Amazing achievements from the Parker Solar Probe

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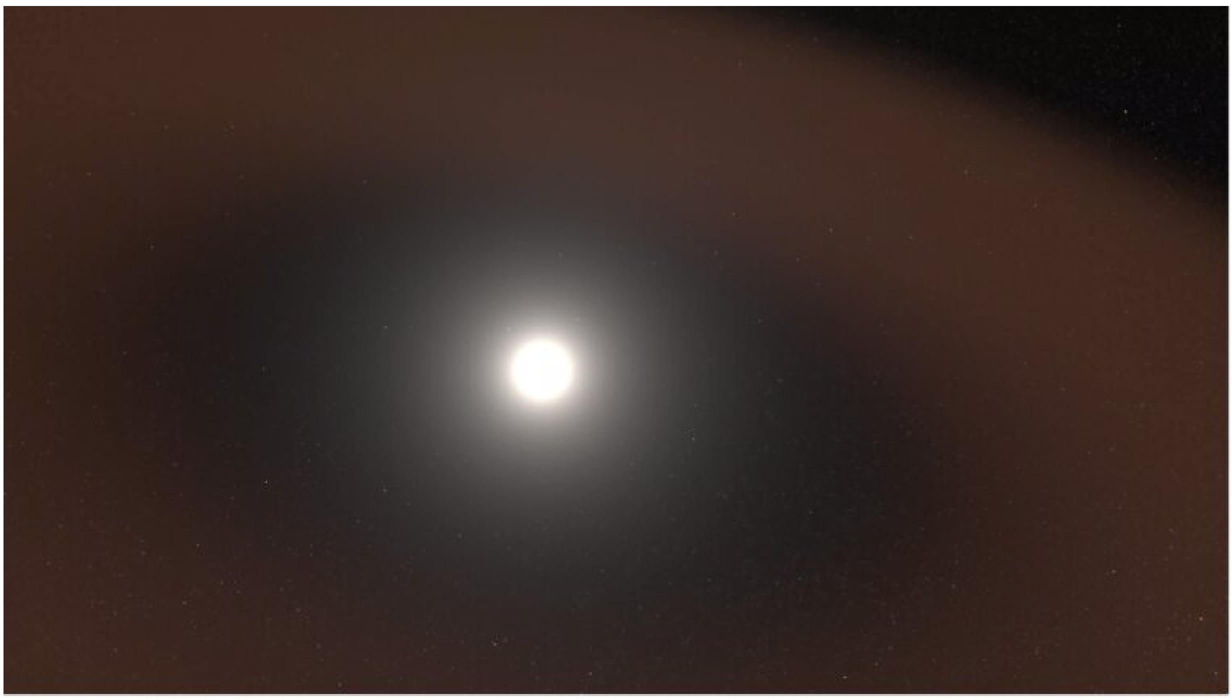

Parker Solar Probe saw cosmic dust (illustrated here) — scattered throughout our solar system — begin to thin out close to the sun, supporting the idea of a long-theorized dust-free zone near the sun. Credit: NASA's Goddard Space Flight Center/Scott Wiessinger

In 2018, NASA launched the Parker Solar Probe on an unprecedented mission to study the sun up close. The mission was defined with three key scientific goals:

1. To trace the flow of energy that heats the sun's outer atmosphere.
2. To shed light on the sources of the solar wind, the constant flow of solar material escaping from the sun.
3. To explore how solar energetic particles—which can make the 93-million mile (150 million kilometer) journey to Earth in under an hour—are transported and accelerated.

Now four years after launch, the mission has made inroads towards achieving these key goals and more. As Parker Solar Probe continues its mission, it continues to break records and capture first-of-its-kind measurements of the sun.

Here are the need-to-know facts about NASA's historic mission to touch the sun.

1. Parker Solar Probe was the first NASA mission named for a living person.

In honor of Eugene Parker, eminent physicist who first predicted the solar wind, NASA announced in May 2017, that it would rename the Solar Probe Plus mission to Parker Solar Probe. Parker witnessed the spacecraft's launch in person and the discoveries made in the mission's few years. He passed away on March 15, 2022, at age 94.

2. The spacecraft carries revolutionary technology.

The mission was conceived in 1958, but it took 60 years to develop the technology to make it happen. Designed and built at the Johns Hopkins Applied Physics Laboratory in Laurel, Maryland, Parker Solar Probe carries a heat shield, autonomous onboard "smarts" to keep the spacecraft facing the sun, and an efficient cooling system.

3. It's a repeated record-breaker.

Just a few months after launch, Parker Solar Probe became the closest human-made object to the sun, passing within 26.55 million miles (42.72 million kilometers) from the sun's surface, and became the fastest human-made object, reaching speeds of 153,454 miles per hour. Since then, it has repeatedly broken both of those records, and will reach a top speed of about 430,000 miles per hour (700,000 kilometers per hour) as it flies to within 3.9 million miles (6.2 million kilometers) of the sun's surface in 2024. See where the Parker Solar Probe is in real time here.

4. Parker Solar Probe has officially sampled the sun.

In December 2021, NASA announced that Parker Solar Probe had achieved its cornerstone objective: making the first measurements from within the atmosphere of a star.

5. It's made game-changing discoveries.

Parker Solar Probe carries four instrument suites, and each is now credited with several groundbreaking discoveries. A small sample of them is described below.

The Solar Wind Electrons Alphas and Protons investigation (SWEAP): Surveying where sun becomes solar wind

When Parker Solar Probe entered the solar atmosphere, it made the first-ever crossing of what's known as the Alfvén critical surface—the boundary where solar material anchored to the sun first escapes and becomes the solar wind.

Until this crossing, no one knew what that boundary would look like. During its first pass close enough to cross the boundary, Parker Solar Probe passed into and out of the corona several times. This revealed key information about the boundary's shape, revealing that the Alfvén critical surface wasn't shaped like a smooth ball. Rather, it has spikes and valleys that wrinkle the surface.

The SWEAP instrument established that the wrinkles were due to coronal streamers—giant plumes of solar material rising through the sun's atmosphere. Streamers have long been observed by sun-watching spacecraft near Earth, but never before measured directly. The results are reshaping what we know about the sun's atmosphere and how it transforms into the solar wind.

The Wide-Field Imager for Parker Solar Probe (WISPR): The first hints of a dust-free zone

Dust is just about everywhere in our solar system—the remnants of collisions that formed planets, asteroids, comets and other celestial bodies billions of years ago. Almost a century ago, astronomer Henry Norris Russell predicted that there should a region around the sun where dust particles should get hot enough to sublimate and thus disappear, creating a dust-free zone. People looked for evidence of the sublimation zone for decades but there was no consistent evidence for its existence whatsoever.

The WISPR instrument made the first detection of dust depleting close to the sun, observing the light reflected from dust dimming at about 19 solar radii (8.2 million miles, or 13.2 million kilometers, away from the sun). Models of the results suggest that a dust-free zone should exist starting at about 5 solar radii (2.2 million miles, or 3.5 million kilometers, from the sun).

FIELDS: Tracking down the sun's magnetic reversals

When Parker Solar Probe sent back the first observations from its voyage to the sun, scientists found their magnetic field measurements spiked with what became known as switchbacks: rapid flips in the sun's magnetic field that reversed direction like a zig-zagging mountain road.

FIELDS has since helped narrow down their origins. During Parker Solar Probe's 6th flyby of the sun, FIELDS data revealed that the switchbacks aligned with magnetic "funnels" in the solar surface. These funnels emerge from between structures called supergranules—giant bubbles on the sun in which hot plasma from the solar interior rises up, spreads out across the surface, cools and then sinks back down. The magnetic geometry of these regions suggests that magnetic reconnection powers the solar wind.

While the new findings locate where switchbacks are made, the question of how they're formed is still a matter of active research.

The Integrated Science Investigation of the sun (IS⊙IS): Rewriting the book on solar energetic particles

IS⊙IS, pronounced "ee-sis" and including the symbol for the sun in its acronym, measures solar energetic particles, the most energetic particles that escape the sun. Measured near Earth, solar energetic particles events are relatively rare and hard to predict. But detecting SEPs close to the sun, IS⊙IS has changed just about everything we know about these speedy particles. IS⊙IS has found that SEPs are much more common than expected, that they contain a wider range of types of particles than expected, and that their paths from the sun are not as direct as previously thought—they can be disrupted by the switchbacks detected by fields and can at times follow a path twice as long as expected. By measuring these events so close to the sun, ISʘIS is detecting events so small that all trace of them is lost before they reach Earth, helping scientists develop a fuller picture of where they come from and how they're accelerated away from the sun.

… And the results keep coming.

Each new dataset expands the limits of space science—and it's not just about the sun. Parker Solar Probe has also studied comets, detected radio emissions from Venus' atmosphere, and even captured the first-ever images of Venus' surface in visible wavelengths.

With its closest pass of the sun still ahead in 2024, only time will tell what new discoveries await.

Provided by NASA