

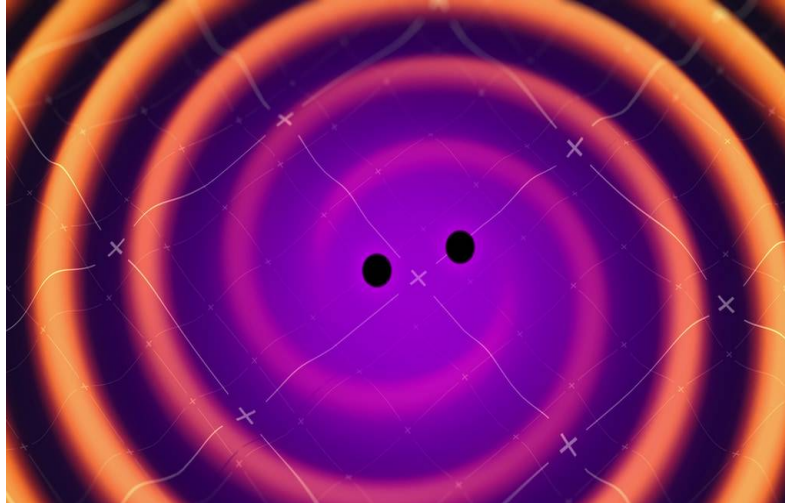
### Night Sky Notes: Let's Go, LIGO!

By Kat Troche



This article is distributed by NASA's Night Sky Network (NSN). The NSN program supports astronomy clubs across the USA dedicated to astronomy outreach. Visit [go.nasa.gov/nightskynetwork](http://go.nasa.gov/nightskynetwork) to find local clubs, events, and more!

supernova, it could produce the same effect. Neutron stars can also create these waves for various reasons. While these waves are invisible to the human eye, [this animation](#) from NASA's Science Visualization Studio shows the merger of two black holes and the waves they create in the process.



Two black holes orbit around each other and generate space-time ripples called gravitational waves in this image. Credit: NASA's Goddard Space Flight Center Conceptual Image Lab

September 2025 marks ten years since the first direct detection of gravitational waves as predicted by Albert Einstein's 1916 theory of General Relativity. These invisible ripples in space were first directly detected by the Laser Interferometer Gravitational-Wave Observatory (LIGO). Traveling at the speed of light (~186,000 miles per second), these waves stretch and squeeze the fabric of space itself, changing the distance between objects as they pass.

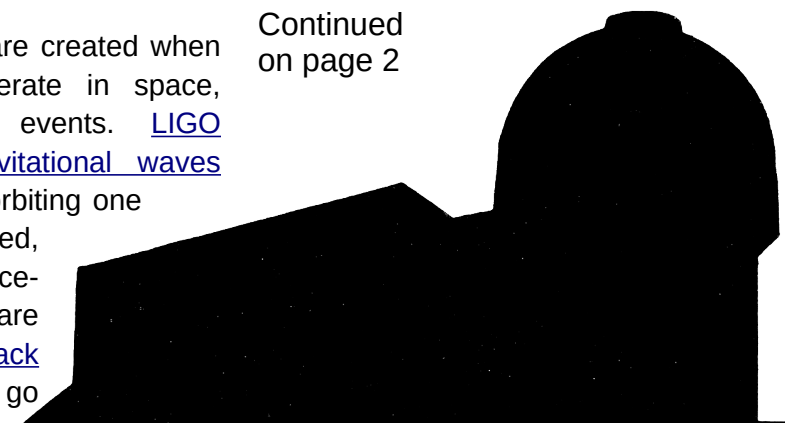
#### Waves In Space

Gravitational waves are created when massive objects accelerate in space, especially in violent events. [LIGO detected the first gravitational waves](#) when two black holes, orbiting one another, finally merged, creating ripples in space-time. But these waves are [not exclusive to black holes](#). If a star were to go

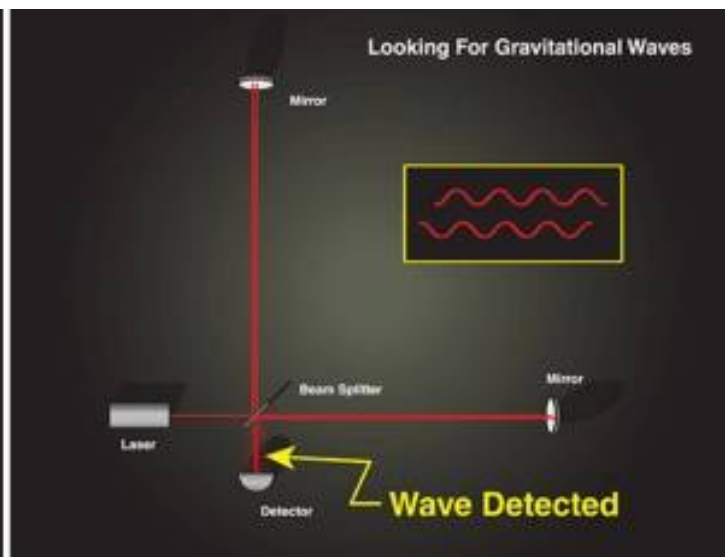
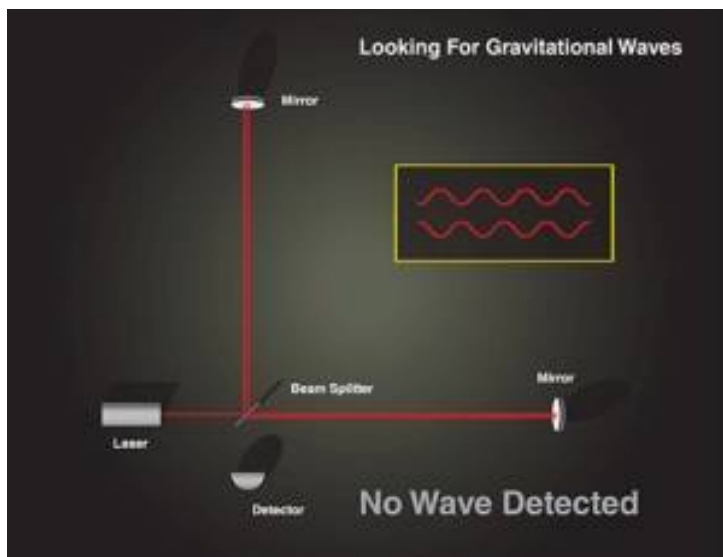
#### How It Works

A gravitational wave observatory, like LIGO, is built with two tunnels, each approximately 2.5 miles long, arranged in an "L" shape. At the end of each tunnel, a highly polished 40 kg mirror (about 16 inches across) is mounted; this will reflect the laser beam that is sent from the observatory. A laser beam is sent from the observatory room and split into two, with equal parts traveling down each tunnel, bouncing off the mirrors at the end. When the beams return, they are recombined. If the arm lengths are perfectly equal, the light waves cancel out in just the right way, producing darkness at the detector. But if a gravitational wave passes, it slightly stretches one arm while squeezing the other, so the returning beams no longer cancel perfectly, creating a flicker of light that reveals the wave's presence.

Continued on page 2



## Ligo... (Continued from page 1).



The actual detection happens at the point of recombination, when even a minuscule stretching of one arm and squeezing of the other changes how long it takes the laser beams to return. This difference produces a measurable shift in the interference pattern. To be certain that the signal is real and not local noise, both LIGO observatories — one in Washington State (LIGO Hanford) and the other in Louisiana (LIGO Livingston) — must record the same pattern within milliseconds. When they do, it's confirmation of a gravitational wave rippling through Earth. We don't feel these waves as they pass through our planet, but we now have a method of detecting them!

### Get Involved

With the help of two additional gravitational-wave observatories, [VIRGO](#) and [KAGRA](#), there have been [300 black hole mergers detected in the past decade](#); some of which are confirmed, while others await further study.

While the average person may not have a laser interferometer lying around in the backyard, you can

help with two projects geared toward detecting gravitational waves and the black holes that contribute to them:

- **Black Hole Hunters:** Using data from the [TESS satellite](#), you would study graphs of how the brightness of stars changes over time, looking for an effect called gravitational microlensing. This lensing effect can indicate that a massive object has passed in front of a star, such as a black hole.
- **Gravity Spy:** You can help LIGO scientists with their gravitational wave research by looking for glitches that may mimic gravitational waves. By sorting out the mimics, we can train algorithms on how to detect the real thing.

You can also use gelatin, magnetic marbles, and a small mirror for a more hands-on demonstration on how gravitational waves move through space-time with JPL's [Dropping In With Gravitational Waves](#) activity! ★

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### Grand Traverse Astronomical Society - Est. June 1982 – 43 years of service

-----Officers-----		-----Directors-----	-----Patrons-----
President	Jerry Dobek	Charles Bell	Charles Bell, Robert Carroll & Terri Mills, Daniel Dall'Olmo, Jessica DeWitt, Don and Kathy Flegel, Bill Hathaway, Richard Kuschell, Mark Leugers, Judy Moler, Ronald & Jan Uthe
Vice President	Kim Dobek	Don Flegel	
Secretary	Joe Brooks	Bill Hathaway	
Treasurer	Gary Carlisle		
Editor	Bob Moler, transitioning to Mary Gribbin		

## Upcoming Society Events

Events not held at the Joseph H. Rogers Observatory depend on the weather.

**Friday, December 5 – Monthly meeting and star party** at NMC Rogers Observatory. Also available via **Zoom**. See our website <http://www.gtastro.org> for instructions and a link.

7 PM – Board of Directors Meeting

8 PM – General Meeting: Bob Moler will continue his December series on ancient astronomy with ***Ptolemy—The Good, Bad and the Ugly***.

9 PM – Star Party, if it is clear.

**Friday, January 2 – Monthly meeting and star party** at NMC Rogers Observatory. Also available via **Zoom**. See our website <http://www.gtastro.org> for instructions and a link.

7 PM – Board of Directors Meeting

8 PM – General Meeting

9 PM – Star Party, if it is clear.

### Zoom Meeting Link:

<https://us02web.zoom.us/j/8388913229?omn=88435646093>

## Membership renewals for 2026

2026 will be the second year that we are having everyone's dues expire at the end of the year, rather than at various times during the year. Last year due to some mix ups on our part, we have lost some members. We will endeavor to gain those members back by sending this newsletter out to everyone even those who did not renew for the current year.

I, your Newsletter Editor, with Board approval, will extend the reception of the Stellar Sentinel to February for delinquent members. Only those who have paid their dues by mid-February will receive further Stellar Sentinels, or be eligible to run for, or serve as a Board Member.

The application/renewal form is blank, so for renewals Just enter your name, email address, dues information and any other information that changed.

I will endeavor to produce an application/renewal form that can be filled in via Acrobat Reader and other PDF reader apps. The form can be saved, printed or

sent via email. I have an idea I'll discuss with the Board this December meeting to help with the dues process, and the accurate recording of the above. ★



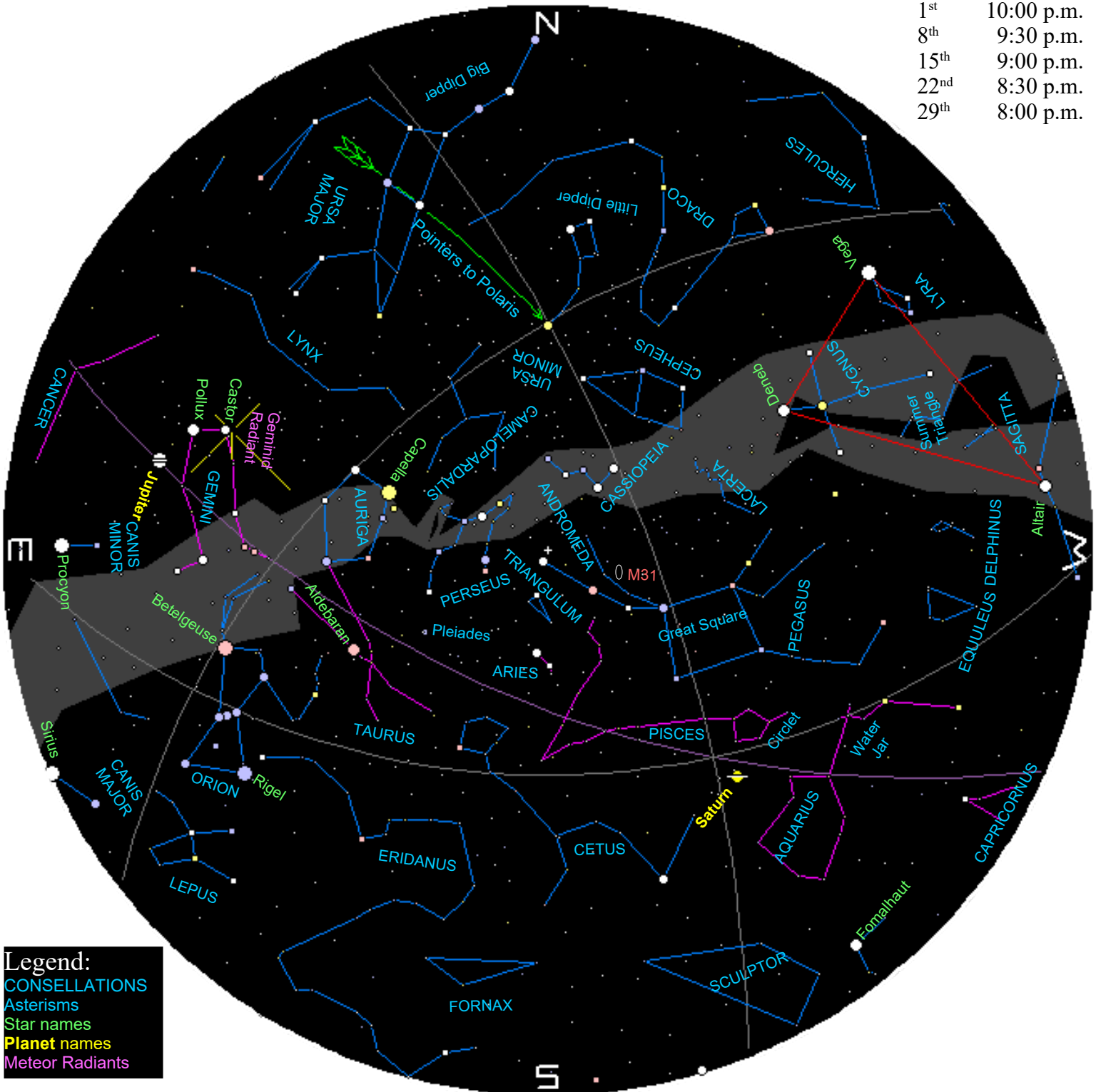
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# The Stars and Planets for December 2025

By Bob Moler

Planets are plotted for mid month. The star positions are correct for:

1 <sup>st</sup>	10:00 p.m.
8 <sup>th</sup>	9:30 p.m.
15 <sup>th</sup>	9:00 p.m.
22 <sup>nd</sup>	8:30 p.m.
29 <sup>th</sup>	8:00 p.m.

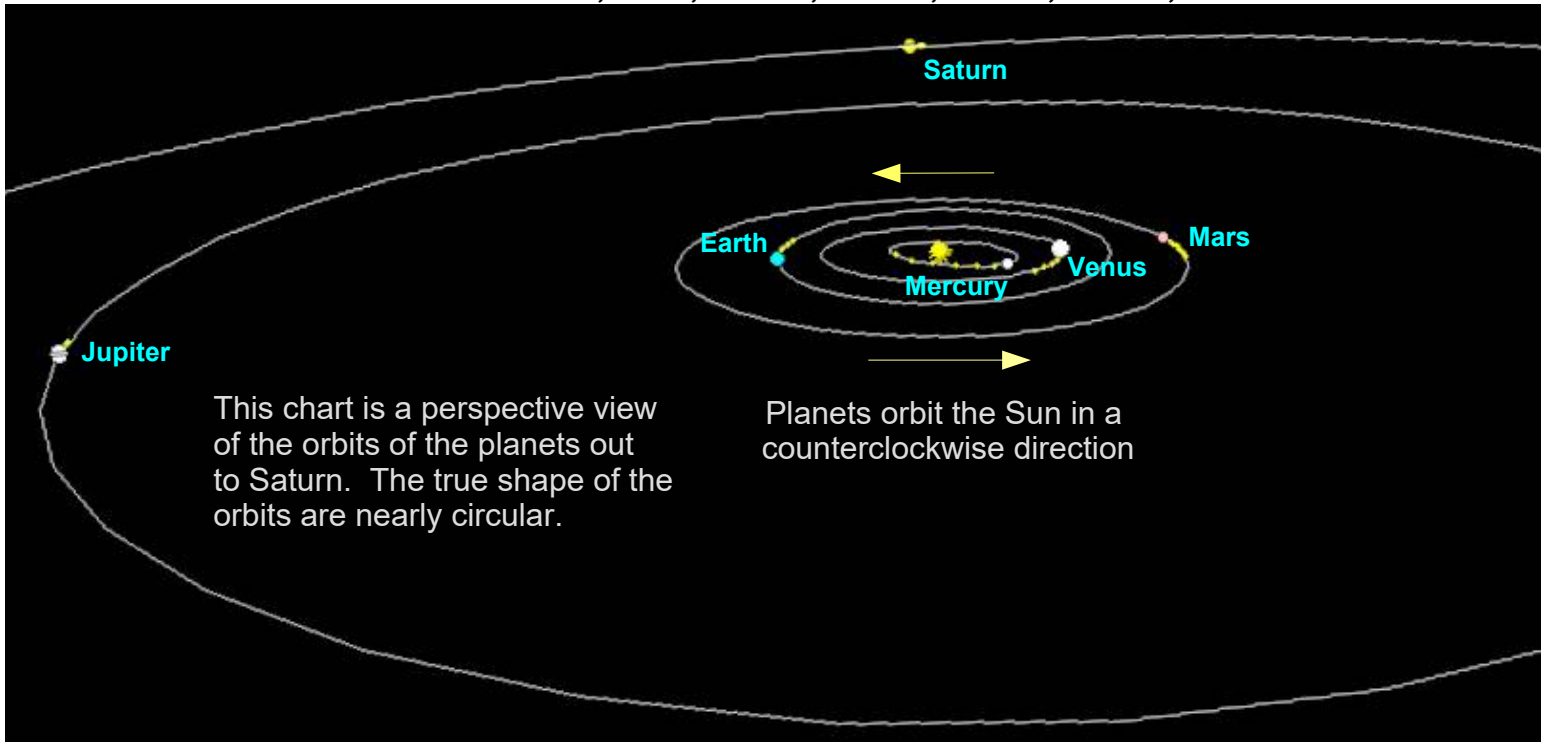


**Legend:**  
 CONSELLATIONS  
 Asterisms  
 Star names  
 Planet names  
 Meteor Radiants

Orion the hunter is moving into the southeast about to take its place as the central constellation of winter in our evening sky now. Jupiter and Saturn are the evening planets at chart time. The Little Dog Star Procyon is living up to its name. Procyon means “Before the dog”, because even though it is east of Sirius, the Dog Star, Procyon rises before it. As can be seen by the chart, Procyon is up in the east as Sirius is just rising. The Geminid meteor shower will reach peak in the morning hours of the 14<sup>th</sup>. The waning crescent Moon will rise at 3:03 that morning. The evening hours of the 13<sup>th</sup> are also great, since the radiant rises early in the evening.

# The Naked Eye Planets

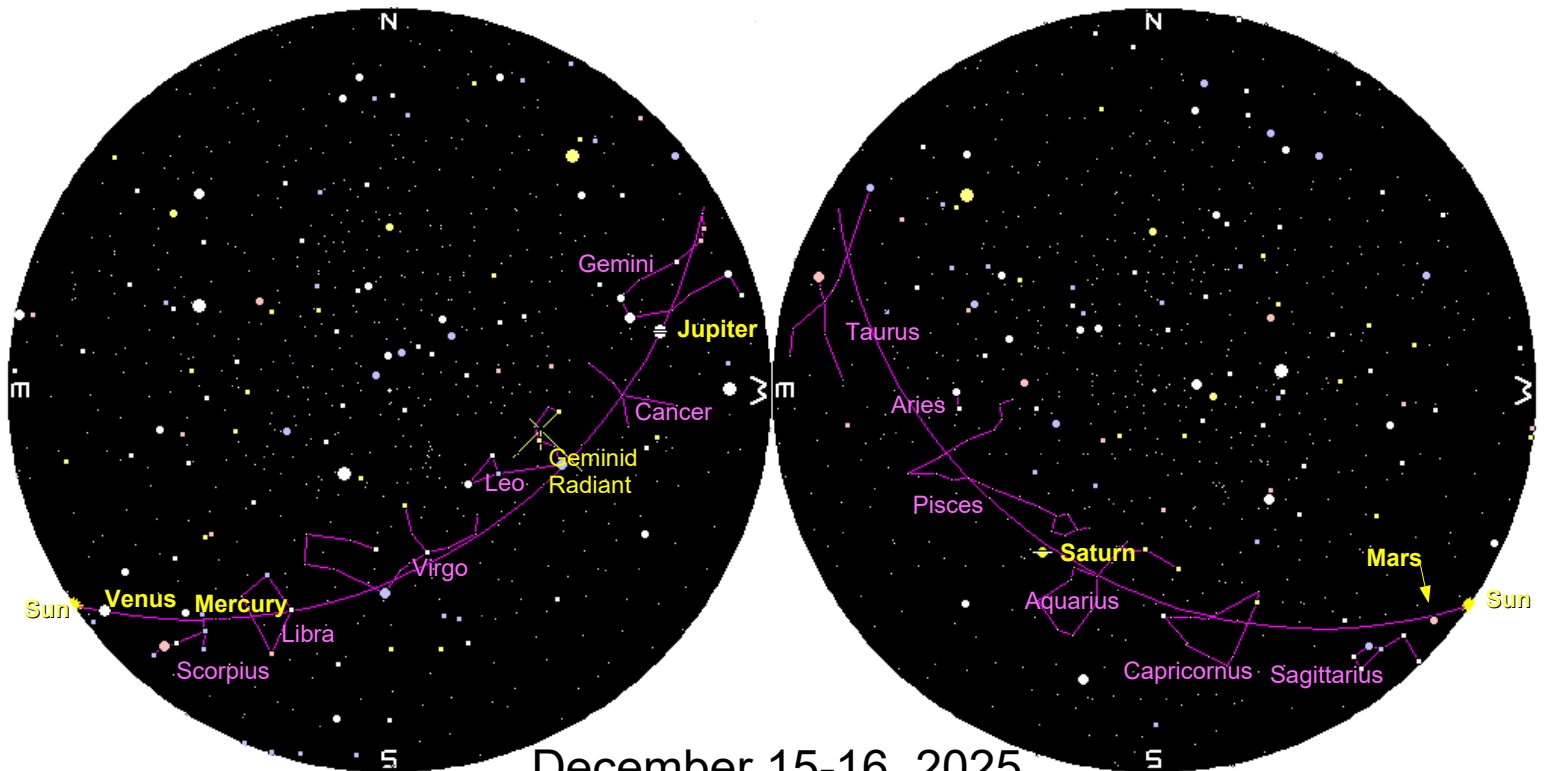
December 1st, 6th, 11th, 16th, 21st, 26th, 31st



## The Planets as Seen From Northern Michigan

Sunrise

Sunset



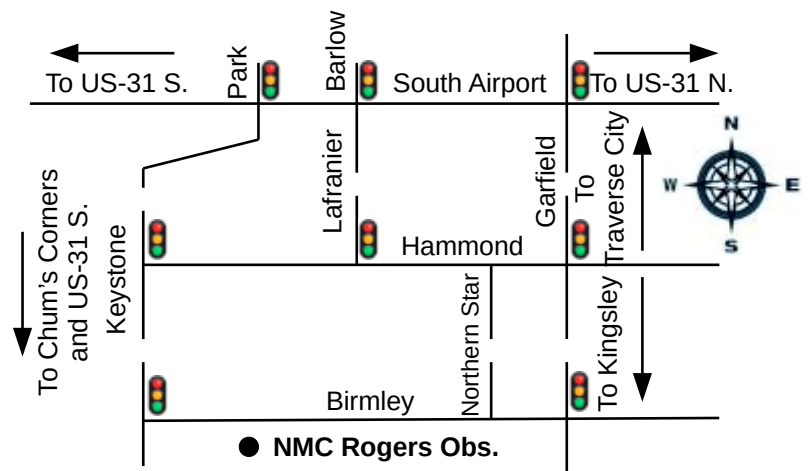
December 15-16, 2025

# CELESTIAL CALENDAR

	Date	Time	Event
Dec	1	Mo	Venus: 8.7° W
	3	We	9:54 PM Moon-Pleiades: 0.8° S
	4	Th	6:06 AM Moon Perigee: 357000 km
	4	Th	6:14 PM Full Moon
	5	Fr	4:51 PM Moon North Dec.: 28.3° N
	7	Su	10:48 AM Moon-Jupiter: 3.7° S
	7	Su	11:21 AM Moon-Pollux: 2.9° N
	7	Su	3:59 PM Mercury Elongation: 20.7° W
	8	Mo	9:23 AM Moon-Beehive: 1.5° S
	10	We	1:32 AM Moon-Regulus: 0.8° S
	11	Th	2:34 AM Moon Descending Node
	11	Th	3:52 PM Last Quarter
	14	Su	2:21 AM Geminid Shower: ZHR = 120
	14	Su	11:27 AM Moon-Spica: 1.5° N
	17	We	1:09 AM Moon Apogee: 406300 km
	17	We	3:41 PM Jupiter-Pollux: 6.5° S
	19	Fr	9:07 AM Mercury-Antares: 5.5° N
	19	Fr	6:18 PM Moon South Dec.: 28.2° S
	19	Fr	8:43 PM New Moon
	21	Su	10:03 AM Winter Solstice
	22	Mo	11:00 AM Ursid Shower: ZHR = 10
	25	Th	5:03 PM Moon Ascending Node
	26	Fr	10:24 PM Moon-Saturn: 4.2° S
	27	Sa	2:10 PM First Quarter
	31	We	8:21 AM Moon-Pleiades: 0.9° S
Jan	1	Th	Venus: 1.3° W

Sky Events Calendar by Fred Espenak and Sumit Dutta (NASA's GSFC), <http://eclipse.gsfc.nasa.gov/SKYCAL/SKYCAL.html> to make your own for any year. Some additions and clarifications were made by the editor.

The Grand Traverse Astronomical Society meets on the 1st Friday of each month except August at the Northwestern Michigan College Rogers Observatory. The public is invited to all society functions as our guests. We are a non-profit group dedicated to the study of astronomy. If you'd like more information about us, our meeting and outreach schedule, see our website: [www.gtastro.org](http://www.gtastro.org).



Map is not to scale

# Ephemeris of Sky Events for NMC Observatory

December, 2025      Local time zone: EST

DATE	SUN RISE	SUN SET	DAYLIGHT HOURS	TWILIGHT*		MOON PHASE	RISE OR SET**	OR TIME	ILLUM FRACTN
				END	START				
Mon 1	07:59a	05:03p	09:04	06:12p	06:50a		Set	05:06a	87%
Tue 2	08:00a	05:03p	09:02	06:12p	06:51a		Set	06:32a	94%
Wed 3	08:01a	05:02p	09:01	06:12p	06:52a		Set	07:58a	98%
Thu 4	08:02a	05:02p	08:59	06:12p	06:53a	Full	Rise	04:24p	100%
Fri 5	08:03a	05:02p	08:58	06:12p	06:54a		Rise	05:25p	98%
Sat 6	08:04a	05:02p	08:57	06:12p	06:55a		Rise	06:39p	94%
Sun 7	08:05a	05:02p	08:56	06:12p	06:55a		Rise	07:59p	87%
Mon 8	08:06a	05:02p	08:55	06:12p	06:56a		Rise	09:19p	78%
Tue 9	08:07a	05:02p	08:54	06:12p	06:57a		Rise	10:34p	69%
Wed 10	08:08a	05:02p	08:53	06:12p	06:58a		Rise	11:45p	59%
Thu 11	08:09a	05:02p	08:52	06:12p	06:59a	L Qtr	Rise	12:52a	49%
Fri 12	08:10a	05:02p	08:52	06:12p	07:00a		Rise	01:58a	39%
Sat 13	08:11a	05:02p	08:51	06:12p	07:00a		Rise	03:02a	30%
Sun 14	08:11a	05:02p	08:50	06:13p	07:01a		Rise	04:07a	22%
Mon 15	08:12a	05:02p	08:50	06:13p	07:02a		Rise	05:13a	14%
Tue 16	08:13a	05:03p	08:49	06:13p	07:02a		Rise	06:18a	8%
Wed 17	08:14a	05:03p	08:49	06:14p	07:03a		Rise	07:22a	4%
Thu 18	08:14a	05:03p	08:49	06:14p	07:04a		Rise	08:21a	1%
Fri 19	08:15a	05:04p	08:49	06:14p	07:04a	New	Set	04:22p	0%
Sat 20	08:15a	05:04p	08:48	06:15p	07:05a		Set	05:18p	1%
Sun 21	08:16a	05:05p	08:48	06:15p	07:05a		Set	06:22p	4%
Mon 22	08:16a	05:05p	08:48	06:16p	07:06a		Set	07:30p	8%
Tue 23	08:17a	05:06p	08:49	06:16p	07:06a		Set	08:40p	14%
Wed 24	08:17a	05:06p	08:49	06:17p	07:07a		Set	09:51p	22%
Thu 25	08:18a	05:07p	08:49	06:18p	07:07a		Set	11:01p	31%
Fri 26	08:18a	05:08p	08:49	06:18p	07:07a		Set	12:12a	41%
Sat 27	08:18a	05:09p	08:50	06:19p	07:08a	F Qtr	Set	01:26a	52%
Sun 28	08:18a	05:09p	08:50	06:20p	07:08a		Set	02:43a	63%
Mon 29	08:19a	05:10p	08:51	06:20p	07:08a		Set	04:04a	74%
Tue 30	08:19a	05:11p	08:52	06:21p	07:08a		Set	05:27a	84%
Wed 31	08:19a	05:12p	08:52	06:22p	07:09a		Set	06:48a	91%

\* Nautical Twilight

\*\* Moonrise or moonset, whichever occurs between sunset and sunrise



## Grand Traverse Astronomical Society – Membership Application / Renewal for 2026

I am interested, please send me more information about the next GTAS meeting. (Also see [www.gtastro.org](http://www.gtastro.org))

I'll join, payment enclosed

Email Address: \_\_\_\_\_

Membership renewal

**Newsletter Delivery:**  **Email**  **Mail** (Postcard only)

Membership term runs from January to December

Interests: \_\_\_\_\_

Name(s): \_\_\_\_\_ Home Phone: \_\_\_\_\_ Cell: \_\_\_\_\_

Address: \_\_\_\_\_

(Street, City, State ZIP)

Dues:  Single Membership .....\$25.00/yr    **Mail check to:** G.T.A.S.

Family.....\$30.00/yr    Gary Carlisle, Treasurer

Student (up to 18 years age)...\$15.00/yr    1473 Birmley Road

Patron (Donation).....\$\_\_\_\_\_    Traverse City, MI 49696-8808

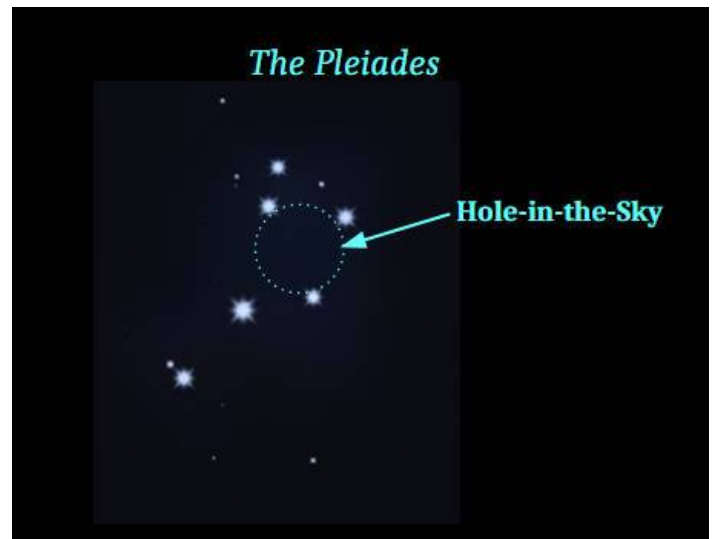
For new members just joining mid-year, pro rate the dues thus:  
**Annual Dues X months remaining in the year / 12.**  
 Example: Single Joining in June:  
 \$25.00 X 6 (Jul-Dec) / 12 = \$12.50

## Tidbits from Bob Moler's Ephemeris: The Pleiades

A marvelous member of the autumn skies can be found low in the east early in the evening. It is the famous star cluster called the Pleiades or the Seven Sisters. I might also add the 'Tiny Dipper'. Many people can spot a tiny dipper shape in its six or seven stars, and mistake it for the Little Dipper. With binoculars, one can see over a hundred stars that appear, along with the dipper shape of the brightest. In photographs, the Pleiades actually illuminate wisps of the dust that surround them. In Greek mythology, the sisters were daughters of the god Atlas and Pleione. The most people can only see is six stars. The reason, according to mythology, is that one of the sisters married a mortal, dimming her star.

In early evening the hunter Orion is rising in the east to chase the Pleiades across the sky until dawn. The word Pleiades is related to the Greek word for sail, and in ancient times the sailing season in the Mediterranean Sea started with the heliacal rising of the Pleiades at dawn in mid-spring.

To the Anishinaabe native peoples around here, the Pleiades is the "Hole in the Sky" or the seven stones that are heated for the sweat lodge ceremony. To the Kiowa, these were sisters who were whisked up into the sky from the top of Devil's Tower in Wyoming, where they were threatened by a huge bear. An Iroquoian legend has seven daughters who danced all day and were drawn into the sky, along with a black bear who danced with them. One daughter heard her mother's call and fell back down to the Earth. In Norse mythology, these were the goddess Freya's hens. ★



### Eileen Carlisle

Avon Representative

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E-Mail: [EileenAvonRep@charter.net](mailto:EileenAvonRep@charter.net)

**WANTED: Astronomers interested in working with Project ASTRO POLARIS.** Willingness to work with K-12 students and teachers. Visiting classrooms and conducting experiments, discussing astronomy interests and events. Sharing your love of astronomy with others. Will provide; training, materials, instructions and support. Please contact: Jerry Dobek Site Coordinator Project ASTRO POLARIS NMC Science & Math 1701 East Front Street Traverse City, MI 49686 email [jdobek@nmc.edu](mailto:jdobek@nmc.edu) phone 946-1787 obsv. 223-4545 home

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