BOOKS *et al.*

An artist's rendering depicts what it would be like to stand on the surface of the exoplanet TRAPPIST-1 e.

IMAGE: NASA/JPL-CALTECH

EXOPLANETS

Imagining other worlds

An astronomer offers a vivid portrait of exoplanet landscapes

By **Elizabeth Tasker**

As you rock your child to sleep in the lunar base, a glance outside reveals a night sky where the stars shine with a steady, unwavering light on the Moon's airless surface. Nursery rhymes such as "Twinkle, Twinkle, Little Star" will baffle this new generation of humankind who are unfamiliar with the way Earth's atmosphere distorts the light from stars, causing the appearance of twinkling. Such otherworldly musings enliven astronomer Lisa Kaltenegger's *Alien Earths*, which invites readers to consider the kinds of environments that could exist on planets around other stars and to discover what evidence of their strange landscapes might be detectable by our telescopes.

Alien Earths: The New Science of Planet Hunting in the Cosmos
Lisa Kaltenegger
St. Martin's Press, 2024. 288 pp.

It has only been during Kaltenegger's career that data have begun to replace speculation to drive such studies. The first exoplanets—planets orbiting stars beyond the Sun—that might host comfortable surface temperatures were discovered around 2010, and it is only with the launch of instruments such as the James Webb Space Telescope (JWST) that we have a genuine hope of detecting information about their environments.

It is the launch of the JWST that begins *Alien Earths*. Here, Kaltenegger recounts the telescope's first detection of an exoplanet atmosphere: the gases that cloak the boiling gas giant known as WASP-96 b. The planet might not be a candidate for life, but this discovery marks the beginning of what might yet be found. She then describes the properties a planet needs for life, questioning whether conditions must be identical to those on Earth before discussing how we might detect alien life on an inhabited planet. From there, she takes readers on a tour to the first exoplanets discovered. These include worlds that might be habitable and others that circle stars that have already died and are therefore likely to be spectacularly different from ours. Finally, Kaltenegger zooms out, putting our small blue dot planet in the perspective of the incredibly vast Universe.

In the laboratory, Kaltenegger creates examples in petri dishes of the possible surfaces of distant planets. These tiny spots are home to microorganisms that exist in remote crevices on Earth but might flourish in alien environments to create seas as red as tomato soup from the algae that covers the water. "It would be a pity for scientists to miss signs of life in the cosmos because they were looking only for green plants," warns Kaltenegger, as she describes the brilliant colors on the lab bench.

Engrossing descriptions of what the planet-sized versions of these environments might be like are brought to life throughout the book. Kaltenegger describes, for example, the coffee ground–like dunes on Saturn's largest moon, Titan, and worlds where it rains rocks. She writes of the multi-"moon" sky of the exoplanet known as TRAPPIST-1 e, where the moons are actually incredibly close neighboring planets, and of lands where an organism would need to outrun the sunrise to survive. Many of the smaller rocky planets we have discovered orbit red stars, which are smaller than our own Sun and emit high levels of harsh ultraviolet light. Organisms evolving on these worlds might develop biofluorescence, which could allow them to absorb the light waves and emit them in a wide range of luminous colors.

Kaltenegger also briefly touches on some of the darker aspects she has encountered as a woman in science. In chapter 5, for example, she describes a student's indignation after overhearing two men publicly claim that Kaltenegger received a prestigious grant only because she was a woman. Here, she writes about how she manages her frustration at such times and recounts the support she has received from colleagues, demonstrating that conditions for women can improve.

Kaltenegger understands that studying the conditions on other planets requires an interdisciplinary collaboration of scientists from very different fields—a reality that has led to unusual challenges. She reveals some of these challenges with amusing anecdotes, recounting, for example, the story of the "Cinderella glass-slipper planet," so named to allow geologists to understand their astronomer colleagues' definition of "glass."

The book succeeds in its attempt to keep the big picture in view, but at times, the scientific explanations can feel too brief or may come later than a reader new to the search for planets might require. But what it lacks as a deep dive it makes up for in its immense readability.

Although we cannot yet observe the surfaces of most of the exoplanets we have found to confirm which of our models about them might be correct, Kaltenegger's vivid imaginings, together with her insider experiences, bring a sense of reality and excitement to our journey to find life on other worlds. ■

The reviewer is at the Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, Sagamihara, Kanagawa, Japan. Email: elizabeth.tasker@jaxa.jp

10.1126/science.ado1465