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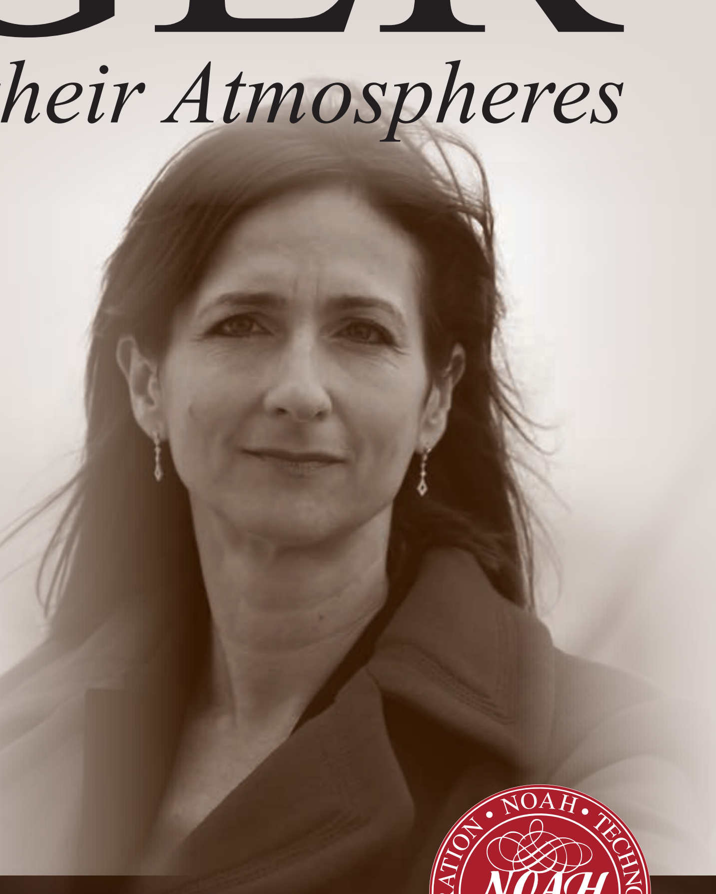
NOAH TECHNOLOGIES HONORS

DR. SARA SEAGER

Canadian-American astronomer & planetary scientist

Extrasolar Planets & their Atmospheres



"FOR EXOPLANETS, ANYTHING IS POSSIBLE UNDER THE LAWS OF PHYSICS AND CHEMISTRY."

A Journey of Exploration
Celebrating the Past, Present and Future of Space

On July 20th, 1969, Apollo 11 landed on the lunar surface allowing Neil Armstrong and Buzz Aldrin to be the first men to walk on the moon. As we celebrate the 50th anniversary of this historical achievement, it lends the question: What about the next 50 years in space exploration?

One of the researchers leading us into the future of space exploration is Dr. Sara Seager, astrophysicist, planetary scientist, and professor at MIT. Dr. Seager's research focuses on novel space missions and theoretical models of exoplanets.

The Search For Life

Seager's research was driven by one burning question : Could there be Earth-like exoplanets and signs of life on other habitable worlds? Though the exploration of exoplanets was a nascent field of study, she used her early years at Harvard to begin studying exoplanets around sun-like stars by evaluating atmospheres of the so-called hot Jupiter planets.

The Next 50 Years In Space Exploration

With more powerful telescopes, researchers will be able to begin studying planets closer to the size of Venus and Earth, which may even be habitable. Seager foresees us reaching this milestone within the next 50 years. Seager expects that we will be able to study planets of a size similar to Earth and anticipates planets to be chemically much more different than Earth.

The Chemistry Under The Atmosphere

As researchers explore the atmospheres of other planets, they operate under the assumption that life on other planets use chemistry. Seager explains that it is nearly impossible to know the details of chemistry of other planets, including whether or not the chemical ingredients are similar to Earth's. Seager says "what I love about my field of work is the ability to combine fundamentals like basic chemistry, physics, math, computer programming, and engineering. It's like making a cake, you're just taking these different fundamental ingredients and putting it together in a new way to study something new at the frontiers."

Chemical Signs of Life

In the search for functional gases on exoplanets, a return to the fundamentals drives the search for life. Exploration may turn up some more obscure molecules like dimethyl sulfide or methyl chloride, but some of the chief indicators of life Seager and her team look for are much more familiar to the layperson.

Water Vapor

At present, we're unable to see oceans on other planets. We can only study their atmosphere to collect clues about the world below. According to Seager, water vapor serves as a smoke signal to researchers. It is evidence that liquid water is present, a requirement for all life as we know it.

Seager explains that water vapor gets broken apart by ultraviolet radiation from the sun in the process of photodissociation. On a small planet without a huge reservoir of water, the water vapor would split into hydrogen and oxygen, allowing it to escape into outer space. Therefore, the presence of water vapor in a planet's atmosphere provides strong evidence there will be ocean-like bodies of water on the planet.

Oxygen

As researchers hunt foreign atmospheres, top among the list of functional gases they are searching for is oxygen, which Seager explains is highly reactive. It should not exist in an atmosphere unless it is produced by life. For example, on Earth, 20% of our atmosphere is made up of oxygen where it is primarily produced by vegetation and photosynthetic bacteria.

"Being a scientist is like being an explorer. You have this immense curiosity, this stubbornness, this resolute will that you will go forward no matter what other people say."

Phosphine

Phosphine, a highly toxic gas that was used in chemical warfare in World War I, has become a focus for Seager's team. When exploring scientific literature, they uncovered evidence that indicates that phosphine is actually produced by life on Earth.

What makes phosphine of particular interest for its potential as a biosignature gas is the lack of false positives. It is challenging to produce phosphine. It would not be present on planets that have the conditions for liquid water. Seager explains, "if you were able to identify phosphine on another planet, you'll never be 100% sure that a gas you see is made by life, but you would be able to be more confident that it was made by life."

The Diversity of Exoplanets

Seager's team is always learning. Some of her team's most recent findings have revealed that exoplanets come in all sizes and orbits. Astronomers have revealed it is currently easier to find planets that are close to their star rather than far away. For example, there is a class of planets so close to their star that the planet's year, the time it takes for the planet to travel around its star, is equivalent to one day!

Empowered by cutting edge technology, we have much to look forward to as we move further into exoplanetary exploration. Seager hopes the next 50 years will be an era of understanding atmospheres of planets around other stars. To see a man walking on the moon gave rise to the idea of humanity in space. As we look to the next 50 years of space exploration, one of the profound questions is whether life is common or extremely rare in our galaxy. Seager thinks that life abounds in space, and we could see examples in this century.