Extreme Exploration!

Join us as NASA's Parker Solar Probe and ESA/NASA's Solar Orbiter revolutionize our understanding of our star, the Sun. The two missions offer complementary perspectives of the Sun, each putting the other's view in a larger context. Parker Solar Probe's orbit carries it directly through the inner regions of the Sun's atmosphere, while Solar Orbiter remotely observes the solar surface, providing the first-ever images of the solar poles.

The missions help unravel key questions about fundamental processes in magnetized plasmas that drive solar activity and how they lead to material that can affect us near Earth. Together, Parker Solar Probe (launched August 12, 2018) and Solar Orbiter (launching early 2020) will help us better understand the star we live with.

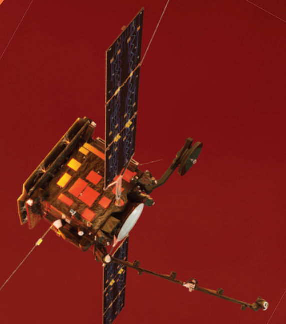
esa

European Space Agency

Solar Orbiter

Solar Orbiter is a joint ESA/NASA collaboration that addresses a central question of heliophysics: How does the Sun create and control the giant bubble of magnetized plasma around it, the heliosphere?

To answer this question, Solar Orbiter images the Sun in a variety of wavelengths from closer than ever before, and measures the solar wind plasma, fields, waves, and energetic particles. Solar Orbiter's orbit is highly tilted, allowing first-ever images of the Sun's poles, which many researchers believe hold the key to understanding what drives the constant activity and eruptions on the Sun.



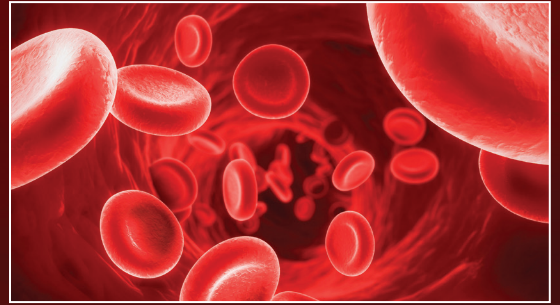
sci.esa.int/solar-orbiter
science.nasa.gov/missions/solar-orbiter

Fun Sun Facts

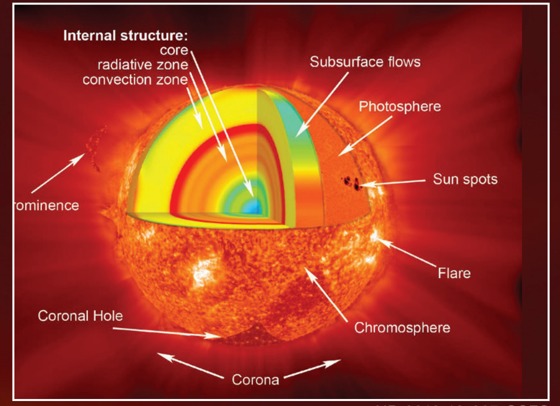
- Our Sun has lots of company: It is one of more than 200 billion stars in the Milky Way Galaxy alone. Every individual star that you can see with the naked eye is in the Milky Way.

- Stars are factories for new elements. As they live and die, they convert their hydrogen gas into all the rest of the elements on the periodic table. These elements make up Earth and you.
- A star's mass—how much matter it contains—determines its temperature, luminosity, and color, and how it will live and die.
- Our Sun is more massive than the average star in its neighborhood. Nearly 90 percent of stars are less massive, making them cooler and dimmer.
- The hottest and most massive stars are bright and blue, while the coolest and least massive stars are dim and red. Yellow stars, like our Sun, are in-between.

- About 99 percent of stars, including our Sun, will end their lives as white dwarfs. Only about one percent of stars are massive enough to explode as a supernova.
- The Sun's processes take more than 200,000 years to bring a photon's energy from its core to the surface. It takes only another eight minutes for that light to reach Earth.
- The iron in your blood was made in the cores of stars that exploded billions of years ago.



- The Sun contains 99.9 percent of all matter in our solar system.
- During a single second, the Sun converts 4 million tons of matter into pure energy.
- The Sun's radius is 432,470 miles (695,993 kilometers), which is equal to 109 Earth radii.
- It would take about 1 million Earths to fill the Sun if it were a hollow ball.
- The Sun rotates on its axis approximately once every 27 days.
- The Sun's surface rotates at different speeds in different latitudes. The fastest rotation is at the equator (approx. 25.4 days). The slowest rotation is at the poles (approx. 36 days).
- The Sun is 93 million miles (about 150 million kilometers) away from Earth and is almost 5 billion years old.
- On April 8, 1947, the largest sunspot in modern history reached its maximum size of over 35 times Earth's area.
- The core of the Sun is nearly as dense as lead and has a temperature of 27 million degrees Fahrenheit (about 15 million degrees Celsius). The surface of the Sun is around 10,800 degrees Fahrenheit (5,982 degrees Celsius).
- Solar flares can sometimes heat the solar surface to temperatures of 80 million degrees Fahrenheit (about 45 million degrees Celsius)—far hotter than the Sun's core.
- The primary energy the Earth receives from the Sun is radiant energy, or light.



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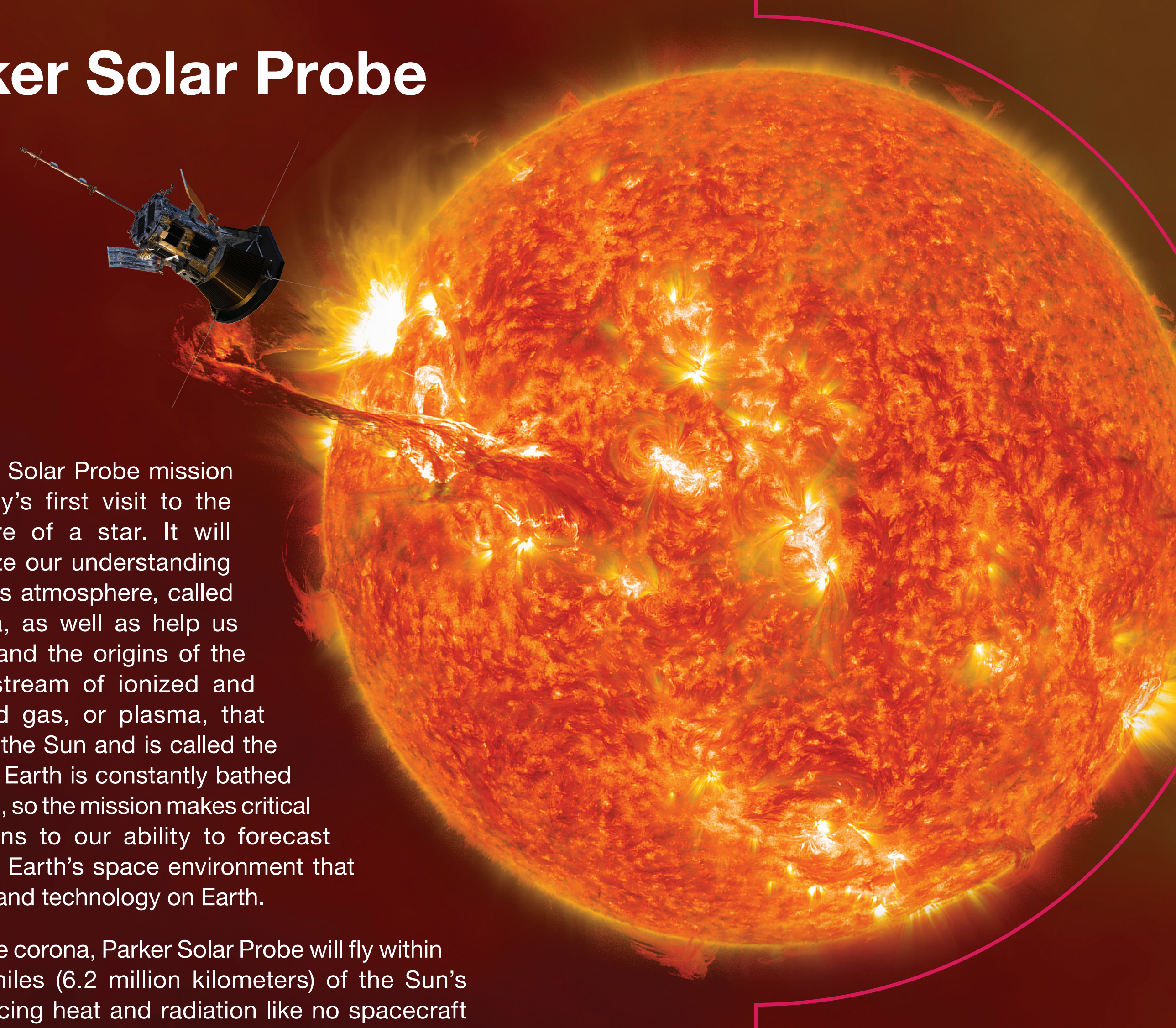
National Aeronautics and Space Administration

NASA

Parker Solar Probe



The Parker Solar Probe mission is humanity's first visit to the atmosphere of a star. It will revolutionize our understanding of the Sun's atmosphere, called the corona, as well as help us to understand the origins of the constant stream of ionized and magnetized gas, or plasma, that flows from the Sun and is called the solar wind. Earth is constantly bathed by this wind, so the mission makes critical contributions to our ability to forecast changes in Earth's space environment that impact life and technology on Earth.

To study the corona, Parker Solar Probe will fly within 4 million miles (6.2 million kilometers) of the Sun's surface, facing heat and radiation like no spacecraft before it.

nasa.gov/solarprobe
solarprobe.jhuapl.edu

Parker Solar Probe is named for Dr. Eugene Parker, whose prediction of the solar wind and other insights have revolutionized our understanding of the Sun. Parker Solar Probe will fly repeatedly through the Sun's inner atmosphere, the corona, to help answer scientific questions that have puzzled scientists for decades. The primary science goals for the mission are to determine why the plasma in the solar corona is more than 300 times hotter than the solar surface, to trace how energy and heat move through the solar corona, including how plasma from the corona is accelerated to the supersonic speeds of the solar wind, and to understand how hazardous solar energetic particles are accelerated and transported through the heliosphere.

Scientists have sought these answers for more than 60 years, but the solution required designing a probe that can withstand temperatures of nearly 2,500 degrees Fahrenheit (1,371 degrees Celsius). Parker Solar Probe is on its journey toward the Sun thanks to the cutting-edge thermal engineering advances that can protect the spacecraft. The spacecraft bus and most of the science instruments will operate within the shade of the heat shield at nearly room temperatures.

Scientific Goals

- Trace the flow of energy that heats the solar corona and accelerates solar wind.
- Determine the structure and dynamics of the plasma and magnetic fields at the sources of the solar wind.
- Explore mechanisms that accelerate and transport energetic particles.

At closest approach, Parker Solar Probe hurtles around the Sun at approximately 430,000 miles per hour (700,000 kilometers per hour). That's fast enough to get from Philadelphia to Washington, D.C., in one second.

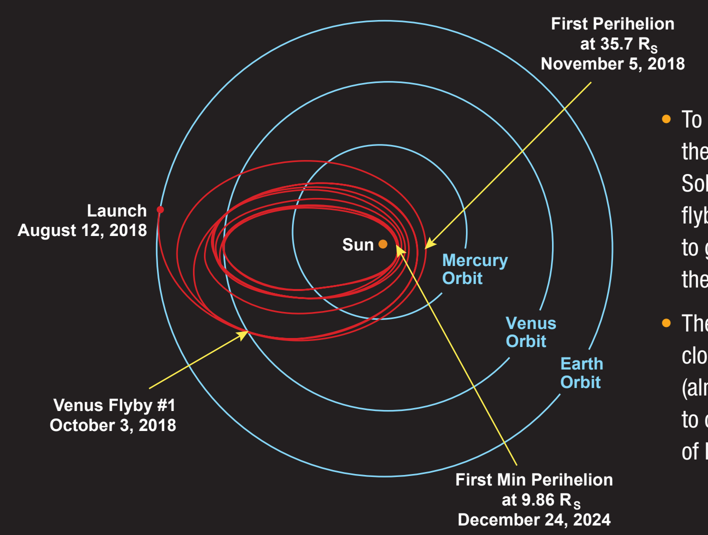
At closest approach to the Sun, the front of the spacecraft's solar shield reaches extremely high temperatures, while the spacecraft's payload remains near room temperature.

On the final three orbits, the mission will fly more than seven times closer than the current record-holder for a close solar pass, the Helios 2 spacecraft, which came within 27 million miles (43 million kilometers) in 1976.

EXTREME EXPLORATION:

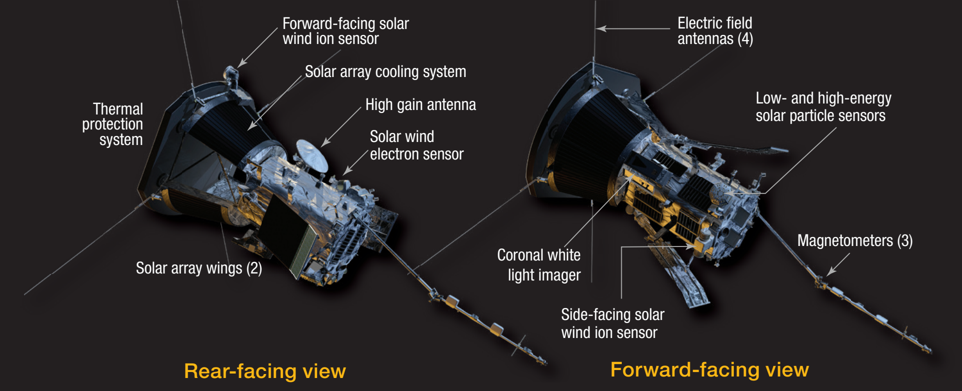
Parker Solar Probe and Solar Orbiter Will Blaze Toward the Sun

How Are We Getting There?



- To unlock the mysteries of the Sun's atmosphere, Parker Solar Probe uses seven Venus flybys over nearly seven years to gradually circle closer to the Sun.
- The spacecraft orbit comes as close as almost 4 million miles (almost 6.5 million kilometers) to our star, well within the orbit of Mercury.

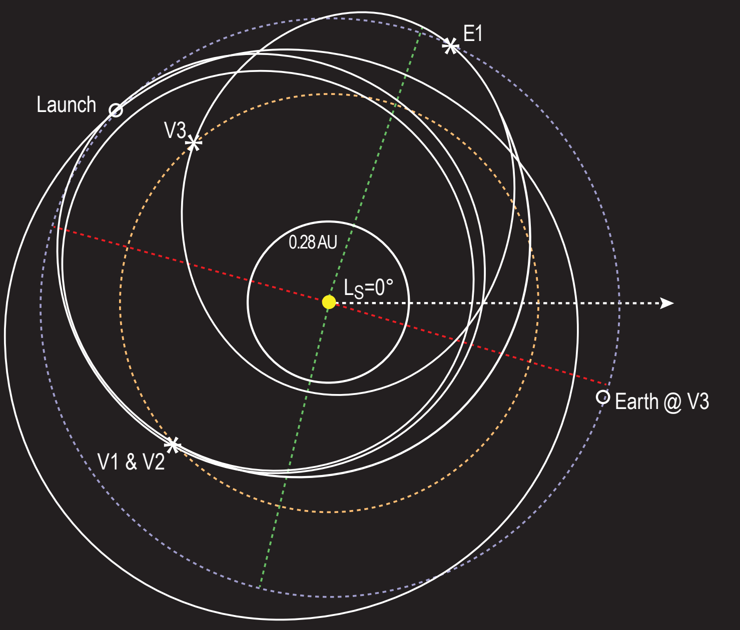
Parker Solar Probe Instruments



Parker Solar Probe fly through regions of intense heat and solar radiation. The spacecraft flies close enough to the Sun to measure the solar wind as it accelerates, traveling though the birthplace of the highest-energy solar particles. To perform these measurements, the spacecraft and instruments are protected from the Sun's heat by a 4.5-inch-thick (11.43 cm) carbon-composite shield. Parker Solar Probe carries four instrument suites designed to study magnetic fields, plasma, and energetic particles, as well as image the solar wind.

Solar Orbiter's path traces an elliptical orbit around the Sun, coming as close as 26 million miles (42 million kilometers) away from the star every five months—even closer than Mercury. It takes three years to reach this orbit using a series of Venus flybys. Around closest approach, Solar Orbiter remains positioned over approximately the same region of the solar atmosphere, allowing unprecedented observations of magnetic activity building up and evolving in the atmosphere.

How Are We Getting There?

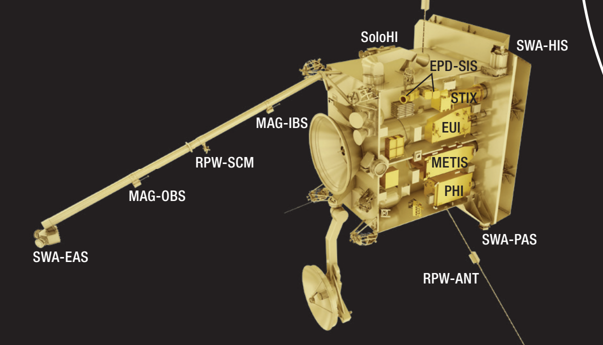


The inclined orbit allows Solar Orbiter to image the regions around the Sun's poles for the first time.

- Solar Orbiter examines how the Sun creates and controls the heliosphere, the vast bubble of charged particles blown by the solar wind into the interstellar medium.
- The mission combines in situ and remote-sensing observations to gain new information about the solar wind, the solar and heliospheric magnetic field, solar energetic particles, and transient interplanetary disturbances.

When traveling at its fastest, Solar Orbiter is positioned for several days over roughly the same region of the solar atmosphere, matching the speed of the Sun as it rotates on its axis. Just as geostationary weather and telecommunications satellites are stationed over particular spots on Earth's surface, so too will the spacecraft seem to hover for a while over the Sun. This enables Solar Orbiter to watch magnetic activity building up in the atmosphere, which can lead to powerful flares and eruptions.

Solar Orbiter Instruments



The spacecraft carries a suite of 10 state-of-the-art instruments to observe the turbulent, sometimes violent, surface of the Sun and study the changes that take place in the solar wind, which flows outward at high speed from our nearest star.

The spacecraft's tilted orbit also enables it to observe the polar regions of the Sun, which are not visible from Earth. This new view of the solar poles provides insight into how the Sun's internal dynamo generates its powerful magnetic field. Solar Orbiter should also reveal for the first time what happens at the Sun's polar regions when the solar magnetic field flips polarity—as it does about every 11 years.

Scientific Goals

Solar Orbiter seeks to answer four overarching science questions:

- What drives the solar wind and where does the corona's magnetic field originate?
- How do coronal mass ejections drive heliospheric variability?
- How do solar eruptions produce energetic particle radiation that fills the heliosphere?
- How does the Sun's inner magnetic motion work and drive connections between the Sun and the heliosphere?