Dr. Andrew Layden—Professor of Physics and Astronomy

Professor in the physics and astronomy department, Dr. Andrew Layden explains the different forms of eclipses during the first half of this interview. Following this, Dr. Layden discusses the experience of witnessing eclipses while travelling, and the importance of wearing the proper viewing glasses. This interview is concluded by exploring the scientific explanation of this phenomenon, and the changes of eclipse predictions throughout history.

Interviewee: Dr. Andrew Layden (AL)
Interviewers: Samantha Davis (SD), Peter Limbert (PL), Nicolas Urso (NU)
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[START OF INTERVIEW]
SD: [00:00:00] So my name is Samantha Davis and I am a 2nd year graduate student in history.

PL: [00:00:05] I'm Peter Limbert, I'm a 1st year graduate student in history here at BGSU [Bowling Green State University].

NU: [00:00:09] I'm Nicholas Hartzell. I'm technically a 5th year here at BGSU [Bowling Green State University] and my major is International Studies.

PL: [00:00:15] Great. Would you like to introduce yourself for us?

AL: [00:00:17] Sure. I'm Andy Layden. I'm a professor in the physics and astronomy department. I specialize in astronomy, and I'm excited about the upcoming eclipse. So I thank you for inviting me here to talk a little bit.

PL: [00:00:30] Absolutely. So I guess we're going to just launch right into this. So one of the first things we have to do. Could you briefly define what an eclipse is?

AL: [00:00:38] Sure, sure. Well there's several types of eclipses actually. The primary classes are lunar eclipses and solar eclipses. When the Moon's orbit around the Earth carries it exactly in line with the Earth and the sun, and into the Earth's shadow away from the sun, we get what's called a lunar eclipse. And they're pretty common and pretty easy to see. They happen at

nighttime, and you pretty much just have to go outside and look up when you're told that one is occurring and you'll see the moon go dark, or maybe even kind of a darkish red color. It's not super dramatic. And it happens slowly. And they they happen fairly frequently. So maybe once a year or so from Bowling Green. The other type of eclipse is a solar eclipse. And that's when the moon's orbit carries it exactly between the sun and the Earth. And the moon's shadow gets cast onto the Earth somewhere. The moon's smaller so it doesn't completely cover the Earth. The Earth's shadow during a lunar eclipse completely covers the moon, and it can all go dark. But because the moon is smaller, its shadow during a solar eclipse only makes a small mark on the Earth. And in fact, it makes kind of 2 shadows.

AL: [00:01:50] The people who on the earth who are in the moon's outer shadow, which is called the penumbra. When they look up, they see the moon partially covering the sun. And that's what we call a partial solar eclipse. And you may not even notice this is happening because it only knocks out 10, 20, 30, 40% of the sun's light. So the Earth seems pretty normal. If you didn't know it was happening and look up, you wouldn't notice that there was a bite missing out of the the disk of the sun. But in order to look up, you don't want to damage your eyes. So, during a partial solar eclipse, you need to have on the eclipse filter glasses to protect your eyes. Now, if you're lucky enough to be in the moon's inner shadow, the deep dark shadow called the umbra. If you're there and you look up, you will see the moon completely covering the sun. And so you'll see a profoundly black circle surrounded by the softly glowing outer atmosphere of the sun, which is called the corona. This is a rare and really beautiful natural phenomenon, and we will get to see one of these total solar eclipses in Bowling Green on April 8th of 2024, weather permitting. I mean, it'll happen, but we may not see it if the clouds are in the way to block it and we won't see another total solar eclipse here in BG until, well, for another 99 years. So, we hope that the sky is going to be clear, and we hope that we can enjoy it in its full glory.

SD: [00:03:29] Yes, definitely. Yeah, that would be a big bummer if we couldn't actually see it this time for sure. Speaking of that, could you possibly describe the experience of seeing an eclipse?

AL: [00:03:39] Sure, sure. So I mentioned a partial solar eclipse and a total solar eclipse. Even if you're in the path of the total solar eclipse, it starts out maybe an hour or two before the total solar eclipse occurs, with the sun and the moon slowly moving across as it falls. As the moon follows its orbit, it slowly starts to cover a little bit, and then a little bit more and a little bit more. And again, if you don't know what's happening, you probably won't notice it because it takes about an hour and 15 minutes for the moon to to cover a significant portion of the sun and for the

the sky to start appearing darker. And at some point, birds start chirping like it's morning time. And sometimes if you're near a farm, the cows will decide it's nighttime and they go back to the barn, right? So everybody starts going into night mode. But you should still be wearing your partial solar eclipse glasses, because any time you can see even just a sliver of the bright surface of the sun, it's enough brightness to damage your eyes. But as the moon keeps moving, eventually it will totally cover the surface of the sun. And that's where you pull off your eclipse glasses because you don't want to miss the show. The April 8th eclipse here in Bowling Green will last just over 3 minutes, so you know, there's enough time to to sit and watch with your glasses off. What you see then, is that profound black circle of the moon and the softly glowing corona around it. Oftentimes you can see sort of streamer shapes in the gas that is the corona.

AL: [00:05:19] The magnetic fields of the sun kind of sculpt the the gas into streamer shapes at different, different eclipses. Everyone looks a little bit different this way. So we're eager to see what this eclipse looks like. Again. It's dark out. And so if you look up at the sky, the sky has stopped being blue. It's now kind of twilight black. You can often see planets and some bright stars. It's that dark out, kind of like deep into twilight, not total black. Oftentimes if you look down by the horizon, you can see sort of colors around the horizon, sort of dusky colors around the horizon. And so it's just it's a very serene and beautiful eclipse. It happens in total silence, unless you happen to be with a crowd. And I encourage you to be with a crowd because it's, it's it's kind of an emotional experience for a lot of people. And so it's interesting to hear how other people react, you know, their cheers and their voices, but it only lasts about three minutes. So if you want to take a photo, you've got to be ready to go. If you want to just sit back in a lawn chair and enjoy the show, you know, drink it in, because after that 3 minutes, the moon is going to continue moving and a bright sliver of the sun will appear. And you want to get your eclipse glasses back on as much as you want to keep watching, you got to get your eclipse glasses back on. And in those moments, right when the moon is about to cover the sun, we get some neat effects.

AL: [00:06:51] One is called the diamond ring effect. And what that is, is, I mean, we think of the moon as being a perfect sphere, a perfect black circle on the sky. But really it's got mountains and valleys as well. And so as it's just about to cover up the last sliver of the sun, sometimes in some eclipses, for some observers, you get to see light shining through one of those valleys, and so you get a bright glow of this bright surface of the sun with just sort of a ring around the. Rest. Occasionally you get a few valleys and you get a few of these bright spots, and that's called baily's beads. So there's some neat effects, and it's hard to predict what any single observer will see, so it's always sort of a mystery. It's always sort of part of the expectation of, of an eclipse.

But as the moon retreats, you might get that diamond ring, you might get that baily's bead effect, but then you get the sliver of the sun getting bigger and bigger as the moon continues on. It's smoothly in its orbit, and over the next hour and 15 minutes or so, it undoes what it did. The cookie bite gets smaller and smaller, and after about 2.5 hours total duration, the eclipse sequence is done. Most of that time you're wearing your glasses, but in that 3 minutes of totality, pull them off and see the glory of the total solar eclipse. Once in a lifetime event for people who don't travel.

SD: [00:08:19] Definitely.

AL: [00:08:20] People who stay home. And we get to stay home. And the eclipse comes to us in April.

SD: [00:08:25] Yes, I cannot wait for that.

PL: [00:08:28] And have you ever traveled to see to witness an eclipse yourself?

AL: [00:08:31] I have yeah, yeah. So I've been to 3 eclipses in the past, and because I'm an astronomer, you know, I'm interested in and aware of these things. And also I happen to be in places like sometimes an astronomy conference is scheduled when and where an eclipse is happening. So in 1999 there was an astronomy conference in Budapest, Hungary. And I went to that conference. And, you know, we took an afternoon out of giving talks and sharing astronomy, astronomical data and all, got in busses and went off to a field, you know, somewhere in rural Hungary and watched a solar eclipse. And that was a great experience because I got to watch that one with astronomers. Before that, in the in the mid 90s, mid early 90s, I was working at an observatory in Chile and an eclipse was passing through the north part of Chile. So I had to take a flight for that one up to a little town called Iquique on the coast, and I literally decided at the last minute to do that. I booked my flight the day of or the day before the eclipse. I had no hotel reservations, I had nothing going on. So I just, I walked off the plane and I found a hotel. And as I was checking in, it turns out that the pilot of my plane was checking in too, and he said, ‘hey, why don't you come with me? I've rented a car and I'm going to drive from sea level, where it's likely to be foggy up into the Altiplano.’

AL: [00:10:06] So this is 14,000 feet above sea level. It's the plane, the high plane of Chile. And so this is like, you know, Pikes Peak. It's the highest mountains in Colorado, but it's the flat plane in Chile. So we got in the car at about 4 a.m. and started zigzagging up the coast into the

Altiplano. And it turned out it was beautiful and clear up there. And so we were on this stark plane, the desert plane with essentially nothing growing. It never rains there with volcanic mountains that go up to 20,000 feet. This is the high cordillera of the Andes around us. One of the volcanoes is actually smoking a little bit, and it had snow on the cap. And so that was a very different experience. But the, you know, the solar eclipse, the beautiful, serene experience was similar. And then the most recent one was 2017 when it was the first day of classes here at Bowling Green. But I said 'nope!', and I drove down to Tennessee into the path of totality and saw that one as well. And I was lucky enough so that in all three cases, it was a clear day and I got the full experience.

SD: [00:11:23] So that's amazing. Yeah. Wow. Three eclipses. That's got to be more than most.

AL: [00:11:27] More than most. Yeah I care. And so I travel to the eclipses. This time the eclipse comes to me.

SD: [00:11:34] Beautiful. I was wondering if maybe you could speak a little bit to how scientific knowledge about eclipses has changed over time.

AL: [00:11:42] Yeah, so. Time, history. Right? The earliest sort of eclipse knowledge we have, I think, were the, the earliest attempts at predicting when an eclipse might be, may have been built around Stonehenge. Some people this is not a certainty, but some people think the arrangement of the stones, and in particular some of the holes that are left behind where they had dug posts into the ground, were markers for where the sun was at different times of the year, the solstices and the equinoxes. And there were. Also, perhaps some people interpret some of the holes to indicate markers where you could move a stone from day to day and keep track of the lunar cycle, and thereby predict when the sun and the moon would come into alignment.

SD: [00:12:40] Oh, wow.

AL: [00:12:41] There's no user's manual left behind. There was not writing at that time. And so this is a sort of an interpretation that Archeoastronomers have put together and thrown out there as a possibility, but nobody knows for sure. But as time went on and people gathered more information and more experience with this sort of profound phenomenon, they got better at tracking when past eclipses had occurred, keeping records, and then that allowed them to see the cycles involved in the Moon's orbit and the Earth's orbit around the sun, and gave them increasing ability to predict when eclipses would occur.

AL: [00:13:22] And so now, when we think about predicting eclipses, right? We think about when and where they're going to happen, what the track along the ground is looking like. If you've seen one of these maps with an eclipse track showing where you need to be in order to experience totality, knowing where that is depends on knowing the size of the earth, the size of the moon, the size of the sun, their exact shape. Not just, let's say, their spheres, but you know the Earth is a little bit squashed. The sun is a little bit squashed as well. We need to know their orientation of their orbits. How does the moon's orbit go around and the exact size and even how fast the Earth rotates on its axis. So there's a lot of scientific observation that goes into measuring those things, those scientific facts. And once we have those scientific facts well established, we can combine them mathematically. Nowadays, we use a computer model to combine them and predict where that moon's shadow will fall and how it's going to move, and where it will be at different times across the Earth's surface. And to me, the fascinating part of this is we know all these facts, all these properties, well enough to be able to predict where the eclipse will be to a few seconds of time and a few kilometers of space.

AL: [00:14:51] So the eclipse tracks are drawn accurately to, you know, you're in Toledo, you've got a couple kilometers, and if you go north more than a few kilometers, you're going to be out of the track, you know? So we know we can predict it that well. But we're getting better, too. With every eclipse, we know where the edges of the eclipse are and what time it was. And that helps us refine all those scientific facts and make our next prediction better. It also means that we can predict forward into the future better not just next year or ten years from now, but 100 or perhaps even 1000 years. The farther we go into the future, the more the uncertainties build up and the less precise we can be in our prediction. But for historians, more interesting is going backwards, and we can now go backwards hundreds and even potentially thousands of years to perhaps even help date historical events based on if an eclipse was reported, you know, ten days before or a year and a half before. It helps us pin down the historic dates.

SD: [00:15:57] Wow. So you can use the prediction method to go backwards?

AL: [00:16:00] Yes.

SD: [00:16:00] Backwards or forwards? Crazy.

AL: [00:16:02] Yep, yep, yep. Kind of run the model forward to make a forward eclipse and run the model backward in time to make a historical prediction. Wow.

PL: [00:16:12] Well then tying into that. So we've talked about the scientific ways of understanding eclipses. And those are mostly sort of based in Western science and sort of the established, you know, system of knowledge. But how have alternative means of knowledge sort of either challenged the traditional Western narrative of astronomy or enhanced it in certain cases?

AL: [00:16:38] Yeah, that's an interesting question, and I'm not sure I have an answer. Well, the answer I have an answer, sort of from my perspective as being one of these Western science people. Right. I love eclipses for their natural beauty, and that's why I travel to see them when I can. And, you know, that sort of beauty of nature is what got me interested in being an astronomer in the first place. The beauty of the nighttime sky, and the challenge of picking out constellations and looking at planets with a small telescope and things like that, that sort of appreciation of natural beauty. I also like to travel to interesting places to the mountains in Chile, because I love. The natural beauty of mountains and the seacoast and and all these places that I get to travel. And so, you know, I think beauty is something that everybody has in common. And so I'm not sure I can speak for or even very well to other ways of viewing the universe. But I do remember there's a great, a great video that you can see on YouTube came out after the 2017 eclipse.

AL: [00:18:00] It was NPR. National Public Radio produced this. It's about a seven minute video, but it talks to lots of people about their experiences, and it shows a lot of people, Native Americans, for example, experiencing the eclipse from their historical and cultural viewpoint as part of the great beauty of nature. It showed a Roman Catholic priest talking about the beauty of God and the beauty of God's creation. And why would this happen just on its own? His argument was God must have created the moon and the earth and put them at the right distance from the sun to create the beauty of eclipses for us to enjoy. So that's a different perspective, and I'm sure there's dozens of other ones. If you go to different cultures and they all have their merits and their relevance, and they all link us together as humans. And I think it's part of the reason why I would encourage everybody to be with a crowd during the upcoming eclipse, because you get to experience your viewpoint, and you may get some insights into other people's viewpoint of what this all means. Why is it so beautiful?

SD: [00:19:20] Have you seen any really interesting reactions from people when you've been watching eclipses?

AL: [00:19:27] Yeah, usually it's ‘oooh’, when the totality happens and ‘ahhh’ when it ends. But a lot of excitement. And one of the neat things that people may not realize is going to happen is during the partial phases. This is before and after a total solar eclipse, or even just a partial solar eclipse like is happening in October of 2023. When the sun appears as a crescent, when the moon is taking a big black cookie bite out of the sun's bright surface. The light that shines down through trees, for example, through the gaps in the leaves, usually that makes little round circles. And we're so used to it we don't even realize that that's a pinhole image of the sun and all those little dapples on the ground are little images of the sun, but when it's a partial eclipse, they all become little crescents, and they get bigger and smaller as the crescent up in the sky gets bigger and smaller. And that evokes real shock and surprise because they look going about their business, they look down and something is just very different. Something is wrong here. And it's it's that is always interesting to watch.

SD: [00:20:40] Awesome. Yeah, that is very fascinating. I think I personally I don't have any additional questions. What about you?

PL: [00:20:47] I think that pretty much covers very well everything that we had laid out. Yeah.

SD: [00:20:52] You addressed everything. Very perfect, concise, but like a lot of detail, I don't think we could have asked for anything better, honestly.

AL: [00:21:00] Well, I'm so happy to share my experiences and my thoughts. Yes, it's a great opportunity. Thanks.

[Note: Some tangential discussion from the audio file has been omitted]

[END OF INTERVIEW]