The Astronomical Society of South Africa

Handbook for

1950

CONTENTS

PREFACE

THE adoption of a more convenient size for the Handbook has met with the general approval of our members and it would, therefore, appear unnecessary to make any alterations in this respect for the present.

Tables of the phenomena of Jupiter's and Saturn's satellites and Solar and Lunar eclipses have been substituted for the list of Celestial Objects of Interest and the Principal Elements of the Solar System. Most of the astronomical material is derived from the Nautical Almanac suitably altered to S.A.S.T. It should be mentioned here that the Society's Handbook is designed mainly to meet the needs of South African observers and is supplementary to such well-known Handbooks as those of the B.A.A. and R.A.S.C.

Suggestions for the improvement of the next issue of the Handbook would be appreciated *now.*

The chief credit for the preparation of this Handbook is again due to Dr. R. H. Stoy, but sincere thanks are also tendered to Messrs. R. P. de Kock, A. Menzies, A. J. Moran, S. C. Venter and H. Davies, who is responsible for the Planetary Diagram.

Additional copies of this Handbook may be obtained from the Editor of the Monthly Notes. Members 1/-; Non-members 1/6.

TIME

All the times given in this booklet are South African Standard Time, that is, mean solar time for a meridian 30° (or two hours) east of Greenwich.

To get the local mean time at other places in the Union the longitude difference shown in Table I must be applied to the ordinary S.A.S.T.

TABLE I

Correction for Longitude.

Bloemfontein	...	−15 m.	Grahamstown	...	−14 m.
Cape Town	...	−46 ,,	Johannesburg	...	−08 ,,
Durban ...	...	+04 ,,	Port Elizabeth	...	−18 ,,
East London	...	−08 ,,	Pretoria ...	...	−07 ,,

Conversely to get the S.A.S.T. from the local mean time these longitude corrections must be applied with the sign reversed. Thus the S.A.S.T. of local mean noon (i.e., 12 h. 00 m. local mean time) at Port Elizabeth is 12 h. 18 m.

Owing to the fact that the earth does not go round the sun with uniform circular motion in the plane of the earth's equator, the local apparent solar time (i.e., the time shown by a sundial) differs from the local mean solar time by a quantity which is usually referred to as the "Equation of Time." This quantity is given in the third column of Table II. It has to be added to the mean solar time to give the apparent solar time.

Example: Find the S.A.S.T. of apparent noon at Port Elizabeth on November 1.

		hr.	min.
S.A.S.T. of local mean noon	... ...	12	18
Subtract Equation of Time	... ... +		16
S.A.S.T. of noon	... ...	12	02

For many purposes *sidereal time*, that is, local time as measured by the stars, is extremely useful. The sidereal time can be found by applying the S.A.S.T. (on a 24-hour basis) to the corresponding "Sidereal Time at 0 hours S.A.S.T." which is given in the fourth column of Table II and correcting for longitude by means of Table I. A further small correction is needed to allow for the four minute difference in length between the solar and sidereal day. This correction is given below.

For times between S.A.S.T.—

03.00 and 09.00 add 1 minute
09.00 ,, 15.00 ,, 2 ,,
15.00 ,, 21.00 ,, 3 ,,
21.00 ,, 23.59 ,, 4 ,,

Example: Find the sidereal time at 8.15 p.m. on October 4 at Port Elizabeth.

		hr.	min.
Sid. time at 00.00 S.A.S.T. on October 4 ...		00	48
S.A.S. Time		20	15
		21	03
Correction for longitude	−		18
Interval Correction	+		3
Required Sidereal Time		20	48

For recording the time of variable star observations, the *Julian Day* calendar is usually used. This numbers the days consecutively from the beginning of the Julian Era in 4713 B.C. The Julian day begins at Greenwich mean noon, that is at 14.00 (2 p.m.) S.A.S.T.

The position of a star in the sky is fixed by its *right ascension* and *declination*, much as the position of a point on the earth is fixed by its longitude and latitude. In fact the right ascension and declination of any star is the longitude and latitude of the point on the earth directly beneath it at zero hours sidereal time at Greenwich. Latitude and declination are always measured in degrees north or south of the equator. Longitude and right ascension are measured either in degrees or in time, 360° being equal to 24 hours. (1° equal 4 minutes; 15′ equals 1 minute). Right ascension is always measured eastwards from the zero celestial meridian, and so is the equivalent of the longitude measured eastwards from the Greenwich meridian.

For considering the motions of the Sun, Moon and Planets, the system of co-ordinates known as *celestial latitude* and *longitude* is very convenient. These co-ordinates define the position of a celestial body with reference to the Ecliptic in exactly the same way as right ascension and declination define its position with reference to the Celestial Equator. The (celestial) latitude is the angular distance of the body north or south of the ecliptic while the longitude is the distance from the Vernal Equinox as measured eastwards along the Ecliptic. Celestial latitude and longitude are usually measured in degrees.

The Ecliptic is defined by the apparent path of the sun about the earth. The latitude of the sun is therefore always (approximately) zero, whilst its longitude increases by approximately 1° per day.

TABLE II.

Date.		Julian Date at 14 hours	Equation of Time at 12 hrs.		Sidereal Time at 0 hrs.		Sidereal Time at 18 hrs.	
			m.	s.	h.	m.	h.	m.
January	1	2,433,283.0	− 3	26	6	40	0	43
,,	11	293	− 7	50	7	19	1	22
,,	21	303	−11	17	7	59	2	2
February	1	314	−13	38	8	42	2	45
,,	11	324	−14	20	9	22	3	25
,,	21	334	−13	47	10	1	4	4
March	1	342	−12	33	10	33	4	36
,,	11	352	−10	14	11	12	5	15
,,	21	362	− 7	25	11	51	5	54
April	1	2,433,373.0	− 4	5	12	35	6	38
,,	11	383	− 1	12	13	14	7	17
,,	21	393	+ 1	11	13	54	7	57
May	1	403	+ 2	53	14	33	8	36
,,	11	413	+ 3	42	15	13	9	15
,,	21	423	+ 3	33	15	52	9	55
June	1	434	+ 2	23	16	35	10	38
,,	11	444	+ 0	37	17	15	11	18
,,	21	454	− 1	31	17	54	11	57
July	1	2,433,464.0	− 3	36	18	34	12	37
,,	11	474	− 5	17	19	13	13	16
,,	21	484	− 6	16	19	52	13	55
August	1	495	− 6	15	20	36	14	39
,,	11	505	− 5	12	21	15	15	18
,,	21	515	− 3	13	21	55	15	58
September	1	526	− 0	8	22	38	16	41
,,	11	536	+ 3	12	23	17	17	20
,,	21	546	+ 6	44	23	57	18	0
October	1	2,433,556.0	+10	9	0	36	18	39
,,	11	566	+13	6	1	16	19	19
,,	21	576	+15	14	1	55	19	58
November	1	587	+16	22	2	39	20	41
,,	11	597	+15	59	3	18	21	21
,,	21	607	+14	13	3	57	22	0
December	1	617	+11	7	4	37	22	40
,,	11	627	+ 6	56	5	16	23	19
,,	21	637	+ 2	6	5	56	23	59

THE SUN, MOON AND PLANETS

The Sun enters the Sign of—

Aries (Equinox)	... ...	March	21 d. 07 h.
Cancer (Solstice)	... ...	June	22 d. 02 h.
Libra (Equinox)	... ...	Sept.	23 d. 17 h.
Capricorn (Solstice)	... ...	Dec.	22 d. 12 h.

The Earth is at Perihelion on January 3 and at Aphelion on July 5.

There will be four eclipses during 1950, two of the Sun and two of the Moon.

The annual eclipse of the Sun on March 18 will be visible from South Africa as a small partial eclipse beginning just after 5.00 p.m. and ending after sunset. The annular phase of this eclipse will be visible only from a small part of the Antarctic Ocean.

The total eclipse of the Sun on September 12 will be invisible from South Africa, the path of totality running from the North Pole across north-eastern Siberia and out into the North Pacific Ocean.

Both the total eclipses of the Moon on April 2 and on September 26 will be visible from South Africa, the former in all its phases, the latter in its earlier phases onlyl The circumstances of these two eclipses are as follows:—

		d.	h.	m.		d.	h.	m.
Moon enters penumbra	April	2	20	09.3	Sept.	26	03	20.0
Moon enters umbra			21	09.0			04	31.5
Total eclipse begins			22	29.5			05	53.8
Middle of the eclipse			22	44.1			06	16.7
Total eclipse ends ...			22	58.7			06	39.6
Moon leaves umbra			24	19.2			08	01.9
Moon leaves penumbra			25	18.8			09	13.5
P.A. of First Contact			92°				85°	
P.A. of Last Contact			325°				217°	
Magnitude of the eclipse (Moon's diameter=1.0)			1.039			1.084		

PHASES OF THE MOON.

Full Moon	d. h. m.	Last Quarter	d. h. m.	New Moon	d. h. m.	First Quarter	d. h. m.
Jan.	4 09 48	Jan.	11 12 31	Jan.	18 09 59	Jan.	26 06 39
Feb.	3 00 16	Feb.	9 20 32	Feb.	17 00 53	Feb.	25 03 52
Mar.	4 12 34	Mar.	11 04 38	Mar.	18 17 20	Mar.	26 22 09
April	2 22 49	April	9 13 42	April	17 10 25	Arpil	25 12 40
May	2 07 19	May	9 00 32	May	17 02 54	May	24 23 28
May	31 14 43	June	7 13 35	June	15 17 53	June	23 07 12
June	29 21 58'	July	7 04 53	July	15 07 05	July	22 12 50
July	29 06 17	Aug.	5 21 56	Aug.	13 18 48	Aug.	20 17 35
Aug.	27 16 51	Sept.	4 15 53	Sept.	12 05 29	Sept.	18 22 54
Sept.	26 06 21	Oct.	4 09 53	Oct.	11 15 33	Oct.	18 06 18
Oct.	25 22 46	Nov.	3 03 00	Nov.	10 01 25	Nov.	16 17 06
Nov.	24 17 14	Dec.	2 18 22	Dec.	9 11 28	Dec.	16 07 56
Dec.	24 12 23						

Mercury. A glance at the chart will show that Mercury, like the god after which it is named, moves from the morning to evening sky with great rapidity. The only occasions on which Mercury is likely to be seen is near an elongation. In 1950 these are as follows:—

Eastern (Evening Star)			Western (Morning Star)		
Date.	*Elong.*	*Mag.*	*Date.*	*Elong.*	*Mag.*
January 1 ...	19°	−0.4	February 10	26°	+0.2
April 23 ...	20°	+0.3	June 10	24°	+0.7
August 21 ...	27°	+0.5	October 3	18°	−0.2
Dec. 15 ...	20°	−0.3			

Of these elongations only the morning ones in February and June and the evening one in August are likely to be of much interest. At the other elongation Mercury will be lost in the twilight.

Mercury will be at Superior Conjunction on March 28, July 11 and November 1; at Inferior Conjunction on January 17, May 14 and September 17; at Stationary Points on January 8, January 29, May 4, May 27, September 3, September 25 and December 23.

Mercury will be in Conjunction with Venus on February 16d. 07h., September 24d. 05h. and December 27d. 23 h.; with Jupiter on March 1d. 17h.; with Saturn on August 17d. 00h. and October 6d. 10h.; and with the bright star Regulus on August 1d. 13h. when the two objects will be only 0.5° apart.

Venus. At the beginning of the year Venus is an evening star, but becomes a morning star after the Inferior Conjunction on January 31. It remains a morning star for most of the year and returns to the evening sky only after its Superior Conjunction on November 13. The greatest elongation west of the Sun is 46° on April 11. Venus will be at Stationary Points on January 8 and February 20 and will attain its greatest brilliance of −4.3 on March 6.

Venus will be in Conjunction with Jupiter on January 25d. 15h. and April 5d. 11h.; with Saturn on September 30d. 00h.; with Uranus on July 28d. 17h.; and with the bright star Regulus on September 9d. 06h. The last three conjunctions are all close, being 0.6°, 0.9° and 0.7° respectively.

Mars. Mars is in Opposition with the Sun on March 23 and will be suitably placed for observation throughout the first half of the year. This is not a favourable opposition for the study of Mars as the opposition distance is just over 60,000,000 miles—nearly twice as large as the 34,500,000 miles that this distance can be.

At the beginning of the year Mars will be found in Virgo, but its retrograde motion between February 12 and May 5—the two Stationary Points—just carries it into the eastern portion of Leo. After May 5, the planet resumes its eastward course with a gradually increasing rate. It re-enters Virgo about May 15 and by the end of the year it has got as far as Capricornus.

The apparent brightness of Mars increases from +0.8m. on January 1 to −1.1m. at the time of opposition and then gradually decreases so that by the end of the year it is only +1.3m.

Mars will be in Conjunction with Neptune on July 16d. 02h., but the separation of the two planets will be just over 2°.

Jupiter. Jupiter is still visible as an evening star at the beginning of the year, but passes to the morning sky after Conjunction on February 3. It will be in Opposition on August 26 and will be a conspicuous evening object during the later months of the year in the constellation of Aquarius. The brightness at the beginning of March is −1.5m. and gradually increases to −2.4m at the time of Opposition; thereafter it fades again and by the end of the year is back to −1.8m.

Jupiter will be moving slowly eastwards amongst the stars except between June 27 and October 24 (the two Stationary Points) when it will be retrograding.

Saturn. Saturn, which is in Opposition on March 7, will be visible as an evening star throughout the first part of the year. After Conjunction on September 16, it will be a morning star but not easily visible as such until November. At the beginning of the year, Saturn is retrograding slowly in Leo. This motion ceases on May 16 (Stationary Point) and from then until the end of the year Saturn moves slowly eastwards into Virgo.

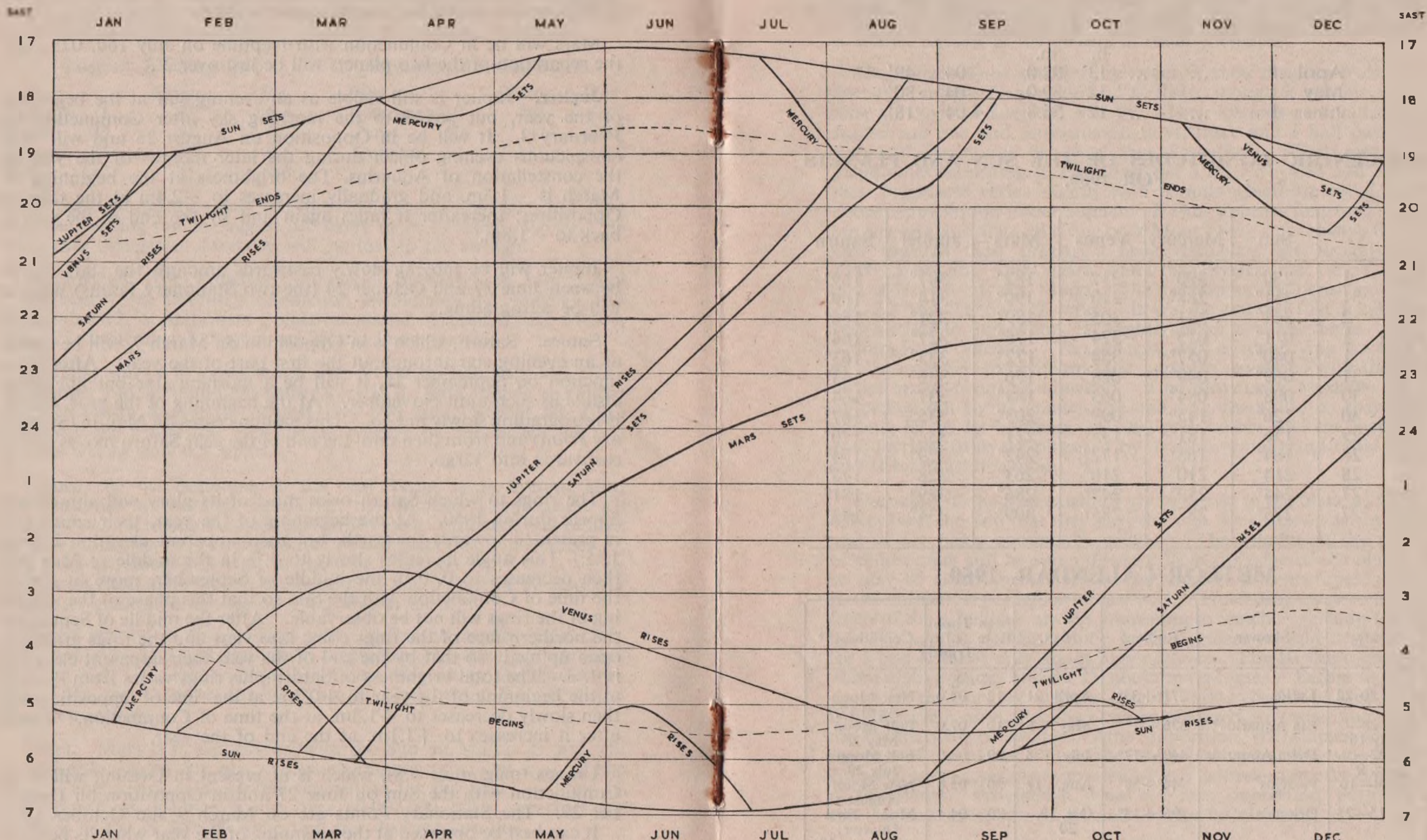
The rings to which Saturn owes most of its glory will almost disappear during 1950. At the beginning of the year, their south face is presented towards the earth, but their apparent elevation is only 1.°5. This angle increases slowly to 4.°8 in the middle of May and then decreases to 0.°0 in the middle of September, more or less at the time of Conjunction with the Sun so that this phase of the vanishing of the rings will not be observable. After the middle of September the northern face of the rings come into view and the rings gradually open up again so that by the end of the year their apparent elevation is 4.°3. The total brightness of Saturn plus rings varies from +1.1m. at the beginning of the year to +0.7m. at the time of Opposition and then slowly decreases to +1.3m. at the time of Conjunction. Thereafter it increases to +1.1m. at the end of the year.

Uranus (magnitude 5.8), which is at present in Gemini, will be in Conjunction with the Sun on June 27 and in Opposition on December 29. The Stationary Points are on March 9 and October 16.

It can best be observed at the beginning of the year when its position will be as follows:—

		h.	m.		
January 1	... ...	06	11.5	+23°	41′
February 1	... ...	06	06.5	+23°	43′
March 1	... ...	06	04.2	+23°	43′

THE PLANETS AS SEEN FROM SOUTH AFRICA 1950



LATITUDE 30° SOUTH LONGITUDE 30° EAST

Neptune (magnitude 7.7) is in Virgo and will be in Opposition on April 6 and in Conjunction on October 11. The Stationary Points are on January 19 and June 27. The best months for observing Neptune are April, May and June. Its position will be—

		h.	m.		
April 1	... ...	13	02.0	−04°	49′
May 1	... ...	12	59.0	−04°	30′
June 1	... ...	12	56.8	−04°	18′

GEOCENTRIC LONGITUDES OF THE SUN AND PLANETS FOR 1950.

	Sun	Mercury	Venus	Mars	Jupiter	Saturn
Jan. 1	280°	300°	317°	182°	307°	169°
,, 31	311°	288°	310°	190°	314°	169°
Mar. 2	341°	321°	305°	189°	321°	166°
April 1	011°	015°	324°	178°	327°	164°
May 1	040°	057°	354°	172°	333°	163°
,, 31	069°	049°	028°	176°	336°	163°
June 30	098°	084°	063°	188°	337°	164°
July 30	126°	145°	099°	203°	335°	167°
Aug. 29	156°	181°	135°	221°	332°	170°
Sept. 28	184°	168°	172°	242°	329°	174°
Oct. 28	214°	210°	210°	263°	328°	178°
Nov. 27	244°	259°	247°	286°	329°	181°
Dec. 27	275°	287°	285°	309°	334°	182°

METEOR CALENDAR, 1950

Date	Shower	Radiant	Max.	Max Rate	Time of Trans.	Conditions**
					h.	
April 20–22	Lyrids	271°+33°	April 21	12	04.0	New Moon April 17.
April 28—May 16	Eta Aquarids*	336°—1°	May 5	10	07.0	Full Moon May 2.
July 22—Aug. 9	Delta Aquarids	340°—17°	July 28	20	02.0	Full Moon July 29.
Aug. 4—16	Perseids	44°+58°	Aug. 12	50	05.6	New Moon August 13
Oct. 15—25	Orionids	96°+15°	Oct. 19—20	20	04.4	Moon: First Quarter: October 18
Nov. 15—20	Leonids†	152°+22°	Nov. 16	20	06.5	Moon: First Quarter: Nov. 16.
Dec. 9—14	Geminids	113°+32°	Dec. 12	30	02.0	New Moon: Dec. 9.

*Halley's Comet. †Seen at their best every 33 years. Next return 1965.
**The best time to observe meteors is during moonless nights.

JUPITER'S SATELLITES

The four bright moons of Jupiter with their continuous series of eclipses, occulations, transits and shadow transits provide a perpetual source of interest to the owners of small telescopes.

The names of the satellites, in order of their distance from Jupiter are: Io, Europa, Ganymede and Callisto, though it is more usual to refer to them as I, II, III and IV. Their periods of rotation about Jupiter are one and three-quarter days, three and a half days, seven days and sixteen and two-third days respectively. Their mean stellar magnitudes according to Pickering, are 5.28, 5.31, 4.88 and 5.98, but their brightness varies slightly with periods which are equal to their times of revolution about Jupiter. It thus appears that their surfaces are marked and that, like our own Moon, they turn always the same face towards their primary. Their diameters are roughly 2,400, 2,000, 3,300 and 3,300 miles, while their masses are 1.09, 0.65, 2.10 and 0.58 that of our Moon. The corresponding densities are 2.9, 2.9, 2.2 and 0.6 that of water. It will be noticed that I and II are very similar to our Moon, III slightly larger and less dense, while IV is completely different. The quickest way of identifying the satellites in a telescope is to compare their apparent positions with those predicted in the Nautical Almanac. If no almanac is available, III can be picked out by its greater size and brightness and its rosy orange colour; IV by its faintness, its steel grey colour and the fact that it goes furthest from the planet; I by its straw colour and rapid motion and II by its white colour.

The orbits of the four satellites are so nearly in the plane of Jupiter's orbit about the Sun that they pass through the shadow cast by Jupiter and so are being continually *eclipsed.* The satellite at the moment of eclipse may still be some distance from the edge of the planet and so may be clearly seen, even in the smallest of telescropes, right up to the moment it plunges into darkness. The fading away or breaking forth of the satellite is always interesting to watch. A sharp look-out must be kept as the diminution or the increase in light is speedy and for I and II takes only about four minutes. For III the total time is about eight minutes and for IV about ten minutes. Before its opposition with the Sun, the shadow cast by Jupiter lies to its west as seen from the earth, so that eclipses can be observed only when the satellites are on the west of Jupiter. After opposition, the eclipses are all on the east of the planet. Only the immersion or the emersion of I and II can be seen according as to whether it is before or after the opposition of the planet. Provided it is not too near opposition, both the immersion and emersion of III and IV can be observed.

The transit of a satellite across Jupiter's disc is a phenomenon more striking than either an occulation or an eclipse. The satellite glides on to the disc like a brilliant bead and, on account of its greater surface brightness, remains visible for some time till it is lost in the luminous background. After a time it reappears and passes off the disc; if it traverses a dark belt, it may be perceptible throughout the transit

But this is not all. The shadow of the satellite falls on to the disc and forms a conspicuous object, perfectly round and black as ink, preceding or following the satellite according to the relative positions of the Sun, Jupiter and the Earth. When Jupiter is not near opposition the shadow (especially of III and IV) may be far within the disc, while the satellite shines out in the dark sky. Occasionally two of these transits may be going on at once and it is very interesting to mark the unequal velocities of the shadows and their distances from the satellites to which they belong.

The following table gives the times of a selection of eclipses and transits visible between sunset and midnight at a station in longitude 30° east and latitude 30° south. E. denotes Eclipse, Tr. Transit of the Satellite, Sh. Transit of the Shadow, c commences and f finishes.

June

d.	h.	m.	
23	23	00	II E.c.
24	23	45	IV Sh.f.
25	23	21	II Tr.f.
27	23	16	III E.c.
29	23	02	I E.c.
30	22	29	I Sh.f.
30	23	38	I Tr.f.

July

2	22	56	II Tr.c.
2	23	29	II Sh.f.
7	22	06	I Sh.c.
7	23	10	I Tr.c.
9	23	12	II Sh.c.
11	23	14	IV Tr.c.
19	21	56	IV E.c.
22	23	13	I E.c.
23	20	22	I Sh.c.
23	21	10	I Tr.c.
23	22	39	I Sh.f.
23	23	26	I Tr. f.
25	22	36	II E.c.
27	20	37	II Sh.f.
27	22	03	II Tr.f.
30	22	16	I Sh.c.
30	22	55	I Tr.c.

August

d.	h.	m.	
3	20	20	I Sh.c.
3	21	28	II Tr.c.
3	23	13	II Sh.f.
5	20	44	IV E.f.
7	21	30	I E.c.
8	20	56	I Sh.f.
8	21	22	I Tr.f.
9	23	19	III E.c.
10	22	56	II Sh.c.
31	20	59	I Tr.f.
31	21	08	I Sh.f.

September

4	19	34	II Tr.c.
4	20	03	II Sh.c.
4	22	05	II Tr.f.
4	22	55	II Sh.f.
7	18	55	III E.f.
7	20	26	I Tr.c.
7	20	46	I Sh.c.
7	22	43	I Tr.f.
7	23	03	I Sh.f.
8	20	24	I E.f.
11	21	49	II Tr.c.
11	22	39	II Sh.c.
13	19	44	II E.f.
14	22	11	I Tr.c.
14	22	41	I Sh.c.
14	22	55	III E.f.
15	22	19	I E.f.
20	22	21	II E.f.
21	23	57	I Tr.c.
23	19	05	I Sh.c.
23	20	40	I Tr.f.
23	21	22	I Sh.f.
24	22	46	IV E.c.
29	20	01	II Sh.f.
30	20	10	I Tr.c.
30	21	00	I Sh.c.
30	22	27	I Tr.f.
30	23	17	I Sh.f.

October

d.	h.	m.	
1	20	37	I E.f.
2	20	48	III Sh.f.
2	23	56	IV Tr.c.
16	21	37	I Sh.f.
19	20	10	IV Tr.f.
20	22	41	II Tr.c.
22	22	12	II E.f.
23	20	05	I Tr.c.
23	21	16	I Sh.c.
23	22	22	I Tr.f.
23	23	33	I Sh.f.
27	19	36	III E.c.
27	23	03	III E.f.
30	21	57	I Tr.c.
30	23	12	I Sh.c.
31	22	47	I E.f.

November

3	23	38	III E.c.
5	21	06	IV Sh.c.
6	23	50	I Tr.c.
7	22	18	II Sh.f.
8	20	35	I Tr.f.
8	21	53	I Sh.f.
9	19	11	I E.f.
14	20	57	III Sh.f.
14	22	05	II Sh.c.
14	22	17	II Tr.f.
15	21	33	I Sh.c.
15	22	30	I Tr.f.
15	23	49	I Sh.f.
16	21	06	I E.f.
21	21	37	III Sh.c.
21	22	03	II Tr.c.
22	22	09	I Tr.c.
22	23	29	I Sh.c.
23	22	07	II E.f.
23	23	02	I E.f.
28	23	41	III Tr.f.

10 23 44 II Tr.c.	6 20 44 II Tr.f.	December
14 23 25 I E.c.	6 22 37 II Sh.f.	1 20 51 I Tr.f.
15 22 50 I Sh.f.	7 21 58 I Tr.c.	1 22 10 I Sh.f.
15 23 06 I Tr.f.	7 22 56 I Sh.c.	8 21 05 IV Tr.c.
19 19 41 II E.c.	8 22 33 I E.f.	8 21 50 I Sh.c.
20 20 42 III Sh.f.	9 20 46 III Tr.f.	8 22 49 I Tr.f.
20 21 14 III Tr.f.	9 21 22 III Sh.c.	9 21 21 I E.f.
22 22 27 I Sh.c.	11 21 22 IV E.f.	9 21 59 II Sh.f.
22 22 33 I Tr.c.	13 20 16 II Tr.c.	9 23 12 III E.f.
23 19 48 I E.c.	13 22 22 II Sh.c.	15 22 31 I Tr.c.
27 21 05 III Tr.c.	13 23 06 II Tr.f.	16 21 47 II Sh.c.
27 21 12 III Sh.c.	14 23 47 I Tr.c.	17 22 05 IV E.f.
28 20 11 II Tr.f.	15 19 34 II E.f.	
28 20 19 II Sh.f.	16 20 31 I Tr.f.	
30 23 11 IV Tr.f.	16 20 54 III Tr.c.	

SATURN'S SATELLITES

Saturn's satellites seldom receive the attention they deserve. This may be partly because the difficulty of seeing them has been greatly exaggerated and partly because of the comparative rarity of the successive eclipses and transits which are such a feature of Jupiter's system. These phenomena occur only at times when Saturn is near the ascending or descending node of the ring system—as it will be during 1950. As the angle of tilt of the rings decreases, the rings and the orbits of the seven inner satellites are seen more nearly edge-on, so that the satellites pass through Saturn's shadow or are seen projected on the disk.

The nine known satellites of Saturn can be classified into three groups according to their distance from Saturn. The first group is composed of Mimas, Enceladus, Tethys, Dione and Rhea which all lie within 300,000 miles of the surface of Saturn. Their orbits are almost circular and lie close to the plane of the rings, while their orbital periods range from 22h. 37m. for Mimas to 4d. 12h. for Rhea. Mimas and Enceladus are difficult objects owing to their nearness to the bright planet, but Tethys and Dione are visible in a four-inch telescope, while Rhea is, when suitably placed, an easy object for a three-inch. The maximum separation of Rhea from Saturn is just over one minute of arc.

The following table shows the S.A.S.T. times at which Rhea will be at Eastern Elongation during 1950:—

	d.	h.		d.	h.		d.	h.		d.	h.
Jan.	0	08.8	Feb.	28	01.5	Apr.	27	17.9	June	25	11.8
,,	4	21.2	Mar.	4	13.8	May	2	06.3	,,	30	00.3
,,	9	09.6	,,	9	02.2	,,	6	18.8	July	4	12.8
,,	13	22.0	,,	13	14.5	,,	11	07.2	,,	9	01.3
,,	18	10.3	,,	18	02.8	,,	15	19.6	,,	13	13.9
,,	22	22.7	,,	22	15.1	,,	20	08.0			
,,	27	11.1	,,	27	03.4	,,	24	20.4			
,,	31	23.5	,,	31	15.8	,,	29	08.8			

Feb.	5	11.8	Apr.	5	04.2	June	2	21.3			
,,	10	00.2	,,	9	16.5	,,	7	09.8	Dec.	14	08.5
,,	14	12.5	,,	14	04.9	,,	11	22.3	,,	18	20.9
,,	19	00.8	,,	18	17.2	,,	16	10.8	,,	23	09.4
,,	23	13.1	,,	23	05.6	,,	20	23.3	,,	27	21.9

The approximate position angle of Rhea at any time T. after an Eastern Elongation is as follows:—

T.		P.	T.		P.	T.		P.
d.	h.		d.	h.		d.	h.	
0	0	85°	1	12	271°	3	0	259°
	6	84°		18	268°		6	247°
	12	82°	2	0	266°		12	107°
	18	79°		6	265°		18	92°
1	0	66°		12	264°	4	0	88°
	6	286°		18	262°		6	86°

The second group of satellites which consists of Titan and Hyperion are separated from Rhea by a gap of over 400,000 miles. Titan, the largest and brightest of Saturn's satellites, can be seen with a one inch aperture and is large enough to show a distinct disc in a big telescope. Its apparent magnitude is about 8.5, its orbital period 15d. 23h., and its maximum separation from Saturn just over three minutes of arc. The times of its Eastern Elongations during 1950 are as follows:—

	d.	h.		d.	h.		d.	h.
January	11	16.3	April	1	05.2	June	19	22.2
,,	27	14.5	,,	17	03.0	July	5	21.9
February	12	12.3	May	3	01.2			
,,	28	10.0	,,	18	23.8	December	13	00.0
March	16	07.5	June	3	22.8	,,	28	23.3

The approximate position angle of Titan at any time T. after an Eastern Elongation is as follows:—

T.	P.	T.	P.	T.	P.	T.	P.
0d	85°	4d	310°	8d	265°	12d	140°
1d	84°	5d	270°	9d	263°	13d	92°
2d	82°	6d	267°	10d	262°	14d	88°
3d	77°	7d	266°	11d	257°	15d	86°

A further gap of over a million miles separates Iapetus and Phoebe the two satellites of group three, from Hyperion. The orbits of Iapetus and Phoebe are considerably inclined to the plane of the rings. Like that of the three outermost satellites of Jupiter, the motion of Phoebe is retrograde.

Iapetus shows decided variations in brightness and is always brighter at Western Elongation. This suggests that one side of Iapetus is brighter than the other, and that it rotates in the same period (79 days) as that of its revolution round Saturn. In 1950 Iapetus is at Western Elongation on March 6 and May 23. On, or near these dates, Iapetus should be well within the reach of a three inch telescope. Its maximum separation from Saturn will be over nine minutes of arc.

ECLIPSES

The following table, which is taken from the "New Handbook of the Heavens," by Bernhard, Bennett and Rice, gives the total eclipses of the Sun from 1948 to 2000, the annular eclipses of the Sun and the total eclipses of the Moon from 1948 to 1965. The data is derived from Oppolzer's "Canon der Finsternisse."

1. TOTAL SOLAR ECLIPSES, 1948 to 2000 A.D.

Date	*Path of Total Eclipse.*
1948, May 9	Indian Ocean, south-eastern Asia, across the Pacific Ocean.
1948, Nov. 1	Central Africa, south Indian Ocean to the Pacific west of New Zealand.
1950, Sept. 12	North Polar regions, north-eastern Siberia, into mid-north Pacific Ocean.
1952, Feb. 25	Across North Africa and Arabia, into Central Asia.
1954, June 30	Central United States, north-eastern Canada, Greenland, southern Scandinavia, across Russia into India.
1955, June 20	Indian Ocean, south India, across south-eastern Asia, to north Pacific Ocean.
1956, June 8	South Pacific Ocean.
1958, Oct. 12	South Pacific Ocean, ending in southern South America.
1959, Oct. 2	Eastern New England, across the north Atlantic and north Africa to the north Indian Ocean.
1961, Feb. 15	Bay of Biscay, across France, northern Italy, south-eastern Europe, north-western and northern Asia, to the Arctic.
1962, Feb. 5	Borneo, New Guinea, central and northern Pacific Ocean.
1963, July 20	Japan, Bering Sea, Alaska, northern Canada, mid-north Atlantic Ocean.
1965, May 30	South Pacific: New Zealand—Marquesas Islands—Peru.
1966, May 20	Atlantic Ocean, N.W. Africa, Mediterranean Sea, across Asia.
1966, Nov. 12	Pacific, west of Galapagos Islands, across southern South America, across the south Atlantic to the Indian Ocean.
1967, Nov. 2	Antarctic Ocean, Antarctica.
1968, Sept. 22	Arctic Ocean, northern Russia, to Central Asia.
1970, Mar. 7	Central Pacific Ocean, Mexico, Florida, to mid-north Atlantic Ocean.
1972, July 10	North-eastern Asia, Alaska, northern Canada, to mid-Atlantic Ocean.
1973, June 30	Northern South America, Atlantic Ocean, across northern Africa to mid-Indian Ocean.
1974, June 20	Southern Indian Ocean and Antarctic Ocean, south of Australia.

1976, Oct. 23	East Africa, across the Indian Ocean and Australia to a point near New Zealand.
1977, Oct. 12	Mid-north Pacific Ocean, south-eastward, extending into northern South America.
1979, Feb. 26	North Pacific Ocean, north-west tip of United States, across Canada, Hudson Bay, into Central Greenland.
1980, Feb. 16	Atlantic Ocean, across central Africa, Indian Ocean, India, southern China.
1981, July 31	South-eastern Europe, across Siberia, to mid-north Pacific Ocean.
1983, June 11	South Indian Ocean, across the East Indies, to western Pacific Ocean.
1984, May 30	Pacific Ocean, across Mexico, southern United States, across the Atlantic to northern Africa.
1984, Nov. 22	East Indies, across the south Pacific Ocean to a point off the coast of Chile.
1985, Nov. 12	Antarctic Ocean.
1986, Oct. 3	(A short eclipse.) In the Atlantic just off the south-east coast of Greenland.
1987, Mar. 29	Patagonia, across the south Atlantic Ocean, across Africa.

Date	*Path of Total Phase.*
1988, Mar. 18	Eastern Indian Ocean, across Sumatra, the Malay Peninsula, into the north Pacific, across the Philippine Islands to a point south of Alaska.
1990, July 22	Finland, the Arctic Ocean, north-eastern Asia, across the North Pacific.
1991, July 11	Mid-Pacific Ocean, across Mexico, Central America, northern South America, into Brazil.
1992, June 30	South-eastern South America, across mid-South Atlantic to Indian Antarctic Ocean.
1994, Nov. 4	Pacific Ocean south of the Galapagos Islands, across South America and the south Atlantic Ocean to the western Indian Ocean.
1995, Oct. 24	South-western Asia, across northern India, the Malay Peninsula, into mid-Pacific Ocean.
1997, Mar. 9	Central Asia, across N.E. Asia, into the Arctic Ocean.
1998, Feb. 26	Mid-Pacific Ocean, across the northern tip of South America, across the Atlantic Ocean to the Canary Islands.
1999, Aug. 11	Atlantic Ocean south of Nova Scotia, across the North Atlantic, across Central Europe, Southern Asia, and Northern India.
2000	(No total solar eclipse.)

2. ANNULAR ECLIPSES, 1948 to 1965 A.D.

Date	*Path of Annular Phase.*
1950, Mar. 18	Antarctica and the Antarctic Ocean.
1951, Mar. 7	New Zealand, across the south Pacific Ocean, across the extreme northern tip of South America.
1951, Sept. 1	Eastern United States, across the Atlantic Ocean and the Sahara to Madagascar.
1952, Aug. 20	Pacific Ocean, west of Central America, across South America to the Antarctic Ocean south of Africa.
1954, Jan. 5	Antarctic Ocean, Antarctica, south Pacific Ocean.
1954, Dec. 25	South Atlantic Ocean, around South Africa, the south Indian Ocean to the East Indies.
1955, Dec. 14	The Sahara, north Indian Ocean, across south-eastern Asia to the western Pacific Ocean.
1957, April 29	(A short eclipse.) The northern coast of Russia and the Arctic Ocean.
1958, April 19	North Indian Ocean, across south-eastern Asia, into mid-north Pacific Ocean.
1959, April 8	South Indian Ocean, across Australia, into the west Pacific Ocean.
1961, Aug. 11	South Atlantic Ocean, the Antarctic Ocean, Antarctica.
1962, July 31	Northern South America, across the Atlantic Ocean, the Sahara, and East Africa, to Madagascar.
1963, Jan. 25	South Pacific west of Chile, across southern South America, into the Atlantic Antarctic Ocean and to the Indian Ocean just east of Madagascar.
1965, Nov. 23	North-west India to the east near Calcutta, across the Malay Peninsula, Borneo, and New Guinea, into the mid-North Pacific Ocean.

3. TOTAL LUNAR ECLIPSES, 1948 to 1965.

Date	*Duration.* h.	m.	*Region of visibility.*
1948			(No total lunar in 1948.)
1949, April 12	1	30	North and South America.
1949, Oct. 6	1	10	Generally, in North and South America.
1950, April 2	0	38	Africa, Europe, Asia and Australia.
1950, Sept. 25	0	44	North and South America.
1953, Jan. 29	1	22	Africa, Europe, Asia and Australia.
1953, July 26	1	44	Chiefly in Australia, Asia, Western and mid-Pacific Ocean.
1954, Jan. 18	0	38	South America, eastern North America, Western Africa and Europe.
1956, Nov. 18	1	18	North and South America.
1957, May 13	1	20	Africa, Europe, and partly in North and South America and Western Asia.
1957, Nov. 7	0	32	Asia, Australia, western and mid-Pacific Ocean.
1960, Mar. 13	1	36	North and South America.
1960, Sept. 5	1	30	Mid-Pacific regions, and partly in North America.
1961, Aug. 25	0	14	North and South America, western Africa and Europe.
1963, Dec. 30	1	24	Mid-Pacific, and partly in North America.
1964, June 24	1	38	Africa, Europe, South America, eastern North America.
1964, Dec. 18	1	4	South America and most of North America Western Africa and Europe.
1965			(No total lunar in 1965.)

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