"The Solar Science That Happens During A Total Eclipse" Excerpt Transcript

Excerpt from May 5, 2017 episode of Science Friday.

FLORA LICHTMAN: This is Science Friday. I'm Flora Lichtman. I don't know if you heard, but the place to be on August 21st is Hopkinsville, Kentucky. At exactly 1:24 PM, central time, the sun over Hopkinsville will go dark for exactly two minutes and 45 seconds, and that's because this summer, the continental US will have its first total solar eclipse in about 40 years.

The path of the eclipse will stretch from the coast of Oregon all the way down to South Carolina, and Hopkinsville will have the longest stretch of darkness. And there is a group of solar scientists who are pretty pumped about this, and that's because the eclipse is a chance to learn new things about the sun. So while tens of thousands of people will be staring up at the sky this August, solar scientists will be taking photos and even flying through it.

Let me introduce my guests. Shadia Habbal ball is a professor of astronomy at the University of Hawaii at Manoa in Honolulu, Hawaii, and Matt Penn is an astronomer at the National Solar Observatory and principal investigator of the project Citizen CATE. He's based in Tucson. Welcome to you both.

SHADIA HABBAL: Good morning.

MATT PENN: Yes, hi, Flora. Thanks for the invitation.

LICHTMAN: Yeah, thanks for being on. So let's start with the basics. What do you need, what are the ingredients for a total solar eclipse?

HABBAL: The most important thing is for the moon to totally obscure the disk of the sun, the very bright disk of the sun, so that the outer atmosphere appears. Because the corona, which is the crown of the sun, is a million times fainter than the bright solar disk that we see every day.

PENN: Exactly. During an eclipse, the sunlight is reflecting off the gas in the atmosphere of the sun and into our telescopes. But we really need the moon to block out the bright source so that we can see it.

LICHTMAN: I feel very compelled to see it. Shadia, you are an eclipse chaser yourself.

HABBAL: Yes, I do it for science, yes.

LICHTMAN: How many have you seen?

HABBAL: Well I've tried to see 14 and we were clouded out by four, so I would say I've seen 10 eclipses. I just find it awe-inspiring. It's an incredible sensation when you see the corona appear. I mean, this is what's so fantastic. All of a sudden, everything dims and then you have this gorgeous aura of lights around the sun that just comes out. And you have the impression that the streams are going out to infinity.

LICHTMAN: And what scientific questions are you interested in about the corona?

HABBAL: So what's puzzling about the corona that was discovered in 1869 also from a total solar eclipse, was the fact that it's actually a very hot atmosphere. The surface of the sun is around 6,000 degrees. It has dropped from the center where you have nuclear fusion, from 10 million to the surface of 6,000, and then all of a sudden the temperature starts to rise. Now the difference is--

LICHTMAN: What? Wait, wait, wait.

HABBAL: Yes?

LICHTMAN: It gets hotter...

HABBAL: As you go farther away from the surface.

LICHTMAN: From the surface.

HABBAL: So you go from the center to the surface, it drops, and then it starts to go up again.

LICHTMAN: That's so puzzling.

HABBAL: Yes. So that's the biggest puzzle, and we're still trying to figure out what are the processes that are allowing this gas to, all of a sudden, get hot. Now, mind you, that gas is very, very tenuous. So the density is much, much lower than the surface.

However, because of this very high temperature, you have some elements in the corona, for example. All the elements you find on earth, iron, chromium, nickel, whatever, they have been stripped of a large number of electrons because it's so hot. And as they're losing all these electrons and they get ionized and excited, they emit a certain light of a certain color. So we try to capture this light to be able to get some clues as to what's causing this hot corona.

LICHTMAN: So the light you can trace back from the colors that you pick up to understand better basically what's happening and what chemical processes are happening?

HABBAL: Yes, we try to do that.

LICHTMAN: Matt, tell me about Citizen CATE.

PENN: Oh, yeah. So Citizen CATE is the Citizen Continental America Telescopic Eclipse Experiment, and so now you see why we call it CATE. But the idea is to spread identical telescopes across the entire continent and during the eclipse to take data to look at some science questions. We have volunteers across the country, and they range from middle schoolers through high school up to retired solar physicists who are going to operate the equipment. And then a key part of the experiment is that after the eclipse is over, the various groups get to keep their equipment and continue on with other astronomy projects using that in the future.

LICHTMAN: And what do you want them to look for?

PENN: So the corona is a mystery, as Shadia was mentioning. One thing that we think as we're going to see in our data are these polar plumes. So above the north and the south poles of the sun, we expect to see these really thin threads of gas which are constrained by magnetic fields.

So what we know is happening from our observations from space and from the ground is that at the bottom of these plumes, the gas is not really moving very much, but at the top of these plumes, about two solar radii, we know that the gas is moving about 60 miles per second. It's really flying. This is part of the solar wind. This is a flux of particles that comes from the sun. So one of our goals is to understand how the solar wind is accelerated, to get some basic understanding about how we can then predict solar weather better, or space weather better.

LICHTMAN: Shadia, can you study the sun by simulating a solar eclipse in the lab could you take a telescope and block out the sun?

HABBAL: Oh, yes.

LICHTMAN: --And look at the corona that way?

HABBAL: Yes, yes, of course you do. And this is what's done in most space-based telescopes that look at the sun and the visible part of the spectrum, those parts that we see with our eye. But the difference between those and the total solar eclipse is that this blocker that they use, which is a man-made blocker, is fairly small, and then it doesn't-- see, the beauty of the eclipses is you start to look at the corona from the solar surface out to several, several solar radii. With a man-made occulter, you are limited to the distance range that you can cover. So sometimes, you lose details that you can only see during a total solar eclipse.

LICHTMAN: I'd like to thank both of you, Shadia Habbal a professor of astronomy at the University of Hawaii at Manoa in Honolulu, and Matt Penn is an astronomer at the National Solar Observatory and principal investigator of the project at Citizen CATE.