

## Air and Space this Week

### Item of the Week

# ***THE APRIL 8, 2024 TOTAL SOLAR ECLIPSE***

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KEY WORDS: 2024 Total Solar Eclipse

*The contiguous United States will experience a total solar eclipse on April 8, 2024. Total eclipses are perhaps Nature's most spectacular of spectacles, and they are quite rare; the next one to hit the Lower 48 will be in 2045. If you see one, you will remember it for the rest of your life.*

***Perhaps more importantly, if your (grand)children see one, THEY will never forget it, and the experience could affect their ultimate career path.***

### WHAT IT IS

A total solar eclipse (TSE) occurs when the shadow of the Moon falls squarely on the Earth. It is quite a rare event, because of the following factors:

- A TSE can only occur right at New Moon
- Because the plane of the Moon's orbit is inclined to the plane of the Earth's orbit, a TSE can only occur at the two points where the orbit planes intersect (if the orbits were coplanar, we'd see a TSE at every New Moon!
- The apparent size of the Moon in the sky is almost exactly the same as the apparent size of the Sun. The Moon's orbit is slightly elliptical; when it is closer than average, we can see a TSE, but when it is more distant than average, the Moon does not fully cover the Sun, resulting in an annular eclipse (aka a "Ring of Fire" eclipse). Annular eclipses are really cool, but nowhere near as cool as a TSE!
- The size of the Moon's shadow on the Earth is rather small, so only a narrow strip of land sees a TSE when a TSE occurs. A wider area on both sides of the totality track will see a partial solar eclipse. [Since the Earth is considerably larger than the Moon, its shadow is much wider at the Moon's distance, making lunar eclipses more common and seen over a much broader area than a TSE.]
- Anyone in the umbra part of the Moon's shadow will see the Moon blocking the entire Sun; if you are in the penumbra part of the Moon's shadow, you will see some of the Sun's surface, a partial eclipse. If the Earth-Moon distance is too large, the umbra cone will not reach the Earth's surface, and the Moon will not fully-cover the Sun, even though their centers overlap. The resulting eclipse shows the moon in silhouette, surrounded by a ring ("annulus") of the Sun's disc – an annular eclipse. NPR has a good diagram of this [here](#).

## WHERE TO SEE IT

NASA has published an on-line map of the eclipse track (<https://science.nasa.gov/eclipses/future-eclipses/eclipse-2024/where-when>), which shows where the Sun will be totally eclipsed (the spectacle is MUCH better for a totally-eclipsed Sun, rather than a partially-eclipsed Sun!). This page also has information on the how you can observe the eclipse safely, and more info about the Sun.

You can also download an interactive version here:

<https://science.nasa.gov/learn/heat/resource/interactive-map-2024-solar-eclipse-across-the-us>. Many people saw the last eclipse to hit the Lower 48 (August 2017), but many didn't, and they will be determined to get to see it this time around. There won't be another in the Lower 48 for quite a while (2045). People have been making plans for months, and lodging prices are quite jacked up from normal for places anywhere near the track.

Don't underestimate the logistical difficulties in getting to the path of totality. Don't underestimate the emotional impact of seeing a total solar eclipse with your own eyes!

## WEATHER

You can go to a great effort to get into the totality zone, only to be thwarted by the weather. You can only put yourself in a position to succeed, but you can still fail due to bad weather; it goes with the eclipse follower's territory. However, some places on the track are more likely to be clear than others. Weather prospects in Mexico are the best, but the State Department is discouraging travel there, but there will be a number of cruise ships off shore. The farther north on the track one goes, the worse the weather prospects will be; Texas sites have about an 80% chance of clear skies but farther north...

*Sky and Telescope* magazine, an excellent source of eclipse info, did a piece on the eclipse day record a few months ago, see: <https://skyandtelescope.org/2024-total-solar-eclipse/el-nino-2024-total-solar-eclipse-cloud-cover>.

NOAA has a prediction page at: <https://www.ncei.noaa.gov/news/take-your-head-out-clouds-view-2024-total-solar-eclipse>.

Check out what weather.com thinks here: <https://weather.com/forecast/national/news/2024-01-24-solar-eclipse-april-8-cloud-cover-climatology>.

And if you can tolerate the dreadful music on the site, check out what the National Weather Service thinks, at least for the Midwest part of the totality path, at:

[https://www.weather.gov/iln/20240408\\_Eclipse](https://www.weather.gov/iln/20240408_Eclipse).

## SAFETY

**YOU MUST USE PROPER EYE PROTECTION WHEN LOOKING AT THE SUN!**

If **ANY** part of the Sun's face is visible, you must use proper eye protection, or use the projection method of viewing. Sun glasses are not enough, use special eclipse glasses for quick looks.

**ONLY** during the **FULLY-TOTAL** part of the eclipse is safe to look at the Sun, even with binoculars. If you see the background of one side of the Moon start to brighten, **IMMEDIATELY** look away!

## WHAT YOU'LL LIKELY SEE DURING THE ECLIPSE

**Solar Corona:** The atmosphere of the Sun is hot enough to glow brightly, but we cannot normally see it because the light from the solar disc is very much brighter. When the Moon blocks all of the Sun's face during the total phase of the eclipse, the corona becomes visible as a "pearly glow." Depending on the level of solar activity, the corona may be fairly uniform, or it may be quite jagged.

**At the Edge of the Eclipsed Sun:** The edge ("limb") of the Moon looks smooth to us, but it really is a bit jagged because lunar mountains, craters, and valleys are there. Just as the last bit of the Sun starts to slide behind the edge of the Moon, light comes through to low point(s) on the limb last, just before the observer is thrust fully into the lunar shadow. This produces an interesting visual effect, with a ring of light from the just-appearing corona and a bright spot where light is coming through the low point. It looks like a **Diamond Ring!** The same effect is seen in reverse at the end of the totality phase of the eclipse, a diamond ring is seen then, just before a larger amount of the Sun's rim is exposed. [Aside: The 2023 solar eclipse in western Australia showed an excellent diamond ring effect at both the start and end of the totality phase. When the totality phase ended, an astronomically-prepared young man not even twenty feet from me turned to his girlfriend and said, "We just saw two amazing Diamond Rings. How would you like to see a third!?!". He got down on one knee, held up his hand, opened the box concealed therein, and proposed.]

Sometimes, the exact shape of the Moon's limb results in two or more "diamonds" being seen, all smaller than the flash from a single "diamond." These smaller lights on the limb are called "**Bailey's Beads.**"

Another thing that might be seen at the very start and finish of the totality phase are **solar prominences**, glowing outbursts of gas from the Sun, typically reddish, associated with sunspots or other disturbances. The 2023 hybrid solar eclipse in western Australia showed several of them, all around the Moon (because the Moon's apparent size was just a little bit larger than the Sun's).

By the way, she said, "Yes!"

### **Jupiter and Venus – and a comet?**

The sky gets very dark during totality, when the only sky illumination comes from the solar corona and the site of the observer's light pollution. The brighter stars and planets will be seen

easily. Jupiter will be to the upper-left of the Sun and quite bright; Venus will be closer, to the lower-right.

You may even be able to see a comet during totality. Look between Jupiter and the Sun, closer to the former. Comet Pons-Brooks, well-known periodic comet is there. It may be bright enough for you to see it without optical aid, but it should be readily visible in binoculars.

### **Shadow Bands**

Just before and after totality, faint shadows moving like ripples across the ground can sometimes be seen. Called “shadow bands,” they don’t always appear, but we should be on the lookout for them. Astronomers have known about them for over two hundred years, but there is no consensus yet as to their cause. Perhaps the leading idea is that they are manifestations of turbulence in the upper atmosphere, sort of like the heat distortion you can see over a fire, only more organized but fainter. Another is that they are some sort of diffraction phenomenon related to the Moon’s limb. Try laying a white sheet out flat at your observing site and looking at it just before and just after totality. For information from NASA about shadow bands for the 2017 eclipse, see: <https://eclipse2017.nasa.gov/exploring-shadow-bands>.

## **PREPARATION AND PHOTOGRAPHY TIPS**

A TSE is an amazing experience. You know exactly when it is going to happen, and nothing on Earth can stop it. Excitement builds to a crescendo, amplified by the excitement of those around you, and then it is over too soon, but the memories of the event will stay with you a long, long time.

To get the most of the experience, some planning is necessary.

First and foremost, especially if this is your first TSE, make sure you take some time to look at the eclipsed Sun and take in the experience as a whole. This is not a “you’ll see it when we look at the pictures after” kind of event. It will move you.

It will be very dark during the eclipse, and you don’t want to waste time messing around with camera settings and other distractions. Have all your observing tools near you and in focus and aimed properly well before totality, be able to find what you want by feel, be ready with your white sheet in place for looking for shadow bands, etc.

You’ll see a variety of astronomical recording equipment all around you, from relatively simple to very elaborate (\$\$\$). Be aware of just how small the Moon looks in the sky; you’ll need a lot of magnification to make a decent image, and that will likely require a tripod. You’ll want to bracket exposures if possible; get an idea of the correct settings and a whole lot more about how to “Capture the Moment” from the section by that title here:

[https://skyandtelescope.org/total-solar-eclipse-2024/?utm\\_source=homepage&utm\\_medium=button](https://skyandtelescope.org/total-solar-eclipse-2024/?utm_source=homepage&utm_medium=button). It is also possible to take useable pictures with a cell phone; see Space.com: <https://www.space.com/how-to-photograph-a-solar-eclipse-with-a-smartphone>

## CITIZEN SCIENCE OPPORTUNITIES

Many CS opportunities for the 2024 TSE are already closed, but some still have room for participants, at least those in certain areas. Time is short, so if you are interested, contact the following immediately.

**The Dynamic Eclipse Broadcast (DEB) Initiative:** Their goal is to make observations of the solar corona from many different locations. They are still seeking a citizen observing team in the northeastern US (as of 2/25/2024). For more about DEB and the opportunity, see: <https://debinitiative.org/main/what-is-deb>.

**Citizen Continental-America Telescope Eclipse (CATE) 2024:** Similar to DEB; see: <https://eclipse.boulder.swri.edu/citizen-cate-2024/participate>

**Eclipse Megamovie 2024:** EM 2024 seeks to make a movie of the movements of solar jets and plumes during the eclipse, using photos from many places along the eclipse track. There is still room for you to contribute. For more information, see: <https://eclipsemegamovie.org>.

**NASA Soundscapes Project:** The disappearance of the Sun at an unexpected time can affect animal/bird behavior profoundly. “The Eclipse Soundscapes Project will use modern technology to collect multisensory observations, such as audio recordings, during the eclipse, and participants also make written accounts of what is seen, heard, or felt during the event. One of the aims of the project will be to see how animals that are awake during the day react to the eclipse in contrast to those that are active at night.” For more information, see: <https://eclipsesoundscapes.org>.

**Solar Eclipse QSO Party** (for ham radio operators): Solar activity affects the ionosphere, which in turn affects “skip” radio signals. Hams will broadcast/listen during the eclipse period to produce data useful for upper atmosphere research. For more info, see: <https://hamsci.org/seqp-faqs>

**More from NASA:** <https://science.nasa.gov/eclipses/future-eclipses/eclipse-2024/eclipse-2024-citizen-science>

## MORE INFORMATION

An excellent overall resource for the 2024 TSE is *Sky & Telescope* magazine’s on-line “[Your 2024 Eclipse Guide](#).” It has a LOT of information about the 2024 TSE and TESs in general, including a section with idea on eclipse-related education/outreach activities, DIY projects, and other resources.

*Sky & Telescope* also published a 60+-page special edition on the eclipse, “The Great 2024 Eclipse,” that would be a big help in your planning to see this wonderful spectacle. Find out how to get a copy here: <https://shopatsky.com/products/2024-eclipse-guide>. It comes with eclipse glasses.

**NASA**

<https://eclipse.gsfc.nasa.gov/SEgoogle/SEgoogle2001/SE2024Apr08Tgoogle.html>

<https://science.nasa.gov/resource/2024-total-solar-eclipse-fact-sheet>

<https://science.nasa.gov/eclipses/future-eclipses/eclipse-2024>

<https://science.nasa.gov/eclipses/future-eclipses/eclipse-2024/where-when>

### **Other info sources**

Smithsonian: <https://www.smithsonianmag.com/smart-news/how-to-watch-the-spectacular-total-solar-eclipse-in-april-2024-180983732/>

CNN: <https://www.cnn.com/interactive/2024/02/world/solar-eclipse-2024-map-dg-scn/>

**Social Media** has some good information, but be careful because there is a lot of misinformation out there, too. The “2024 U.S. Total Solar Eclipse Discussion Group” on FaceBook is a good source of information; I am sure there are other reliable social media resources.

## **EDUCATION AND OUTREACH OPPORTUNITIES**

An amazing event like a total solar eclipse makes for an excellent opportunity to build outreach and educational activities around it.

NASA Eclipse-related education materials: <https://www.nasa.gov/learning-resources/nasa-releases-new-solar-eclipse-educational-materials> . TEACHERS: Check out the “My NASA Data” set of resources here: <https://mynasadata.larc.nasa.gov/phenomenon/solar-eclipse/>

Check with your local library and/or astronomy club for information on eclipse events near you. NASA’s Night Sky Network (<https://science.nasa.gov/skywatching/night-sky-network>) and [NASA Solar System Ambassadors](#) (like me!) are good resources, too.

*Sky & Telescope’s* “Your 2024 Eclipse Guide” has a section on “Educate & Inspire” with info on eclipse-related educational activities for all ages, do-it-yourself projects, and outreach info from local libraries and the American Astronomical Society. See: [https://skyandtelescope.org/total-solar-eclipse-2024/?utm\\_source=homepage&utm\\_medium=button](https://skyandtelescope.org/total-solar-eclipse-2024/?utm_source=homepage&utm_medium=button). See also *Sky & Telescope’s* recommendations on eclipse-related outreach at: <https://skyandtelescope.org/astronomy-news/how-to-do-eclipse-outreach-on-and-off-the-path!>

## **IF IT’S CLOUDY – WATCH THE ECLIPSE ON-LINE**

A total Solar eclipse and a good display of the Northern Lights are two of Nature’s top spectacles! Seeing them in person is vastly more impressive than seeing them in a video. But video is better than nothing, and NASA TV and a number of other sources will televise/stream images of the eclipse from a number of places on the eclipse track. It’s a great back-up insurance against bad weather!

NASA TV: <https://nasaviz.gsfc.nasa.gov/14520>

American Astronomical Society: <https://eclipse.aas.org/resources/livestreams>

Exploratorium: <https://www.exploratorium.edu/eclipse/livestream>

timeanddate: <https://www.timeanddate.com/live/eclipse-solar-2024-april-8>

## **OK, THAT WAS SUPER COOL! WHEN'S THE NEXT ONE?!**

The next TSEs are (partial and annular eclipses excluded):

August 12, 2026: The track goes down the east coast of Greenland, hits western Iceland, then crosses the north Atlantic to Spain.

August 2, 2027: The track runs across the southern coast of the Mediterranean Sea into Egypt. Luxor and the Valley of the Kings are in the totality zone, and this will be a very long eclipse (6+ minutes).

July 22, 2028: The track slashes across Australia from its north-northwest coast to Sydney, and hits New Zealand's South Island at sunset.

November 25, 2030: The track cuts across southernmost Africa and hits Australia near sunset.

March 20, 2034: The track runs diagonally NE across central Africa, Saudi Arabia, and into the Himalayas.

September 2, 2035: The track runs across western China, North Korea, and Honshu

July 13, 2037: The track cuts straight across the middle of Australia, then crosses the North Island of New Zealand.

December 26, 2038: Australia gets lucky again, and the track goes over the strait between New Zealand's North and South Islands.

There are TSEs on March 30, 2033 and December 15, 2039, but they are lower quality and difficult to get to.

The (non-updated) NASA Eclipse Website is an excellent resource for future eclipses and transits: <https://eclipse.gsfc.nasa.gov/eclipse.html>

***I hope you get to enjoy this amazing event!***

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