

# View the Solar Eclipse Safely



You'll enjoy the eclipse a lot more knowing that your eyes and equipment are protected from harm.

By Richard Tresch Fienberg

I can still hear my mother's voice from when I was a child: "Never look at the Sun! You'll go blind!" Telescope manufacturers' mothers must have said that too, because nearly every instrument sold today has a sticker on the tube with a similar warning: "Never point this telescope at the Sun. Severe eye injury will result."



**Above:** April 20th brings the opportunity to see a deep solar eclipse — and even totality — from deep in the Southern Hemisphere. But before glancing toward the Sun, make sure you're viewing it safely.

**Top:** In preparation for the August 2017 solar eclipse, manufacturers worked overtime to print millions of solar viewers. You can purchase them inexpensively — in bundles they can cost less than 50 cents each.

Yet as you've no doubt heard, experts are urging you not to miss this year's solar eclipse and, if possible, to get into the path of totality so you can see the glorious solar corona. Were our mothers wrong? Not exactly.

The problem is the word "never." There is actually one time when it's perfectly safe to look directly at the Sun — with your unaided eyes, with binoculars, and even with a telescope. That time is when the Moon completely covers the Sun's bright face — during the brief total phase of a total solar eclipse. This complete coverup permits the Sun's shimmering outer atmosphere, the corona, to become visible, and it too is safe to view directly.

At all other times follow Mom's advice — unless you have a safe solar filter and know how to use it. Here I'll describe the different types of filters available, explain what makes them safe (or not), and tell you how to use them. I'll also share some ideas on how you can observe the Sun safely even if you don't have a solar filter.

## Sunlight and the Eye

Our daytime star poses no more of a threat during a solar eclipse than at any other time — it shines the same before, during, and after an eclipse. It won't emit light or other kinds of radiation that it isn't emitting right now. The corona is there all the time, too, shining with the eerie fluorescent light of million-degree gas. We just can't see it because it's only as bright as the full Moon, and so the dazzling brilliance of the Sun's surface ordinarily overwhelms it.

So where's the danger? The Sun emits energy across the electromagnetic spectrum, most of it in the form of visible light. It puts out lesser amounts of ultraviolet (UV) and infrared (IR) radiation too. Many people think these invisible rays are the main dangers, but that's not true.

The real issue is that the Sun is insanely bright, even when all but a tiny sliver of it is covered by the Moon, and the danger it poses to the retinas in your eyes is ever present.

“Exposure of the retina to intense visible light causes damage to its light-sensitive rod and cone cells,” explains Dr. Ralph Chou, professor emeritus of optometry and vision science at the University of Waterloo in Canada. “The light triggers chemical reactions within the cells that damage them and, in extreme cases, can destroy them.”

A single fraction-of-a-second glance sunward with your unaided eyes won't hurt you, but if you look longer, or repeatedly — and especially if you look through unfiltered binoculars or a telescope — you're in deep trouble. Then, says Dr. Chou, “the photochemical damage may be accompanied by a thermal injury, in which sunlight absorbed by the retina is transformed into heat that literally cooks the exposed tissue.” And you won't realize it's happening, because retinas don't have pain receptors.

### Solar Viewers: The Good, the Bad, and the Ugly

So what's the solution? For direct viewing, it's to look at the Sun only through a special-purpose solar filter designed expressly for looking at the Sun's bright face. Such filters reduce sunlight to safe levels across the spectrum. Just because some material blocks most of the Sun's visible light doesn't mean it's safe. Unless it also blocks other parts of the spectrum, while you're enjoying a “comfortable” view of the “dim” Sun, infrared radiation could be frying your retinas. Ultraviolet light is less of an issue, because it doesn't get past our eyes' lenses; we wear UV-blocking sunglasses on bright days to protect against the development of cataracts, not because of any threat to our retinas.

Safe solar filters come in two main types: “eclipse glasses” or other handheld viewers that go between your eyes (or eyeglasses, if you wear them) and the Sun; and filters that cover the front opening of a camera lens, telescope, or binoculars.

In 2015 the International Standards Organization (ISO) took the guesswork out of knowing whether filters for direct solar viewing are safe. Any filter that meets the new ISO 12312-2 standard reduces visible sunlight to a safe, comfortable level and simultaneously blocks solar UV and IR radiation. More than a dozen manufacturers have certified that their eclipse glasses and handheld solar viewers meet this standard. For a complete list of these, go to [eclipse.aas.org/resources/solar-filters](http://eclipse.aas.org/resources/solar-filters).

Rainbow Symphony's Eclipse Shades and American Paper Optics' Eclipser glasses are made with black polymer (a specially tinted resin) or silver-black polymer (the same resin plus a layer of aluminized polyester) that's manufactured by Thousand Oaks Optical, which uses the same materials in its Solar Viewers. TSE 17 makes its own metal-coated polyester film and calls it SUNsafe SOLARfoil.

You'll find “ISO 12312-2” or “ISO 12312-2:2015” printed on all these filters. You can buy them directly from the manufacturers or from authorized resellers for at most a few dollars per filter; in bulk quantities they can cost less than 50 cents each.

On the other hand, lots of everyday materials might seem to dim the Sun enough but are not safe. These include dark sunglasses, neutral density or polarizing filters, smoked glass, unexposed or exposed film, “space blankets,” snack bags, CDs, and DVDs. Anything you might have heard about for solar viewing that lacks the ISO certification is not safe.



Smoked glass, CDs, DVDs, and Mylar food wrapping — along with everyday sunglasses, no matter how dark — are not safe for solar viewing.



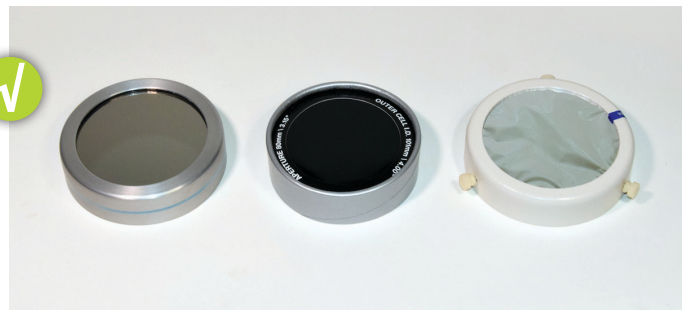
If you view the partially eclipsed Sun with binoculars, you must have approved solar filters covering the front lenses (as in the upper image). It's extremely dangerous to put on solar viewers meant only for your eyes and then look through unfiltered binoculars or a telescope (lower image).

In addition to using a filter that meets the ISO safety standard, make sure it's in good condition. If the filter is torn, scratched, punctured, or coming loose from its cardboard or plastic frame, discard it. Read and follow any instructions either printed on or packaged with the filter, and always supervise children using solar filters.

If you're within the path of totality, remove your solar filter only when the Moon completely covers the Sun's bright face and you're plunged into darkness. Experience the magnificence of totality — and then, as soon as the bright Sun begins to reappear, put your solar viewer back on to glance at the remaining partial phases.

### Solar Filters for Your Gear

Never look at the unclipped or partially eclipsed Sun through a camera, telescope, binoculars, or other optics while using eclipse glasses or a handheld solar viewer — the concentrated solar rays will instantly burn through the filter and injure your eye(s).



**Solar-safe filters utilize three types of materials: metal-coated glass (left), black polymer (middle), and metal-coated polymer (right). These are available in various sizes made to fit snugly on the front of your binoculars or telescope.**



**When using a telescope to observe the Sun at any time other than during the total phase of the eclipse, you must put a safe solar filter over the aperture (front) of the telescope, as shown here. Note that the small finderscope has been capped; this prevents concentrated sunlight from melting the crosshairs in its eyepiece.**

Instead, solar filters designed for use with cameras, telescopes, and binoculars must be attached to their front. You'll encounter three types: metal on glass (usually the most durable and expensive), aluminized polyester film (frequently but incorrectly called aluminized Mylar), and black or black-silver polymer. They're typically mounted in aluminum rings sized to fit snugly over the front of your optics. (When ordering these, you'll need to measure your optical tube's outer diameter.)

The ISO 12312-2 standard doesn't apply to filters for optics, so you should buy from a reputable manufacturer whose products have been independently tested and found to be safe. These include filters made from Baader AstroSolar film, sold in North America by Alpine Astronomical, Astro-Physics, and Kendrick Astro Instruments, as well as filters made by Meade Instruments, Celestron, Orion Telescopes & Binoculars, Thousand Oaks Optical, Rainbow Symphony, Lunt Solar Systems, DayStar Instruments, Explore Scientific, and others.

There was a time when telescopes routinely came with a "Sun" filter designed to thread into an eyepiece. Untold thousands of these still exist alongside scopes stashed in closets and attics, but they are not safe. Sunlight concentrated by the telescope's main lens or mirror can crack the dark glass, with disastrous results. Also, if your telescope has a small finderscope or other optical aiming device, make sure it is capped, removed, or safely filtered just like the main telescope whenever you're pointing at the Sun.

### Pinhole & Optical Projection

There's another safe way to observe the Sun: indirectly, by projecting an image onto a card, wall, or other surface. And it comes with a bonus: Multiple people can view the projected image simultaneously.

The simplest approach is pinhole projection. If you have leafy trees at your observing site, look at the dappled sunlight on the ground during the partial eclipse. You'll see a bunch of crescent Suns projected by the tiny spaces between the leaves, each of which acts as a pinhole camera.

No trees? No problem! A "handy" way to achieve the same effect (pictured on the facing page) is to cross the outstretched, slightly open fingers of one hand over the outstretched, slightly open fingers of the other, creating a waffle pattern. With your back to the Sun, look at your hands' shadow on the ground. The little spaces between your fingers will project a grid of small crescent Suns that everyone around you can admire. Straw hats, spaghetti colanders, and other household items with lots of small holes in them will also work.

You can also use a telescope or binoculars to project images of the partially eclipsed Sun onto a surface. This optical projection generally provides bigger, brighter, sharper images than pinhole projection does. But because bright sunlight passing through binoculars or a telescope can damage the device, and because of the danger that someone might accidentally look into the bright beam of concentrated sunlight emerging from the eyepiece, you shouldn't try optical projection unless you're an experienced astronomical observer, you're using your own equipment, and you can remain with your setup at all times.

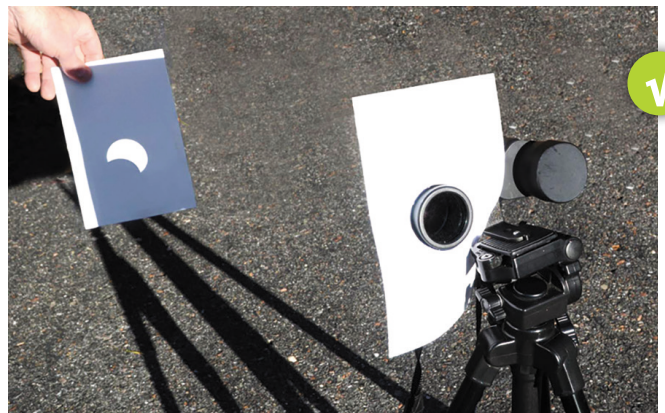
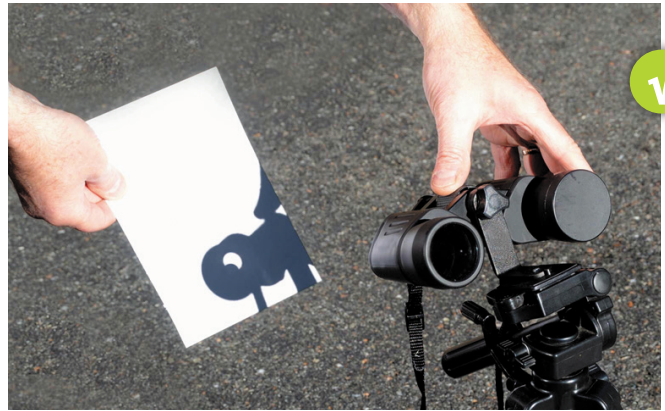
The Sun Funnel is probably the safest tool for solar projection with a telescope, because no bright sunlight comes out of the optics. Instead, the eyepiece is secured in the neck of a funnel and casts the Sun's image onto a rear-projection screen stretched over the funnel's mouth. This do-it-yourself device can be assembled inexpensively from readily available materials; instructions are online at [https://is.gd/sun\\_funnel](https://is.gd/sun_funnel). Even if you don't plan to build a Sun Funnel, you might download the tutorial anyway for its helpful tips on how to aim a telescope at the Sun without looking through it.

As when using aperture solar filters, be sure to cap or remove any finderscope or other auxiliary optics when doing solar projection. You might also find it helpful to add a cardboard or foam-board shade collar around the front end of your telescope or binoculars to cast a shadow around the projected image, making it easier to see in bright daylight.

### Ready & Waiting

You are now immunized against “alternative facts” and “fake news” that might direct you to stay indoors and draw the shades during the upcoming eclipse. My own mother, who told me never to look at the Sun, has seen two total solar eclipses. And although she won't be traveling to the path of totality for this year's, she, my dad, and other residents and staff of their retirement home were outside watching August 2017's partial eclipse through their ISO-certified eclipse glasses!

***Rick Fienberg** recently retired as the American Astronomical Society's press officer and is a veteran of 13 solar-eclipse expeditions. He worked at Sky & Telescope for 22 years, serving as Editor in Chief in 2000–08.*



**Put your binoculars on a short tripod, uncover one side, and point them toward the Sun. Then put a white card near the eyepiece to see a projected image of the Sun (you'll need to focus for a sharp image). By moving the card farther away, the Sun's image gets bigger but somewhat dimmer. Add a shield around the binocular's main lens to create a larger dark projection area on the card.**



**During the eclipse, cross two hands so your fingers make a waffle pattern. The tiny holes between them will act like pinhole projectors to create a pattern of tiny crescent Sun images in the shadow below.**

### USEFUL LINKS

**American Astronomical Society**  
[eclipse.aas.org/eye-safety](http://eclipse.aas.org/eye-safety)

**NASA**  
[eclipse2017.nasa.gov/safety](http://eclipse2017.nasa.gov/safety)

**Manufacturers**  
[eclipse.aas.org/resources/solar-filters](http://eclipse.aas.org/resources/solar-filters)