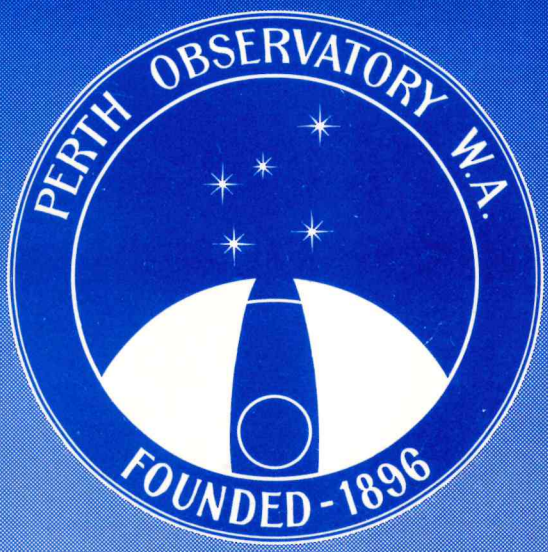
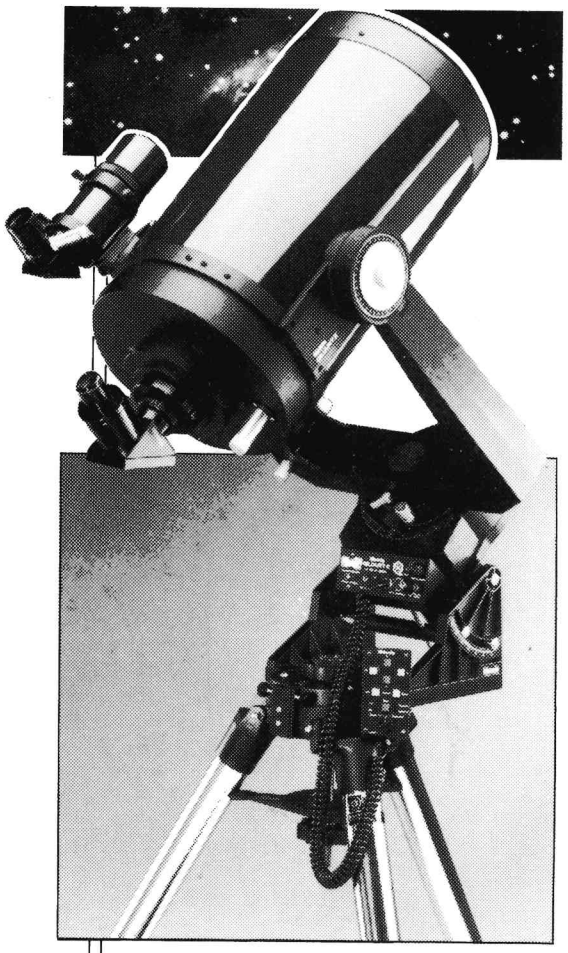


1991 ASTRONOMICAL HANDBOOK



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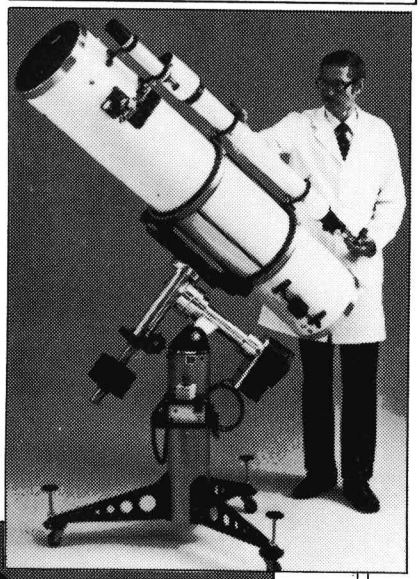

THE LEADER'S EDGE

ASTRONOMICAL HANDBOOK 1991

THE PERTH OBSERVATORY LOGO WAS DESIGNED AND CREATED BY PETER JEKABSONS IN 1987

This book is dedicated to the memory of

PETER JEKABSONS

1943 - 1990

WHOSE HUMOUR, PATIENCE AND

CREATIVITY ARE SADLY MISSED.

HIS FINE BLEND OF ART AND

OBSERVING SKILLS WAS UNIQUE

REST IN PEACE, P.J.

Q78364-1

CALENDAR 1991

JANUARY

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

FEBRUARY

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

MARCH

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

APRIL

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

MAY

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

JUNE

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

JULY

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

AUGUST

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

SEPTEMBER

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

OCTOBER

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

NOVEMBER

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

DECEMBER

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

PREFACE

The 1991 ASTRONOMICAL HANDBOOK is a continuation of the ASTRONOMICAL DATA BOOK published annually by PERTH OBSERVATORY since 1965. To provide for amateur astronomers and students alike, there is less technical detail and more generalised information than previously.

Unless otherwise stated, all times are in Western Australian Standard Time (WAST). Where whole day numbers are given for dates, these refer to the date at 0 hrs WAST. The equinoxes for Right Ascension and Declination are given. Precession tables are provided.

Due to their limited appeal, the Lunar Occultations have been omitted. They are available from the Perth Observatory. Star charts provided in 1989 and 1990 have not been provided in 1991. They have been replaced with charts of areas of special interest. Comment on their usefulness would be appreciated. Planispheres and project kits are for sale at the Observatory, along with photographs, posters, and other astronomical souvenirs. See Section 5 for charges

These organisations and people greatly assisted in this work.

1. The Royal Greenwich Observatory.

2. Dr S. Nakano - Editor of "STAR and PLANET CATALOGUE (2000) "

3. British Astronomical Association.

4. United States Naval Observatory.

5. Proof reading was by Carmel Borg, Mike Candy, Greg Lowe and Tom Smith.

Comments on the layout and content and suggestions for improvements will be welcomed.

Further information is available from the Perth Observatory Telephone Information Service on 2938109. This recorded message is regularly updated to cover current and topical Astronomical information. The "Night Sky" column appears in the "West Australian" information pages each Monday.

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1990 NOVEMBER 1

Section 1

The SUN

EXPLANATION OF SECTION 1

SUNRISE and SUNSET

TWILIGHT

ALTITUDE and AZIMUTH TABLE

SOLAR ECLIPSE

SUNDIALS

EXPLANATION OF SECTION 1

SUNRISE, SUNSET AND TWILIGHTS FOR PERTH

GIVEN in Western Australian Standard Time (WAST) are the times for the three types of twilight as explained at the bottom of the page. The left hand column shows the date while columns 2, 3, and 4 are the times of commencement of morning twilights. Column 5 is the time of sunrise for PERTH, while column 6 is the time when, the SUN transits the meridian of longitude that passes through PERTH (115° 51 East). Column 7 is the sunset time , and columns 8, 9 and 10 show the times of the end of the three types of twilight.

ALTITUDE AND AZIMUTH OF THE SUN AT PERTH

GIVEN in degrees, this table defines the position of the Sun in the sky at hourly intervals while it is above the horizon. Asterisks indicate that the Sun is below the horizon for this date and time. Computation is for the 20th day of each month. Each pair of numbers denotes an altitude (height above the horizon in degrees) and an azimuth (or compass bearing). For most cases, linear interpolation for inbetween dates will give answers correct to within a degree. For more exact figures contact the Perth Observatory.

SUNRISE, SUNSET FOR WESTERN AUSTRALIA

GIVEN are three tables of sunrise and sunset for three different locations in WA. All are for longitude 120° E, but vary according to latitude : 15° S, 25° S, and 35° S. From these tables the sunrise and sunset for any location in WA can be calculated once the latitude and longitude is known. Tables of Latitude and Longitude for many WA towns are provided in Section 5.

Example: Sunset for WAGIN on 1991 August 20. Latitude 33° 19' S
Longitude 117° 20' E

Find	Sunset for 25° S, 120° E for August 20	17 42.8
	Sunset for 35° S, 120° E for August 20	17 31.4
	Interpolate for 33°19' S, 120° E	17 33.3
	Add correction for longitude from Latitude/ Longitude table (section 5)	$+10.7^{m}$
	Sunset for 33°19' S, 117°20' E (WAGIN)	17 44.0 WAST

Note : The Observatory can provide accurate sunrise/ sunset times for ANY location

THE SUN

GIVEN in column 1 is the date assumed as 0hrs Ephemeris Time (or Universal Time). Column 2 is the JULIAN date - 0 hrs E.T. corresponds to 0.5 days on the Julian calendar. Column 3 is the Local Sidereal Time for 0hrs WAST. Columns 4 and 5 are the Apparent Right Ascension and Declination of the Sun, followed by the Semi- Diameter. Columns 7, 8, and 9 are the Equation of Time, the True Distance, and the Horizontal Parallax of the Sun. Units are stated at the head of the column.

CHRONOLOGICAL CYCLES AND ERAS

GIVEN are the various ERAS, CYCLES and RELIGIOUS festival dates that are important to large sections of the community. The conversion from the normal calendar to the Julian Calendar is also documented.

1991

SUNRISE, SUNSET AND TWILIGHTS FOR PERTH

Date		Astro		Nautl		Civil		Rise		Transit		Set		Civil		Nautl		Astro	
	d	h	m	h	m	h	m	h	m	h	m	h	m	h	m	h	m	h	m
Jan	0	3	33	4	11	4	45	5	13	12	20	19	25	19	54	20	28	21	5
	10	3	42	4	19	4	52	5	20	12	24	19	26	19	54	20	28	21	4
	20	3	54	4	29	5	2	5	29	12	27	19	24	19	52	20	25	21	0
	30	4	6	4	40	5	12	5	39	12	30	19	20	19	46	20	18	20	52
Feb	9	4	19	4	51	5	22	5	48	12	31	19	12	19	38	20	9	20	41
Feb	19	4	30	5	1	5	31	5	57	12	31	19	3	19	28	19	58	20	29
Mar	1	4	41	5	11	5	40	6	5	12	29	18	52	19	17	19	46	20	16
	11	4	50	5	19	5	48	6	12	12	27	18	40	19	4	19	33	20	2
	21	4	58	5	27	5	55	6	19	12	24	18	27	18	52	19	20	19	49
	31	5	5	5	34	6	2	6	26	12	21	18	14	18	39	19	7	19	35
Apr	10	5	12	5	40	6	8	6	33	12	18	18	2	18	26	18	55	19	23
	20	5	18	5	46	6	15	6	40	12	16	17	50	18	15	18	44	19	12
	30	5	24	5	52	6	21	6	47	12	14	17	40	18	5	18	34	19	3
May	10	5	30	5	58	6	28	6	53	12	13	17	31	17	57	18	26	18	55
	20	5	35	6	4	6	34	7	0	12	13	17	25	17	51	18	21	18	50
May	30	5	40	6	10	6	40	7	6	12	14	17	20	17	47	18	17	18	47
Jun	9	5	45	6	14	6	45	7	12	12	16	17	18	17	45	18	16	18	45
	19	5	48	6	18	6	48	7	15	12	18	17	19	17	46	18	17	18	46
	29	5	50	6	20	6	50	7	17	12	20	17	22	17	49	18	19	18	49
Jul	9	5	50	6	19	6	50	7	16	12	22	17	26	17	53	18	23	18	53
Jul	19	5	48	6	17	6	47	7	13	12	23	17	31	17	58	18	28	18	57
	29	5	43	6	12	6	42	7	8	12	23	17	38	18	4	18	33	19	2
Aug	8	5	37	6	5	6	34	7	0	12	22	17	44	18	10	18	39	19	7
	18	5	28	5	56	6	25	6	50	12	21	17	50	18	15	18	44	19	13
	28	5	17	5	46	6	14	6	39	12	18	17	57	18	21	18	50	19	18
Sep	7	5	5	5	34	6	2	6	27	12	15	18	3	18	27	18	55	19	24
	17	4	52	5	21	5	49	6	13	12	11	18	9	18	33	19	1	19	30
	27	4	39	5	7	5	36	6	0	12	8	18	15	18	39	19	8	19	37
Oct	7	4	24	4	54	5	23	5	47	12	5	18	21	18	46	19	15	19	45
	17	4	11	4	41	5	10	5	35	12	2	18	29	18	54	19	23	19	53
Oct	27	3	57	4	29	4	59	5	24	12	1	18	36	19	2	19	32	20	4
Nov	6	3	45	4	18	4	49	5	15	12	0	18	45	19	11	19	42	20	15
	16	3	35	4	9	4	42	5	8	12	1	18	54	19	20	19	53	20	27
	26	3	28	4	3	4	37	5	4	12	4	19	3	19	30	20	3	20	39
Dec	6	3	24	4	0	4	34	5	2	12	7	19	11	19	39	20	13	20	49
Dec	16	3	24	4	1	4	36	5	4	12	11	19	18	19	46	20	21	20	58
	26	3	28	4	5	4	40	5	8	12	16	19	23	19	51	20	26	21	3

In the EVENINGS:
CIVIL TWILIGHT ends when the Sun is 6^{o} below the horizon. After this time ordinary outdoor activities are impractical without artificial lighting.

NAUTICAL TWILIGHT ends when the Sun is 12^{o} below the horizon.

ASTRONOMICAL TWILIGHT ends when the Sun is 18^{o} below the horizon. At this time the residual sunlight is less than the level of illumination of the night sky.
In the MORNINGS, the twilights BEGIN as the Sun reaches the same depressions.

The ALTITUDE and AZIMUTH of the SUN at PERTH

on the 20th day of each month

TIME W.A.S.T.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0600	5,111	0,104	*******	*******	*******	*******	*******	*******	*******	5, 99	9,107	10,112
0700	17,103	12, 96	8, 86	3, 74	*******	*******	*******	2, 74	10, 82	17, 91	22,100	22,105
0800	30, 96	24, 88	20, 77	15, 66	11, 58	7, 57	8, 60	14, 66	22, 73	30, 83	34, 93	34, 98
0900	42, 89	37, 79	33, 67	26, 55	21, 48	17, 46	18, 50	25, 55	34, 62	42, 73	47, 85	47, 91
1000	55, 79	49, 68	44, 54	36, 43	29, 36	26, 35	27, 38	34, 43	44, 48	54, 59	60, 73	60, 82
1100	67, 64	60, 50	53, 36	43, 26	35, 21	32, 20	33, 24	42, 27	52, 29	63, 38	71, 53	72, 66
1200	77, 30	68, 21	58, 11	46, 6	38, 4	34, 4	37, 7	45, 7	56, 4	68, 3	78, 4	81, 18
1300	76,327	68,341	57,343	45,344	37,346	34,348	36,350	44,346	54,339	64,326	72,312	77,308
1400	66,295	61,311	51,319	40,326	32,330	29,332	32,333	39,328	47,318	55,303	61,289	65,284
1500	54,280	50,293	42,303	31,311	24,316	22,319	25,319	31,313	38,302	44,288	49,277	53,273
1600	41,271	38,282	30,291	21,300	15,305	13,309	16,308	21,301	26,291	31,278	36,268	40,265
1700	29,263	25,273	18,281	9,290	4,296	2,299	5,299	10,291	14,281	19,270	23,261	28,258
1800	16,256	13,265	5,273	*******	*******	*******	*******	*******	1,273	6,262	11,254	15,252
1900	4,249	0,256	*******	*******	*******	*******	*******	*******	*******	*******	*******	4,244

ALTITUDE is the angular distance above the horizon, measured in degrees.

AZIMUTH is related to compass bearing : North = 0^{o} ; East = 90^{o} ; South = 180^{o} ; West = 270^{o} etc

Each pair of numbers represents the Altitude, followed by the Azimuth. Accurate to within +/- 1^{o}.

******* denotes that the SUN is BELOW THE HORIZON for that time.

Sunrise / Sunset in Western Australia during 1991
for longitude 120.0 degrees East

For latitude 15.0 degrees SOUTH

Date		Rise		Set		Date		Rise		Set		Date		Rise		Set	
	d	h	m	h	m		d	h	m	h	m		d	h	m	h	m
Jan	0	5	33	18	33	May	10	6	12	17	40	Sep	7	6	1	17	54
	10	5	38	18	35		20	6	14	17	37		17	5	54	17	55
	20	5	44	18	37		30	6	18	17	36		27	5	46	17	56
	30	5	49	18	36	Jun	9	6	21	17	36	Oct	7	5	39	17	57
Feb	9	5	54	18	34		19	6	23	17	38		17	5	32	17	58
	19	5	57	18	29		29	6	25	17	40		27	5	26	18	1
Mar	1	6	0	18	24	Jul	9	6	26	17	43	Nov	6	5	22	18	4
	11	6	2	18	17		19	6	26	17	46		16	5	20	18	9
	21	6	3	18	10		29	6	23	17	49		26	5	19	18	14
	31	6	5	18	3	Aug	8	6	20	17	51	Dec	6	5	21	18	20
Apr	10	6	6	17	56		18	6	15	17	53		16	5	24	18	25
	20	6	7	17	50		28	6	8	17	54		26	5	29	18	30
	30	6	9	17	44												

For latitude 25.0 degrees SOUTH

Date		Rise		Set		Date		Rise		Set		Date		Rise		Set	
	d	h	m	h	m		d	h	m	h	m		d	h	m	h	m
Jan	0	5	13	18	53	May	10	6	26	17	26	Sep	7	6	6	17	50
	10	5	19	18	54		20	6	31	17	21		17	5	56	17	53
	20	5	27	18	54		30	6	35	17	18		27	5	45	17	57
	30	5	34	18	51	Jun	9	6	40	17	17	Oct	7	5	34	18	1
Feb	9	5	41	18	46		19	6	43	17	18		17	5	25	18	6
	19	5	48	18	39		29	6	45	17	21		27	5	16	18	11
Mar	1	5	54	18	30	Jul	9	6	45	17	24	Nov	6	5	9	18	17
	11	5	59	18	21		19	6	43	17	29		16	5	4	18	24
	21	6	3	18	10		29	6	39	17	33		26	5	2	18	32
	31	6	7	18	0	Aug	8	6	33	17	38	Dec	6	5	2	18	39
Apr	10	6	12	17	50		18	6	25	17	42		16	5	4	18	45
	20	6	16	17	41		28	6	16	17	46		26	5	9	18	50
	30	6	21	17	33												

For latitude 35.0 degrees SOUTH

Date		Rise		Set		Date		Rise		Set		Date		Rise		Set	
	d	h	m	h	m		d	h	m	h	m		d	h	m	h	m
Jan	0	4	49	19	17	May	10	6	42	17	9	Sep	7	6	12	17	44
	10	4	56	19	17		20	6	50	17	2		17	5	58	17	52
	20	5	6	19	15		30	6	57	16	57		27	5	43	17	59
	30	5	16	19	9	Jun	9	7	3	16	54	Oct	7	5	29	18	7
Feb	9	5	26	19	1		19	7	7	16	55		17	5	16	18	15
	19	5	36	18	50		29	7	8	16	57		27	5	4	18	24
Mar	1	5	46	18	38	Jul	9	7	7	17	2	Nov	6	4	53	18	33
	11	5	54	18	25		19	7	4	17	8		16	4	45	18	43
	21	6	3	18	11		29	6	57	17	15		26	4	40	18	53
	31	6	11	17	57	Aug	8	6	48	17	22	Dec	6	4	38	19	2
Apr	10	6	19	17	43		18	6	38	17	30		16	4	40	19	10
	20	6	26	17	30		28	6	25	17	37		26	4	44	19	15
	30	6	34	17	19												

Q78364-2

THE SUN 1991.

Date	J.D.	L.S.T	Apparent R.A.	Apparent DEC.	Semi Dia.	Eq. of Time	True Dist.	H.P.
	244-	h m	h m s	o '	' "	m s	A.U.	"
Jan 0	8256.5	6 35.3	18 39 20	-23 8	16 17.5	- 2 55	0.98331	8.95
10	8266.5	7 14.8	19 23 15	22 4	16 17.4	7 23	0.98342	8.95
20	8276.5	7 54.2	20 6 17	20 17	16 16.8	10 56	0.98399	8.94
30	8286.5	8 33.6	20 48 5	17 51	16 15.8	13 15	0.98500	8.94
Feb 9	8296.5	9 13.0	21 28 33	14 54	16 14.3	14 12	0.98656	8.92
19	8306.5	9 52.5	22 7 43	-11 32	16 12.4	-13 53	0.98848	8.90
Mar 1	8316.5	10 31.9	22 45 45	7 52	16 10.2	12 26	0.99069	8.88
11	8326.5	11 11.3	23 22 54	4 0	16 7.7	10 8	0.99327	8.86
21	8336.5	11 50.7	23 59 32	- 0 3	16 5.0	7 20	0.99600	8.84
31	8346.5	12 30.2	0 35 56	+ 3 52	16 2.3	4 18	0.99880	8.81
Apr 10	8356.5	13 9.6	1 12 28	+ 7 41	15 59.5	- 1 25	1.00172	8.79
20	8366.5	13 49.0	1 49 26	11 16	15 56.9	+ 1 0	1.00452	8.76
30	8376.5	14 28.4	2 27 5	14 33	15 54.4	2 45	1.00715	8.74
May 10	8386.5	15 7.9	3 5 35	17 26	15 52.0	3 38	1.00966	8.72
20	8396.5	15 47.3	3 45 3	19 50	15 50.0	3 32	1.01182	8.70
30	8406.5	16 26.7	4 25 24	+21 40	15 48.3	+ 2 35	1.01360	8.68
Jun 9	8416.5	17 6.1	5 6 28	22 52	15 46.9	+ 0 56	1.01509	8.67
19	8426.5	17 45.6	5 47 59	23 25	15 46.0	- 1 12	1.01603	8.66
29	8436.5	18 25.0	6 29 32	23 16	15 45.5	3 19	1.01657	8.66
Jul 9	8446.5	19 4.4	7 10 47	22 27	15 45.4	5 7	1.01669	8.66
19	8456.5	19 43.9	7 51 23	+20 59	15 45.8	- 6 14	1.01625	8.66
29	8466.5	20 23.3	8 31 4	18 55	15 46.7	6 27	1.01535	8.67
Aug 8	8476.5	21 2.7	9 9 45	16 21	15 47.8	5 40	1.01408	8.68
18	8486.5	21 42.1	9 47 29	13 20	15 49.5	3 56	1.01233	8.69
28	8496.5	22 21.6	10 24 22	9 58	15 51.5	- 1 21	1.01022	8.71
Sep 7	8506.5	23 1.0	11 0 38	+ 6 20	15 53.7	+ 1 50	1.00789	8.73
17	8516.5	23 40.4	11 36 34	+ 2 32	15 56.2	5 20	1.00523	8.75
27	8526.5	0 19.8	12 12 28	- 1 21	15 58.8	8 52	1.00244	8.78
Oct 7	8536.5	0 59.3	12 48 41	5 13	16 1.5	12 2	0.99963	8.80
17	8546.5	1 38.7	13 25 35	8 59	16 4.3	14 32	0.99673	8.83
27	8556.5	2 18.1	14 3 25	-12 32	16 7.0	+16 4	0.99395	8.85
Nov 6	8566.5	2 57.5	14 42 28	15 46	16 9.5	16 22	0.99141	8.87
16	8576.5	3 37.0	15 22 55	18 33	16 11.8	15 17	0.98902	8.90
26	8586.5	4 16.4	16 4 44	20 48	16 13.8	12 50	0.98700	8.91
Dec 6	8596.5	4 55.8	16 47 47	22 24	16 15.4	9 8	0.98542	8.93
16	8606.5	5 35.2	17 31 45	-23 17	16 16.6	+ 4 34	0.98419	8.94
26	8616.5	6 14.7	18 16 6	-23 23	16 17.3	- 0 22	0.98348	8.95

NOTES:

The values for J.D. (Julian date) are for 0 hours U.T. (Universal Time). L.S.T. (Local Sidereal Time) is for 0 hours WAST for the date in the first column and longitude 120° E. All other values listed are for 0 hours E.T. (Ephemeris Time) but may be regarded as being for 0 hours U.T. in the above table.

ACKNOWLEDGEMENTS:

Information pertaining to R.A. (Right Ascension), DEC. (Declination) , Semi Dia(meter)., Eq(uation) of. Time , True Dist(ance), H.P.(Horizontal Parallax), at 0 hours E.T. are from "STAR AND PLANET CATALOGUE (2000) " by S. Nakano & A. Otawara.

1991
CHRONOLOGICAL CYCLES AND ERAS

Dominical Letter	F	Julian Period (year of)	6704
Epact	14	Roman Indiction	14
Golden Number	XVI	Solar Cycle	12

NOTE:- All dates are in terms of the Gregorian Calendar in which 1991 January 14 corresponds to 1991 January 1 of the Julian Calendar.

ERA	YEAR BEGINS	ERA	YEAR BEGINS
Byzantine	7500 Sep 14	Japanese	2651 Jan 1
Jewish (A.M.)*	5752 Sep 8	Grecian (Seleucidae)	2303 Sep 14
Chinese	4628 Feb 15		(or Oct 14)
Roman (A.U.C)	2744 Jan 14	Indian (Saka)	1913 Mar 22
Nabonassar	2740 Apr 26	Diocletian	1708 Sep 12
		Islamic (Hegira)*	1412 Jul 12

* Year begins at sunset .

RELIGIOUS CALENDARS .

Epiphany	Jan 6	Ascension Day	May 9
Ash Wednesday	Feb 13	Whitsunday- Pentecost	May 19
Palm Sunday	Mar 24	Trinity Sunday	May 26
Good Friday	Mar 29	First Sunday in Advent	Dec 1
Easter Day	Mar 31	Christmas Day (Wednesday)	Dec 25
First Day of Passover (Pesach)	Mar 30	Day of Atonement (Yom Kippur)	Sep 18
Feast of Weeks (Shavuot)	May 19	First Day of Tabernacles (Succoth)	Sep 23
Jewish New Year (tabular) (Rosh Hashanah)	Sep 9	First Day of Ramadan (tabular)	Mar 17
Islamic New Year (tabular)	Jul 13		

NOTE:- The Jewish and Islamic dates above are tabular dates, which begin at Sunset on the previous evening and end at Sunset on the date tabulated .

JULIAN CALENDAR .

Date	Day	(20 hours WAST)	Date	Day	(20 hours WAST)
Jan 1	Tue	244 8258	Jul 1	Mon	244 8439
Feb 1	Fri	244 8289	Aug 1	Thu	244 8470
Mar 1	Fri	244 8317	Sep 1	Sun	244 8501
Apr 1	Mon	244 8348	Oct 1	Tue	244 8531
May 1	Wed	244 8378	Nov 1	Fri	244 8562
Jun 1	Sat	244 8409	Dec 1	Sun	244 8592

During 1991 the Julian date may be obtained from:-
J. D. = 2448256.5 + day number + fraction of day from 0 hours U.T.

1991 IS NOT A LEAP YEAR

ANNULAR SOLAR ECLIPSE - 1991 Jan 16

Early in the morning of January 16, 1991 there will be an annular, or at least a partial solar eclipse visible throughout Western Australia. The Sun will rise partially eclipsed for all of WA, but there will be a path in the South West of the state that will experience an annular eclipse. This phenomenon occurs when the distance of the Moon from the Earth is such that the apparent diameter of the Moon is less than the apparent diameter of the Sun. The result is that a ring or annulus of sunlight is visible around the edge of the Moon on the central line.

AT NO TIME IS IT SAFE TO VIEW THIS ECLIPSE DIRECTLY.
ONLY WATCH AN IMAGE PROJECTED ONTO A SCREEN.

The central line of the annular eclipse passes across the coast at Kwinana, and proceeds through the South West of WA to cross the coast again near Hopetoun. The total width of the path of the annulus is 340 - 350 km, and the time of visibility of the annular phase from any one site depends on the distance from the central line. The accompanying table gives details for selected locations in WA. All times are given in Western Australian Standard Time.

LOCATION	ANNULARITY BEGINS	ENDS	ALTITUDE/AZIMUTH OF SUN (Degrees) AT MAXIMUM		MAXIMUM % OF SUN OBSCURED	PARTIAL ENDS
ALBANY	partial	only	9	110	83.8	0715
ARMADALE	0557	0603	6	111	84.1	0711
BICKLEY	0557	0603	6	111	84.1	0711
BRIDGETOWN	0600	0603	7	111	84.1	0712
BUNBURY	0559	0604	6	111	84.1	0712
BUSSELTON	0600	0603	6	111	84.1	0712
COLLIE	0559	0604	7	111	84.1	0712
CORRIGIN	0558	0603	8	110	84.1	0712
ESPERANCE	0559	0605	12	108	84.3	0716
EYRE	partial	only	14	106	79.4	0718
FREMANTLE	0557	0603	6	111	84.0	0711
GERALDTON	partial	only	3	112	81.4	0707
KALGOORLIE	partial	only	10	109	80.2	0713
KATANNING	0559	0604	8	110	84.1	0713
KOJONUP	0559	0604	8	110	84.1	0713
MERREDIN	partial	only	7	110	84.1	0712
MT BARKER	0601	0603	9	110	84.2	0714
NARROGIN	0558	0604	7	110	84.1	0712
NORTHAM	0558	0602	6	111	84.1	0711
PERTH	0557	0603	6	111	84.0	0711
PINJARRA	0558	0603	6	111	84.1	0711
ROCKINGHAM	0558	0603	6	111	84.0	0711
WAGIN	0559	0604	8	110	84.1	0713
WICKEPIN	0558	0604	8	110	84.1	0712
YORK	0558	0603	6	111	84.1	0711

Times are correct to the nearest minute. If more accurate timing predictions are required please contact Perth Observatory.

ALTITUDE : Angle above the horizon.
AZIMUTH : Compass bearing ; East = 90^{o}, South = 180^{o}, etc.

After crossing the Great Australian Bight, the central line of the eclipse also crosses Tasmania and New Zealand.

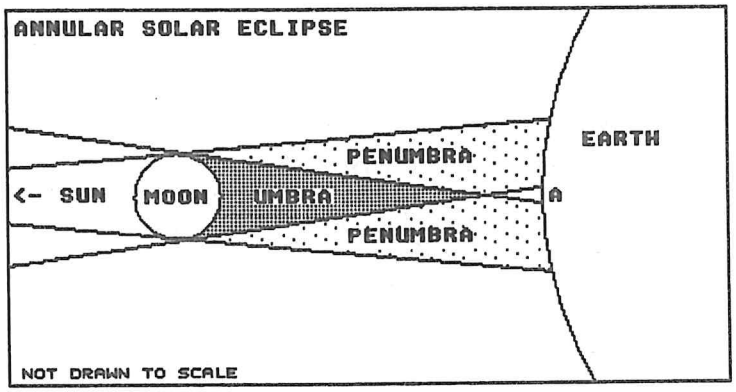
SOLAR ECLIPSES

A solar eclipse, occurs when the Moon passes between the Sun and the Earth. The eclipse may be of three types.

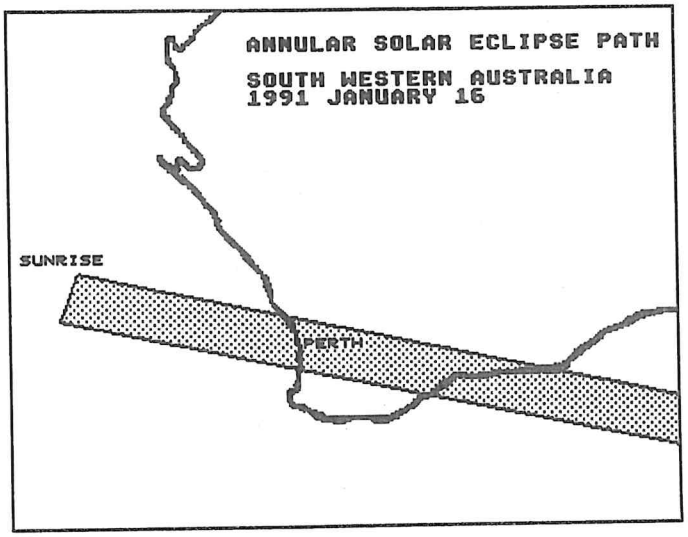
1) Partial Eclipse: The Earth passes through the Penumbral shadow of the Moon. A percentage of the Moon's disk obscures the solar disk.

2) Annular Eclipse: The Moon's umbral shadow is unable to reach the Earth's surface, therefore the Moon's apparent diameter will be smaller than that of the Sun. A ring of bright sunlight remains visible at mid-eclipse. The diagram represents an annular eclipse for the observer at point "A".

3) Total Eclipse: The Moon totally obscures the disk of the sun. Only the Sun's chromosphere and corona are visible.



On January 16th, 1991 the annular eclipse path will extend through the south western portion of Western Australia, northern Tasmania, central New Zealand and finally end up in the mid Pacific Ocean. All observers are cautioned to observe this eclipse only by projected images;do not use any method which would cause you to look directly at the Sun.



HORIZONTAL SUNDIAL

The shadow cast by the horizontal sun dial indicates the local apparent time. This " shadow time " does not indicate the true Civil Time for two reasons . First; The time zone in which you operate is based on a standard longitude, and any variation from that longitude requires a time correction. See the Latitude - Longitude tables in this Handbook. The second time correction is due to the tilt of the Earth, and its motion through a non- circular orbit. This cyclic value is known as the Equation of Time and can be located in this handbook under the title "THE SUN". The first correction is added to the sundial reading and the equation of time is subtracted since we are in the southern hemisphere.
Example: PERTH : February 9th

Sundial reading	11 h 30.0 m
Longitude correction	+ 16.6 m
	11 h 46.6 m

If the Equation of time is negative then you add.
If the Equation of time is positive then you subtract.
(The Equation of Time is - 14.2 m)

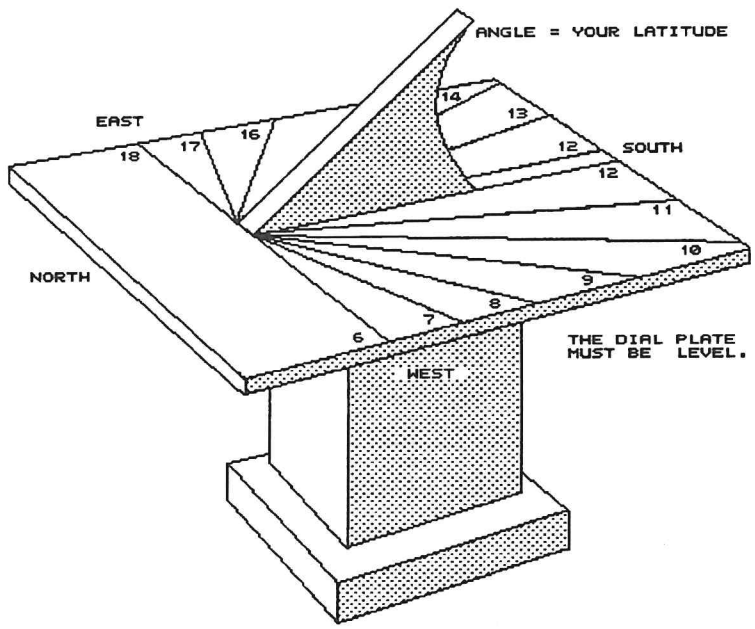
	+ 14.2 m
	12 h 00.8 m

The true Civil Time according to sundial is 12 hours and 48 seconds.

HORIZONTAL SUNDIAL FOR PERTH
All the angles are measured from the noon mark (12 hours)

Angle for marks	11 and 13	=	8.07 degrees
Angle for marks	10 and 14	=	16.99 degrees
Angle for marks	9 and 15	=	27.89 degrees
Angle for marks	8 and 16	=	42.51 degrees
Angle for marks	7 and 17	=	63.14 degrees
Angle for marks	6 and 18	=	90.00 degrees

The western edge of the gnomon (dial pointer) is used for the morning readings and the eastern edge is used for the afternoon readings. To align this unit the dial plate must be placed in the horizontal and turned so that gnomon points due south.



Section 2

The MOON

EXPLANATION OF SECTION 2

LUNAR MAP

MOON PHASES

APSIDES

MOONRISE and MOONSET

LUNAR ECLIPSES

THIN LUNAR CRESCENTS

EXPLANATION OF SECTION 2

PHASES OF THE MOON

This table provides the phase of the Moon, the lunation number, and the time when the phenomenon occurs (in WAST). Lunar phases are independent of geographic location, and depend on the relative positions of the Sun, Earth and Moon. A lunation is one cycle of phases, beginning with a New Moon.

PERIGEE and APOGEE

The Moon's orbit is not circular - it is an ellipse. The Moon is at PERIGEE when it is closest to the Earth - approximately 380000km; and at APOGEE when furthest from the Earth - approximately 401000km. This is why a full Moon that occurs near perigee will appear larger than a full Moon that occurs near apogee.

MOONRISE and MOONSET for PERTH

These three pages give the Moonrise and Moonset times specifically for the latitude and longitude of Perth. The calculations assume a flat, clear horizon, and that the location is at sea level. Times are all in Western Australian Standard Time (WAST). If a Moonset time has an asterisk after it, this indicates that the Moon sets on the day after it rises. For example, on January 6, Moonrise is at 2302WAST on the 6th, and Moonset is at 1158 WAST on the morning of the 7th.
Calculations take refraction into account. For the metropolitan area, there will not be very much variation in the times. However, for locations more than 50 kilometers from Perth, there may be a variations of several minutes. The Perth Observatory can provide accurate Moonrise and Moonset tables for any location.

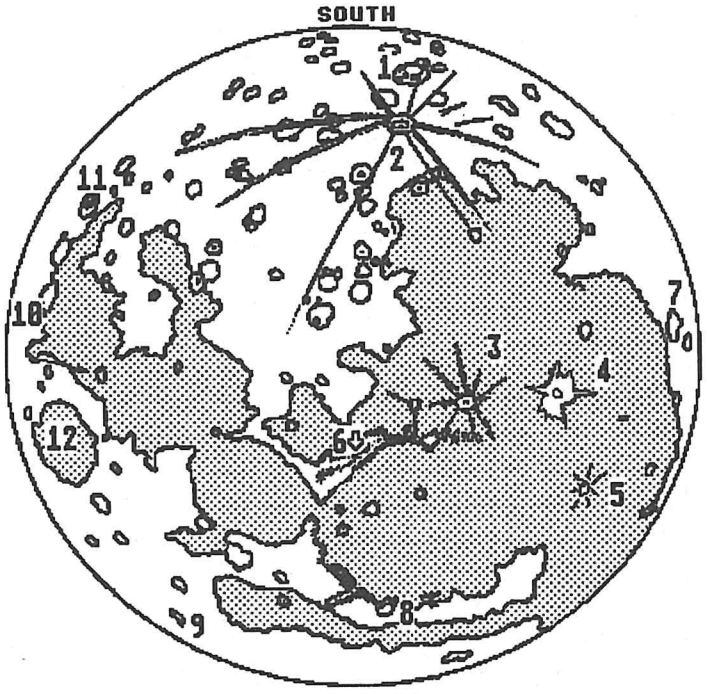
LUNAR ECLIPSES

Dates and times are given for the two lunar eclipses that will be visible from WA. More details will be provided for various locations if public interest warrants.
The event on July 27 will be the darker of the two eclipses, and although the Moon will turn a brownish colour, it will not get very dark because of the direct sunlight striking it as well as the reflected light from the Earth (earthshine), and from light refracted through the atmosphere.
Only the very end phase of the partial eclipse of December 21 will be visible from Western Australia.

THIN LUNAR CRESCENTS

This information is provided to assist people who wish to view the new lunar crescent as soon as possible after the New Moon.

BASIC LUNAR MAP



LUNAR FEATURES

1.	CLAVIUS	7.	GRIMALDI
2.	TYCHO	8.	PLATO
3.	COPERNICUS	9.	ENDYMION
4.	KEPLER	10.	LANGRENUS
5.	ARISTARCHUS	11.	PETAVIUS
6.	APENNINE MOUNTAINS	12.	MARE CRISIUM

PHASES of the MOON for 1991

Lunation	New Moon	First Quarter	FULL MOON	Last Quarter
	d h m	d h m	d h m	d h m
841			Jan 1 2 35	Jan 8 2 35
842	Jan 16 7 50	Jan 23 22 21	Jan 30 14 10	Feb 6 21 52
843	Feb 15 1 32	Feb 22 6 58	Mar 1 2 25	Mar 8 18 32
844	Mar 16 16 10	Mar 23 14 3	Mar 30 15 17	Apr 7 14 45
845	Apr 15 3 38	Apr 21 20 39	Apr 29 4 58	May 7 8 46
846	May 14 12 36	May 21 3 46	May 28 19 37	Jun 5 23 30
847	Jun 12 20 6	Jun 19 12 19	Jun 27 10 58	Jul 5 10 50
848	Jul 12 3 6	Jul 18 23 11	Jul 27 2 24	Aug 3 19 25
849	Aug 10 10 28	Aug 17 13 1	Aug 25 17 7	Sep 2 2 16
850	Sep 8 19 1	Sep 16 6 1	Sep 24 6 40	Oct 1 8 30
851	Oct 8 5 39	Oct 16 1 33	Oct 23 19 8	Oct 30 15 10
852	Nov 6 19 11	Nov 14 22 2	Nov 22 6 56	Nov 28 23 21
853	Dec 6 11 56	Dec 14 17 32	Dec 21 18 23	Dec 28 9 55

MOON at PERIGEE

d h		d h
Jan 28 17	Aug	9 2
Feb 25 9	Sep	6 3
Mar 22 13	Oct	3 2
Apr 18 1	Oct	28 0
May 16 1	Nov	24 10
Jun 13 8	Dec	22 17
Jul 11 18		

MOON at APOGEE

d h		d h
Jan 12 19	Jun	27 15
Feb 9 12	Jul	24 19
Mar 9 9	Aug	21 7
Apr 6 5	Sep	17 23
May 3 23	Oct	15 19
May 31 11	Nov	12 16
	Dec	10 10

LUNAR ECLIPSES

A PENUMBRAL lunar eclipse will be visible from many parts of the Earth on 1991 JULY 27 (Early in the Morning of the night of JULY 26/27).

Penumbral Eclipse begins	:	0^h48^m WAST
Middle of the eclipse	:	2 8 WAST
Penumbral Eclipse ends	:	3 28 WAST

Penumbral magnitude: 0.280

A PARTIAL lunar eclipse will be visible from Western Australia on 1991 DECEMBER 21, but only the final stage will be seen. From Perth , Moonrise is at 19^h23^m WAST, well after central eclipse.

Partial Eclipse ends : 20^h41^m WAST

....Moonrise and Set for 1991...

PERTH

Latitude 31.95° S Longitude 115.85° E Ht. 0.00 m.
Std Long. 120.0° E

Date	Rise d	Rise h	Rise m	Set h	Set m	Date	Rise d	Rise h	Rise m	Set h	Set m	Date	Rise d	Rise h	Rise m	Set h	Set m	Date	Rise d	Rise h	Rise m	Set h	Set m
Jan.	1	20	5	6	34*	Feb.	1	20	30	8	41*	Mar.	1	18	57	7	25*	Apr.	1	19	3	9	12*
	2	20	51	7	46*		2	21	0	9	43*		2	19	28	8	26*		2	19	41	10	11*
	3	21	29	8	54*		3	21	30	10	43*		3	19	59	9	27*		3	20	23	11	7*
	4	22	03	9	58*		4	22	1	11	42*		4	20	31	10	27*		4	21	9	11	59*
	5	22	33	10	59*		5	22	34	12	41*		5	21	6	11	26*		5	22	0	12	47*
Jan.	6	23	2	11	58*	Feb.	6	23	10	13	38*	Mar.	6	21	45	12	23*	Apr.	6	22	54	13	29*
	7	23	31	12	56*		7	23	50	14	34*		7	22	29	13	17*		7	23	50	14	7*
	8						8						8	23	17	14	8*		8				
	9	0	2	13	54		9	0	35	15	27		9						9	0	47	14	41
	10	0	35	14	51		10	1	25	16	15		10	0	9	14	53		10	1	45	15	13
Jan.	11	1	12	15	47	Feb.	11	2	18	16	59	Mar.	11	1	4	15	34	Apr.	11	2	44	15	43
	12	1	54	16	42		12	3	15	17	38		12	2	2	16	11		12	3	43	16	13
	13	2	40	17	33		13	4	14	18	13		13	3	0	16	44		13	4	45	16	44
	14	3	32	18	20		14	5	13	18	46		14	3	59	17	15		14	5	48	17	17
	15	4	27	19	2		15	6	12	19	16		15	4	59	17	45		15	6	55	17	55
Jan.	16	5	25	19	39	Feb.	16	7	11	19	45	Mar.	16	5	59	18	15	Apr.	16	8	4	18	38
	17	6	23	20	13		17	8	11	20	14		17	7	1	18	47		17	9	15	19	29
	18	7	22	20	44		18	9	12	20	46		18	8	5	19	21		18	10	24	20	28
	19	8	20	21	13		19	10	16	21	20		19	9	12	19	59		19	11	27	21	33
	20	9	18	21	41		20	11	21	21	59		20	10	20	20	44		20	12	23	22	41
Jan.	21	10	18	22	11	Feb.	21	12	29	22	45	Mar.	21	11	28	21	36	Apr.	21	13	10	23	50
	22	11	19	22	43		22	13	36	23	39		22	12	34	22	35		22	13	51	0	56*
	23	12	23	23	18		23	14	41	0	41*		23	13	34	23	40		23	14	26	2	0*
	24	13	29	24	0		24	15	39	1	49*		24	14	26	0	48*		24	14	58	3	2*
	25	14	38	0	50*		25	16	30	2	59*		25	15	11	1	57*		25	15	28	4	2*
Jan.	26	15	47	1	48*	Feb.	26	17	14	4	9*	Mar.	26	15	50	3	3*	Apr.	26	15	58	5	2*
	27	16	52	2	55*		27	17	52	5	16*		27	16	25	4	7*		27	16	29	6	1*
	28	17	49	4	7*		28	18	26	6	22*		28	16	56	5	10*		28	17	2	7	1*
	29	18	39	5	20*								29	17	27	6	11*		29	17	38	8	0*
	30	19	21	6	30*								30	17	57	7	12*		30	18	18	8	57*
Jan.	31	19	57	7	37*							Mar.	31	18	29	8	12*						

* Sets next Date

....Moonrise and Set for 1991....

PERTH

Latitude 31.95 S Longitude 115.85 E Ht. 0.000 m.

Std Long. 120.00 E

Date	Rise d	Rise h	Rise m	Set h	Set m	Date	Rise d	Rise h	Rise m	Set h	Set m	Date	Rise d	Rise h	Rise m	Set h	Set m	Date	Rise d	Rise h	Rise m	Set h	Set m
May.	1	19	3	9	51*	Jun.	1	20	30	10	39*	Jul.	1	21	12	10	13*	Aug.	1	22	57	10	15*
	2	19	53	10	40*		2	21	26	11	11*		2	22	8	10	41*		2	23	59	10	51*
	3	20	45	11	24*		3	22	22	11	41*		3	23	5	11	10*		3				
	4	21	41	12	4*		4	23	18	12	10*		4						4	1	4	11	33
	5	22	37	12	39*		5						5	0	4	11	40		5	2	10	12	23
May.	6	23	34	13	11*	Jun.	6	0	15	12	39	Jul.	6	1	5	12	14	Aug.	6	3	17	13	22
	7						7	1	14	13	9		7	2	10	12	53		7	4	20	14	29
	8	0	31	13	41		8	2	15	13	41		8	3	18	13	40		8	5	16	15	41
	9	1	29	14	10		9	3	20	14	19		9	4	27	14	36		9	6	6	16	54
	10	2	28	14	40		10	4	29	15	2		10	5	35	15	41		10	6	48	18	5
May.	11	3	29	15	12	Jun.	11	5	40	15	55	Jul.	11	6	37	16	52	Aug.	11	7	26	19	14
	12	4	34	15	47		12	6	50	16	57		12	7	31	18	7		12	8	0	20	21
	13	5	42	16	28		13	7	56	18	6		13	8	17	19	19		13	8	32	21	25
	14	6	53	17	17		14	8	54	19	19		14	8	56	20	29		14	9	5	22	27
	15	8	5	18	14		15	9	43	20	31		15	9	31	21	35		15	9	38	23	28
May.	16	9	13	19	18	Jun.	16	10	25	21	41	Jul.	16	10	3	22	39	Aug.	16	10	14	0	28*
	17	10	14	20	28		17	11	0	22	47		17	10	34	23	40		17	10	53	1	26*
	18	11	6	21	39		18	11	33	23	49		18	11	6	0	40*		18	11	37	2	21*
	19	11	50	22	48		19	12	3	0	50*		19	11	40	1	40*		19	12	25	3	12*
	20	12	27	23	53		20	12	34	1	49*		20	12	16	2	38*		20	13	16	3	58*
May.	21	13	0	0	56*	Jun.	21	13	5	2	48*	Jul.	21	12	56	3	34*	Aug.	21	14	11	4	39*
	22	13	31	1	57*		22	13	39	3	46*		22	13	41	4	27*		22	15	7	5	16*
	23	14	1	2	56*		23	14	16	4	44*		23	14	30	5	16*		23	16	4	5	49*
	24	14	31	3	55*		24	14	58	5	39*		24	15	22	6	1*		24	17	0	6	19*
	25	15	3	4	53*		25	15	44	6	31*		25	16	18	6	40*		25	17	57	6	48*
May.	26	15	38	5	52*	Jun.	26	16	34	7	19*	Jul.	26	17	14	7	15*	Aug.	26	18	54	7	17*
	27	16	16	6	49*		27	17	28	8	2*		27	18	11	7	47*		27	19	52	7	46*
	28	17	0	7	44*		28	18	24	8	39*		28	19	7	8	16*		28	20	51	8	18*
	29	17	47	8	35*		29	19	20	9	13*		29	20	3	8	45*		29	21	52	8	52*
	30	18	39	9	21*		30	20	16	9	44*		30	21	0	9	13*		30	22	56	9	32*
May.	31	19	34	10	2*							Jul.	31	21	57	9	43*	Aug.	31				

* Sets next Date

....Moonrise and Set for 1991....

PERTH

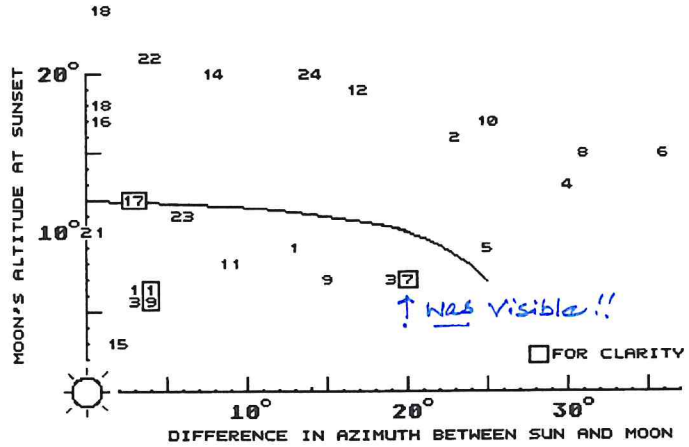
Latitude 31.95° S Longitude 115.85° E Ht. 0.00m.
Std Long. 120.00° E

Date		Rise	Set	Date		Rise	Set	Date		Rise	Set	Date		Rise	Set
	d	h m	h m		d	h m	h m		d	h m	h m		d	h m	h m
Sep.	1	0 1	10 19	Oct.	1	1 0	11 14	Nov.	1	1 53	13 35	Dec.	1	1 32	14 35
	2	1 6	11 13		2	1 52	12 22		2	2 26	14 38		2	2 5	15 36
	3	2 9	12 15		3	2 37	13 30		3	2 58	15 40		3	2 39	16 37
	4	3 6	13 23		4	3 17	14 38		4	3 30	16 42		4	3 17	17 36
	5	3 57	14 33		5	3 52	15 44		5	4 4	17 44		5	3 59	18 34
Sep.	6	4 41	15 44	Oct.	6	4 26	16 48	Nov.	6	4 40	18 46	Dec.	6	4 46	19 28
	7	5 20	16 53		7	4 58	17 52		7	5 20	19 46		7	5 36	20 18
	8	5 55	18 0		8	5 31	18 55		8	6 4	20 43		8	6 30	21 2
	9	6 28	19 5		9	6 6	19 58		9	6 52	21 36		9	7 25	21 41
	10	7 1	20 9		10	6 44	20 59		10	7 44	22 23		10	8 21	22 15
Sep.	11	7 35	21 12	Oct.	11	7 25	21 58	Nov.	11	8 38	23 5	Dec.	11	9 16	22 47
	12	8 10	22 14		12	8 11	22 54		12	9 34	23 43		12	10 11	23 16
	13	8 49	23 14		13	9 0	23 44		13	10 29	0 16*		13	11 5	23 44
	14	9 32	0 11*		14	9 53	0 30*		14	11 24	0 47*		14	12 0	0 12*
	15	10 18	1 4*		15	10 48	1 10*		15	12 20	1 16*		15	12 57	0 42*
Sep.	16	11 9	1 52*	Oct.	16	11 44	1 45*	Nov.	16	13 15	1 45*	Dec	16	13 56	1 15*
	17	12 2	2 35*		17	12 40	2 18*		17	14 13	2 14*		17	14 58	1 52*
	18	12 58	3 14*		18	13 36	2 48*		18	15 12	2 46*		18	16 4	2 36*
	19	13 54	3 48*		19	14 32	3 17*		19	16 14	3 22*		19	17 12	3 29*
	20	14 51	4 20*		20	15 29	3 47*		20	17 20	4 3*		20	18 20	4 30*
Sep.	21	15 47	4 49*	Oct.	21	16 28	4 18*	Nov.	21	18 28	4 51*	Dec.	21	19 23	5 39*
	22	16 45	5 19*		22	17 30	4 51*		22	19 37	5 48*		22	20 20	6 52*
	23	17 43	5 48*		23	18 34	5 29*		23	20 42	6 53*		23	21 9	8 5*
	24	18 42	6 19*		24	19 40	6 13*		24	21 41	8 2*		24	21 51	9 15*
	25	19 44	6 54*		25	20 48	7 4*		25	22 32	9 13*		25	22 28	10 22*
Sep.	26	20 48	7 33*	Oct.	26	21 54	8 2*	Nov.	26	23 16	10 22*	Dec.	26	23 2	11 26*
	27	21 54	8 18*		27	22 55	9 7*		27	23 54	11 28*		27	23 34	12 29*
	28	22 59	9 10*		28	23 49	10 15*		28				28		
	29				29				29	0 28	12 32		29	0 7	13 30
	30	0 2	10 9		30	0 36	11 23		30	1 1	13 34		30	0 41	14 31
				Oct.	31	1 17	12 30					Dec.	31	1 17	15 30

* Sets next Date

OBSERVING VERY THIN LUNAR CRESCENTS

Many calendars, both ancient and modern, begin their month with the first appearance of the Moon. To detect this first lunar crescent after conjunction requires good vision, a suitable climate and years of perseverance. The chart represents how visible a thin lunar crescent would appear from Perth in the year 1991. The numbers on the chart can be cross- referenced to the dates in the tabulated list. If a date falls below the line on the chart, the lunar crescent will not be visible. Alternatively a date above the line indicates a favourable sighting. The larger the difference the more favourable the sighting becomes. The tabulated list provides the date and the Moon's azimuth and altitude at sunset. Binoculars and a compass will be of great assistance.



LUNAR CRESCENT DATA (alt az @ Sunset.)

		d	o	o			d	o	o			d	o	o
1	Jan	17	258	9	9	May	15	307	7	17	Sep	9	273	12
2	Jan	18	268	16	10	May	16	317	17	18	Sep	10	274	24
3	Feb	16	274	7	11	Jun	13	306	8	19	Oct	8	259	6
4	Feb	17	285	13	12	Jun	14	314	19	20	Oct	9	261	18
5	Mar	18	293	9	13	Jul	12	299	6	21	Nov	7	250	10
6	Mar	19	305	15	14	Jul	13	304	20	22	Nov	8	254	21
– 7	Apr	16	301	7 –	15	Aug	10	286	3	23	Dec	7	249	11
8	Apr	17	313	15	16	Aug	11	289	17	24	Dec	8	256	20

Example: Point 7 Represents, Apr 16 ---> Not visible. ✗ wrong!
Point 8 Represents, Apr 17 ---> Favourable for viewing after Sunset.

Section 3

The SOLAR SYSTEM

PLANETARY APPEARANCES

PLANETARY DESCRIPTIONS

PLANETS

PHYSICAL DATA for PLANETS

PLANETARY SATELLITE DATA

COMETS

SATELLITES of JUPITER

DIARY

METEOR SHOWERS

EXPLANATION OF SECTION 3

APPEARANCE and PLANETARY DESCRIPTIONS

The appearance page gives the shapes of the planets as seen from the Earth at the given dates. Because of the rapidly changing aspects of Mercury and Venus, shapes are only given for the most suitable observing times.
The description page provides information about the Sun, as well as for Mercury, Venus, Earth, Mars, Jupiter and Saturn.

MERCURY and VENUS

The three pages on Mercury and Venus are in the same format as the information given for the superior planets and explained below. Geocentric phenomena are given but the Heliocentric phenomena for these inferior planets have been omitted because of limited interest. This information is available from Perth Observatory.

SUPERIOR PLANETS

The ephemerides of these planets are provided at 10, 20, or 30 day intervals. Column 1 is the date considered to be 0 hours E.T. This is followed by the Right Ascension and Declination for THAT DATE (NOT for Epoch 2000.0). The magnitude is followed by the apparent diameter of the planet in seconds of arc. Next is the distance from Earth in AU(Astronomical Units). The Elongation indicates whether the planet is to the East or West of the Sun. If it is East, the planet will be an evening object, but if West, it will be more easily viewed in the mornings. The four final columns are the rise and set times of the planet - first at 25°S and 120°E, and then for Perth. To calculate rise and set times for other locations, corrections for latitude and longitude must be made. Longitude corrections for various locations in WA are given in Section 5. Latitude corrections can be calculated from the following table.

CORRECTION TABLE FOR OBJECT SET TIMES (for rise times, reverse the sign)

		LATITUDE					
		-10°	-15°	-20°	-25°	-30°	-35°
DECLINATION OF OBJECT	+30°	+39m	+27m	+14m	0m	-15m	-32m
	+20°	+24	+16	+ 8	0	- 9	-20
	+10°	+12	+ 8	+ 4	0	- 4	- 9
	0°	0	0	0	0	0	0
	-10°	-12	- 8	- 4	0	+ 5	+10
	-20°	-25	-17	- 9	0	+10	+20

PHYSICAL DATA

The physical and orbital data are given for the major planets, and for all the known natural satellites - including those discovered at Neptune by Voyager 2.

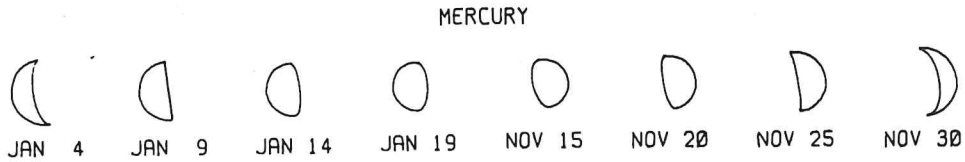
DIARY

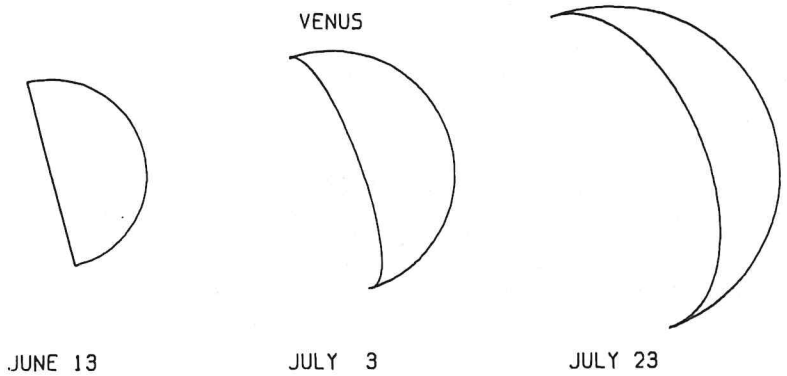
The diary of phenomena includes information on objects that appear to be close together in the sky, as well as times of other interesting occurences.

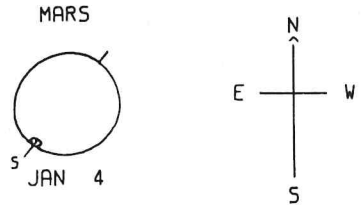
METEOR SHOWERS

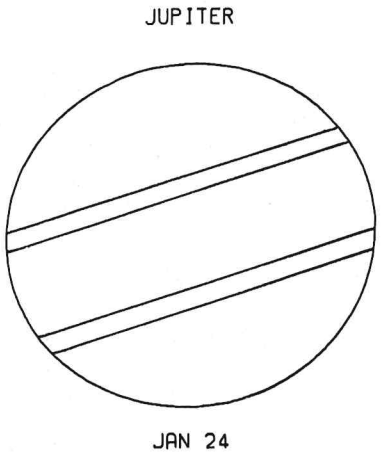
This table is a guide to the most important of the known periodic meteor showers. Observations of very bright meteors or fireballs are of interest if they are reported promptly to the Observatory. Please record accurate time, place of observation, direction of travel, colour, duration of sighting, and any sound heard.

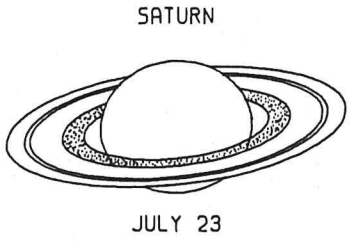
APPEARANCE OF THE PLANETS











DATE 0h ET

20 SECONDS OF ARC

Q78364-4

THE SUN AND INNER PLANETS

The Sun's interior is a vast nuclear furnace slowly converting hydrogen into helium. As this high energy radiation moves through the inner layers of the Sun it is absorbed and re-emitted many times. Perhaps 10 million years later it will reach the Sun's surface (photosphere) through heat convection. The interior of the Sun is about 15 million^{o}C but the surface that we observe is 5500^{o}C. As the Sun ages, different nuclear process will convert our ordinary yellow star into a red giant star. It will then become hotter, smaller and pass through a stage where it will become unstable (variable star) - finally ending up as a very dense white dwarf star. At present the Sun is 5000 million years old and is expected to take another 5000 million years to reach the white dwarf stage.

As we journey from this gravitational centre of our Solar System we first encounter the planet Mercury. Cratered and barely larger than our Moon this world rotates in 58.65 Earth days. As this is exactly two-thirds of its orbital period (87.97 days); one Mercurian day (sunrise to sunrise) lasts 176 days. The temperature at noon approaches 415^{o}C and since the planet has virtually no atmosphere it cools rapidly as night falls. Night temperature approaches -170^{o}C.

Venus is the next planet of the Solar System. The brilliant clouds and haze that cover this Earth sized planet mainly consist of highly reflective droplets of sulphuric acid in an atmosphere of carbon dioxide with a little water vapour. This atmosphere allows heat from the sun to warm its surface but any heat that is generated from the planet cannot escape. This is the commonly known as the "greenhouse effect". The mean surface temperature fluctuates only a few degrees from 455^{o}C during the day and night cycle. Venus rotates in a retrograde motion every 243.01 Earth days and has a surface pressure of 90 times that on the Earth at sea level.

The Earth is a dynamic living system that orbits the sun at a mean distance of one astronomical unit (149,597,870 km). The Earth's surface is blanketed by an atmosphere composed of approximately 78% nitrogen, 21%oxygen, 1%argon, 0.03% carbon dioxide and other gases. The "greenhouse gases" keep the planet from freezing while the upper atmospheric ozone, shield the Earth from ultraviolet radiation emitted from the Sun. A magnetic field generated by the Earth that forms a barrier (known as the Van Allen Belts) to the solar winds. However if these energetic particles (electrons and protons) enter the Earth's upper atmosphere through the magnetic poles they may give rise to an Aurora. As we look into the night sky we can occasionally see a "shooting star" (Meteor) . These objects are small particles from the solar system that enter the Earth's atmosphere at high speed and are vaporized due to frictional heating. If a meteor has sufficient mass to "land" on the Earth then its known as a meteorite. Many fine examples can be viewed in your local museum. The Moon is the Earth's only natural satellite.

Mars is the fourth planet from the Sun. Its atmosphere is thin (0.7% of Earth) and composed of about 95% carbon dioxide, 2.7% nitrogen, 1.6% argon and other gasses. The polar caps are a mixture of water ice and frozen carbon dioxide that shrink and expand as the "687 Earth day" season varies. The polar temperature goes down to -140^{o}C in mid-winter and up to 10^{o}C at the equator during mid-summer. The temperature falls rapidly at night to a -80^{o}C since the atmosphere is too thin to retain the daytime heat. One Martian day is 24.6 Earth hours long. Winds with velocities exceeding 300 km per hour cause vast dust storms for weeks on end. Extinct volcanoes and enormous canyons exist on Mars. Olympus Mons is the largest volcano so far known in the Solar System -an impressive height of 25 kilometres. On this dusty planet there are ancient water channels. In 1976 the Viking spacecraft detected no known life processes in the Martian soil samples. Phobos and Deimos are the two natural satellites of Mars.

JUPITER AND SATURN

One of the most rewarding planets to observe is Jupiter. This "noble planet" orbits the sun at a mean distance of 778.3 million kilometres. If all the other planets were put together, their combined mass would be slightly less than half that of Jupiter. The observable upper atmosphere features zones and belts. The zones are ammonia ice-crystal clouds and the darker belts are mainly ammonium hydrosulphide clouds. Below this exquisite disk lies the atmosphere of mainly hydrogen and helium with other compounds such as ammonia, methane and simple hydrocarbons. The small rocky core at the planet's centre is most likely encased in a thick mantle of metallic hydrogen. Jupiter's mean density is 1.33 grams per cubic centimetres. The observable disk is a dynamic system of zones, belts, dark spots, light spots, striations and interactions between the belts and zones by dark rifts and loops called festoons. The "Great Red Spot" appears as a salmon-coloured elliptical vortex in the southern tropical zone of the planet and is believed to be an upwelling of compounds from a disturbance below. Its colour and structure varies from year to year. The equatorial zone rotates in 9 hours and 50 minutes. Other zones rotate with periods increasing with latitude. Jupiter is the ruler of at least 16 moons. Io, Europa, Ganymede and Callisto are the four brightest satellites of Jupiter. The first large satellite we encounter is Io. Due to a gravitational effect between Jupiter and the satellite Europa, Io has become volcanically active. Sulphur and sulphurous compounds cover the landscape in hues of yellow, orange and white. Dark lava flows and active calderas are visible. In contrast Europa, is a smooth bright icy surface covered in cracks. The next moon we encounter is Jupiter's largest satellite, Ganymede. This heavily cratered moon has large dark areas separated by ridges and valleys of a lighter material. The final bright moon of Jupiter is Callisto, it's ice and rock surface completely covered by impact craters. It appears that Callisto is the oldest unaltered surface in the Solar System.

The next planet beyond Jupiter is the "ringed planet" Saturn. This beautiful world is one of the telescope's finest objects. The planet atmosphere is mainly composed of hydrogen with mixtures of methane, ammonia, phosphine, acetylene and ethane - the density of which is 0.70 grams per cubic centimetre. Saturn rotates once in 10 hours and 30 minutes (system II) and this combined with its gaseous nature produces a noticeable flattening of the polar regions. The equatorial diameter is 120,000 km. Clouds in this region are blown by 1800 kilometre per hour winds; four times faster than the equatorial winds of Jupiter. The ring system is mainly composed of billions of particles of water ice ranging in size from tiny specks to boulders kilometres across. For observers on the Earth the ring system seems to be composed of 3 parts, rings A,B and C. The closest ring to the planet is the "crepe" ring C, then bright ring B which is separated by the Cassini division and finally the bright ring A. Saturn has at least 18 satellites with Titan being the largest. Titan's atmosphere is mostly nitrogen at -180^{o}C.

OBSERVING THE GALILEAN SATELLITES

The charts provided within this handbook allow the "binocular" observer to locate the four brightest satellites of Jupiter. The central band represents the equatorial diameter of Jupiter's disk. The vertical time scale allow the observer to locate the relative positions of the satellites. All times are given in Universal time for compatibility. To convert to Western Australian Standard Time, add 8 hours.

PLANET AND STAR LOCATION

To locate a planet in the night sky it's Right Ascension (RA) and Declination (DEC) for a particular date is extracted from the tables within this handbook. This information is then cross referenced to a "Planisphere" for that date and time. The ecliptic line will be of assistance. The "Planisphere" principally identifies a star's location in the sky. This item is available for sale from the Perth Observatory. See the appropriate page in this handbook.

MERCURY 1991

		RA	(App't)	DEC	Mag	Diam	Dist AU	Elong		Long 120°E Lat 25°S Rise	Set	Perth W.A.S.T. Rise	Set
	d	h	m	o '		"			o	h m	h m	h m	h m
Jan	0	17	38.1	-20 11	+1.6	9.1	0.731	W	15	4 20	17 41	4 23	18 11
	10	17	43.8	21 11	- 0.1	7.2	0.926		23	3 44	17 12	3 46	17 43
	20	18	27.7	22 38	0.2	6.0	1.111		23	3 44	17 20	3 45	17 53
	30	19	26.0	22 40	0.2	5.4	1.248		20	4 3	17 40	4 4	18 12
Feb	9	20	30.1	20 41	0.4	5.0	1.338		15	4 32	18 0	4 34	18 30
	19	21	36.7	-16 28	- 0.9	4.8	1.384	W	9	5 8	18 18	5 14	18 45
Mar	1	22	45.0	9 57	1.6	4.9	1.374	E	2	5 50	18 34	6 0	18 57
	11	23	54.5	- 1 25	1.5	5.2	1.281		8	6 36	18 48	6 52	19 5
	21	0	58.8	+ 7 34	- 0.9	6.2	1.071		17	7 18	18 55	7 40	19 7
	31	1	38.4	13 24	+0.3	8.3	0.807		18	7 30	18 43	7 55	18 51
Apr	10	1	38.0	+13 22	+3.6	10.8	0.621	E	8	6 50	18 2	7 15	18 10
	20	1	15.7	8 46	3.9	11.6	0.576	W	9	5 40	17 10	6 2	17 21
	30	1	9.5	5 25	1.7	10.3	0.649		21	4 48	16 31	5 8	16 44
May	10	1	29.9	6 5	0.7	8.5	0.783		26	4 30	16 11	4 50	16 24
	20	2	10.4	9 52	+0.1	7.1	0.947		25	4 38	16 6	5 0	16 16
	30	3	8.0	+15 26	- 0.5	6.0	1.121	W	19	5 6	16 14	5 33	16 20
Jun	9	4	24.5	21 13	1.3	5.3	1.271	W	10	5 56	16 39	6 26	16 42
	19	5	57.7	24 41	2.2	5.1	1.322	E	3	6 57	17 26	7 31	17 26
	29	7	29.0	23 48	0.9	5.4	1.246		14	7 47	18 20	8 20	18 21
Jul	9	8	43.0	19 40	- 0.2	6.0	1.107		22	8 13	19 3	8 43	19 7
	19	9	37.7	+14 15	+0.2	7.0	0.954	E	26	8 17	19 29	8 43	19 36
	29	10	13.2	9 4	0.7	8.3	0.805		27	8 3	19 34	8 25	19 45
Aug	8	10	25.1	5 46	1.6	9.9	0.677		21	7 29	19 11	7 49	19 24
	18	10	7.5	6 27	3.7	10.9	0.611	E	8	6 34	18 11	6 54	18 24
	28	9	40.8	10 42	3.0	9.8	0.683	W	11	5 36	16 58	5 59	17 8
Sep	7	9	52.6	+12 51	+0.0	7.3	0.911	W	18	5 12	16 28	5 37	16 37
	17	10	47.5	9 27	- 1.0	5.7	1.177		14	5 21	16 52	5 43	17 3
	27	11	55.1	+ 2 25	1.4	5.0	1.348	W	6	5 36	17 34	5 54	17 49
Oct	7	12	59.4	- 5 20	1.3	4.7	1.415	E	3	5 46	18 13	5 59	18 33
	17	14	0.1	-12 25	0.7	4.7	1.411	E	9	5 54	18 48	6 2	19 13
	27	14	59.5	-18 21	- 0.4	4.9	1.354	E	15	6 2	19 20	6 6	19 49
Nov	6	15	58.5	22 45	0.3	5.4	1.245		19	6 12	19 49	6 13	20 21
	16	16	54.1	25 13	- 0.3	6.2	1.080		22	6 22	20 10	6 21	20 45
	26	17	31.9	25 17	+0.1	7.7	0.865		21	6 21	20 7	6 19	20 41
Dec	6	17	14.6	22 24	3.0	9.7	0.688	E	6	5 31	19 0	5 32	19 32
	16	16	28.7	-18 54	+1.0	8.8	0.758	W	15	4 14	17 29	4 17	17 59
	26	16	42.0	-19 57	- 0.2	6.8	0.976	W	22	3 44	17 8	3 48	17 38

GEOCENTRIC PHENOMENA
SEE NEXT PAGE

GEOCENTRIC PHENOMENA FOR MERCURY 1991

		d	h	o		d	h	o		d	h	o		d	h
Stationary	Jan	4	3		Apr	27	14		Aug	31	4		Dec	18	20
Greatest Elong.West	Jan	14	17	(24)	May	13	2	(26)	Sep	8	2	(18)	Dec	28	5
Superior Conjunction	Mar	2	11		Jun	17	13		Oct	4	1				
Greatest Elong.East	Mar	27	23	(19)	Jul	25	10	(27)	Nov	19	10	(22)			
Stationary	Apr	5	1		Aug	7	12		Nov	29	2				
Inferior Conjunction	Apr	15	5		Aug	22	5		Dec	8	23				

All times are in Western Australian Standard Time.

PLANETARY CONFIGURATIONS

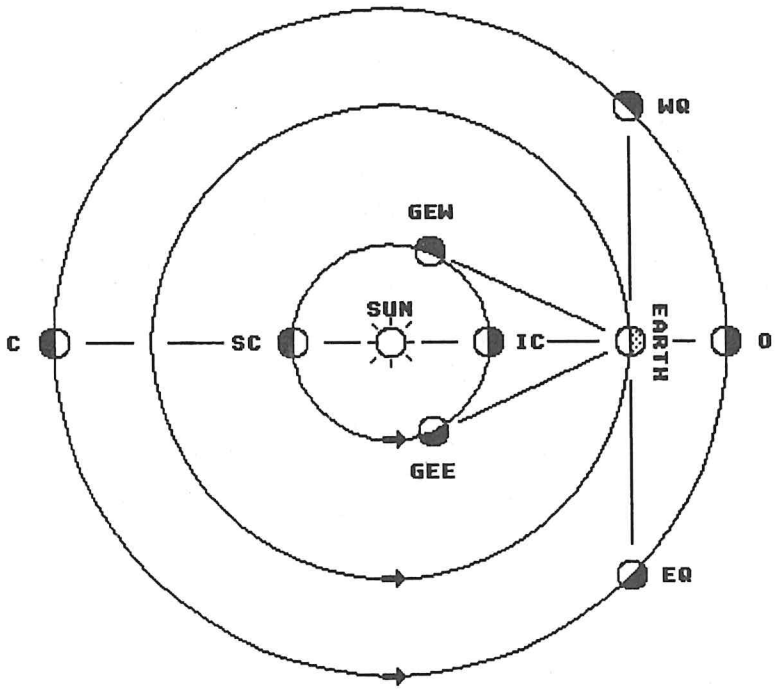
This simplified view of the Solar System shows the most significant planetary configurations. The planets that orbit between the Sun and the Earth are known as the "inferior" planets (Mercury, Venus) while the planets from Mars to Pluto are known as the "superior" planets.

"INFERIOR" PLANET

IC = Inferior Conjunction
GEW = Greatest Elongation West
SC = Superior Conjunction
GEE = Greatest Elongation East

"SUPERIOR" PLANET

O = Opposition
WQ = Western Quadrature
C = Conjunction
EQ = Eastern Quadrature



VENUS 1991

	d	RA h	(App't) m	DEC °	'	Mag	Diam "	Dist AU	Elong	°	Long 120°E Lat 25°S Rise h	m	Set h	m	Perth W.A.S.T. Rise h	m	Set h	m
Jan	0	19	42.3	- 22	38	- 3.9	10.3	1.637	E	14	6	18	19	54	6	19	20	26
	10	20	35.1	20	11	3.9	10.4	1.611		17	6	37	20	2	6	40	20	32
	20	21	25.9	16	45	3.9	10.6	1.581		19	6	55	20	5	7	1	20	33
	30	22	14.5	12	34	3.9	10.9	1.547		21	7	13	20	6	7	21	20	31
Feb	9	23	1.2	7	48	3.9	11.1	1.510		24	7	30	20	4	7	41	20	25
	19	23	46.6	- 2	43	- 3.9	11.5	1.468	E	26	7	45	20	0	8	0	20	18
Mar	1	0	31.3	+ 2	30	4.0	11.8	1.422		28	8	0	19	56	8	18	20	11
	11	1	15.9	7	38	4.0	12.3	1.372		30	8	15	19	51	8	36	20	3
	21	2	1.2	12	29	4.0	12.8	1.318		33	8	30	19	48	8	55	19	56
	31	2	47.6	16	51	4.0	13.4	1.259		35	8	46	19	46	9	13	19	52
Apr	10	3	35.4	+20	33	- 4.0	14.1	1.196	E	37	9	2	19	47	9	32	19	50
	20	4	24.5	23	22	4.1	14.9	1.129		39	9	18	19	51	9	50	19	51
	30	5	14.6	25	11	4.1	15.9	1.058		41	9	33	19	57	10	7	19	57
May	10	6	4.6	25	55	4.1	17.1	0.984		42	9	45	20	6	10	20	20	5
	20	6	53.6	25	31	4.2	18.5	0.907		44	9	54	20	17	10	28	20	16
	30	7	40.1	+24	6	- 4.2	20.3	0.828	E	45	9	57	20	27	10	30	20	27
Jun	9	8	23.2	21	49	4.3	22.5	0.747		45	9	56	20	36	10	27	20	38
	19	9	2.0	18	50	4.3	25.3	0.666		45	9	49	20	41	10	18	20	46
	29	9	35.5	15	26	4.4	28.7	0.585		44	9	36	20	42	10	2	20	49
Jul	9	10	2.6	11	50	4.4	33.1	0.507		42	9	17	20	37	9	41	20	46
	19	10	21.5	+ 8	24	- 4.5	38.7	0.434	E	38	8	50	20	22	9	11	20	34
	29	10	29.6	5	30	4.5	45.5	0.370		32	8	13	19	56	8	33	20	9
Aug	8	10	24.1	3	42	4.4	52.6	0.320		22	7	25	19	13	7	43	19	28
	18	10	5.3	3	31	4.1	57.7	0.291	E	11	6	26	18	15	6	45	18	30
	28	9	41.8	4	55	4.0	57.8	0.291	W	12	5	26	17	10	5	46	17	23
Sep	7	9	26.5	+ 6	56	- 4.3	52.9	0.318	W	23	4	35	16	12	4	56	16	24
	17	9	26.3	8	31	4.5	46.0	0.366		33	3	59	15	30	4	20	15	41
	27	9	40.3	9	10	4.6	39.4	0.427		39	3	34	15	4	3	56	15	15
Oct	7	10	4.5	8	45	4.5	34.0	0.495		43	3	18	14	50	3	40	15	1
	17	10	35.4	7	20	4.5	29.6	0.568		45	3	7	14	44	3	28	14	56
	27	11	10.7	+ 5	3	- 4.4	26.2	0.642	W	46	2	58	14	44	3	18	14	58
Nov	6	11	48.7	+ 2	3	4.3	23.4	0.718		46	2	51	14	49	3	9	15	4
	16	12	28.7	- 1	28	4.3	21.2	0.793		46	2	45	14	56	3	1	15	14
	26	13	10.3	5	18	4.3	19.4	0.867		45	2	40	15	5	2	53	15	26
Dec	6	13	53.6	9	13	4.2	17.9	0.939		44	2	37	15	17	2	47	15	39
	16	14	38.6	- 12	59	- 4.1	16.7	1.010	W	42	2	35	15	30	2	43	15	55
	26	15	25.7	- 16	24	- 4.1	15.6	1.078	W	41	2	36	15	44	2	41	16	12

* Indicates planet sets on the following date

GEOCENTRIC PHENOMENA

		d	h	°		d	h
GREATEST ELONG East	Jun	14	6	(45)			
GREATEST BRILLIANCY	Jul	17	13		Sep	29	7
STATIONARY	Jul	30	12		Sep	12	10
INFERIOR CONJUNCTION	Aug	23	4				
GREATEST ELONG West	Nov	2	17	(47)			

MARS 1991

		RA (App't)		DEC		Mag	Diam	Dist AU		Elong	Long 120°E Lat 25°S Rise		Set		Perth W.A.S.T. Rise		Set	
	d	h	m	o	'		"			o	h	m	h	m	h	m	h	m
Jan	0	3	39.7	+21	56	-1.1	14.0	0.671	E	139	15	42	2	19*	16	13	2	21*
	10	3	41.5	22	5	0.7	12.5	0.746		129	15	5	1	42*	15	37	1	44*
	20	3	48.1	22	26	0.4	11.3	0.831		120	14	33	1	9*	15	5	1	10*
	30	3	58.8	22	56	-0.1	10.2	0.922		113	14	6	0	39*	14	38	0	40*
Feb	9	4	12.8	23	30	+0.1	9.2	1.017		106	13	42	0	13*	14	14	0	13*
	19	4	29.4	+24	5	+0.3	8.4	1.116	E	100	13	20	23	49	13	53	23	49
Mar	1	4	48.1	24	36	0.5	7.7	1.216		94	13	1	23	27	13	34	23	27
	11	5	8.5	25	1	0.7	7.1	1.316		88	12	43	23	7	13	17	23	7
	21	5	30.2	25	17	0.9	6.6	1.416		83	12	26	22	49	13	0	22	48
	31	5	52.9	25	22	1.1	6.2	1.515		79	12	9	22	32	12	43	22	31
Apr	10	6	16.5	+25	15	+1.2	5.8	1.612	E	74	11	53	22	17	12	27	22	16
	20	6	40.5	24	54	1.3	5.5	1.706		70	11	37	22	2	12	11	22	2
	30	7	4.9	24	19	1.4	5.2	1.797		66	11	21	21	49	11	54	21	49
May	10	7	29.5	23	30	1.5	5.0	1.884		62	11	4	21	36	11	37	21	36
	20	7	54.1	22	26	1.6	4.8	1.968		58	10	47	21	23	11	19	21	25
	30	8	18.6	+21	8	+1.6	4.6	2.046	E	54	10	29	21	11	11	0	21	14
Jun	9	8	43.0	19	38	1.7	4.4	2.121		50	10	11	20	59	10	40	21	3
	19	9	7.1	17	55	1.7	4.3	2.190		47	9	52	20	48	10	20	20	53
	29	9	31.0	16	1	1.8	4.2	2.253		43	9	33	20	36	9	59	20	42
Jul	9	9	54.6	13	56	1.8	4.0	2.312		40	9	13	20	24	9	38	20	32
	19	10	18.1	+11	43	+1.8	4.0	2.364	E	36	8	52	20	13	9	16	20	22
	29	10	41.4	9	22	1.8	3.9	2.411		33	8	32	20	1	8	54	20	12
Aug	8	11	4.6	6	55	1.8	3.8	2.452		30	8	11	19	50	8	32	20	2
	18	11	27.8	4	23	1.8	3.8	2.487		26	7	50	19	38	8	9	19	52
	28	11	51.1	+1	47	1.8	3.7	2.516		23	7	29	19	27	7	47	19	43
Sep	7	12	14.6	-0	52	+1.7	3.7	2.539	E	20	7	8	19	16	7	24	19	33
	17	12	38.3	3	31	1.7	3.7	2.556		17	6	48	19	5	7	2	19	24
	27	13	2.5	6	9	1.7	3.6	2.567		13	6	27	18	55	6	40	19	16
Oct	7	13	27.2	8	44	1.6	3.6	2.572		10	6	8	18	45	6	19	19	8
	17	13	52.6	11	15	1.6	3.6	2.572		7	5	49	18	36	5	58	19	0
	27	14	18.6	-13	38	+1.5	3.6	2.566	E	4	5	31	18	27	5	38	18	53
Nov	6	14	45.5	15	53	1.5	3.7	2.555	E	1	5	14	18	19	5	20	18	47
	16	15	13.3	17	56	1.5	3.7	2.540	W	2	4	58	18	12	5	2	18	41
	26	15	42.0	19	46	1.5	3.7	2.519	W	5	4	43	18	5	4	46	18	35
Dec	6	16	11.7	21	19	1.5	3.8	2.494		8	4	30	17	59	4	32	18	30
	16	16	42.3	-22	32	+1.5	3.8	2.465	W	11	4	19	17	53	4	20	18	25
	26	17	13.7	-23	25	+1.4	3.8	2.433	W	14	4	8	17	47	4	9	18	20

* Indicates planet sets on the following date

GEOCENTRIC PHENOMENA

	d	h
STATIONARY	Jan 2	0
CONJUNCTION	Nov 8	17

HELIOCENTRIC PHENOMENA

	d
GREATEST N LATITUDE	May 2
APHELION	Jun 9
DESCENDING NODE	Nov 16

JUPITER 1991

		RA (App't)	DEC	Mag	Diam	Dist AU	Elong	Long 120°E Lat 25°S Rise	Long 120°E Lat 25°S Set	Perth W.A.S.T. Rise	Perth W.A.S.T. Set
	d	h m	o '		"		o	h m	h m	h m	h m
Jan	0	8 59.0	+17 49	-2.5	44.5	4.430	W 147	20 52	7 46*	21 20	7 51*
	10	8 54.7	18 9	2.6	45.2	4.360	158	20 9	7 2*	20 37	7 7*
	20	8 49.7	18 31	2.6	45.6	4.318	W 170	19 25	6 17*	19 54	6 21*
	30	8 44.4	18 53	2.6	45.7	4.307	E 179	18 42	5 31*	19 10	5 36*
Feb	9	8 39.0	19 14	2.6	45.5	4.328	167	17 58	4 46*	18 27	4 50*
	19	8 34.1	+19 33	-2.5	45.0	4.380	E 156	17 14	4 1*	17 43	4 5*
Mar	1	8 29.9	19 48	2.5	44.2	4.460	145	16 31	3 17*	17 1	3 21*
	11	8 26.8	19 59	2.4	43.1	4.565	134	15 49	2 35*	16 19	2 38*
	21	8 24.8	20 6	2.3	42.0	4.690	124	15 8	1 53*	15 38	1 57*
	31	8 24.2	20 7	2.3	40.8	4.830	114	14 28	1 13*	14 58	1 17*
Apr	10	8 24.9	+20 4	-2.2	39.5	4.982	E 104	13 50	0 35*	14 19	0 38*
	20	8 26.9	19 57	2.1	38.3	5.140	95	13 12	23 58	13 42	0 1*
	30	8 30.0	19 46	2.1	37.2	5.300	86	12 35	23 22	13 5	23 26
May	10	8 34.2	19 30	2.0	36.1	5.458	77	12 0	22 48	12 29	22 51
	20	8 39.4	19 11	1.9	35.1	5.611	69	11 25	22 14	11 54	22 18
	30	8 45.3	+18 48	-1.9	34.2	5.755	E 61	10 51	21 42	11 20	21 46
Jun	9	8 51.9	18 22	1.9	33.4	5.889	53	10 17	21 10	10 46	21 14
	19	8 59.1	17 53	1.8	32.8	6.009	45	9 44	20 39	10 12	20 44
	29	9 6.7	17 20	1.8	32.2	6.114	37	9 11	20 8	9 39	20 13
Jul	9	9 14.6	16 45	1.8	31.8	6.203	30	8 38	19 38	9 6	19 44
	19	9 22.9	+16 8	-1.7	31.4	6.273	E 22	8 6	19 8	8 33	19 14
	29	9 31.3	15 28	1.7	31.1	6.324	15	7 34	18 38	8 0	18 45
Aug	8	9 39.8	14 47	1.7	31.0	6.356	E 7	7 2	18 9	7 28	18 16
	18	9 48.4	14 4	1.7	30.9	6.367	W 1	6 29	17 39	6 55	17 47
	28	9 56.8	13 20	1.7	31.0	6.358	8	5 57	17 10	6 22	17 18
Sep	7	10 5.2	+12 36	-1.7	31.1	6.327	W 15	5 25	16 40	5 49	16 49
	17	10 13.4	11 52	1.8	31.4	6.277	23	4 52	16 11	5 16	16 20
	27	10 21.2	11 9	1.8	31.7	6.207	30	4 19	15 41	4 43	15 50
Oct	7	10 28.8	10 27	1.8	32.2	6.119	38	3 46	15 10	4 9	15 20
	17	10 35.9	9 47	1.8	32.8	6.013	46	3 12	14 39	3 35	14 50
	27	10 42.4	+ 9 10	-1.9	33.4	5.891	W 54	2 39	14 7	3 1	14 18
Nov	6	10 48.4	8 36	1.9	34.2	5.756	63	2 4	13 35	2 26	13 46
	16	10 53.6	8 7	2.0	35.1	5.610	72	1 29	13 2	1 51	13 13
	26	10 58.0	7 43	2.0	36.1	5.456	80	0 53	12 28	1 15	12 40
Dec	6	11 1.4	7 24	2.1	37.2	5.298	90	0 17	11 52	0 38	12 4
	16	11 3.8	+ 7 12	-2.2	38.3	5.140	W 99	23 36	11 12*	23 57	11 24*
	26	11 5.0	+ 7 8	-2.2	39.5	4.986	W 109	22 57	10 34*	23 18	10 46*

* Indicates planet sets on the following date

GEOCENTRIC PHENOMENA

	d	h
OPPOSITION	Jan 29	8
STATIONARY	Mar 30	22
CONJUNCTION	Aug 18	6

Dec 31 20

HELIOCENTRIC PHENOMENA

NONE in 1991

SATURN 1991

		RA (App't)		DEC		Mag	Diam	Dist AU		Elong	Long 120°E Lat 25°S Rise		Set		Perth W.A.S.T. Rise		Set	
	d	h	m	o	'		"			o	h	m	h	m	h	m	h	m
Jan	0	19	50.2	-21	10	+0.6	15.2	10.930	E	16	6	29	19	56	6	31	20	27
	10	19	55.1	20	58	0.6	15.2	10.964	E	7	5	55	19	21	5	57	19	52
	20	20	0.1	20	45	0.6	15.2	10.972	W	2	5	21	18	46	5	24	19	17
	30	20	5.1	20	31	0.6	15.2	10.954		11	4	47	18	11	4	50	18	42
Feb	9	20	10.0	20	17	0.6	15.3	10.911		20	4	13	17	36	4	16	18	7
	19	20	14.6	-20	3	+0.7	15.4	10.843	W	29	3	39	17	1	3	42	17	31
Mar	1	20	19.1	19	50	0.7	15.5	10.752		38	3	5	16	26	3	8	16	56
	11	20	23.1	19	37	0.7	15.6	10.640		47	2	30	15	50	2	33	16	20
	21	20	26.6	19	25	0.7	15.8	10.510		56	1	55	15	14	1	58	15	44
	31	20	30.0	19	15	0.7	16.1	10.365		65	1	19	14	37	1	23	15	7
Apr	10	20	32.7	-19	7	+0.7	16.3	10.209	W	74	0	43	14	0	0	46	14	30
	20	20	34.6	19	0	0.7	16.6	10.046		83	0	6	13	23	0	9	13	52
	30	20	36.3	18	56	0.6	16.9	9.879		93	23	24	12	41*	23	28	13	10*
May	10	20	37.1	18	54	0.6	17.1	9.714		102	22	46	12	2*	22	49	12	32*
	20	20	37.3	18	55	0.5	17.4	9.554		112	22	6	11	23*	22	10	11	53*
	30	20	36.8	-18	58	+0.5	17.7	9.405	W	122	21	26	10	43*	21	30	11	13*
Jun	9	20	35.6	19	3	0.4	18.0	9.271		131	20	46	10	3*	20	49	10	33*
	19	20	33.9	19	10	0.3	18.2	9.155		141	20	4	9	22*	20	8	9	52*
	29	20	31.7	19	20	0.3	18.4	9.063		151	19	23	8	41*	19	26	9	11*
Jul	9	20	29.1	19	30	0.2	18.5	8.995		162	18	40	7	59*	18	44	8	29*
	19	20	26.2	-19	41	+0.1	18.6	8.957	W	172	17	58	7	18*	18	1	7	48*
	29	20	23.1	19	52	0.1	18.6	8.947	E	178	17	15	6	36*	17	18	7	6*
Aug	8	20	20.1	20	3	0.2	18.6	8.967		168	16	32	5	54*	16	35	6	24*
	18	20	17.3	20	13	0.2	18.4	9.017		157	15	50	5	12*	15	52	5	42*
	28	20	14.7	20	22	0.2	18.3	9.094		147	15	7	4	30*	15	10	5	1*
Sep	7	20	12.7	-20	29	+0.3	18.1	9.195	E	137	14	26	3	49*	14	28	4	20*
	17	20	11.1	20	34	0.4	17.8	9.318		127	13	45	3	9*	13	47	3	39*
	27	20	10.2	20	37	0.4	17.6	9.459		117	13	5	2	29*	13	7	2	59*
Oct	7	20	10.0	20	38	0.5	17.3	9.613		107	12	25	1	49*	12	27	2	20*
	17	20	10.5	20	37	0.5	17.0	9.775		97	11	46	1	10*	11	49	1	41*
	27	20	11.7	-20	34	+0.6	16.7	9.941	E	87	11	8	0	32*	11	11	1	3*
Nov	6	20	13.5	20	28	0.6	16.5	10.105		78	10	31	23	55	10	34	0	25*
	16	20	16.0	20	21	0.6	16.2	10.264		68	9	54	23	17	9	57	23	48
	26	20	19.0	20	11	0.7	16.0	10.413		59	9	18	22	41	9	21	23	11
Dec	6	20	22.6	20	0	0.7	15.8	10.548		50	8	43	22	5	8	46	22	35
	16	20	26.5	-19	46	+0.7	15.6	10.665	E	41	8	8	21	29	8	11	21	59
	26	20	30.6	-19	32	+0.7	15.5	10.762	E	31	7	33	20	53	7	37	21	23

* Indicates planet sets on the following date

GEOCENTRIC PHENOMENA

		d	h
CONJUNCTION	Jan	18	16
STATIONARY	May	17	19
OPPOSITION	Jul	27	8
STATIONARY	Oct	5	10

HELIOCENTRIC PHENOMENA

NONE in 1991

URANUS 1991

		RA (App't)		DEC		Mag	Diam	Dist AU	Elong		Long 120°E Lat 25°S Rise		Set		Perth W.A.S.T. Rise		Set	
	d	h	m	o	'		"			o	h	m	h	m	h	m	h	m
Jan	0	18	42.2	-23	24	+6.1	3.4	20.428	W	1	5	16	18	53	5	17	19	26
	10	18	44.8	23	22	6.1	3.4	20.417		9	4	40	18	16	4	40	18	49
	20	18	47.3	23	19	6.1	3.4	20.379		19	4	3	17	39	4	3	18	12
	30	18	49.8	23	16	6.1	3.4	20.313		28	3	26	17	2	3	27	17	35
Feb	9	18	52.0	23	14	6.1	3.4	20.222		38	2	49	16	25	2	50	16	58
	19	18	54.1	-23	11	+6.1	3.4	20.109	W	47	2	12	15	48	2	13	16	20
Mar	1	18	55.9	23	9	6.1	3.4	19.976		57	1	35	15	10	1	35	15	43
	11	18	57.5	23	7	6.1	3.5	19.828		67	0	57	14	32	0	57	15	5
	21	18	58.7	23	6	6.0	3.5	19.669		76	0	19	13	54	0	19	14	27
	31	18	59.5	23	5	6.0	3.5	19.503		86	23	37	13	12*	23	37	13	44*
Apr	10	19	0.0	-23	5	+6.0	3.5	19.335	W	96	22	58	12	33*	22	58	13	5*
	20	19	0.2	23	5	6.0	3.6	19.170		106	22	19	11	54*	22	19	12	26*
	30	18	59.9	23	5	6.0	3.6	19.013		115	21	39	11	14*	21	39	11	47*
May	10	18	59.4	23	6	6.0	3.6	18.868		125	20	59	10	34*	20	59	11	7*
	20	18	58.4	23	8	6.0	3.7	18.740		135	20	19	9	54*	20	19	10	26*
	30	18	57.3	-23	10	+5.9	3.7	18.633	W	145	19	38	9	13*	19	39	9	46*
Jun	9	18	55.8	23	12	5.9	3.7	18.549		155	18	57	8	33*	18	58	9	5*
	19	18	54.2	23	14	5.9	3.7	18.493		165	18	16	7	52*	18	17	8	25*
	29	18	52.5	23	16	5.9	3.7	18.464	W	175	17	35	7	11*	17	35	7	44*
Jul	9	18	50.8	23	19	5.9	3.7	18.465	E	175	16	54	6	30*	16	54	7	3*
	19	18	49.0	-23	21	+5.9	3.7	18.495	E	165	16	13	5	49*	16	13	6	22*
	29	18	47.4	23	23	5.9	3.7	18.554		155	15	32	5	8*	15	32	5	41*
Aug	8	18	46.0	23	24	6.0	3.7	18.639		145	14	51	4	27*	14	51	5	0*
	18	18	44.8	23	25	6.0	3.7	18.748		135	14	10	3	47*	14	11	4	20*
	28	18	43.8	23	26	6.0	3.6	18.879		125	13	30	3	7*	13	30	3	40*
Sep	7	18	43.2	-23	27	+6.0	3.6	19.026	E	116	12	50	2	27*	12	50	3	0*
	17	18	42.9	23	27	6.0	3.6	19.186		106	12	11	1	47*	12	11	2	20*
	27	18	43.0	23	27	6.0	3.5	19.354		96	11	31	1	8*	11	32	1	41*
Oct	7	18	43.5	23	26	6.0	3.5	19.526		87	10	53	0	29*	10	53	1	2*
	17	18	44.3	23	25	6.1	3.5	19.695		77	10	14	23	51	10	14	0	24*
	27	18	45.5	-23	24	+6.1	3.4	19.859	E	67	9	36	23	13	9	36	23	45
Nov	6	18	47.0	23	22	6.1	3.4	20.011		58	8	58	22	35	8	59	23	7
	16	18	48.8	23	20	6.1	3.4	20.148		48	8	21	21	57	8	21	22	30
	26	18	50.9	23	18	6.1	3.4	20.266		38	7	44	21	20	7	44	21	52
Dec	6	18	53.1	23	15	6.1	3.4	20.362		29	7	7	20	43	7	7	21	15
	16	18	55.5	-23	12	+6.1	3.3	20.433	E	19	6	30	20	5	6	30	20	38
	26	18	58.1	-23	8	6.1	3.3	20.477	E	10	5	53	19	29	5	54	20	1

* Indicates planet sets on the following date

GEOCENTRIC PHENOMENA

	d	h		d	h
STATIONARY	Apr 18	20	Sep	19	17
OPPOSITION	Jul 4	15			

HELIOCENTRIC PHENOMENA

NONE in 1991

NEPTUNE 1991

	d	RA (App't) h	m	DEC °	'	Mag	Diam "	Dist AU		Elong °	Long 120°E Lat 25°S Rise h	m	Set h	m	Perth W.A.S.T. Rise h	m	Set h	m
Jan	0	19	0.8	-21	55	+7.9	2.3	31.181	E	5	5	39	19	9	5	41	19	40
	20	19	4.0	21	50	7.9	2.4	31.153	W	14	4	24	17	53	4	25	18	25
Feb	9	19	7.0	21	45	7.9	2.4	31.012		34	3	8	16	37	3	10	17	9
Mar	1	19	9.5	21	41	7.9	2.4	30.776		54	1	52	15	21	1	54	15	53
	21	19	11.3	21	38	7.9	2.4	30.471		73	0	36	14	4	0	37	14	36
Apr	10	19	12.2	-21	36	+7.9	2.4	30.133	W	93	23	14	12	42*	23	16	13	14*
	30	19	12.1	21	36	7.9	2.5	29.801		112	21	56	11	24*	21	57	11	55*
May	20	19	11.2	21	37	7.9	2.5	29.513		132	20	36	10	4*	20	38	10	36*
Jun	9	19	9.5	21	40	7.9	2.5	29.302		151	19	16	8	44*	19	17	9	15*
	29	19	7.4	21	43	7.9	2.5	29.194	W	171	17	55	7	23*	17	56	7	55*
Jul	19	19	5.1	-21	47	+7.9	2.5	29.199	E	169	16	34	6	3*	16	35	6	34*
Aug	8	19	3.0	21	51	7.9	2.5	29.319		150	15	13	4	42*	15	14	5	14*
	28	19	1.4	21	54	7.9	2.5	29.538		130	13	52	3	22*	13	54	3	54*
Sep	17	19	0.5	21	56	7.9	2.5	29.832		111	12	33	2	3*	12	34	2	34*
Oct	7	19	0.5	21	56	7.9	2.4	30.166		91	11	14	0	44*	11	16	1	16*
	27	19	1.5	-21	55	+7.9	2.4	30.502	E	71	9	57	23	26	9	58	23	58
Nov	16	19	3.4	21	53	7.9	2.4	30.801		52	8	40	22	10	8	41	22	41
Dec	6	19	6.0	21	50	7.9	2.4	31.027		32	7	24	20	53	7	26	21	25
	26	19	9.0	-21	45	+7.9	2.4	31.155	E	13	6	9	19	38	6	10	20	9

GEOCENTRIC PHENOMENA

		d	h
CONJUNCTION	Jan	5	11
STATIONARY	Apr	19	7
OPPOSITION	Jul	8	8

HELIOCENTRIC PHENOMENA

	d	h
Sep	26	13

NONE in 1991

PLUTO 1990

	d	RA (App't) h	m	DEC °	'	Mag	Diam "	Dist AU		Elong °	Long 120°E Lat 25°S Rise h	m	Set h	m	Perth W.A.S.T. Rise h	m	Set h	m
Jan	0	15	24.5	- 3	13	+13.7	0.0	30.274	W	51	2	40	14	56	2	55	15	14
	30	15	27.1	3	11	13.7	0.0	29.827		80	0	45	13	0	1	0	13	19
Mar	1	15	27.9	3	0	13.7	0.0	29.335		109	22	44	10	59*	22	59	11	17*
	31	15	26.7	2	43	13.7	0.0	28.928		137	20	46	8	59*	21	1	9	18*
Apr	30	15	24.1	2	27	13.7	0.0	28.715	W	161	18	46	6	58*	19	1	7	16*
May	30	15	21.0	- 2	17	+13.7	0.0	28.751	E	155	16	45	4	57*	17	0	5	15*
Jun	29	15	18.4	2	18	13.7	0.0	29.022		129	14	45	2	56*	14	59	3	15*
Jul	29	15	17.3	2	29	13.7	0.0	29.454		102	12	45	0	58*	13	0	1	16*
Aug	28	15	17.9	2	49	13.7	0.0	29.939		74	10	47	23	1	11	2	23	20
Sep	27	15	20.4	3	14	13.7	0.0	30.356		47	8	51	21	6	9	5	21	25
Oct	27	15	24.2	- 3	39	+13.7	0.0	30.603	E	22	6	56	19	13	7	10	19	32
Nov	26	15	28.7	3	59	13.7	0.0	30.617	W	19	5	2	17	20	5	16	17	40
Dec	26	15	32.9	- 4	10	+13.7	0.0	30.389	W	44	3	8	15	27	3	22	15	46

GEOCENTRIC PHENOMENA

		d	h
STATIONARY	Feb	25	22
OPPOSITION	May	10	11
CONJUNCTION	Nov	13	12

HELIOCENTRIC PHENOMENA

	d	h
Aug	3	3

NONE in 1991

* Indicates planet sets on the following date

MAJOR PLANETS - Physical data

Planet	Mass x 10^{24} kg	Radius (equ.) Km	Angular Diameter "	Minimum Distance from Earth A.U.	Geometric flattening	Mean density g/cm3
Mercury	0.33022	2439	11.0	0.613	0.0	5.43
Venus	4.8690	6052	60.2	0.277	0.0	5.24
Earth	5.9742	6378.140	-	-	0.00335281	5.515
Mars	0.64191	3397	17.9	0.524	0.0051865	3.94
Jupiter	1898.8	71398	46.8	4.203	0.0648088	1.33
Saturn	568.40	60000	19.4	8.539	0.1076209	0.70
Uranus	86.978	26000	3.9	18.182	0.030	1.30
Neptune	102.78	24200	2.0	29.06	0.0259	1.76
Pluto	0.015	1223	0.1	38.44	0.0	1.4

At least 7 planetary moons are bigger than Pluto.
av. T ~ -39°F = - ° C.

	Sidereal period of rotation d	Inclination of Equator to Orbit o	Geometric Albedo	Visual Magnitude V(1,0)	V0
Mercury	58.6462	0.0	0.106	-0.42	-
Venus	-243.01	177.3	0.65	-4.40	-
Earth	0.99726968	23.45	0.367	-3.86	-
Mars	1.02595675	25.19	0.150	-1.52	-2.01
Jupiter	0.41354(system II)	3.12	0.52	-9.40	-2.70
Saturn	0.4375(system II)	26.73	0.47	-8.88	+0.67
Uranus	-0.65	97.86	0.51	-7.19	+5.52
Neptune	0.669	29.56	0.41	-6.87	+7.84
Pluto	-6.3867	118	0.3	-1.0	+15.12

NOTE: Negative sign denotes retrograde motion

MEAN ORBITAL ELEMENTS

Planet	Dist.from Sun A.U.	Period of Rev (sidereal) P	Eccent e	Inclin i	Long of Node o	Long of Peri-helion o	Mean Long at Epoch,L o
Mercury	0.387	87.97d	0.206	7.0	48.2	77.3	116.5
Venus	0.723	224.70d	0.007	3.4	76.6	131.4	314.0
Earth	1.000	365.26d	0.017	0.0	0.0	102.8	99.7
Mars	1.524	686.98d	0.093	1.8	49.5	335.9	72.3
Jupiter	5.203	11.86yr	0.048	1.3	100.4	14.2	121.0
Saturn	9.539	29.46yr	0.056	2.5	113.6	92.9	299.9
Uranus	19.182	84.01yr	0.047	0.8	74.0	170.5	274.6
Neptune	30.058	164.79yr	0.009	1.8	131.7	44.5	285.1
Pluto	39.439	247.69yr	0.250	17.2	109.9	224.2	181.6

These elements are for epoch Jan 0.5 ET, 1991.
Reference: Handbook of the British Astronomical Association - 1991

PLANETARY SATELLITE DATA

Planet	Satellite	Distance A.U.*10^{-3}	Period days	Radius km	Magnitude	Albedo
Earth						
	Moon	2.570	27.322	1738	- 12.7	0.12
Mars						
	I Phobos	0.063	0.319	13.5x10.8x9.4	11.3	0.06
	II Deimos	0.157	1.262	7.5x 6.1x 5.5	12.4	0.07
Jupiter						
	I Io	2.821	1.769	1815	5.0	0.61
	II Europa	4.486	3.551	1569	5.3	0.64
	III Ganymede	7.153	7.155	2631	4.6	0.42
	IV Callisto	12.589	16.689	2400	5.65	0.20
	V Almalthea	1.210	0.498	135x83x75	14.1	0.05
	VI Himalia	76.749	250.566	93	14.84	0.03
	VII Elara	78.467	259.653	38	16.77	0.03
	VIII Pasiphae	157.0	735(r)	25	17.03	
	IX Sinope	158.0	758(r)	18	18.3	
	X Lysithea	78.354	259.22	10	18.4	
	XI Carme	151.0	692(r)	20	18.0	
	XII Ananke	142.0	631(r)	15	18.9	
	XIII Leda	74.169	238.72	5	20.2	
	XIV Thebe	1.484	0.6745	55x45	15.6	0.05
	XV Adrastea	1.862	0.2983	12.5x10x7.5	19.1	0.05
	XVI Metis	0.856	0.2948	20	17.5	0.05
Saturn						
	I Mimas	1.24	0.9424	196	12.9	0.5
	II Enceladus	1.59	1.3702	250	11.7	1.0
	III Tethys	1.97	1.8878	530	10.2	0.9
	IV Dione	2.52	2.7369	560	10.4	0.7
	V Rhea	3.52	4.5175	765	9.7	0.7
	VI Titan	8.17	15.9454	2575	8.3	0.21
	VII Hyperion	9.90	21.2766	205x130x110	14.19	0.3
	VIII Iapetus	23.81	79.3302	730	11.1	0.2
	IX Phoebe	86.59	550.48(r)	110	16.5	0.06
	X Janus	1.01	0.6945	110x100x80	14	0.8
	XI Epimetheus	1.01	0.6942	70x60x50	15	0.8
	XII Helene	2.52	2.7369	18x16x15	18	0.7
	XIII Telesto	1.97	1.8878	17x14x13	18.5	0.5
	XIV Calypso	1.97	1.8878	17x11x11	18.7	0.6
	XV Atlas	0.92	0.6019	20x10	18	0.9
	XVI Prometheus	0.93	0.6130	70x50x40	16	0.6
	XVII Pomdora	0.95	0.6285	55x45x35	16	0.9
	XVIII 1981S13			10		

r indicates retrograde motion .

PLANETARY SATELLITE DATA

Planet	Satellite	Distance A.U.*10^{-3}	Period days	Radius km	Magnitude	Albedo
Uranus						
	I Ariel	1.28	2.5204	579	14.2	0.34
	II Umbriel	1.78	4.1442	586	14.8	0.18
	III Titania	2.91	8.7059	790	13.73	0.27
	IV Oberon	3.90	13.4632	762	13.94	0.24
	V Miranda	0.86	1.4135	240	16.3	0.27
	VI Cordelia	0.33	0.3350	25		
	VII Ophelia	0.36	0.3764	25		
	VIII Bianca	0.40	0.4346	25		
	IX Cressida	0.41	0.4636	30		
	X Desdemona	0.42	0.4737	30		
	XI Juliet	0.43	0.4931	40		
	XII Portia	0.44	0.5132	40		
	XIII Rosalind	0.47	0.5585	30		
	XIV Belinda	0.50	0.6235	25		
	XV Puck	0.57	0.7618	85		
Neptune						
	I Triton	2.37	5.8768(r)	1750	13.47	
	II Nereid	36.84	360.2	200	18.7	
	1989N1	0.78	1.12	210	20	
	1989N2	0.49	0.55	100	22	
	1989N3	0.35	0.40	80	23	
	1989N4	0.41	0.33	70	23	
	1989N5	0.33	0.31	45		
	1989N6	0.32	0.30	25		
Pluto				600.	Discovered in 1978.	
	I Charon	0.13	6.3872	1200	16.8	

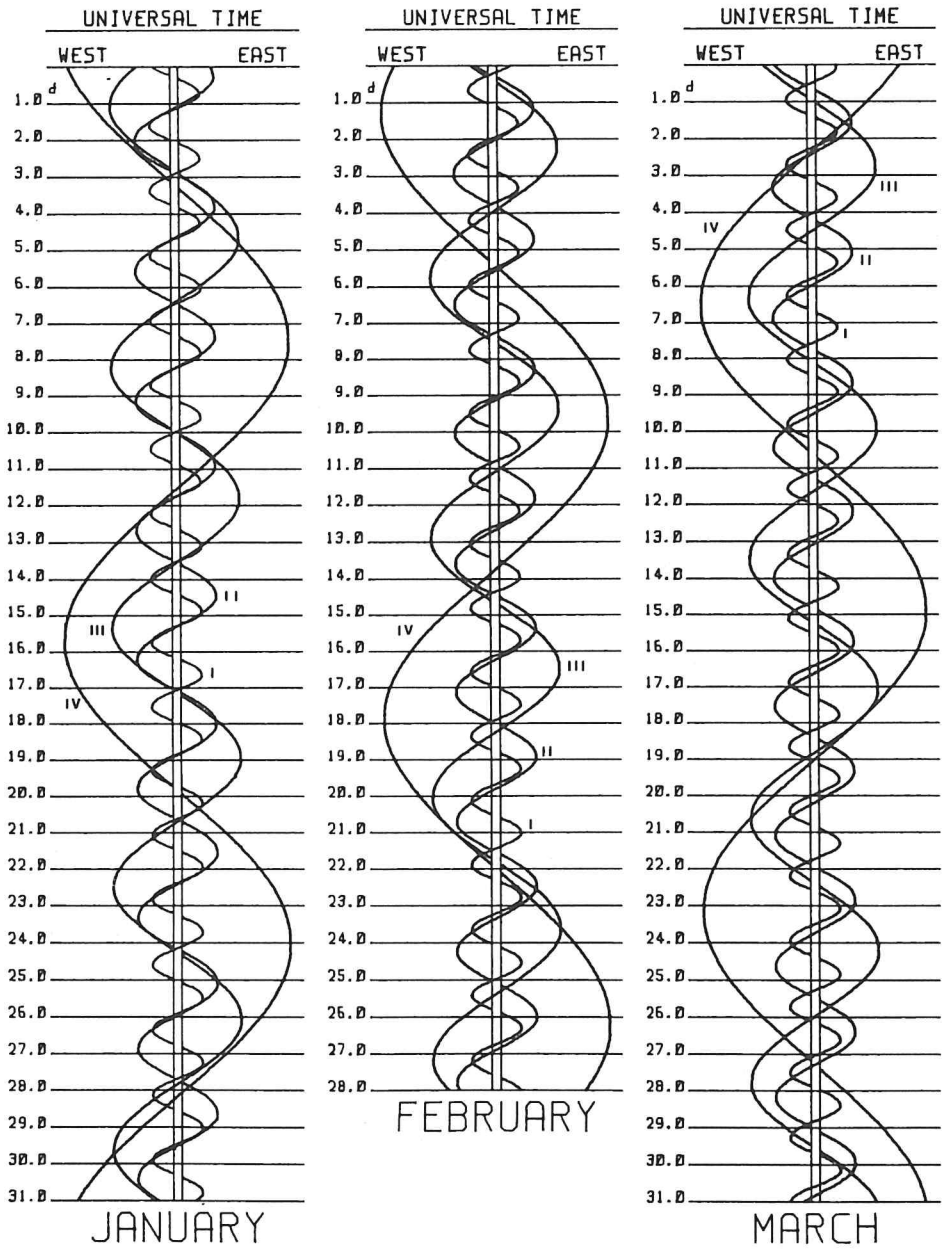
Diam ~ 745 mi. = ~ 1200 Km)
(Pluto ~ 1400 mi = 2250 km)

r indicates retrograde motion .

COMETS

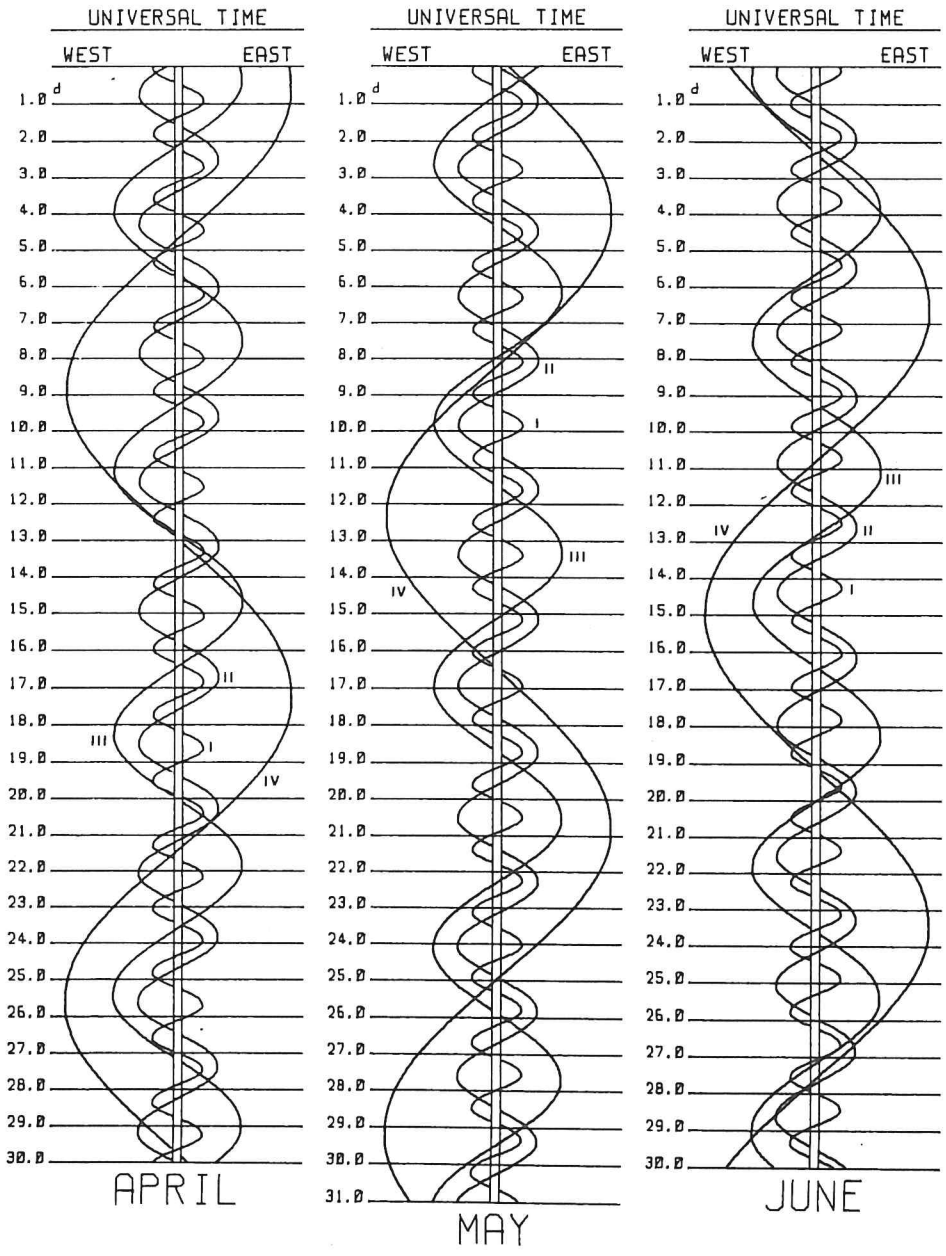
There are three comets predicted bright enough to be seen in small instruments as they pass through perihelion during 1991. All are during our winter, and attain maximum brightness while well north. None appears to be particularly exciting. If a new bright comet is discovered, or if one of the faint periodic comets gets unusually bright, there will be press and media coverage. Organisations or amateurs interested in such phenomena should keep in touch with the Perth Observatory from time to time to check such details. Ephemerides can be provided for any comet.

SATELLITES OF JUPITER (I-IV)



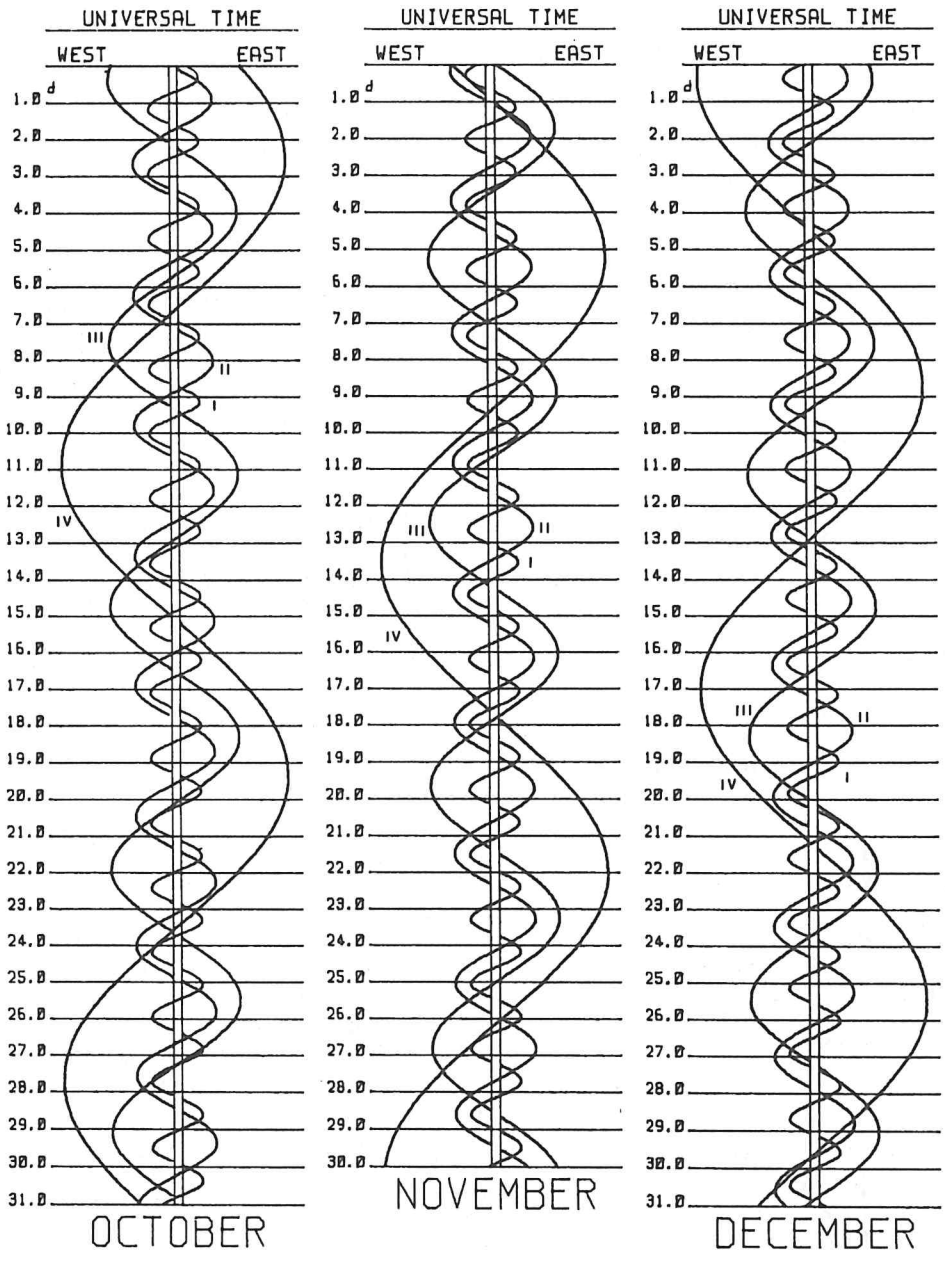
I = IO II = EUROPA III = GANYMEDE IV = CALLISTO

SATELLITES OF JUPITER (I-IV)



I = IO II = EUROPA III = GANYMEDE IV = CALLISTO

SATELLITES OF JUPITER (I-IV)



I = IO II = EUROPA III = GANYMEDE IV = CALLISTO

DIARY OF PHENOMENA FOR 1991

d	h	January
1	3	FULL MOON
1	23	Venus 1.°2 S of Saturn
3	7	Jupiter 2° N of Moon
3	11	Earth at Perihelion
8	3	LAST QUARTER
12	11	Antares 0.°6 S of Moon
14	4	Mercury 4° N of Moon
16	8	SOLAR ECLIPSE - NEW MOON
18	2	Venus 3° S of Moon
18	16	Saturn in Conjunction with Sun
23	22	FIRST QUARTER
24	1	Mercury 0.°4 N of Uranus
25	23	Mars 2° S of Moon
26	22	Mercury 1.°1 S of Neptune
29	8	Jupiter at Opposition
30	13	Jupiter 1.°8 N of Moon
30	14	FULL MOON

d	h	February
6	0	Mercury 1.°2 S of Saturn
6	22	LAST QUARTER
8	19	Antares 0.°7 S of Moon
11	12	Uranus 1.°1 N of Moon
11	19	Neptune 1.°9 N of Moon
13	2	Saturn 0.°5 N of Moon
15	2	NEW MOON
17	10	Venus 6° S of Moon
22	7	FIRST QUARTER
22	16	Mars 8° N of Aldebaran
22	21	Mars 1.°6 S of Moon
26	17	Jupiter 1.°6 N of Moon

d	h	March
1	2	FULL MOON
8	3	Antares 0.°8 S of Moon
8	19	LAST QUARTER
10	23	Uranus 0.°9 N of Moon
11	5	Neptune 1.°8 N of Moon
12	16	Saturn 0.°9 S of Moon
16	16	NEW MOON
17	23	Mercury 5° S of Moon
19	8	Venus 5° S of Moon
21	11	EQUINOX
23	1	Mars 0.°7 S of Moon
23	14	FIRST QUARTER
25	21	Jupiter 1.°6 N of Moon
30	15	FULL MOON

d	h	April
4	11	Antares 1.°1 S of Moon
7	8	Uranus 0.°6 N of Moon
7	14	Neptune 1.°5 N of Moon
7	15	LAST QUARTER
9	5	Saturn 1.°4 S of Moon
15	4	NEW MOON
18	0	Venus 2° S of Moon
20	8	Mars 0.°6 N of Moon
21	21	FIRST QUARTER
22	3	Jupiter 1.°9 N of Moon
22	12	Venus 7° N of Aldebaran
29	5	FULL MOON

~24 00h Regulus 3°N of Moon.

d	h	May
4	16	Uranus 0.°3 N of Moon
4	22	Neptune 1.°2 N of Moon
6	15	Saturn 1.°8 S of Moon
7	9	LAST QUARTER
10	11	Pluto at Opposition
12	21	Mercury 9° S of Moon
14	13	NEW MOON
16	13	Mars 5° S of Pollux
17	15	Venus 1.°6 N of Moon
18	18	Mars 2° N of Moon
19	15	Jupiter 2° N of Moon
21	4	FIRST QUARTER
28	20	FULL MOON
31	9	Venus 4° S of Pollux
31	21	Uranus 0.°2 N of Moon

d	h	June
1	4	Neptune 1.°1 N of Moon
2	22	Saturn 2° S of Moon
5	23	LAST QUARTER
12	20	NEW MOON
14	13	Mars 0.°6 N of Jupiter
16	4	Venus 4° N of Moon
16	6	Jupiter 3° N of Moon
16	8	Mars 4° N of Moon
18	7	Venus 1.°2 N of Jupiter
19	12	FIRST QUARTER
22	5	SOLSTICE
23	20	Venus 0.°3 N of Mars
27	11	FULL MOON
28	1	Uranus 0.°3 N of Moon
28	8	Neptune 1.°1 N of Moon
30	2	Saturn 2° S of Moon

DIARY OF PHENOMENA FOR 1991

July

d	h	
1	6	Mercury 5° S of Pollux
4	15	Uranus at Opposition
5	11	LAST QUARTER
6	23	Earth at Aphelion
8	8	Neptune at Opposition
11	16	Venus 1° S of Regulus
12	3	NEW MOON
13	22	Mercury 3° N of Moon
14	1	Jupiter 3° N of Moon
14	23	Mars 5° N of Moon
15	0	Mars 0.°7 N of Regulus
15	2	Venus 3° N of Moon
15	16	Mercury 0.°08 S of Jupiter
17	13	Venus greatest brilliancy
18	23	FIRST QUARTER
22	14	Venus 4° S of Mars
25	5	Uranus 0.°4 N of Moon
27	2	FULL MOON
		PENUMBRAL ECLIPSE
27	4	Saturn 1.°9 S of Moon
27	8	Saturn at Opposition
27	9	Mercury 2° S of Regulus

August

3	19	LAST QUARTER
7	14	Mercury 2° N. of Venus
10	10	NEW MOON
11	15	Venus 3° S of Moon
11	16	Mercury 0.°6 S of Moon
12	16	Mars 6° N of Moon
17	8	Venus 9° S. of Regulus
17	13	FIRST QUARTER
18	6	Jupiter in Conjunction with Sun
21	10	Uranus 0.°4 N of Moon
21	18	Neptune 1.°2 N of Moon
23	7	Saturn 1.°8 S of Moon
25	17	FULL MOON
29	13	Mercury 6° N of Venus

September

2	2	LAST QUARTER
7	1	Venus 5° S of Moon
7	13	Mercury 3° N of Moon
7	19	Jupiter 5° N of Moon
8	19	NEW MOON
10	10	Mars 6° N of Moon
10	16	Jupiter 0.°4 N of Regulus
10	18	Mercury 0.°07 S of Jupiter
10	18	Mercury 0.°3 N of Regulus
16	6	FIRST QUARTER
17	17	Uranus 0.°2 N of Moon
18	1	Neptune 1° N of Moon
19	12	Saturn 1.°8 S of Moon
23	21	EQUINOX
24	7	FULL MOON
29	7	Venus greatest brilliancy

October

d	h	
1	8	LAST QUARTER
4	23	Venus 0.°2 N of Moon
5	13	Jupiter 5° N of Moon
6	8	Mars 3° N. of Spica
8	6	NEW MOON
8	12	Venus 3° S of Regulus
15	2	Uranus 0.°06 S of Moon
15	10	Neptune 0.°7 N of Moon
16	2	FIRST QUARTER
16	20	Saturn 2° S of Moon
17	11	Venus 2° S of Jupiter
23	19	FULL MOON
30	15	LAST QUARTER

November

2	4	Jupiter 6° N of Moon
3	5	Venus 6° N of Moon
6	19	NEW MOON
8	13	Mercury 0.°7 N of Moon
8	17	Mars in Conjunction with Sun
11	11	Uranus 0.°4 S of Moon
11	15	Mercury 2° N of Antares
11	19	Neptune 0.°4 N of Moon
13	6	Saturn 2° S of Moon
13	12	Pluto in Conjunction with Sun
14	22	FIRST QUARTER
22	7	FULL MOON
28	23	LAST QUARTER
29	16	Jupiter 6° N of Moon
29	17	Venus 4° N of Spica

December

2	22	Venus 8° N of Moon
6	12	NEW MOON
8	22	Uranus 0.°6 S of Moon
9	4	Neptune 0.°2 N of Moon
10	18	Saturn 3° S of Moon
11	23	Mars 4° N of Antares
14	0	Mercury 3° N of Mars
14	18	FIRST QUARTER
16	6	Mercury 8° N of Antares
21	14	Mercury 7° N of Antares
21	18	FULL MOON
		PARTIAL ECLIPSE
22	17	SOLSTICE
27	1	Jupiter 7° N of Moon
28	10	LAST QUARTER

SOUTHERN METEOR SHOWERS FOR 1991

Date of Max	Name	Normal Limits	ZHR	R.A. h m	DEC. o	
Apr 12	VIRGINIDS	Mar to Apr	5	14 4 (211)	- 9	* 1
		Apr 7 - Apr 18	5	13 36 (204)	-11	
May 5	η AQUARIDS	Apr 24 - May 20	35	22 20 (335)	- 1	* 2
Apr 28	α SCORPIDS	Apr 20 - May 19	5	16 32 (248)	-24	* 3
May13				16 4 (241)	-24	
Jun 10	OPHIUCHIDS	May 19 - July	5	17 56 (269)	-23	* 4
Jun 20				17 20 (260)	-20	
Jul 8	CAPRICORNIDS	July to August	5			
Jul 15				20 44 (311)	-15	* 5
Jul 26				21 0 (315)	-15	
Jul 29	δ AQUARIDS	July 15 - Aug 20	20	22 36 (339)	-17	* 6
Aug 7			10	23 4 (346)	+ 2	
Jul 31	PISCIS AUSTRALIDS	July 15 - Aug 20	5	22 40 (340)	-30	* 7
Aug 2	α CAPRICORNIDS	July 15 - Aug 25	5	20 36 (309)	-10	* 8
Aug 6	ι AQUARIDS	July - August	8	22 10 (333)	-15	* 9
				22 4 (331)	- 6	
Sep 9	PISCIDS	Sept. to October	10	0 36 (9)	+ 7	*10
Sep 21			5	0 24 (6)	+ 0	
Oct 13			?	1 44 (26)	+14	
Oct 22	ORIONIDS	Oct 16 - Oct 27	25	6 24 (96)	+15	*11
Nov 3	TAURIDS	Oct 20 - Nov 30	8	3 44 (56)	+14	*12
				3 44 (56)	+22	
Nov 18	LEONIDS	Nov 15 - Nov 20	10	10 8 (152)	+22	*13
Dec 9	PUPPIDS -	Nov 27 - Jan 9	15	9 0 (135)	-48	*14
Dec 26	VELIDS			9 20 (140)	-65	
Dec 14	GEMINIDS	Dec 7 - Dec 16	75	7 28 (112)	+32	

NOTES: ZHR denotes Zenith Hourly Rate.

(1) . Several radiants in Virgo active March / April. Slow long paths.
(2) . Best southern shower. Has a broad maximum and multiple radiant. Associated with Comet Halley.
(3) . Part of the Scorpio- Sagittariid complex. Many radiants April to July.
(4) . Weak activity from several radiants.
(5) . Bright meteors. Probably has three maxima / multiple radiant.
(6) . Double radiant. Main peak from S : N. component has broad maximum. Rich in faint meteors. Very favourable.
(7) . May have two maxima. Little is known about this shower.
(8) . Has splendid slow yellow fireballs. Probably has three maxima.
(9) . Rich in faint meteors. Double radiant. Active and bright in 1990.
(10). Several radiants in Pisces and Aries at this time with low rates.
(11). Swift with fine trains. Associated with comet Halley.
(12). Activity near maximum for about ten days. Rich in fireballs. Slow yellow meteors. Associated with Comet Encke.
(13). Swift bright meteors with fine trains.
(14). Two of several radiants present in Puppis, Vela and Carina

Section 4

STARS

ASTRONOMICAL PHOTOGRAPHY

The BRIGHTEST STARS

The NEAREST STARS

Some BRIGHT DOUBLE STARS

STANDARD STARS

NONSTELLAR ASTRONOMICAL OBJECTS

CHARTS

EXPLANATION OF SECTION 4

ALL POSITIONS ARE GIVEN FOR EQUINOX 2000.0

BRIGHTEST and NEAREST STARS

Tables of the brightest and nearest stars are given. All of the brighter stars are visible to the naked eye, although some of the more northern stars will not always be available from these latitudes. Apparent and absolute magnitudes are given - for an explanation of the magnitude scale it is recommended that the observer consult an astronomy textbook.

DOUBLE STARS

These stars are useful to amateur astronomers as they give an indication of the resolving power of a telescope. Given is the star name and position, followed by the apparent visual magnitude of each component. Most should be visible in a small telescope. Following spectral type is the angular separation, which can be used to test various eyepieces for resolution. Last is the position angle with North = 0 degrees.

STANDARD STARS

These standard stars are given to enable enthusiasts to calibrate any photometry, and to give an idea of the variation of spectral types of brighter stars. They are also useful for accurate setting of telescope circles, as most of these stars should be visible to the naked eye.

NONSTELLAR ASTRONOMICAL OBJECTS

Two pages of these objects are given - most should be visible in a small telescope. The best viewing of these will be on moonless nights as many of the objects are extended. The Mvis column indicates visual magnitude, and is only an estimate.

CHARTS

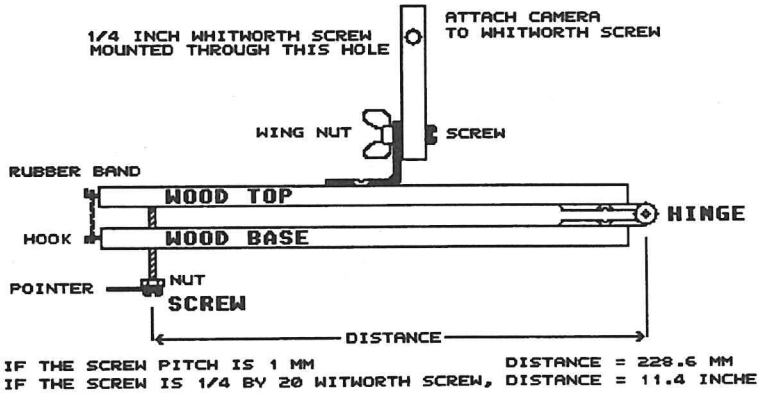
Four pages of charts of popular Southern Hemisphere areas are included. These can be useful in identifying areas, and are suitable for use with binoculars. The "all sky" charts from previous editions have been omitted. Comments and suggestions on the usefulness of these charts are invited.

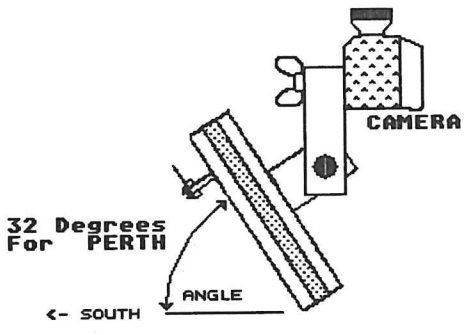
The pages on the Messier Catalogue and the Variable stars have been omitted for 1991. Please contact Perth Observatory if a copy is needed.

For any enquiries about the use of these pages, contact Perth Observatory (293 8255)

ASTROPHOTOGRAPHY

To compensate for the Earth's rotation in astrophotography, G.Y. HAIG invented the ingenious "Scotch mount". This simple low cost device will allow the astrophotographer to produce wide field photographs of the night sky using an ordinary camera. The camera must be of a short focal length type (~50mm or less), having an aperture setting of f/2.8 or less and be capable of time exposures. The mount consists of two boards joined via a hinge. At a predetermined length from the center of the hinge, a drive screw is self-tapped through a slightly undersized hole in the base board. A simple "universal joint" mechanism is constructed on the top board, allowing the camera to be positioned to any part of the sky. The two boards are held together via an elastic band. See basic diagram. The drive screw is manually turned at the same rate as the sweep-second hand of a watch. To align the mount, the center of the hinge is aligned due south, and tilted from the horizontal to your equivalent latitude. (ignore the sign of the latitude). The mount is now ready to operate. The stars rise in the east and set in the west so the drive screw must be turned at one revolution per minute in the correct direction to compensate for this motion. Exposure times up to 20 minutes can be taken before tangential arm effects come into play.





It is recommended that a film speed of 400 ASA or faster is used for dark sky photography of the Milky Way. The exposure times are dependent on the speed of the film, the lens and the local sky conditions. Ten minutes would a good starting point.

Meteor photography requires a high speed film and a dark sky. Point the camera near a known radiant and expose the film for at least 15 minutes.
The original article for the Scotch mount is described in the April, 1975 issue of SKY & TELESCOPE, page 263.

The Brightest Stars

Star Name	R.A. (2000) h	m	Dec o	'	Magnitude Apparent	Abs	Spectral Type	Parallax "	Distance l.y.
Sun					-26.7	+4.8	G2		
Sirius	6	45.1	-16	43	-1.47	+1.41	A1	0.377	8.7
Canopus	6	24.0	-52	42	-0.71	-2.5	F0	0.028	74
Rigil Kent	14	39.6	-60	50	-0.27	+4.1	G2	0.750	4.3
Arcturus	14	15.7	+19	11	-0.04	+0.2	K2	0.097	34
Vega	18	36.9	+38	47	+0.03	+0.6	A0	0.133	25
Capella	5	16.7	+46	0	+0.08	+0.12,0.37	G8,G0	0.080	41
Rigel	5	14.5	-8	12	+0.12	-8.1	B8	0.013	1400
Procyon	7	39.3	+5	14	+0.38	+2.6	F5	0.285	11
Achernar	1	37.7	-57	14	+0.46	-1.3	B5	0.026	69
Betelgeuse	5	55.2	+7	24	+0.50(var)	-7.2	M2	0.005	1400
Hadar	14	3.8	-60	22	+0.61	-4.4	B1	0.009	320
Acrux	12	26.6	-63	6	+0.76	-4.6	B2	0.008	510
Altair	19	50.8	+8	52	+0.77	+2.3	A7	0.202	16
Aldebaran	4	35.9	+16	31	+0.85	-0.3	K5	0.054	60
Antares	16	29.4	-26	26	+0.96	-5.2	M1	0.024	520
Spica	13	25.2	-11	10	+0.98	-3.2	B1	0.023	220
Pollux	7	45.3	+28	2	+1.14	+0.7	K0	0.094	40
Fomalhaut	22	57.7	-29	37	+1.16	+2.0	A3	0.149	22
Mimosa	12	47.7	-59	41	+1.25	-4.7	B0		460
Deneb	20	41.4	+45	17	+1.25	-7.2	A2	0.000	1500
Regulus	10	8.4	+11	58	+1.35	-0.3	B7	0.045	69
Adhara	6	58.6	-28	58	+1.50	-4.8	B2	0.001	570
Castor	7	34.6	+31	53	+1.57	0.5	B2	0.067	49
Gacrux	12	31.2	-57	7	+1.63	-1.2	M3		120
Shaula	17	33.6	-37	6	+1.63	-3.5	B1		330

APPARENT MAGNITUDE :The brightness of a star as seen by an observer. The magnitude system is logarithmic based around five magnitudes being the equivalent of one hundred times the brightness.

ABSOLUTE MAGNITUDE :The magnitude a star would appear to have if it were ten parsecs away.

SPECTRAL TYPE :The result of classifying stars according to their spectral lines.

PARALLAX :Half the angle through which a star appears to be displaced when the Earth moves from one side of the Sun to the other - it is inversely proportional to the distance to the star.

The Nearest Stars

Star Name	R.A. (2000) h	m	Dec °	'	Parallax "	Dist l.y.	Spect Type	Magnitude App't	Abs't
Sun							G2	-26.7	4.8
Proxima Cen	14	30.0	-62	40	0.772	4.2	M5	11.0	15.5
α Cen A	14	39.6	-60	50	0.750	4.3	G2	0.0	4.4
α Cen B	14	39.6	-60	50	0.750	4.3	K1	1.3	5.7
Barnard's Star	17	57.9	+ 4	41	0.547	6.0	M5	9.5	13.2
Wolf 359	10	56.7	+ 7	0	0.419	7.8	M8	13.5	16.6
Lal 21185	11	3.4	+35	58	0.398	8.2	M2	7.5	10.5
UV Cet (A)	1	38.8	-17	57	0.382	8.5	M5	12.5	15.5
UV Cet (B)	1	38.8	-17	57	0.382	8.5	M5	13.0	16.0
Sirius A	6	45.1	-16	43	0.376	8.7	A1	- 1.5	1.4
Sirius B	6	45.1	-16	43	0.376	8.7	A5	8.3	11.2
Ross 154	18	49.7	-23	49	0.342	9.5	M6	10.6	13.1
Ross 248	23	41.9	+44	10	0.314	10.4	M6	12.3	14.8
ε Eri	3	32.9	- 9	28	0.307	10.6	K2	3.7	6.1
Ross 128	11	47.6	+ 0	48	0.302	11.1	M5	11.1	13.5
L 789-6	22	38.4	-15	18	0.294	11.1	M7	12.2	14.5
BD +43°44 A	0	18.1	+44	0	0.291	11.2	M1	8.1	10.4
BD +43°44 B	0	18.1	+44	0	0.291	11.2	M1	11.1	13.4
61 Cyg A	21	6.9	+38	45	0.291	11.2	K5	5.2	7.6
61 Cyg B	21	6.9	+38	45	0.291	11.2	K7	6.0	8.4
BD +59°1915A	18	42.9	+59	37	0.290	11.2	M4	8.9	11.2
BD +59°1915B	18	42.9	+59	37	0.290	11.2	M4	9.7	11.9
ε Ind	22	3.4	-56	47	0.290	11.2	K3	4.7	7.0
τ Ceti	1	44.1	-15	56	0.287	11.7	G8	3.5	5.7
Lac 9352	23	5.9	-35	51	0.286	11.9	M1	7.4	9.6
Procyon A	7	39.3	+ 5	14	0.285	11.4	F5	0.4	2.6
Procyon B	7	39.3	+ 5	14	0.285	11.4	DF	10.8	13.0
G51-15	8	29.9	+26	46	0.276	11.8	M7	14.8	17.0
YZ Cet	1	12.4	-16	59	0.268	12.1	M5	12.0	14.1
BD + 5°1668	7	27.4	+ 5	13	0.266	12.3	M4	9.8	11.9
Kapteyn's star	5	11.2	-45	1	0.260	12.5	M0	8.8	10.9
Lac 8760	21	17.3	-38	52	0.260	12.5	K6	6.7	8.7
Kruger 60 A	22	28.1	+57	42	0.253	12.9	M3	9.8	11.9
Kruger 60 B	22	28.1	+57	42	0.253	12.9	M5	11.3	13.3
BD -12°4523	16	30.3	-12	39	0.245	13.3	M4	10.1	12.1
Ross 614 A	6	29.3	- 2	48	0.242	13.5	M5	11.1	13.1
Ross 614 B	6	29.3	- 2	48	0.242	13.5	M5	14	16
Wolf 424 A	12	33.4	+ 9	1	0.233	14.0	M5	13.1	15.0
Wolf 424 B	12	33.4	+ 9	1	0.233	14.0	M5	13.4	15.2
van Maanen	0	49.0	+ 5	23	0.231	14.1	DB	12.4	14.2
TZ Ari	2	0.2	+13	3	0.223	14.6	M5	12.3	14.1
HD 225213	0	5.1	-37	21	0.223	14.6	M2	8.6	10.3
CD -46°11540	17	28.6	-46	54	0.221	14.8	M3	9.4	11.0
L 145-141	11	45.4	-64	49	0.219	14.9	DC	11.5	13.1
CD-49°13515	21	33.5	-49	0	0.217	15.1	M2	8.7	10.3
BD+68°946	17	36.5	+68	20	0.216	15.1	M3	9.1	10.8

SOME BRIGHT DOUBLE STARS

Star	Coordinates R.A. (2000.0)	Dec.	apparent visual magnitude	spectral type	angular sep. in arcsec	position angle in degrees
35 Pisc	$0^h15.0^m$	+ 8° 49′	5.9, 7.6	FO	11″.8	148°
65 Pisc	0 49.9	+27 42	6.3, 6.3	FO, FO	4.4	296
37 Ceti	1 14.4	- 7 55	5.2, 7.8	FO, G	49.6	331
γ Arietis	1 53.6	+19 17	4.8, 4.8	AOP, AOP	8.2	359
66 Ceti	2 12.8	- 2 24	5.7, 7.7	GO	16.3	232
θ Eridani	2 58.2	-40 19	3.4, 4.4	A2, A2	8.5	88
α Fornax	3 12.0	-29 0	4.0, 7.0	dF5	1.6	298
32 Eri	3 54.4	- 2 58	4.9, 6.3	gG4, A1	7.0	348
39 Eri	4 14.4	-10 15	5.1, 8.9	gK2	6.4	147
β 744	4 21.5	-25 44	6.6, 6.6	dF2	0.7	280
β Ori	5 14.5	- 8 12	0.3, 6.7	B8, B5	9.5	203
λ Ori	5 35.2	+ 9 56	3.7, 5.6	08, B2	4.4	42
υ' CMa	6 36.4	-18 39	5.8, 7.9	gG3, dA8	17.5	263
38 Gem	6 54.6	+13 11	4.7, 7.4	dA8, dG4	6.9	150
γ Vol	7 8.6	-70 29	3.9, 5.8	KO, GO	13.8	299
δ Gem	7 20.1	+22 1	3.5, 8.1	dA8, dK6	6.8	211
γ Vel	8 9.5	-47 20	2.2, 4.8	OW9, B3	41.0	220
h.4104	8 29.2	-47 56	5.7, 7.9	B5	3.4	245
ξ' Ant	9 30.7	-31 52	6.3, 7.2	AO, AO	8.2	211
Δ 81	9 54.3	-45 17	5.9, 8.0	B5	5.0	240
α Leo	10 8.4	+11 59	1.3, 7.6	B6, dK1	176.5	307
h.4383	10 53.9	-70 43	6.6, 7.2	B8, B8	1.7	284
H III 96	11 32.3	-29 15	5.8, 5.9	dF6, dF7	9.2	209
β Hya	11 53.0	-33 54	5.0, 5.4	B9	1.0	6
h.4498	12 6.4	-65 42	6.2, 7.9	F5, A3	8.7	60
δ Crv	12 29.9	-16 30	3.1, 9.2	AO, dK2	24.0	218
84 Vir	13 43.1	+ 3 33	5.6, 8.2	gK3, dG5	3.2	228
Rmk 18	13 52.1	-52 48	5.7, 7.7	B8, A3	18.0	290
h.4690	14 37.2	-46 7	5.5, 8.9	G7, A	19.0	26
HN 28	14 57.4	-21 22	5.8, 8.9	dK5, dM2	22.0	302
Σ 1910	15 7.6	+ 9 14	7.3, 7.4	dG5, dG5	4.4	211
γ Circ	15 23.4	-59 19	5.2, 5.3	B5, F8	1.1	42
β Sco	16 5.4	-19 48	2.9, 5.1	B2, B3	14.0	23
ν Sco	16 12.0	-19 28	4.3, 6.5	B3, A	41.0	336
ρ Oph	16 25.6	-23 26	5.2, 5.9	B5, B5	3.2	345
o Oph	17 18.1	-24 18	5.4, 6.9	gK1, dF5	10.1	354
61 Oph	17 44.7	+ 2 36	6.2, 6.6	AO, AO	20.0	94
21 Sgr	18 25.4	-20 32	5.0, 8.3	gK1, AO	1.8	287
59 Ser	18 27.2	+ 0 12	5.3, 7.8	GO, A2	4.0	318
β Sgr	19 22.6	-44 27	4.2, 7.1	B8, A3	28.0	76
Δ 227	19 52.7	-54 59	6.1, 6.8	G5, A2	23.0	148
Σ 2644	20 12.6	+ 0 51	6.8, 7.1	AO, AO	3.0	207
γ Del	20 46.7	+16 8	4.5, 5.5	gK1, dF6	10.0	268
12 Aqr	21 4.1	- 5 50	5.9, 7.3	gG4, A3	2.7	194
λ Oct	21 50.3	-82 44	5.5, 7.6	G5, A3	3.1	69
δ Tuc	22 27.3	-64 58	4.8, 9.2	B9	7.0	282
ξ Aqr	22 28.9	- 0 2	4.4, 4.6	dF2, dF1	1.9	261
94 Aqr	23 19.1	-13 28	5.6, 7.6	dG4, dK3	13.0	350
Σ 3009	23 24.3	+ 3 42	6.8, 8.8	gK2, dF4	7.2	230

STANDARD STARS FROM +25° TO -40°

BS-HR No.	Name	R.A. (2000)	Dec	V	U-B	B-V	V-R	V-I	Spectral Type
39	88 Peg	0h13m.2	+15° 11'	2.84	-0.86	-0.23	-0.10	-0.29	B2 IV
45	89 Peg	0 14.6	+20 12	4.80	+1.93	+1.57	+1.34	+2.47	M2 III
437	99 Psc	1 31.5	+15 21	3.62	+0.74	+0.97	+0.72	+1.22	G8 III
553	6 Ari	1 54.6	+20 48	2.65	+0.10	+0.13	+0.14	+0.22	A5 V
617	13 Ari	2 7.2	+23 28	2.00	+1.13	+1.15	+0.84	+1.46	K2 IIIab
718	73 Cet	2 28.2	+ 8 28	4.29	-0.11	-0.06	+0.02	-0.03	B9 III
753		2 36.1	+ 6 53	5.82	+0.79	+0.97	+0.83	+1.36	K3 V
875		2 56.6	- 3 43	5.17	+0.05	+0.08	+0.11	+0.16	A1 V
996	96 Cet	3 19.4	+ 3 22	4.84	+0.19	+0.68	+0.57	+0.93	G5 V
1144	18 Tau	3 45.2	+24 50	5.65	-0.36	-0.07	+0.03	-0.04	B8 V
1165	25 Tau	3 47.5	+24 6	2.87	-0.35	-0.09	+0.03	-0.01	B7 III
1172		3 48.3	+23 25	5.45	-0.32	-0.07	+0.05	-0.01	B8 V
1346	54 Tau	4 19.8	+15 38	3.65	+0.81	+0.99	+0.73	+1.20	K0-IIIak
1373	61 Tau	4 22.9	+17 33	3.76	+0.82	+0.99	+0.73	+1.20	K1 III
1409	74 Tau	4 28.6	+19 11	3.54	+0.87	+1.01	+0.73	+1.23	K1 III
1412	78 Tau	4 28.7	+15 52	3.39	+0.12	+0.18	+0.18	+0.27	A7 III
1552	3 Ori	4 51.2	+ 5 36	3.68	-0.81	-0.16	-0.05	-0.21	B2 III
1666	67 Eri	5 7.8	- 5 5	2.79	+0.10	+0.13	+0.14	+0.22	A3 III
1781		5 22.7	+ 0 10	5.70	-0.88	-0.21	-0.08	-0.27	B2 V
1855	36 Ori	5 31.9	- 7 18	4.62	-1.07	-0.26	-0.12	-0.38	B0 V
2010	134Tau	5 49.5	+12 39	4.91	-0.16	-0.07	+0.02	-0.06	B9 IV
2382	12 Mon	6 32.3	+ 4 51	5.83	+0.78	+1.00	+0.72	+1.25	K0 III
2421	24 Gem	6 37.7	+16 24	1.92	+0.05	0.00	+0.06	+0.05	A0 IV
2693	25 CMa	7 8.4	-26 24	1.84	+0.54	+0.67	+0.51	+0.84	F8 Ia
2763	54 Gem	7 18.1	+16 32	3.58	+0.09	+0.12	+0.12	+0.17	A3 V
2782	3 CMa	7 18.7	-24 34	4.50	-0.99	-0.15	-0.04	-0.22	O9 Ib
2787		7 18.6	-36 45	4.67	-0.79	-0.10	+0.10	+0.05	B3 Ve
3249	17 Cnc	8 16.5	+ 9 11	3.53	+1.77	+1.48	+1.12	+1.90	K4 III
3314		8 25.7	- 3 54	3.90	-0.03	-0.02	+0.03	-0.02	A0 V
3454	7Hya	8 43.2	+ 3 24	4.30	-0.74	-0.20	-0.07	-0.26	B4 V
3982	32 Leo	10 8.4	+11 58	1.35	-0.36	-0.11	-0.02	-0.12	B7 V
4031	36 Leo	10 16.7	+23 25	3.44	+0.19	+0.31	+0.31	+0.50	F0 III
4133	47 Leo	10 32.8	+ 9 18	3.85	-0.95	-0.14	-0.05	-0.21	B1 Iab
4534	94 Leo	11 49.1	+14 34	2.14	+0.08	+0.08	+0.06	+0.08	A3 V
4662	4 Crv	12 15.8	-17 33	2.58	-0.35	-0.11	-0.04	-0.13	B8 IIIp
5019	61 Vir	13 18.4	-18 19	4.74	+0.26	+0.71	+0.58	+0.94	G6 V
5235	8 Boo	13 54.7	+18 24	2.68	+0.20	+0.58	+0.44	+0.73	G0 IV
5264	93 Vir	14 1.6	+ 1 33	4.26	+0.13	+0.10	+0.15	+0.21	A3 V
5340	16 Boo	14 15.7	+19 11	-0.05	+1.28	+1.23	+0.97	+1.62	K2 IIIp
5359	100 Vir	14 19.1	-13 22	4.52	+0.09	+0.13	+0.10	+0.14	A2m
5511	109 Vir	14 46.2	+ 1 54	3.73	-0.03	-0.01	+0.07	+0.05	A0 V
5570	16 Lib	14 57.2	- 4 21	4.49	+0.04	+0.32	+0.32	+0.49	F0 IV
5634	45 Boo	15 7.3	+24 52	4.93	-0.02	+0.43	+0.40	+0.61	F5 V
5685	27 Lib	15 17.0	- 9 23	2.61	-0.37	-0.11	-0.04	-0.14	B8 V
5854	24 Ser	15 44.3	+ 6 26	2.64	+1.25	+1.17	+0.81	+1.37	K2 III
5933	41 Ser	15 56.5	+15 40	3.86	-0.03	+0.48	+0.49	+0.73	F6 V
6175	13 Oph	16 37.2	-10 34	2.56	-0.85	+0.02	+0.10	+0.06	O9.5 Vnn
6603	60 Oph	17 43.5	+ 4 34	2.77	+1.24	+1.17	+0.82	+1.39	K2 III
7235	17 Aql	19 5.4	+13 52	2.99	-0.01	+0.01	+0.01	+0.01	A0 V:nn
7377	30 Aql	19 25.5	+ 3 7	3.36	+0.04	+0.32	+0.25	+0.41	F0 IV
7446	39 Aql	19 36.9	- 7 2	4.96	-0.87	0.00	+0.06	+0.02	B0.5 IIIn
7602	60 Aql	19 55.3	+ 6 24	3.72	+0.49	+0.86	+0.66	+1.15	G8 IV
7906	9 Del	20 39.6	+15 55	3.77	-0.21	-0.06	0.00	-0.04	B9 IV
7950	2 Aqr	20 47.7	- 9 30	3.77	+0.02	0.00	+0.07	+0.07	A1 V
8781	54 Peg	23 4.8	+15 12	2.48	-0.06	-0.04	+0.01	-0.02	B9.5 III

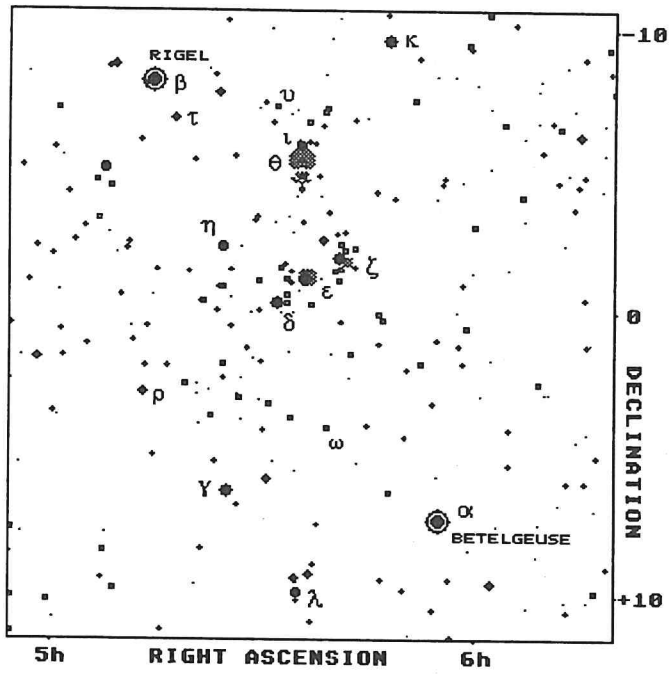
NONSTELLAR ASTRONOMICAL OBJECTS

DESIGNATION	RA(2000)	DEC	TYPE	Mvis.	NAME
NGC 55	$0^h15.0^m$	$-39^\circ13'$	Spiral galaxy	8.0	
NGC 104	0 24.1	-72 4	Globular cluster	4.5	47 Tucanae
NGC 224	0 42.7	+41 16	Spiral galaxy	4.5	M31 Andromeda
NGC 253	0 47.6	-25 18	Spiral galaxy	8.9	radio source
NGC 288	0 52.6	-26 36	Globular cluster	9.0	
NGC 330	0 56.1	-72 28	Open cluster	7.5	
NGC 346	0 59.0	-72 11	Gaseous nebula		
NGC 362	1 2.3	-70 51	Globular cluster	6.0	62 Tucanae
NGC 376	1 3.9	-72 49	Open cluster		
NGC 598	1 33.9	+30 39	Spiral galaxy	6.7	M 33
NGC 752	1 57.7	+37 40	Open cluster	7.0	
NGC 1068	2 42.7	- 0 1	Spiral galaxy	8.9	radio sourceM77
NGC 1261	3 12.3	-55 14	Globular cluster	9.5	
NGC 1647	4 46.1	+19 4	Open cluster	6.3	
NGC 1837	5 5.8	-70 8	Open cluster		
NGC 1850	5 9.0	-68 56	Open cluster	9.5	
NGC 1851	5 14.0	-40 2	Globular cluster	8.1	
NGC 1904	5 24.3	-24 31	Globular cluster	8.4	M 79
IC 418	5 27.7	-12 42	Planetary nebula		
NGC 1912	5 28.7	+35 50	Open cluster	7.4	M 38
NGC 1983	5 27.6	-69 2	Open cluster	8.5	
NGC 1952	5 34.5	+22 1	Supernova remnant	8.4	M1 Crab nebula
NGC 1960	5 35.3	+34 9	Open cluster	6.3	M 36
NGC 1976	5 35.4	- 5 23	Gaseous nebula	4.0	Orion nebulaM42
NGC 2070	5 39.6	-69 3	Gaseous nebula	8.3	30 Doradus
NGC 2024	5 41.9	- 1 51	Dark nebula 11 Head		
NGC 2068	5 46.8	+ 0 3	Gaseous nebula		M 78
NGC 2099	5 52.3	+32 34	Open cluster	6.2	M 37
NGC 2168	6 8.8	+24 19	Open cluster	5.3	M 35
NGC 2169	6 8.5	+13 57	Open cluster	6.4	
IC 2165	6 21.9	-12 59	Planetary nebula		
NGC 2244	6 32.4	+ 4 52	Open cluster	6.2	
NGC 2264	6 41.0	+ 9 54	Open cluster	4.0	
NGC 2287	6 47.0	-20 45	Open cluster	5.0	M 41
NGC 2301	6 51.8	+ 0 27	Open cluster	5.8	
NGC 2323	7 2.9	- 8 20	Open cluster	6.9	M 50
NGC 2362	7 18.7	-24 58	Open cluster	10.5	
NGC 2392	7 29.2	+20 55	Planetary nebula		
NGC 2422	7 36.6	-14 29	Open cluster	4.5	
NGC 2437	7 41.9	-14 49	Open cluster	6.0	M 46
NGC 2447	7 44.5	-23 52	Open cluster	6.0	M 93
NGC 2467	7 53.4	-26 24	Gaseous nebula	7.0	
NGC 2477	7 52.3	-38 33	Open cluster	5.7	
NGC 2516	8 0.5	-60 52	Open cluster	3.0	
NGC 2548	8 13.7	- 5 47	Open cluster	5.3	
NGC 2632	8 40.4	+19 41	Open cluster	3.7	M 44, Praesepe
IC 2395	8 45.0	-48 11	Open cluster		
NGC 2682	8 51.0	+11 49	Open cluster	6.1	M 67
IC 2448	9 7.1	-69 56	Planetary nebula		
NGC 2808	9 11.9	-64 51	Globular cluster	8.0	
NGC 2867	9 21.4	-58 19	Planetary nebula	9.5	
NGC 3114	10 2.7	-60 8	Open cluster	4.5	
NGC 3132	10 7.0	-40 26	Planetary nebula	8.0	
NGC 3199	10 16.9	-57 58	Gaseous nebula		
NGC 3242	10 24.8	-18 38	Planetary nebula		

NONSTELLAR ASTRONOMICAL OBJECTS

DESIGNATION	RA (2000)	DEC	TYPE	Mvis.	NAME
NGC 3372	10h45.0m	-59°41	Gaseous nebula	var	Eta Carina
NGC 3532	11 5.5	-58 40	Open cluster	3.3	
NGC 3766	11 36.5	-61 36	Open cluster	5.1	
NGC 3918	11 50.3	-57 11	Planetary nebula	8.5	
NGC 4374	12 25.1	+12 53	Galaxy	9.3	radio sourceM84
NGC 4372	12 25.9	-72 41	Globular cluster	9.0	
NGC 4486	12 30.8	+12 23	Elliptical galaxy	9.2	radio sourceM87
NGC 4579	12 37.6	+11 49	Spiral galaxy	9.2	M 58 in Virgo
NGC 4590	12 39.5	-26 45	Globular cluster	8.2	M 68 in Hydra
NGC 4594	12 39.9	-11 37	Spiral galaxy	8.7	Sombrero M104
NGC 4755	12 53.6	-60 21	Open cluster	5.2	Jewel Box cluster
NGC 4826	12 56.8	+21 41	Spiral galaxy	6.6	Black-eyenebM46
NGC 4833	12 59.4	-70 52	Globular cluster	8.5	
NGC 4945	13 5.3	-49 17	Spiral galaxy	9.0	radio source
NGC 5024	13 12.9	+18 10	Globular cluster	7.6	M 53
NGC 5128	13 25.3	-43 1	Galaxy	7.5	Centaurus "A"
NGC 5139	13 26.8	-47 19	Globular cluster	3.7	Omega Centauri
NGC 5236	13 37.1	-29 52	Spiral galaxy	10.1	radio source
NGC 5272	13 42.2	+28 23	Globular cluster	6.4	M 3
NGC 5281	13 46.6	-62 54	Open cluster	8.0	
NGC 5617	14 29.7	-60 43	Open cluster	8.5	
NGC 5822	15 5.3	-54 21	Open cluster	6.4	
NGC 5904	15 18.5	+ 2 5	Globular cluster	6.2	M 5
NGC 5986	15 46.1	-37 46	Globular cluster	8.7	
NGC 5999	15 52.2	-56 29	Open cluster	9.2	
NGC 6025	16 3.7	-60 30	Open cluster	5.8	
NGC 6067	16 13.2	-54 13	Open cluster	6.7	
NGC 6093	16 17.1	-22 59	Globular cluster	7.7	M 80 in Scorpius
NGC 6087	16 18.9	-57 54	Open cluster	6.0	
NGC 6121	16 23.7	-26 31	Globular cluster	6.4	M 4 in Scorpius
NGC 6124	16 25.6	-40 42	Open cluster	6.3	
NGC 6167	16 34.4	-49 36	Open cluster	6.4	
NGC 6193	16 41.4	-48 46	Open cluster	5.0	
NGC 6205	16 41.7	+36 27	Globular cluster	5.7	M 13 in Hercules
NGC 6302	17 13.8	-37 6	Gaseous nebula		
NGC 6388	17 36.3	-44 45	Globular cluster	8.5	
NGC 6397	17 40.9	-53 41	Globular cluster	7.5	
NGC 6405	17 40.1	-32 13	Open cluster	5.3	M 6
NGC 6475	17 54.0	-34 49	Open cluster	3.2	M 7 in Scorpius
NGC 6494	17 56.9	-19 1	Open cluster	6.9	M 23
NGC 6514	18 1.9	-23 2	Gaseous nebula	5.0	M 20 Trifid
NGC 6523	18 4.7	-24 20	Gaseous nebula	5.0	M 8 Lagoon
NGC 6572	18 12.1	+ 6 51	Planetary nebula	9.5	
NGC 6611	18 18.9	-13 47	Gaseous nebula	6.4	M 16
NGC 6618	18 20.8	-16 11	Gaseous nebula	7.0	M 17 Omega
NGC 6626	18 24.6	-24 52	Globular cluster	7.3	M 28
IC 4725	18 31.7	-19 15	Open cluster	6.5	M 25
NGC 6705	18 51.1	- 6 16	Open cluster	6.3	M 11(Wild Duck)
NGC 6720	18 53.6	+33 2	Planetary nebula	9.3	M 57 Ring
NGC 6779	19 16.5	+30 10	Globular cluster	8.2	M 56 in Lyra
NGC 6853	19 59.6	+22 43	Planetary nebula	7.5	M 27 Dumb-bell
NGC 6885	20 12.0	+26 29	Open cluster	9.1	
NGC 7009	21 4.1	-11 23	Planetary nebula	8.5	Saturn nebula
NGC 7078	21 30.0	+12 10	Globular cluster	6.0	M 15 in Pegasus
NGC 7293	22 29.7	-20 51	Planetary nebula	6.8	Helix nebula

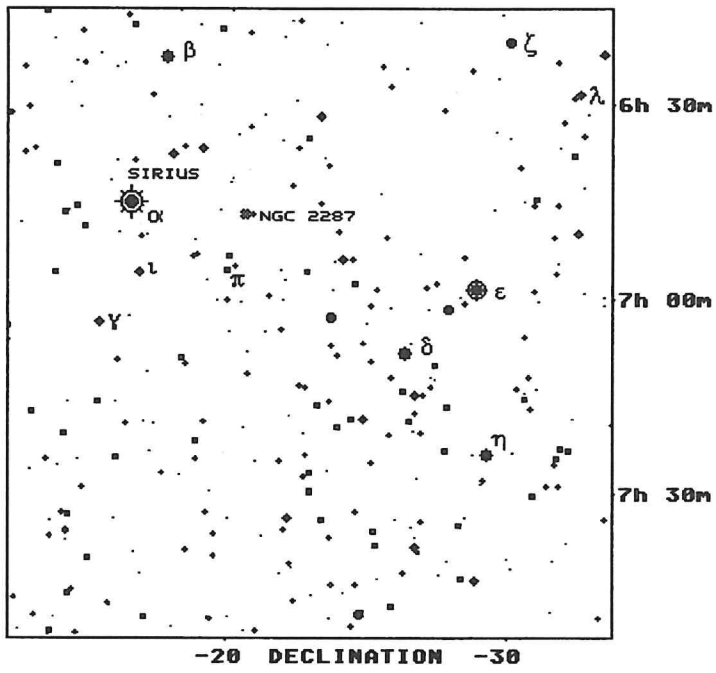
ORION



The Constellation of Orion, popularly known as "The Pot" is of particular interest to the amateur astronomer. It contains the Great Nebula in Orion, a magnificent luminous gas cloud in an adjacent arm of our galaxy. To the unaided eye this nebula appears as a haze around Theta (θ) Orionis. Embedded within this nebula is a small group of four, young bright blue stars known as "the Trapezium". Their intense ultraviolet radiation excites the neighbouring gases, producing the emission light of the nebula. A small telescope or binoculars will reveal this object. The Great Nebula in Orion (M42), is 1300 light years distant and 23 light years across. The Horsehead nebula can be located south of ζ Orionis. It requires a large telescope for visual observation, or may be photographed with a smaller instrument. This dark nebula is composed of gas and dust that absorb the light of the more distant emission nebula (IC 434). This is a fine object for photography.
The two bright stars, Rigel and Betelgeuse can be located north and south of the belt of Orion. The red supergiant Betelgeuse is a semiregular variable star with an intensity variation of 1.3 magnitudes . Its surface temperature is 3,000 degrees Celsius . The blue-white star, Rigel on the other hand has a surface temperature of 20,000 degrees Celsius

RIGEL	β Orionis, "Leg of the giant"
BETELGEUSE	α Orionis, "Giant's shoulder"
ALNITAK	ζ Orionis, "Girdle"
ALNILAM	ε Orionis, "Belt of pearls"
MINTAKA	δ Orionis, "Belt"

CANIS MAJOR

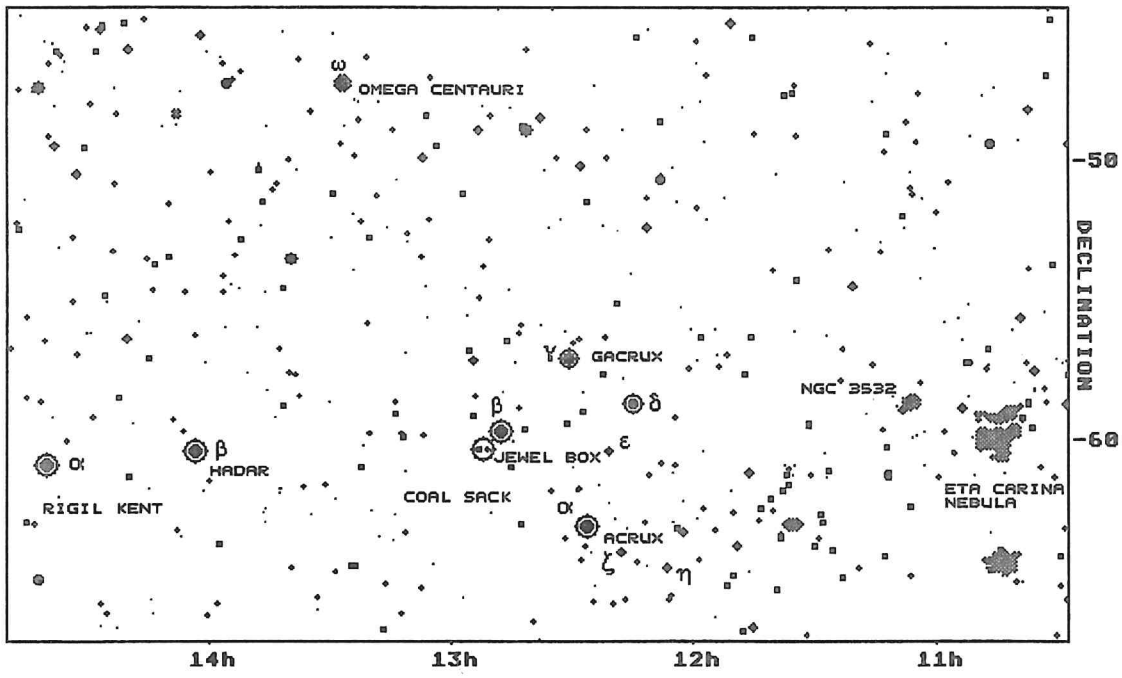


The Constellation of Canis Major (The Greater Dog) can be located to the southeast of Orion. This region contains the magnificent star, Alpha Canis Major (Sirius), the brightest star in the night sky. Irregularities in the proper motion of Sirius, attracted the attention of the astronomer Friedrich Bessel, who in 1844 concluded that these irregularities were due to an invisible companion star. In 1862 the American astronomer Alvan Clark, visually observed the white dwarf star that orbits Sirius. This white dwarf has a diameter similiar to that of the planet Uranus but contains a comparable mass with that of the Sun. A teaspoon full of matter from this star would weigh a tonne.

NGC 2287 is fine example of an open star cluster, and provides a splendid sight in binoculars.

SIRIUS	α CMa A ,	"The Dog Star" , 8.7 Light years distance
MIRZAM	β CMa ,	"Roarer"
MULIPHEIN	γ CMa	
WEZEN	δ CMa ,	"Weight"
ADHARA	ε CMa	
ALUDRA	η CMa	

THE SOUTHERN CROSS AREA



The Constellation of Crux is popularly known as "The Southern Cross". This imaginary cross is formed by drawing two lines from α Crucis (Acrux) to γ Crucis, and from β Crucis to δ Crucis, thus forming the cross. Additionally, α Centauri (Rigil Kent) and β Centauri (Hadar) form the "Pointers " that point to the cross. Through a small telescope α Centauri is resolved into a splendid example of a double star. Additionally a faint (11th mag) nearby companion star known as Proxima Centauri orbits this system. Proxima Centauri is the nearest star to our Sun (4.2 Light years); it is a known Flare Star.

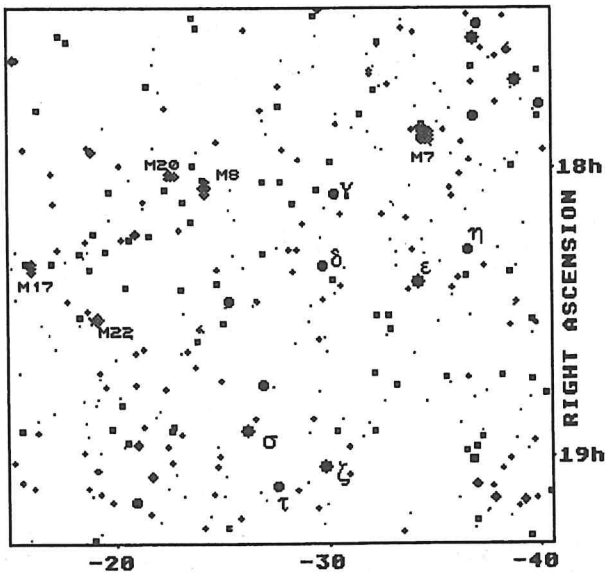
The Coal Sack is a nearby dark nebula obscuring the stars beyond it. This object is visible to the unaided eye on a clear moonless night.

A splended example of an open cluster is the Jewel Box. It requires a telescope for observation. Sir John Herschel described it as resembling "a superb piece of fancy jewellery".

Omega Centauri is the brightest and probably the finest example of a globular cluster in the night sky. A telescope is needed to resolve this object. It is 17,000 light years distant, approximately spherical in shape and contains over 100,000 stars.

The Eta Carina nebula is a fine example of an emmision nebula. This object photographs well and is fine viewing through a small telescope. This area of the Milky Way will reveal many objects when viewed with a pair of binoculars.

THE SAGITTARIUS AREA



The constellations Sagittarius (The Archer) and Scorpius (The Scorpion) provide the richest area in the Milky Way for the observer. Many profitable hours can be spent sweeping this area with binoculars. Rich star fields and nebula will be observed.

M7 is an open cluster of bright stars. It has a field diameter of 50 minutes of arc. This object is 800 light years distant.

M8 is an open cluster of stars and emission nebula known as the Lagoon. This object appears particulary attractive in photographs.

M17 is known as the Omega Nebula.

M20 is the famous Trifid Nebula in Sagittarius. This nebula has dark lanes of dust dividing it into three major segments.

M22 is a globular cluster.

When viewing the area of Sagittarius, we are looking towards the central region of our own galaxy - the Milky Way. This spiral galaxy contains at least 100,000 million stars and takes around 220 million years to make one revolution. The disk is approximately 100,000 light years in diameter. As we look into this area we are looking into the distant past, as light from the central hub of the galaxy has taken about 30,000 years to arrive.

Section 5

TABLES

DEFINITIONS and CONSTANTS

LATITUDES and LONGITUDES

PRECESSION TABLES

CHARGES

LATITUDES AND LONGITUDES OF SOME W.A. TOWNS

	Latitude (S)	Longitude (E)	Time Correction Longitude(min)
	o '	o '	
ALBANY	35 1	117 53	+ 8.5
ASHBURTON DOWNS	23 23	117 2	+ 11.9
AUGUSTA	34 19	115 9	+ 19.4
BALLADONIA HOTEL	32 21	123 37	- 14.5
BEVERLY	32 7	116 56	+ 12.3
BICKLEY OBSERVATORY	32 1	116 8	+ 15.5
BRIDGETOWN	33 58	116 8	+ 15.5
BROOKTON	32 22	117 0	+ 12.0
BROOME	17 58	122 14	- 8.9
BRUCE ROCK	31 52	118 9	+ 7.4
BUNBURY	33 20	115 38	+ 17.5
CARNAMAH	29 41	115 53	+ 16.5
CARNARVON	24 53	113 40	+ 25.3
COLLIE	33 22	116 9	+ 15.4
CORRIGIN	32 20	117 52	+ 8.5
CUE	27 26	117 54	+ 8.4
DENMARK	34 58	117 21	+ 10.6
DERBY	17 19	123 38	- 14.5
DONNYBROOK	33 35	115 49	+ 16.7
ESPERANCE	33 52	121 54	- 7.6
EUCLA MOTEL	31 41	128 53	- 35.5
EXMOUTH	21 54	114 7	+ 23.5
EYRE	32 15	126 18	- 25.2
FITZROY CROSSING	18 11	125 36	- 22.4
GERALDTON	28 46	114 37	+ 21.5
GIBBS MOUNT	32 55	119 59	+ 0.1
GILES MET STN	25 2	128 18	- 33.2
GNOWANGERUP	33 56	118 0	+ 8.0
HALLS CREEK	18 14	127 40	- 30.7
HARVEY	33 5	115 54	+ 16.4
JERRAMUNGUP	33 57	118 54	+ 4.4
JURIEN	30 18	115 2	+ 19.9
KALANNIE	30 22	117 7	+ 11.5
KALBARRI	27 42	114 12	+ 23.2
KALGOORLIE	30 45	121 28	- 5.9
KARRATHA	20 44	116 52	+ 12.5
KATANNING	33 41	117 33	+ 9.8
KELLERBERRIN	31 38	117 43	+ 9.1
KOJONUP	33 50	117 9	+ 11.4
KUNUNURRA	15 46	128 44	- 34.9
LAKE GRACE	33 6	118 28	+ 6.1
MADURA MOTEL	31 54	126 0	- 24.0
MANDURAH	32 32	115 43	+ 17.1
MANJIMUP	34 15	116 9	+ 15.4
MARBLE BAR	21 10	119 45	+ 1.0
MEEKATHARRA	26 36	118 28	+ 6.1
MERREDIN	31 29	118 16	+ 6.9
MILING	30 29	116 21	+ 14.6
MOORA	30 38	116 0	+ 16.0
MOUNT BARKER	34 38	117 40	+ 9.3
MOUNT MAGNET	28 4	117 51	+ 8.6

LATITUDES AND LONGITUDES OF SOME W.A. TOWNS

	Latitude (S)		Longitude (E)		Time Correction
	o	'	o	'	Longitude(min)
MOUNT NEWMAN	23	19	119	45	+ 1.7
MOUNT TOM PRICE	22	41	117	47	+ 8.9
MUKINBUDIN	30	55	118	12	+ 7.2
MULLEWA	28	32	115	30	+ 18.0
MUNDIWINDI	23	48	120	15	- 1.0
NANNUP	33	59	115	45	+ 17.0
NAREMBEEN	32	4	118	24	+ 6.4
NARROGIN	32	56	117	11	+ 11.3
NEWDEGATE	33	6	119	1	+ 3.9
NORSEMAN	32	12	121	47	- 7.1
NORTHAM	31	39	116	40	+ 13.3
NORTHAMPTON	28	21	114	38	+ 21.5
NORTHCLIFFE	34	38	116	7	+ 15.5
NYABING	33	33	118	9	+ 7.4
ONSLOW	21	38	115	7	+ 19.5
PANNAWONICA	21	39	116	19	+ 14.7
PARABURDOO	23	12	117	40	+ 9.3
PAYNES FIND	29	16	117	41	+ 9.3
PEMBERTON	34	27	116	2	+ 15.9
PERTH	31	57	115	51	+ 16.6
PINDAR	28	29	115	47	+ 16.9
PINGELLY	32	32	117	05	+ 11.7
PINJARRA	32	38	115	52	+ 16.5
PORT HEDLAND	20	18	118	35	+ 5.7
QUAIRADING	32	1	117	24	+ 10.4
RAVENSTHORPE	33	35	120	2	- 0.1
RAWLINNA	31	1	125	20	- 21.3
ROEBOURNE	20	47	117	9	+ 11.4
SAFETY BAY	32	18	115	43	+ 17.1
SHAY GAP PASS	20	30	120	9	- 0.6
SOUTHERN CROSS	31	14	119	19	+ 2.7
TOODYAY	31	33	116	28	+ 14.1
WAGIN	33	19	117	20	+ 10.7
WALPOLE	34	59	116	44	+ 13.1
WARBURTON MISSION	26	8	126	35	- 26.3
WAROONA	32	51	115	55	+ 16.3
WILLIAMS	33	2	116	53	+ 12.5
WILUNA	26	35	120	14	- 0.9
WONGAN HILLS	30	54	116	43	+ 13.1
WUBIN	30	6	116	38	+ 13.5
WUNDOWIE	31	46	116	23	+ 14.5
WYALKATCHEM	31	11	117	23	+ 10.5
WYNDHAM	15	28	128	6	- 32.4
YAMPI SOUND	16	8	123	36	- 14.4
YANCHEP	31	33	115	41	+ 17.3
YORK	31	53	116	46	+ 12.9

DEFINITIONS AND CONSTANTS (IAU 1976 System) .

Distance	1 Astronomical Unit (A.U.)	149 597 870 km
	1 Light Year (ly)	63 240 A.U.
	1 Parsec (pc)	206 265 A.U

Time

The Sun: Principal years as derived from the Sun's mean motion

Length of Year:	Tropical (Equinox to Equinox)	365.242 191 ^{d}
	Sidereal (Fixed star to fixed star)	365.256 363
	Anomalistic (Perigee - Perigee)	365.259 635
	Eclipse year (Moon's nodes)	346.620 072

The Moon: Mean months as derived from the mean orbital elements

Length of Month:	Synodical (New Moon- New Moon)	29.530589 ^{d}
	Tropical (Equinox to Equinox)	27.321582
	Sidereal (Fixed star to fixed star)	27.321662
	Anomalistic (Apse to Apse)	27.554550
	Draconic (Node to Node)	27.212221

Day:	Mean solar day (Sidereal time)	$24^h03^m56.55537^s$
	Mean sidereal day (Solar time)	23 56 04.09030
	Sidereal rotation period of Earth	23 56 04.09900
	Caesium Resonator Frequency	91926317 Hz

The Earth	Polar Radius	6356.775 km
	Equatorial Radius	6378.174 km
	Equatorial Rotational Velocity	0.46510 km/s
	Mean Orbital Speed	29.79 km/s
	Geocentric gravitational constant (GE)	$3.986005 \times 10^{14} m^3 s^{-2}$
The Moon	Mass of Moon	7.3483×10^{22} kg
	Earth/Moon mass ratio	81.3004
	Moon/Earth mass ratio	0.01230002
	Mean distance Earth to Moon	384 400 km
The Sun	Mass	1.9891×10^{30} kg
	Sun/Earth mass ratio	332946.0
	Sun/Earth+Moon mass ratio	328900.5
	Solar Motion (relative to nearby stars)	20.0 km/s
	Solar Apex R.A. $18^h\ 6^m$ Dec. $+30^o$; l=57^o, b=$+22^o$	
The Galaxy		
	Mass	2.2×10^{41} kg
	North Pole of Galactic Plane R.A. 12^h52^m, Dec. $+27^o\ 7'$	
	Centre R.A. 17 46 , Dec. - 28 55	
	Distance to the Centre, from the Sun	9 Kpc.
	Rotational Velocity, at Sun's distance	250 km/s
	Diameter	100 Kpc
	Period of revolution of Sun about centre	2.2×10^8 yr
Miscellaneous		
	Constant of Gravitation	$6.672 \times 10^{-11} m^3 kg^{-1} s^{-2}$
	Gaussian gravitational constant k =	0.01720209895
	Obliquity of the Ecliptic	$23^o26'25."90$

General Precession in Longitude = 5029.0966 arcsec per Julian century

Magnetic Declination at Gnangara Observatory $3^o13'$ West decreasing by 1' per year.

(Information kindly supplied by the Mundaring Geophysical Observatory)

Light- time for Unit Distance (1 A.U.) =	499.004782 seconds
Constant of Nutation at standard epoch 2000	9.2025 arcsec
Constant of Aberration	20.49552 arcsec
Solar parallax	8.794148 arcsec
Speed of Light	299 792 458 m/s

PRECESSION TABLE 1950.0 to 1991.0

	Precession in RA (mins)													
Dec	o +60	o +50	o +40	o +30	o +15	o 0	o -15	o -30	o -40	o -50	o -60	o -70	o -80	Prec.in Dec(')
RA(h)	m	m	m	m	m	m	m	m	m	m	m	m	m	' RA
0	+ 2.1	+ 2.1	+ 2.1	+ 2.1	+ 2.1	+ 2.1	+ 2.1	+ 2.1	+ 2.1	+ 2.1	+ 2.1	+ 2.1	+ 2.1	+13 0
1	+ 2.5	+ 2.4	+ 2.3	+ 2.2	+ 2.2	+ 2.1	+ 2.0	+ 2.0	+ 1.9	+ 1.8	+ 1.7	+ 1.4	+ 0.8	+13 1
2	+ 2.9	+ 2.7	+ 2.5	+ 2.4	+ 2.2	+ 2.1	+ 2.0	+ 1.8	+ 1.7	+ 1.6	+ 1.3	+ 0.8	- 0.5	+11 2
3	+ 3.2	+ 2.9	+ 2.6	+ 2.5	+ 2.3	+ 2.1	+ 1.9	+ 1.7	+ 1.6	+ 1.3	+ 1.0	+ 0.3	- 1.5	+ 9 3
4	+ 3.5	+ 3.0	+ 2.8	+ 2.6	+ 2.3	+ 2.1	+ 1.9	+ 1.6	+ 1.4	+ 1.2	+ 0.7	- 0.1	- 2.3	+ 6 4
5	+ 3.6	+ 3.2	+ 2.8	+ 2.6	+ 2.3	+ 2.1	+ 1.9	+ 1.6	+ 1.4	+ 1.0	+ 0.6	- 0.3	- 2.9	+ 3 5
6	+ 3.7	+ 3.2	+ 2.9	+ 2.6	+ 2.3	+ 2.1	+ 1.9	+ 1.6	+ 1.3	+ 1.0	+ 0.5	- 0.4	- 3.1	0 6
7	+ 3.6	+ 3.1	+ 2.8	+ 2.6	+ 2.3	+ 2.1	+ 1.9	+ 1.6	+ 1.4	+ 1.0	+ 0.6	- 0.3	- 2.9	- 3 7
8	+ 3.5	+ 3.0	+ 2.8	+ 2.6	+ 2.3	+ 2.1	+ 1.9	+ 1.6	+ 1.4	+ 1.2	+ 0.7	- 0.1	- 2.4	- 6 8
9	+ 3.2	+ 2.9	+ 2.6	+ 2.5	+ 2.3	+ 2.1	+ 1.9	+ 1.7	+ 1.6	+ 1.3	+ 1.0	+ 0.3	- 1.6	- 9 9
10	+ 2.9	+ 2.6	+ 2.5	+ 2.4	+ 2.2	+ 2.1	+ 2.0	+ 1.8	+ 1.7	+ 1.6	+ 1.3	+ 0.8	- 0.5	-11 10
11	+ 2.5	+ 2.4	+ 2.3	+ 2.2	+ 2.2	+ 2.1	+ 2.0	+ 2.0	+ 1.9	+ 1.8	+ 1.7	+ 1.5	+ 0.8	-13 11
12	+ 2.1	+ 2.1	+ 2.1	+ 2.1	+ 2.1	+ 2.1	+ 2.1	+ 2.1	+ 2.1	+ 2.1	+ 2.1	+ 2.1	+ 2.1	-13 12
13	+ 1.7	+ 1.8	+ 1.9	+ 2.0	+ 2.0	+ 2.1	+ 2.2	+ 2.2	+ 2.3	+ 2.4	+ 2.5	+ 2.8	+ 3.5	-13 13
14	+ 1.3	+ 1.6	+ 1.7	+ 1.8	+ 2.0	+ 2.1	+ 2.2	+ 2.4	+ 2.5	+ 2.7	+ 2.9	+ 3.4	+ 4.8	-11 14
15	+ 1.0	+ 1.3	+ 1.6	+ 1.7	+ 1.9	+ 2.1	+ 2.3	+ 2.5	+ 2.6	+ 2.9	+ 3.2	+ 3.9	+ 5.8	- 9 15
16	+ 0.7	+ 1.2	+ 1.4	+ 1.6	+ 1.9	+ 2.1	+ 2.3	+ 2.6	+ 2.8	+ 3.0	+ 3.5	+ 4.3	+ 6.6	- 6 16
17	+ 0.6	+ 1.0	+ 1.4	+ 1.6	+ 1.9	+ 2.1	+ 2.3	+ 2.6	+ 2.8	+ 3.2	+ 3.6	+ 4.5	+ 7.1	- 3 17
18	+ 0.5	+ 1.0	+ 1.3	+ 1.6	+ 1.9	+ 2.1	+ 2.3	+ 2.6	+ 2.9	+ 3.2	+ 3.7	+ 4.6	+ 7.3	0 18
19	+ 0.6	+ 1.0	+ 1.4	+ 1.6	+ 1.9	+ 2.1	+ 2.3	+ 2.6	+ 2.8	+ 3.1	+ 3.6	+ 4.5	+ 7.1	+ 3 19
20	+ 0.7	+ 1.2	+ 1.4	+ 1.6	+ 1.9	+ 2.1	+ 2.3	+ 2.6	+ 2.8	+ 3.0	+ 3.5	+ 4.3	+ 6.5	+ 6 20
21	+ 1.0	+ 1.3	+ 1.6	+ 1.7	+ 1.9	+ 2.1	+ 2.3	+ 2.5	+ 2.6	+ 2.9	+ 3.2	+ 3.9	+ 5.7	+ 9 21
22	+ 1.3	+ 1.6	+ 1.7	+ 1.8	+ 2.0	+ 2.1	+ 2.2	+ 2.4	+ 2.5	+ 2.6	+ 2.9	+ 3.3	+ 4.6	+11 22
23	+ 1.7	+ 1.8	+ 1.9	+ 2.0	+ 2.0	+ 2.1	+ 2.2	+ 2.2	+ 2.3	+ 2.4	+ 2.5	+ 2.7	+ 3.4	+13 23

PRECESSION TABLE 1991.0 to 2000.0

Precession in RA (mins)

Dec	+60°	+50°	+40°	+30°	+15°	0°	-15°	-30°	-40°	-50°	-60°	-70°	-80°	Prec.in Dec(')	
RA(h)	m	m	m	m	m	m	m	m	m	m	m	m	m	'	RA
0	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 3	0
1	+ 0.6	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.4	+ 0.4	+ 0.4	+ 0.4	+ 0.4	+ 0.3	+ 0.2	+ 2	1
2	+ 0.6	+ 0.6	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.4	+ 0.4	+ 0.4	+ 0.3	+ 0.3	+ 0.2	- 0.1	+ 2	2
3	+ 0.7	+ 0.6	+ 0.6	+ 0.5	+ 0.5	+ 0.5	+ 0.4	+ 0.4	+ 0.3	+ 0.3	+ 0.2	+ 0.1	- 0.3	+ 2	3
4	+ 0.8	+ 0.7	+ 0.6	+ 0.6	+ 0.5	+ 0.5	+ 0.4	+ 0.4	+ 0.3	+ 0.3	+ 0.2	- 0.0	- 0.5	+ 1	4
5	+ 0.8	+ 0.7	+ 0.6	+ 0.6	+ 0.5	+ 0.5	+ 0.4	+ 0.3	+ 0.3	+ 0.2	+ 0.1	- 0.1	- 0.6	+ 0	5
6	+ 0.8	+ 0.7	+ 0.6	+ 0.6	+ 0.5	+ 0.5	+ 0.4	+ 0.3	+ 0.3	+ 0.2	+ 0.1	- 0.1	- 0.7	0	6
7	+ 0.8	+ 0.7	+ 0.6	+ 0.6	+ 0.5	+ 0.5	+ 0.4	+ 0.3	+ 0.3	+ 0.2	+ 0.1	- 0.1	- 0.6	+ 0	7
8	+ 0.8	+ 0.7	+ 0.6	+ 0.6	+ 0.5	+ 0.5	+ 0.4	+ 0.4	+ 0.3	+ 0.3	+ 0.2	- 0.0	- 0.5	- 1	8
9	+ 0.7	+ 0.6	+ 0.6	+ 0.5	+ 0.5	+ 0.5	+ 0.4	+ 0.4	+ 0.3	+ 0.3	+ 0.2	+ 0.1	- 0.3	- 2	9
10	+ 0.6	+ 0.6	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.4	+ 0.4	+ 0.4	+ 0.3	+ 0.3	+ 0.2	- 0.1	- 2	10
11	+ 0.6	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.4	+ 0.4	+ 0.4	+ 0.4	+ 0.4	+ 0.3	+ 0.2	- 2	11
12	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.5	- 3	12
13	+ 0.4	+ 0.4	+ 0.4	+ 0.4	+ 0.4	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.6	+ 0.6	+ 0.8	- 2	13
14	+ 0.3	+ 0.3	+ 0.4	+ 0.4	+ 0.4	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.6	+ 0.6	+ 0.7	+ 1.0	- 2	14
15	+ 0.2	+ 0.3	+ 0.3	+ 0.4	+ 0.4	+ 0.5	+ 0.5	+ 0.5	+ 0.6	+ 0.6	+ 0.7	+ 0.9	+ 1.3	- 2	15
16	+ 0.2	+ 0.3	+ 0.3	+ 0.4	+ 0.4	+ 0.5	+ 0.5	+ 0.6	+ 0.6	+ 0.7	+ 0.8	+ 0.9	+ 1.4	- 1	16
17	+ 0.1	+ 0.2	+ 0.3	+ 0.3	+ 0.4	+ 0.5	+ 0.5	+ 0.6	+ 0.6	+ 0.7	+ 0.8	+ 1.0	+ 1.6	- 0	17
18	+ 0.1	+ 0.2	+ 0.3	+ 0.3	+ 0.4	+ 0.5	+ 0.5	+ 0.6	+ 0.6	+ 0.7	+ 0.8	+ 1.0	+ 1.6	0	18
19	+ 0.1	+ 0.2	+ 0.3	+ 0.3	+ 0.4	+ 0.5	+ 0.5	+ 0.6	+ 0.6	+ 0.7	+ 0.8	+ 1.0	+ 1.6	+ 0	19
20	+ 0.2	+ 0.3	+ 0.3	+ 0.4	+ 0.4	+ 0.5	+ 0.5	+ 0.6	+ 0.6	+ 0.7	+ 0.8	+ 0.9	+ 1.4	+ 1	20
21	+ 0.2	+ 0.3	+ 0.3	+ 0.4	+ 0.4	+ 0.5	+ 0.5	+ 0.5	+ 0.6	+ 0.6	+ 0.7	+ 0.8	+ 1.3	+ 2	21
22	+ 0.3	+ 0.3	+ 0.4	+ 0.4	+ 0.4	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.6	+ 0.6	+ 0.7	+ 1.0	+ 2	22
23	+ 0.4	+ 0.4	+ 0.4	+ 0.4	+ 0.4	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.5	+ 0.6	+ 0.6	+ 0.8	+ 2	23

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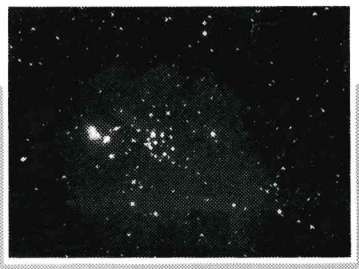

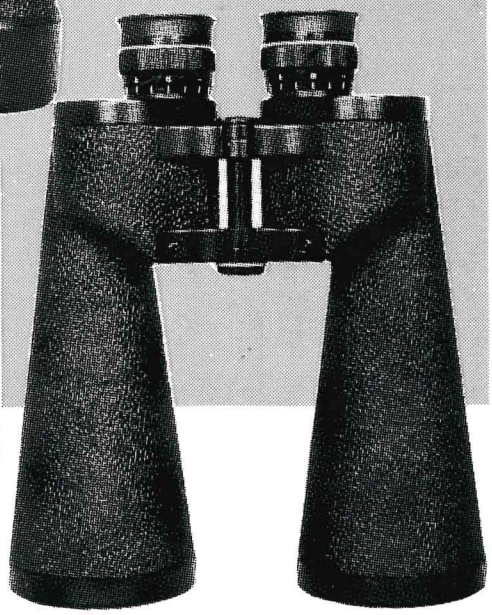

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