But Why: A Podcast for Curious Kids

What is a solar eclipse?

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Jane 00:20
This is But Why: A Podcast for Curious Kids, from Vermont Public. I'm Jane Lindholm. On this show, we take questions from curious kids just like you, and we find interesting people to answer them. On April 8th, 2024, something is happening in the skies over North America: a total solar eclipse. It's being called the Great American Eclipse because the path of the total eclipse cuts across parts of Mexico, almost all the way across the US from west to east, and then into eastern Canada. I think it should be called the Great North American Eclipse, personally, but they're calling it the Treat American Eclipse.

Jane 01:00
What's happening during a solar eclipse is that the moon lines up perfectly between the Earth and the sun to block out our view of the sun. And it creates a shadow on the earth, making it look kind of like nighttime, but just for a couple of minutes. When the moon completely blocks the sun, that's called totality. Parts of the US states of Texas, Oklahoma, Arkansas, Missouri, a teeny sliver of Tennessee, Illinois, a tiny bit of Kentucky, Indiana, Ohio, a really tiny bit of Michigan, Pennsylvania, New York, Vermont, New Hampshire and Maine are all in the path of totality. But even if you're not in the path of totality, if you live in North America, almost all of you will have a chance to see at least a partial eclipse. Today, we're going to learn more about what's happening during a solar eclipse and what you can expect on April 8th. And we're also going to talk about how to watch the eclipse safely. Because you can't just watch it happening with your bare eyes anymore than you would look at the sun on a normal day with your bare eyes. So let's start with the basics.

Jake 02:08
Hello, my name is Jake. I am five years old. And I live in Altoona, Pennsylvania. And my question is, why does the moon sun and earth all line up for an eclipse?

Camila 02:29
Hi, my name is Camila. I live in Duxbury, New York. And my question is, what is a solar eclipse? And why are people going to it?

Frederick 02:39
Hi, my name is Frederick. I'm nine years old. I live in Dallas, Texas. And my question is, what are eclipses and how do they happen?

Jane 02:47
As I mentioned, an eclipse happens when the moon passes between the Earth and the sun and blocks the light of the sun. But to get more details, we talked to Martina Arndt, who's an astrophysicist.

Martina Arndt 02:59
So I study the sky and the stars. And I really focus, actually, on the sun these days. So that makes me a solar physicist.

Jane 03:08
Professor Arndt knows a lot about solar eclipses, and she has even seen a lot of them. So we thought she'd be a great person to help answer your questions.

Martina Arndt 03:17
The basic definition of an eclipse is that one celestial body moves in front of the other one, and, in doing so, blocks some of that object's light, and it eclipses some of that light. And so we have what are called eclipsing binary stars, where you might have two stars that are orbiting around each other. When one when one passes in front of the other, it blocks some of the light. Or there are stars that have exoplanets going around them, and those planets will block out some of the light. And that's how we actually detect a lot of these exoplanets that are being discovered is that there's something moving in front of a star, eclipsing it, and blocking some of the light. And the one that you're sort of referring to, that you are referring to is a total solar eclipse, where we have the moon coming between the sun and the Earth, and blocking this really, really bright star.

Jane 04:12
Right, because you mentioned celestial bodies, and celestial just means up in the sky. And so these are two things that move in front of one another, or one moves in front of the other, and somebody at a third location can see what's happening or see the shadow. So when a solar eclipse happens, for us to see it on Earth, it's the moon moving in front of the sun and blocking the light. And sometimes you get a partial eclipse where you only have a part of the moon blocking the sun because the path is not direct. But on April 8th, for many people, they're going to see totality where the sun is totally blocked. And Nora wants to know:

Nora 04:55
Why do the edges of the sun get so bright in a solar eclipse?

Jane 05:00
Given that the moon is blocking out the entire sun, why do the edges of the sun get so bright? If it's supposedly all blocked out?

Martina Arndt 05:12
Yeah. And I love this question that Nora has. The sun is always bright, okay, and then there's the surface of the sun. And then above that is an atmosphere. Like the Earth has an atmosphere. And the atmosphere is not as dense, which means there's not as many particles smushed together in one place. And, as a result, it's very hard to see unless we block out the sun. And when the moon does block the sun, what we do get to see is a tiny, tiny little bit of the sun's surface, the chromosphere and the photosphere. And that part is really the bright part that I think she's talking about. And it can look

very red. And it's just that that material is denser than the upper atmosphere, which is the one that we're studying.

Jane 06:00
One thing we should probably note even before that question is when we study the Earth and the moon and the sun in school, we learn that the earth is much smaller than the sun, and the moon is even smaller than that. So if the moon is very, very, very small compared to the sun, how can it block out all the light of the sun?

Martina Arndt 06:23
Yeah, so what I do in my classes is I have students hold their thumb up, and try to maybe block out a light bulb. And if you hold the thumb far away, it doesn't do as nice of a job of blocking out the light bulb as if you bring your thumb really close to your eye. And it looks so much bigger, right? And the fact that the sun is so far away, it looks smaller. And because the moon is much closer to us, even though it's small, it looks bigger, and the geometry works out perfectly that we have the moon being essentially looking like the same size as the sun.

Jane 06:58
Okay, so what do we know so far? In a solar eclipse, the moon blocks out the light of the sun, but you can still see the sun's atmosphere radiating out from the shadow created by the moon. Now, not everyone will get to experience this total eclipse. But most people living in North America will see as we said, at least a partial eclipse.

Mark Breen 07:19
But it actually starts out in the Pacific.

Jane 07:21
That's Mark Breen. He's a meteorologist, someone who studies the weather. And he's also the director of a planetarium at the Fairbanks Museum in St. Johnsbury, Vermont. He knows a lot about the path this solar eclipse is going to take.

Mark Breen 07:36
It takes us a few thousand miles before it gets to Mexico. It cuts across northern Mexico and then through Texas, goes through big cities like Indianapolis, then into Cleveland, Buffalo, and then right across northern Vermont.

Jane 07:51
And then slightly into Canada for a little while, as well.

Mark Breen 07:53
Yes, it continues on right into Atlantic Canada.

Jane 07:56

If you live right in the center of that path, you'll get three minutes or more of totality, when the moon is totally covering the sun. If you're on the outer edge of totality, you might only get a minute or even less. And if you're outside the path of totality, you'll see a partial eclipse, which is still pretty cool. Jimmy asks, "Why do eclipses happen very rarely?"

Mark Breen 08:19
So they worked out an average that in any one location, it's about every 400 years.

Jane 08:24
Oh my gosh, every 400 years!

08:26
Yes. But there's a place in Tennessee, where the eclipse in 2017 will basically happen again this year. So they get two eclipses in seven years.

Jane 08:36
Martina Arndt says there are a lot of factors that need to line up for an eclipse to be visible in any one location.

Martina Arndt 08:43
Well, I have good news for Jimmy, because actually, an eclipse happens every month. But I want, I have to clarify this: it happens every month because the moon comes between the sun and the Earth every month, and it casts the shadow. And unfortunately, though, the shadow is, most of the time, either above the Earth or below the Earth. So we'd have to jump really high to try and see it, which we can't do. So what we do is we wait for those two times a year where the moon and the sun and the Earth are lined up so that the shadow from the eclipse falls on the Earth. Okay, now, so that so that says that we should, in principle, have two solar eclipses every year. And sometimes we do. However, just like with this, this conversation, or this example I gave with the thumb, that if the moon is farther away, it looks smaller. And if the moon is closer, it looks bigger. And in fact, the moon isn't always the exact same distance away from us. So we need the perfect combination of the shadow falling on the earth and the moon being the right distance away from us to be able to get a total solar eclipse. And that's why they they feel rare, right, because we need those conditions to happen. But I like to think of the fact that if I could jump really high, I'd get an eclipse every month.

Martina Arndt 09:57
Right, well, and then you also have to be in the right part of the world at the right time. So a total eclipse could be a once in a lifetime event depending on where you live.

Martina Arndt 10:07
Yes. Or if you have the ability to travel the world like I have you get to travel wherever the eclipse shadow takes you.

Jane 10:16
What happens if there's bad weather or clouds or snow or rain during an eclipse? What do you see?

Martina Arndt 10:23
Well, we can't see the sun. But we can see that when the sun gets covered by--the moon is still covering the sun even though we can't see it. So it still makes the skies darker. And so you will notice, even if it's cloudy, that the skies will darken. And it's an interesting kind of darkness. It's not like middle-of-the-night darkness. But it's a grayish darkness, a dark grey, if that makes any sense.

Jane 10:50
A few of you have questions about animals and eclipses.

Savannah 10:54
Hi, my name is Savannah. I am seven years old, and I live in St. Catharines, Ontario. And my question is, can dogs look at the solar eclipse?

Martina Arndt 11:04
I've seen animals respond to the change in light in different ways. My favorite was when I was in Zambia, one of the eclipses, there were some hippos near where we were set up. And the hippos, because it's so hot out ,like during the day, they like to sit and sleep while they they lay down and they sleep. And they relax. And they tend to do more things at night. And when it got dark during the eclipse, they started to kind of get up and move around. And they they were like, "Oh, it's not so hot anymore." Because you see you also find out that the temperature goes down. So you'll see the skies get darker. But you'll also feel a difference in temperature by quite a few degrees actually.

Charlotte 11:45
Hello, my name is Charlotte. I am seven years old. I live in Scottsdale, Arizona, and my question is do animals hurt their eyes on the solar eclipse?

Martina Arndt 11:56
Charlotte, I hope these animals listened to me. They need to be wearing eclipse glasses during the one and a half hours before the sun is totally covered and for the one and a half hours after the sun is totally covered. Because that's the time when you can hurt your eyes. And so yes, animals could. I don't think that many of them look up though.

Jane 12:17
Or if they do and it starts to be a little too much, then they look down.

Martina Arndt 12:21
If it starts to hurt, then they look down. Sure. I mean, I have to be tell the truth. I've sometimes looked at the sun by accident. You know if I'm, I'm take off my sunglasses or something and I look up to see if I can see a bird that's going by or where that helicopter might be coming from and I look at the sun and I know how uncomfortable it is. And I'm sure if it's ever happened to any of the listeners, they know how uncomfortable it is. And the animals, you're absolutely right, are probably smart enough to say no, that's not good for me, I'm not going to do it anymore.

Jane 12:51
We're animals too, of course. And we should definitely not be looking at the sun, even during an eclipse, without taking safety precautions. Let me say that very clearly: you should never look at a partially eclipsed sun without protection for your eyes. Looking at a partial eclipse without eye protection can lead to permanent and serious eye damage. And you may not know it's happening because your eyes won't necessarily feel pain. So if you can get a pair of solar eclipse glasses, you could put those on and then you can look up at the sun safely. Maybe your school or local library or community organization has some solar eclipse glasses. And there may be a group nearby that has special telescopes with solar filters that are safe to look through. But any camera or binoculars or telescope or even cell phone that you want to take pictures of or look at the eclipse through needs to have a solar filter, too. Now if you're in the path of totality, and the sun is fully covered, meaning there is no light showing, just that corona we talked about, then it is safe to remove your eclipse glasses and take a brief look. You might even see that corona, the outer atmosphere of the sun. But before you take off your eclipse glasses, check in with an adult and make sure they tell you it's safe to do so. Now if you don't have a pair of eclipse glasses, that doesn't mean you're out of luck for viewing the eclipse. It just might mean that you have to look down instead of up in order to see it.

Martina Arndt 14:22
You can find things around your house that have little holes in them. So I'm thinking like a cracker that might have holes in it or the pasta strainer that your parents might use to strain their pasta. There's lots of little holes in there. If you take something that has a small, lots of small holes on it, and if you don't have any of that than take a pin and break, poke some holes through a piece of paper. And you look, you put that out there so that the sky is above the paper and you look below the paper and look below the colander and you will see little tiny images of partial solar eclipses and you can take a picture of that If you want it to. But it's a nice safe way to do it because you're looking down at the ground and not up at the sky. And another thing if you don't have any of those things, maybe there are trees near you because trees when they have leaves and an April, hopefully there'll be some trees with leaves, those leaves overlap and they make little tiny pinhole cameras just naturally. And so if you look under a tree, you should see lots of little partial solar eclipses on the ground, dancing around as the leaves move, and it's it can be really beautiful.

Jane 15:29
Coming up, we'll learn more about the corona, the sun's atmosphere that's still visible during a total solar eclipse.

BREAK 15:36
BREAK

Jane 15:37
This is But Why: A Podcast for Curious Kids. I'm Jane Lindholm and today we're learning about solar eclipses, how they happen and why people are so excited about the Great American Eclipse on April 8th. Scientists are especially excited about solar eclipses because it's a chance for them to observe the atmosphere of the sun, which is tough to do normally. That's one of the things Martina Arndt studies.

Martina Arndt 16:02
The sun itself has two main parts. It has the sphere, the ball itself, which is the part that you might see at sunrise or sunset in the clouds. And above that we have an atmosphere like the Earth has an atmosphere. And this atmosphere is called the corona, on the sun. And it's a lot fainter than the surface of the sun. And if we want to study this corona, this upper atmosphere, we have to block out the surface of the sun because we have some interesting problems we're trying to solve. The corona is hotter than the surface of the sun. The sun is spitting out particles in two categories of speeds: we got fast, and we've got slow, and we don't know why that happens. And so there's a lot of scientists working to figure out the answers to these questions. And they come up with models and ideas. And anytime you have a theory like this, you maybe do some computer simulations, you do the math, and you say, "Okay, I think this is the explanation." And then what we need to do is to get data to test this hypothesis and see how close we are. And then if it's not right, then we go back and do it again. So the only way to get data from the corona is during a total solar eclipse, because the sun is so so so bright, okay, that we can get data close to the solar surface and further away. Now, there are some instruments in space that take, they have their own version of their thumb, and they block out the sun, right. But even space images don't get us enough information about what's happening between the surface of the sun and the atmosphere of the sun, that we need that information in that crucial zone between the two.

Martina Arndt 17:55
Why is it important to learn these things about the sun?

Martina Arndt 17:58
Well, I just like learning, personally. I think it's a wonderful thing to try and understand the world around us. So there's there's two ways to answer this. I would say that if we want to understand the universe around us and how things work, we have a sun, which is a star literally in our backyard, that we can take data from on a regular basis. And if we can understand our star, then we can understand what happens in other places. And I just think that's human nature to try and understand the universe in which we live. That being said, there are also reasons for us to understand the sun because it interacts with the earth that affects us. I mean, we've got sunburns, we've got, you know, other things that that that the sun does for us, and does to us. One of them is that all these particles that are being sent out by the wind are interacting with the Earth's magnet, Earth's magnetic field. And that's how we get the northern lights and the southern lights. And so to understand that. Those particles can also knock out power grids and so then our TVs wouldn't work and you know, all this, that that would be bad. And then there's another component to that, if we can predict when the sun is going to be sending us a large quantity of charged particles, it allows us the opportunity to protect any satellites. You know, we can have them turn their back on the sun for a little bit. It also is a way to, you know, alert maybe astronauts who are up in space that a big storm is coming. And I think also the more we understand it'll help us kind of be prepared for let's say if we ever do make it to Mars, right to be able to go to Mars and understand and predict what may be happening when the sun does a particular something.

Jane 19:48
Well, that has me convinced. Martina Arndt has already seen a dozen total eclipses around the world all as part of her work. But for most of us, a total eclipse is a once-in-a-lifetime experience. That's been true throughout human history. And throughout human history, we've been trying to make sense of

what's happening in the sky. Before people understood the science of eclipses, they attached many different meanings and myths to them. Thomas Hockey is a Professor of Astronomy at the University of Northern Iowa, and the author of a book called America's First Eclipse Chasers. We asked him to tell us a little bit about some of the earliest written records of humans experiencing eclipses.

Thomas Hockey 20:32
We find this in civilizations all over the world, trying to keep track of eclipses. Mesopotamia and China, India, the Mayans and other cultures. The goal was always the same to try to find some pattern in eclipses.

Jane 20:55
You're saying early civilizations realized this was likely not a one time event, or something that they wanted to make sure that they could be prepared for, should it happen again.

Thomas Hockey 21:06
Exactly. If you, over many centuries, kept track of them, you might have a chance of, at least if not predicting, at least saying when an eclipse might occur, and then take what you consider to be necessary steps which involve certain rites, loud noises to scare whatever was taking the eclipse away. Or in the case of the Babylonians, who thought this was an omen directed at the king, they would pull someone off the street, put him on the throne, crown on his head, hide the real king. And during that eclipse peril, it was this "nobody" who was the pretend King, and supposedly would take whatever bad effect the Eclipse add in store.

Jane 22:05
Tell us a little bit about some of the other associations that civilizations had with eclipses before we had the science to know what was actually happening.

Thomas Hockey 22:16
It often involved something...China, for instance, a dragon devouring the sun. The partial eclipse before a total eclipse kind of looks like someone has taken a bite out of the sun. And the eclipses, of course would end. They would, eventually, the monster would disgorge the sun, but there was no guarantee of that. A fire, after all, will not necessarily rekindle itself. So I'm sure there was a great deal of relief when whatever and the sun let go.

Jane 23:05
How did we start to gain the knowledge about what's actually happening scientifically and astronomically during an eclipse?

Thomas Hockey 23:13
While many civilizations reached the point of at least being able to anticipate possible eclipse, it was the Greeks who had a theory of science that probably got closest. It involved great shells spinning about the Earth with the various bodies involved mounted on them. The idea is they were made of crystals, so you can see through them. Or some preferred wheel-on-wheel arrangement, kind of like a

carnival ride. Such systems did do a fair job of predicting where things were in the sky under normal times. Less successful in the exact alignment that was necessary to predict an actual solar eclipse.

Jane 24:11
You know, today, we teach our children that this is the the moon moving in between the Earth and the sun and just temporarily blocking out the light of the sun because of the specific place the moon is at this moment. And there's a lot of hard facts, hard science, that we use to describe language around the solar eclipse. And yet, there are also still cultural significances to a solar eclipse that go beyond just what we know about the path of the Earth and the moon. What is the central gut feeling that people have when they see this remarkable thing?

Thomas Hockey 24:52
We still have within us I think, that primal feeling about eclipses from as long as we have those records, going on for millennia. And that is a not just, "Oh, that's interesting in the sky," but it evokes a very visceral all-body feeling that is difficult to describe. And I'm always not successful in telling people about that. I end up just saying "Yeah, you gotta go you gotta out one of these." And then then you'll see why people's interaction with total solar eclipses since the beginning as been strong.

Jane 25:48
That's true of Martina Arndt Remember how I said she has chased a whole bunch of eclipses? She says the feeling of wonder at sea and one doesn't go away. But having good weather certainly helps the experience.

Martina Arndt 26:02
I have traveled to 12 and it's brought me to six of the seven continents on the on the earth. The only one I haven't been to is Antarctica. And I would say of those 12 eclipses, we had good weather for probably half of them. When we were in Australia, we thought we had clear skies. But then because the sun was getting covered and we were by the ocean, it was almost like a little weather change instantaneously happened. And then it was windy and raining and blowing and we didn't get to see anything. And at my first eclipse in Mongolia, it snowed. Here we went, we traveled halfway around the world with all of this equipment, and we set up and it was snowing, and we couldn't see anything. But then, you know, in 2017, in the last great American eclipse that came across the United States in the other way, we had beautiful clear weather and it was perfect.

Jane 26:52
Given that you've seen so many of these. Is it still exciting in a visceral human way to see a total eclipse?

Martina Arndt 27:01
Yes, it absolutely is. And I'll tell you that people have a variety of responses to these sorts of events. Some people really are just overwhelmed. Some people are, some people are scared. And for me, I have to be honest with you, I see it as beautiful but I have a job to do when I'm there, which is taking the data. And I usually stand there and go, "Oh my goodness, we got it right. We were in the right place

at the right time." And it just gives me a real appreciation for how we understand, already, so much about nature that we can predict where to stand and it works. It's pretty amazing.

Jane 27:36
I hope those of you in the path of totality get to see this amazing sight. Get your eclipse glasses ready or make a pinhole viewer. We have a video up on our But Why YouTube channel and on our Instagram page, showing you how to make one. Even if you're outside the path of totality, you may be able to see a partial eclipse. So have an adult help you look up your location and find out what you'll see. And if you go to butwhykids.org or vermontpublic.org, you can listen to me broadcast live during the solar eclipse, from three to 4pm Eastern Time on April 8. That's it for today. Thanks to Martina Arndt, Mark Breen and Thomas Hockey for teaching us about eclipses. As always, if you have a question about anything, have an adult record it. It's easy to do on a smartphone using a voice memo or voice recording app. Then your adult can email the question to questions@butwhykids.org We can't answer every question we get, but we love hearing from you. But Why is produced by Melody Bodette, Kianna Haskin and me, Jane Lindholm, at Vermont Public. We are distributed by PRX. Our theme music is by Luke Reynolds. Special thanks this week to David Littlefield, Joey Palumbo, Kaylee Mumford and Kyle Ambusk. We'll be back in two weeks with an all new episode. Until then, stay curious!