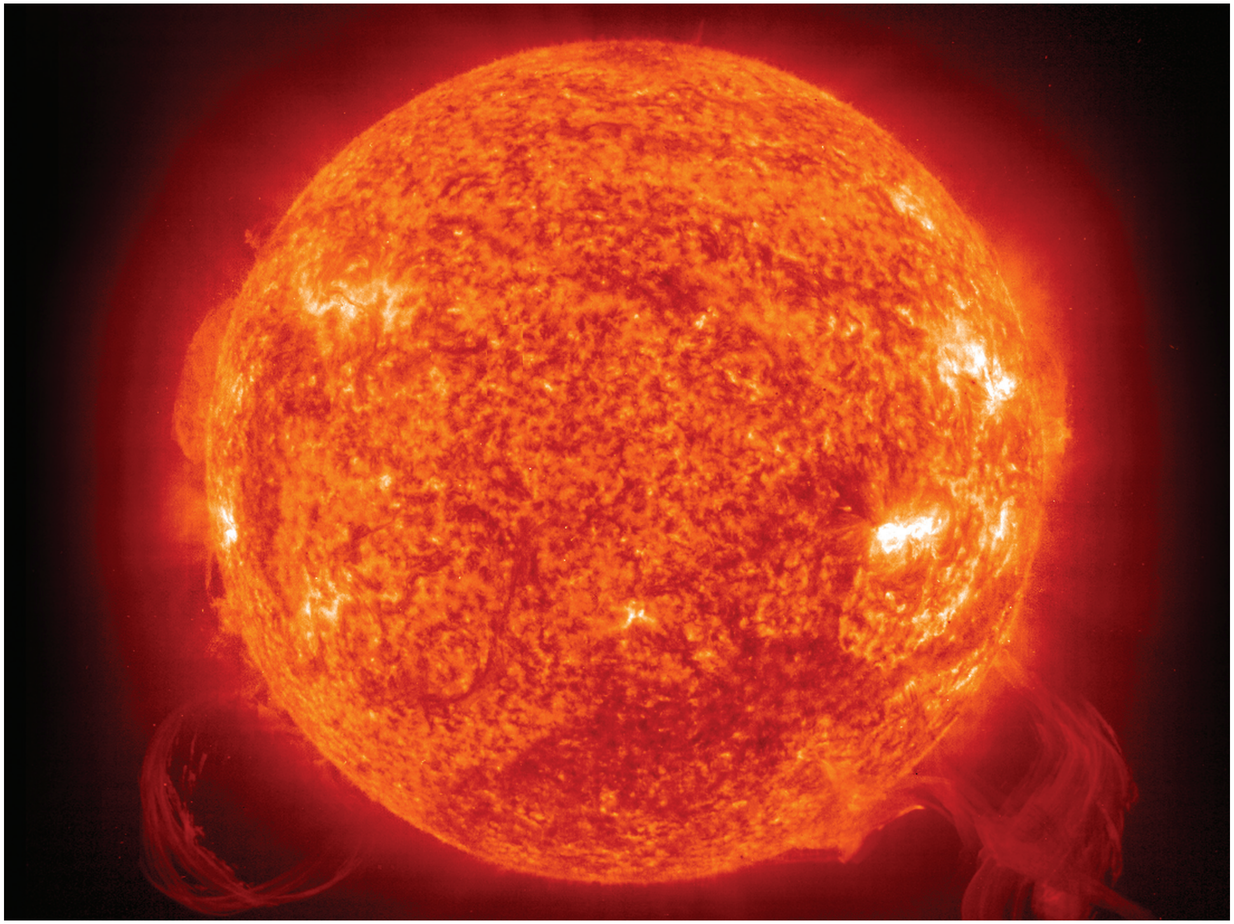
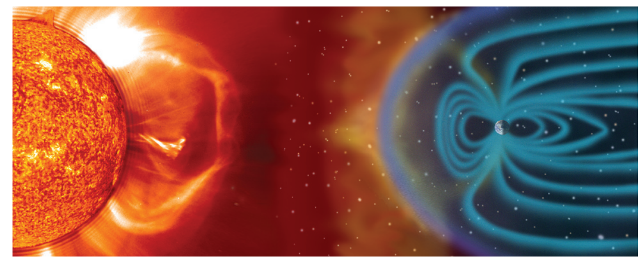
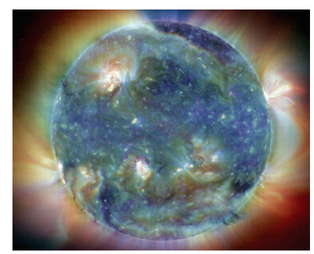
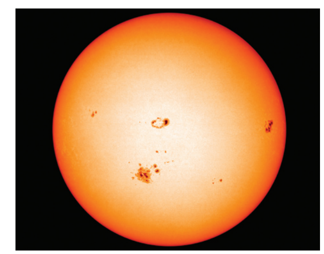
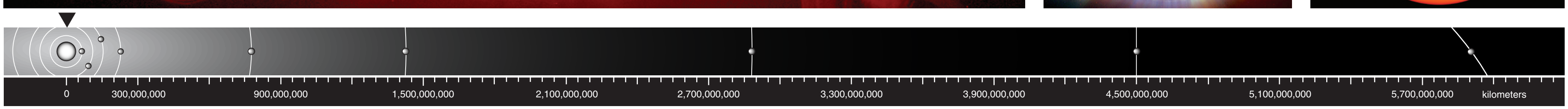
National Aeronautics and Space Administration












# Our Star — The Sun

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Our solar system's central star, the Sun, has inspired mythological stories in cultures around the world, including those of the ancient Egyptians, the Aztecs of México, Native American tribes of North America and Canada, the Chinese, and many others. A number of ancient cultures built stone structures or modified natural rock formations to mark the motions of the Sun and Moon — they charted the seasons, created calendars, and monitored solar and lunar eclipses. These architectural sites show evidence of deliberate alignments to astronomical phenomena: sunrises, moonrises, moonsets, even stars or planets. Many cultures believed that the Earth was immovable and the Sun, other planets, and stars revolved about it. Ancient Greek astronomers and philosophers knew this "geocentric" concept from as early as the 6th century B.C.

The Sun is the closest star to Earth, at a mean distance from our planet of 149.60 million kilometers (92.96 million miles). This distance is known as an astronomical unit (abbreviated AU), and sets the scale for measuring distances all across the solar system. The Sun, a huge sphere of mostly ionized gas, supports life on Earth. The connection and interactions between the Sun and Earth drive the seasons, ocean currents, weather, and climate.

About one million Earths could fit inside the Sun. It is held together by gravitational attraction, producing immense pressure and temperature at its core. The Sun has six regions — the core, the radiative zone, and the convective zone in the interior; the visible surface (the photosphere); the chromosphere; and the outermost region, the corona.

At the core, the temperature is about 15 million degrees Celsius (about 27 million degrees Fahrenheit), which is sufficient to sustain thermonuclear fusion. The energy produced in the core powers the Sun and produces essentially all the heat and light we receive on Earth. Energy from the core is carried outward by radiation, which bounces around the radiative zone, taking about 170,000 years to get from the core to the convective zone. The temperature drops below 2 million degrees Celsius (3.5 million degrees Fahrenheit) in the convective zone, where large bubbles of hot plasma (a soup of ionized atoms) move upwards.

The Sun's "surface" — the photosphere — is a 500-kilometer-thick (300-mile-thick) region, from which most of the Sun's radiation escapes outward and is detected as the sunlight we observe here on Earth about eight minutes after it leaves the Sun. Sunspots in the photosphere are areas with strong magnetic fields that are cooler, and thus darker, than the surrounding region. The number of sunspots goes up and down every 11 years as part of the Sun's magnetic activity cycle. Also connected to this cycle are bright solar flares and huge coronal mass ejections that blast off the Sun.

The temperature of the photosphere is about 5,500 degrees Celsius (10,000 degrees Fahrenheit). Above the photosphere lie the tenuous chromosphere and the corona ("crown"). Visible light from these top regions is usually too weak to be seen against the brighter photosphere, but during total solar eclipses, when the Moon covers the photosphere, the chromosphere can be seen as a red rim around the Sun while the corona forms a beautiful white crown with plasma streaming outward, forming the "points" of the crown.

Above the photosphere, the temperature increases with altitude, reaching temperatures as high as 2 million degrees Celsius (3.5 million degrees Fahrenheit). The source of coronal heating has been a scientific mystery for more than 50 years. Likely solutions have emerged from observations by the Solar and Heliospheric Observatory (SOHO) and the Transition Region and Coronal Explorer (TRACE) missions, which found patches of magnetic field covering the entire solar surface. Scientists now think that this magnetic "carpet" is probably a source of the corona's intense heat. The corona cools rapidly, losing heat as radiation and in the form of the solar wind — a stream of charged particles that flows to the edge of the solar system.

## FAST FACTS

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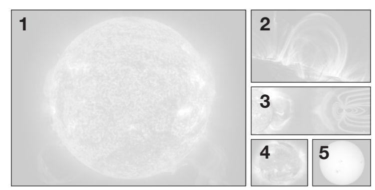
|---|---|
| Spectral Type of Star | G2V |
| Age | 4.6 billion years |
| Mean Distance to Earth | 149.60 million km (92.96 million mi) (1 astronomical unit) |
| Rotation Period at Equator | 26.8 days |
| Rotation Period at Poles | 36 days |
| Equatorial Radius | 695,500 km (432,200 mi) |
| Mass | $1.989 \times 10^{30}$ kg |
| Density | 1.409 g/cm$^3$ |
| Composition | 92.1% hydrogen, 7.8% helium, 0.1% other elements |
| Surface Temperature (Photosphere) | 5,500 deg C (10,000 deg F) |
| Luminosity* | $3.83 \times 10^{33}$ ergs/sec |

*Luminosity measures the total energy radiated by the Sun (or any star) per second at all wavelengths.

## SIGNIFICANT DATES

150 A.D. — Greek scholar Claudius Ptolemy writes the *Almagest*, formalizing the Earth-centered model of the solar system. The model was accepted until the 16th century.
1543 — Nicolaus Copernicus publishes *On the Revolutions of the Celestial Spheres* describing his heliocentric (Sun-centered) model of the solar system.
1610 — First observations of sunspots through a telescope by Galileo Galilei and Thomas Harriot.
1645–1715 — Sunspot activity declines to almost zero, possibly causing a "Little Ice Age" on Earth.
1860 — Eclipse observers see a massive burst of material from the Sun; it is the first recorded coronal mass ejection.
1994 — The Ulysses spacecraft makes the first observations of the Sun's polar regions.
2004 — NASA's Genesis spacecraft returns samples of the solar wind to Earth for study.
2006 — Ulysses begins its third set of data-gathering passes over the north and south poles of the Sun.
2007 — NASA's double-spacecraft Solar Terrestrial Relations Observatory (STEREO) mission returns the first three-dimensional images of the Sun.
2009 — After more than 18 years, the Ulysses mission ends. Ulysses was the first and only spacecraft to study the Sun at high solar latitudes.

## ABOUT THE IMAGES




1 Two huge clouds of plasma erupt from the chromosphere of the Sun (SOHO image taken in extreme ultraviolet light).

2 Magnetic fields are believed to cause huge, super-hot coronal loops to tower above the Sun's surface (TRACE image).

3 An illustration of a coronal mass ejection and interaction with Earth's magnetic field (not to scale). The pressure from the Sun forces Earth's magnetic field into a windsock shape.

4 A false-color image of the Sun's corona taken in three wavelengths emitted at different temperatures (SOHO image).

5 These large sunspots in the photosphere were associated with several powerful solar flares in 2003 (SOHO image).

## FOR MORE INFORMATION

*solarsystem.nasa.gov/sun*

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