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Science AMA Series: I'm Craig DeForest, a solar astrophysicist. I'm here to talk about next week's eclipse: how to view it safely, what to look for, why you should plan to be in the path of totality, and logistics of getting there.

CRAIG_DEFOREST R/SCIENCE

The total solar eclipse on 21-August will be the most attended in American history. I'm prepared to answer questions and discuss eclipse viewing, eclipse safety, the wonder of the event, and last-minute logistics of getting to the path of totality. There's a surprising amount of new science we can get done during eclipses, and eclipse observations are still needed in an era of spaceborne observatories. But the wonder of the event is worth the trip all by itself.
I'm in meetings most of the morning but will begin answering questions in earnest at 1pm EDT.
Edit: Thanks, everyone, for the discussion. I enjoyed answering your questions. I'll check in once more this evening. Happy eclipse viewing!

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TLDR; How can I validate the safety of unknown glasses?

So I got some shade 14 glasses, with the plastic frame (not paper) from Amazon a few weeks ago. Ikadeer was the 'brand' and the listing and glasses had the certification markings all over them.

Recently Amazon sent a notice that they can't validate the certification and refunded and advised that we not use them. It's very difficult to find replacements now.

They seem to be fine, a 50-watt halogen lamp is barely visible, and I've tried them on the sun low in the sky.

How do I validate that these glasses are good?

scirocco

It's hard to know, without specialized equipment. The problem that eclipse glasses solve is a bug in the "wetware" of your eyes. It has primarily to do with raw heat input. Your eyes aren't adapted to extremely high visual contrasts. They *are* adapted to be able to withstand brief exposure to the noonday Sun: your irises close to about 1-2mm diameter in the bright sunlight (like "stopping down" a camera) limiting the amount of sunlight that is focused on the retina. If your eyes are healthy and not artificially dilated, you can look briefly at the midday Sun without long-term harm (just "phosphenes" -- dazzle effects -- that fade after a few minutes). At some point in your life, you have probably already done that.

The problem with an eclipse is that in the gloom of the partial phases, the pupils open up more, to perhaps 6mm diameter in the deep partial phases (90% or higher). Literally TEN TIMES as much sunlight lands on each retinal cell as would if you were staring at the noonday Sun. That is enough to cook the cells quite quickly. The biggest risk is that there's no sensation of pain -- just ordinary "dazzle" phosphenes ... that never go away, leaving a hole in your vision.

There are other effects than heat, too. UV from the Sun can produce sunburn on your retina, just like on your skin. On a dry day at noon at high altitude, it might take as little as a minute of solar exposure to produce sunburn ("UV-induced retinopathy") on your retina. On a hazy day with the Sun low in the sky, it might take many minutes.

The problem with counterfeit glasses is that there's no guarantee that they block UV (so you could get retinal sunburn quite quickly, especially with dilated pupils -- this is the problem with old-style "cheap sunglasses" back in the late 20th century) or IR (which can cause retinal heating and damage). Of the two effects, UV is the more insidious. Even if the glasses protect your eyes from retinal heating, you an still get retinal sunburn from staring through a poorly made lens or film.

There are several other ways to view the eclipse if you don't trust your glasses. I will post those shortly under /u/Doomslayr's question.

Hey Craig! I'm so excited for this eclipse (like always) and want to know the easiest DIY way to view it from home? Edit: without worrying about dangers from looking at the sun etc

Doomslayr

See my answer to /u/scirocco about eclipse glasses and why they're important. Here are some ideas for SAFE eclipse viewing:

- **Use a pinhole camera**, as /u/Gobias_Industries points out. One good method is to use a case box (a half-rack case box for bottled beer is a good size). Rip or cut off the top flaps, leaving a topless box. Tape a piece of white paper inside the box, on one of the smaller inside faces (the ends of the box). Use a pin or other sharp point to poke a hole all the way through the opposite small face. Point the hole directly at the Sun, and look in through where the top of the box used to be. You'll see a small image of the Sun (with a lunar cutout, during partial phases) on the white paper. (Incidentally, the very, very easiest way to get this effect is by finding a tree with dappled shade under it. Each "dapple" is an image of the Sun, formed by accidental pinhole cameras between the leaves of the tree).

- **Use a simple, real projection lens**: Use the same method as the box, but instead of a pinhole, use a lens to focus the sunlight. You can use a magnifying glass or the lens from a cheap pair of dollar-store reading glasses. The dollar-store glasses come with a number that tells you their strength. That number is the reciprocal of the length to form a solar image, in meters. So if you happen to have a pair with a +2 label and a box 1/2 meter long (about 1.5 feet), you can rig up the pinhole camera as above -- but instead of a pinhole, make a bottlecap-sized hole, and tape the dime-store glasses over it. That method works best with weaker lenses. +1 lenses will make an image 1 meter (a little over a yard) away, and the image of the Sun will be about 18mm (2/3 inch) across. +3 lenses will make a very bright, very small image about 1/3 meter (1 foot) away.

- **Use binoculars and a photo tripod to do eyepiece projection**: My favorite way of projecting the solar image is with binoculars. Most people have binoculars or can get their hands on a pair. If you're a photography wonk, or know one, you can access a tripod. Zip-tie or bungee-cord the binoculars to the little platform on the tripod. Get a roughly 1- to 1.5-foot square piece of cardboard or foam, and cut a hole in it the size of one of the objective lenses of the binoculars. Slip the hole over the binoculars, and tape it in place (especially if you're using cardboard). Now, set up the

> tripod on a flat, not-black surface (like a sidewalk) and point it so the binoculars face the Sun. DO NOT LOOK THROUGH THE BINOCULARS!!! When you get it just right, you'll see an out-of-focus solar image in the shadow of the foam or cardboard, on the ground below the tripod. Use the binos' focus knob to bring the image into focus. This method gives you a large, sharp image that many people can view at once. I have used it many times with 7x35 and 10x50 binoculars.

I am a little surprised to hear about the new science that can happen during this event. Can you explain a little?

s-c-i

Eclipses give us a great chance to view the corona in great detail, at high speed. They also allow us to view the corona with the latest technology. Scientists like me (and many, many others) view the whole corona on a daily basis using "coronagraphs" like SOHO/LASCO in space, or like KCOR on Earth. These are telescopes with a small "occulting disk" that provides an artificial eclipse, for continuous viewing of the corona. But ground-based coronagraphs have to fight against the brightness of the sky itself -- which limits how much detail they can record, and how far from the Sun they can measure. Spaceborne coronagraphs have severe engineering constraints: they have to be light and small to fit on a spacecraft, and strong and tough to survive launch. Their cameras have to survive the radiation environment in space. Also, space missions take a loooong time by the standards of Silicon Valley. SOHO is our sole remaining spaceborne coronagraph -- and it was launched in 1995, before the digital camera revolution, using technology from the late 1980s and early 1990s. Cameras get better but space assets stay the same once launched.

There are many groups that are taking cameras to the eclipse, or flying them through the path, to get the best images and spectra possible -- or to test out new technologies that might later be deployed at a permanent observatory or in space.

The High Altitude Observatory is flying a Gulfstream V jet through the eclipse path, to get above the troposphere and make infrared and polarization measurements of the corona. Southwest Research Institute and Southern Research are flying NASA's WB-57 converted bomber jets as high as possible, to get high contrast and avoid atmospheric seeing effects. They hope to observe tiny wave motions in the visible corona, and to characterize the infrared appearance of the corona. Williams College and the University of Hawaii are bringing large arrays of telescopes with various experiments in them. A group led by the National Solar Observatory (Citizen CATE) is collecting long series of images from similar amateur rigs spread along the eclipse path. They hope to observe changes in the corona over the 90 minute period it takes the Moon to cross the whole nation.

I live about 4 hours from the direct eclipse, how different will it be for me?

drewa512

If you're a 4 hour freeway drive away from totality, you'll see about a 90% partial eclipse (90% of the Sun occulted). If there are no clouds, you will see some optical effects -- like "gloomy sunlight" that feels a little odd. (The day will appear normal, but without the strong heat and glare of the Sun.) You'll notice that shadows appear sharper. Near maximum eclipse for you, you *might* be able to pick out four planets lying along a straight line across the Sky -- the plane of the ecliptic, which forms the main shape of our solar system. It's best to be above 95% totality to catch the full view, though.

This is one of the few chances you'll ever get to see the whole inner solar system lain out across the sky like that, and it is quite spectacular.

On the other hand, from the standpoint of the visceral wonder of a total eclipse, 90% is very small

potatoes. The difference has been compared to the difference between kissing someone and marrying that person.

I'm going to be in a plane traveling along the path of the eclipse. Will the eclipse be extended from my perspective?

dick_van_weiner

Yes, some. If you're traveling eastbound in a commercial jet, you should expect your eclipse to be *up to* about 50% longer than it would on the ground, depending on winds aloft and the speed of the jet.

Hello, I have a 2 year old and I'm wondering whether I should let him view this even with glasses on? 2 year olds tend to get fussy and do things like pull glasses off, or maybe view out the side of glasses. Any recommendations for safe viewings for toddlers? Like an indoor vowing area with sufficient protection built into the glass? Planetarium... Etc.

eric_reddit

Very young children are especially at risk to retinal damage, so it's best to go for projection viewing, especially in the very deep partial phases. See my answer to /u/Doomslayr, above, for methods you can use. One answer is to use a pavilion or tent, and project through a hole in that using something like the binocular solution I described. Another is to hang out under a tree and look at the dapples in the shade -- which will mitigate the "ripping off the glasses" problem.

Thanks for being here! Can you tell us about the worries we are hearing about the fake eclipse glasses? What is different about them, what % of eclipse glasses sold are fake, how dangerous are they, and how can consumers tell if theirs are potentially dangerous?

p1percub

Great question! See my answer to /u/scirocco, above. I don't know what percentage of eclipse glasses sold are fake, but the potential danger is real. The biggest problem is that the symptoms of eclipse-induced retinopathy are hard to recognize: your retina doesn't generate pain, so it's not obvious if you're destroying your vision.

I live in Michigan and the 21st is my birthday. What will the visibility be by me I'm in Detroit. Any advice would be appreciated maybe a method to view properly?

sirK3

See my answer to /u/Doomslayr above, for some projection methods that will give you a safe view. You can also visit a hardware store to try to find some eclipse viewing glasses -- though they're getting scarce this close to eclipse day.

Hi Craig! I am an undergrad who spent my summer doing a solar physics REU. I was wondering if you were involved in any of the projects planned for this eclipse, and if so what do you hope to learn/what specifically are you looking at?

briannamator

I'm involved in a group that is flying NASA's WB-57 jets above the troposphere to get a better view. We're looking for signatures of small-scale magnetic energy release in the "mid corona" (more than 1 solar radius above the surface). The jets help us reduce the overall brightness of the sky, and also get us above the turbulence of the troposphere -- so we should be able to *see* wave motions and "small" (Earth-sized) moving jets of material in the corona.

Is the pinhole method that they taught us in school still a viable method to use? Or should it only be viewed with glasses?

thetinymoo

The pinhole method works fine. See my answer to /u/doomslayr, above, for some methods I like better (using a pair of binoculars is my favorite).

Dr. DeForest, thanks for doing the AMA. We're driving down from NY to South Carolina for a family science road trip, and I was wondering if you had any thoughts on how I can explain the sun's corona to my kids (3 and 7)?

rockingme

The corona is the largest, brightest object in the sky -- other than the Sun. The problem is that you can never really see it, because the Sun is so bright. An eclipse is a great chance to see it.

The corona is the Sun's atmosphere. It is very, very hot, and many times larger than the Sun itself. The Sun may *seem* hot, but the surface is only about as hot as the inside of the projector at a movie theater. The corona is about a thousand times hotter than that. Nobody knows why. You can see the corona mostly because it scatters sunlight. Sort of like the air does, so you see blue sky when the Sun is up, but the corona is wrapped around the Sun instead of around the Earth. There isn't much material in the corona. It's many, many times larger than the Sun, which itself is about a million times larger than Earth -- but the whole thing weighs about as much as the water in Lake Michigan.

Around the corona you'll see planets come out. You will be able to see four planets, all lined up across the sky. That is the shape of our solar system. All the planets orbit the Sun in a flat plane, like the surface of a table. An ant on a picnic table would see all the other ants on the table lining up in a straight line (the horizon). Since the planets are all in a flat plane (the "plane of the ecliptic") and we're standing on one, they all line up in the sky.

Hello Mr. DeForest, thanks so much for doing this!

Unfortunately I am unable to view the total solar eclipse due to my location and I don't have the time to drive down to see it. When is the next total solar eclipse going to happen in the United States?

Pokerdude02052

There is another one coming on 8 April 2024, from southwest to northeast. Mark your calendar!

I live near the Portland area, where the eclipse will be about 99.5% total. My parents think that this will be an ideal spot to view the eclipse, but I've heard otherwise from other sources. Is it worth it to drive the hour down to where the eclipse is total? They're saying that it will be the worst traffic jam in Oregon history. I've even heard somewhere on Reddit to anticipate a 72 hour blockage. If I do go, do you think

I would be able to make it to work the next day?

phoibosphoenix

You really want to get down to McMinnville or farther south, to see the *total* eclipse and the corona itself. The traffic will be absolutely horrible, but (A) you don't have that far to go, and (B) if you plan ahead you can avoid the absolute worst. Here in Colorado (where I live) the I-25 corridor is expected to be slammed, with up to 30 hours' worth of maximum-capacity traffic trying to get up to Wyoming in the final 6 hours before the eclipse. I've been pointing out to people here that if they leave at dawn, they likely won't make it through what is normally a 2-3 hour drive.

The best way to drive to the eclipse is to leave as early as possible -- preferably not much later than midnight -- and to have a relaxed attitude about it. So pack food, leave well before dawn, and plan for a daylong outing.

The difference between 99.5% and 100% is very large. It is a once-in-a-lifetime experience (for most of us) to have an eclipse come so close to home. It would be shame to not take full advantage.

[deleted]

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It's hard to test them without specialized equipment. If they're on the NASA list of approved vendors, they're probably OK. See my answer to /u/scirocco for some other methods of projection, to make the solar image visible to more people.

On the instruction manual it says this: "Limited to 3 minutes continuous use, intermittently for several hours."

If I look for 3 minutes, how long would the break need to be to start using them again?

ErickFTG

I would not use a pair of eclipse shades with that instruction.

It sounds like they're trying to prevent retinal sunburn -- perhaps those particular glasses pass UV. We don't know (and can't easily find out). Your vision isn't worth the risk. Use a projection method instead.

Is it worth the drive to make it from 99% to 100% totality? About 30 miles, but I fear the traffic will make it take 5 hours.

ztycoonz

Absolutely. For best results, plan to leave well before dawn, and bring plenty of supplies (including food, water, and a full tank of gas).

I have an adjustable darkness (#9-#13) welding helmet. Will it be safe to view the eclipse using that? It's a slightly older model of this.

j8048188

Yes. If I remember right, #13 is what you want.

I'm late to this AMA, but does anyone want to recommend viewing glasses that:

- Won't interfere overmuch with real glasses that I have to wear
- Provide 100% UV protection, or close enough that they're technically "safe"
- Are priced minimally, *and* don't require one to purchase them in bulk
- By strong preference, can be ordered via Amazon Prime

I figure, surely, given the importance of this event, there are plenty of options that satisfy all these criteria. The wildcard of the bunch is finding one that has been verified to protect adequately.

Fredasa

At this point, supplies of everything are dwindling. The cardboard glasses are fine for going *under* your regular eyeglasses. Others have posted the list of reputable providers.

What kind of logistics advice do you have?

I live about an hour's drive from one of the cities on the edge of the path of totality, and I can't decide whether it's a better idea to take the interstate to that large city, or whether that's likely to be too crowded and I should take smaller/rural roads to a smaller town also in the path.

Chrondeath

I would aim for the smaller town. I would also leave as early as possible. Near many of the urban centers, dawn is too late. It is well worth getting out of the house at midnight to get to the path and find a place to park. Make sure you have a full tank of gas, and plenty of munchies and water with you -- infrastructure will be strained anywhere along the path of totality. (If you're going to a rural area, bring an entrenching tool also...)