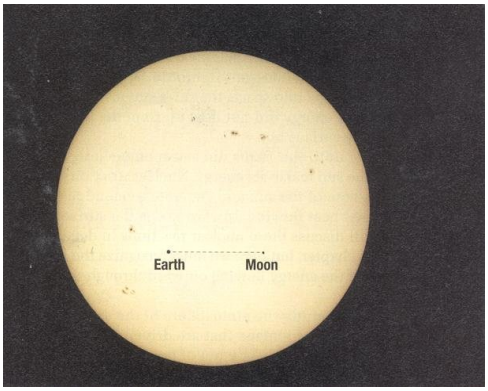
The Society for Telescopy, Astronomy, and Radio

WARNING: NEVER LOOK AT THE SUN WITH YOUR EYES OR WITH BINOCULARS OR TELESCOPES. IT WILL CAUSE PERMANENT, IRREVERSIBLE EYE DAMGE, INCLUDING BLINDNESS. THE EQUIPMENT USED IN THIS DEMONSTRATION IS SPECIALLY DESIGNED FOR OBSERVING THE SUN SAFELY.

Solar Surface Phenomena: What You're Seeing

The Basics

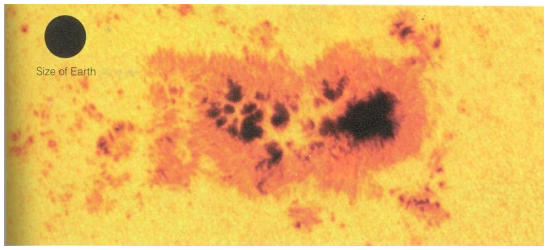
Everyone's life is affected by the Sun. It is responsible for practically all of the light and heat on Earth, and is the engine for our weather. The Sun is a fairly large star, located at an average distance of 93 million miles from the Earth. It has a mass over 300,000 times that of the Earth, and its radius is 109 times larger than Earth's. It would dwarf the Earth and Moon; many features on the Sun's surface are considerably larger than our planet. The Sun generates its incredible energy by fusing 508 million tons of hydrogen to 504 million tons of helium every second in its core, with 4 million tons of mass being converted to pure energy, as described by Einstein's famous equation $E=mc^2$. But the Sun's surface is not a bland disk; it has many interesting features. So just what are you seeing when you look at the Sun through a safely filtered telescope, or at a projection of the Sun?



Scaled image of the Sun and the Earth-Moon system

Sunspots

The first thing you will notice in a white-light projection of the Sun (i.e. normal light including all colors) is that the Sun's surface has spots. You are looking at the visible surface of the Sun, called the *photosphere*; the dark spots you see are called *sunspots.*

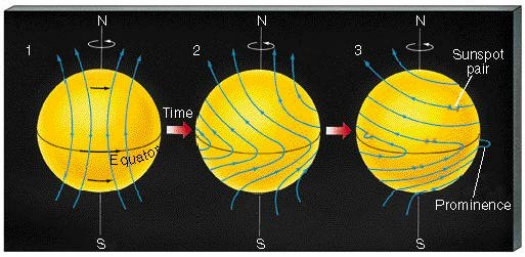


A sunspot, with the Earth compared for scale

The Sun's surface is made of luminous gas; the gas making up the sunspot regions is cooler than its surroundings, so it appears darker. This is actually an illusion. In fact, if the sunspot were viewed alone, it would appear a bright orange. Sunspots glow at about 4,200° Kelvin (7,100°F), as compared to about 6,000° Kelvin (10,000°F) for the rest of the solar surface. Sunspots consist of a dark central region, called the *umbra*, and a brighter outer region, called the *penumbra.* Large groups of sunspots are called *active regions.*

What Causes Sunspots?

These spots, like other solar surface phenomena, are caused by the tangling of magnetic fields. The Sun rotates around its axis once every 25-35 days. The Sun is a gas, and it rotates at its equator faster than it rotates at its poles; this principle is called *differential rotation.* The magnetic field of the sun is "tangled" as the gas at the equator wraps the magnetic field lines around the Sun with its quicker rotation.



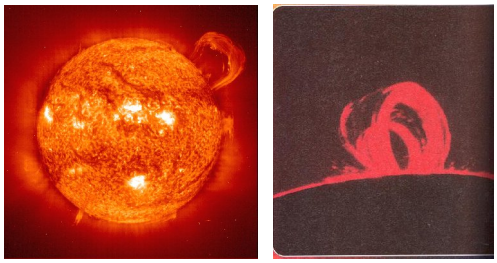
The tangling of magnetic fields from differential rotation

Regions in which the magnetic field is tangled result in sunspots. Instead of warmer gas rising and cooler gas

sinking by convection, like in a coffee pot, the cool gas in a sunspot is held in place by powerful magnetic fields, over 1,000 times that of the strength of the Earth's magnetic field. Therefore, this gas is cooler than the rest of the photosphere. Sunspots go through an 11-year cycle, with the maximum magnetic activity on the solar surface (such as sunspots) occurring every 11 years. The last "solar maximum" was in 2001. Individual sunspots are short-lived lasting only a few weeks.

Prominences

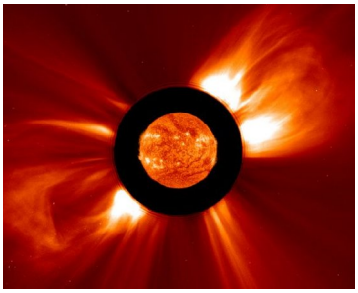
What else is there to see on the sun? Another magnetic phenomenon in the solar surface regions is called a *prominence*. In this event, hot gases erupt along a magnetic field line, in the layer above the photosphere called the *chromosphere*. These prominences consist of gas at about 80,000° Kelvin (140,000°F) and can be many times the size of the Earth. The gas eventually flows back into the solar surface.



Two solar prominences

Flares and CMEs

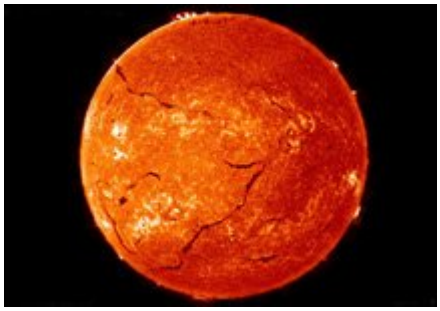
Sometimes, magnetic fields "reconnect" and cancel each other's strengths, and the energy stored in the magnetic fields is released as an enormous "solar flare" which can release particles that disrupt power and communications on Earth. Some flares, called CMEs, for Coronal Mass Ejections, send huge amounts of charged particles towards the Earth, resulting in brilliant auroral displays in the night sky.



A large coronal mass ejection

H-Alpha

Perhaps the most fascinating way to view the Sun is in "H-alpha" light, or hydrogen-alpha light. Atoms in the photosphere (the solar surface) absorb this orange-red wavelength of light, meaning that the light we see in H-alpha comes from the less-dense chromosphere, a layer above the photosphere which can be thought of as the Sun's "atmosphere".



An image of the Sun made in H-alpha light

The long dark streaks visible in H-alpha light are prominences seen directly above the Sun; they are cooler than the rest of the chromosphere and so appear black. It is also possible to observe solar prominences side on by looking at the edge of the sun. The area above sunspots appears very bright in H-alpha images.

Other phenomena that can be observed on the Sun in H-alpha light include *faculae (or plages)* and *spicules*. Faculae are regions of strong magnetic activity – often accompanied by sunspots- and are visible as bright regions. Spicules are jets of gas about 10,000 kilometers long that are shot up through the chromosphere. They appear darker against the rest of the solar surface (because they are absorbing H-alpha light).

Questions, Anyone?

If you have any questions about these features or anything else about the Sun, just ask one of the S*T*A*R members!

S*T*A*R is a member of The Astronomical League.

Meetings are the first Thursday of each month, except July and August, at 8:00 PM at the Monmouth Museum, Brookdale Community College, Lincroft, NJ. Meetings generally consist of lectures and discussion by members or guest speakers on a variety of interesting astronomical topics. Program content is balanced so that both novices and more experienced members can benefit from the meetings. Meetings are followed by an observing session when weather permits.

For more information, visit http://www.starastronomy.org or email richg870@aol.com