Exoplanet explorer

Astrobiologist Aomawa Shields uses computer modeling to gauge extraterrestrial life possibilities

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Terminator planet. Eyeball Earth. They may sound like science fiction film titles but in fact are theoretical constructs devised by astrobiologists to conjure up potentially habitable Earth-like planets, also known as exoplanets, that are still too far away to observe in any detail with our most powerful telescopes.

They are also a couple of the most intriguing research areas for Aomawa Shields, an associate professor of physics and astronomy at UC Irvine. A “terminator planet,” she explains, is an exoplanet that circles its host star in a synchronous orbit, much like Earth’s moon, so that each half of the sphere is either permanently dark and cold or light and hot, depending on which side is facing the star.

If the exoplanet is just the right distance from the star, it’s possible that a sliver along its circumference where dark meets light could be habitable. An “eyeball Earth,” Shields says, is what scientists call a planet whose only habitable area would be within a small circle on its surface closest to the star.

Of course, she notes, these exoplanets are purely theoretical until we invent more powerful telescopes: “Due to the limits of instrumentation, we are usually inferring the presence of planets based on their effects on the host star. The era of being able to take images of light of a planet is just starting, so we can only see a blob of a few pixels.”

Reflecting on her journey into the mysteries of the cosmos, Shields – who wrote the 2023 autobiography *Life on Other Planets: A Memoir of Finding My Place in the Universe* – says she became fascinated with astronomy during her childhood in New Hampshire, then more so in high school at Phillips Exeter Academy. After college at the Massachusetts Institute of Technology, Shields caught the acting bug and even earned an M.F.A. at UCLA in 2001, but after a few years, her passion for the stars drew her back into science.

“When I first got into astronomy, I was studying irregular galaxies and star formation,” Shields recalls. “That was what my bachelor’s thesis was: using a computer program to identify how stars formed in a particular region and figure out if those stars had enough light to be ionizing, or exciting, the gas around them.”

During her second stint in graduate school, at the University of Washington – where she obtained a Ph.D. in astronomy and astrobiology in 2014 – Shields joined the burgeoning field of exoplanets and astrobiology. “Astrobiology combines so many different fields to address questions related to life in the universe,” she says.

This, in fact, is the topic of perhaps her most popular UC Irvine class, Life in the Universe, which engages students in exploring the effect of popular culture on our perceptions of extraterrestrial life. “I have students bring in popular books and movies and use their own experiences to see how that question of whether we are alone has influenced us,” Shields

explains.

When discussing her research team's focus on identifying potentially habitable exoplanets, she underlines the significance of computer modeling in prioritizing their efforts, stating, "We can run models for all different potential atmospheres, orbit shapes, tilt, land fraction, ocean percentage, type of star, number of planets in the system. We can do all those things using computers."

Shields, who is one of just 26 Black female astrophysicists in the United States, founded the nonprofit organization Rising Stargirls to help young girls from diverse backgrounds comprehend the cosmos using theater, writing and visual arts. "Using both science and creative arts to foster their understanding of the universe has been a very rewarding experience," she says, adding that her lab and research team are supported by the National Science Foundation, the NASA Exoplanets Research Program, the Heising-Simons Foundation and other funding sources.

As she envisions the future of exoplanet exploration, Shields remains hopeful about advancements in imaging technology. "We are on the cusp of being able to capture images of smaller exoplanets, which could revolutionize our understanding of these distant worlds," she says. "There are still many limits to what we can see and do, but we are on our way."

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