

# Solar Eclipse Planning Workshop

**OCTOBER 14, 2023**  
ANNULAR SOLAR ECLIPSE

**APRIL 8, 2024**  
TOTAL SOLAR ECLIPSE

October 21-22, 2022 • Rochester, NY





The background is a map of North America, including parts of Canada, the United States, and Mexico. Overlaid on the map are two eclipse paths. One path, labeled 'ANNULAR ECLIPSE' and 'OCTOBER 14, 2023', passes through the central United States and is marked with a yellow circle. Another path, labeled 'TOTAL SOLAR ECLIPSE' and 'APRIL 8, 2024', passes through the southern United States and is marked with a black circle. In the corners, there are compass roses with 'A' for North and 'S' for South. On the left and right sides, there are logos for the 'Great American Eclipse' featuring a stylized sun with rays.

# **Breakout Discussion Session: Essentials of Eclipse Eye Safety: Direct & Indirect Viewing, With or Without Optics**

# The Essentials of Solar Eclipse Safety

Rick Fienberg



Solar Eclipse Task Force



This is  
Mom  
saying...



...“Never  
look at  
the Sun!”



*Exception:* The totally eclipsed Sun is only about as bright as the full Moon — and just as safe to look at.\*



\*Even with binoculars or a telescope!



But the Sun at any other time, such as...

- when no solar eclipse is occurring,
  - during a partial or annular (ring) solar eclipse, and
  - during the partial phases of a total or annular eclipse
- ...is dangerously bright. There is a serious risk of retinal injury.

*To look at the Sun at such times, you must use an appropriate solar filter!*



# What's an “Appropriate Solar Filter”?



One that complies with the ISO 12312-2 international standard, as confirmed by an independent laboratory accredited to test for such compliance.



# Safe Solar Filters Are Very Dark

Maximum visible-light transmission:

<0.001% (that's 1 part in 100,000)

Safe Solar Filters Attenuate UV & IR Too

Maximum ultraviolet transmission ~ 0.001%

Maximum infrared transmission ~ 3%

The main danger comes from intense *short-wavelength (blue) visible light*, which can cause photochemical injury to retinal cells.

# Commonly Available Safe Solar Viewers



Two largest U.S. manufacturers: Rainbow Symphony & American Paper Optics (both use filter material made by Thousand Oaks Optical).

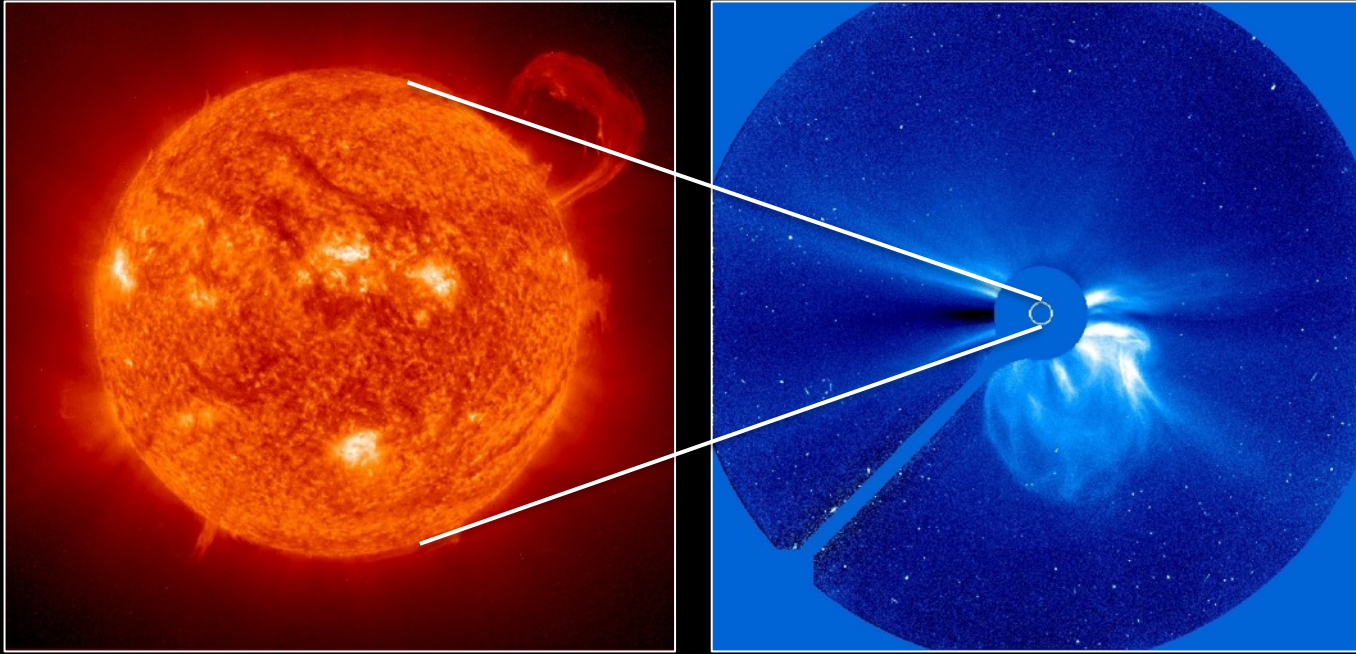
Are very dark sunglasses safe  
for direct viewing of the Sun?



They transmit thousands of times too much light!

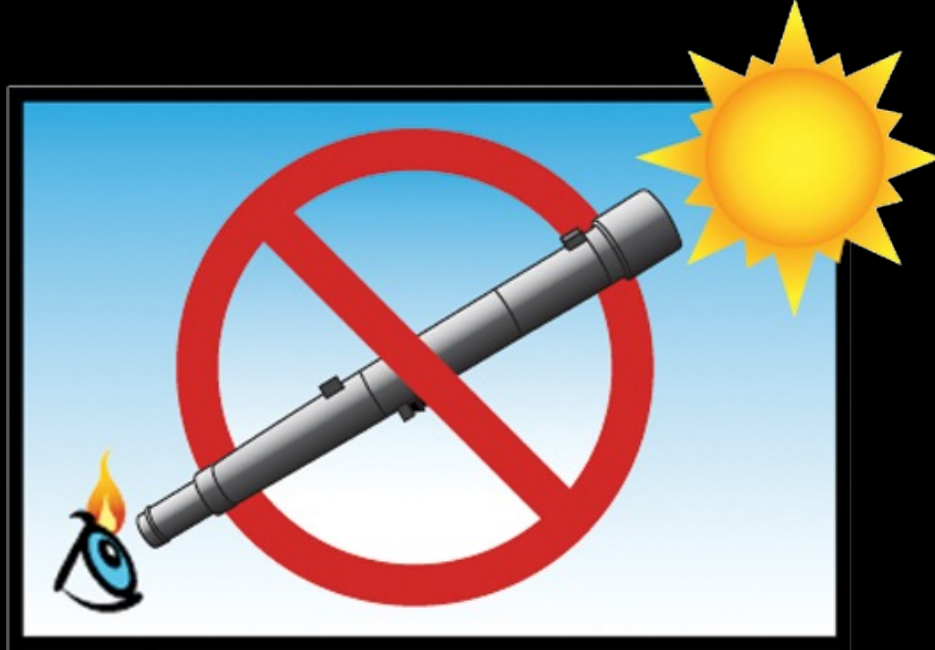


# Doesn't the Sun emit dangerous rays during a solar eclipse?



No more so than at any other time. The Moon has no “focusing” or other effect. Earth’s atmosphere shields us from most harmful solar radiation across the spectrum.

Every commercial telescope comes with a warning never to aim at the Sun.



This is less about *safety* than it is about *legal liability protection*.

Amateur and professional astronomers  
regularly observe and photograph the Sun.



How do they do it?!





They use widely available,  
relatively inexpensive,  
special-purpose solar filters.

# Use only special-purpose solar filters on your precious optics!



These are usually made of metalized glass (*left*) or polyester (*right*).



Is it safe to wear eclipse glasses while  
looking through unfiltered optics?

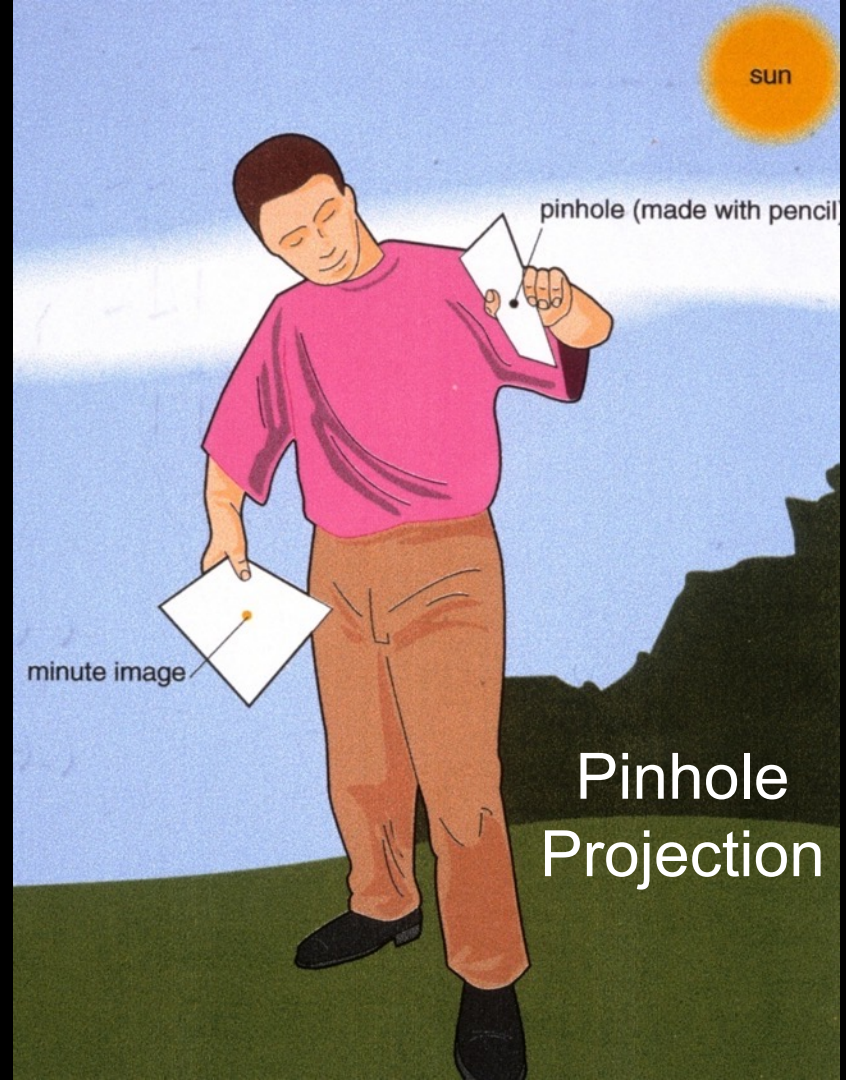




There's another safe approach:

You may safely view a *projected image* of the uneclipsed or partially eclipsed Sun without a filter.

**IMPORTANT:** *Don't look at the Sun through the pinhole!*



Here's a safe way to watch the partial  
and annular phases of a solar eclipse.

What if there are no trees around?





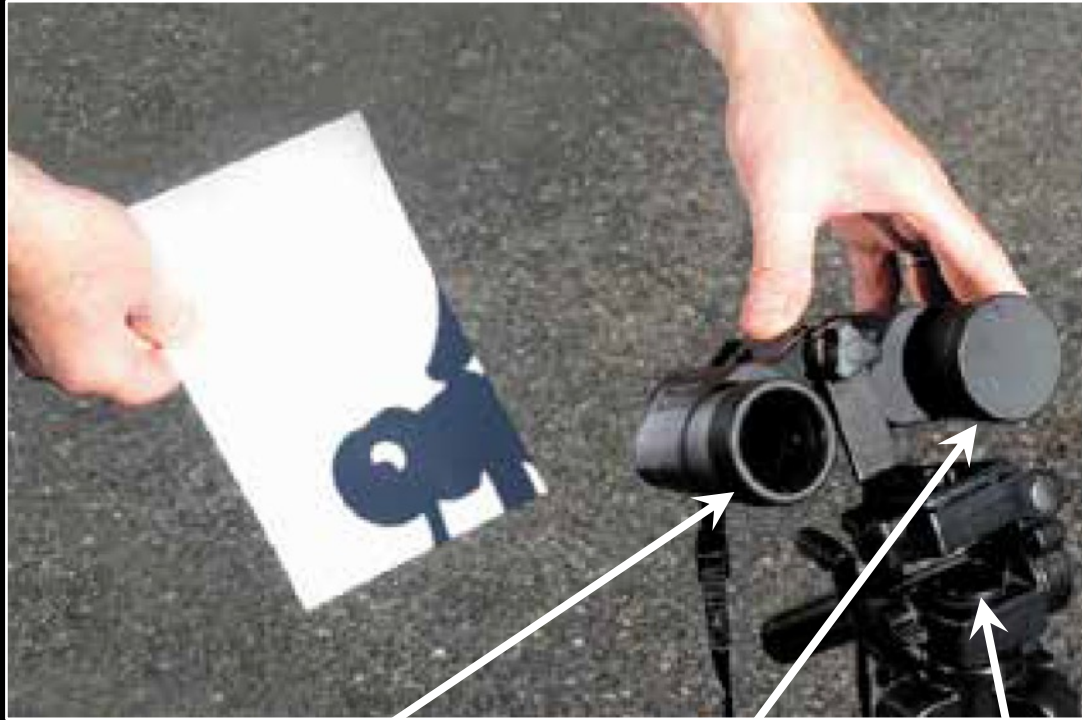
**Use your Sun hat!**

**Cross your fingers!**



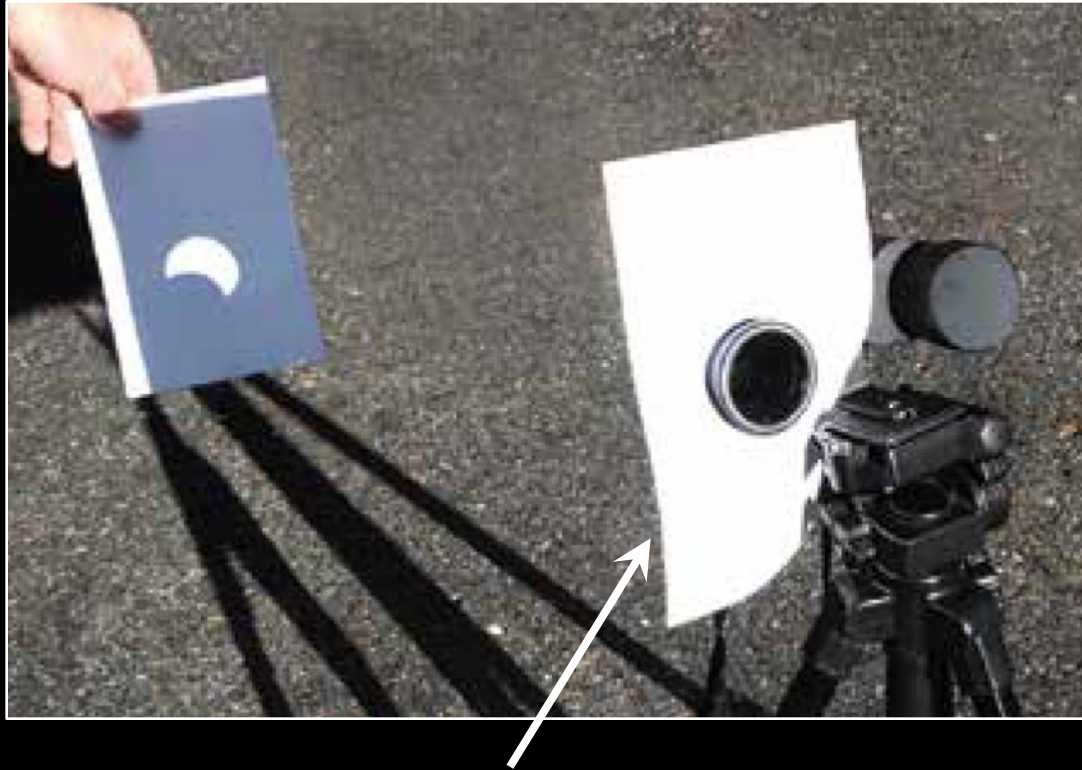


# Binocular Projection



One lens uncovered, one lens covered. Use a tripod.

# Binocular Projection



Add a cardboard “Sun shield” to improve the view.



# SOLAR ECLIPSE ACROSS AMERICA

Sat., October 14, 2023: Sun...Moon...You!



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## HOW TO VIEW A SOLAR ECLIPSE SAFELY

EYEWEAR & HANDHELD VIEWERS

ARE MY SOLAR VIEWERS SAFE?

REPUTABLE VENDORS OF SOLAR VIEWERS

PROJECTION: PINHOLE & OPTICAL

SOLAR FILTERS FOR OPTICS



# 490

Days to the Next  
U.S. Solar Eclipse

Two major solar eclipses are coming to North America! On Saturday, October 14, 2023, an annular ("ring of fire") eclipse sweeps from Oregon to Texas in a 125-mile-wide path that continues to the Yucatán peninsula and northern South America. Six months later, on Monday, April 8, 2024, a total solar eclipse darkens a 115-mile-wide swath from Mexico to the Canadian maritimes, traversing the U.S. from Texas to Maine in the process. In both cases all of North America will have at least a partial solar eclipse.



If your eclipse glasses or viewers are compliant with the transmission requirements of the ISO 12312-2 safety standard, and if their filters aren't scratched, punctured, torn, coming loose from the frame, or otherwise damaged, you may reuse them indefinitely. Furthermore, you may look at the uneclipsed or partially eclipsed Sun through them for as long as you wish. Some glasses/viewers are printed with warnings stating that you shouldn't look through them for more than 3 minutes at a time and that you should discard them if they are more than 3 years old. *Such warnings are outdated and do not apply to eclipse viewers compliant with the ISO 12312-2 standard and in excellent condition.* To make sure you get (or got) your eclipse glasses/viewers from a supplier of ISO-compliant products, see our [Reputable Vendors of Solar Filters & Viewers](#) page.

## Is It Safe to Clean Eclipse Glasses and Handheld Solar Viewers?

Manufacturers of hard plastic eclipse glasses often supply a microfiber pouch that you may use to wipe the lenses clean. The same pouch may be used on the lenses of cardboard eclipse glasses and handheld solar viewers. You may also wipe them clean with any soft, nonabrasive tissue or cloth; Kimwipes are also suitable, but *baby wipes and other wet wipes are not suitable*. Cardboard must be kept dry; if it gets wet, it will swell and likely detach from the lenses. *Do not use water, glass cleaner, or any other solvents or liquids to clean cardboard eclipse glasses and handheld solar viewers.*

## Are Welding Filters Safe for Solar Viewing?

The ISO 12312-2 standard was based, in part, on decades of experience using welding filters for observing the Sun. A welding filter with a shade number of 12 or higher transmits a safely tiny percentage of the Sun's light across the spectrum, whether made of tempered glass or metal-coated polycarbonate. Most observers find the view through a shade 12 welding filter uncomfortably bright and the view through a shade 15 or higher-numbered welding filter unattractively dark. The "sweet spot" is shade 13, which best matches the view in purpose-made eclipse glasses and handheld solar viewers, though shade 14 works well too. Shade 13 (and 14) welding filters are rarely stocked in welders' supply stores, though, so you'll probably have better luck finding them by shopping online.

You should *not* use adjustable and/or auto-darkening welding helmets or similar products to view the Sun. Many don't go as dark as shade 13 or 14, and even those that do pose a grave risk to your eyesight, either because you accidentally adjust them to an unsafe setting or because they don't auto-darken fast enough when you look at the Sun with them.

## What If You Don't Have a Safe Solar Filter/Viewer?

An alternative method for safe viewing of the partially eclipsed Sun is *indirectly* via [pinhole projection](#). For example, 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 images on the ground, showing the Sun as a crescent during the partial phases of any solar eclipse or as a ring during the annular phase of an annular eclipse. Or just look at the shadow of a leafy tree during a partial or annular eclipse; you'll see the ground dappled with crescent or ring-shaped Suns projected by the tiny spaces between the leaves.



or sun projection.

"Build a Sun Funnel for Group Viewing of the Great American Solar Eclipse of August 21, 2017" is a step-by-step illustrated guide to constructing a simple, inexpensive rear-screen-projection device that enables multiple people to observe an optically projected image of the Sun simultaneously and safely. *The document is intended for knowledgeable amateur and professional astronomers who know how to operate a telescope for solar observing.*

- [Instructions for Building a Sun Funnel \(PDF\)](#)

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## The Sunspotter & Solarscope

Originally developed at Learning Technologies, the company that invented the Starlab inflatable planetarium, the Sunspotter is billed as "the safer solar telescope." Like the Sun Funnel, the Sunspotter uses optical projection to produce a magnified image of the Sun that can be viewed by many people at once without risk of anyone looking into a bright beam of sunlight. Its price, around \$400, may be more than many individuals would care to spend, but the Sunspotter wasn't really designed for individuals; it was designed for astronomy clubs, schools, museums, and planetariums.

A similar but less expensive alternative is the Solarscope, which comes in several versions (some made of wood, like the Sunspotter, and some made of cardboard) priced from a little over \$100 to a little less than \$300.

If your school or organization is planning to hold an eclipse-watching event for students or the public on August 21, 2017, a Sunspotter or Solarscope is worth considering.

- [Learn more about the Sunspotter](#) (Starlab / Science First)
- [Learn more about the Solarscope](#) (Solarscope USA)

A less expensive device of similar design is available in kit form: the [Solar Projector](#) from Astromedia in the United Kingdom. It costs only \$25 or so, but it requires assembly by someone who's handy with tape, glue, and sharp knives and willing to follow the 34-step instructions (available as a [6-page PDF](#)).





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50%



40%



30%



20%



10%

10%



30%



40%



50%



60%



70%



80%



90%

Michael Zeiler / GreatAmericanEclipse.com

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## Authorized Resellers

The following resellers offer eclipse glasses made by one or more of the companies listed above. If you buy from any of the following businesses, you know you are getting ISO-compliant safe solar viewers:

- [American Solar Eclipse Company](#)
- [Big Kid Science](#)
- [Eclipse2024.org](#)
- [GreatAmericanEclipse.com](#)
- [ICSTARS Astronomy](#)
- [Mt. Lemmon Science Center](#) (University of Arizona Science)
- [My Science Shop](#) (*Astronomy & Discover* Magazines)
- [NationalEclipse.com](#)
- [Soluna](#) (GSM Sales)

## Free Eclipse Glasses for Libraries

Calling all public librarians! The STAR Library Network (STAR Net), managed by the Space Science Institute, is offering free eclipse glasses along with supporting information, training, and ideas for activities to conduct at eclipse events at U.S. public libraries. Learn more, and register to participate, on the [Solar Eclipse Activities for Libraries \(SEAL\) website](#).



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## Solar Filters for Telescopes, Binoculars & Camera Lenses

Solar filters for optics are meant to go over the aperture, i.e., the front opening, and should be used only by experienced observers. Some of the sources listed below sell aperture filters made from Baader AstroSolar Safety Film. While this material, unlike the newer AstroSolar Silver/Gold Film (see [above](#)), does not meet the ISO 12312-2 international standard for eyes-only direct viewing of the Sun — it transmits slightly more ultraviolet light than the standard allows — it has been safely used by amateur and professional astronomers for several decades for observing and/or imaging the Sun through telescopes, binoculars, and camera lenses (whose glass elements filter out the excess ultraviolet light). *Be sure to read our [safety tips](#) before using solar filters with optics!*

- [Alpine Astronomical](#) ([Filter Sheets](#) / [Mounted Filters](#))
- [Astro-Physics, Inc.](#)
- [Astronomics](#)

# Rick's Recommended Safe Viewing Plan

Initial partial phases and beginning of totality:

Keep your eclipse glasses or other solar filters on until you can't see anything through them, then take them off to marvel at the totally eclipsed Sun, especially the corona.

*Yes, you'll miss the first diamond ring, but you will get a terrific view of the breaking up of the thin solar crescent into Bailey's beads, and you will avoid getting dazzled with bright sunlight, which would make it hard to see faint coronal streamers during totality.*

# Rick's Recommended Safe Viewing Plan

End of totality and final partial phases:

Wait to put your eclipse glasses or other solar filters on until after you've seen the second diamond ring. *Watch the diamond ring for at most a few seconds.*

*This refers to “naked-eye” observing only. If you’re using binoculars or a telescope to look at totality, you MUST replace your solar filters when the chromosphere appears along the Moon’s retreating limb, lest you be harmed by the brilliant light from the first of Baily’s beads to appear (i.e., the “diamond” of the diamond ring).*

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