

A Brief Guide to Seeing the  
**AUGUST 2017**  
**TOTAL SOLAR**  
**ECLIPSE**



**BRIAN VENTRUDO & MANISH PANJWANI**

---

## What's in This Guide

---

|   |    |
|---|----|
| A Coast-to-Coast Total Solar Eclipse.....                                     | 3  |
| Solar Eclipses – Essential Facts.....   | 5  |
| Where and When to See the August 2017 Eclipse .....                           | 8  |
| Maps and Guides to See the 2017 Total Solar Eclipse .....                     | 10 |
| The Five Phases of a Total Solar Eclipse .....                                | 13 |
| Essential Eclipse Safety and Observing Tips .....                             | 17 |
| Seeing the Solar Eclipse #1 – Projecting the Sun’s Image .....                | 20 |
| Seeing the Solar Eclipse #2 – Solar Viewing Cards and Eclipse Glasses.....    | 24 |
| Seeing the Solar Eclipse #3 – Solar Telescopes, Binoculars, and Filters ..... | 29 |
| Taking Images of the Solar Eclipse .....                                      | 36 |
| Summary .....   | 38 |
| About Agena AstroProducts.....  | 39 |

---

## A Coast-to-Coast Total Solar Eclipse

---

On August 21, 2017, a total solar eclipse will pass from west to east across the lower continental United States. This will be the first total solar eclipse visible all over the lower U.S. since February 26, 1979. It will also be the first ‘coast-to-coast’ eclipse across the U.S. since June 8, 1918, when the Moon’s shadow passed rapidly over the country from Oregon to Florida.

Because of its location in such a populous country, where more than 300 million people live within a day’s drive of the path of totality, this eclipse will be perhaps the most watched astronomical event in history. The event will give many sky watchers their best chance to see a total eclipse without the need to travel to a remote international location.

A total solar eclipse is one of the most awesome and spectacular events in all of nature, which is why you should see one for yourself at least once in your life. If you can make your way to the narrow path of the 2017 total solar eclipse, you will see—for a brief span of less than three minutes—the Moon slide across the face of the Sun. During these few minutes, your surroundings will grow dark, birds and animals will go silent, and the sky will fill with bright stars. The brilliant face of the Sun will be replaced by a black disk, and around this disk you will see a band of glowing red gas in the Sun’s outer atmosphere, and the ethereal silver-white streamers of the solar corona, the outer reaches of the Sun that are always there but usually overwhelmed by the Sun’s bright light.

For the August 21, 2017 eclipse, the ‘path of totality’, where you can see the total solar eclipse, runs in a long but narrow band from Oregon to South Carolina. **You must be somewhere in this narrow band to see the 2017 total solar eclipse.** Outside the path of totality—essentially anywhere in North America—you can observe, **with a safe solar filter**, a partial solar eclipse where the Moon slides across the face of the Sun but does not cover it completely. It’s still an impressive sight that shows you firsthand the motion of the solar system in action.

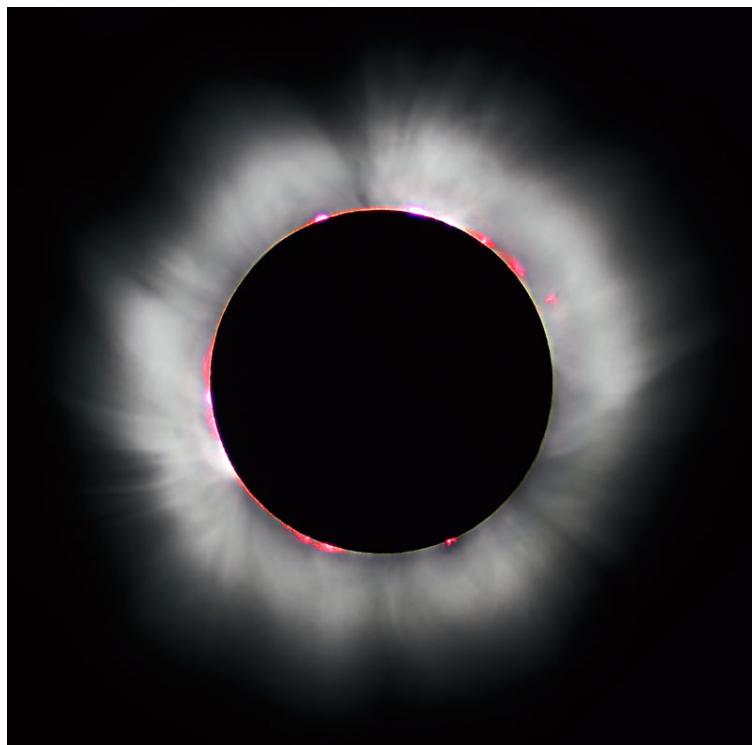
**IMPORTANT PLANNING TIP:** If you plan to purchase eclipse glasses, solar filters, solar telescope and binoculars, or other tools for observing the 2017 eclipse, considering doing so as soon as possible. There will almost certainly be shortages of products as the eclipse nears.

---

## Solar Eclipses – Essential Facts

---

The Sun has a diameter some 400 times greater than our Moon, and by coincidence, it's almost exactly 400 times farther away. That means, when the alignment is just right, the Moon can pass directly between the Earth and Sun and completely cover the visible part of the Sun for a few minutes for observers along a very narrow path of the Earth's surface. This event is called a *total solar eclipse*.



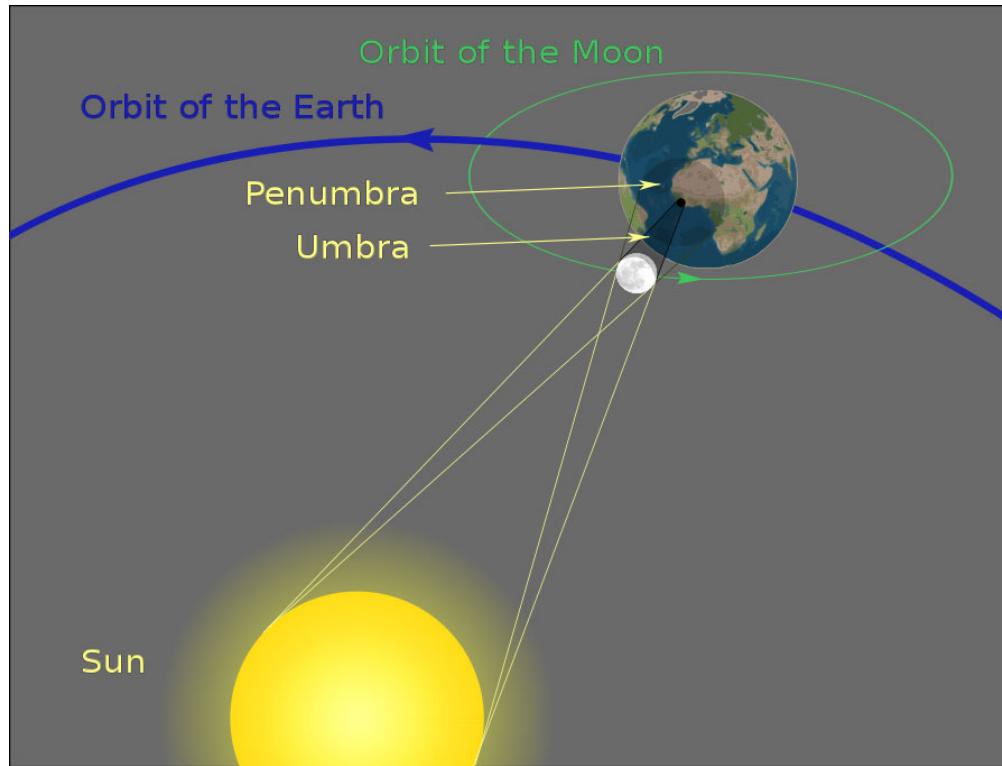
*Fig. 1: A total solar eclipse occurs as the Moon completely covers the bright face of the Sun, and reveals the reddish chromosphere and white streamers from the solar corona. Credit: Luc Viatour/Wikipedia Commons.*

### **Some essential things to know about seeing a solar eclipse:**

- Solar eclipses are a common event somewhere on Earth, and they occur twice a year, on average. Solar eclipses are more likely to occur across oceans, arctic regions, or in the middle of deserts simply because

these regions cover more of the Earth than densely populated urban regions.

- **That's why the total solar eclipse of August 21, 2017 is particularly remarkable:** it will take place over a densely-populated continent with a good road system that makes it easy for millions of people to see the event.



*Fig. 2: The geometry of a solar eclipse showing the umbra and penumbra shadows cast onto the surface of the Earth. Credit: Wikipedia Commons.*

- During a solar eclipse, as the Moon passes between the Sun and Earth over the course of an hour or two, it casts two types of shadows, the **umbra** and the **penumbra**
- The umbra is the narrow dark shadow cast by the Moon, while the penumbra is a fainter outer shadow.
- During an eclipse, both shadows travel along the surface of the Earth at more than 1,000 miles per hour as the Moon moves along in its orbit, and these shadows move west-to-east across thousands of miles of the Earth's surface during the eclipse.

- The path of the umbra is only about 70 miles wide, roughly, and within its path an observer sees the full total solar eclipse during which the Moon blocks the bright face of the Sun. This is the *path of totality*.
- **You MUST be located in the path of totality to see a total solar eclipse.**
- The penumbra is much wider than the umbra and spans many thousands of miles on either side of the path of totality.
- Within this shadow, an observer sees a **partial solar eclipse** in which the Sun's face is only partially covered by the Moon. More of the Sun's face appears covered for observers closer to the path of totality.
- Along the centerline of this path, you will see between two and seven minutes of totality, depending on the Earth-Moon-Sun alignment during a solar eclipse. Off the centerline, but still within the narrow path of the umbra, the duration of totality decreases.
- For the 2017 eclipse, the maximum duration of the eclipse is about **two minutes and forty seconds**.

---

## Where and When to See the August 2017 Eclipse

---

The **path of totality** of the August 2017 eclipse, which is the narrow band where a total solar eclipse will be visible, will pass through Oregon, Idaho, a tiny edge of southwestern Montana, Wyoming, Nebraska, extreme northeastern Kansas, a tiny piece of southwestern Iowa, Missouri, southern Illinois, Kentucky, Tennessee, northeastern Georgia, North Carolina, and South Carolina. The penumbra, in which a partial solar eclipse will be visible, passes across the rest of the United States, all of Canada, Mexico, and Central America, and northern South America.

The total eclipse will also **pass over cities and large towns** including Salem, OR, Idaho Falls, ID, Casper, WY, North Platte and Lincoln, NE, Kansas City, MO (barely), southern St. Louis, MO, Nashville, TN, and Greenville and Charleston, SC. Along the center of the path of totality, the total solar eclipse will appear to last about two and a half minutes.

The eclipse will last longest, about two minutes and forty seconds, at the center of the path of totality near Carbondale, IL.

The eclipse will occur on Monday, August 21, 2017 in the late morning and early-to-mid afternoon, local time, across the United States. It begins as the Moon's shadow falls on the northeast Pacific Ocean at 9:48:39 a.m. Pacific Daylight Time (PDT) on the morning of August 21, 2017. The shadow makes landfall at 10:15:58 a.m. PDT on the Oregon coast, then speeds southeast over the continental United States for the next 93 minutes before moving over the coast of South Carolina into the Atlantic Ocean at 14:49:01 p.m. Eastern Daylight Time. The total eclipse continues into the Atlantic Ocean towards, but not reaching, Africa and ends a little over three hours after it began.



*Fig. 3: The yellow band shows the path of totality across the United States for the solar eclipse of August 21, 2017. All of the U.S. will see a partial eclipse in which at least 70% of the Sun's face is covered by the Moon at maximum eclipse. Credit:*

## Maps and Guides to See the 2017 Total Solar Eclipse

---

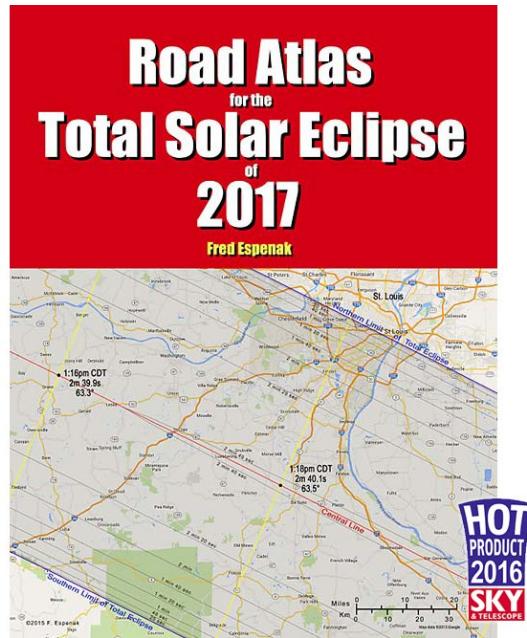
To see the brief total solar eclipse along the path of totality, **you have to be at the right place at the right time!** There are hundreds of towns and cities across the long and narrow path, too many to list in this book. [This link from Eclipse2017.org](#) gives a table of the duration of the total eclipse in hundreds of towns across the country.

[And this video from GreatAmericanEclipse.com](#) shows a short but detailed video of the path of totality across the United States:

[GreatAmericanEclipse.com](#), a website full of excellent resources, also shows the path of the eclipse across the U.S. The website has more detailed maps of the eclipse path across each state [at this link](#).

Agena AstroProducts has detailed planning tools to help you find a place to see the August 2017 total solar eclipse. The retired NASA scientist and eclipse expert Fred Espenak has created the detailed **Road Atlas for the Total Solar Eclipse of 2017** to help you find the best places to drive to and see the 2017 eclipse.

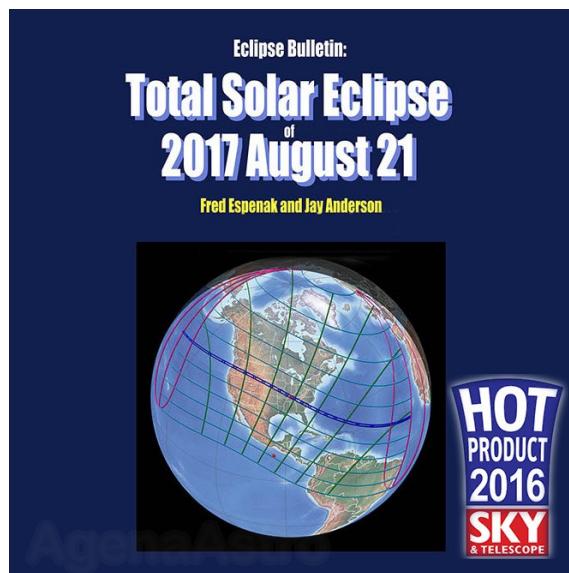
This atlas, considered by many to be the most authoritative of its kind, contains a comprehensive series of 37 full color maps of the path of totality across the USA. It shows both major and minor roads, towns and cities, rivers, lakes, parks, national forests, wilderness areas and mountain ranges. The path of totality on each map is depicted as a lightly shaded region with the northern and southern limits clearly identified. The total eclipse can only be seen inside this path. The closer one gets to the central line of the path, the longer the total eclipse lasts.



*Fig. 4: "The Road Atlas for the Total Solar Eclipse of 2017" by Fred Espenak.*

Armed with the "Road Atlas" and the latest weather forecasts, you will be ready to chase totality no matter where it takes you along the 2500-mile-long path.

The **Road Atlas for the Total Solar Eclipse of 2017** is available in [a color edition](#) or [a black and white edition](#).



*Fig. 5: "Eclipse Bulletin: Total Solar Eclipse of 2017 August 21" by Fred Espenak and Jay Anderson.*

Fred Espenak and his colleague Jay Anderson have also created the highly detailed and authoritative **Eclipse Bulletin: Total Solar Eclipse of 2017 August 21**, a 158-page guide packed with every conceivable detail about the August 2017 solar eclipse. The exact details about the path of the Moon's shadow during the eclipse can be found in this guide in a series of tables containing geographic coordinates, times, altitudes, and physical dimensions. The bulletin also has a set of high resolution maps that plot the total eclipse path across the USA. They show hundreds of cities and towns in the path, the location of major roads and highways, and the duration of totality vs. distance from the central line of the eclipse. **Eclipse Bulletin: Total Solar Eclipse of 2017 August 21** is also available in [a color edition](#) or [a black and white edition](#).

---

## The Five Phases of a Total Solar Eclipse

---

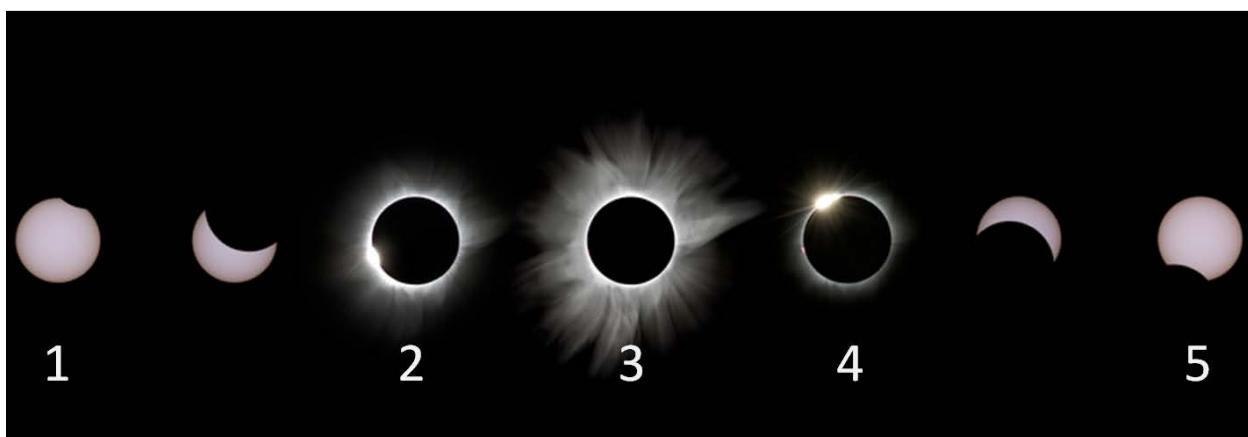
To understand when it's safe to look at a solar eclipse without a proper solar filter, it helps to understand how a solar eclipse unfolds.

A total solar eclipse has five stages. In only one stage—the brief stage of totality when the Moon completely covers the brightest part of the Sun for a few minutes—is it safe to observe the Sun without a safe solar filter over your eyes or over the objective lenses of a camera, telescope, or binoculars.

**Aside from the brief minutes of totality, you MUST use a safe solar filter to observe the solar eclipse with your unaided eyes, with binoculars or a telescope, or with a camera.**

If you look at the eclipse or try to photograph it at any time other than when the Moon completely covers the brightest part of the Sun, **then permanent damage to your eyes or equipment may result.**

And remember—to experience totality, you must be on the narrow path of the total eclipse. **Outside of this path, you will only see a partial eclipse and you must use proper solar filters at all times when you look towards the Sun.**



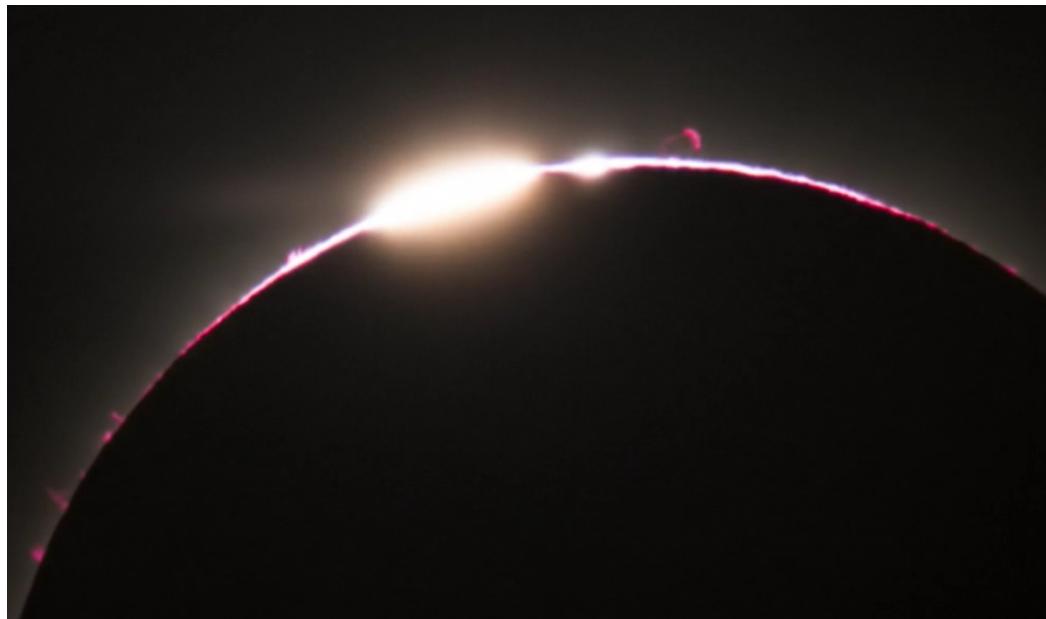
*Fig. 6: The five stages of a total solar eclipse. Credit: Justin Ng  
[www.justiningphoto.com](http://www.justiningphoto.com).*

**Stage 1 – First Contact (Partial Eclipse Begins).** At *first contact*, the leading limb of the Moon becomes visible across the Sun's disk. It looks like the Sun has a bite or a notch taken out of it. Over time, the Moon continues to cover more of the Sun, and if about 70% or more of the Sun is covered during an eclipse, you may notice a slight change in the lighting of the surrounding landscape. But the Sun is still far too bright to look towards without a safe solar filter.

**Stage 2 – Second Contact (Total Eclipse Begins).** Finally, the Moon slides across the Sun's entire face. For observers on the narrow path of totality, the Moon will almost completely cover the Sun: this is the beginning of the total eclipse. Just before second contact, a few rays of light may shine through valleys or gaps between mountains on the limb of the Moon. This will appear as a string of bright points along the Moon's edge that are called **Baily's Beads**. At last, a single point of light will remain giving rise to the **Diamond Ring** effect. Even at this point, the few sunrays peeking through are **still too bright to take in without a filter**. When the Beads or Diamond Ring disappear, the total eclipse begins! Now you can remove the solar filters from your eyes or telescope to see the awesome spectacle of the red chromosphere and icy white corona surrounding the black Moon.

[The video at this link](#) shows you an extraordinary close-up of a solar eclipse in 2012. Note the Diamond Ring effect at the beginning of the total eclipse at third contact, and the reemergence of the Diamond Ring along with Baily's Beads at the end.

**Stage 3 – Maximum Eclipse.** At this point, right in the middle of the brief couple of minutes of totality, the Moon completely covers the disc of the Sun. Only the **Sun's corona** is visible, and possibly a ring of red light from the **Sun's chromosphere**. At this point, the sky has gone dark, the air has cooled, and birds and animals often go quiet. People, however, become quite awestruck at this stage!



*Fig. 7: A combination of 'Baily's Beads' and the 'Diamond Ring' effect at 4<sup>th</sup> contact during a total solar eclipse in 2012. The red ring of the Sun's chromosphere is also visible in this image taken through a telescope. Credit: [Phil Hart/Vimeo](#).*



*Fig. 8: The solar corona at maximum eclipse.*

**Stage 4 – Third Contact (Total Eclipse Ends).** As the trailing edge of the Moon slides across the Sun, you may see the Diamond Ring and Baily's Beads reappear.

This is *third contact* and the point at which the total eclipse ends. **You must look away from the spectacle at this point**, however beautiful you may find it. Put on your solar eclipse glasses or solar filter and continue watching the partial phase of the eclipse over the next 90 minutes or so.

**Stage 5 – Fourth Contact (Partial Eclipse Ends).**Finally, at the final stage of the eclipse, the Moon's trailing edge will pass across the Sun—this is *fourth contact*—and the Sun's disk will appear whole again.



*Fig. 9: A combination of images shows the progress of a partial solar eclipse as seen from southern California in 2012. From this location, a total eclipse did not occur during this event. At all times during a partial solar eclipse, a safe solar filter is essential to prevent eye damage. Credit: Wikipedia Commons/Author Jimnista.*

For the August 21, 2017 eclipse, the span of time from second contact to third contact—the total eclipse or the period of totality—lasts at most two minutes and forty seconds, or more typically two minutes and twenty or thirty seconds depending on the location near the centerline of the path of totality. If you are off the centerline of the path of totality, it will last for a shorter time. As mentioned before, **if you are outside the path of totality, you will only see a partial eclipse of the Sun and you will need eye protection for the entire event.**

---

## Essential Eclipse Safety and Observing Tips

---

Now, a few important words about safety. Solar observing is the most potentially hazardous activity for amateur astronomers and casual sky watchers in an otherwise fairly safe pastime. Looking at the Sun just with your naked eye is dangerous enough. But looking at the Sun through a telescope or binoculars without a proper solar filter is **a sure way of going blind in less time than it takes to blink.**

Equipment manufacturers and astronomers have developed a number of filter technologies that allow safe solar viewing. To make sure you don't make a dangerous mistake when trying to observe the Sun or a solar eclipse (other than the brief period of a total solar eclipse), **here are some things you should NEVER do:**

- Other than during the brief moments of a total solar eclipse, **never look at the Sun directly** with your eyes without a safe solar filter, even with your unaided eye, even through thick haze, for any length of time.
- **Aside from the brief minutes of totality, you MUST use a safe solar filter to observe the solar eclipse with your unaided eyes, with binoculars or a telescope, or with a camera.**
- Again, other than during the brief moments of a total solar eclipse, never look at the Sun through a telescope, even your finder scope, **without a proper solar filter.** Although you may at first feel no pain when you look at the unfiltered Sun because your retina has no nerve endings, you will be permanently blinded almost instantly if you look at the Sun through any size telescope.
- **Never leave a telescope unattended outside in the daylight,** especially around children, unless caps or solar filters are securely placed over the main objective and the finder objective. At the sight of a telescope, the curious and uninformed just might try a little solar observing, either

accidentally or deliberately. You should treat a telescope in daylight like a loaded gun.

- Never use a solar filter designed to thread into the eyepiece of an otherwise unfiltered telescope. These filters are often supplied with cheap "department store" telescopes. All the light from the Sun is focused through the telescope onto these little filters which **eventually crack or melt** and allow concentrated sunlight to suddenly hit your eye. A proper and safe solar filter removes most of the light and heat from the Sun before it enters the telescope at the objective lens or mirror.
- Never use as a solar filter smoked glass, sunglasses, layers of photographic film, photographic filters, sheets of Mylar from a camping blanket, Pop-Tart wrappers, or the bottom of a beer bottle to observe the Sun. **None of these will protect you sufficiently.**



*Fig. 10: A solar observer's hat. Credit: Lunt Solar Systems.*

And unless you live on the path of totality, chances are you're going to have to do a little traveling, for the day if not longer, to get to the right place to see the eclipse. Here are a few more tips for your safety and comfort:

- You may be outside for several hours on the day of the eclipse. Bring some accessories to protect you from the Sun. That includes **sunscreen** with at least 30 SPF (60 is better). **Sunglasses** are a good idea too! So is a "[\*\*solar\*\*](#)

observer's hat", a specially-designed hat to keep the Sun off your head and neck.

- Look up the timing of the eclipse for your location and set your watch to the exact time so you know when to expect totality to begin and end.
- ONLY use safe, approved solar filters, viewers, eclipse glasses, and solar telescopes and binoculars from a reputable astronomy dealer. Agena AstroProducts sells only ISO approved solar observing products from reputable manufacturers.
- Don't leave your telescope unattended during the eclipse.
- If you're using a solar filter, make sure it is fitted securely over the objective lens of your telescope, binoculars, or camera to that it cannot be accidentally removed.

---

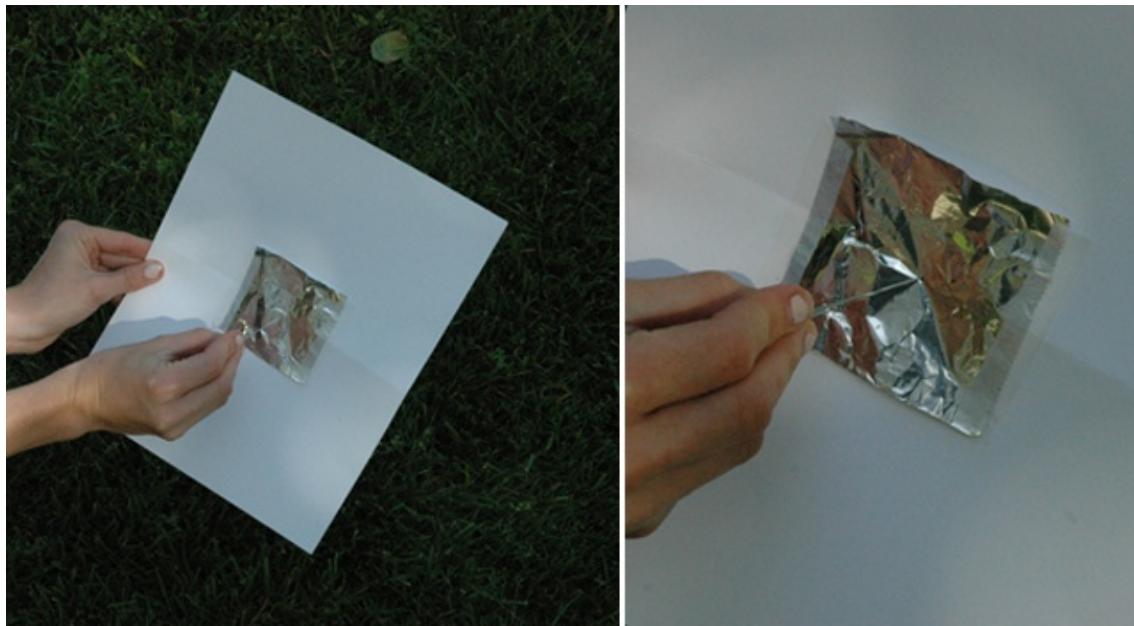
## Seeing the Solar Eclipse#1 – Projecting the Sun’s Image

---

If you’re on the path of totality for the August 21, 2017 eclipse, **you don’t need any special equipment to observe the brief phase of totality when the Moon covers the brightest part of the Sun.** This brief time, which will last less than about 2 minutes and 40 seconds for this eclipse, is the only time when you can turn your unprotected eye towards the Sun. But without some sort of solar filter, you must look away from the Sun before and after totality.

But most people want to observe the eclipse during the time when the Moon only partially covers the Sun. The anticipation of the impending total eclipse is exciting and it’s fun to watch the Moon slowly slide across an increasing fraction of the Sun’s visible face.

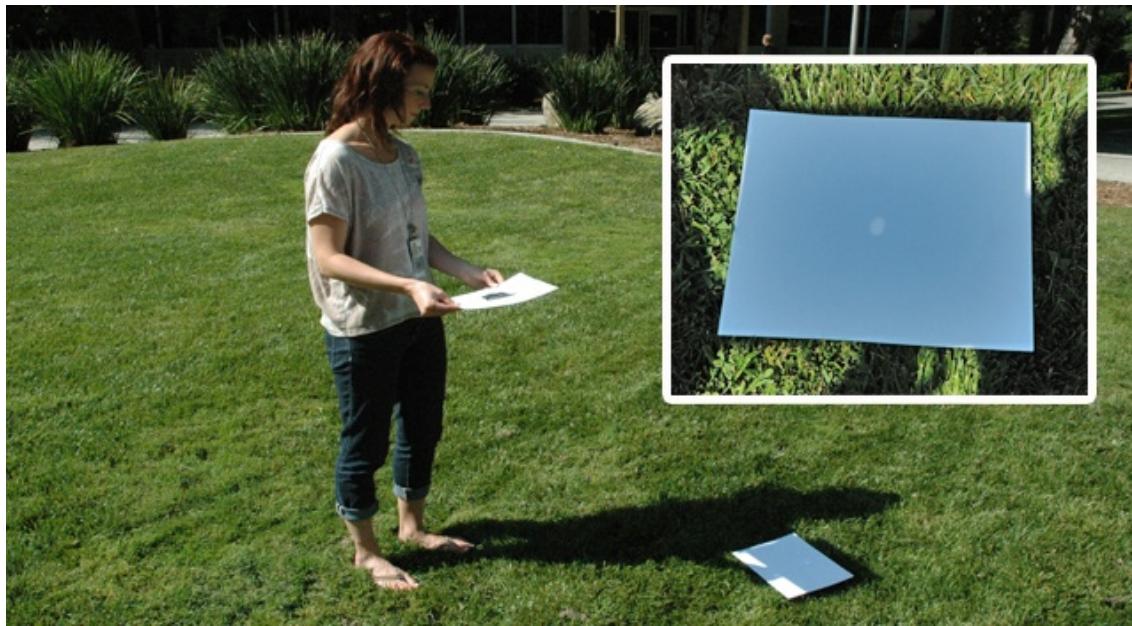
The simplest technique of all to observe the Sun without a telescope: a pinhole camera. Just poke a tiny hole in a piece of cardboard or a thick piece of paper, aim the card at the Sun, and project the image onto a second piece of paper at least a couple of feet away. Or to make a smaller, more precise pinhole, use a piece of aluminum foil taped over a hole in a piece of paper. This approach gives a small and faint image of the Sun, but it’s good enough to reveal the progress of a solar eclipse. Sometimes during a partial eclipse, you can even see multiple images of the eclipsed Sun cast onto the ground by the pinhole gaps between leaves on a tree.



*Fig. 11: Making a pinhole camera to project an image of the Sun. Using aluminum foil taped over a hole in a piece of paper allows for a smaller and more uniform pin hole. Credit: NASA.*

NASA has a step-by-step guide to making a pinhole camera with simple material to observe the Sun and solar eclipses. [See the guide at this link.](#)

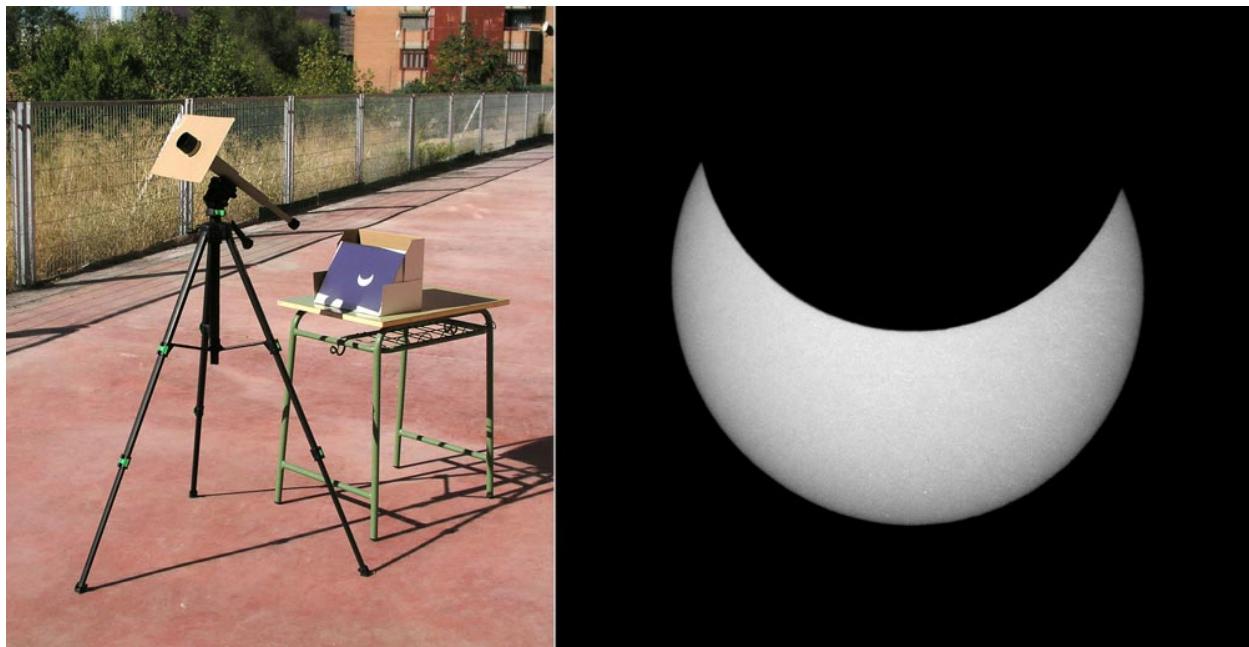
You can also use the projection method to cast the image of the Sun from a small unfiltered telescope onto a white screen. This is an inexpensive technique, especially if you don't have a solar filter available for your binoculars or telescope. Simply hold a thick piece of paper or cardboard a foot or two behind the eyepiece of the telescope when the scope is aimed at the Sun and brought to focus. The image from the eyepiece projects onto the paper screen. The greater the distance from the eyepiece to the screen, the larger the image.



*Fig. 12: Projecting the image of the Sun through a pinhole is a simple and inexpensive way to watch the progress of a solar eclipse. Credit: NASA.*

**SAFETY NOTE:** When using the projection technique with telescopes or binoculars, remember the **full intensity of the Sun is coming out of the eyepiece**. So make sure no one, especially a small child, walks up and looks through it. For the same reason, it's also good practice to cover the finder scope of a telescope during a solar observing session.

To get a projected view on the screen with good contrast, place a small diaphragm made of cardboard over the top or bottom of the telescope tube to block unwanted sunlight from falling onto the screen. No other special equipment is required for this method, though some vendors sell a white screen and a mechanical holder that fixes on the back of the telescope or focuser to hold the screen in place.



*Fig. 13: Projecting the Sun's image during a partial solar eclipse onto a screen with a small unfiltered telescope. Credit: Luis Fernández García/Creative Commons License.*

With binoculars, it's best to place a cap over one objective lens and observe the Sun for only a few minutes at a time because the Sun's heat can damage the adhesive used to hold in place the glass prisms inside the sealed optical tube of the binoculars. The projection method is also well suited for showing the Sun's disk and the progress of a solar eclipse to larger groups of observers since many people can see the screen at once.

Because the telescope is unfiltered when using the projection method and the Sun's full intensity falls into the optics, this method is best suited for small refracting telescopes of less than 3" to 4" aperture. Larger telescopes collect too much light and heat which may result in damage to the eyepiece.

---

## Seeing the Solar Eclipse #2 – Solar Viewing Cards and Eclipse Glasses

---

Solar eclipse glasses and solar viewing cards are the next step up from a pinhole camera. These simple and inexpensive devices are safe solar filters packaged for naked-eye observation of the Sun and solar eclipses. While these simple filters cost only a few dollars, they use a special plastic solar film to reduce the intensity of the Sun's visible light by a factor of 100,000 or more to a safe level. They also reduce dangerous infrared (IR) light and ultraviolet (UV) light as well as the heat from the Sun.



*Fig. 14: A young eclipse watcher wearing a pair of eclipse glasses. Credit: Ken Lund/Flickr under the Creative Commons License.*

Solar viewers or solar viewing cards are simple, inexpensive, and robust and one of the easiest ways to safely look at the Sun with your otherwise unaided eyes. **But do NOT use these to look at the Sun with a telescope or binoculars. They are for use with your unaided eyes only.**

Solar eclipse glasses easily stay on your head and make it easy to observe the Sun during a solar eclipse. Like solar viewers, they're made with a safe plastic solar film that reduces the Sun's light and heat to a safe intensity. Again, **do NOT use them with a telescope or binoculars.**

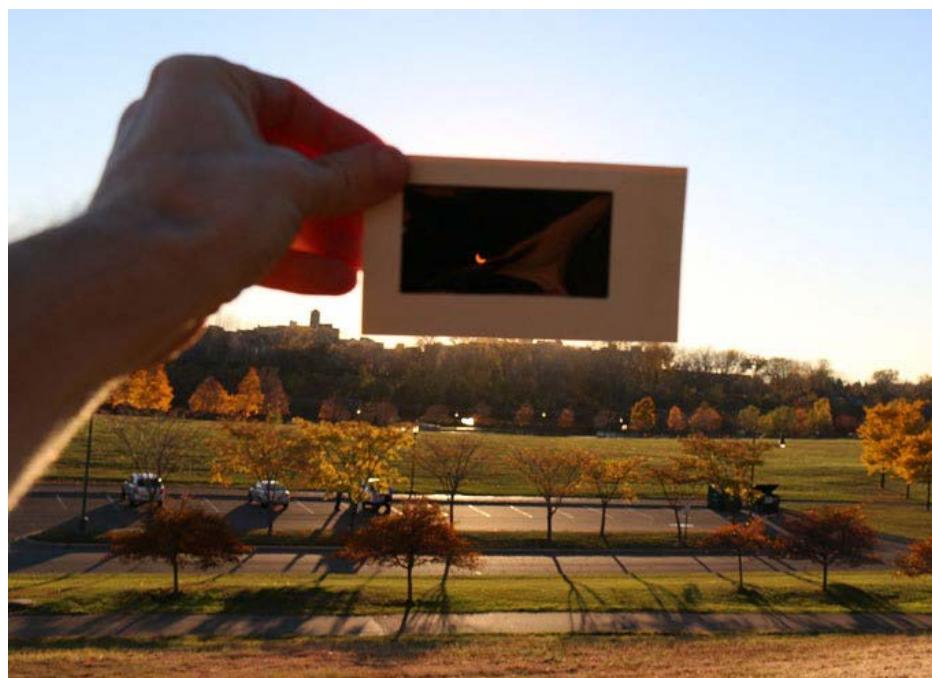
Some tips on using solar eclipse glasses and viewers:

- Eclipse glasses and solar viewers pass so little light that you can't see anything else through them other than the bright disk of the Sun. **So to see the brief phase of totality, when the Moon completely covers the Sun, you will need to remove them.**
- But when you see the Sun begin to poke out from behind the Moon as the total eclipse ends, look away and **put your glasses back on or hold the viewer up to your eyes before you look at the eclipse again.**
- Before using a pair of eclipse glasses or a solar viewer, make sure they are in good condition. Hold them up to a lightbulb or to the sky away from the Sun and look for tiny pinholes or tears in the plastic filter. If you can see any light, discard them and grab a new pair.
- You may hear of other options that will filter the Sun's light such as plastic CDs or DVDs, photographic film, dark sunglasses, metallic candy wrappers or thermal blankets, or the bottom of dark beer bottles. **None of these are safe!** Even if they reduce the visible light sufficiently, they will not block UV and IR light to a safe level. **Do not use them!**



*Fig. 15: A pair of solar eclipse glasses (left) and a solar viewing card (right).*

**SAFETY NOTE:** Solar eclipse glasses and viewers and welder's glass are for use in viewing the Sun with your otherwise unaided eyes only. **Do NOT use these devices to view the Sun through an otherwise unfiltered telescope or binoculars.** The concentrated image of the Sun can quickly damage and burn through solar film and glass and result in permanent eye damage.



*Fig. 16: The image of a partially eclipsed Sun through a solar viewing card held at arm's length. Image credit: Tom Ruen/Wikipedia Commons.*

Because they are so inexpensive, eclipse glasses or solar cards are ideal for handing out to participants at group events during solar eclipses. They are available in larger-volume packs for schools and public events.

Agena AstroProducts has **approved and safe solar viewer cards** from leading brands such as Meade and Thousand Oaks Optical in packs ranging from one piece to 50 pieces (with higher per-piece discounts in larger packs). [See what's available at this link.](#)

Agena AstroProducts also has **approved and safe eclipse glasses** from leading brands such as Celestron, Meade, and Thousand Oaks Optical in packs ranging from one piece to 50 pieces (with higher per-piece discounts in larger packs). [See what's available at this link.](#)



*Fig. 17: The Celestron 8-piece EclipSMART solar observing kit. Credit: Celestron.*

Agena also carries the convenient **Celestron Solar Eclipse Viewing and Imaging Kits**. These kits are ideal for beginners and casual eclipse observers. They're available in four versions:

- [\*\*Celestron Solar Eclipse Kit #1\*\*](#). For families and small groups, Celestron packaged four eclipse shades(glasses) and a short guide into a kit.
- [\*\*Celestron Solar Eclipse Kit #2\*\*](#). Celestron also has a kit with a 2x magnifying solar viewer to help you get a closer view of the Sun, along with a short guide.
- [\*\*Celestron Solar Eclipse Kit #3\*\*](#). This 3-piece kit includes a pair of fashionable solar observing glasses, a photographic filter for your camera, and a short eclipse guide.

- [\*\*Celestron Solar Eclipse Kit #4\*\*](#).The deluxe 8-piece Celestron solar eclipse kit includes four pairs of solar observing shades, a pair of solar eclipse glasses, a photographic filter, a guide, and a double-sided map.

---

## Seeing the Solar Eclipse #3 – Solar Telescopes, Binoculars, and Filters

---

Eclipse glasses or solar viewers are handy tools for all eclipse observers. But to the eye, the Sun and Moon appear frustratingly small, just about half the width of your little finger held at arm's length. So a little magnification is useful when observing the eclipse, and that means a telescope or a pair of binoculars.



*Fig. 18: Sunspots visible on the Sun through a telescope during a partial solar eclipse. Credit: Justin Dolske/Flickr under the Creative Commons License.*

### Dedicated Solar Telescopes and Binoculars

Fortunately, many telescope and solar filter manufacturers offer all-in-one solar telescopes with objective lenses, eyepiece, and a built-in solar filter that reduces to a safe level the white-light from the Sun. These telescopes are ideal for casual observers or for beginners, and you don't need to carry around an extra solar filter or remember to safely mount a solar filter to the front of the telescope before a solar observing session. Also, the solar filter can't be accidentally removed during a session, so these telescopes can be inherently safer when used correctly.

Celestron makes a compact 50mm solar telescope with integrated solar filter that comes with an eyepiece that gives a magnification of 18x, a solar finder to help you find the Sun, and a tripod for mounting. You can [learn more about these solar telescopes at this link.](#)

There is one drawback to these dedicated solar scopes: since you can't remove the solar filter, you can't observe the brief period of totality with these telescopes or binoculars because, during these brief minutes, the totally eclipsed Sun is too faint to be visible through the solar filter. But these scopes are excellent for watching the partial phase of the solar eclipse. They are usually designed for a modest magnification of less than 25-50x, which is far more than binoculars. This shows you more detail of the progress of the eclipse itself as well as better views of sunspots.



*Fig. 19: The Celestron EclipSMART solar telescope with an integrated white-light solar filter. Note that the solar filter is inside the telescope and not visible in this photo. Credit: Celestron.*

For even more convenient observing, although with lower magnification, a pair of dedicated solar binoculars is also a useful tool for eclipse observers. Like solar telescopes, these binoculars, which are available from Celestron, Meade, and Lunt Solar Systems, have polished glass solar filters mounted over the objectives. They have objective lenses of 25mm to 42mm, enough to provide much more detail than a pair of eclipse glasses, and a magnification of 8x or 10x. That's less than a telescope, but the lower magnification makes it easier to get a steady image when hand-holding these optics. As with the solar telescopes, you don't need to carry around the solar filters for the solar binoculars as separate parts, and the filters can't be removed accidentally. Nor can they be removed to observe the Sun during the time of the total solar eclipse.



*Fig. 20: A pair of Lunt "Sunocular" solar binoculars, available in several colors, provide a magnification of 8x and have objective lenses with a diameter of 32mm.*

*Credit: Lunt Solar Systems.*

[\*\*Celestron EclipSMART Solar Binoculars\*\*](#) are intended for handheld use and travel, and these dedicated solar binoculars with integrated polished glass solar filters are available in 10x25 and larger 10x42 configurations for improved resolution of solar features.

[\*\*Lunt Solar Systems Sunoculars and MiniSunoculars\*\*](#) are pocket-sized 6x30 and 8x32 solar binoculars ideal for inspecting solar eclipses or large sunspot groups. Available in four colors, these small optics are perfect for travelers and casual solar observers.

## Add-On Solar Filters for “Non-Solar” Binoculars and Telescopes

If you already have binoculars, or a telescope or spotting scope, can you use them to observe the solar eclipse?

The answer is ‘yes’, but only if you safely outfit them with a solar filter. **You must use a solar filter over your binoculars or telescope during all times of the solar eclipse except the brief moments of totality.** During totality, you can remove the solar filter from your optics and get a close-up and dramatic look at the total eclipse.

A **white-light solar filter** is the simplest and least expensive choice for telescopes or binoculars. White light is simply the full spectrum of light we can see with our eyes. The actual color of the Sun rendered by a specific white light solar filter may actually be white, yellow, orange, or yellow-orange, but they are all “white light” views of the Sun.

There are two common types of white-light solar filter: glass solar filters and solar polymer film filters.

**Glass solar filters** are a great choice for budget solar observing with a telescope. These filters use flat polished glass coated with nickel and chromium to attenuate the Sun to 1/1000 of 1% of full intensity. The filter is mounted in a holder that can be fixed to the entrance of a telescope tube. You must order a glass solar filter that’s mounted in a cell to fit your particular telescope, camera lens, or pair of binoculars. One size does NOT fit all!

Glass solar filters give good white-light views of the Sun and a partial solar eclipse at low to moderate magnification, and they give the Sun's image a pleasing orange-yellow tint.



*Fig. 21: A glass solar filter that mounts over the objective lens of a telescope (left). The view through the glass solar filter (right). Credit: Spectrum Telescope/Agena AstroProducts.*

**Thin polymer solar filters** such as BaaderAstroSolar film and Solarlite from Thousand Oaks are durable and they give you a natural white image of the Sun with just a slight tint of blue(in the case of BaaderAstroSolar film) and yellow-orange (in the case of Solarlite). They result in very good white-light solar images at high magnification, generally much better than what's available with a glass solar filter.Film filters are mounted in mechanical cells without added stress to help maintain high-image quality over a wide range of operating temperature. Don't be surprised to see wrinkles in these thin-film filters when they are mounted in a cell. The wrinkling does not affect image quality.

Like glass filters, solar film filters can fit a wide range of telescope apertures, and they are also available for binoculars, spotting scopes, and camera lenses as well.



*Fig. 22: An objective-mounted solar filter made with BaaderAstroSolar film (left). An image of the Sun through BaaderAstroSolar film (right). Credit: Baader Planetarium/Agena AstroProducts.*



*Fig. 23: A BaaderAstrosolar film filter mounted in a cell on a small spotting scope.*  
*Credit: Baader Planetarium.*

To choose a white-light solar filter that fits your telescope, you can use the **Agena AstroProducts solar filter finder tool**. This comprehensive and searchable table was compiled by Agena AstroProducts using many inputs from companies and

individuals and a lot of cross-referencing. It provides solar filter compatibility information for over 300 telescopes at the time of this writing:

<http://astronomyconnect.com/database/solar-filter-finder-tool-for-telescopes>

**SAFETY NOTE:** Make sure you double check to make sure your glass or film solar filter and its mounting cell are securely fixed to the front of your telescope tube before you aim at the Sun. Make sure you get a filter that fits the tube of your scope or binoculars. One size does not fit all. Most vendors have the filters mounted in cells to match the most common apertures of telescopes available on the market.

---

## Taking Images of the Solar Eclipse

---

When it comes to trying to take an image of the solar eclipse during the brief few minutes of totality, many expert photographers and amateur astronomers have one suggestion: don't. You only have, at most, 150-160 seconds during the August 2017 eclipse to enjoy one of the most spectacular events you will ever see. You don't want to spend time fiddling with your camera during this fleeting opportunity. This will surely be the most photographed eclipse of all time, so if it's your first total eclipse, just enjoy the show and you can see plenty of images taken by expert photographers afterwards.



*Fig. 24: A cropped image of a total solar eclipse taken with a DSLR with a 55mm focal-length lens, ISO1600, f/4, and 1/15s shutter speed. Credit: Romeo Durscher/NASA Goddard.*

However, if you wish to try your hand at imaging, here are a few tips and ideas to get you started taking simple images with a camera and lens or at the eyepiece of a telescope with a safe solar filter:

- Taking an image of a solar eclipse during the partial phase involves the same consideration as imaging the Sun in general. You **MUST use a solar filter over your camera lens or the objective lens of your telescope or binoculars.** If the Sun is too bright to look at with your eyes without a solar filter, it's too bright to image without a solar filter.
- As with visual observation, once the eclipse reaches totality and becomes safe enough to see with your eyes, you can—and must—remove the solar filter from your camera. Otherwise, your camera will not see anything. Once totality ends, if you wish to image the subsequent partial eclipse, **you must replace the filter.**
- Do not use a flash. It will not help with an image of the eclipse and it's distracting to those around you.
- If you don't have a long zoom lens for your smartphone, point-and-shoot, or DSLR, you can try snapping an image of the surrounding landscape during the total eclipse, or of people silhouetted against the darkened sky, or even a short video of the sounds of the crowd during totality. Or you can snap an image of the partial solar eclipse through a solar eclipse card or eclipse glasses
- Don't trust autofocus to work correctly during totality. Focus on the Sun manually through a solar filter, then turn off autofocus before totality begins.
- Practice focusing and taking images during the partial phase of the eclipse before totality begins, or practice using your camera weeks in advance on the full Moon (the full Moon is about the same brightness as a total solar eclipse)
- Make a checklist of all the equipment you need for the eclipse, especially if you are traveling. Also make a checklist of the steps required to take an image of the eclipse, including these tips.
- Use a tripod to get a steadier image. And use a timed or remote shutter release to avoid camera shake.

---

## Summary

---

This guide has taken you the basics of how to see the total solar eclipse of August 21, 2017. You learned why eclipses happen and how they work. You learned when and where to see the 2017 total solar eclipse. And you found some essential tips and suggestions about how to safely see the eclipse with a wide range of tools from a simple solar viewer or pair of eclipse glasses, to white-light solar filters for your telescope or camera, to complete white-light solar telescopes.

Now it's up to you to make your way to the narrow path of totality!

---

## About Agena AstroProducts

---

[www.AgenaAstro.com](http://www.AgenaAstro.com)

Whether you are an absolute beginner with a passing interest in the upcoming eclipse, an enthusiastic amateur astronomer, or an advanced expert in astronomy, Agena AstroProducts has everything you need to get ready for the Total Solar Eclipse of August 2017 at: <http://agenaastro.com/solar-astronomy.html>

Founded in 2003 and based in the greater Los Angeles area, Agena AstroProducts is one of the largest and most trusted online astronomy stores in the world. With over 2,500 products in stock, Agena has telescopes, binoculars, eyepieces, imaging cameras, and astronomy accessories, including many hard-to-find items you won't see anywhere else. Agena carries products from the leading brands you know and trust:

- Celestron
  - Meade
  - Coronado
  - Lunt Solar Systems
  - Tele Vue
  - Baader Planetarium
  - Thousand Oaks Optical
  - Explore Scientific
  - Blue Fireball
  - GSO
  - Lumicon
  - Optolong
  - Sky-Watcher
  - William Optics
  - ZWO Astronomical Cameras
  - And many more...
- 
- 

