Astronomy magazine

Sky Guide 2020

• BY MARTIN RATCLIFFE AND RICHARD TALCOTT •

Mars returns to brilliance in 2020 as it climbs high into the sky for Northern Hemisphere observers.
NASA/JPL/USGS

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A supplement to *Astronomy* magazine

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			1	◑	3	4
5	6	7	8	9	●	11
12	13	14	15	16	◐	18
19	20	21	22	23	○	25
26	27	28	29	30	31	

4 Quadrantid meteor shower peaks

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

10 Mercury is in superior conjunction, 10 A.M. EST

Penumbral lunar eclipse, 2 P.M. EST

13 Pluto is in conjunction with the Sun, 8 A.M. EST

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

Dwarf planet Ceres is in conjunction with the Sun, 1 P.M. EST

16 Mars passes 5° north of Antares, 11 P.M. EST

20 The Moon passes 2° north of Mars, 2 P.M. EST

22 The Moon passes 0.4° south of Jupiter, 10 P.M. EST

27 Venus passes 0.08° south of Neptune, 2 P.M. EST

28 The Moon passes 4° south of Neptune, 1 A.M. EST

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

31 The Moon passes 5° south of Uranus, 10 P.M. EST

Venus points the way to Neptune

It's rare to see Venus, the planet whose orbit brings it closest to Earth, line up with Neptune, the most distant major planet. Yet they do just that January 27. That evening, the two worlds appear closer to each other than they have at any point since January 1984. Any telescope will show the pair in a single field of view.

The two certainly make an odd couple. Although a thick atmosphere cloaks both planets, the similarities end there. Venus is an Earth-sized world that lies just 67 million miles from the Sun. Baked by our star's intense heat, the rocky planet's surface temperature soars above 850 degrees Fahrenheit, hot enough to melt lead. Neptune is an ice giant four times Venus' diameter that lurks on the frigid edge of our solar system a staggering 2.8 billion miles from the Sun. Its atmospheric temperature dips to –330 F, nearly cold enough to freeze nitrogen.

Planetary conjunctions in 2020

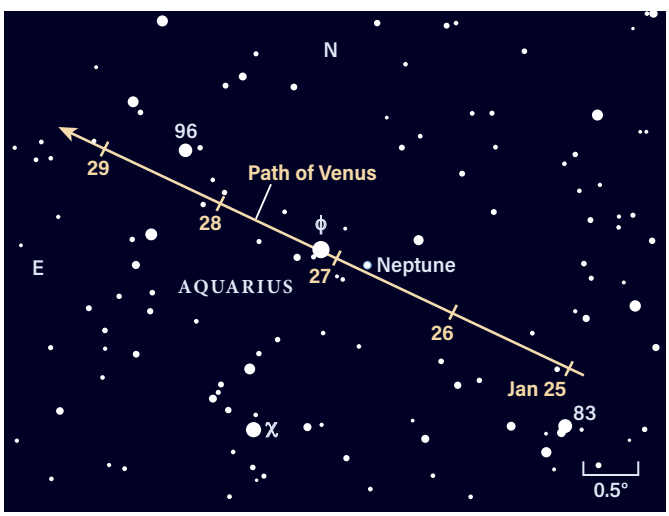
Nearer planet	Farther planet	Date	Separation
Venus	Neptune	Jan. 27	0.1°
Venus	Uranus	March 9	2.4°
Mars	Jupiter	March 20	0.7°
Mars	Saturn	March 31	0.9°
Venus	Mercury	May 22	0.9°
Mars	Neptune	June 12	1.7°
Jupiter	Saturn	Dec. 21	0.1°

Although Venus and Neptune cross paths roughly once a year, they rarely come as close as they do this month. Part of the reason is that Venus' orbit tilts 3.4° to the plane of Earth's orbit around the Sun while Neptune's tilts only 1.8°. So, more often than not, when the two planets pass near each other, they miss by at least 1°. Complicating matters further, the planets' conjunctions often occur when they lie too close to the Sun to observe.

That's what makes this month's event so appealing. Venus passes just 5' south of Neptune on January 27. The two lie 40° east of the Sun and stand some 20° high in the west-southwest once darkness falls. You can't miss Venus, which dazzles at magnitude –4.1. You'll likely need a telescope to spot magnitude 7.9 Neptune in the brighter planet's glare. A slim crescent Moon adds to the naked-eye scene from its perch 7° below the planetary pair.

The conjunction arrives precisely at 2 P.M. EST. By the time night falls in North America a few hours later, Neptune appears 12' due west of its companion. The 4th-magnitude star Phi (ϕ) Aquarii stands a nearly equal distance to Venus' east-northeast. A telescope shows Venus' disk, which appears 15" across and three-quarters lit. Neptune's disk spans 2.2" and looks fully illuminated.

If you miss this event, Venus and Neptune have two more close conjunctions in the coming years. In April 2022, they approach within 0.5' of each other, and in February 2023, they'll appear 1' apart. Unfortunately, the planets will lie significantly lower in the sky both times.



Venus slides within 0.1° of Neptune on January 27, the closest approach of the two planets in 36 years. ALL ILLUSTRATIONS: *ASTRONOMY*: ROEN KELLY

Lovely Luna conceals Mars

Mars crosses the border between Ophiuchus the Serpent-bearer and Sagittarius the Archer on February 11, setting up a series of superb encounters for early risers. On the 16th, the Red Planet forms an equilateral triangle with the Lagoon Nebula (M8) and Trifid Nebula (M20). Mars shines at magnitude 1.2 and adds an elegant focus to Sagittarius' rich star fields.

The planet's eastward motion against the stellar backdrop carries it midway between the Lagoon and Trifid on February 17, but that's nothing compared with the show awaiting observers on the 18th. That morning, the waning crescent Moon slides in front of Mars for observers across most of North America.

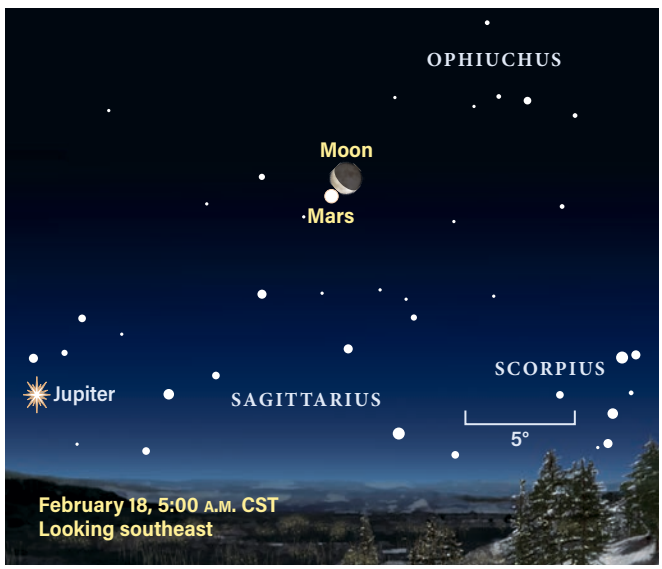
Although you can watch this wonderful occultation with your naked eyes, binoculars or a telescope greatly enhance the view. Optical aid lets you see Mars slowly fade out as the Moon's bright limb devours its prey. Depending on your location, it can take the Moon up to 15 seconds to fully engulf the planet's 5.2"-diameter disk.

The occultation's timing depends on where you live. Not only does the event occur earlier the farther west you live, but changes in latitude also affect the timing. The event occurs in darkness in western North America and during twilight in the Midwest. Although it won't be visible along the East Coast because it happens after sunrise, observers there can still see a stunningly close conjunction between the two objects before dawn. On the West Coast, where Mars has already disappeared by the time the two objects rise, observers can still watch the planet reappear from behind the Moon's dark limb.

Mars appeared at the limb of a waxing crescent Moon on July 27, 2006, moments before the Moon occulted the planet. TUNÇ TEZEL

For example, Mars disappears at 6:05 A.M. CST in Chicago and at 5:47 A.M. CST in Houston. In Denver, the disappearance occurs at 4:40 A.M. MST with the objects 9° high in a dark sky. In San Francisco, Mars returns to view at 4:29 A.M. PST, while the same event occurs one minute earlier in Los Angeles.

According to David Dunham of the International Occultation Timing Association (IOTA), Mars itself occults a faint star later this year. On September 24, the magnitude –2.4 planet passes in front of a 10th-magnitude star in eastern Pisces. This will be a challenging observation because of the huge brightness difference.



The waning crescent Moon glides in front of the Red Planet before dawn February 18. This view captures the scene just before the event starts.

Feb 2020

S	M	T	W	T	F	S
						◑
2	3	4	5	6	7	8
●	10	11	12	13	14	◐
16	17	18	19	20	21	22
○	24	25	26	27	28	29

10 Mercury is at greatest eastern elongation (18°), 9 A.M. EST

18 The Moon passes 0.8° north of Mars, 8 A.M. EST

19 The Moon passes 0.9° south of Jupiter, 3 P.M. EST

20 The Moon passes 0.7° south of Pluto, 3 A.M. EST

The Moon passes 1.7° south of Saturn, 9 A.M. EST

25 Mercury is in inferior conjunction, 9 P.M. EST

27 The Moon passes 6° south of Venus, 7 A.M. EST

28 The Moon passes 4° south of Uranus, 7 A.M. 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**

2020 March

S	M	T	W	T	F	S
1	◑	3	4	5	6	7
8	●	10	11	12	13	14
15	◐	17	18	19	20	21
22	23	○	25	26	27	28
29	30	31				

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

9 Venus passes 2° north of Uranus, 11 A.M. EDT

18 The Moon passes 0.7° south of Mars, 4 A.M. EDT

The Moon passes 1.5° south of Jupiter, 6 A.M. EDT

The Moon passes 0.9° south of Pluto, 11 A.M. EDT

The Moon passes 2° south of Saturn, 8 P.M. EDT

19 Equinox (northern spring/southern autumn begins), midnight EDT

20 Mars passes 0.7° south of Jupiter, 2 A.M. EDT

21 The Moon passes 4° south of Mercury, 2 P.M. EDT

23 Mercury is at greatest western elongation (28°), 10 P.M. EDT

24 Venus is at greatest eastern elongation (46°), 6 P.M. EDT

26 The Moon passes 4° south of Uranus, 5 P.M. EDT

28 The Moon passes 7° south of Venus, 7 A.M. EDT

31 Mars passes 0.9° south of Saturn, 7 A.M. EDT

A series of splendid conjunctions

March's predawn sky holds three planetary gems. Mars, Jupiter, and Saturn string out like pearls set against the backdrop of Sagittarius the Archer. The beautiful scene appears above the southeastern horizon on every clear morning this month.

Mars treks eastward during March and passes close to both Jupiter and Saturn. Each conjunction would attract attention on its own, so having two in the same month is a treat — and a rare one at that. Jupiter and Saturn appear near each other at roughly 20-year intervals. The last time all three planets came this close was April 2000.

As March opens, 19° separate the three worlds. Mars rises first, at around 3:30 A.M. local time. Jupiter follows about 40 minutes later, and Saturn appears a half-hour after that.

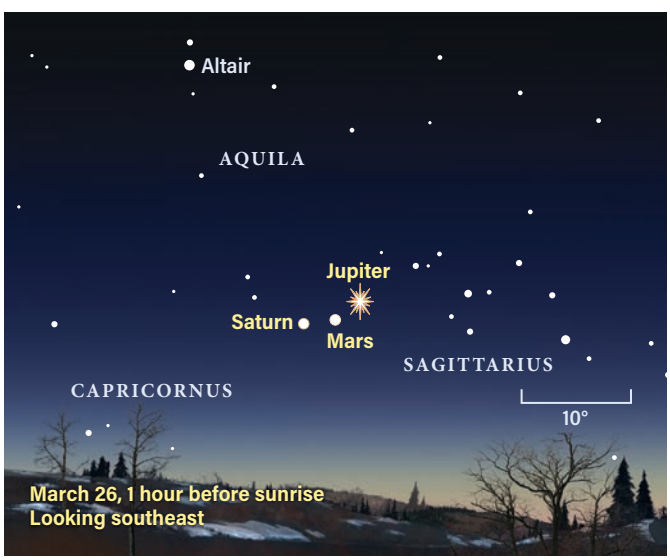
A brilliant Moon joined Mars, Jupiter, and Saturn on March 8, 2018. Jupiter appears to Luna's right, with Mars and Saturn to the left. RYAN IMPERIO

Jupiter is the brightest of the trio, gleaming at magnitude –2.0, with Saturn next at magnitude 0.7, and Mars slightly fainter at magnitude 1.1.

Because Mars lies closer to Earth than Jupiter and Saturn, it moves eastward more quickly and soon catches up with the other two. It reaches Jupiter's vicinity March 18, when a waning crescent Moon joins the pair. All three lie within a 2.5°-wide circle, with the two planets 1.3° apart.

Mars and Jupiter appear closest March 20. The rust-colored Mars then stands 0.7° south of the slightly yellowish Jupiter. A telescope at low power will capture both planets in the same field. Even though Jupiter lies much farther from Earth, its apparent diameter of 36" towers over Mars' 6" girth. Saturn lies 7° — about one binocular field — east of the pair.

Mars continues moving eastward, reaching a point approximately midway between the other two planets on the 26th. The month's final morning sees Mars passing 0.9° south of Saturn against the backdrop of western Capricornus. Mars has brightened to magnitude 0.8, almost matching Saturn's luster. They present a stunning sight before dawn, with Jupiter located 6° to their west.



Mars appears midway between Jupiter and Saturn the morning of March 26, when all three planets lie within 7° of one another.

Dazzling Venus meets the Pleiades

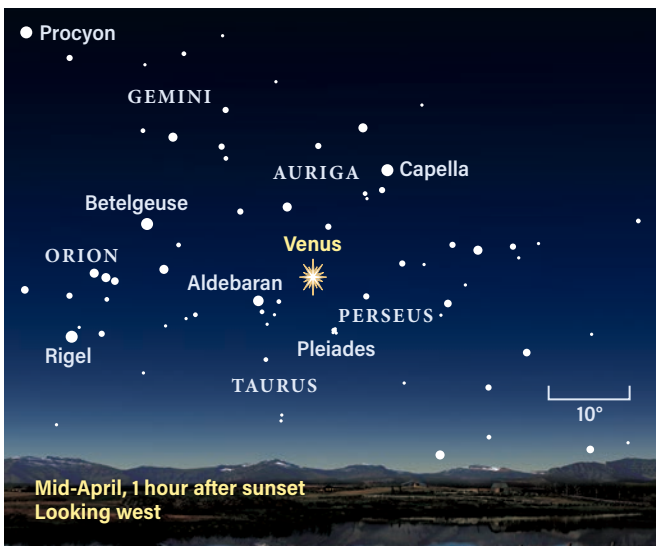
Venus dominates the western evening sky from the beginning of 2020 until late May. But it shines brightest, at magnitude –4.7, during April's final week. Venus spends the entire month among the background delights of Taurus the Bull. Its best encounter comes in early April when it slips through the southern part of the Pleiades star cluster (M45).

On the evening of April 3, Venus stands 15' — half the Full Moon's diameter — south of magnitude 2.9 Alcyone, the cluster's luminary. The planet shines 1,000 times brighter than the star. From Hawaii, where darkness falls a few hours later than on the mainland, Venus appears closer to magnitude 3.6 Atlas, the cluster's second-brightest star. At their closest, just 6' separate the two objects.

The scene looks spectacular whether you view it with your naked eyes or with optical aid. You'll need a scope to resolve Venus' disk, which spans 27" and appears 45 percent lit. Venus remains within a few degrees of M45 for several days before and after April 3, and you'll want to revisit the scene every clear evening.

Although April ranks as Venus' finest month, the rest of 2020 isn't shabby. The planet begins the year in Capricornus shining at magnitude –4.0. It then stands some 15° above the southwestern horizon an hour after sunset. Its distance from the Sun grows until greatest elongation March 24, when it lies 46° east of our star and climbs 32° high in the west an hour after sundown. That evening, a telescope shows the planet's 24"-diameter disk and nearly half-lit phase.

Brilliant Venus shines next to the dipper-shaped star cluster known as the Pleiades. The striking objects meet again in early April. JOHN CHUMACK



Venus dominates the western sky after sunset for the first half of 2020, but it appears most spectacular as it crosses Taurus during April.

Venus continues to grow larger while its crescent wanes for the next two months. At greatest brilliancy April 27, it sports a disk 37" across and barely one-quarter lit. Although its rising telescopic appeal is tempered by its diminishing altitude, it still stands 25° high an hour after the Sun goes down on the 27th.

Venus disappears for about two weeks around its June 3 solar conjunction, before reemerging in the morning sky in mid-June. The planet reaches greatest western elongation August 12 and appears nearly as high as it did in late March. Venus remains a stunning sight before dawn through the end of the year.

2020 April

S	M	T	W	T	F	S
			◑	2	3	4
5	6	●	8	9	10	11
12	13	◐	15	16	17	18
19	20	21	○	23	24	25
26	27	28	29	◑		

2 Asteroid Juno is at opposition, 4 P.M. EDT

3 Mercury passes 1.4° south of Neptune, 11 A.M. EDT

14 The Moon passes 1.2° south of Pluto, 6 P.M. EDT

The Moon passes 2° south of Jupiter, 7 P.M. EDT

15 The Moon passes 2° south of Saturn, 5 A.M. EDT

16 The Moon passes 2° south of Mars, 1 A.M. EDT

17 Venus passes 10° north of Aldebaran, 4 P.M. EDT

19 The Moon passes 4° south of Neptune, 3 A.M. EDT

22 Lyrid meteor shower peaks

26 Uranus is in conjunction with the Sun, 5 A.M. EDT

The Moon passes 6° south of Venus, 11 A.M. EDT

27 Venus is at greatest brilliancy, 2 P.M. EDT

May 2020

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	21	○	23
24	25	26	27	28	◑	30
31						

4 Mercury is in superior conjunction, 6 P.M. EDT

5 Eta Aquariid meteor shower peaks

12 The Moon passes 2° south of Jupiter, 6 A.M. EDT

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

14 The Moon passes 3° south of Mars, 10 P.M. EDT

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

17 Mercury passes 7° north of Aldebaran, 5 A.M. EDT

20 The Moon passes 4° south of Uranus, noon EDT

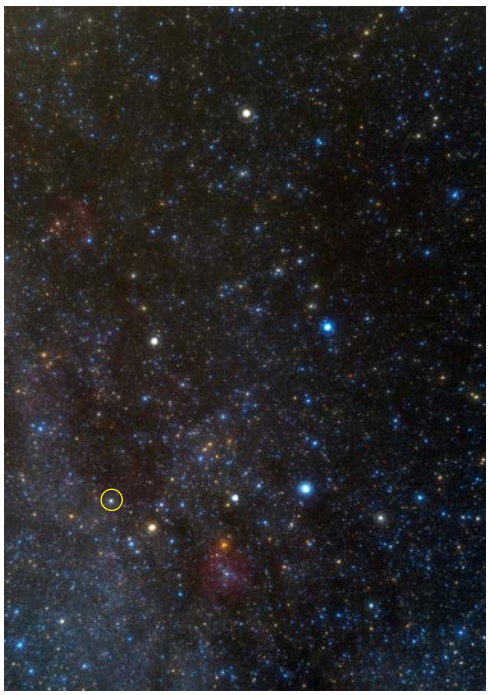
22 Mercury passes 0.9° south of Venus, 4 A.M. EDT

23 The Moon passes 4° south of Venus, 11 P.M. EDT

24 The Moon passes 3° south of Mercury, 7 A.M. EDT

Watch a giant star wax and wane

One of the sky's most important stars climbs high in the northeast on May nights. Glowing at 4th magnitude, Delta (δ) Cephei resides in the southeastern corner of Cepheus the King. It's a yellow supergiant star whose light output varies in response to regular pulsations in its outer layers.



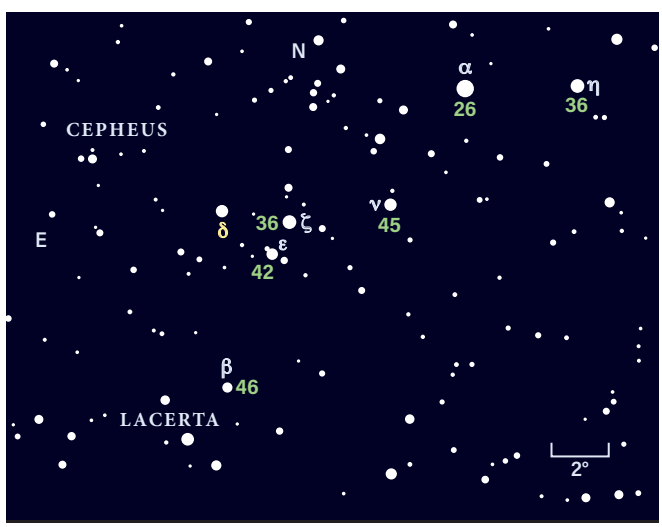
Delta Cephei lurks in southeastern Cepheus, a constellation whose shape resembles a child's drawing of a house. TONY HALLAS

British amateur astronomer John Goodricke first noticed Delta's unusual behavior in 1784. He found the star varied from magnitude 3.5 to 4.4 and back again over a period of 5.366 days. In the years since, observers have discovered many other stars showing similar patterns, though the periods range from a few days up to about 100 days. They became known as Cepheid variables, after the prototype in Cepheus.

A huge breakthrough came in 1912 when American astronomer Henrietta Swan Leavitt discovered 25 Cepheids in the Small Magellanic Cloud, one of the Milky Way's many satellite galaxies. She found that the brighter a Cepheid appears, the longer it takes to go from maximum light to minimum light and back. Once astronomers calibrated this so-called period-luminosity relation, they could calculate the distance to any of these stars. They simply had to measure the star's period and compare the observed brightness with the intrinsic brightness derived from the relation. Because all Cepheids are luminous supergiants, they can be seen in galaxies tens of millions of light-years from Earth.

You can track Delta's variations with your own eyes. The star lies midway between Cygnus' brightest star, Deneb, and the familiar W shape of the constellation Cassiopeia. Delta belongs to a tight triangle of 4th-magnitude stars with Zeta (ζ) and Epsilon (ε) Cephei. These two companions make good comparison stars because Zeta shines at magnitude 3.6 and Epsilon at magnitude 4.2.

To find Delta's magnitude, mentally place it on a scale of one to five between the brightness of Zeta and Epsilon. At first this may seem unusual, but you'll soon gain experience. This method will gauge Delta's brightness to within 0.2 magnitude.

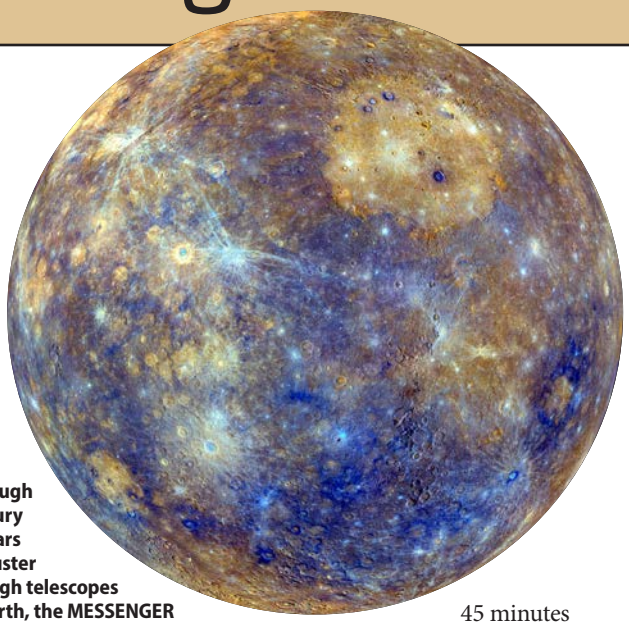


Delta (δ) Cephei changes brightness by 0.9 magnitude every 5.4 days. (Numbers are magnitudes with their decimal points omitted.)

Mercury glows in evening twilight

Mercury appears highest in the evening sky for 2020 during June's first week. The innermost planet reaches greatest elongation on the 4th, when it lies 24° east of the Sun and appears 10° high in the west-northwest 45 minutes after sunset. Mercury glows at magnitude 0.5 and should show up nicely to the naked eye in the gathering darkness. It slightly outshines Castor and Pollux, the two brightest stars in the constellation Gemini, which stand 15° higher in the twilight.

Mercury shines brighter and lies nearly as high in late May, so plan to start tracking it then. You can use Venus as a guide. On the 21st, the brilliant planet shines at magnitude –4.3 and lies 9° high 45 minutes after sundown. Mercury glows at magnitude –0.7 just 1° below it. The two make a delightful pair in the twilight sky.

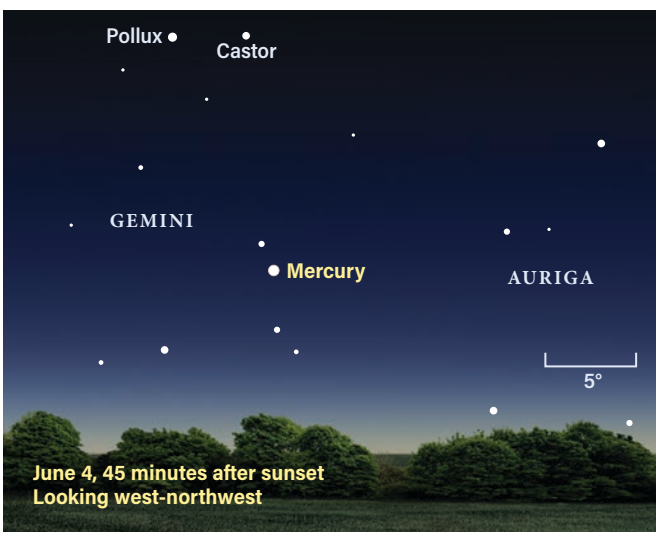


Although Mercury appears lackluster through telescopes on Earth, the MESSENGER spacecraft revealed signs of geologic activity. NASA/JHUAPL/CIW

A slender crescent Moon adds to the beauty of the evening scene May 23. Look for Luna 4° to Venus' lower left and Mercury the same distance to the brighter planet's upper left. The following night, a slightly fatter crescent Moon stands 13° above the horizon 45 minutes after sunset while Venus lies to its lower right and is just 5° high. Magnitude –0.4 Mercury nestles midway between the two.

If you want to view Mercury through a telescope, the time around greatest elongation is best. On June 4, the planet's disk appears 8" across and 36 percent lit. Mercury grows larger and shows a skinnier crescent in the week that follows, though it also becomes harder to see as it dims and sinks closer to the horizon.

Mercury makes two other evening appearances this year. It climbs nearly as high at its February 10 greatest eastern elongation, though it likely will be lost in twilight at its October 1 peak. For those who prefer viewing Mercury in the quiet hours before dawn, the planet hits its high point at greatest western elongation November 10. It appears slightly lower on mornings around its July 22 peak and barely scrapes the horizon at its March 23 appearance.



The best time to view Mercury this year comes when it climbs highest in evening twilight around its June 4 greatest eastern elongation.

2020 June

S	M	T	W	T	F	S
	1	2	3	4	●	6
7	8	9	10	11	12	◐
14	15	16	17	18	19	20
○	22	23	24	25	26	27
◑	29	30				

3 Venus is in inferior conjunction, 2 P.M. EDT

4 Mercury is at greatest eastern elongation (24°), 9 A.M. EDT

5 Penumbral lunar eclipse, 3 P.M. EDT

8 The Moon passes 2° south of Jupiter, 1 P.M. EDT

The Moon passes 3° south of Saturn, 10 P.M. EDT

12 Mars passes 1.7° south of Neptune, 8 A.M. EDT

The Moon passes 4° south of Neptune, 7 P.M. EDT

The Moon passes 3° south of Mars, 8 P.M. EDT

16 The Moon passes 4° south of Uranus, 10 P.M. EDT

19 The Moon passes 0.7° north of Venus, 5 A.M. EDT

20 Solstice (northern summer/southern winter begins), 6 P.M. EDT

21 Annular solar eclipse, 3 A.M. EDT

30 Mercury is in inferior conjunction, 11 P.M. EDT

July 2020

S	M	T	W	T	F	S
			1	2	3	4
●	6	7	8	9	10	11
◐	13	14	15	16	17	18
19	○	21	22	23	24	25
26	◑	28	29	30	31	

- **5** Penumbral lunar eclipse, 1 A.M. EDT
- The Moon passes 1.9° south of Jupiter, 6 P.M. EDT
- **6** The Moon passes 2° south of Saturn, 5 A.M. EDT
- **10** The Moon passes 4° south of Neptune, 3 A.M. EDT
- Venus is at greatest brilliancy, 4 A.M. EDT
- **11** The Moon passes 2° south of Mars, 4 P.M. EDT
- **12** Venus passes 1.0° north of Aldebaran, 3 A.M. EDT
- Asteroid Pallas is at opposition, 10 P.M. EDT
- **14** Jupiter is at opposition, 4 A.M. EDT
- The Moon passes 4° south of Uranus, 8 A.M. EDT
- **15** Pluto is at opposition, 3 P.M. EDT
- **17** The Moon passes 3° north of Venus, 3 A.M. EDT
- **18** The Moon passes 4° north of Mercury, midnight EDT
- **20** Saturn is at opposition, 6 P.M. EDT
- **22** Mercury is at greatest western elongation (20°), 11 A.M. EDT

Jupiter and Saturn rule the night

The solar system's two largest planets reach opposition and peak visibility within a week of each other this month. Jupiter and Saturn, which haven't been this close to each other in 20 years, form a marvelous pair that remains on view all night.

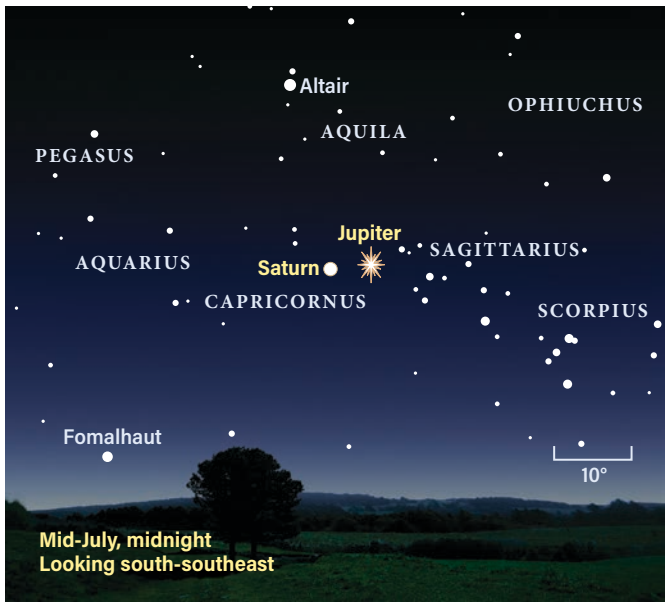
Jupiter spends most of 2020 in Sagittarius. The planet's normal eastward motion relative to the starry backdrop comes to a halt in mid-May at a point 5° west of Saturn. Jupiter then heads westward, or retrograde, as it approaches its July 14 opposition. The gas giant shines brightest, at magnitude –2.8, at opposition.

Saturn also begins its retrograde loop in mid-May. It crosses the border from Capricornus into Sagittarius on July 3 ahead of its July 20 opposition. At its peak, the ringed planet shines at magnitude 0.1, just 7 percent as bright as Jupiter.

Both planets look stunning through a telescope. Jupiter's disk spans 48" at opposition. Its dynamic atmosphere displays two parallel dark belts that sandwich a brighter zone coinciding with the equator. Saturn excels because of its rings. At opposition, the planet's disk measures 18" across while the rings span 42" and tilt 22° to our line of sight.

Both planets also host several moons visible through small scopes. Jupiter boasts four — Io, Europa, Ganymede, and Callisto — while Saturn claims 8th-magnitude Titan and a quartet of 10th-magnitude moons.

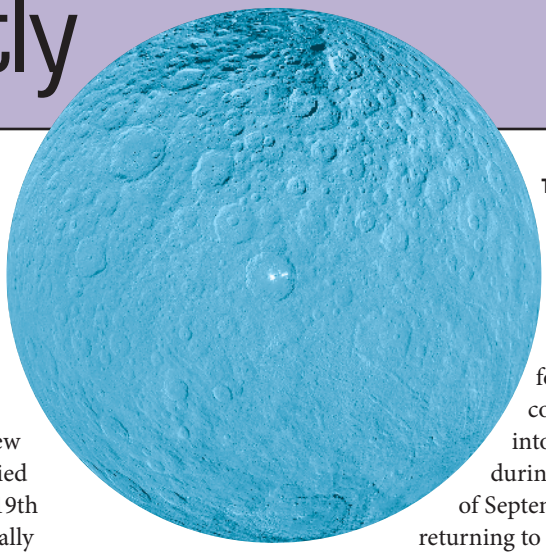
Both planets end their retrograde loops in September, when 8° separate them. As they head eastward, Jupiter moves faster and catches up with its neighbor. The two meet December 21 when Jupiter passes 0.1° south of Saturn. The stunning pair stands 12° high in the southwest an hour after sunset.



Gas giants Jupiter and Saturn come to opposition within six days of each other this month, when a mere 7° separate the two.

The brightly colored bands in Jupiter's atmosphere stand out when it looms large, as it does at opposition July 14. NASA/ESA/A. SIMON (GSFC)/M.H. WANG (UC, BERKELEY)

A dwarf planet glows brightly



The Dawn spacecraft captured Ceres, with Occator Crater at the center, from 240 miles away. NASA/JPL-CALTECH/UCLA/MPS/DLR/IDA

On January 1, 1801, Italian astronomer Giuseppe Piazzi discovered an object circling the Sun between the orbits of Mars and Jupiter. Initially thought to be a new planet, Ceres was reclassified as an asteroid later in the 19th century before being partially resurrected as a dwarf planet in 2006. This 584-mile-wide object reaches opposition August 28.

Although Ceres glows brightest at opposition, it's easier to find in early August when it slides past 88 Aquarii, a 4th-magnitude star in far southern Aquarius. The magnitude 8.0 dwarf planet will be simple to spot through binoculars or a small telescope.

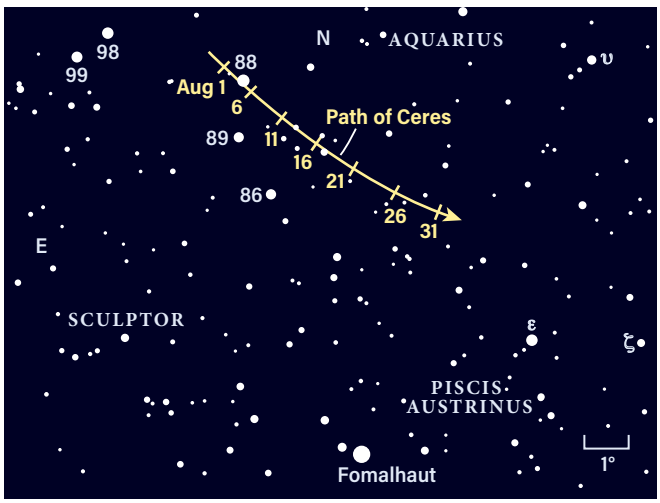
The trickiest part is finding 88 Aqr. Fortunately, a brighter star helps point the way. First-magnitude Fomalhaut rises around 11 P.M. local daylight time in early August and climbs highest in the south around 3 A.M. Center Fomalhaut in your binoculars, then scan 6° north and slightly east to find three similarly bright stars: 86, 89, and 88 Aqr. Our guide star is the slightly brighter, northernmost member of this trio.

Ceres appears within 1° of 88 Aqr during August's first 10 days. On the 1st, the dwarf planet lies 32' — about the diameter of a Full Moon — east-northeast of the star. Ceres moves southwest from night to night and seems to be on a collision course with 88 Aqr. The asteroid passes just 5' east of the star on the 4th and 9' south of the star on the 5th. No other object in the vicinity glows brighter than 9th magnitude, so you shouldn't have any trouble identifying Ceres.

Once you've found Ceres, you can track it through the end of August as it wanders into a sparser region near the Aquarius-Piscis Austrinus border. The dwarf planet brightens to magnitude 7.7 by August 18 and remains this bright through month's end. On the 22nd, you can find it 6° due north of Fomalhaut.

After opposition, Ceres follows a westerly course, dipping into Piscis Austrinus during the first half of September before returning to Aquarius in mid-October. Along the way, it passes 16' south of 6th magnitude 49 Aqr on October 11. A week later, it stands a similar distance east of the interacting Atoms for Peace Galaxy (NGC 7252). Astroimagers will want to capture the magnitude 8.5 dwarf planet next to this peculiar system.

A better chance to shoot Ceres near a bright deep-sky object comes when it cruises within 1° of the Helix Nebula (NGC 7293) between November 18 and 22. Although the asteroid has faded to magnitude 8.9, it remains within easy reach of a small telescope.



The dwarf planet Ceres glides through southern Aquarius during August, about one binocular field north of 1st-magnitude Fomalhaut.

2020 Aug

S	M	T	W	T	F	S
						1
2	●	4	5	6	7	8
9	10	◐	12	13	14	15
16	17	○	19	20	21	22
23	24	◑	26	27	28	29
30	31					

1 The Moon passes 1.5° south of Jupiter, 8 P.M. EDT

2 Mercury passes 7° south of Pollux, 2 A.M. EDT

The Moon passes 1.1° south of Pluto, 2 A.M. EDT

The Moon passes 2° south of Saturn, 9 A.M. EDT

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

9 The Moon passes 0.8° south of Mars, 4 A.M. EDT

10 The Moon passes 4° south of Uranus, 5 P.M. EDT

12 Perseid meteor shower peaks

Venus is at greatest western elongation (46°), 8 P.M. EDT

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

17 Mercury is in superior conjunction, 11 A.M. EDT

28 Dwarf planet Ceres is at opposition, 8 A.M. EDT

The Moon passes 1.4° south of Jupiter, 10 P.M. EDT

29 The Moon passes 1.2° south of Pluto, 7 A.M. EDT

The Moon passes 2° south of Saturn, 1 p.m. EDT

An ice giant in the celestial sea

2020 Sept

S	M	T	W	T	F	S
		1	●	3	4	5
6	7	8	9	◐	11	12
13	14	15	16	○	18	19
20	21	22	◑	24	25	26
27	28	29	30			

1 Venus passes 9° south of Pollux, 1 P.M. EDT

2 The Moon passes 4° south of Neptune, 5 P.M. EDT

6 The Moon passes 0.03° north of Mars, 1 A.M. EDT

The Moon passes 3° south of Uranus, midnight EDT

11 Neptune is at opposition, 4 P.M. EDT

14 The Moon passes 4° north of Venus, 1 A.M. EDT

18 The Moon passes 6° north of Mercury, 6 P.M. EDT

22 Mercury passes 0.3° north of Spica, 5 A.M. EDT

Equinox (northern autumn/southern spring begins), 10 A.M. EDT

25 The Moon passes 1.6° south of Jupiter, 3 A.M. EDT

The Moon passes 2° south of Saturn, 5 P.M. EDT

29 The Moon passes 4° south of Neptune, 10 P.M. EDT

The solar system hosts eight major planets, but none is as hard to see as Neptune. It's the only planet that's never bright enough to see with the naked eye. Still, binoculars or a small telescope capture its light quite easily. And there's no better time to hunt it down than in September, when it reaches opposition and peak visibility.

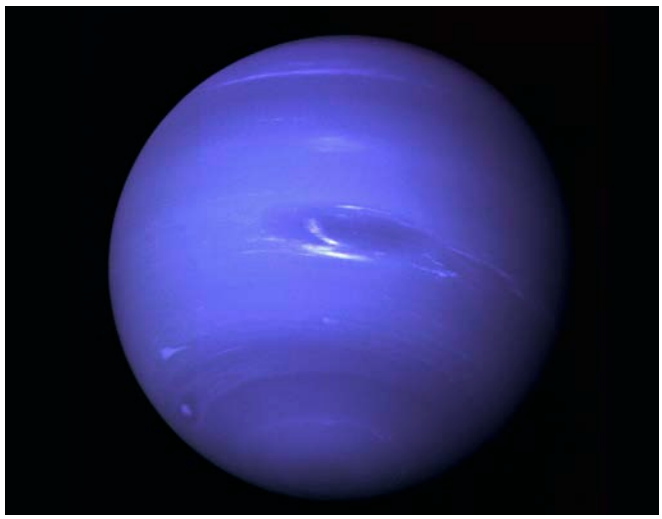
Neptune resides among the background stars of Aquarius the Water-bearer. Although it has called Aquarius home since 2011, it has now moved into the far eastern part of this constellation. To find it, first locate the 4th-magnitude star Phi (ϕ) Aquarii. Neptune stays within 2.5° of Phi all month.

The ice giant planet reaches opposition September 11, when it lies opposite the Sun in our sky and thus remains visible all night. A planet typically shines brightest at opposition, but in Neptune's case, it sustains its magnitude 7.8 glow from mid-July to early November.

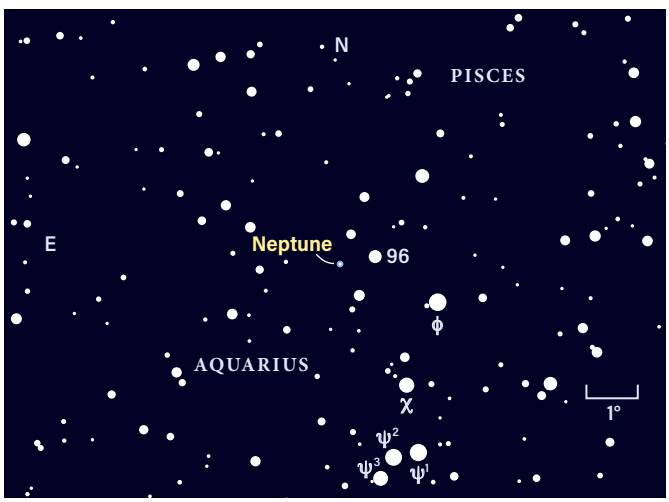
On September 11, Neptune forms an equilateral triangle with two brighter stars — 5.6-magnitude 96 Aqr and a 6.2-magnitude field star — located 1.5° east of Phi. The planet lies east of a line joining these suns and some 0.7° away from each. Neptune's westward motion after opposition carries it directly between these stars during October's first week. The ice giant comes within 0.7° of Phi when it wraps up its retrograde loop in late November.

Although binoculars gather enough light to show you Neptune, you'll need a telescope to see it as more than a point of light. At opposition, the planet shows a disk that spans 2.4" and has a subtle blue-gray hue.

Neptune's sister world, Uranus, reaches opposition October 31. You might have a hard time spotting it that night, however, because a Halloween Full Moon lies one binocular field to its east. Wait a couple of nights, and you can track down its magnitude 5.7 glow against the backdrop of southern Aries, some 10° south-southeast of 2nd-magnitude Hamal, the Ram's brightest star. Although Uranus shows up easily through binoculars, you'll need a telescope to see its 3.8"-diameter disk and distinctive blue-green color.



Amateur telescopes show Neptune's small disk and blue-gray color, but don't expect to see the level of detail Voyager 2 captured in 1989. NASA/JPL



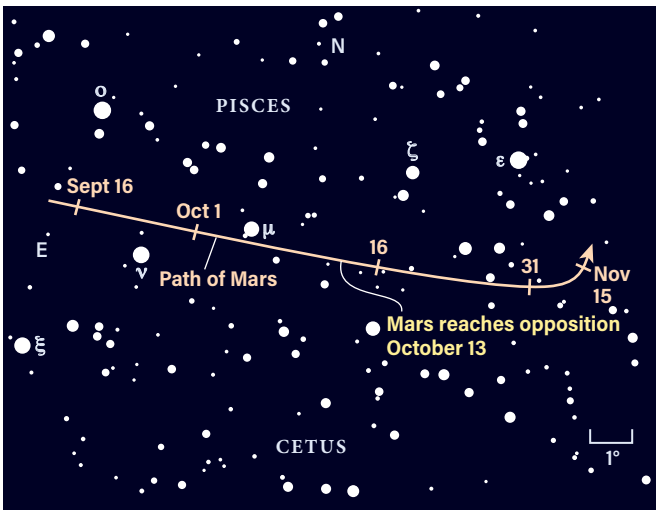
The constellation Aquarius hosts Neptune again this year. At opposition September 11, the ice giant lies 2.1° east-northeast of Phi (ϕ) Aquarii.

The Red Planet climbs high in the sky

Mars reaches opposition at roughly 26-month intervals, but some of these appearances are much better than others. October brings one of the best. At opposition on the 13th, the Red Planet shines at magnitude –2.6 and shows a disk 22.3" in diameter. (It appears 0.3" larger when it comes closest to Earth a week earlier.)

Although Mars came slightly closer to Earth and shone a bit brighter at its previous opposition in July 2018, the view this year should be even better for those in the Northern Hemisphere. In 2018, Mars lurked in southern Capricornus at a declination of –26°. This meant that for an observer at 40° north latitude, the planet climbed no higher than 24°. At opposition this year, Mars lies in Pisces at a declination of 5° and climbs 55° above the horizon at its peak. The higher altitude reduces atmospheric turbulence and improves seeing conditions significantly, which more than offsets the planet's slightly smaller diameter.

Mars remains visible throughout 2020, though it's strictly a morning object for the first six months of the year. Be sure to watch it pass 0.7° south of Jupiter on March 20, 0.9° south of Saturn on March 31, and 1.7° south of Neptune on June 12.

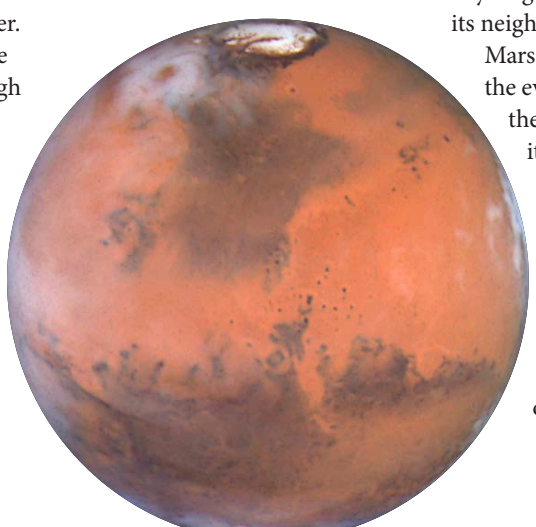


The Red Planet reaches its peak at opposition in October, when it resides among the background stars of eastern Pisces the Fish.

The Red Planet brightens steadily in the lead-up to opposition. It reaches magnitude 1.0 on March 8, magnitude 0.0 on May 28, magnitude –1.0 on June 26, and magnitude –2.0 on September 7. This rapid brightening coincides with a surge in Mars' apparent size. Its diameter swells from 5" on February 10 to 10" on June 12, 15" on August 4, and 20" on September 8. These changes finally become visible to evening observers once the planet rises before midnight local daylight time starting in mid-July.

By the time of opposition, Mars surpasses Jupiter as the brightest point of light in the evening sky. Only Venus appears brighter once it rises in the wee hours. The Red Planet appears even more conspicuous thanks to its distinctive color and the lack of any bright stars in Pisces and its neighbors.

Mars remains a fixture in the evening sky through the end of the year. And it shouldn't be an afterthought: Even on New Year's Eve, it gleams at magnitude –0.2 and appears 10" across from its perch 60° high in the south as darkness falls.



Mars won't appear this big or bright until 2035.
STEVE LEE (UNIVERSITY OF COLORADO)/JIM BELL (CORNELL UNIVERSITY)/MIKE WOLFF (SSI)/NASA

Oct 2020

S	M	T	W	T	F	S
				●	2	3
4	5	6	7	8	◐	10
11	12	13	14	15	○	17
18	19	20	21	22	◑	24
25	26	27	28	29	30	●

1 Mercury is at greatest eastern elongation (26°), noon EDT

2 Venus passes 0.09° south of Regulus, 8 P.M. EDT

The Moon passes 0.7° south of Mars, 11 P.M. EDT

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

13 Mars is at opposition, 7 P.M. EDT

The Moon passes 4° north of Venus, 8 P.M. EDT

17 The Moon passes 7° north of Mercury, 3 P.M. EDT

21 Orionid meteor shower peaks

22 The Moon passes 2° south of Jupiter, 1 P.M. EDT

The Moon passes 3° south of Saturn, midnight EDT

25 Mercury is in inferior conjunction, 2 P.M. EDT

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

29 The Moon passes 3° south of Mars, noon EDT

31 The Moon passes 3° south of Uranus, 9 A.M. EDT

Uranus is at opposition, noon EDT

Nov 2020

S	M	T	W	T	F	S
1	2	3	4	5	6	7
◐	9	10	11	12	13	14
○	16	17	18	19	20	◑
22	23	24	25	26	27	28
29	●					

10 Mercury is at greatest western elongation (19°), noon EST

12 The Moon passes 3° north of Venus, 4 P.M. EST

13 The Moon passes 1.7° north of Mercury, 4 P.M. EST

15 Venus passes 4° north of Spica, 8 A.M. EST

17 Leonid meteor shower peaks

19 The Moon passes 2° south of Jupiter, 4 A.M. EST

The Moon passes 3° south of Saturn, 10 A.M. EST

23 The Moon passes 5° south of Neptune, 7 A.M. EST

25 The Moon passes 5° south of Mars, 3 P.M. EST

27 The Moon passes 3° south of Uranus, noon EST

30 Penumbral lunar eclipse, 4 A.M. EST

Dark skies for autumn meteors

Observers can expect a flurry of meteors the morning of November 17. That's when the annual Leonid meteor shower reaches its peak. Viewers under a dark sky should then see up to 20 "shooting stars" per hour.

This year's shower occurs only two days after New Moon, which leaves the prime viewing hours after midnight free from our satellite's interference. Meteor rates spike in the pre-dawn hours because Earth then faces the direction of its orbital motion. (It's the same reason why a snowstorm looks much worse out the front windshield of a moving car.) It also helps that the shower's radiant, which lies in the constellation Leo the Lion, climbs highest around the time morning twilight begins. To see the most meteors, observe from a site far from the lights of civilization where you can take in a wide swath of sky.

Leonid meteors stem from dusty debris ejected by Comet 55P/Tempel-Tuttle during its countless trips through the inner solar system. When these dust particles slam into Earth's atmosphere, friction with air molecules incinerates them and produces the streaks of light we see. Leonids blaze into the atmosphere at 44 miles per second, the fastest of any shower meteors. The high speeds mean they produce a greater percentage of fireballs than most showers.

This Leonid meteor pierced the heart of Orion in 2018, passing through the Hunter's Belt just north of the Orion Nebula (M42). CRAIG BURTIS

The Leonids are the middle cog in a string of great meteor showers lined up for 2020's closing months. The Orionids in October likewise peak under a waxing crescent Moon that sets well before midnight. In recent years, this shower has produced 20 to 25 meteors per hour. But both of these displays are mere warmups for the year's best shower: December's Geminids. Observers under a dark sky can expect to see up to 150 meteors per hour — that's better than two per minute, on average — when the shower peaks at New Moon the night of December 13/14.

Early January 2020's Quadrantid shower is nearly as prolific, with a peak rate of 120 meteors per hour. The waxing gibbous Moon sets around 1 A.M. local time, leaving nearly five hours of unspoiled viewing. Unfortunately, the third great annual meteor shower — the Perseids in August — shares the sky with a fat crescent Moon. Although Luna's presence will drown out fainter meteors, observers shouldn't skip this summer favorite. Astronomers predict that Earth may encounter a denser filament of comet debris around 6 A.M. EDT on August 12, timed perfectly for viewers in western North America.

Meteor showers in 2020

Name	Peak date	Moon's phase	Prospects
Quadrantids	Jan. 4	Waxing gibbous	Good
Lyrids	April 22	New Moon	Excellent
Eta Aquariids	May 5	Waxing gibbous	Poor
Perseids	Aug. 12	Waning crescent	Fair
Orionids	Oct. 21	Waxing crescent	Excellent
Leonids	Nov. 17	Waxing crescent	Excellent
Geminids	Dec. 13	New Moon	Excellent

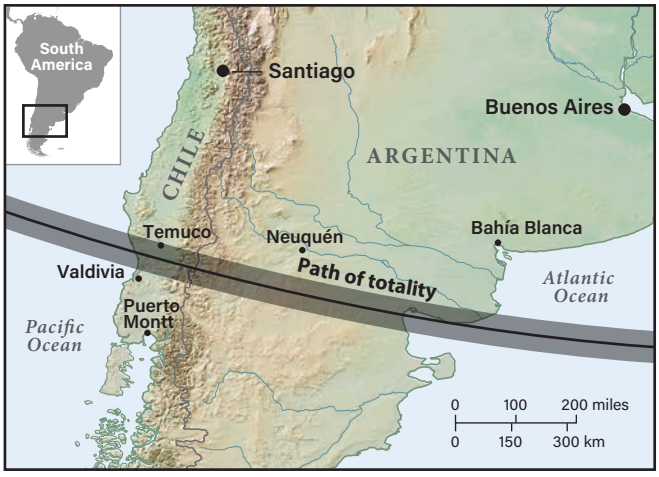
Totality returns to South America

On December 14, for the second time in a year and a half, a total solar eclipse graces the skies above Chile and Argentina. This year, however, the path of totality lies some 600 miles farther south. The eclipse occurs near noon just one week before the summer solstice, so the Sun will appear much higher in the sky than it did during the July 2019 spectacle. Summertime weather means good viewing prospects across most of the eclipse path, with slightly cloudier conditions in Chile.

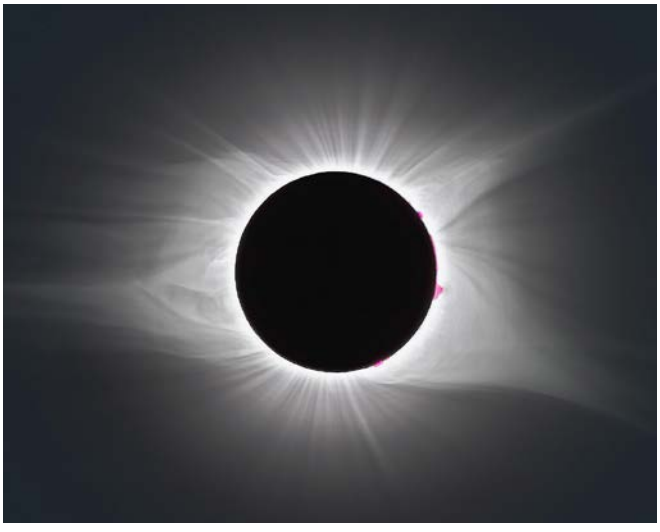
Totality begins at sunrise over the South Pacific, but the real thrills don't start until the Moon's umbral shadow hits the Chilean coast southwest of Temuco. Totality there lasts 2 minutes 9 seconds beginning at 1:00 P.M. Chile Summer Time. The shadow moves quickly inland, cutting across Villarrica National Park, which lays claim to three volcanoes.

The eclipse path then enters Argentina in the picturesque Patagonia region, which should prove to be a big attraction for eclipse chasers. Greatest duration — 2 minutes 10 seconds starting at 1:12 P.M. Argentina Time — occurs in the central part of the country not far north of the tiny town of Sierra Colorada. By the time the umbral shadow leaves Argentina near La Loberia, the duration along the center line drops only slightly, to 2 minutes 9 seconds. The eclipse's partial phases, of course, add more than an hour of excitement both before and after totality. During these stages where the Moon does not completely cover the Sun, observers need to use safe solar-viewing techniques to avoid serious eye damage.

The December 14 event is the highlight of 2020 eclipse viewing. An annular eclipse, where the Moon passes directly in front of the Sun but does not appear big enough to cover the entire solar disk, cuts a narrow track across Africa and southern Asia on June 21. At maximum in northern India, the Moon blocks 99 percent of the Sun's area. Four lunar eclipses take place in 2020. In each case, however, Luna only enters Earth's lighter penumbral shadow, so observers won't see the Full Moon darken significantly.



The December 14 total solar eclipse promises superb views for observers positioned along a narrow path that crosses Chile and Argentina.



This month's solar eclipse occurs near solar minimum, so the Sun should display long coronal streamers like it did in August 2017. JOHN FISANOTTI

Dec 2020

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	28	●	30	31		

12 The Moon passes 0.8° north of Venus, 4 P.M. EST

13 Geminid meteor shower peaks

14 Total solar eclipse, 11 A.M. EST

16 The Moon passes 3° south of Jupiter, 11 P.M. EST

The Moon passes 3° south of Saturn, midnight EST

19 Mercury is in superior conjunction, 10 P.M. EST

20 The Moon passes 5° south of Neptune, 3 P.M. EST

21 Solstice (northern winter/southern summer begins), 5 A.M. EST

Jupiter passes 0.1° south of Saturn, 9 A.M. EST

22 Venus passes 6° north of Antares, 8 P.M. EST

23 The Moon passes 6° south of Mars, 2 P.M. EST

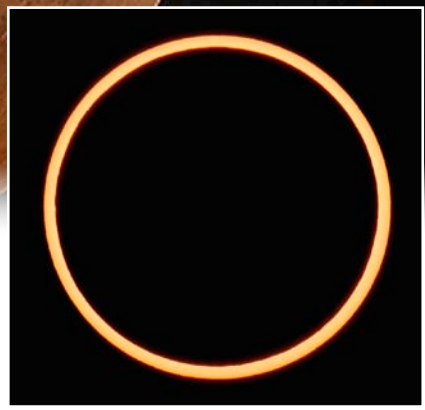
24 The Moon passes 3° south of Uranus, 6 P.M. EST

2021 Preview

Looking ahead to next year . . .

Left: A partial lunar eclipse visits North America on November 18/19, mimicking this view from August 16, 2008. ANTHONY AYIOMAMITIS

Below: Observers across much of southern Ontario will witness an annular solar eclipse as the Sun rises June 10. DARREN TRIZZINO



A Perseid meteor streaked beside the Milky Way during the 2018 shower. Similarly great scenes await viewers this year. JOSHUA RHOADES

ECLIPSE VIEWERS' FOCUS

shifts from the Sun to the Moon in 2021. After 2020 brought us only penumbral lunar eclipses, 2021 welcomes one total and one deep partial event. The May 26 eclipse delivers 18 minutes of totality for observers across the western half of North America. (The continent's eastern half experiences only the preliminary partial phases.) And on the night of November 18/19, every North American with a clear sky can watch Earth's dark umbral shadow cover 98 percent of the Full Moon.

Although solar eclipses take a back seat in 2021, two intriguing events should entice astronomy enthusiasts. On June 10, the Moon crosses in front of the Sun but doesn't block it entirely, bringing an annular eclipse to parts of Canada, Greenland, and Siberia. The eclipse begins at sunrise in southern Ontario, where viewers can see 3 minutes 37 seconds of annularity. Residents across much of the northern and eastern U.S. can witness a partial eclipse at daybreak. The December 4 total eclipse presents more of a challenge because it makes landfall only in Antarctica.

The solar system's planets should prove equally fascinating. Mars continues its fine appearance into early 2021. On January 1, it stands high in the evening sky while shining at magnitude –0.2 and spanning 10" when viewed through a telescope. The Red Planet remains brighter than magnitude 1.0 into early March. Meanwhile, Venus puts on a great show as darkness falls in autumn. At greatest elongation October 29, the magnitude –4.5 inner planet lies nearly 15° high in the southwest 45 minutes after sunset.

Jupiter and Saturn remain companions throughout 2021. They reach opposition within three weeks of each other in August. Jupiter peaks at magnitude –2.9 while sporting a 49"-diameter disk. Saturn reaches magnitude 0.2 and displays a ring system that spans 42".

Fortunes reverse for the three main meteor showers in 2021. The Quadrantids and Geminids both battle a bright Moon, though the latter shower enjoys a few dark hours before dawn. The Perseids rebound nicely in 2021, however, peaking under a waxing crescent Moon that shouldn't interfere at all.

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