

# Sun in a Million

## The Case for the Rarity of Our Solar System Strengthens

by Hugh Ross

**I**t's easy to take our solar system for granted. After all, the universe holds countless stars and planets. Why wouldn't we expect to more planetary systems similar to ours? Before getting too comfortable with such a thought, . . .

we must take into account the fact that our current, life-friendly configuration of planets in orbit about our star, the Sun, has not always been as it now is.

Astronomical research reveals that our solar system began with five rocky planets: Mercury, Venus, Theia, Earth, and Mars; and five gas giants: Jupiter, Saturn, Uranus, Neptune, and an unnamed planet slightly smaller than Uranus. Early in the system's formation, a remarkably choreographed event brought Theia into contact with the proto-Earth. This slow-motion collision formed what we now know as Earth and the Moon.<sup>1</sup> Meanwhile, the unnamed gaseous planet was either ejected from the planetary system or bounced out into an orbit roughly 50 times more distant than Neptune's.<sup>2</sup>

### Extraordinary Rocks

Thanks to the discovery of several hundred rocky exoplanets (planets outside our solar system), we can now observe just how unusual Earth and its rocky neighbors must be—especially when we see the great distance at which they orbit the Sun. Of the 169 detected and confirmed rocky planets orbiting nuclear burning stars (other than the Sun), all orbit closely. More than 90 percent orbit their host stars 10 times more closely than Earth orbits the Sun.<sup>3</sup>

Given how closely these rocky exoplanets orbit their stars, astronomers anticipated they would be significantly denser than our solar system's

rocky planets. After all, their light elements would have been vaporized by the heat in proximity to their star. Surprisingly, they are less dense, on average, than all rocky planets in our neighborhood, at only 4.472 grams/cubic centimeter.<sup>4</sup> By comparison, Mercury, Venus, and Earth possess an average density of 5.395 grams/cubic centimeter. Clearly, our solar system's rocky planets depart from those observed in exoplanetary systems. The big question is, why?

### Quest for Answers

To begin answering that question, we must start with the Sun. Astronomers observe that its relative abundance of elements is unlike that of any other known star. Multiple studies establish a correlation between the Sun's unique abundance of elements and its unique configuration of rocky planets.

One research team compared elemental abundances of 21 stars most closely resembling the Sun.<sup>5</sup> They found that the Sun has a 20 percent lower ratio of refractory elements (those with high boiling points) to volatile elements (those with low boiling points). A follow-up study of 79 Sun-like stars affirmed this finding.<sup>6</sup>

Analysis of primitive solar system meteorites tells us that lithium was relatively abundant in the gas cloud out of which the Sun and its planets formed. Yet the amount of lithium on the Sun's surface today is far below that of the primordial solar system—roughly 170 times below.<sup>7</sup> Given the Sun's relative youth—just 4.567 billion years old—this finding is shockingly unexpected and yet essential for life's existence<sup>8</sup> (see sidebar, "Unique Sun, Unique Rocky Planets").

**Astronomers now understand that the Sun's exceptionally low abundance of refractory elements and lithium most likely explains the uniqueness of our solar system's rocky planets. As one team of astronomers conservatively concluded, this peculiar solar elemental composition "would imply that solar-like stars with planetary systems similar to our own are a relatively rare occurrence."**<sup>9</sup>

## Significance for Life

What do these atypical features tell us? The Sun's anomalous elemental composition, together with its mass and age, serves to keep the Sun's flaring activity at an extremely—and uniquely—low level.<sup>10</sup> These solar features also help account for the Sun's exceptionally low levels of short ultraviolet and x-ray radiation, at present. If not for these extremely low levels and intensities of flares and short ultraviolet and x-ray radiation, global high-technology civilization on our planet would be impossible.

While the enormous quantity of refractory elements and angular momentum transferred from the Sun to its rocky planets should, theoretically, allow for the existence of a high-mass, high-density rocky planet orbiting as distantly as Earth, such a transfer would *not* guarantee that this planet would possess

other features essential for life. It would likely possess a thick atmosphere, at least twice as thick as Venus's atmosphere, and a too-thick hydrosphere. In reality, the Sun's transfer of angular momentum and refractory elements to its rocky planets produced a unique set of five distantly orbiting rocky planets, two of which orbit at a remarkably great distance.

The early collision between proto-Earth and the Sun's fifth rocky planet, Theia, guaranteed that Earth would gain enough mass and density and lose enough gas and water to become a potential home for advanced life. This early collision also produced a large Moon, which played a key role in preventing Earth from losing *all* its atmosphere and hydrosphere.<sup>11</sup>

Meanwhile, Earth's orbital distance from the Sun is barely sufficient to prevent Earth from becoming tidally locked to the Sun and, thus, ending up with a long rotation rate like that of Mercury or Venus. Earth's companion rocky planets also play important roles in stabilizing the orbital architecture of Earth as well as those of all the other solar system planets, including the gas giants.

These discoveries of the Sun's anomalous elements and rocky planets add to the weight of evidence for the rarity of Earth, the Sun, and our planetary system. This multiplied rarity adds significant weight to the case for divine intervention in the formation of a habitat for humans and for global, advanced civilization to thrive, at least for a time, here on Earth. •

## Unique Sun, Unique Rocky Planets

A team of astronomers led by Marília Carlos measured the surface lithium abundance in 77 stars most closely matching the Sun's effective temperature, surface gravity, and metallicity.<sup>1</sup> Their research affirmed a correlation between a star's age and its surface lithium depletion. The Sun's surface lithium, however, proved far more depleted than that of any other star in the 4.1–5.1-billion-year age range.

In 2004, a team of astronomers led by Garik Israelian compared the surface lithium abundance of stars hosting planets with stars that host none.<sup>2</sup> They observed lower surface lithium (greater lithium depletion) in the 79 planet-hosting stars with surface temperatures similar to the Sun's. This lithium depletion, they explained, resulted from the transfer of angular momentum from a star to its protoplanetary disk and eventually its rocky planets.

Astronomers Yu-Qin Chen and Gang Zhao affirmed that planet-hosting solar-type stars experience more severe lithium depletion than stars without planets.<sup>3</sup> In a 2009 study of 451 stars with effective temperatures similar to the Sun's, Israelian and his colleagues found that 50 percent of solar-analog stars with no detected planets have, on average, 10 times more surface lithium than solar-analog, planet-hosting stars.<sup>4</sup>

In 2019, Carlos's team clarified that the key difference is not just whether a star hosts

planets but what kinds of planets it hosts.<sup>5</sup> In particular, what matters is the total mass of rocky planets a star hosts and how far they orbit from the host star.

The only known planetary system with a higher total mass of rocky planets than our solar system is the TRAPPIST-1 system.<sup>6</sup> But this system is vastly different from ours in every other way. The seven TRAPPIST-1 planets orbit their host star at distances ranging from only 1–6 percent of Earth's distance from the Sun. The most massive planet in the system is only 15 percent more massive than Earth. What's more, five of the seven TRAPPIST-1 planets cannot be considered rocky. They possess very thick "envelopes of volatiles in the form of thick atmospheres, oceans, or ice."<sup>7</sup>

The bottom line: our solar system differs from other known planetary systems both in its quantity of refractory elements and in its transfer of angular momentum to its rocky planets (as determined by the masses and orbital distances of planets). •

### Notes

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2. Hugh Ross, "Recent Research Strengthens the Creation-Friendly Grand Tack Model," *Today's New Reason to Believe* (Feb. 1, 2016), <https://reasons.org/explore/publications/articles/recent-research-strengthens-the-creation-friendly-grand-tack-model>; Konstantin Batygin, Michael E. Brown, and Hayden Betts, "Instability-Driven Dynamical Evolution Model of a Primordially Five-Planet Outer Solar System," *Astrophysical Journal Letters* 744 (Jan. 1, 2012), id. L3, doi:10.1088/2041-8205/744/1/L3.
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10. Maria M. Katsova et al., "Superflare G and K Stars and the Lithium Abundance," *The 19th Cambridge Workshop on Cool Stars, Stellar Systems, and the Sun (CS19)*, Uppsala, Sweden, June 6–10, 2016 (July 31, 2016), id. 124, doi:10.5281/zenodo.59176; Y. Takeda et al., "Behavior of Li Abundances in Solar-Analog Stars. II. Evidence of the Connection with Rotation and Stellar Activity," *Astronomy & Astrophysics* 515 (June 2010), id. A93, doi:10.1051/0004-6361/200913897.
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1. Marília Carlos et al., "The Li-Age Correlation: The Sun Is Unusually Li Deficient for Its Age," *Monthly Notices of the Royal Astronomical Society* 485, no. 3 (May 2019), 4052–4059, doi:10.1093/mnras/stz681.
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