Canberra
Nightscape Photography
Handbook 2023

Photo by Joe Cali. The observing field at Queensland Astrofest

Compiled and Edited by Joe Cali

Shoot Planning Data for Astrophotography and Astronomical Nightscapes in the Canberra Region 2023

[149ºE, 35ºS]

Compiled & Edited by Joe Cali
http://joe-cali.com/nightscape

Comet Leonard

Above: *Photograph Comet Leonard on December 31st. This is an HDR image produced by combining different exposures for the head and tail with an 8" telescope.*

Front cover: *Whilst guest speaking at Queensland Astrofest in July 2022, I shot a number of nightscapes to illustrate an article about the event that appears in the October 2022 issue of Australian Sky and Telescope*

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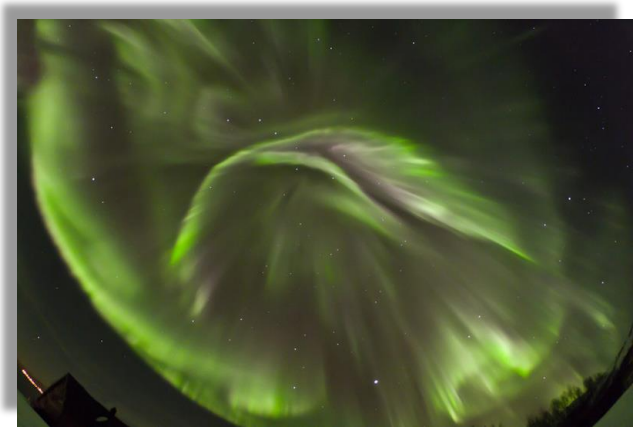
Introduction

News Flash!! A potentially bright comet ZTF 2022 E3 will be visible in our skies mid-February. You will find a write up on the apparition, as seen at this latitude, at the very end of this publication.

Although many smartphone apps can give you rise and set and other information for a specific day, usually the day on the app calendar, I find it useful to farm online resources to produce an annual almanac of rise/set and other useful planning information that I use for forward planning of nightscape and astronomical observing activities in the local region. I teach this approach in my nightscape photography themed workshops and events. I have produced a collection of such information each year for many years but only shared with a few close friends. In recent years, I have put in extra time, it turned out to be a **lot** of extra time, producing a pdf book for wider distribution. I have found that the number of people downloading the publication is far too low to justify the time that goes into preparing this document. As a result, this is the last time I will produce the publication and make it available for public download.

About me

I have been an avid observer of all things astronomical and a keen photographer since the 1970's. I built my first telescope when I was 15, and my last scope ....well, I guess I haven't built or even planned it yet. I really enjoy the meditative solitude of spending a whole night alone under the stars watching the Earth revolving. However, I equally love sharing it with close friends or introducing new people to the joys of the night sky. I have observed 14 total solar eclipses, many of them with my late friend, Bengt Alfredsson pictured above.



***Photos. Above left**, Bengt observing Omega Centauri through my 18" reflector a year before his death.*

***Above right,** In March 2015, we observed a total solar eclipse from Svalbard, only 800km from the north pole at a chilly 22ºC below zero.*

***Left:** A sky filling aurora lit the entire sky, and snow-covered ground beneath us on Kvaløya, Norway just one week before the 2015 total solar eclipse on Svalbard.*

ACT Government

ACT PUBLIC HOLIDAYS 2023

The following public holidays will be observed in the Australian Capital Territory during 2023.

Public holiday	Date to be observed
New Year's Day	Monday 2 January 2023*
Australia Day	Thursday 26 January 2023
Canberra Day	Monday 13 March 2023
Good Friday	Friday 7 April 2023
Easter Saturday	Saturday 8 April 2023
Easter Sunday	Sunday 9 April 2023
Easter Monday	Monday 10 April 2023
ANZAC Day	Tuesday 25 April 2023
Reconciliation Day	Monday 29 May 2023
Queen's Birthday	Monday 12 June 2023
Labour Day	Monday 2 October 2023
Christmas Day	Monday 25 December 2023
Boxing Day	Tuesday 26 December 2023

Note: All public holiday dates are accurate at the time of publication. Information is sourced from the *Holidays Act 1958* (ACT).

*As 1 January 2023 falls on a Sunday in 2023, the following Monday is observed as the public holiday.

**The H*olidays Act 1958* also provides for bank holidays in the ACT. In addition to the above public holidays, there is a bank holiday on the first Monday in August. Bank holidays do not apply to everyone. Employers and employees are advised to check the *Holidays Act 1958* for all bank holidays and refer to their relevant Enterprise Agreement or Award.

(Information correct as of 19 February 2021)
Workplace Safety and Industrial Relations Division
Chief Minister, Treasury and Economic Development Directorate
Email: wsir@act.gov.au

Chief Minister, Treasury and Economic Development
GPO Box 158 Canberra ACT 2601 | phone: 132281 | www.act.gov.au

Source : https://act.gov.au

Daylight Savings Switchovers

End DST: Sunday, 2 April 2023, 3 am turn 1 hour backward
Start DST: Sunday, 1 October 2023, 2 am turn 1 hour forward
Source : https://act.gov.au

CALENDAR 2023

JANUARY

Mo	Tu	We	Th	Fr	Sa	Su
						1
2		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

Mo	Tu	We	Th	Fr	Sa	Su
		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

Mo	Tu	We	Th	Fr	Sa	Su
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

APRIL

Mo	Tu	We	Th	Fr	Sa	Su
					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

Mo	Tu	We	Th	Fr	Sa	Su
						1
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

Mo	Tu	We	Th	Fr	Sa	Su
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

JULY

Mo	Tu	We	Th	Fr	Sa	Su
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

AUGUST

Mo	Tu	We	Th	Fr	Sa	Su
	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

Mo	Tu	We	Th	Fr	Sa	Su
				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

Mo	Tu	We	Th	Fr	Sa	Su
						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

Mo	Tu	We	Th	Fr	Sa	Su
		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

Mo	Tu	We	Th	Fr	Sa	Su
				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

25 NEW MOON

18 NATIONAL & ACT PUBLIC HOLIDAYS

20 Eclipses

April 20 SOLAR ECLIPSE- TOTAL (Exmouth, WA) PARTIAL (SE Australia)

May 5 Penumbral Lunar Eclipse

Nov 8 Partial Lunar Eclipse

2023 New Moon Phase Dates

Date and Time of New Moon's

2023 Lunar Phases — Sydney (Australia/Sydney) Time	
New Moon	**Full Moon**
	Jan. 7, Sat *10:09 AM*
Jan. 22, Sun *07:55 AM*	Feb. 6, Mon *05:30 AM*
Feb. 20, Mon *06:09 PM*	Mar. 7, Tue *11:42 PM*
Mar. 22, Wed *04:26 AM*	Apr. 6, Thu *02:37 PM*
Apr. 20, Thu *02:15 PM*	May 6, Sat *03:36 AM*
May 20, Sat *01:55 AM*	June 4, Sun *01:43 PM*
June 18, Sun *02:39 PM*	July 3, Mon *09:40 PM*
July 18, Tue *04:33 AM*	Aug. 2, Wed *04:33 AM*
Aug. 16, Wed *07:38 PM*	Aug. 31, Thu *11:37 AM*
Sept. 15, Fri *11:40 AM*	Sept. 29, Fri *07:58 PM*
Oct. 15, Sun *04:55 AM*	Oct. 29, Sun *07:24 AM*
Nov. 13, Mon *08:27 PM*	Nov. 27, Mon *08:16 PM*
Dec. 13, Wed *10:32 AM*	Dec. 27, Wed *11:33 AM*

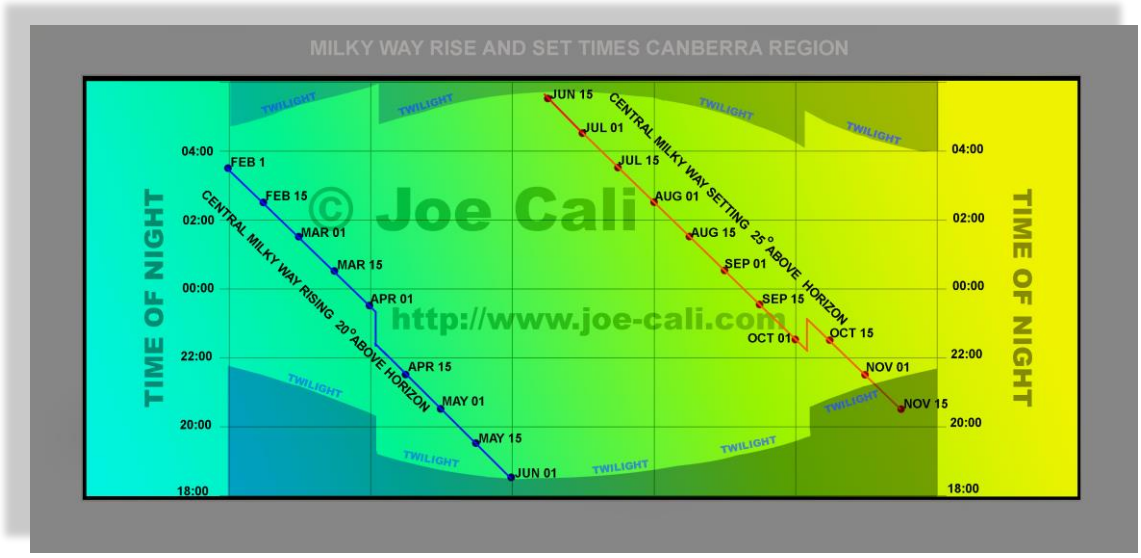
Moon Perigees near Full Moon (Super Moon's)

Perigee Date	Perigee Time	Moon Distance	Nearest Full Moon
7 Jun	9:09 am	364859 km	9 Jun
5 Jul	8:29 am	360149 km	6 Jul
2 Aug	3:53 pm	357309 km	3 Aug
31 Aug	1:52 am	357181 km	31 Aug
28 Sept	11:06 am	359910 km	27 Sept

WORKSHOPS - 2023

I won't be conducting workshops during 2023. Hope to be back early in 2024!

Milky Way Rise & Set – Canberra region



This rise and set graphic plots the time when the Milky Way centre is above the horizon at a "good" or "minimum" photographic altitude. I use the star Antares, at 20º altitude, for the rising Milky Way and the Trifid nebula at 25º for the setting Milky Way. These are somewhat arbitrary but values that I've found, by trial and error, work well for me. At lower altitudes, the muck in the atmosphere causes too much extinction. The discontinuity in the plots represents the shifts between eastern daylight savings time [EDT] and eastern standard time [EST] in autumn and spring respectively.

Rising – Antares 20 º altitude

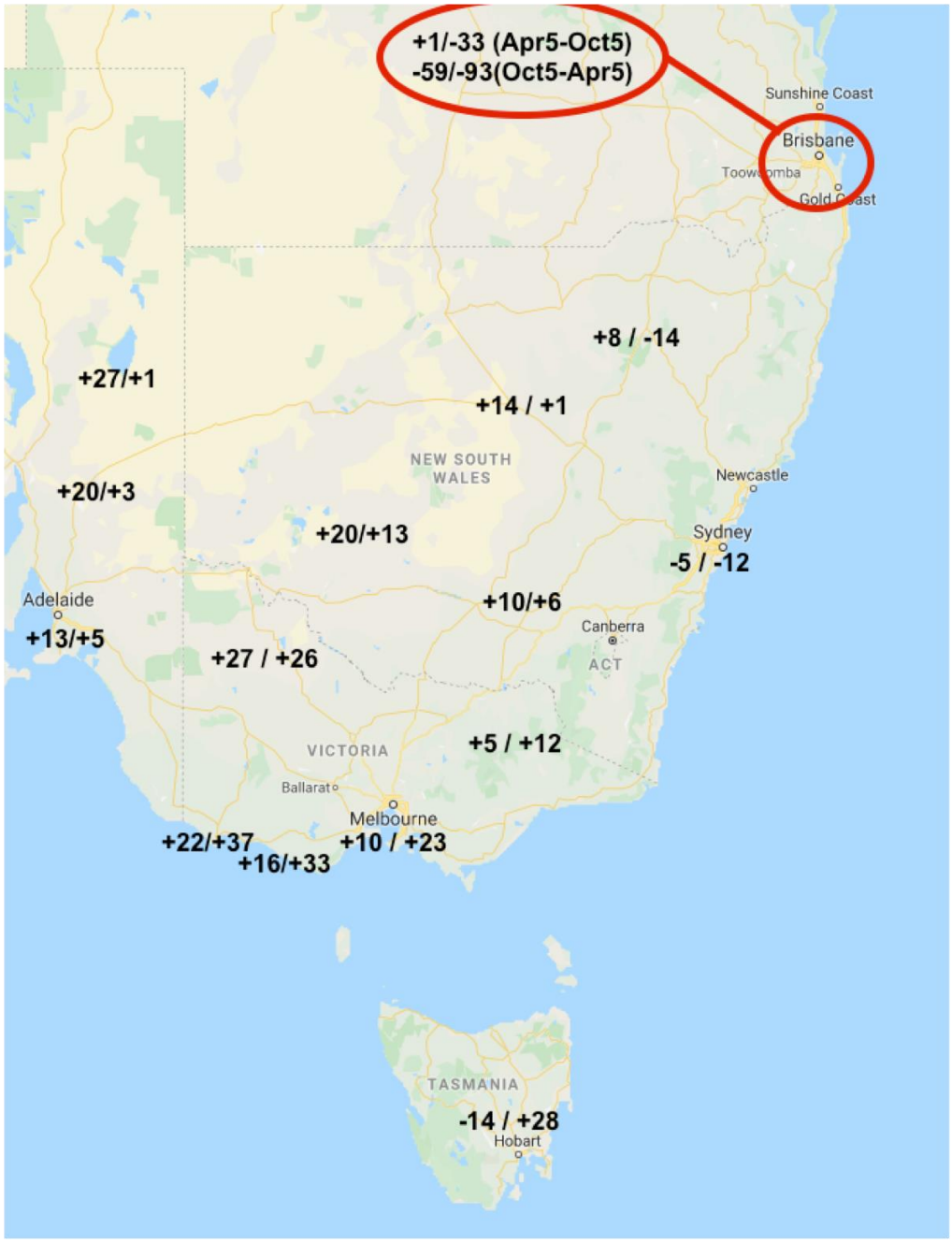
Setting – Triffid Nebula 25 º altitude

While a rising or setting Milky Way can be photographed at higher or lower altitudes. I find these to be good working limits.

Milky Way Rise & Set
Time Corrections for Other Locations

Eg Narrabri +8 / -14 =>

- Add 8 mins to MW rise & morning twilight times.
- Subtract 14 mins from MW set and evening twilight times.
- These corrections only work for the Milky Way, not for the Moon and Sun because they have declinations that vary leading to variable corrections throughout the year.



Avoiding trailed star images

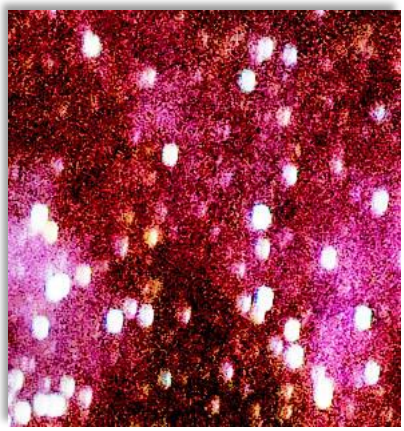
Reading about nightscape photography, you will have no doubt have come across someone claiming they have the perfect rule for pinpoint stars. One person will claim the "700 rule," another the "600, 500, 400, 300, 250 rule. I have read many such articles and posts. In almost every case the author does not understand the basics of astro-mechanics and the translation of moving stars onto a flat image plane when capturing nightscapes.

No simple "rule" can adequately calculate the maximum exposure for stars to appear stationary for all cameras, sensors and output formats. Why? Because it's a function of a number of factors –

- Sensor size
- Pixel size in the sensor
- Lens focal length
- Declination (stellar latitude) of the stars
- Final display output format/size

In 2013, I derived a formula that took all of these factors into account. At about the same time as I published my formula, I was contacted by Frédéric Michaud from the Société Astronòmique du Havre who, at about the same time, had derived a different formula now called the NPF rule. We compared our maths derivations and although we had approached the problem using different math derivations, and our formulae look very different, when we compared our results we found our two formulae to be quite consistent and any small differences had no practical effect on the image appearance.

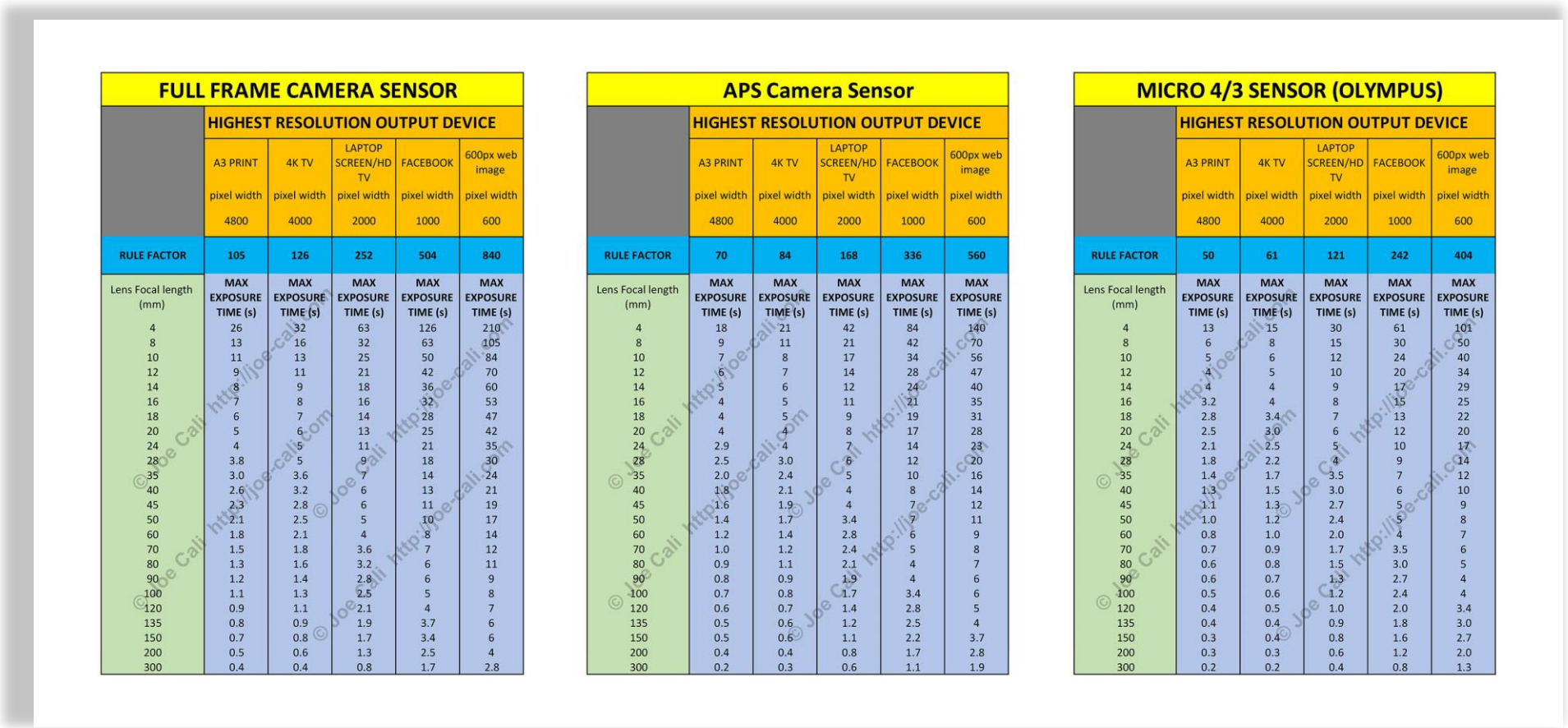
To test the method at the extreme I shot the above image of Eta Carinae nebula using an APS camera, ISO12800, a 300mm f4 lens and a 4s exposure. The recommendation in the table is 2s for a 600px output image and when I blow this up to 100%, I can see oval shaped stars with trails twice as long as they are wide, perfectly consistent with the formula result.



Recently I re-examined the maths derivation and discovered a simplification based on using sensor dimension, lens focal length and final output size only. Other parameters are used but cancel out. You will note that as you make your desired output format smaller, you can afford to have more pixels of movement on the camera sensor and consequently, longer allowable exposure times. If you want to express this as a "600 rule" type of formula, the blue line indicates the number for the rule for various formats. You can see that it varies greatly with output format.

These techniques allow remarkable work to be produced with little more than a camera, tripod and remote release. There comes a point where, if you want to do very large prints or show work on large format 4K TV screens, you probably will need to move to using a tracking device else the exposures will be so short, the images will be very noisy.

Don't get too tied up in knots about capturing pinpoint images. If in pursuit of pinpoint stars, the exposures are so short that the captured image is full of noise then what's the point. Given the choice of a little trailing with good signal and no trailing with a lot of noise, I'll accept a little trailing any "night."



FULL FRAME CAMERA SENSOR

	HIGHEST RESOLUTION OUTPUT DEVICE				
	A3 PRINT pixel width 4800	4K TV pixel width 4000	LAPTOP SCREEN/HD TV pixel width 2000	FACEBOOK pixel width 1000	600px web image pixel width 600
RULE FACTOR	105	126	252	504	840
Lens Focal length (mm)	MAX EXPOSURE TIME (s)	MAX EXPOSURE TIME (s)	MAX EXPOSURE TIME (s)	MAX EXPOSURE TIME (s)	MAX EXPOSURE TIME (s)
4	26	32	63	126	210
8	13	16	32	63	105
10	11	13	25	50	84
12	9	11	21	42	70
14	8	9	18	36	60
16	7	8	16	32	53
18	6	7	14	28	47
20	5	6	13	25	42
24	4	5	11	21	35
28	3.8	5	9	18	30
35	3.0	3.6	7	14	24
40	2.6	3.2	6	13	21
45	2.3	2.8	6	11	19
50	2.1	2.5	5	10	17
60	1.8	2.1	4	8	14
70	1.5	1.8	3.6	7	12
80	1.3	1.6	3.2	6	11
90	1.2	1.4	2.8	6	9
100	1.1	1.3	2.5	5	8
120	0.9	1.1	2.1	4	7
135	0.8	0.9	1.9	3.7	6
150	0.7	0.8	1.7	3.4	6
200	0.5	0.6	1.3	2.5	4
300	0.4	0.4	0.8	1.7	2.8

APS Camera Sensor

	HIGHEST RESOLUTION OUTPUT DEVICE				
	A3 PRINT pixel width 4800	4K TV pixel width 4000	LAPTOP SCREEN/HD TV pixel width 2000	FACEBOOK pixel width 1000	600px web image pixel width 600
RULE FACTOR	70	84	168	336	560
Lens Focal length (mm)	MAX EXPOSURE TIME (s)	MAX EXPOSURE TIME (s)	MAX EXPOSURE TIME (s)	MAX EXPOSURE TIME (s)	MAX EXPOSURE TIME (s)
4	18	21	42	84	140
8	9	11	21	42	70
10	7	8	17	34	56
12	6	7	14	28	47
14	5	6	12	24	40
16	4	5	11	21	35
18	4	5	9	19	31
20	4	4	8	17	28
24	2.9	4	7	14	23
28	2.5	3.0	6	12	20
35	2.0	2.4	5	10	16
40	1.8	2.1	4	8	14
45	1.6	1.9	4	7	12
50	1.4	1.7	3.4	7	11
60	1.2	1.4	2.8	6	9
70	1.0	1.2	2.4	5	8
80	0.9	1.1	2.1	4	7
90	0.8	0.9	1.9	4	6
100	0.7	0.8	1.7	3.4	6
120	0.6	0.7	1.4	2.8	5
135	0.5	0.6	1.2	2.5	4
150	0.5	0.6	1.1	2.2	3.7
200	0.4	0.4	0.8	1.7	2.8
300	0.2	0.3	0.6	1.1	1.9

MICRO 4/3 SENSOR (OLYMPUS)

	HIGHEST RESOLUTION OUTPUT DEVICE				
	A3 PRINT pixel width 4800	4K TV pixel width 4000	LAPTOP SCREEN/HD TV pixel width 2000	FACEBOOK pixel width 1000	600px web image pixel width 600
RULE FACTOR	50	61	121	242	404
Lens Focal length (mm)	MAX EXPOSURE TIME (s)	MAX EXPOSURE TIME (s)	MAX EXPOSURE TIME (s)	MAX EXPOSURE TIME (s)	MAX EXPOSURE TIME (s)
4	13	15	30	61	101
8	6	8	15	30	50
10	5	6	12	24	40
12	4	5	10	20	34
14	4	4	9	17	29
16	3.2	4	8	15	25
18	2.8	3.4	7	13	22
20	2.5	3.0	6	12	20
24	2.1	2.5	5	10	17
28	1.8	2.2	4	9	14
35	1.4	1.7	3.5	7	12
40	1.3	1.5	3.0	6	10
45	1.1	1.3	2.7	5	9
50	1.0	1.2	2.4	5	8
60	0.8	1.0	2.0	4	7
70	0.7	0.9	1.7	3.5	6
80	0.6	0.8	1.5	3.0	5
90	0.6	0.7	1.3	2.7	4
100	0.5	0.6	1.2	2.4	4
120	0.4	0.5	1.0	2.0	3.4
135	0.4	0.4	0.9	1.8	3.0
150	0.3	0.4	0.8	1.6	2.7
200	0.3	0.3	0.6	1.2	2.0
300	0.2	0.2	0.4	0.8	1.3

How to use it?

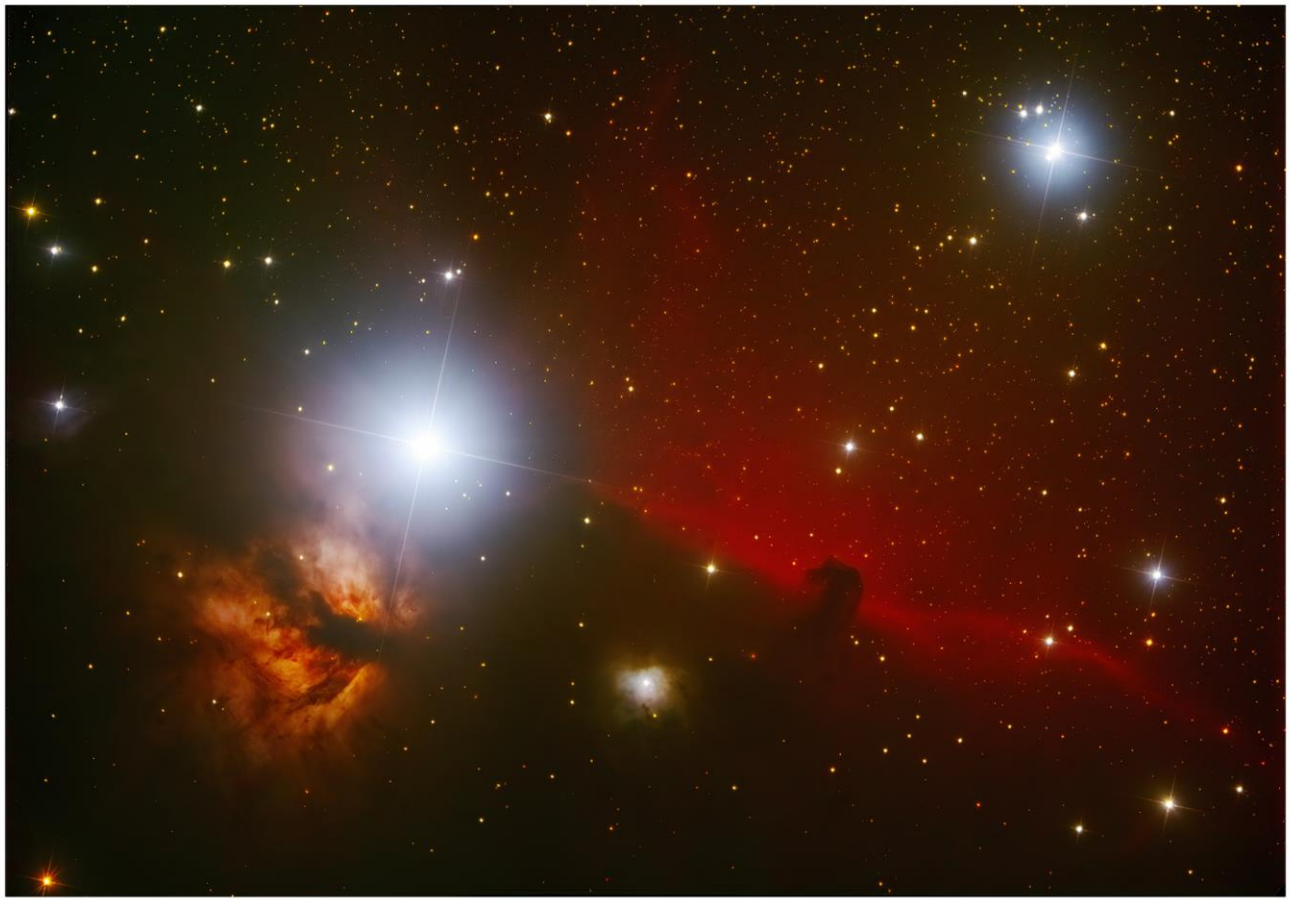
These tables use overall sensor size, final display size and lens focal length. While pixel size is important, it drops out when exposure times are calculated on final display scale. There are three tables on this page. Choose the table (full-frame, APS C, Micro 4/3rds) that corresponds to your DSLR or mirrorless camera sensor. Choose the row corresponding to the lens focal length and the column that is closest to your desired output. This is the maximum exposure time in seconds corresponding to a star movement of 1 pixel on your final output.

"Under the Milky Way tonight" © Joe Cali 2018

Panorama Stitching

When shooting panoramas, the final image ends up much bigger than the sensor's native pixel dimension. For example, my camera full frame sensor is 7400px wide. When using a 14mm lens for a 2000 pixel display the recommendation is 18s. If I produce a 21000 pixel wide pano like this one, approximately 3 times wider than my sensor, I can increase the exposure time for each panel to one minute as in the panorama example above. Trailing is visible in each individual panel when examined in detail. Once the image is stitched and down-sized for display, these short trails disappear.

When shooting star trails and time sequences, long exposures can be quite practical. In the star trail image on page 26, just after the meteor shower section, I did shoot many short 40s exposures. My original intention was to capture a time-lapse. Shooting short, point star images gives you the option of producing a star trail or a time lapse from an imaging session. When capturing for star trails only, I set my shutter speed to 2 minutes leaving me less images to composite and better signal to noise in the captured sub-exposures.



Horsehead and Flame Nebulae

Joseph Cali

Pentax K1 Vixen VC200L 1280mm f6.4

Two Panel Mosaic: ISO 12800 Left side: 23 x 120s Right Side: 17 x 120s

Times Of Sunrise And Sunset

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

Times Of Sunrise And Sunset

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

Times Of Astronomical Twilight

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

Times Of Astronomical Twilight

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


The
Moon

Moon Rise and Moon Set Jan-Jun, 2023

Times Of Moonrise And Moonset												
	Jan		Feb		Mar		Apr		May		Jun	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	15:14	1:42	17:11	1:56	16:01	0:36	16:48	2:05	15:12	1:50	14:53	3:34
2	16:16	2:11	18:06	2:41	16:52	1:25	17:18	3:05	15:36	2:49	15:24	4:39
3	17:18	2:42	18:55	3:31	17:36	2:19	16:45	3:04	16:00	3:48	16:01	5:48
4	18:19	3:17	19:37	4:27	18:14	3:17	17:10	4:03	16:26	4:48	16:47	6:59
5	19:17	3:58	20:13	5:25	18:47	4:16	17:34	5:01	16:55	5:52	17:44	8:11
6	20:10	4:45	20:45	6:24	19:16	5:15	17:59	6:01	17:28	6:58	18:50	9:17
7	20:57	5:37	21:13	7:23	19:42	6:14	18:25	7:02	18:09	8:08	20:02	10:15
8	21:37	6:33	21:38	8:21	20:07	7:13	18:55	8:06	18:58	9:18	21:17	11:02
9	22:12	7:32	22:02	9:19	20:31	8:11	19:30	9:12	19:56	10:27	22:29	11:42
10	22:42	8:31	22:26	10:17	20:56	9:10	20:12	10:21	21:03	11:28	23:39	12:15
11	23:09	9:29	22:52	11:16	21:23	10:11	21:03	11:29	22:15	12:20		12:44
12	23:34	10:27	23:20	12:17	21:53	11:15	22:03	12:34	23:27	13:04	0:47	13:11
13	23:58	11:25	23:52	13:21	22:30	12:21	23:11	13:32		13:40	1:52	13:38
14		12:23		14:29	23:14	13:29		14:22	0:38	14:12	2:57	14:07
15	0:23	13:23	0:32	15:39		14:36	0:24	15:03	1:47	14:40	4:02	14:38
16	0:50	14:27	1:21	16:47	0:08	15:40	1:37	15:38	2:54	15:07	5:08	15:13
17	1:20	15:34	2:20	17:51	1:12	16:36	2:48	16:09	4:00	15:35	6:12	15:54
18	1:56	16:46	3:30	18:46	2:23	17:24	3:58	16:38	5:06	16:05	7:14	16:41
19	2:41	17:58	4:46	19:32	3:38	18:05	5:06	17:06	6:12	16:37	8:10	17:34
20	3:37	19:07	6:04	20:11	4:53	18:39	6:14	17:35	7:19	17:15	9:00	18:31
21	4:44	20:09	7:20	20:44	6:07	19:10	7:22	18:06	8:24	17:59	9:42	19:31
22	5:59	21:00	8:32	21:14	7:17	19:39	8:29	18:41	9:24	18:48	10:18	20:30
23	7:17	21:43	9:42	21:42	8:27	20:07	9:35	19:21	10:18	19:43	10:48	21:29
24	8:34	22:18	10:49	22:11	9:35	20:37	10:39	20:07	11:05	20:42	11:15	22:26
25	9:47	22:48	11:55	22:41	10:42	21:10	11:36	20:59	11:45	21:41	11:39	23:23
26	10:56	23:17	13:00	23:15	11:48	21:47	12:27	21:55	12:18	22:40	12:03	
27	12:02	23:44	14:04	23:53	12:52	22:29	13:11	22:54	12:47	23:38	12:26	0:20
28	13:06		15:04		13:52	23:17	13:47	23:53	13:13		12:52	1:19
29	14:09	0:13			14:46		14:19		13:37	0:36	13:20	2:21
30	15:11	0:43			15:33	0:10	14:46	0:52	14:01	1:34	13:54	3:27
31	16:13	1:17			16:14	1:06			14:26	2:33		

TIMES IN BLUE – EASTERN SUMMER TIME **TIMES IN BLACK – EASTERN STANDARD TIME**

Moon Rise and Moon Set Jul-Dec, 2023

Times Of Moonrise And Moonset												
	Jul		Aug		Sep		Oct		Nov		Dec	
DATE	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	14:35	4:36	16:31	6:40	19:08	7:10	20:17	6:35	23:28	7:59	23:49	8:32
2	15:27	5:48	17:49	7:29	20:19	7:40	22:28	8:07		8:50		9:34
3	16:29	6:58	19:06	8:09	21:30	8:09	23:37	8:43	0:25	9:47	0:26	10:35
4	17:41	8:01	20:20	8:44	22:39	8:39		9:23	1:14	10:47	0:57	11:34
5	18:58	8:54	21:31	9:14	23:47	9:12	0:43	10:10	1:54	11:48	1:24	12:32
6	20:14	9:38	22:39	9:43		9:48	1:43	11:03	2:28	12:47	1:48	13:28
7	21:28	10:15	23:46	10:11	0:53	10:30	2:35	12:00	2:57	13:46	2:11	14:25
8	22:37	10:46		10:41	1:55	11:18	3:19	12:59	3:22	14:43	2:33	15:22
9	23:45	11:14	0:53	11:14	2:50	12:12	3:56	13:59	3:46	15:40	2:58	16:22
10		11:42	1:58	11:51	3:39	13:09	4:28	14:58	4:09	16:37	3:24	17:25
11	0:50	12:10	3:02	12:34	4:20	14:08	4:55	15:56	4:32	17:36	3:55	18:32
12	1:56	12:40	4:01	13:24	4:55	15:08	5:20	16:53	4:57	18:38	4:33	19:41
13	3:01	13:14	4:54	14:18	5:25	16:06	5:43	17:50	5:26	19:43	5:20	20:48
14	4:05	13:52	5:40	15:16	5:51	17:04	6:06	18:48	5:59	20:50	6:16	21:51
15	5:07	14:37	6:19	16:15	6:15	18:01	6:30	19:48	6:40	21:57	7:22	22:45
16	6:05	15:28	6:52	17:15	6:38	18:58	6:56	20:50	7:29	23:02	8:34	23:30
17	6:56	16:24	7:21	18:13	7:01	19:55	7:25	21:54	8:28		9:48	
18	7:40	17:23	7:47	19:10	7:25	20:55	8:00	23:01	9:35	0:01	11:01	0:07
19	8:18	18:22	8:10	20:06	7:52	21:57	8:43		10:46	0:49	12:11	0:39
20	8:50	19:21	8:33	21:03	8:23	23:02	9:34	0:07	11:58	1:31	13:19	1:08
21	9:17	20:19	8:56	22:01	9:00		10:35	1:08	13:09	2:06	14:26	1:35
22	9:42	21:15	9:21	23:01	9:45	0:08	11:43	2:03	14:18	2:36	15:32	2:03
23	10:06	22:12	9:49		10:40	1:13	12:55	2:50	15:26	3:05	16:40	2:33
24	10:29	23:09	10:22	0:04	11:44	2:14	14:08	3:30	16:34	3:32	17:48	3:06
25	10:53		11:02	1:10	12:56	3:07	15:20	4:04	17:43	4:01	18:56	3:44
26	11:19	0:08	11:52	2:18	14:11	3:53	16:31	4:34	18:53	4:32	19:58	4:29
27	11:49	1:11	12:52	3:24	15:27	4:32	17:42	5:03	20:03	5:08	20:55	5:21
28	12:26	2:17	14:03	4:24	16:41	5:05	18:52	5:32	21:10	5:49	21:43	6:19
29	13:11	3:26	15:19	5:16	17:54	5:36	20:03	6:02	22:11	6:38	22:23	7:20
30	14:07	4:36	16:37	6:00	19:05	6:05	21:14	6:36	23:04	7:33	22:56	8:22
31	15:15	5:41	17:54	6:38			22:24	7:14			23:24	9:23

Source: Computed using National Mapping Division's moonrisenset program, version 1.2

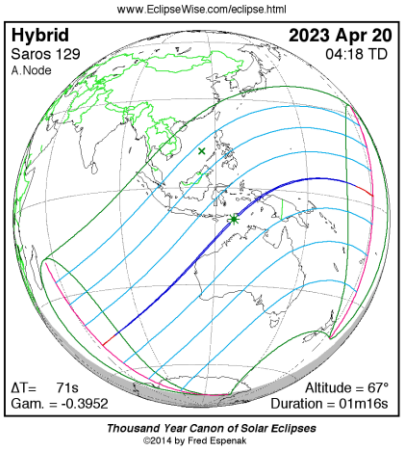
Times in bold blue are Australian Eastern Daylight Time (AEDT). Times in Black are Australian Eastern Time.

Eclipses of 2023

Eclipse Predictions and some graphics by Fred Espenak, http://www.EclipseWise.com
Reproduced by permission.

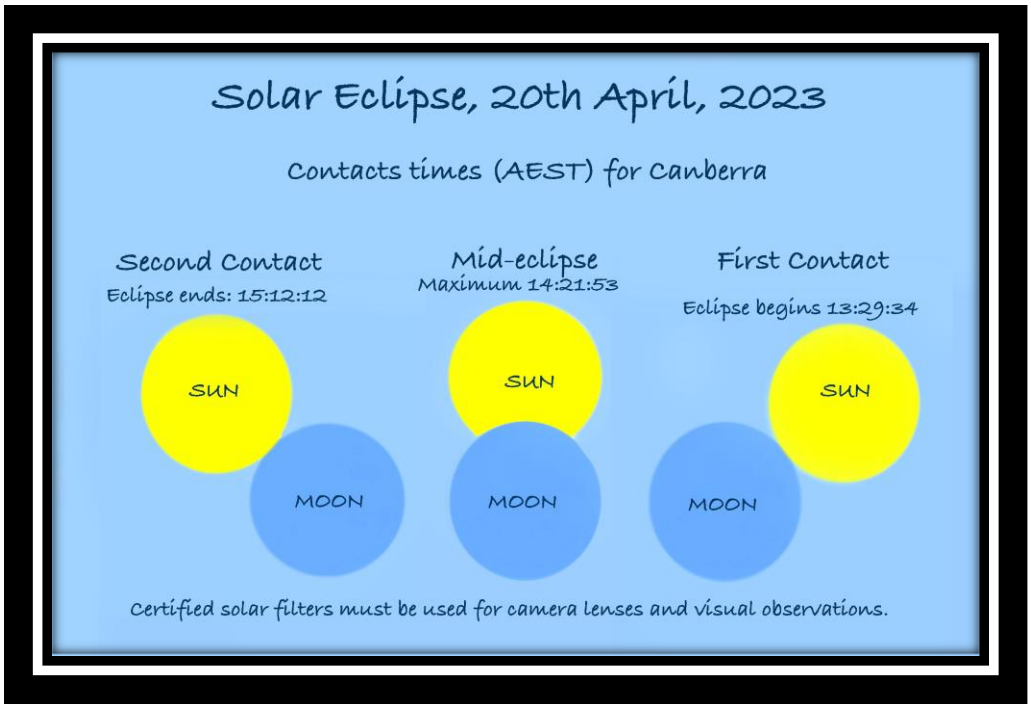
Three eclipses are visible from southeast Australia during 2023. A solar eclipse occurs on April 20th and two lunar eclipses occur on May 5th (penumbral) and October 28th(partial)

Hybrid Annular-Total Solar Eclipse, April 20th 2023



A hybrid eclipse is one where the Earth's surface is very close to the end of the Moon's umbral cone (shadow cone). On the centre line, the eclipses are seen as an annular eclipse at the beginning, or end, or both, but this changes to a total solar eclipse in the centre of the path as the Earth's surface contacts the end of the umbral cone. Such eclipses are typically of short duration due to the shallow immersion in the umbra. This eclipse is no exception. The eclipse can be observed as a total eclipse of 60s duration, from Exmouth, Western Australia. Exmouth is the only landfall of totality on the Australian continent.

From southeast Australia, a partial solar eclipse is visible. Solar eclipse observers express the amount of a partial eclipse by two measures. The **eclipse magnitude** is the ratio or fraction of overlap of the diameters of the two bodies. The other measure is called eclipse obscuration and is expressed as a percentage of the area of the sun that is obscured by the Moon. From Canberra, the eclipse magnitude is 0.19 at maximum and the obscuration is 9.8% as illustrated below.

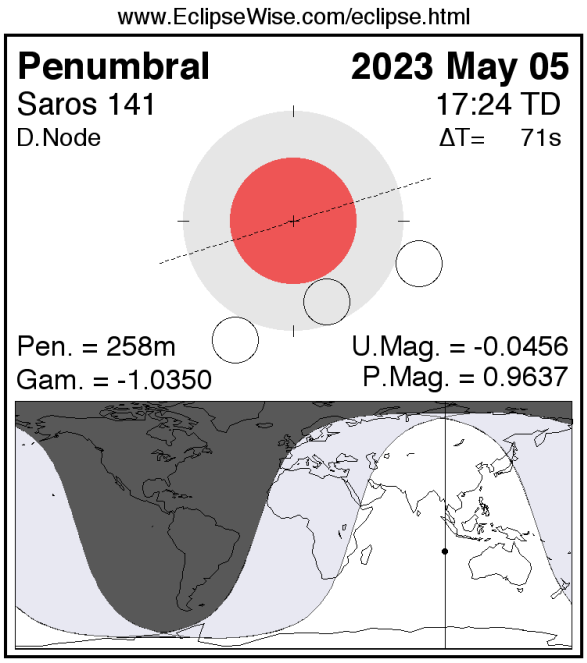


Event (ΔT=70.8s)	Date	Time (UT)	Alt	Azi
Start of partial eclipse (C1)	2023/04/20	03:29:34.4	+38.9°	332.1°
Maximum eclipse (MAX)	2023/04/20	04:21:53.0	+32.8°	318.2°
End of partial eclipse (C4)	2023/04/20	05:12:12.2	+25.2°	307.0°

MORE ABOUT SOLAR FILTERS: https://joe-cali.com/eclipses/EQUIPMENT/solarfilters.html

EYE SAFETY - SOLAR ECLIPSES: https://joe-cali.com/eclipses/Eye_Safety/index.html

Penumbral Lunar Eclipse May 5th 2023



Thousand Year Canon of Lunar Eclipses

A penumbral eclipse of the Moon occurs 2 weeks after the solar eclipse. A penumbral eclipse of the Moon is barely noticeable to the eye even with telescopic viewing.

The Moon does not pass through the dark umbral shadow, rather through the softer penumbral shadow. Standing on the Moon, an observer would observe a partial eclipse of the Sun by the Earth. From Earth, a very slight darkening of one limb may be observed as the Moon grazes the dark umbra.

Lunar Eclipse Contact Times Canberra

Eclipse Event	Contact	Time (EST / UT+10)
Penumbral Begins	P1	01:14:08.0
Greatest Eclipse	Greatest	03:22:53.5
Penumbral Ends	P4	05:31:44.5

Eclipse Durations

Eclipse Phase	Duration
Penumbral (P4 - P1)	04h17m36.5s

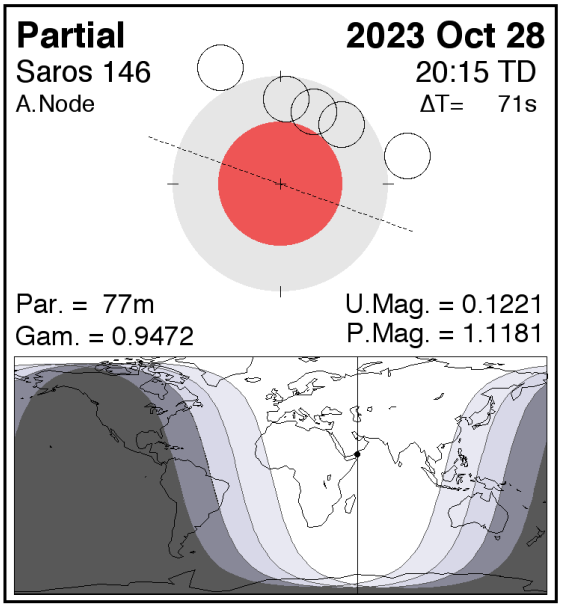
Eclipse Contacts: Partial Lunar Eclipse of 2023 Oct 28

On October 28th the first penumbral part of a partial lunar eclipse can be observed. Unfortunately the Moon sets 30 mins before the partial eclipse begins. So about an hour of penumbral eclipse occurs before the Moon sets.

Lunar Eclipse Contacts

Eclipse Event	Contact	Time AEDT	Moon Altitude	Moon Azimuth
Penumbral Begins	P1	05:01:44.8	+09° 49′	294°37'
Moonset	_	06:02:00	0°	287°22'
Partial Begins	U1	06:35:19.2	-06°11'	283°12'
Greatest Eclipse	Greatest	07:14:05.9	-14°03'	278°16'
Partial Ends	U4	07:52:42.1	-21°39'	273°30'
Penumbral Ends	P4	09:26:23.9	-40°24'	260°27'

www.EclipseWise.com/eclipse.html



Thousand Year Canon of Lunar Eclipses
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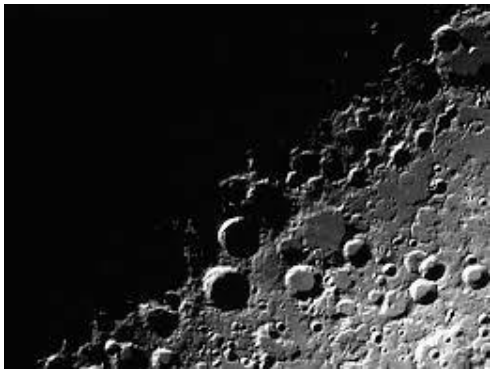
Eclipse Durations

Eclipse Phase	Duration
Penumbral (P4 - P1)	04h24m39.1s
Partial (U4 - U1)	01h17m22.9s

Lunar X

The Lunar X is a feature formed by two ridges that when stuck at a very low angle by sunlight, appear to form the letter X.



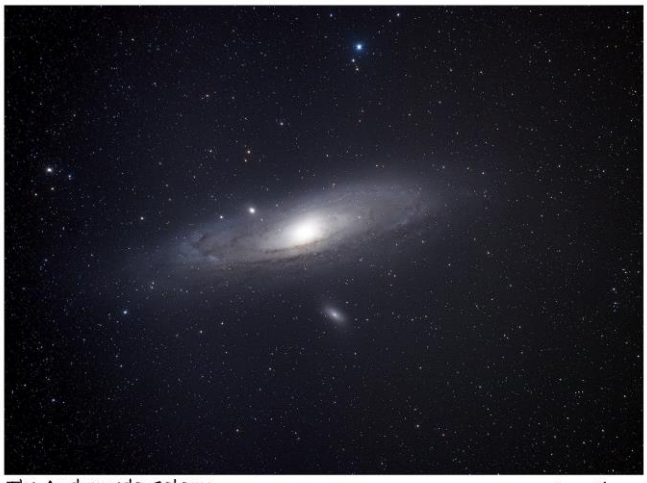
Searching for Sun Angle = -0.9000° over feature at 0.900°E 25.300°S

On these dates and times, search the lunar terminator just south of the centre of the Moon to try to see the lunar X.

		Sun Angle		Sub-Solar Point		Librations			Phase		
Date	Time UT	Altitude	Azimuth	Colong	Lat.	Long.	Lat.	Elong.	%Illum.	Age	
30/12/2022	10:26:59	-0.9000	91.8746	357.485	-1.310	7.405	3.098	94.662	54.193	7.007	*+
29/01/2023	00:51:04	-0.9000	92.1355	357.373	-1.546	7.431	-0.575	94.666	54.199	7.165	*+
27/02/2023	15:15:36	-0.9000	91.8897	357.478	-1.323	5.963	-3.944	93.370	53.073	7.340	*+
29/03/2023	05:12:40	-0.9000	91.2244	357.763	-0.722	3.544	-6.171	91.223	51.202	7.493	*+
27/04/2023	18:23:10	-0.9000	90.3456	358.139	0.072	0.680	-6.858	88.665	48.969	7.591	*+
27/05/2023	06:41:36	-0.9000	89.5003	358.500	0.836	-2.231	-5.973	86.051	46.689	7.617	*+
25/06/2023	18:15:17	-0.9000	88.9069	358.753	1.373	-4.832	-3.748	83.696	44.640	7.568	*+
25/07/2023	05:20:56	-0.9000	88.7117	358.837	1.549	-6.728	-0.624	81.948	43.124	7.451	*+
23/08/2023	16:20:56	-0.9000	88.9653	358.728	1.320	-7.477	2.757	81.183	42.461	7.280	*+
22/09/2023	03:39:52	-0.9000	89.6115	358.452	0.736	-6.701	5.547	81.720	42.923	7.083	*+
21/10/2023	15:40:08	-0.9000	90.4897	358.077	-0.058	-4.337	6.795	83.634	44.580	6.906	*+
20/11/2023	04:36:21	-0.9000	91.3595	357.705	-0.844	-0.892	5.822	86.602	47.161	6.798	*+
19/12/2023	18:29:15	-0.9000	91.9607	357.448	-1.388	2.673	2.766	89.909	50.047	6.790	*+

* = Target feature on visible disk
+ = Azimuth of Sun within 5.00° of target (= 90.000°)

Source: Lunar Terminator Visualisation Tool



The Andromeda Galaxy Joseph Cali

Meteor Shower Calendar

The meteor showers listed below are the easiest to observe and provide the most activity from the Canberra region. Particular attention should be noted to the time and moonlight conditions. **Most showers are best seen after midnight when the part of the night sky you are observing is heading towards the oncoming meteors. Early evening, the night sky is trailing the Earth's motion.** Most are not even visible until after midnight. Showers that peak with the moon's phase greater than one half illuminated (first quarter to last quarter) will be affected by moonlight and difficult to observe. While the time each shower is best seen remains much the same year after year, the moonlight conditions change considerably from one year to the next.

Lyrids

Active from April 16th to April 25th. Peak night Apr 21-22.

Medium strength shower with decent rates for three nights around the maximum. Fireballs possible. In Canberra, the radiant is low in the sky, just 20° altitude & due north at 4:20am. Activity from this shower can be seen from the southern hemisphere, but at a lower rate. Even though these are called the Lyrids, the radiant is in Hercules not far from Vega. At peak on April 21-22 a near new Moon will not interfere with observations in the pre-dawn hours.

Radiant: RA:18:04 **DEC:** +34° - **ZHR**: 18 - Velocity: 30 miles/sec (medium - 48.4km/sec) - Parent Object: C/1861 G1 (Thatcher)

Eta Aquariids

Active from April 19th to May 26th. Peak night May 6-7

Great shower when viewed from northern Australia where they can produce rates of 40-60 per hour. I saw a display like this from Karjini National Park in 2013 just before dawn on a couple of mornings. Rates I've observed from Canberra's latitude have been disappointing by comparison to the show at Karjini. Activity is near peak for a week centred on May 6-7. On May 6-7, a near full Moon will make observing difficult.

Radiant: RA:22:32 **DEC:** -1° - **ZHR**: 55 - Velocity: 42 miles/sec (swift - 66.9km/sec) - Parent Object: 1P/Halley

Southern Delta Aquariids

Active from July 21st to August 23rd. Peak night Jul 29-30

The Delta Aquariids, like the Eta Aquarids are best observed from northern Australia. These meteors also produce numbers for a week centred July 29-30. These are usually faint meteors that lack both persistent trains and fireballs. In 2023, a near full Moon on August 1 will make observing difficult. Early in the week the Moon sets a few hours before twilight begins. On the peak night of July 29, a 2 hr window after moonset is available.

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Radiant: RA: 22:40 **DEC:** -16.4° - **ZHR**: 16 - Velocity: 26 miles/sec (medium - 42km/sec) - Parent Object: 96P/Machholz

Alpha Capricornids

Active from July 11th to August 10th. Peak night Jul 26-27

The Alpha Capricornids are not very active with peak rates of five shower members per hour. The shower can produce bright fireballs and are seen as well from Canberra's latitude as anywhere else. In 2023, a near full Moon on August 1 will make observing difficult late in the observation window. Early in the observing window, the Moon sets some hours before twilight begins. On the peak night of July 26, the Moon sets at 1am leaving a 4 hr window after moonset for meteor watching.

Radiant: RA: 20:28 **DEC:** -10.2° - **ZHR**: 5 - Velocity: 15 miles/sec (slow - 24km/sec) - Parent Object: 169P/NEAT

Perseids

Active from July 13th to August 26th. Peak night Aug 11-12

The Perseids are the most popular meteor shower internationally as they peak on warm August nights as seen from the northern hemisphere. The Perseids are active from July 13 to August 26.

They reach a strong maximum on August 12 or 13, depending on the year. Normal rates seen from rural locations range from 50-75 shower members per hour at maximum. They are well worth a look if you are in the northern hemisphere or even far north Australia but from Canberra, the radiant never rises above the horizon and so we don't see much of a show though some meteors are always visible. In 2023, the peak on Aug 11-12 occurs just a couple of days before new Moon.
Radiant: RA: 03:12 **DEC:** +57.6° - **ZHR**: 100 - Velocity: 37 miles/sec (swift - 60km/sec) - Parent Object: 109P/Swift-Tuttle

Orionids
Active from September 23rd to November 27th. Peak night Oct 21-22
The Orionids are a medium strength shower that sometimes reaches high strength activity. In a normal year the Orionids produce 20-25 shower members at maximum. In exceptional years, such as 2006-2009, the peak rates were on par with the Perseids (50-75 per hour). No accurate prediction model exists but a 12-year cycle is theorised. In 2023, the peak occurs in the days around first quarter, the Moon sets around midnight leaving the morning hours moonless for meteor.
Radiant: RA: 06:20 **DEC:** +15.5° - **ZHR:** 25 - Velocity: 41 miles/sec (swift - 67km/sec) - Parent Object: 1P/Halley

Southern Taurids
Active from September 23rd to November 19th. Peak night Oct 28-29
The Southern Taurids are a long-lasting shower with several minor peaks in October and November. The shower is active for two months but rarely produces more than five shower members per hour, even at maximum activity. The Taurids (both branches) are most notable for colourful fireballs and are often responsible for an increased number of fireball reports from September through November. The shower is active for nearly two months so organise pre-dawn observing activities anytime from new Moons until a few days before full Moons. Peak night of October 28 is full Moon the Moon will interfere all night.
Radiant: RA: 03:12 **DEC:** +12.8° - **ZHR**: 5 - Velocity: 17 miles/sec (slow - 27km/sec) - Parent Object: 2P/Encke

Northern Taurids
Active from October 19th to December 10th. Peak night Nov 10-11.
This shower is much like the Southern Taurids, just active a bit later in the year. When the two showers are active simultaneously in late October and early November, there is sometimes a notable increase in the fireball activity. There seems to be a seven-year periodicity with these fireballs. 2008 was the last remarkable year so 2022 is a possibility. The shower is active for nearly two months so organise pre-dawn observing activities anytime from new Moons until a few days before full Moons. The peak nights of Nov 10-11 are just before the November 13 new Moon in 2023.
Radiant: RA: 03:52 **DEC:** +22.7° - **ZHR**: 5 - Velocity: 18 miles/sec (medium - 30km/sec) - Parent Object: 2P/Encke

Leonids
Active from November 5th to November 30th. Peak night Nov 17-18.
The Leonids are best known for producing great meteor storms in the years of 1833, 1866, 1966, and 2001.

In the late 1990's, Asher and McNaught modelled the orbits of clusters of material reduced from observations of earlier outbursts. They published predictions of high activity, predicting both time and geographic location for high activity showers during the 1999-2001 peak.

- https://www.theguardian.com/science/2000/nov/16/technology
- https://science.nasa.gov/science-news/science-at-nasa/2001/ast08nov_1

This was a seminal paper and ground-breaking prediction technique. I drove to western Queensland (near Quilpie) in November 2001 using these predictions and was privileged to see a great display of bright Leonid fireballs perhaps 60 per hour. These outbursts of meteor activity are best seen when the parent object, comet 55P/Tempel-Tuttle, is closest to the Sun.

Unfortunately, it appears that the Earth will not encounter any dense clouds of debris again until 2099. Therefore, when the comet returns in 2031 and 2064, there will be no meteor storms, but perhaps several good displays of Leonid activity when rates are in excess of 100 per hour. The best we can hope for now until the year 2030 is peaks of around 15 shower members per hour and perhaps an occasional weak outburst when the earth passes near a debris trail. The Leonids are often bright meteors with a high percentage of persistent trains. . This year's event peaks around first quarter so the moon will set around midnight and won't interfere with post midnight meteor observations.
Radiant: RA: 10:08 **DEC:** +21.6° - **ZHR**: 15 - Velocity: 44 miles/sec (swift - 71km/sec) - Parent Object: 55P/Tempel-Tuttle

Geminids
Active from December 4th to December 16th. Peak night Dec 13-14
The Geminids are usually the strongest meteor shower of the year for northern hemisphere observers. The Geminids are often bright and intensely coloured. Due to their medium-slow velocity, persistent trains are not usually seen. These meteors are also seen in the southern hemisphere, but at a reduced rate. On the peak night in 2023, the Moon is 2 days after a new moon setting soon after twilight and leaving the early morning hours moonless for meteor observations. **Radiant: RA:** 07:28 **DEC:** +32.2° - **ZHR**: 120 - Velocity: 22 miles/sec (medium - 35km/sec) - Parent Object: 3200 Phaethon (asteroid)

Comet Leonard C/2021-A1 with intruding meteor

On Boxing Day 2021, Comet Leonard was at what was probably at its brightest. In other pictures taken that night I recorded a 10+ degree tail through the thin cloud

Pentax K1 Rokinon 135mm ED f2
Single exposure raw processed in Adobe Lightroom and Adobe Photoshop.

Comet ZTF 2022 E3 – February 9-15, 2023

ZTF is an abbreviation for the **Zwicky Transient Facility**, a large northern hemisphere survey telescope that surveys the entire night sky every couple of nights looking for transient objects such as comets and asteroids.

Comet ZTF 2022 E3 was discovered by the ZTF on March 2, 2022 at a very faint magnitude 17. This is too faint to be observed visually even through an 18-inch telescope. Northern hemisphere observers are already enjoying a telescopic comet with interesting details in the ion and dust tails as can be seen in this NASA ApOD.

Its predicted peak brightness is approximately magnitude 5 on Feb 1 but the comet will be sitting below our northern horizon. It first appears right on the northern horizon at a peak altitude of 0.5^{o} at 9:30pm on Feb 4.

With a near full Moon nearby and the low altitude, it will be all but invisible unless it goes into an enormous outburst and is vastly brighter than predicted, a highly unlikely but possible occurrence.

Observing the comet will be very difficult from Feb 4 to 9 with the Moon running interference and the comet only increasing it's altitude slowly.

What does magnitude 5 mean?

It is near the limit of naked eye visibility. Each astronomical magnitude is 2.512 times brighter than the next step down. Alpha Centauri, the brightest of the two pointers is close to mag 0. Mag 5 is 100 times fainter. But stars are point sources, all the light comes from a tiny part of the sky, comets, nebulae or clusters have their light spread over an area. The globular cluster 47 Tucanae next to the Small Magellanic Cloud is magnitude 4.1, twice as bright as mag 5 and has a diameter similar to what this comet might have. So if you check that out with binoculars and your naked eye, you'll get an idea of what it might be like if it follows the predicted brightness curve.

The best observing window in SE NSW, taking comet altitude and in Moon into account is after 21:45 on 9th Feb and continuing around this time for about a week. 21:45 is just after astronomical twilight, or true dark, and before moonrise. The window of darkness is very short on 9th February then gets longer with each passing night as the comet gets higher and the moon rises later. Unfortunately as the comet gets higher in the sky and away from the moon, it will also be fading.

Bessellian Orbital Elements (to enter into your own astro-planetarium program)

Orbital Elements

```
Epoch 2023 Feb. 25.0 TT = JDT 2460000.5
T 2023 Jan. 12.78408 TT                                  Rudenko
q   1.1122378            (2000.0)            P               Q
z  -0.0002969      Peri.  145.81568     -0.60063860     -0.07340616
 +/-0.0000008      Node   302.55525     +0.33753478     +0.87940598
e   1.0003303      Incl.  109.16805     +0.72477827     -0.47037927
>From 4715 observations 2021 July 10-2022 Dec. 23, mean residual 0".5.
```

Source Seiichi Yoshida's Bright Comet Page
http://www.aerith.net/comet/catalog/2022E3/2022E3.html

Finding the comet

I have prepared a finder chart on the next page. Of special note, the head of the comet will be right next to Mars on Saturday February 11 and very easy to find. By the 15th it will be next to Aldebaran, the bright orange star in Taurus.

Best viewing dates in SE NSW: February 9-15, 2023

Finder chart Comet ZTF 2022 E3 February 9-15