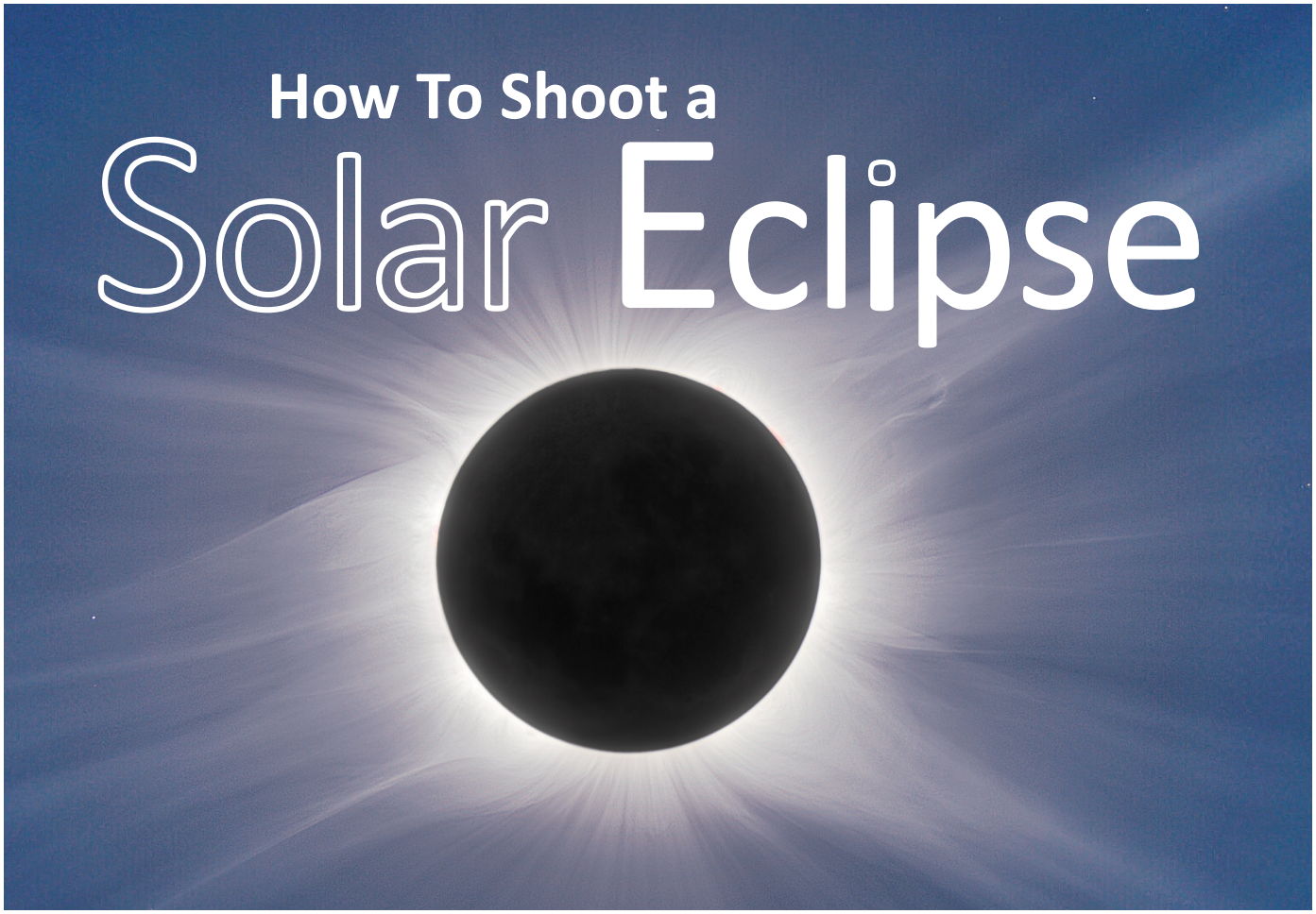
How To Shoot a Solar Eclipse



A LITTLE ADVANCE PLANNING CAN HELP MAKE YOUR PICTURES OF THIS RARE EVENT MEMORABLE.

By Dennis di Cicco • Avid eclipse chasers have called total solar eclipses nature's most spectacular predictable photo ops. And the one that occurred on August 21, 2017, was arguably the most-photographed in history.

Having photographed nearly 20 solar eclipses during the past half century, I have witnessed a huge transformation in the techniques used to record these remarkable events. Digital photography, in particular, has made capturing them much easier than in the past. Consider, for example, this photo taken from Easter Island in 2010. It's perhaps my finest picture of totality to date, yet I took it with the simplest camera setup I've ever used for close-up eclipse photos.

That's the good news. The bad news is that today's digital cameras offer such a varied spectrum of features, it's impossible for an article like this to give specific instructions for using all of them. In fact, some of the most useful features that many digital cameras offer for eclipse photography are ones not used for daily shooting. You might need to check your camera's manual to find if you even have them. Thus, general suggestions and pitfalls to avoid are the order of the day.

This view of the 2010 eclipse seen from Easter Island was captured with a Nikon D700 (full-frame) DSLR camera and a Tele Vue TV-85 refractor, which is effectively a 595-mm f/7 telephoto lens. Nine bracketed exposures ranging from 1/500 to ½ second at ISO 200 were combined to create an image showing detail across a wider range of the corona's brightness than would show in any single exposure.

First, a Warning

If this is your first time seeing a total or deep partial solar eclipse, think twice before committing to photographing it. You're going to be in for a shock at how quickly 1 minute of totality will pass. In 1980, astronomy popularizer Norm Sperling wrote that no matter how long totality lasts, it always seems like only 8 seconds. That concept resonates so well with veteran eclipse chasers that it's become known as "Sperling's 8-second Law."

There's a lot to experience in the minutes surrounding totality, and time spent fiddling with cameras is precious time that won't be available to absorb other things going on. Besides, in the days (even hours)

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after the eclipse, the internet will be awash with images of the event. You'll have no problem obtaining a keepsake photo of the eclipse.

But it's also true that there's nothing like having your own photographs. I like my pictures of the Eiffel Tower more than those on postcards. So if you do have your heart set on shooting your own pictures of the eclipse, let's consider some details.

A Few Ground Rules

• Except during totality and a few seconds before and after, you must always use a *safe solar filter* (see eclipse.aas.org/eye-safety) when looking at the Sun with your unaided eye or through any optical device, including cameras. This includes times when the Moon partly covers the Sun, no matter how much or little.

For the best results your filter should be securely mounted so that it can't be dislodged by an accidental bump or a gust of wind — but can still be quickly removed and replaced. Don't treat this issue lightly. The safe, fast, and easy removal and replacement of a filter can make all the difference when it comes to successfully capturing Baily's Beads, the diamond ring, and the Sun's electric-pink chromosphere in the fleeting seconds at the beginning and end of totality.

• The most useful feature for eclipse photography, one often found in today's digital cameras, is called *exposure bracketing*. It lets you shoot a sequence of images that automatically vary the exposure by preset amounts without you having to fiddle with settings on the camera other than initially enabling the bracketing function. Not all cameras offer automatic bracketing, but I've met a lot of eclipse chasers who were surprised to learn that it is indeed a feature of their cameras. Check your manual!

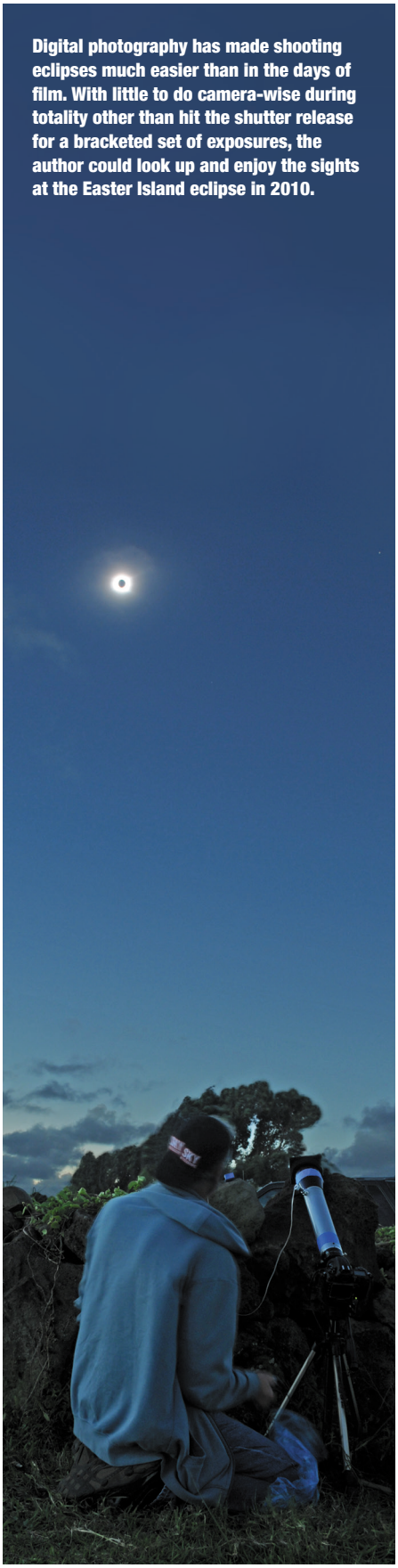
One key to successfully capturing rapid-fire events at the beginning and end of totality is the ability to quickly and easily remove and replace a solar filter without disturbing the aim of your photo setup. Cardboard, masking tape, a little hot-melt glue, and black spray paint were all the author needed to make this simple slide-out holder for Baader AstroSolar filter material.

Bracketing is useful because there's no single, perfect exposure for capturing everything visible during totality. Short exposures record detail in the brightest portion of the corona near the Sun's limb (which has a *surface brightness* equal to roughly that of the full Moon's face). But this same coronal detail is blown out in the longer exposures needed to capture wisps of the faint outer corona. Even bright features like Baily's Beads and the diamond ring, which record well with a relatively predictable short exposure (see the table on page 5), will benefit from bracketing — especially if there is haze or thin clouds in front of the Sun.

• In addition to capturing different aspects of totality with bracketed expo-sures, you can also use special image-processing techniques to combine the different exposures and create one image showing detail over a wider range of brightness than is possible with a single exposure. This technique, called *high-dynamic range* (HDR) imaging, is becoming increasingly popular among everyday photographers, and it's how my Easter Island image was processed.

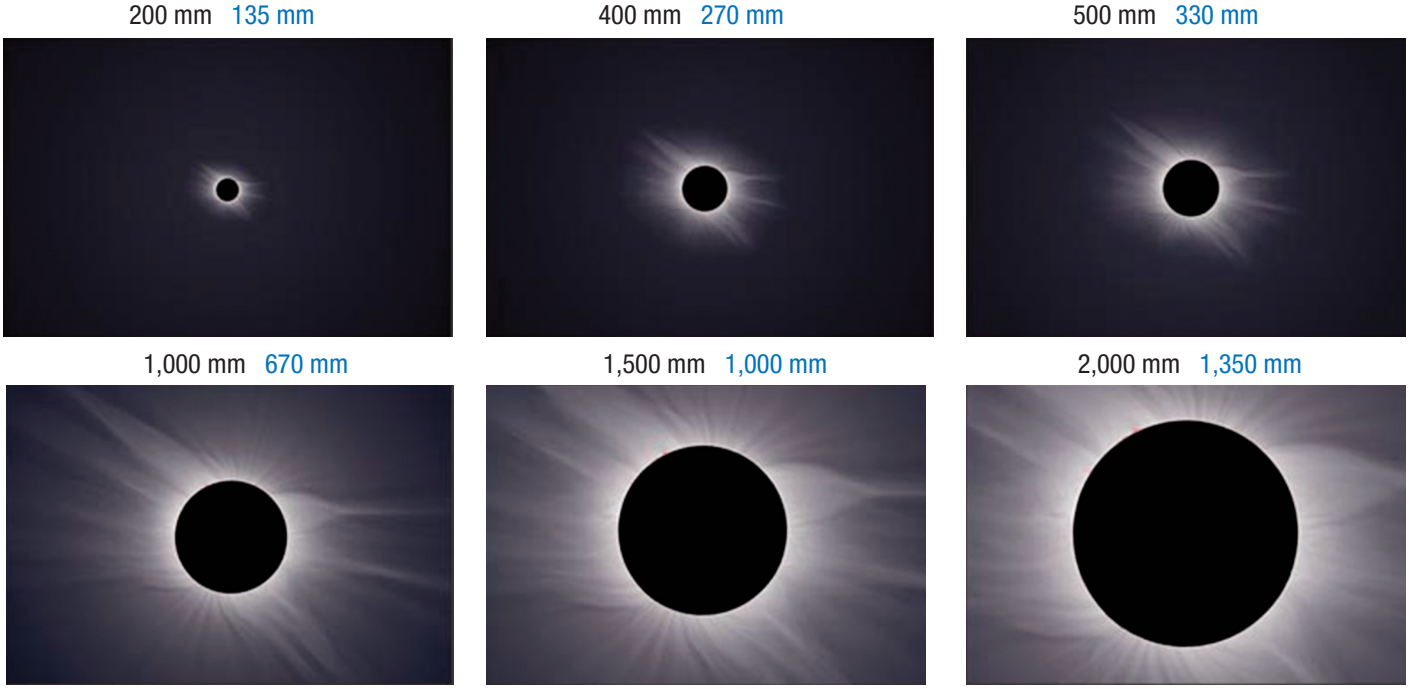
• If your camera has a flash, turn it off. Except for very specific photo setups where extra light is needed to illuminate the foreground, a flash offers no advantage for eclipse photography and will almost certainly annoy others around you.

• You should also disable any auto-ISO setting your camera may have. Auto ISO is designed to boost a camera's sensitivity in low-light situations — but at the expense of increasing the digital noise in images. While an eclipse scene might be dark overall, thus tricking your camera to use a high ISO setting, the detail you're generally trying to capture, including the corona, is bright enough to record well with a lower (and thus low-noise) ISO



Digital photography has made shooting eclipses much easier than in the days of film. With little to do camera-wise during totality other than hit the shutter release for a bracketed set of exposures, the author could look up and enjoy the sights at the Easter Island eclipse in 2010.

Lens Focal Length vs. Field of View



To capture coronal detail, you'll need a telephoto lens with a focal length of at least 300 to 400 mm. This comparison shows what some typical lenses will show during totality. Note: The blue values are for cameras equipped with APS (cropped-frame) sensors.

setting. For most cameras this value falls between ISO 50 and 400.

• If your camera can save images in RAW format, use it. Capturing images is only half of the story when it comes to creating an eclipse masterpiece. The other half is image processing, and the best results always come from processing RAW-format images.

• My last generality involves the focal length of lenses. In this article, as well as other material you might encounter, most lenses are stated has having an *equivalen*t focal length, and this might create some confusion.

The issue is that many modern cameras use an APS sensor that's smaller than a standard 35-mm frame, essentially cropping and enlarging the view by 1.5×. This is known as the *crop factor.* If your camera has an APS-format sensor, you need to do the math to determine the real focal length of the lens you want to use to achieve a given field of view. For example, a 200-mm lens on an APS-equipped camera has a field of view equivalent to that of a 300-mm lens on a full-frame 35-mm camera (200 × 1.5 = 300).

Capturing the partially eclipsed Sun is relatively easy to do with a short exposure. But you'll need a protective filter, typically with an optical density (OD) of 5, to protect your camera's sensor.

Close-Up Photos

Photographs of the partial eclipse, Baily's Beads, the diamond ring, and the chromosphere do not need to cover a field of view much larger than the apparent ½° diameter of the Sun's disk. As such, focal lengths up to 2,000 mm are reasonable. On the other hand, anything shorter than about 400 mm will sacrifice detail, showing a rather small image of the Sun with empty surroundings.

Much of the same advice that applies to any extreme-telephoto photography also applies to this type of eclipse shooting. You'll need a very solid camera support and some form of external shutter release so you don't have to touch the camera itself to snap pictures. While it's a physical inconvenience to keep tripod legs their shortest when you're trying to aim a camera high in the sky, the increased stability is worth the discomfort. Consider hanging weight like a gallon jug of water from the tripod head to further increase stability.

Critical focus is important at these long focal lengths, and you can't count on a camera's auto-focus to work for eclipses. Fortunately, many cameras have a "live-view" feature that produces a real-time, zoomable image on the camera's viewing screen, which assists with critical focusing. But, here, too, eclipses present problems — especially in the final moments before totality when you're trying to make last-second focus tweaks using the shrinking crescent Sun visible through your solar filter. This scene, all black except for the thin sliver of Sun, might cause a camera's live-view electronics to blow out the image on the monitor, making it all but impossible to focus.

TOP: FRED ESPENAK (6)

Your best bet is to actually shoot a picture and check the resulting image at high magnification on the camera's monitor. Do this when there's still about 5 minutes to go before the start of totality, since it could take a few attempts at adjusting the focus before you get everything perfect.

Medium-field Photos

Exposures made with effective focal lengths of 400 to 800 mm are ideal for capturing the full extent of the Sun's corona. Many photographers consider these the classic images of totality.

The key to success here is to bracket your exposures. With ISO settings of 100 to 400 and lenses with f/ratios between f/5.6 and f/11, essentially any exposure from 1/1,000 second to 2 seconds will record an interesting aspect of the totally eclipsed Sun. Given the variables of sky condi-tions and the Sun's corona, it's difficult to recommend which of these exposure times will produce a single "best overall" shot during totality, but my experience shows that the sweet spot is between 1/8 and 1/60 second at ISO 200 with an f/8 lens. As mentioned earlier, bracketed exposures can be combined to create an HDR image showing an extended range of coronal brightnesses.

For shooting the partially eclipsed Sun through a OD5 solar filter at ISO 100, use an exposure of 1/2,000 second with the lens set at f/4, 1/1,000 at f/5.6, and 1/500 at f/8. Again, bracket your exposures.

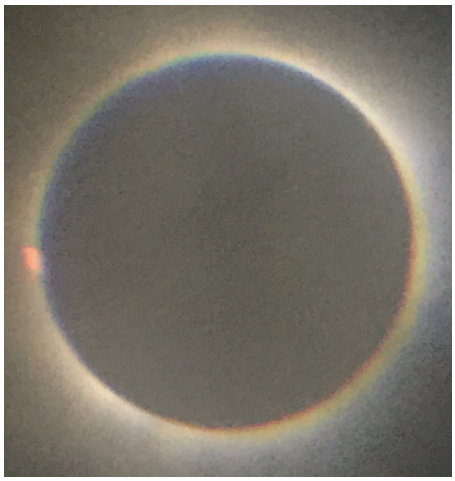
In the days of film, carefully tracking the Sun's motion across the sky was essential for exposures long enough to record the Sun's faint, outer corona. This was especially true when photographing with focal lengths of 500 mm or more, which magnify the Sun's diurnal motion. But the sensitivity of digital cameras makes such long exposures a thing of the past. My 2-second digital exposures now routinely record more outer corona than I captured with 16-second exposures on film. With exposures this brief, you can get away with not tracking the Sun even when working with focal lengths up to 600 or even 800 mm. Part of the reason is that detail in the outer corona is relatively diffuse and thus not blurred by the Sun's apparent motion during a 2-second exposure.

This composite view of the 2008 eclipse seen from China was assembled from a series of exposures made at 5-minute intervals with a Nikon D200 camera and 24-mm lens. The partial-eclipse images were shot through a solar filter, which was removed for a bracketed set of exposures made during totality, recording the foreground, eclipsed Sun, and the planets Mercury (close to the Sun's upper left) and Venus (farther out at upper left).

Wide-field Photos

Despite having an image of the eclipsed Sun too small to show much detail, wide-angle views during totality can be exceptionally dramatic. In addition to including foreground, these images often capture stunning sky coloration along with the brighter stars and planets visible during totality. And some can even show the Moon's approaching or receding shadow. I've had very good success shooting these scenes with lenses ranging from fisheyes that take in the full 180° of heaven's vault up to conventional wide-angle lenses of 24- to 35-mm focal length. I've also had very good success shooting these photos using my camera's auto-exposure setting, but bracketing is still a good idea.

The composite picture on the previous page, made during the 2008 eclipse in China, is one of my personal favorites. It was taken with a camera and equivalent 36-mm lens on a small tripod about 25 feet behind me. The camera's internal intervalometer snapped a bracketed set of exposures every 5 minutes for the multi-hour duration of the eclipse. Unlike the days of film when multiple exposures were recorded on a single frame of film and you had to care-fully plan shooting intervals beforehand, with digital images you can shoot on short intervals and select frames to composite later. It takes approximately 2 minutes for the Sun to move its own diameter across the sky, so images spaced at 5- or 10- minute intervals should work well for compositing.



Left: **A wide variety of zoom-lens accessories for smartphones, such as this 8× model, might seem like a good way to get better shots of an eclipse, but there are still hurdles to overcome, including the need to manually control the camera's focus and exposure with special camera apps. You also need a stable support for the camera, albeit not one that's particularly elaborate!** ***Right:*** **A smartphone with a clip-on telephoto lens recorded the Sun's corona and even a pink prominence along the limb during a total solar eclipse seen from Indonesia in 2016. But such setups can be tricky to use.**

If you try a photo like this, keep in mind that you'll want to include a picture made during the middle of totality at your location, so you'll need to calculate the start time of your sequence by stepping backward from this time in increments of your exposure intervals. The only other thing I had to do for my photo was remember to remove the solar filter for the bracketed burst made during totality, and replace the filter quickly afterward.

Use a Smartphone? Yes, But . . .

Experienced eclipse photographers might sneer at the thought of shooting the eclipse with a smartphone's camera. But given that virtually everyone today has one, there will probably be more pictures of the upcoming eclipse taken with phones than with any other type of camera. And I wouldn't be surprised if some, especially ones in the wide-field category mentioned above, turn out quite well. That said, location and luck, more than photographic skills, will likely be the determining factors.

There are two large hurdles to overcome when trying to shoot close-up eclipse pictures with a smartphone: focus and exposure.

Best Exposures for Recording the Total Eclipse

f/ratio for ISO 100:	f/2.8	f/4	f/5.6	f/8	f/11	f/16
Baily's Beads*	—	—	1/2,000	1/1,000	1/500	1/250
Diamond ring**	1/1,000	1/500	1/250	1/125	1/60	1/30
Prominences	1/1,000	1/500	1/250	1/125	1/60	1/30
Chromosphere	1/2,000	1/1,000	1/500	1/250	1/125	1/60
Inner corona	1/250	1/125	1/60	1/30	1/15	1/8
Outer corona	1/8	¼	½	1	2	4
Wide-field view***	¼	½	1	2	4	8

* These exposures assume the camera's solar filter has been removed. ** Use longer exposures to capture more corona around the "ring." *** For especially dark horizons, use longer exposures.

SMARTPHONE IMAGE: MARK BENDER

Notice that I didn't mention magnification. That's because you'll find a seemingly endless variety of gizmos made to attach cell phones to telescopes and binoculars, not to mention a growing assortment of zoom lenses that clip over your phone's built-in lens. I've tried a handful of them with varying degrees of success, but the best focused and exposed results have always been with terrestrial pictures (think birds on a feeder). These scenes have lighting that's easy for the camera's auto-exposure algorithms to interpret, and they are also filled with detail for the autofocus to latch on to.

Neither of these exists with close-up views of an eclipse. There are apps, however, that let you control the smartphone's auto focus and exposure. One of the most promising is called Solar Snap, available for both iPhones and Android phones from eclipseglasses.com. It's actually a kit that includes solar-filter glasses (for your eyes) and small solar filters for your phone that attach with Velcro. The app lets you control the zoom, focus, and exposure of the smartphone's camera. In any case, if you are set on trying to shoot close-ups of the eclipse with a smartphone, get the necessary accessories and camera-control apps well before the event and learn to use them by shooting the Moon or Sun (with an appropriate solar filter) ahead of time.

Moving Pictures

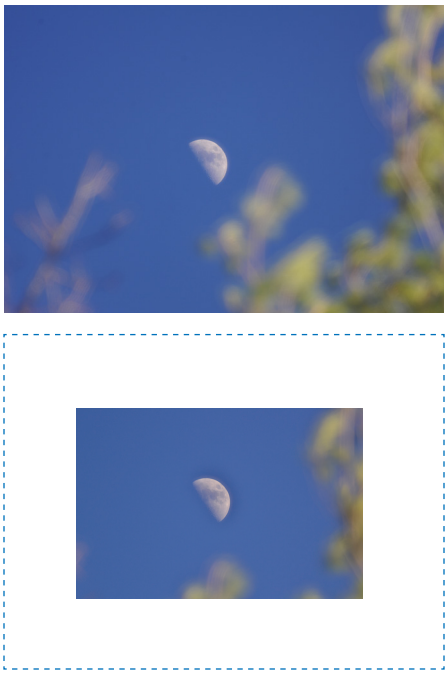
Video brings the added dimensions of motion and sound to eclipse photography, and both can be extraordinarily dramatic. Even years later, playing back an eclipse video and hearing the rising excitement of people around you as you see the shrinking crescent give way to the corona can bring back memories of an eclipse unlike any that a still photograph ever will. But you'll also be paying a price for the advantages that video brings. Views of the corona captured with consumer-grade video cameras or smartphones will lack the dynamic range and overall detail recorded with even relatively simple still photography.

If you do shoot video, most of the same rules mentioned above for still photography will also apply. You'll need a stable tripod or other support, especially if you use a camera that can zoom in for close-ups. Additionally, a fluid head for your tripod is also necessary to smoothly pan around a surrounding crowd of observers.

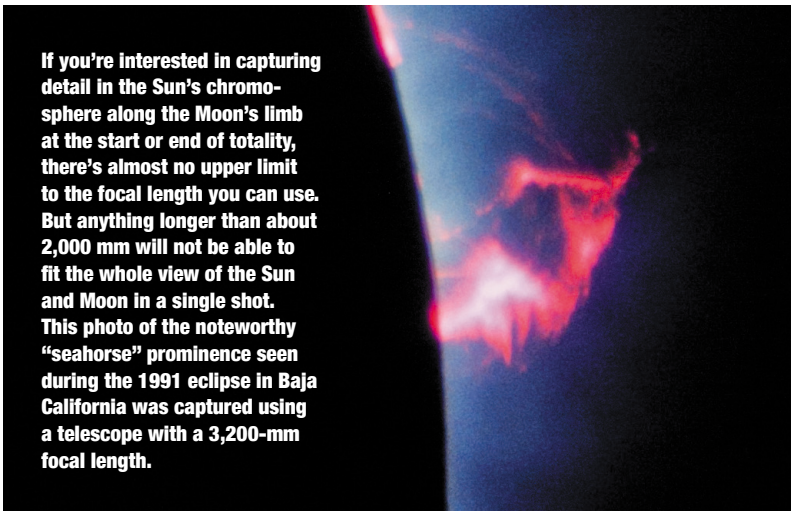
And you should heed my earlier advice about having a safe solar filter mounted in a way that can be quickly and easily removed and replaced. The most dramatic moments to be captured on video are the fleeting seconds at the beginning and end of totality as the Sun's shrinking crescent gives way to Baily's Beads and the diamond ring. You don't want to lose them fumbling with the filter.

Regardless of how you record the eclipse, the best advice is always to become familiar and comfortable with your equipment, practice using it, and create a solid plan well beforehand. That way you'll be able to enjoy the event for years to come with treasured memories and good photographs.

Veteran eclipse chaser Dennis di Cicco still claims that someday there will be a total solar eclipse that he simply watches and doesn't photograph.



Regardless of the camera body it's attached to, the 420-mm lens used for these shots produces an image of the Moon the same size on the camera's sensor (3.8 mm in this case). But the small sensor on the camera with a 1.5× crop factor *(above)* captures a smaller field of view than the full-frame camera *(top)*, making it seem like it's a more powerful telephoto — which it really isn't.



If you're interested in capturing detail in the Sun's chromosphere along the Moon's limb at the start or end of totality, there's almost no upper limit to the focal length you can use. But anything longer than about 2,000 mm will not be able to fit the whole view of the Sun and Moon in a single shot. This photo of the noteworthy "seahorse" prominence seen during the 1991 eclipse in Baja California was captured using a telescope with a 3,200-mm focal length.

Lasting only seconds at the beginning and end of totality, the diamond ring is always a challenging event for eclipse photographers. This one was captured with a 1/125-second exposure at ISO 200 and f/7.