

One Good Target

With Some Other Sights Worth Seeing
While You're in the Neighborhood

April The Eclipsed Sun

Of all nature's astronomical displays, many would say that the most moving and impressive is the totally eclipsed Sun. It's a sight that has led millions to travel halfway 'round the world to experience it for only a few minutes. Many have literally wept at the overwhelming beauty of it, and nearly everyone comes away from the experience with a new and profound understanding of what it means to be "in awe."

Those who have never experienced a total eclipse often misunderstand what it's about, and literally don't know what they're missing. Some appear to think that it's just a few minutes of darkness at midday, and certainly not worth making a long and expensive journey just to see it happen. Others seem to assume it's pretty much the same as the partial phases of an eclipse, only moreso – so if the Sun is 90% covered by the Moon where they're located, they figure they've had 90% of the experience of a total eclipse. In fact, of course, they haven't experienced totality at all. Still others, regurgitating decades-old misunderstandings of the difference between the partial and total phases of an eclipse, proclaim that looking directly at a total eclipse will cause blindness because an eclipsed Sun is somehow "more dangerous" than a "normal" Sun (often attributed to some ill-defined "invisible rays" emanating from the Sun during totality). Sheesh!

This month, we're going to take a good look at a total eclipse of the Sun, and point out some interesting and truly beautiful things to look for during one.

A Word About Cameras and Telescopes

For many years, Michael Bakich of *Astronomy* magazine has advised people to leave their cameras at home when they head off to see a total eclipse. He admits that not a single person has ever come back and told him that they were glad they took his advice – but hundreds have come back later to say they wish they'd taken it.

There's nothing wrong with cameras and telescopes, as long as you don't let them distract you from the main event, which is the eclipse, not the equipment. Unfortunately, however, the equipment will *always* distract you. So go ahead and use it during the partial phases, when you can afford to be distracted – and be sure to use proper solar filters, because an unfiltered view through a camera or telescope, even when the Sun has been reduced to a narrow crescent, is a one-way ticket to permanent eye damage or loss of vision. Just remember to take off the filter when totality begins!

On the other hand, I strongly recommend that during totality, you take *only* point-and-shoot pictures, with the ISO speed set to 800 or faster and the camera in fully automatic mode: no setting f/stops or exposure times or

anything else. Above all, *TURN OFF YOUR FLASH* or cover it with dark tape, even before you arrive at the eclipse site: the flash won't do your pictures a bit of good, but it will constrict the pupils of everyone nearby, ruining their dark adaptation and interfering with their experience of totality – and that's a sin that cannot be forgiven.

Most guidebooks will tell you that point-and-shoot photos of the eclipsed Sun won't come out very well, and that's often true (although I could show you some perfectly acceptable point-and-shoot photos I and others have made, including one during the 2010 eclipse that's indistinguishable from a NASA Astronomy Picture of the Day that was shot at the same moment by another observer at the same site). But even if every one of your point-and-shoot Sun shots comes out bad, you can find all the eclipse photos you could ever want on the internet within an hour after the eclipse ends. If you spend totality fussing with your camera settings or peeking through an eyepiece, you won't be able to replace the missed experience of the eclipse quite so easily.

Observing the Partial Phases

Every total eclipse begins and ends with a partial eclipse, as the Moon slowly covers and then uncovers the face of the Sun. The partial phases of a total eclipse are just like any other partial eclipse: you *must* use safe solar filters for your eyes, your cameras, and your telescopes.

The ingress phase begins with a flurry of excitement at first contact, followed by the long march towards totality. If any sunspots can be seen, you may be surprised at how bright they appear when their color is compared to the deep black of the advancing Moon – a vivid reminder that they may seem quite dark when seen against the brilliance of the Sun's surface, but they're really about as bright as the full Moon. If you're using a telescope, see if you can detect any bumps or hollows in the Moon's silhouette as it traces the course of mountains and valleys on the Moon's backlit limb.

More interesting things begin to happen when the eclipse covers about 75% of the Sun's face. That's when tiny clear paths between the leaves of trees and bushes begin to act like pinhole cameras, splattering the ground with tiny images of the sickle-shaped Sun. You can also make your own display of pinhole images using perforated cards or a kitchen colander, or by placing one hand across the other to form a lattice with your crosshatched fingers – or you can display a projected image of the partially-eclipsed Sun on the ground using a pair of binoculars.

When the Sun has been reduced to just a narrow crescent, shadows become strikingly sharp as the Sun begins to act almost like a point source of light. The shadows become so precise that individual hairs are distinctly visible on shadows of your arms and head. The effect is strongly directional, aligned with the orientation of the solar crescent, so if the shadows of your fingers extended horizontally are unnaturally sharp, those of your fingers extended vertically will be less so.

At about the same time, the sky takes on an increasingly deep and almost unnatural blue color, sometimes adding a hint of violet, and the light itself becomes strange in ways that are difficult to describe: to me, it seems like I'm suddenly seeing the world in exaggerated 3-D, and the space between objects seems to be filled with a shimmering glow that I feel as if I could reach out and touch.

Things happen quickly during the minutes just before totality, when the darkness rushes towards you and shadow bands appear.

After totality ends, the egress phase is a time of decompression and reflection, a chance to wind down after the intense and often unexpectedly emotional experience of totality. You may feel suddenly tired, giddy or

detached. It's a good opportunity to look for pinhole camera effects, sharpened shadows, or any of the other partial eclipse phenomena you might have missed during the ingress phase, since all of them appear again (in reverse order) as the solar crescent expands. However, while the ingress phase became more and more exciting as it progressed, the egress phase may seem almost irrelevant until the moment of fourth contact, marking the end of this eclipse, when a single thought will dominate everyone's mind: *how long do we have to wait until the next one?*

Things You Might See Just Before and During Totality

The Moon's approaching shadow: The Moon's shadow rushes across the Earth at a rate far exceeding the speed of sound – faster than 2000 mph for the April 2024 eclipse. If you're standing on high ground as an eclipse approaches over a large body of water or flat terrain, you might be able to see the Moon's shadow darting along the surface in your direction a minute or so before it arrives. More likely, however, you'll see a vague dark pillar of shadowed sky grow ever larger as it rapidly devours the brightness to your west, and ultimately engulfs you in its eerie embrace.

Shadow bands: These are extremely subtle features, visible from a few minutes before totality until a few minutes after, and highly dependent upon local circumstances. They are caused by light's interaction with pockets of atmospheric turbulence when the Sun has been reduced to a narrow crescent only a few arcseconds wide. The shadows appear as a rapidly moving, flickering series of low-contrast horizontal bands, alternating dark and bright, visible against large light-colored surfaces – the side of a building, a sheet spread across the ground, or even thin clouds overlying the eclipsed Sun. They have been compared to ripples of sunlight crossing the bottom of a swimming pool, but to me they're more like a faint flickering image of scrolling venetian blinds – and far more likely to be seen in photographs than in person.

Baily's Beads and The Diamond Ring: As the Moon's ragged limb reaches the far edge of the Sun, light continues to flow through lunar valleys, creating a series of intense bright spots called *Baily's Beads*, like a string of radiant pearls marking the rapidly disappearing solar surface. The inexorable Moon extinguishes the spots one after another until only one remains, forming the image of a brilliant *Diamond Ring*. Then it too is covered, and you enter the realm of deep enchantment known as totality.

The onset of totality: Even when only a narrow sliver of Sun remains uncovered, the light around you seems nearly as bright as a normal day – certainly bright enough to read by. But when the last trace of Sun disappears behind the Moon, it becomes surprisingly dark in an instant, almost as if someone turned off a switch. Birds may suddenly stop singing, cows may head back toward the barn, and other animals may display their own nightfall behaviors in reaction to the sudden darkness. You may feel a chilled breeze known as *the eclipse wind* as the temperature drops precipitously by 10 or 15 degrees. *Totality has begun!*

The chromosphere: If you look carefully, you'll be able to see the chromosphere as a thin red ring of fire punctuated by an occasional prominence, surrounding the dark silhouette of the eclipsing Moon. Sometimes referred to as "the Sun's atmosphere," the chromosphere is an envelope of hydrogen gas encasing the Sun, lying just above the *photosphere*, which is the blindingly bright layer we perceive as the Sun's surface. The chromosphere is also fairly bright – many times brighter than the full Moon – but it's so much dimmer than the photosphere that it's lost in the Sun's glare, and can be seen in nature only when the Sun's bright disk is covered during a total eclipse. The chromosphere is only around 1500 miles thick, so it is best seen only for a few moments just after totality begins, and again just before it ends.

The 360° sunset: Each evening, as the Sun drops below the edge of the world, the shadow of night marches across the land until only the western horizon is aglow in sunlight. In exactly the same way, at totality, the shadow of the Moon carves out a dark circle with sunlight all around it, giving us a unique sunset that is seen not only to the west, but at all points of the compass.

Earthshine: During totality, sunlight reflected off Earth's surface faintly illuminates the Moon, allowing us to dimly see the Moon's major surface features. The extent of cloud cover on Earth's sunlit side determines the amount of sunlight Earth reflects, and thus whether the effects of Earthshine are easy or difficult to make out.

Stars and planets: As the darkness of totality deepens, you'll be able to see at least a few bright stars and planets, whose specific identities vary from one eclipse to another. In 2024, the eclipsed Sun will sit between Venus 15° to its WSW and Jupiter 30° to its ENE, with Mars and Saturn close to each other a bit farther SW, and an arc of stars of the Winter Hexagon – notably Capella and Rigel – beyond Jupiter to the east. Only Venus and possibly Jupiter will likely be bright enough to pop out distinctly to unaided vision against the eclipsed sky; the others will appear only in binoculars or telescopes.

The corona: For many, this is what totality is really all about: the glorious gossamer corona, extending for dizzying distances from the solar disk, its beautiful wisps and delicate details changing from one apparition to the next as if it were a living thing. A thin soup of ionized hydrogen at temperatures that can reach 1 million degrees Celsius, it occupies a huge area, spreading out as far as 10 million miles beyond the chromosphere. It's always there, but it's even more tenuous than the chromosphere, and completely invisible in the brilliance of the unobstructed Sun. Showing us a different shape, size and structure at every new eclipse, it is both ephemeral and unique, and therefore a fitting symbol of totality.

What to Do During Totality

I said to my soul, be still, and let the dark come upon you
– T.S. Eliot

First, just breathe. Let yourself slow down. Listen – to the soft sounds of nature, or the excited voices of your companions, or the surrounding stillness. Inspect the dark disc at the spot where the Sun once stood: are any of the Moon's familiar features revealed in the faint Earthshine? Follow the curve of the fiery red chromosphere as it circles the now-hidden Sun. Feel what the ancients felt when they beheld this scene for the first time. Look around – check for a 360° sunset, see if any stars or planets popped out, sense the strange unearthly quality of the feeble light that lets you see how others are reacting as this captivating spectacle unfolds. You'll probably see at least one person in tears, but they won't be able to tell you why, either now or later, beyond the words *it's just so beautiful*. Notice how far the corona extends, how delicate it appears, how its shape hints at its magnetic origins. Do any stars or planets shine through its diaphanous veil? Savor the fact that no photograph can portray the corona as your eyes are seeing it at this moment. Know that this corona, and this moment, will never be seen again. Take some pictures if you like, as long as they're the point-and-shoot kind – the sunset, the eclipsed Sun, the people around you, whatever catches your fancy. *Breathe. Observe. Remember.* Because long before you're ready to hear it, distant voices will call out a stark warning – “*Diamond Ring!*” The bland familiar Sun will suddenly replace the magical light, and this wonder will be over, all too soon.

Rick Gering / April 2024