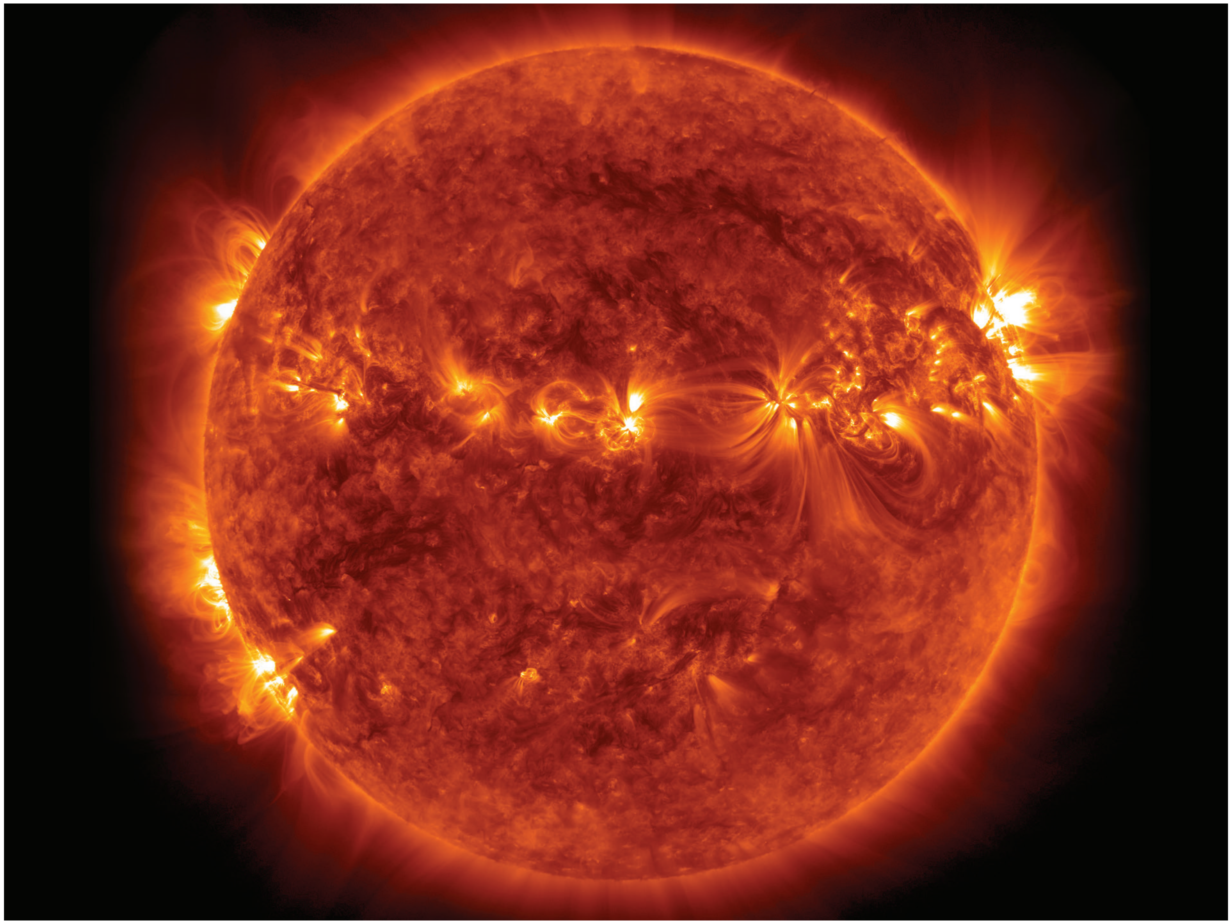
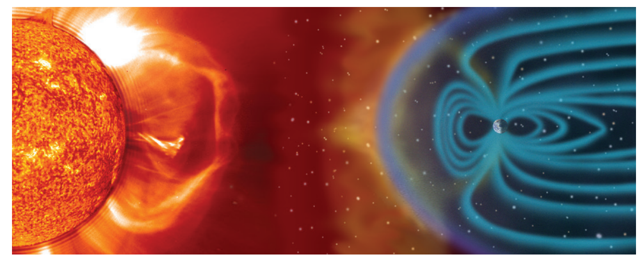
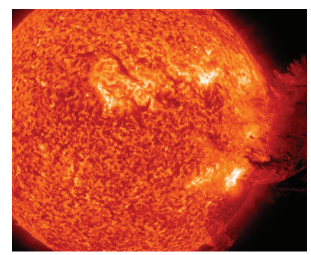
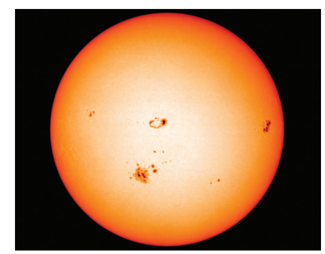
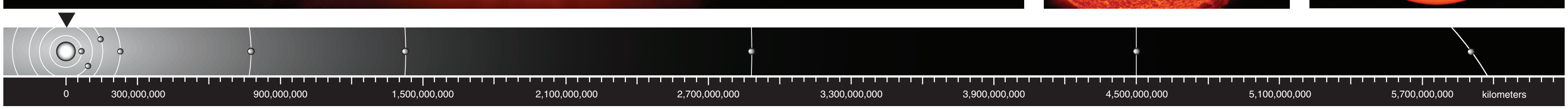
National Aeronautics and Space Administration











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 BCE. Now we know, of course, that all the planets orbit our lone star — the Sun.

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. The Sun has no solid surface.

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. Sunspot numbers fluctuate 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 of 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, temperature increases with altitude, reaching 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 emerged from observations by the Solar and Heliospheric Observatory (SOHO) and the Transition Region and Coronal Explorer (TRACE) missions, but the complete answer still evades scientists. Recent missions — Hinode, Solar Terrestrial Relations Observatory (STEREO), and the Solar Dynamics Observatory (SDO) — greatly improved our knowledge of the corona, getting us still closer to the answer. They also give us an unprecedented understanding of the physics of space weather phenomena such as solar flares, coronal mass ejections, and solar energetic particles. Space weather can adversely affect our technology in space and on Earth; these missions help us to develop space weather reports.

FAST FACTS

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	1.989×10^{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*	3.83×10^{33} ergs/sec

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

SIGNIFICANT DATES

150 CE — 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 made independently 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.

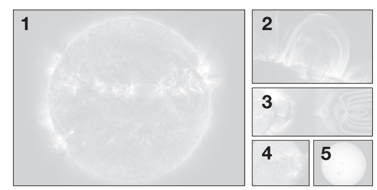
2007 — NASA's double-spacecraft STEREO mission returns the first three-dimensional images of the Sun.

2009 — After more than 18 years, the Ulysses mission ends.

2010 — SDO is launched and begins observing the Sun in super-high definition.

2011 — The STEREO spacecraft, from their dual perspective, see the entire Sun for the first time.

ABOUT THE IMAGES



1 Active regions spin out bright loops above the Sun that trace magnetic field lines (SDO image in extreme ultraviolet light).

2 Magnetic fields are believed to cause huge, super-hot coronal loops that 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 The Sun unleashed a solar flare with a spectacular coronal mass ejection on June 7, 2011 (SDO extreme ultraviolet image).

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

FOR MORE INFORMATION

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