

OBSERVING HIGHLIGHTS for November 16 to 30, 2022, a “dark Moon” Period.
Black Canyon Astronomical Society (BCAS), western Colorado, USA

SUMMARY. Moonless evenings in late November are fine times to enjoy western Colorado’s wonderfully dark night skies. Constellations of autumn, like Pegasus and Pisces, are front and center. And as darkness falls progressively earlier each day, the constellations of summer and even the central Milky Way still linger in the west. The Moon reaches last quarter on November 16. On mornings from November 17 to 22, we can watch a crescent Moon wane. The Moon is new and invisible on November 23. On evenings between November 25 and 29, watch the crescent Moon wax to first quarter on November 30. Enjoy seeing earthshine on the dark part of the crescent Moon, especially on mornings from November 18 to 22 and evenings from November 25 to 28 (use binoculars for stunning views!). After sunset, both Saturn and bright Jupiter are prominent in the south and southeast, respectively. And reddish Mars, as bright as it will get for a decade, rises in the east northeast before 6:30 PM MST. Keep watch for the Leonid Meteors (aka “shooting stars”) during November, especially for possible high meteor rates on the night of November 18-19 (as detailed below). Over the past several months the Sun has been active, unleashing X-ray flares and ejecting charged particles. This solar activity is triggering auroras (“northern lights”) that may be visible in real-time on the AuroraMax.com website, in person from northern U.S. states, or even from Colorado if we get lucky. And for western Colorado, there will be “prime-time”, evening passes of the bright International Space Station between November 16 and 30. Also, there will be a morning pass of China’s nearly-as-bright Tiangong Space Station on November 17 and evening passes of Tiangong between November 27 and 30. Tiangong got a lot brighter after the October 31 installation of the new Mengtian module. The BlueWalker 3 communications satellite deployed its huge, 693 square-ft antennae array on November 14. Will BlueWalker 3 get as bright as Tiangong or even the ISS? Look for BlueWalker 3 on the evenings of November 20, 21, 22, and 23.

WESTERN SLOPE SKIES. Since 2011, the BCAS and KVNF Community Radio have been producing Western Slope Skies (WSS), a biweekly astronomy feature. On November 16, Michael T. Williams presents “Seeing Through the Cosmos.” Then on November 25 and 30, Alice de Anguera will explore science and mythology while “Pondering Pegasus.” Audio, scripts, and images from Western Slope Skies features are linked here:
<https://www.kvnf.org/show/western-slope-skies#stream/0>

Note: The apparent brightness of sky objects is measured in “magnitude” units. Many bright stars are magnitude +1, while the faintest stars easily visible to the unaided eye under dark skies are magnitude +6. Some of the brightest stars are 0 magnitude (e.g., Vega, Arcturus), while the brightest sky objects have negative magnitudes (e.g., Sirius at -1.5, Jupiter at -2 to -3, Venus at -4 to -5, the full Moon at -12 to -13, and the Sun at -26.7 magnitude). Angular distances on the sky are usually cited in degrees of arc. Helpful ways to estimate 1, 5, 10, 15, and 25 degrees of arc can be found here:
<https://www.timeanddate.com/astronomy/measuring-the-sky-by-hand.html>

THE MOON. The Moon reaches **last quarter on November 16** at 6:27 AM MST. From November 17 to 22, the crescent Moon wanes in the mornings. **The Moon is new on November 23** at 3:57 PM MST. On evenings from November 25 to 29, watch the lunar crescent wax. The Moon reaches **first quarter** on November 30 at 7:36 AM MST. On the evening of November 28, look for a 33%-illuminated, crescent Moon about 6 degrees below Saturn. Enjoy seeing earthshine on the dark part of the Moon’s disk, especially on mornings from November 18 to 22 and evenings from November 25 to 28 (binoculars will enhance your view). You can find a stunning visualization of lunar phases for all of year 2022 here:

<https://apod.nasa.gov/apod/ap220201.html>

<https://svs.gsfc.nasa.gov/4955>

Please do your crescent Moon spotting before sunrise and after sunset. NEVER chance looking at the Sun directly; serious eye damage can result.

AUTUMN STARS AND THE LINGERING STARS OF SUMMER. These late November evenings are fine times to enjoy western Colorado's wonderfully dark night skies. Go out on a clear evening around 6:30 PM MST to enjoy the spectacle – yes, it's now completely dark by then! The constellations and stars of fall are on full display. Pegasus is high in the south and southeast with Pisces and brilliant Jupiter below. You can find Piscis Austrinus with the bright star, Fomalhaut, toward the southern horizon. In the northeast and east-northeast, Cassiopeia, Andromeda, and Perseus, are prominent, and Taurus (with bright, reddish Mars) and Auriga (with bright star, Capella) are rising in the east-northeast. Progressively earlier sunsets are allowing the constellations and stars of summer to linger in the western sky. At 6:30 PM MST the bright, central Milky Way in Sagittarius and Scutum is still visible above the southwestern horizon. You can follow the Milky Way up through Cygnus, just west of zenith, to its fainter outlying regions in the northeastern sky in constellations Cassiopeia, Perseus, and Auriga. And, the "Summer Triangle", consisting of the bright stars, Vega, Altair, and Deneb, is still high in the western sky.

SATURN IN THE EVENING. View Saturn and its beautiful rings through a telescope this year, because in following years those rings will appear less inclined and more challenging to see well from Earth's perspective (we will view them "edge-on" during part of 2025). But during 2022 we can see Saturn's rings through telescopes of any size. As the evening sky darkens, Saturn is about 30 degrees above the southern horizon, and the Ringed Planet remains visible until it sets in the southwest at about 11:00 PM MST on November 16 and 10:11 PM MST on November 30. Saturn dims from magnitude +0.7 to +0.8, as its distance from Earth increases from 920 million miles on November 16 to 941 million miles on November 30. Saturn's disk appears about 16 arc seconds wide, and its rings span 38 arc seconds. On the evening of November 28, look for the 33%-illuminated, waxing, crescent Moon about 6 degrees below Saturn. With a telescope or high-magnification binoculars, it's possible to spot Titan, Saturn's largest moon. Telescopes with apertures larger than about 6 inches may reveal several other moons of the Ringed Planet. You can follow the changing positions of Saturn's moons by referring to various planetarium apps and/or this site:

<https://skyandtelescope.org/observing/interactive-sky-watching-tools/saturns-moons-javascript-utility/>

JUPITER – BRIGHT IN THE EVENING. As the sky darkens, Jupiter shines brightly, high above the southeastern horizon and remains visible through much of the night. The Giant Planet is about 49 degrees high in the south at around 8 PM MST. Jupiter sets in the west at 2:24 AM MST on November 16 and 1:30 AM MST on November 30. Jupiter, though still very bright, fades slightly from magnitude -2.7 to -2.6 between November 16 and 30, as its distance from Earth increases from 401 million to 420 million miles. Using binoculars or a telescope, you can resolve Jupiter's disk, which appears 46 to 44 arc seconds wide. With a telescope you can easily see the dark belts and lighter colored zones in the Giant Planet's atmosphere. At times, you may also see the Great Red Spot, a giant storm in Jupiter's southern hemisphere. You can spot Jupiter's four, bright "Galilean" moons with binoculars and telescopes. Identify these moons by their changing positions near Jupiter, night-by-night, by using various astronomy apps, or the following link:

<https://skyandtelescope.org/observing/jupiters-moons-javascript-utility/#>

If you have a telescope, try viewing shadow transits (Jovian solar eclipses!) of Jupiter's moons on the nights listed below. Ganymede casts the largest shadow of Jupiter's moons, and its shadow is the

easiest to spot crossing Jupiter. Europa's smaller shadow is more challenging to see. Io's shadow is larger than Europa's but smaller than Callisto's shadow.

November 16, 2022, 8:38 PM MST to 11:18 PM MST, Europa's shadow crosses Jupiter.

November 17, 2022, 1:28 AM MST to 4:14 AM MST, Ganymede's shadow crosses Jupiter (Locally, Jupiter sets at 2:21 AM MST).

November 17, 2022, 3:52 PM MST to 6:08 PM MST, Io's shadow crosses Jupiter (Locally, the Sun sets at 4:57 PM MST).

November 22 to 23, 2022, 11:18 PM MST to 1:34 PM MST, Io's shadow crosses Jupiter (Locally Jupiter sets at 1:57 AM MST).

November 23 to 24, 2022, 11:14 PM MST to 1:54 AM MST, Europa's shadow crosses Jupiter (Locally Jupiter sets at 1:53 AM MST)

November 24, 2022, 5:48 PM MST to 8:04 PM MST, Io's shadow crosses Jupiter (Locally, the Sun sets at 4:54 PM MST).

November 30, 2022, 1:14 AM MST to 3:30 AM MST, Io's shadow crosses Jupiter (Locally, Jupiter sets at 1:30 AM MST)

MARS – AT ITS BRIGHTEST AND CLOSEST FOR NEXT 11 YEARS! Mars rises in the east northeast in a dark sky at about 6:30 PM MST on November 16. But by November 30, Mars rises in bright evening twilight at about 5:12 PM MST. The Red Planet continues to brighten from magnitude -1.60 on November 16 to magnitude -1.84 on November 30, as its distance from Earth decreases from 52 to 51 million miles and the percentage of Sun-illumination on its disk increases from 97% to 100%. Mars is now brighter than all stars in Colorado's night sky, including Sirius (although the planet Jupiter still appears brighter than Mars). Mars is now retrograding (i.e., moving westward relative to the starry background), as we on Earth "zoom" past Mars in our faster, inner orbit. Through telescopes Mars' reddish disk increases from 16.7 to 17.2 arc seconds wide during this period, plenty large enough to resolve some surface features with telescopes (although Martian dust storms could interfere). After next month, we will have to wait until year 2033 to see Mars appear this bright and this large. And Mars is now very far north (declination +25 degrees) in constellation Taurus, and it rises very high in our Western Slope skies. So, the next several weeks could be the best times to observe Mars for the next decade. You can find an interactive chart of Mars' surface features that are visible from Earth at any time and date at this link...

https://skyandtelescope.org/wp-content/plugins/observing-tools/mars_profiler/mars.html

In 2022, Mars and Earth are at their closest on November 30, although Mars will be opposite the Sun in our sky ("at opposition") on December 8. Amazingly, the Full Moon will occult (move in front of) Mars during "prime-time" evening hours on December 7 - more on that in the next edition.

LATE NOVEMBER METEORS. The Leonid Meteor Shower is active from November 6 to 30 with a nominal activity peak on November 17. The Leonids are debris from periodic Comet 55P/Tempel-Tuttle, which last visited our part of the solar system in 1998. The Leonids produced spectacular meteor "storms" in years 1833 and 1966 and dramatic outbursts in 1998, 1999, 2000, 2001, and 2002. Nothing like those displays is expected on the morning of November 17, when we might see about 10 to 15

meteors per hour. But two astronomers have predicted an encounter with Comet Tempel-Tuttle's 1733 dust trail on the night of November 18-19 with rates possibly as high as 50 to 200 meteors per hour. Locally, the Leonid radiant (apparent origin point of meteors on the sky) does not rise until about 11:10 PM MST. Predicted timings for Earth's encounter with the Tempel-Tuttle's 1733 dust trail are between 11:00 and 11:27 PM MST on November 18. That favors the U. S. Eastern Time Zone, but it still may be worthwhile keeping watch for Leonid Meteors on the night of November 18-19 from about 11:00 PM MST to the rising of the 23%-illuminated, crescent Moon at about 2:10 AM MST (or for diehards, the start of nautical twilight at about 5:57 AM MST). Meteors can be visible over all parts of the sky, and no equipment is necessary to see them. Just find a dark place and a comfortable reclining chair. For more information on meteors, see this link...

<https://www.imo.net/files/meteor-shower/cal2022.pdf>

THE SUN. Solar activity has been generally increasing this year, and it can be interesting to monitor the Sun as the new solar cycle "ramps up." M-class ("moderate") solar flares have been occurring frequently, and there have been several X-class ("extreme") flares this year, including one on October 2. There also have been coronal mass ejections ("CMEs") of charged particles that have triggered auroras recently. As of November 15, several large sunspots and active regions are disappearing from view due to the Sun's rotation. Will these be replaced by new active regions in the next two weeks? Keep an eye out for new active regions and more flares and CMEs! You can monitor sunspots, solar flares, CMEs, and other solar activity safely and in "real time" at the following sites:

<https://sdo.gsfc.nasa.gov/data/>

<https://stereo.gsfc.nasa.gov/beacon/>

<http://halph.nso.edu/>

<https://www.swpc.noaa.gov/>

<https://sohowww.nascom.nasa.gov/data/realtime-images.html>

<http://www.sidc.be/silso/ssngraphics>

Do not look at the Sun directly without safe, specialized solar filters. Looking at the Sun can be very dangerous unless you take adequate precautions. Severe eye damage and even blindness can result.

AURORAS (aka "polar lights" or "northern lights"). Although it can be challenging to spot auroras from Colorado's mid-northern latitudes, "northern lights" have been seen from our region in 2022. Solar magnetic storms, when directed toward Earth, can cause auroras. With current, high solar activity, chances for auroras are good. You can get predictions for auroras, their intensity, and geographic extent from NOAA's Space Weather Prediction Center:

<https://www.swpc.noaa.gov/>

You may also view auroras online in "real time" via the Canadian Space Agency's "AuroraMax" all-sky camera at Yellowknife:

<https://auroramax.com/live>

EARTH SATELLITE HIGHLIGHTS. The following predictions are for western Colorado, specifically Montrose, in Mountain Standard Time (MST). Numerous Earth satellites are visible every clear night. Brighter satellites have smaller magnitude numbers, and the brightest (e.g., the International and Tiangong Space Stations) may have negative magnitudes. These predictions are for selected passes of some bright and/or interesting satellites (as summarized from Heavens-Above.com). Note: The Tiangong Space Station became brighter after addition of the new Mengtian module on October 31. BlueWalker 3 from AST-SpaceMobile is an experimental telecommunications satellite that was launched on September 10, 2022. Its huge, 693 square ft antennae array was deployed on November 14, 2022, and it may be very bright. If successful, there could be hundreds of similar, but larger

satellites in low Earth orbit within several years. For western Colorado, Look for BlueWalker 3 passes on Nov. 20, 21, 22, and 23. For more info, see this link:

<https://skyandtelescope.org/astronomy-news/as-bluewalker-satellites-join-a-brightening-sky-heres-how-you-can-help/>

November 16, 2022. International Space Station (ISS). 6:24 to 6:27 to 6:28 PM MST, SSW to SE, disappears into Earth's shadow at maximum altitude 40 deg above SE, max magnitude -3.2 (Passing through Corona Australis, Capricornus, Aquarius, and Pisces-near Jupiter). Predictions for the ISS are subject to change due to orbital adjustments. Check for updated predictions.

November 16, 2022. Hubble Space Telescope (HST). 7:03 to 7:06 PM MST. SW to S, enters Earth's shadow at maximum altitude of 19 deg above S, maximum brightness mag. +2.8 (Passing through Sagittarius, Capricornus/Microscopium, and Piscis Austrinus). Maximum brightness may vary, depending on orientation of the elongated HST to observer's line of sight.

November 17, 2022. Tiangong (Chinese Space Station launched in April 2021). 5:35 to 5:36 to 5:39 AM MST, WSW to SSW to SE, max magnitude -1.1, appears from Earth's shadow 30 deg above WSW, maximum altitude 33 deg above SSW (Passing through Orion/Monoceros/Canis Major, Puppis, and Hydra). Tiangong's orbit may change frequently. Check for updates.

November 17, 2022. International Space Station (ISS). 5:36 to 5:39 to 5:41 PM MST, S to SE to E, maximum altitude 22 deg above SE, disappears into Earth's shadow at 12 deg above E, max magnitude -2.2 (Passing through Sagittarius, Microscopium, Piscis Austrinus-near Fomalhaut, Cetus, and Pisces). Predictions for the ISS are subject to change due to orbital adjustments. Check for updated predictions.

November 17, 2022. Hubble Space Telescope (HST). 6:50 to to 6:53 to 6:54 PM MST. SW to S, maximum altitude 17 deg above S, enters Earth's shadow 16 deg above S, maximum brightness mag. +2.9 (Passing through Sagittarius, Capricornus/Microscopium, and Piscis Austrinus). Maximum brightness may vary, depending on orientation of the elongated HST to observer's line of sight.

November 18, 2022. International Space Station (ISS). 6:24 to 6:27 to 6:28 PM MST, WSW to NW to NNE, maximum altitude 62 deg above NW, disappears into Earth's shadow at 42 deg above NNE, max magnitude -3.5 (Passing through Ophiuchus/Aquila, Lyra/Cygnus, Cepheus, and Camelopardalis). Predictions for the ISS are subject to change due to orbital adjustments. Check for updated predictions.

November 19, 2022. International Space Station (ISS). 5:35 to 5:39 to 5:42 PM MST, SW to SE to NE, maximum altitude 71 deg above SE, disappears into Earth's shadow at 12 deg above NE, max magnitude -3.8 (Passing through Sagittarius, Aquila, Pegasus, Andromeda, and Perseus). Predictions for the ISS are subject to change due to orbital adjustments. Check for updated predictions.

November 20, 2022. International Space Station (ISS). 6:24 to 6:27 to 6:28 PM MST, W to NNW to N, maximum altitude 25 deg above NNW, disappears into Earth's shadow at 21 deg above N, max magnitude -2.0 (Passing through Ophiuchus, Hercules, and Draco). Predictions for the ISS are subject to change due to orbital adjustments. Check for updated predictions.

November 20, 2022. BlueWalker 3. 6:53 to 6:57 PM MST, SW to W, disappears into Earth's shadow at max altitude of 71 deg above W. **Max magnitude unknown, but it could be very bright** (Passing through Sagittarius, Aquila, Delphinus/Sagitta, and Cygnus).

November 21, 2022. International Space Station (ISS). 5:35 to 5:39 to 5:42 PM MST, WSW to NNW to NE, maximum altitude 39 deg above NNW, disappears into Earth's shadow at 9 deg above NE, max magnitude -2.7 (Passing through Ophiuchus, Hercules, Draco, Ursa Minor, and Camelopardalis). **Predictions for the ISS are subject to change due to orbital adjustments. Check for updated predictions.**

November 21, 2022. BlueWalker 3. 6:35 to 6:38 to 6:39 PM MST, SW to NW to NNE, maximum altitude 74 deg above NW, disappears into Earth's shadow 54 deg above NNE. **Max magnitude unknown, but it could be very bright** (Passing through Scutum, Aquila, Sagitta, Cygnus, Cepheus, and Cassiopeia).

November 22, 2022. BlueWalker 3. 6:16 to 6:20 to 6:22 PM MST, SW to NW to NE, maximum altitude 68 deg above NW, disappears into Earth's shadow 30 deg above NE. **Max magnitude unknown, but it could be very bright** (Passing through Scutum, Aquila, Cygnus, Cepheus, and Camelopardalis).

November 22, 2022. International Space Station (ISS). 6:25 to 6:27 to 6:28 PM MST, NW to NNW to N, maximum altitude 14 deg above NNW, disappears into Earth's shadow at 13 deg above N, max magnitude -1.4 (Passing through Corona Borealis, Boötes, and Ursa Major/Draco). **Predictions for the ISS are subject to change due to orbital adjustments. Check for updated predictions.**

November 23, 2022. International Space Station (ISS). 5:36 to 5:38 to 5:41 PM MST, WNW to NNW to NNE, maximum altitude 19 deg above NNW, disappears into Earth's shadow at 7 deg above NNE, max magnitude -1.6 (Passing through Corona Borealis, Boötes, and Ursa Major/Draco). **Predictions for the ISS are subject to change due to orbital adjustments. Check for updated predictions.**

November 23, 2022. BlueWalker 3. 5:58 to 6:02 to 6:05 PM MST, WSW to NW to NE, maximum altitude 63 deg above NW, disappears into Earth's shadow 18 deg above NE. **Max magnitude unknown, but it could be very bright** (Passing through Ophiuchus/Aquila, Lyra/Cygnus, Cepheus, and Camelopardalis).

November 25, 2022. International Space Station (ISS). 5:37 to 5:38 to 5:40 PM MST, NW to NNW to NNE, maximum altitude 12 deg above NNW, disappears into Earth's shadow at 6 deg above NNE, max magnitude -1.2 (Passing through Boötes and Ursa Major-Big Dipper). **Predictions for the ISS are subject to change due to orbital adjustments. Check for updated predictions.**

November 27, 2022. Tiangong (Chinese Space Station launched in April 2021). 6:42 to 6:44 PM MST, SSW to S, max magnitude -0.1, disappears into Earth's shadow at maximum altitude 21 above S (Passing through Microscopium and Piscis Austrinus). **Tiangong's orbit may change frequently. Check for updates.**

November 29, 2022. Tiangong (Chinese Space Station launched in April 2021). 6:20 to 6:23 to 6:24 PM MST, SW to SSE to SE, max magnitude -1.8, maximum altitude 49 deg above SSE, disappears into Earth's shadow at 47 deg above SE (Passing through Sagittarius, Capricornus, Aquarius, and Pisces-near Jupiter). **Tiangong's orbit may change frequently. Check for updates.**

November 30, 2022. International Space Station (ISS). 6:25 to 6:26 PM MST, NNW to N, disappears into Earth shadow at maximum altitude of 13 deg above N, max magnitude -1.4 (Passing through Boötes and Ursa Major). **Predictions for the ISS are subject to change due to orbital adjustments. Check for updated predictions.**

November 30, 2022. Tiangong (Chinese Space Station launched in April 2021). 6:58 to 7:00 PM MST, rising in the West, max magnitude -0.1, disappears into Earth's shadow at 28 deg above W (Passing through Ophiuchus and Aquila). **Tiangong's orbit may change frequently. Check for updates.**

Satellite orbits can change. **These predictions for satellite passes may be inaccurate by up to several minutes, especially after November 21.** For more accurate predictions of these and other satellites, check Heavens-Above.com or other satellite prediction sites for updates on the nights you wish to observe. Check out the "Live Sky View" feature at Heavens-Above.com. "Live Sky View" shows positions of visible satellites, their changing brightness (magnitude), and their motion in "real time." Be sure to set application(s) for your location and time zone.

HAPPY OBSERVING!