Astronomy magazine

Sky Guide 2023

• BY MARTIN RATCLIFFE AND RICHARD TALCOTT •

contents

A spectacular ring of fire will appear above parts of the U.S., Mexico, Central America, and northern South America Oct. 14. CHRIS SCHUR

Martin Ratcliffe *is a planetarium professional with Evans & Sutherland and enjoys observing from Salt Lake City.*
Richard Talcott *is a contributing editor of* **Astronomy.**

A supplement to *Astronomy* magazine

2023 Jan

S	M	T	W	T	F	S
1	2	3	4	5	●	7
8	9	10	11	12	13	◐
15	16	17	18	19	20	○
22	23	24	25	26	27	◑
29	30	31				

1 The Moon passes 0.7° north of Uranus, 5 P.M. EST

3 The Moon passes 0.5° south of Mars, 3 P.M. EST

Quadrantid meteor shower peaks

7 Mercury is in inferior conjunction, 8 A.M. EST

8 Asteroid Pallas is at opposition, 2 P.M. EST

18 Pluto is in conjunction with the Sun, 10 A.M. EST

20 The Moon passes 7° south of Mercury, 3 A.M. EST

22 Venus passes 0.4° south of Saturn, 3 P.M. EST

23 The Moon passes 4° south of Saturn, 2 A.M. EST

The Moon passes 3° south of Venus, 3 A.M. EST

25 The Moon passes 3° south of Neptune, 1 A.M. EST

The Moon passes 1.8° south of Jupiter, 9 P.M. EST

28 The Moon passes 0.9° north of Uranus, 11 P.M. EST

30 Mercury is at greatest western elongation (25°), 1 A.M. EST

The Moon passes 0.1° south of Mars, 11 P.M. EST

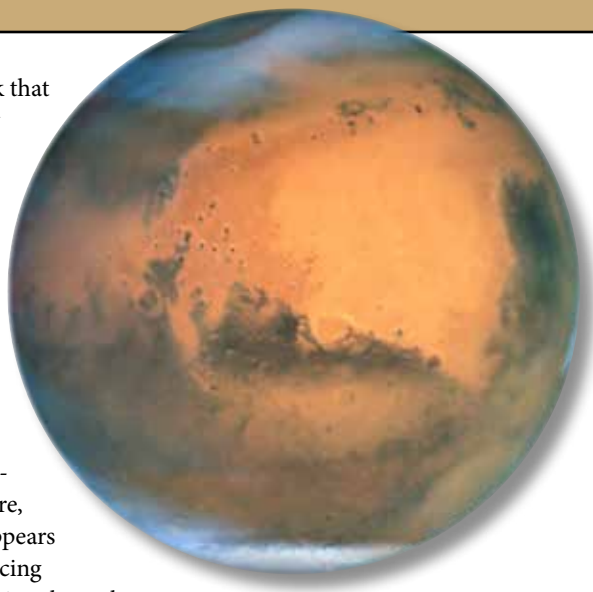
The Red Planet's story continues

Although Mars reached opposition in early December, it remains a stunning object in the evening sky throughout January. It begins the month shining at magnitude –1.2 against the background stars of northern Taurus the Bull. The Red Planet rarely appears so high in the sky for Northern Hemisphere observers; at its midevening peak, it stands about 75° above the southern horizon.

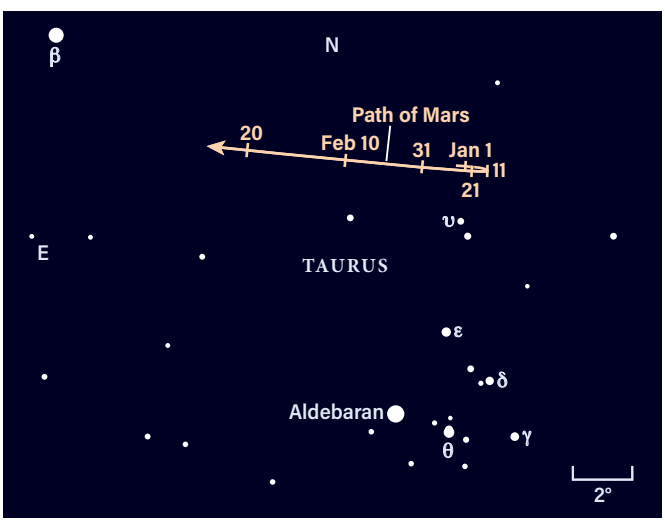
On the first night of 2023, Mars resides 9° east of the dazzling Pleiades star cluster (M45) and 8° north-northwest of 1st-magnitude Aldebaran, the Bull's luminary. The planet shines eight times brighter than the star. Astronomers classify Aldebaran as a red giant, and it's worth taking a few moments to compare its color with that of the planet.

Swing a telescope toward Mars early in the month, and you'll see a disk that spans a healthy 15". That's plenty big enough to resolve dark and bright surface features. Throughout January's first week, the planet's most prominent dark feature, Syrtis Major, appears on the Earth-facing hemisphere during the early evening hours. Also look for the brighter-than-average Hellas Basin directly south of Syrtis Major. Such features stand out particularly well this month because Mars lies high in the sky and thus we view it through a minimal amount of Earth's turbulent atmosphere.

The Red Planet steadily pulls away from Earth during January, causing it to grow both dimmer and smaller. It ends the month glowing at magnitude –0.3 and sporting a disk measuring 11" across. Mars' phase also diminishes this month, waning from 97 percent to 92 percent illumination.



The Hubble Space Telescope captured dark surface markings, sandy deserts, and a large dust storm during Mars' October 2005 close approach. NASA/ESA/THE HUBBLE HERITAGE TEAM (STSCI/AURA)



The Red Planet shines brightly as it slides through northern Taurus the Bull during early 2023. ALL ILLUSTRATIONS: *ASTRONOMY*: ROEN KELLY

A wonderful event occurs the night of Jan. 30/31 when a three-quarters-lit waxing gibbous Moon slides past Mars. According to David Dunham of the International Occultation Timing Organization, observers located south of a line stretching from southern Georgia to central California will see a stunning occultation as the Moon passes in front of Mars. The planet takes nearly a minute to disappear behind the Moon and later reappear, so be sure to get your telescope ready well ahead of time. Observers located north of the line get to see a dramatic near miss.

A comet brightens wintery nights

Comets are fickle beasts. Fresh visitors from the distant Oort Cloud can become spectacular objects — or fizzle to near invisibility.

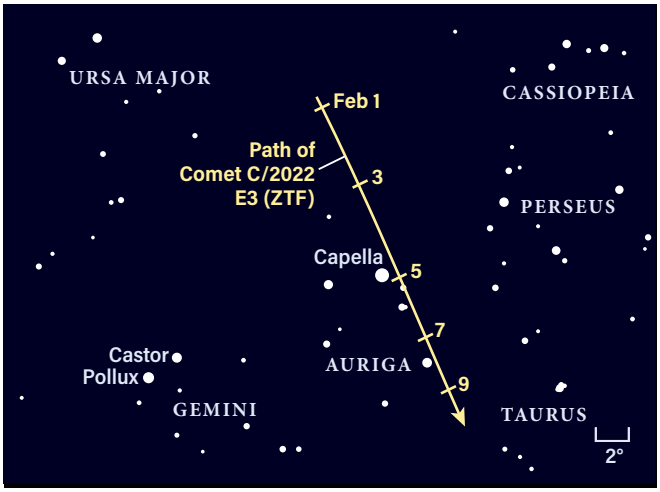
One thing is certain in astronomical predictions: We know *where* comets will be at any given moment because they follow well-defined laws of gravity. But a comet's *brightness*? That's another story. So when astronomers discover a comet that will come within 0.3 astronomical unit (AU) of Earth and remain visible all night near Polaris, and predict it could brighten to 6th magnitude, observers pay attention but don't get overly excited right away.

Researchers working at the Zwicky Transient Facility on Palomar Mountain in California discovered Comet C/2022 E3 (ZTF) in March 2022 when it was a mere 17th-magnitude speck of light. Calculations show it comes closest to Earth on Feb. 1, passing 0.28 AU (26 million miles) from our home world. Its close approach means it moves across the sky rapidly, changing positions noticeably from night to night.

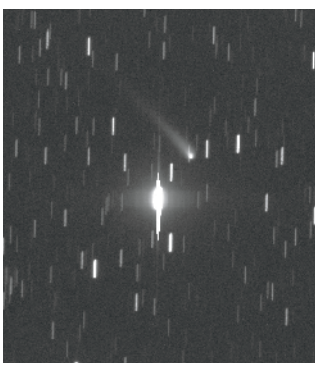
You can start looking for the comet through binoculars in late January as its path carries it through Draco the Dragon and Ursa Minor the Little Bear. It then lies low in the evening sky but climbs higher throughout the night. Does it glow at 7th magnitude or brighter? If so, things are looking good. The comet passes within 5° of Beta (β) Ursae Minoris on Jan. 26 and 27. On Jan. 29, it lies 10° from Polaris. This makes the comet circumpolar, so it stays visible all night. Unfortunately, a brightening gibbous Moon in Taurus interferes with spotting the comet.

On Feb. 5 (alas, it's the night of the Full Moon), Comet C/2022 E3 passes 3° due west of brilliant Capella in the evening sky. The bright Moon means you'll need binoculars or a telescope to spot the expected 6th-magnitude comet near Auriga the Charioteer's brightest star. As our satellite passes into the morning sky, evening observers might catch the comet as it heads south. Look for it within 1° of Mars on Feb. 10 and some 2° from Aldebaran on Feb. 13 and 14. Expect it to be a delightful addition to the rich star fields in Taurus. Binoculars should show the comet as a small fuzzball, while telescopes should reveal both a dust and gas tail.

By mid-February, the comet likely has faded to 7th magnitude as it heads away from Earth and the Sun and starts its long journey back to the depths of the solar system. C/2022 E3 soon dims beyond the reach of binoculars, and a brightening Moon interferes again in late February as the comet prepares to leave Taurus and head south into Eridanus the River.



Comet C/2022 E3 (ZTF) could reach 6th magnitude and show up nicely through binoculars as it plies the far northern sky in early 2023.



The wispy tail of Comet C/2022 E3 (ZTF) cuts across the center of this July 31, 2022, image. Because the telescope tracked the comet's motion, stars appear as vertical streaks. GIANLUCA MASI

Feb 2023

S	M	T	W	T	F	S
			1	2	3	4
●	6	7	8	9	10	11
12	◐	14	15	16	17	18
19	○	21	22	23	24	25
26	◑	28				

- 5 Mars passes 8° north of Aldebaran, 2 A.M. EST
- 15 Venus passes 0.01° south of Neptune, 7 A.M. EST
- 16 Saturn is in conjunction with the Sun, noon EST
- 18 The Moon passes 4° south of Mercury, 4 P.M. EST
- 21 The Moon passes 2° south of Neptune, 1 P.M. EST
- 22 The Moon passes 2° south of Venus, 3 A.M. EST
- The Moon passes 1.2° south of Jupiter, 5 P.M. EST
- 25 The Moon passes 1.3° north of Uranus, 8 A.M. EST
- 27 The Moon passes 1.1° north of Mars, midnight EST

Moon Phases

- ◑ First Quarter
- ● Full Moon
- ◐ Last Quarter
- ○ New Moon

Events that can be viewed with **the naked eye**

Events that can be viewed with **binoculars**

Events that can be viewed with a **telescope**

2023 March

S	M	T	W	T	F	S
			1	2	3	4
5	6	●	8	9	10	11
12	13	◐	15	16	17	18
19	20	○	22	23	24	25
26	27	◑	29	30	31	

2 Venus passes 0.5° north of Jupiter, 6 A.M. EST

15 Neptune is in conjunction with the Sun, 8 P.M. EDT

17 Mercury is in superior conjunction, 7 A.M. EDT

19 The Moon passes 4° south of Saturn, 11 A.M. EDT

20 Equinox (northern spring/southern autumn begins), 5 P.M. EDT

21 Dwarf planet Ceres is at opposition, 4 A.M. EDT

22 The Moon passes 0.5° south of Jupiter, 4 P.M. EDT

24 The Moon passes 0.1° south of Venus, 6 A.M. EDT

The Moon passes 1.5° north of Uranus, 9 P.M. EDT

28 The Moon passes 2° north of Mars, 9 A.M. EDT

Mercury passes 1.5° north of Jupiter, 11 A.M. EDT

31 Venus passes 1.3° north of Uranus, 2 A.M. EDT

Venus joins Jupiter at dusk

March opens with a dramatic pairing of the two brightest planets in the western evening sky. Venus dominates the scene, shining at magnitude –3.9. Jupiter, though only one-fifth as bright as its neighbor at magnitude –2.1, still outshines any star. Venus pops into view first, becoming noticeable within 30 minutes after the Sun sets. Once you see it, scan with binoculars to find Jupiter close by. As the sky darkens, both become conspicuous.

Twilight fades to darkness about 90 minutes after the Sun goes down when the two planets lie 10° high. The dim background stars of Pisces the Fish should be visible by then.

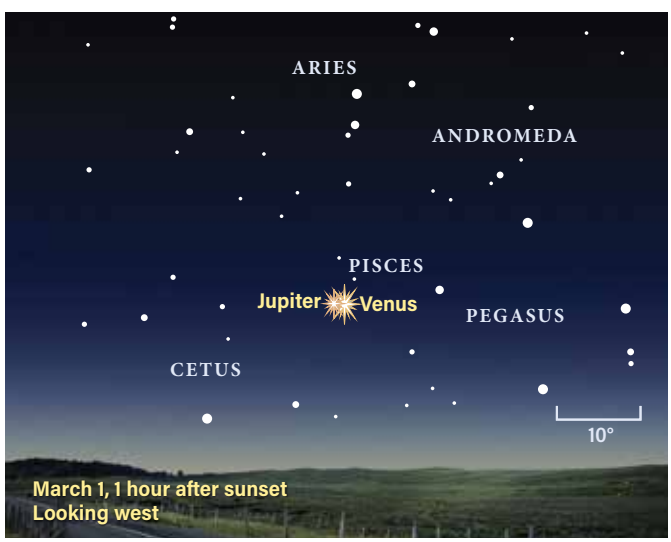
Don't wait until the 1st to get your initial view. A good time to start is a week prior to the conjunction. On Feb. 22, a slender crescent Moon appears less than 2° to Jupiter's left with Venus 7° below. As the Moon climbs rapidly higher with each passing night, Venus crawls 1° closer to Jupiter.

By the time of their March 1 conjunction, Venus stands 30' — the width of a Full Moon — to Jupiter's right (northwest). The true conjunction, when Venus passes due north of Jupiter, occurs well after the pair has set from North America. If clouds interfere on the 1st, you'll get a nice reprise the following evening when Venus lies 1° above Jupiter.

A telescope with a 1° or slightly larger field of view provides the best view. Venus shows a 12"-diameter disk that appears 86 percent lit. Despite lying more than four times farther from Earth, Jupiter sports a diameter of 34".

As you soak in the view, contemplate how each planet contributed to our understanding of the universe. In 1610, Galileo Galilei observed Venus with a gibbous phase similar to how we see it now. His observations refuted the Earth-centered cosmology Claudius Ptolemy popularized because Venus could show only a crescent phase in that system. Galileo's observations of four moons orbiting Jupiter proved that not every object revolves around Earth. You can see those satellites yourself March 1. In the early evening, look for Io, Ganymede, and Callisto east of the planet. Europa joins the trio when it pops into view from behind Jupiter's eastern limb at 8:50 P.M. EST.

Venus (to the left) and Jupiter meet in evening twilight above the Sandy Point Lighthouse in Nova Scotia Nov. 25, 2019. BARRY BURGESS



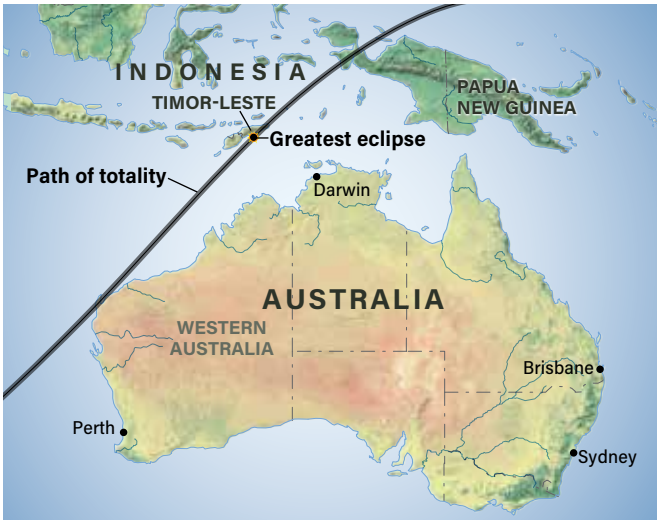
Venus passes within 0.5° of Jupiter the evening of March 1. The two brightest planets always look stunning when they appear this close.

A two-faced solar eclipse

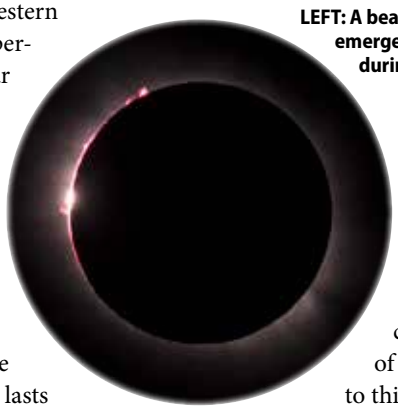
An unusual solar eclipse occurs April 20 across parts of Australia and Indonesia. The Sun, the Moon, and Earth line up exactly during this event. This normally would produce either a total eclipse — when the Moon completely blocks the Sun's disk from view — or an annular eclipse — when the Moon lies too far from Earth and a ring of sunlight remains visible at the peak.

But the April 20 event is a hybrid eclipse: total along part of the track and annular at the eastern and western ends. Only 5 percent of all solar eclipses belong to this class. What makes April's eclipse even odder, however, is that the annular phase lasts less than one second. Essentially, the annular part shows up only in calculations assuming the Moon has a smooth surface with no irregularities. So, for all intents and purposes, you can consider the April 20 eclipse to be totally total.

The track first touches Earth's surface in the waters of the southern Indian Ocean. The umbral path then heads northeast, making its first landfall along Australia's remote northwestern coast. Exmouth receives 54 seconds of totality with the Sun 54° high. You'll add a couple of seconds to this total if you head to the center line.



ABOVE: The April 20 hybrid solar eclipse offers more than a minute of totality for observers on the center line in western Australia, New Guinea, and the islands in between.



LEFT: A beautiful diamond ring and several prominences emerge above the Moon's dark limb at second contact during the March 2015 total eclipse. TUNÇ TEZEL

The moment of greatest eclipse lies just off the southern coast of East Timor. Viewers there will experience 1 minute 16 seconds of totality. The track crosses the eastern end of the island nation, where residents and visitors can expect just a few seconds less totality.

The track's next major landfall occurs in Western New Guinea. Observers who place themselves on the center line here can expect about 70 seconds of totality if the weather allows. After leaving this slice of Indonesia, the path of totality lies mainly over water with a few small tropical (and often rainy) islands interspersed. The most substantial of these are the Schouten Islands. On Baik Island, totality lasts just over one minute.

As with every total eclipse, tour operators are offering adventurous travelers the trip of a lifetime to experience the geography and culture of exotic lands in addition to nature's greatest spectacle. If you're not up for travel, two other eclipses in the near future may be more your cup of tea. The next total eclipse will cross parts of the U.S. on April 8, 2024. And the next annular eclipse also touches the U.S., on Oct. 14 (see October).

2023 April

S	M	T	W	T	F	S
						1
2	3	4	5	●	7	8
9	10	11	12	◐	14	15
16	17	18	19	○	21	22
23	24	25	26	◑	28	29
30						

11 Jupiter is in conjunction with the Sun, 6 P.M. EDT

Mercury is at greatest eastern elongation (19°), 6 P.M. EDT

15 The Moon passes 3° south of Saturn, midnight EDT

17 The Moon passes 2° south of Neptune, 1 P.M. EDT

19 Hybrid solar eclipse, midnight EDT

20 Venus passes 8° north of Aldebaran, 5 P.M. EDT

21 The Moon passes 1.7° north of Uranus, 9 A.M. EDT

22 Lyrid meteor shower peaks

23 The Moon passes 1.3° north of Venus, 9 A.M. EDT

24 Asteroid Vesta is in conjunction with the Sun, 5 A.M. EDT

25 The Moon passes 3° north of Mars, 10 P.M. EDT

May 2023

S	M	T	W	T	F	S
	1	2	3	4	●	6
7	8	9	10	11	◐	13
14	15	16	17	18	○	20
21	22	23	24	25	26	◑
28	29	30	31			

1 Mercury is in inferior conjunction, 7 P.M. EDT

5 Penumbral lunar eclipse, 2 P.M. EDT

6 Eta Aquariid meteor shower peaks

9 Uranus is in conjunction with the Sun, 4 P.M. EDT

10 Mars passes 5° south of Pollux, 4 P.M. EDT

13 The Moon passes 3° south of Saturn, 9 A.M. EDT

14 The Moon passes 2° south of Neptune, 9 P.M. EDT

17 The Moon passes 0.8° north of Jupiter, 9 A.M. EDT

The Moon passes 4° north of Mercury, 10 P.M. EDT

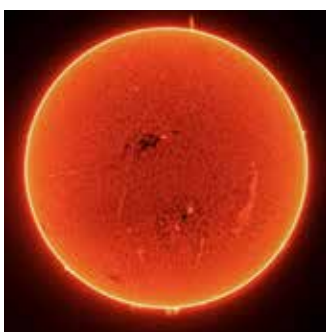
23 The Moon passes 2° north of Venus, 8 A.M. EDT

24 The Moon passes 4° north of Mars, 2 P.M. EDT

29 Mercury is at greatest western elongation (25°), 2 A.M. EDT

30 Venus passes 4° south of Pollux, noon EDT

The Sun puts on a sterling show



ABOVE: Auroral curtains dance above snow-covered central Alaska April 1, 2022. Expect displays of the northern lights to surge this year as the Sun grows more active. JOHN CHUMACK

LEFT: Sunspots and filaments appear dark against the Sun's surface while plasma-rich prominences leap above the solar limb July 11, 2022. ROB LYONS

The Sun should continue to impress observers throughout 2023. Solar activity ebbs and flows over a roughly 11-year cycle. The last minimum occurred in late 2019 when months went by without any sunspots. Astronomers expect activity to keep ramping up until hitting its next peak in mid-2025.

This cycle, numbered 25, has been showing some of the fastest increases in activity seen in recent decades. Although predictions of how high solar activity will climb is fraught with complexity, scientists expect a modest peak similar to Cycle 24. That cycle proved to be one of the quietest periods for the Sun in the past century, so the recent rapid rise in activity is worth following.

Observing the Sun can be dangerous. Do your homework on safe solar filters, which always should be placed over the front end of your telescope. Never view the Sun directly through any optical instrument, including your finder scope, without a safe solar filter in place; blindness can occur within seconds.

Unlike most astronomical observing, which requires a large telescope to capture faint light, solar observing profits from small apertures. After all, there is no shortage of light to work with. A 60mm refractor with a solar filter over its front end provides superb views of sunspots, plages (bright regions often seen around sunspots), and granulation that populates the photosphere (the Sun's visible surface).

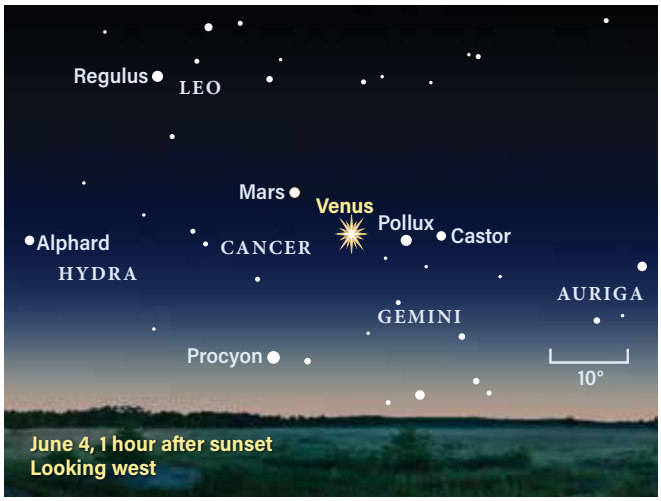
The safest way to observe the Sun? Use sunlight as the light source, the telescope as a projector, and a white card in place of your eye. The farther you place the card from the eyepiece, the larger the solar image. H-alpha telescopes offer exciting views of the solar atmosphere's upper layers called the chromosphere, where filaments, prominences, and active regions occur.

With care and attention to safety, observing the Sun provides hours of enjoyment. In this season of increasing solar activity, expect to see new things every day — and you'll get a good night's rest to boot.

The evening star comes to the fore

Although Venus reaches its greatest elongation from the Sun on June 4, it remains a conspicuous evening object from Jan. 1 until late July. Strictly a twilight object in early 2023, the inner planet slowly pulls away from the Sun. It has memorable conjunctions with Saturn on Jan. 22 and Jupiter on March 1. In April, Venus passes through Taurus the Bull, sliding south of the Pleiades star cluster (M45), north of the Hyades star cluster, and between the Bull's horns. And by late May, the planet has crossed most of Gemini the Twins and slips 4° south of 1st-magnitude Pollux.

On June 1, Venus stands 25° above the western horizon an hour after sunset and doesn't set until close to midnight local daylight time, more than three hours after the Sun. Gleaming at magnitude –4.4, Venus appears far brighter than any other celestial object. It stands against the background stars of eastern Gemini, near that constellation's border with Cancer the Crab. A much dimmer Mars lies 11° to its east, embedded within the beautiful Beehive star cluster (M44).



Venus reaches its evening peak in early June when it sets more than three hours after the Sun. Nearby Mars appears less than 1 percent as bright as its sister world.

At greatest elongation, Venus lies 45° east of the Sun and stands 24° high in the west an hour after sundown. Don't fret if it's cloudy that evening — the planet remains near this angular distance from the Sun for two weeks either side of this date. Venus lies in western Cancer and has its eyes set on the Beehive. The planet appears 1.1° northwest of the cluster's center June 12 and 0.8° north on the 13th.

A splendid crescent Moon passes 4° north of Venus on June 21. Venus dazzles at magnitude –4.6 while the four-day-old Moon hangs above it. Look for earthshine illuminating the Moon's "dark" side. The planet brightens to magnitude –4.7 when it hits greatest brilliancy July 7.

The planet's telescopic appearance changes rapidly during this evening apparition. Its disk measures just 10" across and is almost fully illuminated in early January. It grows to 17" across and two-thirds lit May 1, and to 24" in diameter and half-lit at greatest elongation. At greatest brilliancy, Venus' disk spans 37" and appears about one-quarter lit.

A tree's nearly bare branches make a striking foreground for brilliant Venus in the dawn's early light Nov. 23, 2015. JOHN CHUMACK

2023 June

S	M	T	W	T	F	S
				1	2	●
4	5	6	7	8	9	◐
11	12	13	14	15	16	17
○	19	20	21	22	23	24
25	◑	27	28	29	30	

4 Mercury passes 3° south of Uranus, 1 A.M. EDT

Venus is at greatest eastern elongation (45°), 7 A.M. EDT

9 The Moon passes 3° south of Saturn, 4 P.M. EDT

11 The Moon passes 2° south of Neptune, 4 A.M. EDT

14 The Moon passes 1.5° north of Jupiter, 3 A.M. EDT

15 The Moon passes 2° north of Uranus, 6 A.M. EDT

16 The Moon passes 4° north of Mercury, 5 P.M. EDT

17 Mercury passes 4° north of Aldebaran, 10 A.M. EDT

20 Asteroid Juno is in conjunction with the Sun, 4 A.M. EDT

21 Solstice (northern summer/southern winter begins), 11 A.M. EDT

The Moon passes 4° north of Venus, 9 P.M. EDT

22 The Moon passes 4° north of Mars, 6 A.M. EDT

July 2023

S	M	T	W	T	F	S
						1
2	●	4	5	6	7	8
◐	10	11	12	13	14	15
16	○	18	19	20	21	22
23	24	◑	26	27	28	29
30	31					

1 Mercury is in superior conjunction, 1 A.M. EDT

6 The Moon passes 3° south of Saturn, 11 P.M. EDT

7 Venus is at greatest brilliancy, 10 A.M. EDT

8 The Moon passes 1.7° south of Neptune, 10 A.M. EDT

10 Mars passes 0.7° north of Regulus, 4 A.M. EDT

11 The Moon passes 2° north of Jupiter, 5 P.M. EDT

12 The Moon passes 2° north of Uranus, 2 P.M. EDT

19 The Moon passes 4° north of Mercury, 5 A.M. EDT

20 The Moon passes 8° north of Venus, 5 A.M. EDT

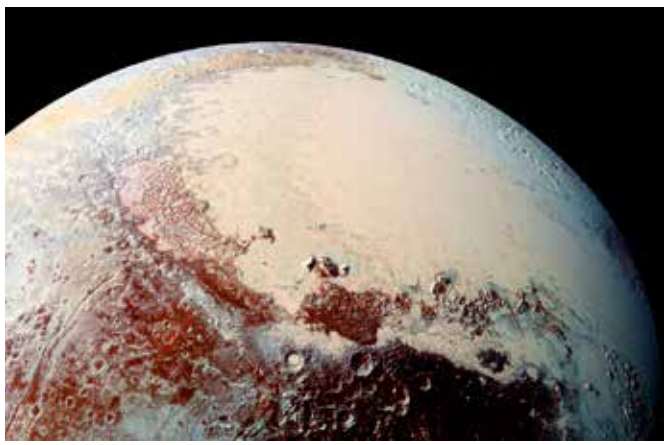
The Moon passes 3° north of Mars, midnight EDT

21 Pluto is at opposition, midnight EDT

26 Mercury passes 5° north of Venus, 9 A.M. EDT

28 Mercury passes 0.1° south of Regulus, 9 P.M. EDT

Pluto spans a pair of constellations



The massive nitrogen-ice glacier named Sputnik Planitia stood out to the cameras aboard New Horizons when the spacecraft flew past in July 2015.
NASA/JHUAPL/SWRI

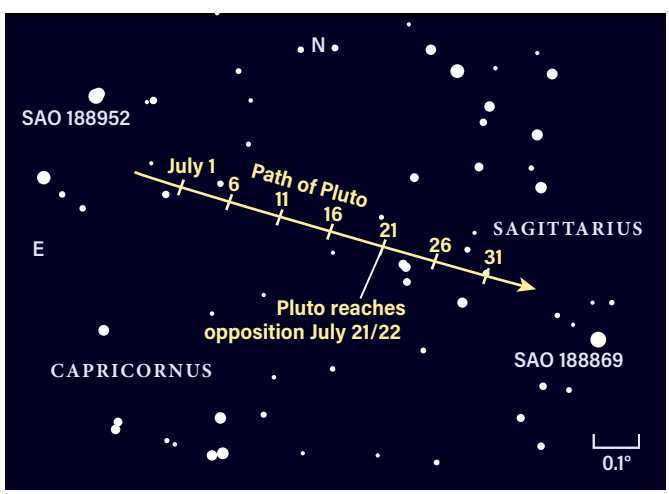
Pluto is everyone's favorite dwarf planet. Located in the frozen outer reaches of the solar system beyond the orbit of Neptune, Pluto represents a challenge for any observer. Detecting Pluto visually requires an 8-inch or larger (preferably much larger) telescope under good dark-sky conditions. Imaging can show the planet through smaller apertures. Just take exposures on different nights and look for the object that has moved.

Since NASA's New Horizons spacecraft flew past Pluto in July 2015 and revealed it as a dynamic world with mountains of water ice and glaciers of frozen nitrogen, observers have a renewed interest in the distant world. This year you can track it down as it lurks on the border between Sagittarius the Archer and Capricornus the Sea Goat. It peaks at opposition July 21/22, when it reaches magnitude 15.0 and remains visible all night.

Your two guide stars for finding Pluto in July are magnitude 8.7 SAO 188952, which lies slightly northeast of the dwarf planet's path, and magnitude 8.5 SAO 188869, which stands southwest of the path. Pluto wanders westward all month without encountering many bright stars. Luckily that changes around opposition. On the evenings of July 22 and 23, the dwarf planet slides just 2' north of a close pair of 11th-magnitude stars. And on the 31st, you can find Pluto less than 1' south of another 11th-magnitude sun.

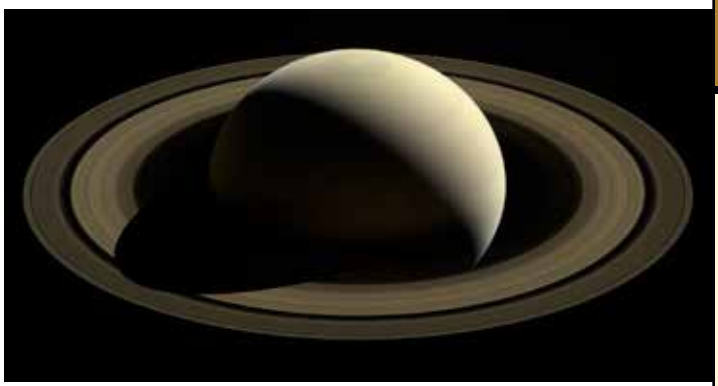
Don't stop viewing and imaging as Pluto continues its westward march in August and September. It passes 4' north of SAO 188869 Aug. 11 and 34' south of magnitude 6.0 SAO 188829 Sept. 18. By this point, Pluto lies highest in the south shortly after darkness falls. The dwarf planet stops its westward motion and begins moving east during October's second week.

Pluto is one of the largest icy dwarf planets lurking in the Kuiper Belt beyond Neptune's orbit. These objects' inclined orbits offer a distinctive record of their origins in the early solar system. Once formed within the protoplanetary nebula that gave birth to all the planets, interactions with the gas giants eventually ejected them into the distant and eccentric orbits we see today.



Distant Pluto straddles the border between Sagittarius and Capricornus as it comes to opposition and peak visibility in July.

Late summer sees Saturn at its peak



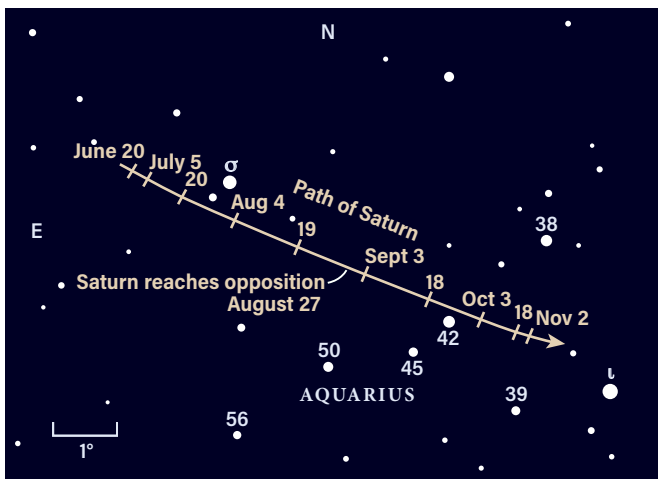
The Cassini spacecraft exposed Saturn and its glorious rings in October 2016, toward the end of the probe's 13-year orbital mission. NASA/JPL-CALTECH/SSI

When people first see Saturn through a telescope, it comes as a total surprise. Everyone has seen pictures of the ringed planet, but to actually view it in the eyepiece is a wholly different experience. Even seasoned observers get a thrill looking at Saturn. Great opportunities abound this year, particularly around opposition and peak visibility Aug. 27.

Saturn resides against the backdrop of Aquarius the Water-bearer throughout this apparition. The constellation boasts no star brighter than magnitude 2.9, so the planet stands out. Saturn peaks at magnitude 0.4, 10 times brighter than the Water-bearer's best. The planet also climbs some 4° higher in our Northern Hemisphere sky than it did at last year's opposition, providing us better views through less of Earth's atmosphere.

This year brings a noticeably different appearance to the ringed world for telescope owners. For the past 13 years, we've been looking down on Saturn's northern hemisphere. For most of this time, the ring system has tipped appreciably to our line of sight, but it now is closing down quickly. In two years, the rings will tilt edge-on and essentially disappear from view.

Our changing view of Saturn is a product of the planet's 29.4-year orbit around the Sun. Saturn's axis tilts 27° to its orbital plane. In some years, the planet's northern hemisphere tilts sunward, as it does now. After 2025, it will be the southern hemisphere's turn.



The ringed planet spends most of 2023 among the background stars of Aquarius the Water-bearer, peaking at magnitude 0.4 in late August.

In May, when Saturn appears in the morning sky, the rings tilt 8° to our line of sight. That drops to 7° in June but climbs back to 9° in late August. The planet's disk spans 19" at opposition, while the rings more than double that. The lower inclination of the rings means we get to see more of Saturn's disk compared with previous years. Although atmospheric features are subtle, their greater exposure now should make storm systems more visible.

While you observe Saturn, you can't miss 8th-magnitude Titan, the planet's brightest moon. Inside its orbit lie three 10th-magnitude satellites: Tethys, Dione, and Rhea. The icy moon Enceladus hugs the rings, but at 11th magnitude, it's quite a challenge to see in small scopes. Also look for Iapetus, which glows at 10th magnitude when its brighter hemisphere faces Earth in early September.

2023 Aug

S	M	T	W	T	F	S
		●	2	3	4	5
6	7	◐	9	10	11	12
13	14	15	○	17	18	19
20	21	22	23	◑	25	26
27	28	29	●	31		

3 The Moon passes 2° south of Saturn, 6 A.M. EDT

4 The Moon passes 1.5° south of Neptune, 6 P.M. EDT

8 The Moon passes 3° north of Jupiter, 6 A.M. EDT

The Moon passes 3° north of Uranus, 9 P.M. EDT

9 Mercury is at greatest eastern elongation (27°), 10 P.M. EDT

13 Perseid meteor shower peaks

Venus is in inferior conjunction, 7 A.M. EDT

18 The Moon passes 7° north of Mercury, 7 A.M. EDT

The Moon passes 2° north of Mars, 7 P.M. EDT

27 Saturn is at opposition, 4 A.M. EDT

30 The Moon passes 2° south of Saturn, 2 P.M. EDT

2023 Sept

S	M	T	W	T	F	S
					1	2
3	4	5	◐	7	8	9
10	11	12	13	○	15	16
17	18	19	20	21	◑	23
24	25	26	27	28	●	30

1 The Moon passes 1.4° south of Neptune, 3 A.M. EDT

4 The Moon passes 3° north of Jupiter, 4 P.M. EDT

5 The Moon passes 3° north of Uranus, 5 A.M. EDT

6 Mercury is in inferior conjunction, 7 A.M. EDT

11 The Moon passes 11° north of Venus, 9 A.M. EDT

16 The Moon passes 0.7° north of Mars, 3 P.M. EDT

19 Neptune is at opposition, 7 A.M. EDT

Venus is at greatest brilliancy, 10 A.M. EDT

22 Mercury is at greatest western elongation (18°), 9 A.M. EDT

23 Equinox (northern autumn/southern spring begins), 3 A.M. EDT

26 The Moon passes 3° south of Saturn, 9 P.M. EDT

28 The Moon passes 1.4° south of Neptune, 1 P.M. EDT

Mercury at its best before dawn

Mercury isn't named after the winged-footed messenger god for nothing — it flits around the Sun in a mere 58 days, swinging alternately to its east for evening viewing and to its west for early-morning observers.

This month sees Mercury's best morning appearance of the year. After passing between the Sun and Earth on Sept. 6, it quickly climbs higher in the predawn sky with each passing day. It reaches greatest elongation Sept. 22, when it lies 18° west of the Sun and stands 8° high in the east 45 minutes before sunrise. Mercury's brightness also increases as the apparition progresses.

How soon you catch Mercury depends on your location and weather: Choose a spot with an unobstructed view to the east on a morning with clear skies. Give it a try Sept. 16 when the planet shines at magnitude 1.0 and lies 5° high 45 minutes before sunup. Don't confuse Mercury with the star Regulus, which glows a little fainter and stands 8° above the planet.

Mercury's visibility continues to improve through Sept. 22, when it reaches peak altitude and shines at magnitude –0.4. A view through a telescope that morning reveals a 7"-diameter disk and 49-percent-lit phase.

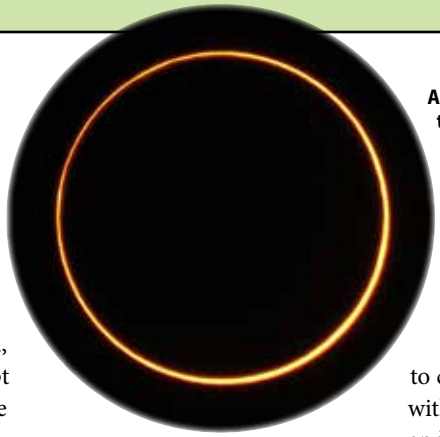
You can follow Mercury as it falls back toward the Sun over the next couple of weeks. On Oct. 1, the planet stands 5° high 45 minutes before the Sun rises and shines brightly at magnitude –1.1. Your last good chance to see the innermost planet comes Oct. 6 when it stands 4° high just a half-hour before sunrise. It does shine at magnitude –1.2, however, giving you a fighting chance to spot the elusive world. The Sun's glow envelops the winged messenger after this date as it heads toward superior conjunction Oct. 19/20.

Mercury appears conspicuous in evening twilight from north of Marion, Iowa, near its April 2016 greatest elongation. GREGG ALLISS

The innermost planet shines brightly and climbs well above the eastern horizon before dawn around its Sept. 22 peak.

Mercury's rapid orbital motion means it makes several other appearances in our sky this year. The best of the bunch occurs around the planet's April 11 greatest eastern elongation, when it climbs highest in the west after sunset. It has another nice morning apparition in late January, but its other three appearances (in late May, mid-August, and early December) won't amount to much.

A ring of fire for the United States



An annular solar eclipse leaves a thin ring of sunlight visible. During this February 2017 event, the Moon blocked 99 percent of the Sun's diameter. LES PORTER

A spectacular annular eclipse appears above parts of the U.S. on Oct. 14. While observers in most of North America, Central America, and South America (except the southern parts of Chile and Argentina) get to witness a partial eclipse, you'll want to position yourself in the path of annularity. It's only along this narrow track that viewers see the Moon pass directly in front of the Sun, leaving an annulus, or ring of fire, around the Moon. Because this eclipse leaves a little of the Sun's brilliant surface exposed, observers must use safe solar filters to view the event.

Why is this an annular eclipse? The Moon reaches apogee, the farthest point in its orbit around Earth, four days prior to the eclipse — it's just too far away to cover the Sun completely.

The annular path first makes landfall in Oregon south of Eugene at 9:19 A.M. PDT. Observers on the center line get to see an annular phase lasting 4 minutes 24 seconds. The track heads south and east, crossing parts of Oregon, California, Nevada, Idaho, Utah, Arizona, Colorado, New Mexico, and Texas. Along the way, it passes over Crater Lake National Park, Capitol Reef National Park, and Canyonlands National Park, along with the cities of Albuquerque, New Mexico, and San Antonio and Corpus Christi, Texas. Viewers in Corpus Christi can experience up to 4 minutes 53 seconds of annularity just before the clock strikes 12:00.

After crossing the Gulf of Mexico, the path hits Mexico's Yucatán Peninsula and parts of Belize, Honduras, Nicaragua, Costa Rica, and Panama. The northern part of Panama's Sante Fé National Park experiences the longest duration of annularity — 5 minutes 7 seconds — over land. The track then gives people in sections of Colombia and Brazil a last look before heading into the Atlantic Ocean.

Photographers often try to capture annular eclipses with stunning foregrounds, and this eclipse offers countless opportunities. The track crosses the beautiful Oregon shore, dramatic Crater Lake, and the spectacular canyonlands of southern Utah and northern Arizona. A photographer who can't find a nice foreground just isn't trying. Striking features in silhouette combined with either a single or multiple exposure of the eclipsed Sun through a solar filter can result in breathtaking scenes.

Once the eclipse concludes, all eyes will turn to April 8, 2024, when a total eclipse will cross portions of the U.S., Canada, and Mexico.

On Oct. 14, eclipse enthusiasts will descend on the path of annularity, which crosses the U.S. from Oregon to Texas.

Oct 2023

S	M	T	W	T	F	S
1	2	3	4	5	◐	7
8	9	10	11	12	13	○
15	16	17	18	19	20	◑
22	23	24	25	26	27	●
29	30	31				

1 Asteroid Pallas is in conjunction with the Sun, noon EDT

The Moon passes 3° north of Jupiter, 11 P.M. EDT

2 The Moon passes 3° north of Uranus, 1 P.M. EDT

10 Venus passes 2° south of Regulus, 1 A.M. EDT

The Moon passes 6° north of Venus, 6 A.M. EDT

14 Annular solar eclipse, 2 P.M. EDT

20 Mercury is in superior conjunction, 2 A.M. EDT

21 Orionid meteor shower peaks

23 Venus is at greatest western elongation (46°), 7 P.M. EDT

24 The Moon passes 3° south of Saturn, 4 A.M. EDT

25 The Moon passes 1.5° south of Neptune, 9 P.M. EDT

28 Partial lunar eclipse, 4 P.M. EDT

29 The Moon passes 3° north of Jupiter, 4 A.M. EDT

The Moon passes 3° north of Uranus, 10 P.M. EDT

Nov 2023

S	M	T	W	T	F	S
			1	2	3	4
◐ 6	7	8	9	10	11	
12	○ 14	15	16	17	18	
19	◑ 21	22	23	24	25	
26	● 28	29	30			

- 3 Jupiter is at opposition, 1 A.M. EDT
- 9 The Moon passes 1.0° north of Venus, 4 A.M. EST
- 13 Uranus is at opposition, noon EST
- 16 Mercury passes 3° north of Antares, 1 P.M. EST
- 17 Leonid meteor shower peaks
- 18 Mars is in conjunction with the Sun, 1 A.M. EST
- 20 The Moon passes 3° south of Saturn, 9 A.M. EST
- Dwarf planet Ceres is in conjunction with the Sun, 11 A.M. EST
- 22 The Moon passes 1.5° south of Neptune, 3 A.M. EST
- 25 The Moon passes 3° north of Jupiter, 6 A.M. EST
- 26 The Moon passes 3° north of Uranus, 4 A.M. EST
- 28 Venus passes 4° north of Spica, 4 A.M. EST

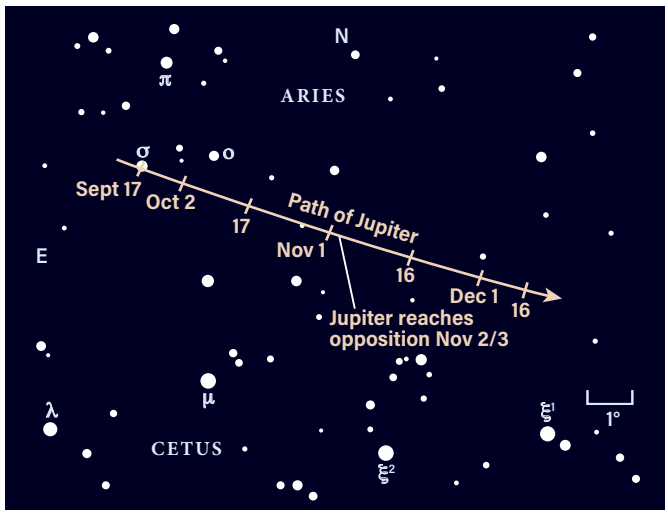
Autumn nights find Jupiter a delight

Jupiter reaches opposition and peak visibility the night of Nov. 2/3. This marks the middle of the best time this year to view the solar system's largest planet. And this year proves particularly noteworthy because Jupiter reached its closest point to the Sun in its 12-year orbit in January, so it appears about as big and bright as it can get.

The giant world spends its prime months among the background stars of southern Aries the Ram. It begins its retrograde (westward) path in early September not far from magnitude 5.5 Sigma (σ) Arietis. The planet slides just 5' south of this star Sept. 17. Jupiter reaches magnitude –2.9 at opposition, some 100 times brighter than the Ram's luminary, magnitude 2.0 Hamal.

Jupiter should look stunning through a telescope this year, particularly around opposition. Not only does the planet lie relatively close to Earth, resulting in an equatorial diameter of 50", but it also stands nearly 65° high, so we don't have to look through much of Earth's atmosphere to view it.

The gas giant always presents a rich variety of atmospheric features to observe. Small telescopes easily show the bright Equatorial Zone that coincides with the planet's equator as well as two darker equatorial belts that sandwich this zone. The South Equatorial Belt includes the Great Red Spot, a gigantic storm system that has persisted for centuries. Despite its name, the feature's color appears more salmon-pink than red.

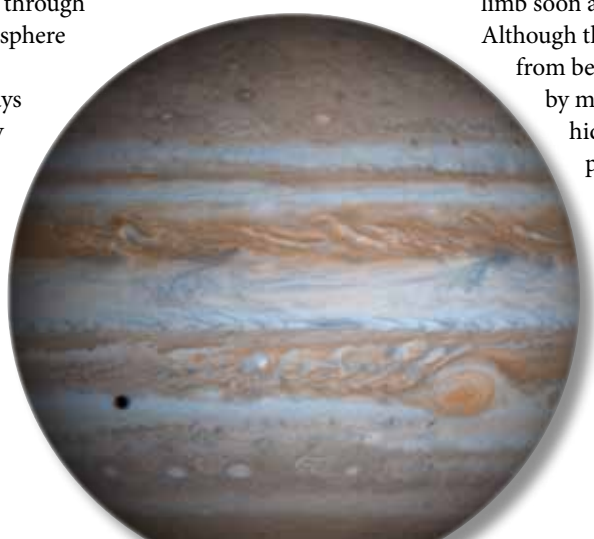


Jupiter dazzles at magnitude –2.9 in October and November against the background stars of southern Aries the Ram.

Four moons also appear prominent. In fact, they would be visible to the unaided eye on a dark night if Jupiter's brilliant orb weren't close by. Any telescope can show these Galilean moons: Io, Europa, Ganymede, and Callisto. They orbit the planet in 1.8, 3.6, 7.2, and 16.7 days, respectively. As they do, they can disappear from view as they pass behind Jupiter's globe. Half an orbit later, the moons and their shadows cross the jovian cloud tops.

A nice example occurs the night of Nov. 6/7. Watch Ganymede, the largest moon, glide behind Jupiter's northern limb soon after 10:30 P.M. EST. Although the moon comes out from behind the jovian disk by midnight, it remains hidden in the giant planet's shadow. Ganymede comes out of eclipse shortly after 12:30 A.M. EST, gradually brightening as sunlight once again falls on its surface.

The Cassini spacecraft spent more than a decade orbiting Saturn, but it also captured Jupiter in striking detail when it passed the giant planet in December 2000. NASA/JPL/UNIVERSITY OF ARIZONA



Meteors rule December nights

The Geminid meteor shower peaks each year in mid-December. It ranks as one of the top annual meteor showers because it is prolific, reliable, and has a fairly broad maximum lasting a full day. And it doesn't hurt that the shower's radiant in Gemini climbs quite high in the sky by 10 P.M. local time, making it a nice late-evening event instead of an all-nighter.

The Geminids remain active from Dec. 4 to 17 and peak on the 14th. With New Moon arriving Dec. 12, conditions could hardly be better. Observers may see up to 150 meteors per hour if they observe under a dark sky with no interfering artificial lights. This peak rate occurs when Gemini lies nearly overhead from about 1 A.M. to 3 A.M. local time.

Evening observers watching from a suburban backyard shouldn't expect to see more than 40 meteors per hour because the radiant lies lower and light pollution drowns out fainter meteors. You might see a few in rapid succession followed by several minutes of inactivity.

Patience is the key to successful meteor watching. The anticipation will keep you outside — you wouldn't want to miss a bright one that explodes at the end of its atmospheric flight, would you? Settle back on a reclining chair, wrap yourself in warm clothes, and have additional blankets ready if you need them. Enjoy some hot coffee or tea to keep your insides toasty as well. Direct your attention 30° to 60° away from Gemini to see longer trails. And avoid looking at your phone — the light affects your ability to see faint objects. It's best to get dark adapted for a good 15 minutes to see the best show.

A Geminid fireball lights up a star- and aurora-filled sky Dec. 14, 2017. The imager captured this scene from the Knik River Area near Palmer, Alaska.
MATT SKINNER

Meteor showers in 2023

Name	Peak date	Moon's phase	Prospects
Quadrantids	Jan. 3	Waxing gibbous	Poor
Lyrids	April 22	Waxing crescent	Excellent
Eta Aquariids	May 6	Full Moon	Poor
Perseids	Aug. 13	Waning crescent	Excellent
Orionids	Oct. 21	First Quarter Moon	Good
Leonids	Nov. 17	Waxing crescent	Excellent
Geminids	Dec. 14	Waxing crescent	Excellent

Meteor showers typically derive from comets that have spread dust along their orbits, but the Geminids appear to originate from asteroid 3200 Phaethon. Astronomers think this object was once a comet that lost its volatile ices after passing near the Sun too often.

This entire year looks promising for meteor viewing. Conditions for the Perseids in August — the Geminids' chief rival for supremacy — are nearly as good. Although a waning crescent Moon rises around 3 A.M. local daylight time, it appears less than 10 percent lit and won't pose a problem. Likewise, April's Lyrids, October's Orionids, and November's Leonids experience little moonlight during the prime observing hours after midnight. Only January's Quadrantids and May's Eta Aquariids suffer from a bright Moon.

Dec 2023

S	M	T	W	T	F	S
					1	2
3	4	◐	6	7	8	9
10	11	○	13	14	15	16
17	18	◑	20	21	22	23
24	25	●	27	28	29	30
31						

- **4** Mercury is at greatest eastern elongation (21°), 9 A.M. EST
- **9** The Moon passes 4° south of Venus, noon EST
- **13** The Moon passes 4° south of Mercury, midnight EST
- **14** Geminid meteor shower peaks
- **17** The Moon passes 2° south of Saturn, 5 P.M. EST
- **19** The Moon passes 1.3° south of Neptune, 8 A.M. EST
- **21** Asteroid Vesta is at opposition, 2 P.M. EST
- Solstice (northern winter/southern summer begins), 10 P.M. EST
- **22** The Moon passes 3° north of Jupiter, 9 A.M. EST
- Mercury is in inferior conjunction, 2 P.M. EST
- **23** The Moon passes 3° north of Uranus, 10 A.M. EST

April 8, 2024, brings a total solar eclipse to the U.S., the second in just seven years. This image recorded the Aug. 21, 2017, eclipse above the Grand Tetons. ALAN DYER

2024 Preview

Looking ahead to next year . . .

IT'S RARE WHEN TWO CONSECUTIVE YEARS have similar eclipse profiles, but 2024 delivers a near repeat of 2023 with vital distinctions. On the lunar front, this year saw a penumbral eclipse and a partial eclipse with 12 percent of the Moon immersed in Earth's umbra. In 2024, we'll experience a penumbral eclipse and a partial eclipse with 9 percent of the Moon within the umbra.

Solar eclipses in 2024 also provide us with a total and an annular event, with parts of the U.S. getting to experience one of them. The key difference: North America falls under the Moon's umbral shadow, delivering a long total eclipse April 8 to viewers on the center line. Landfall first occurs on Mexico's west coast near Mazatlán, where residents will see up to 4 minutes 20 seconds of totality. Totality reaches a maximum of 4 minutes 28 seconds near Nazas, Mexico.

The path of totality enters the U.S. in Texas, where both San Antonio and Dallas-Fort Worth lie in the path. The track heads north and east, crossing parts of Oklahoma, Arkansas, Missouri, Tennessee, Kentucky, Illinois, Indiana, Michigan, Ohio, Pennsylvania, New York, Vermont, New Hampshire, and Maine. Indianapolis, Cleveland, and Buffalo are among the big cities near the center line. The eclipse track also covers parts of southern Ontario, Quebec, and the Canadian Maritimes.

The annular eclipse Oct. 2 proves anticlimactic. It crosses only two countries — Chile and Argentina — though it does pass over Chile's Easter Island.

The top planets in 2024 are Jupiter, which reaches opposition Dec. 7, and Saturn, which peaks Sept. 7/8. But December will see both Mars and Venus shining brightly. The Red Planet will come to opposition in January 2025, five days after Venus reaches greatest eastern elongation.

Meteor observing suffers a down year in 2024. Of the big showers, only the Eta Aquariids and Perseids avoid moonlight.

The 2024 Perseid meteor shower peaks at First Quarter Moon, promising dark skies for predawn viewing. This shot caught the 2020 Perseids from Iran. PARISA BAJELAN

Mars and Jupiter will have a dramatic close encounter Aug. 14, 2024. The two planets last met May 29, 2022, shown here. JOHN CHUMACK