^s.091 = 0^d\cdot99726\ 957$ mean solar time

Dimensions of the Earth (*Hayford's Spheroid*, as adopted at Madrid, 1924)

Equatorial radius	$a = 6378\cdot388$ km. = 3963·35 miles
Polar radius	$b = 6356\cdot912$ km. = 3950·01 miles
Flattening or ellipticity	$c = (a-b)/a = 1/297\cdot0$
Eccentricity of meridian	$e = \sqrt{2c - c^2} = 0\cdot08199\ 189$

$\rho \sin\phi' = S \sin\phi \qquad \rho\cos\phi' = C\cos\phi$ where

$$S = 0\cdot994953 - 0\cdot001678\cos 2\phi + 10^{-6}(2\cos 4\phi + 0\cdot0478H)^*$$

$$C = 1\cdot001687 - 0\cdot001689\cos 2\phi + 10^{-6}(2\cos 4\phi + 0\cdot0478H)$$

$$\tan\phi' = (0\cdot993277 + 10^{-6}\,0\cdot0003H)\tan\phi$$

$$\rho = 0\cdot998320 + 0\cdot001684\cos 2\phi - 10^{-6}(4\cos 4\phi - 0\cdot0478H)$$

$$\phi - \phi' = 695''\cdot66\sin 2\phi - 1''\cdot17\sin 4\phi$$

1° of latitude	$111\cdot136 - 0\cdot562\cos 2\phi$ km.
1° of longitude	$111\cdot417\cos\phi - 0\cdot094\cos 3\phi$ km.

Acceleration due to gravity, in cm. per second per second (*Bowie*)

$$g = 980\cdot621 - 2\cdot589\cos 2\phi + 0\cdot007\cos^2 2\phi - 0\cdot0003\ 086h$$

Gaussian gravitation constant	$k = 0\cdot01720\ 209895 = 0^\circ\cdot98560\ 76686$
Period of a comet or asteroid	$1\cdot00004\ 027\ a^{3/2}$ tropical years = $365\cdot256898\ a^{3/2}$ mean solar days
Earth's mean orbital speed	29·8 km. = 18·5 miles per second
Constant of gravitation (*Heyl*)	$G = 6\cdot670 \times 10^{-8}$ c.g.s. units
Mass of the Earth (*derived from above*)	$5\cdot98 \times 10^{27}$ grams
Mean density of the Earth (*derived from above*)	5·517 (water = 1)
Mass of the Sun (*derived from above*)	$2\cdot00 \times 10^{33}$ grams
Invariable plane of the solar system (*Innes*)	$\Omega = 106^\circ\ 35'\ 01'' + 3452''T$; $i = 1^\circ\ 34'\ 59'' - 18''T$

* T = time measured in Julian centuries from 1900·0; ϕ = geographical latitude; h = height above sea-level in metres and H = same in feet.

† Corresponding to the value of the Solar Parallax given above. The more recent value of $8''\cdot79$ (*Handbook*, 1942) would give a distance of 149,700,000 km. = 93,000,000 miles.

‡ The sidereal year (or month) is the interval between successive returns of the Sun (or Moon) to the same point among the stars.

§ The interval between successive returns of the Sun to the Moon's node.

Pole of galactic plane (*I.A.U.*) ... ... 1900·0 R.A. 190° Dec. + 28°
Co-ordinates of galactic plane (assuming pole as above) referred to
Ecliptic ... ... Ω = 266°·96 + 1°·40T i = 60°·55 + 0°·00T
Equator ... ... Ω = 280°·00 + 1°·23T i = 62°·00 + 0°·55T
Centre of galaxy* ... ... G = 330° or R.A. 265° Dec. – 26°
Distance to centre of galaxy* ... ... 7500 parsecs
Mass of galactic system* ... ... 9×10^{10} × mass of Sun = $1{\cdot}8 \times 10^{44}$ grams
Period of rotation* (for stars in vicinity of Sun) ... ... $2{\cdot}1 \times 10^{8}$ years
Vertex of star streaming† (*Eddington*) ... ... R.A. 94° Dec. + 12°
Solar apex†. (*Wilson, Campbell and Moore*) ... ... R.A. 271° Dec. + 31°
Solar motion† (*Campbell and Moore*) ... ... 19·6 km. = 12·2 miles per second

Solar constant (*Abbot*) ... ... 1·93 gram-calories per square cm. per minute
Sun's emission of energy (*derived from above*) ... ... $3{\cdot}8 \times 10^{33}$ ergs per second
Sun's emission of energy per cm.^{2} of surface... ... ... $6{\cdot}2 \times 10^{10}$ ergs per second

Velocity of light in vacuo (*Michelson, Pease and Pearson*)
299,774 km. = 186,271 miles per second
Light travels unit distance in‡ ... ... $498^{s}{\cdot}38$ = $8^{m}{\cdot}306$ = $0^{h}{\cdot}1384$ = $0^{d}{\cdot}005768$

Light ratio for one magnitude 2·512 ... ... Logarithm of ratio 0·4000
Sun's stellar magnitude (*mean of various observers*) ... ... – 26·6
Sun's absolute magnitude (at distance of 10 parsecs) ... ... 5·0
Magnitude of Full Moon (*mean of various observers*) ... ... – 12·5
Total light of all stars (*Van Rhijn*) = 1440 1st Mag. stars.
Illuminating Power of one 1st Mag. star = 0·000 000 6 ft. candles = 1 standard candle at 1300 ft.

Light-year ... ... $9{\cdot}463 \times 10^{12}$ km. = $5{\cdot}880 \times 10^{12}$ miles
= 63,290 astronomical units = 0·3069 parsecs
Parsec ... ... $30{\cdot}84 \times 10^{12}$ km. = $19{\cdot}16 \times 10^{12}$ miles
= 206,265 astronomical units = 3·259 light-years
Number of square degrees in the sky 41,253

* Combined from all published data.
† From bright stars.
‡ Corresponding to a constant of aberration of 20″·47, not to the measured velocity of light in the previous line. In ephemerides it is more usual to take a value of $498^{s}{\cdot}58$ = $0^{d}{\cdot}005770$.

DIMENSIONS OF SATURN'S RING-SYSTEM

Diameter		At Unit Distance	At Mean Opposition Distance	Miles	Ratio
		″	″		
Ring A	outer	375·4	43·96	169,300	1·0000
	inner	330·4	38·69	149,000	0·8801
Ring B	outer	322·8	37·80	145,500	0·8599
	inner	249·6	29·24	112,600	0·6650
Ring C	inner	205·9	24·12	92,900	0·5486
Saturn	equat.	166·7	19·52	75,100	0·4440
	polar	149·1	17·46	67,200	0·3973

The ring-plane is inclined at 28°·068 to the ecliptic, and its ascending node is in longtitude 168°·801 (1949 January 0).

ELEMENTS OF THE PLANETARY ORBITS

Fixed Elements of the Planetary Orbits

Planet	Mean Distance: Astronomical Units a	Mean Distance: Millions of Miles	Sidereal Period in Tropical Years P	Sidereal Mean Daily Motion n	Mean Synodic Period	Period of Axial Rotation
				°	d	
Mercury	0·387099	36·0	0·24085	4·092338	115·88	88^d
Venus	0·723331	67·2	0·61521	1·602131	583·92	225^d (?)
Earth	1·000000	92·9	1·00004	0·985609	..	$23^h\ 56^m\ 04^s{\cdot}100$
Mars	1·523688	141·5	1·88089	0·524033	779·94	$24^h\ 37^m\ 22^s{\cdot}654$
Jupiter	5·202803	483·3	11·86223	0·083091	398·88	See below
Saturn	9·538843	886·1	29·45772	0·033460	378·09	$10^h\ 14^m$
Uranus	19·190978	1783	84·01529	0·011732	369·66	About $10^h{\cdot}8$
Neptune	30·070672	2793	164·78829	0·005981	367·49	$15^h\ 40^m$
Pluto	39·45743	3666	247·6968	0·003979	366·74	Unknown

Elements for the Epoch 1949, Jan. 0.5 U.T.

Planet	Eccentricity e	Inclination to the Ecliptic i	Mean Longitude of the Ascending Node Ω	Mean Longitude of the perihelion ϖ	Mean Longitude at the Epoch L
		° ′ ″	° ′ ″	° ′ ″	° ′ ″
Mercury	0·205 6242	7 00 13·6	47 43 36·2	76 39 43·0	339 27 02·6
Venus	0·006 7973	3 23 38·8	76 13 14·4	130 51 12·7	216 46 49·5
Earth	0·016 7305	— — —	— — —	102 03 48·0	99 49 37·6
Mars	0·093 3580	1 51 00·0	49 09 51·2	335 07 12·7	313 02 57·6
Jupiter	0·048 4174	1 18 21·5	99 55 59·6	13 30 03·5	285 49 01·5
Saturn	0·055 7199	2 29 25·3	113 12 41·2	92 02 56·1	146 04 36·7
Uranus	0·047 1815	0 46 22·7	73 44 05·7	169 50 07·9	94 00 44·9
Neptlne	0·008 5675	1 46 28·5	131 13 02·7	44 09 01·6	192 45 19·4
Pluto	0·248 5200	17 08 34·3	109 37 12·4	223 30 30·5	164 08 10·2

The annual variations in these elements may be deduced by comparing the values printed each year.

Notes

The rotation period of Mercury is according to Schiaparelli. That of Venus is according to Schiaperelli and Lowell; others have given 24^h, but V. M. Slipher has shown from spectroscopic evidence that such a short period is impossible. The rotation periods of Mars and Jupiter are those adopted for physical ephemerides by Marth; those of Jupiter are: System I (equatorial), $9^h\ 50^m\ 30^s{\cdot}003$; System II, $9^h\ 55^m\ 40^s{\cdot}632$. That of Saturn is for the equator; spots in the temperate zones give longer periods. That of Neptune is twice the photometric period ($7^h\ 50^m$) derived by Maxwell Hall, Öpik and Liviänder; Moore and Menzel found $15^h{\cdot}8 \pm 1^h$ by spectroscopic methods, while Jackson and others have shown that $7^h\ 50^m$ is irreconcilable with the shift in the satellite's node.

The elements of Pluto are the barycentric elements with the mass of the solar system, given by Nicholson and Mayall in *Contributions from the Mount Wilson Observatory*, vol. xviii; No. 417.

The remaining elements are derived from the *Astronomical Papers of the American Ephemeris*. The mean distance is the theoretical value of the semi-major axis, freed from perturbations, that has been adopted in the tables of the planets. The sidereal period and mean daily motion are derived from observations, and not from the mean distance by Kepler's third law.

DIMENSIONS OF SUN, MOON AND PLANETS

Name	Semi-diameter at: Unit Distance	Semi-diameter at: Mean* Opp'n Distance	Diameter in: Kilometres	Diameter in: Miles	Authority for preceding Columns	Mass † Sun = 1: 1 ÷	Mass † Sun = 1: Logarithm increased by 10	Density‡ Water = 1	On scale Earth = 1: Diameter	On scale Earth = 1: Mass	On scale Earth = 1: Density	On scale Earth = 1: Surface	On scale Earth = 1: Volume	On scale Earth = 1: Surface Gravity §
	″	″ ′												
Sun ...	959·63	...	1,391,000	864,000	Auwers	...	10·000000	1·41	109	333,434	0.26	11,900	1,300,000	28·0
Moon ...	2·40	932·58	3,476	2,160	Newcomb	27,158,000	2·566099	3·34	0·272	0·0123	0·60	0·074	0·0203	0·16
Mercury ...	3·34	5·45	4,800	3,000	Le Verrier	9,000,000	3·045757	3·73	0·38	0·037	0·68	0·14	0·055	0·26
Venus ...	8·41	30·40	12,200	7,600	Auwers	403,490	4·394167	5·21	0·96	0·826	0·94	0·91	0·876	0·90
Earth (Eq'l.) ...	8·80	...	12,757	7,927	Hayford	329,390	4·482290	5·52	1·000	1·000	1·00	1·00	1·000	1·00
Earth (Polar)	8·77	...	12,714	7,900					0·997					1·00
Mars ...	4·68	8·94	6,800	4,200	Hartwig	3,093,500	3·509550	3·94	0·53	0·108	0·71	0·28	0·151	0·38
Jupiter (Eq'l)	98·47	23·43	142,700	88,700	Sampson	1047·35	6·979908	1·34	11·2	318·4	0·24	120	1312	2·64
Jupiter (Polar)	91·91	21·87	133,200	82,800					10·4					2·67
Saturn (Eq'l)	83·33	9·76	120,800	75,100	H. Struve	3501·6	6.455733	0.69	9·5	95·2	0·12	84	763	1·13
Saturn (Polar)	74·57	8·73	108,100	67,200					8·5					1·15
Uranus ...	34·28	1·88	49,700	30,900	Mean¶	22,869	5·640753	1·36	3·9	14·6	0·25	15	59	0·96
Neptune ...	36·56	1·26	53,000	33,000	Barnard	19,314	5·714128	1·32	4·2	17·3	0·24	17	72	1·00

NOTES.—Columns 2 and 7 are the only independent ones; all the other figures have been computed from those in these two columns. The shape of the planet has been taken into account where necessary, e.g. in the last four columns.

* The values for Mercury and Venus are those at mean inferior conjunction.

† These are according to Newcomb, except those of Mercury and Venus, which are according to Backlund and Ross respectively. They include the mass of the satellite system, if any. The mass of the Earth alone is 1 ÷ 333,434. (log = 4·476990).

‡ The Earth's density was taken as 5·517, after Heyl.

§ The values here compared are those of the planets' attractions, and not the resultant of gravity and centrifugal force; the latter would diminish the result given for the equator of Jupiter by 9 per cent and that for the equator of Saturn by 16 per cent, but does not affect the attraction at the poles. The material of which the planets are composed has been assumed to be homogeneous.

¶ Barnard, See and Wirtz.

Planet and Satellite	Discoverer	Mean Distance from Primary: Astronomical Units	Mean Distance from Primary: Angular at Mean Opposition Distance	Sidereal Period
			° ′ ″	d
Earth				
Moon	...	0·002 571	...	27·321 661
Mars				
I Phobos	Hall	0·000 062 725	24·7	0·318 910 3
II Deimos	Hall	0·000 156 95	1 1·8	1·262 440 64
Jupiter				
I Io	Galileo †† and Mayer	0·002 819 56	2 18·4	1·769 137 80
II Europa	Galileo †† and Mayer	0·004 486 20	3 40·2	3·551 181 08
III Ganymede	Galileo †† and Mayer	0·007 155 90	5 51·2	7·154 553 12
IV Callisto	Galileo †† and Mayer	0·012 586 5	10 17·7	16·689 018 05
V	Barnard	0·001 207	59·2	0·498 179 23
VI†	Perrine	0·076 605	1 2 40	250·62
VII†	Perrine	0·078 516	1 4 13	260·07
VIII*†	Melotte	0·157 20	2 8 35	738·9
IX*†	Nicholson	[2]0·158	2 9	[1]745
X†	Nicholson	0·077334	1 3 16	254·21
XI*	Nicholson	0·1508336	2 3 24	692·5
Saturn				
I Mimas	Herschel	0·001 240 1	30·0	0·942 421 9
II Enceladus	Herschel	0·001 590 9	38·4	1·370 217 8
III Tethys	Cassini	0·001 969 4	47·6	1·887 802 5
IV Dione	Cassini	0·002 522 4	1 0·9	2·736 915 9
V Rhea	Cassini	0·003 522 6	1 25·1	4·517 502 6
VI Titan	Huyghens	0·008 166 0	3 17·3	15·945 452
VII Hyperion	Bond	0·009 892 9	3 59·0	21·276 665
VIII Iapetus†	Cassini	0·023 797 6	9 34·9	79·330 82
IX Phœbe*†	Pickering	0·086 593	34 52	550·45
Uranus				
I Ariel*	Lassell	0·001 282 0	14·5	2·520 383
II Umbriel*	Lassell	0·001 785 9	20·2	4·144 183
III Titania*	Herschel	0·002 930 3	33·2	8·705 876
IV Oberon*	Herschel	0·003 918 7	44·4	13·463 262
Neptune				
(Triton)*†	Lassell	0·002 363 5	16·8	5·876 833

Where no reference is given, figures are taken from the *Connaissance des Temps*. Tropical periods have been converted to sidereal.

Jupiter's Satellites. Eccentricities, etc., subject to complex variations, see Sampson's *Tables of the Four Great Satellites of Jupiter*. Owing to perturbations by the Sun, the orbits of the outer satellites are not even approximately elliptic.

Saturn's Satellites. For detailed tables of positions, see *Nautical Almanac*.

* Revolution retrograde.

† Highly inclined orbits. Other orbits are nearly in the equatorial planes of the primaries, except that of the Moon, which is inclined both to the equator and the ecliptic. Those of the satellites of Uranus are in the equatorial plane of the planet, but highly inclined to its orbit.

†† See *Journal*, **41**, 164, 415.

Synodic Period	Eccentricity	Diameter	Mass		Stellar Magnitude at Mean Opposition Distance
			Primary ÷	Sun = 10^{10}	
d h m s		Miles			
29 12 44 2·8	0·05490	2160	81·271	367·40	− 12·5
7 39 26·65	0·0170				[6] 10–12
1 6 21 15·68	0·0031				[9] 11–12
1 18 28 35·95	Small and variable	2109	22,240	429.4	[7] 5·3, 5·5, 5·8‡
3 13 17 53·74		1865	39,430	242·1	[7] 5·7, 6·1, 6·4‡
7 3 59 35·86		3273	12,520	762·7	[7] 4·9, 5·1, 5·3‡
16 18 5 6·92		3142	22,220	430·0	[7] 6·1, 6·2, 6·4‡
11 57 27·6					
266 0	0·1550				[8] 14·7
276 16	0·2073				[3] 17·5–18 §
631·2	0·38				[9] 17·0 §
[1] 636	[2] 0·248	[3] 11–17			18·6§
270·01	0·14051				[18] 19
597·0	0·20678				[18] 19
22 37 12·4	0·0190	[4] 370	16,340,000	0·175	
1 8 53 21·9	0·0046	[4] 460	4,000,000	0·714	[10] 12·1
1 21 18 54·8	0·0000	[4] 750	921,500	3·099	[11] 11·7
2 17 42 9·7	0·0020	[4] 900	536,000	5·328	[11] 10·6
4 12 27 56·2	0·0009	[4] 1150	250,000	11·42	[11] 10·7
15 23 15 25	0·02886	[5] 3550	4,700	607·6	[11] 10·0
21 7 39 6	0·119				[11] 8·3
79 22 4 56	0·029				[12] 15
536 16	0·1659				[11] 10·8
					[13] 14
2 12 29 40					[14] 16
4 3 28 25					[14] 16–17
8 17 0 0					[15] 14
13 11 15 36					[15] 14
5 21 3 27			[17] 290	[17] 1800	[16] 13

[1] Nicholson, *Proc. Mat. Acad. Sci. Washington*, **3**, 147.
[2] Derived.
[3] Nicholson and Shapley, *P.A.S.P.*, **28**, 282.
[4] Hepburn, *Journal*, **33**, 248.
[5] Levin, *Journal*, **33**, 216.
[6] Barnard, *A.J.*, **26**, 70. Estimates uncertain.
[7] Guthnick, *Sitz. Ber. K. Acad. Berlin*, 1907, 339.
[8] Barnard, *A.N.*, **179**, 17.
[9] Nicholson, *P.A.S.P.*, **35**, 217
[10] Barnard, *A.J.*, **28**, 29, 30, 3.
[11] Guthnick, *A.N.*, **198**, 251.
[12] Barbard, *A.J.*, **29**, 30.
[13] Barnard, *A.N.*, **194**, 333.
[14] Newcomb.
[15] Vogel.
[16] Barnard, *A.J.*, **28**, 689.
[17] Nicholson and van Maanen, *P.A.S.P.*, **43**, 261.
[18] *Harvard Announcement Card*, Nos. 460 and 462.

‡ Variable; Maximum, Mean and Minimum Magnitudes.
§ Photographic magnitudes.

MISCELLANEOUS DATA

			Logarithm
π		3·14159 26536	0·497 1499
e		2·71828 18285	0·434 2945
$M = \log_{10}e$		0·43429 44819	$\bar{1}$·637 7843
$1/M = \log_e 10$		2·30258 50930	0·362 2157
1 radian		57°·29577 95131	1·758 1226
	=	3437′·74677 078	3·536 2739
	=	206264″·80625	5·314 4251
1″ in radians		0·00000 4848137 = arc 1″	$\bar{6}$·685 5749
1′ in radians		0·00029 08882 = arc 1′	$\bar{4}$·463 7261
1° in radians		0·01745 32925 = arc 1°	$\bar{2}$·241 8774
1 metre	=	3·28084 27 feet	0·515 9855
1 foot	=	0·30479 973 metres	$\bar{1}$·484 0145
1 km.	=	0·621372 miles	$\bar{1}$·793 3516
1 mile	=	1·609342 km.	0·206 6484
miles/hour	=	1·4667 ft./sec.	0·166 33
ft./sec.	=	0·68173 miles/hr.	$\bar{1}$·833 61
Seconds in a day		86,400	4·936 5137
Seconds in a year		31,557,600	7·499 1040
$\sqrt{2}$		1·41421 35624	0·150 5150
$\sqrt{3}$		1·73205 08076	0·238 5606

MEAN MAGNETIC ELEMENTS AT ABINGER

	Declination West	Horizontal Intensity c.g.s. Units	Vertical Intensity c.g.s. Units	Inclination (Dip)
	° ′			° ′
1945	9 59·5	0·18573	0·43207	66 44·3
1946	9 51·1	0·18569	0·43235	66 45·4
1947 (final)	9 43·1	0·18577	0·43246	66 45·2
1948 (provisional)	9 34·9	0·1859	0·4326	66 45
1949 (extrapolated)	9 27	0·1860	0·4328	66 45

The value of the declination at Greenwich may be taken as 14′ less than at Abinger. At other parts of the British Isles, the declination may be very roughly inferred by allowing an increase of 0°·5 per degree of longitude west of Greenwich and 0°·3 per degree of latitude north of Greenwich. Local deviations of the lines of equal declination are, however, considerable, and the above rule must be taken as only approximate—it may give a result as much as 1° in error in places.

ERRATUM

Handbook 1948

p. 29. Top of first column. For *May* read *July*.

GENERAL INDEX TO THE *HANDBOOK*

The *Handbook* has been published annually since 1922, and copies of the earlier issues may be obtained from the Assistant Secretary, 303 Bath Road, Hounslow West, Middlesex, at the price of 6*d*. each, post free.

Extensive notes on *Variable Stars* appeared in the issues 1922-1926, and measures of *Double Stars* annually until 1940.

* Out of print

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