Studying total solar eclipse in Dallas could benefit radio, GPS devices, expert says

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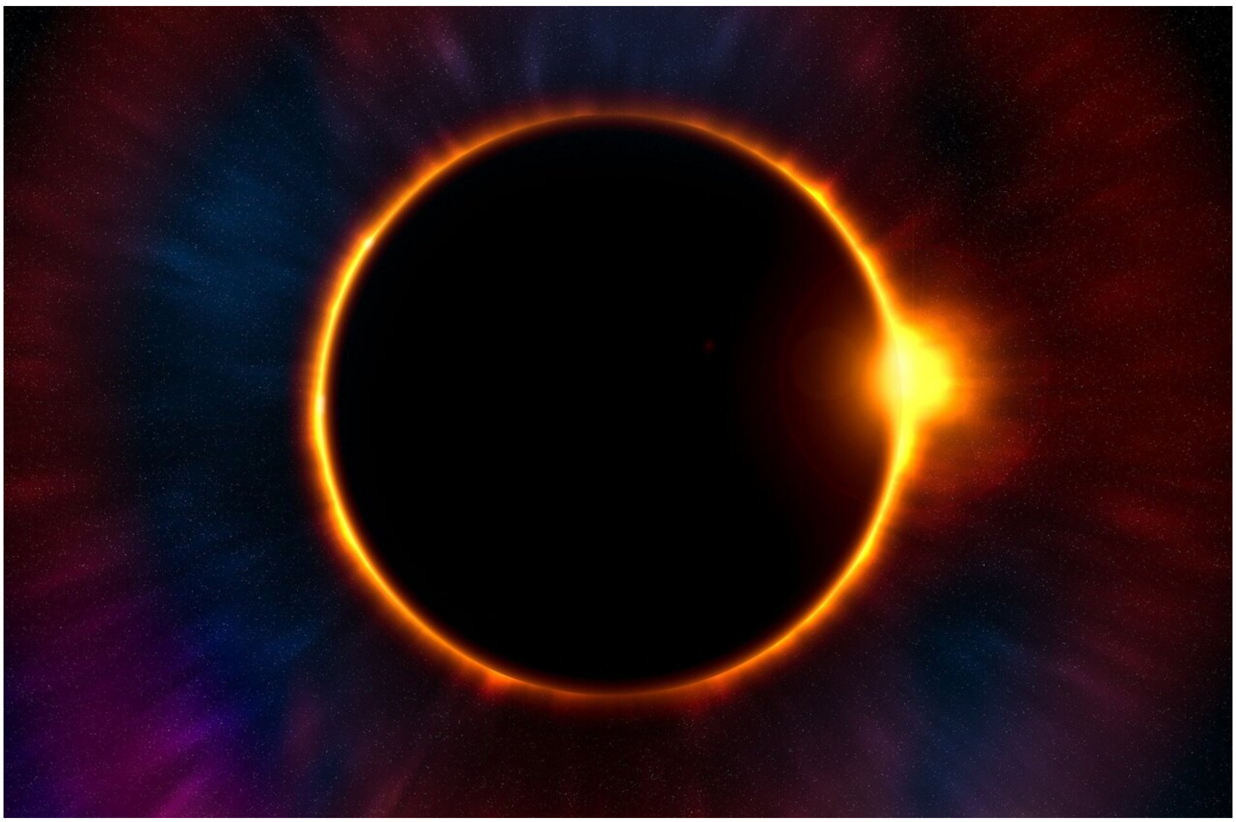

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Where Earth's atmosphere meets space, a sea of gas particles swirl in a dance choreographed by electric and magnetic fields.

During the day, the sun's rays heat the particles until they split, releasing electrically-charged electrons and positive ions that alter the dance's rhythm—but only until nightfall, when particles relax and recombine. Scientists track these changes to learn how this layer of the atmosphere, known as the ionosphere, functions.

But what will happen when nightfall sweeps across parts of North America on an afternoon this April? How will the ionosphere's particles react?

Fabiano Rodrigues, a physics professor at the University of Texas at Dallas, will pursue these questions during the total solar eclipse April 8. He and his team will collect data to see how the ionosphere's particles change when the moon covers the sun, plunging Dallas into total darkness for almost four minutes.

Besides offering a more complete look into the ionosphere's inner workings, Rodrigues said, the research may improve the accuracy of future radio and GPS systems that receive signals sent through the ionosphere.

Electrons in an eclipse

Located between 50 and 400 miles from Earth's surface, the ionosphere acts like a bridge between our planet and space. The quantity and motion of the ionosphere's gas particles change over cycles of day and night, but they are also impacted by Earth weather—pressure waves undulating from hurricanes and thunderstorms—and by space weather—shifting electric and magnetic conditions.

To determine our location, satellites send signals to Earth that travel through the ionosphere, pinging off gas particles and stray electrons en route to trackers and iPhones. Engineers need to know how the ionosphere affects GPS signals to design efficient devices.

Totality, or the time of total darkness during a solar eclipse, provides a unique opportunity to study the ionosphere.

"In the order of a few minutes, you get this abrupt transition," said Dinesh Rajan, an engineering professor at Southern Methodist University not involved with Rodrigues' research, "which makes it a very interesting phenomenon to observe."

Rodrigues wonders: Will electrons in the ionosphere drop off steeply at the exact moment of totality? Or will they ebb away slowly, only to reappear with the sun?

Real-time monitoring

As an undergraduate student in Brazil, Rodrigues designed a radio to measure how radio signals were disrupted by solar flares: intense, unpredictable bursts of solar energy. He was fascinated by how a device the size of a desktop computer could serve as a window into space.

"I can build something, and I can see things that otherwise I would not be able to see, [and] that are not visually detectable," he said.

On April 8, Rodrigues and his team will carry their equipment—including an antenna to receive signals from a satellite and a receiver to collect and store the data—to a yet-to-be-determined space on UTD's campus in Richardson. They'll also set up equipment at two Dallas locations.

During October's partial solar eclipse, Rodrigues and his team distributed receivers across locations in its path—Utah, Colorado, Costa Rica, Brazil and Texas. They noticed differences in the ionosphere during the eclipse, but are still analyzing the data to see whether those differences varied based on location.

In April, they'll have sensors at colleges in New Hampshire, Pennsylvania, Illinois and Texas near or in the path of totality. One of Rodrigues' graduate students, Isaac Wright, is working on an interface that would display in real time the change in the number of electrons during the eclipse.

Rodrigues also wants his team to pursue a related inquiry. During the 2017 solar eclipse, researchers at MIT's Haystack Observatory confirmed the eclipse's shadow generated "bow waves" (think waves fanning out from the bow of a ship as it cuts through the water) in the ionosphere. These waves don't affect radio or GPS signals, but studying them can yield more information about Earth's upper atmosphere.

Rodrigues' lab will seek to learn more about the waves produced in the ionosphere during and after the eclipse, including their speed and direction.

"When you make observations, you see things that you didn't expect to see," he said. "And that's how you have new discovery."

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