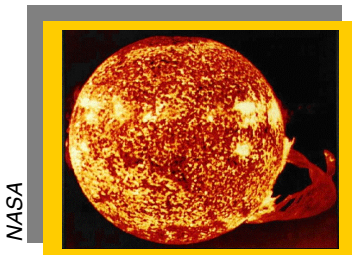


Sunspots

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In the early 1600's when Galileo started playing around with lenses, he projected a magnified image of the sun on his wall. He immediately noticed several small "blotches" on the disc, which we now call sunspots. In fact, publicizing these "imperfections" on the celestial face of the sun was one of the things that got Galileo into trouble with the authorities.

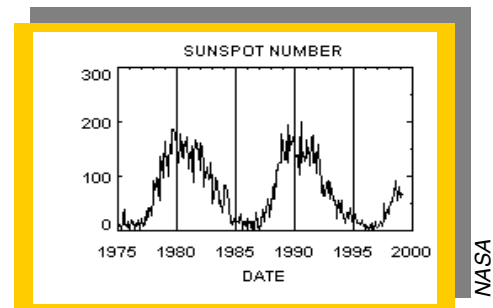


Visibly*, sunspots appear to be dark. But in fact, they put out plenty of light. The sun puts out light because it is hot: nearly 6,000 °Kelvin. Sunspots are also quite hot, about 4,000 °K, or over 6700 °F. Not as hot as the rest of the sun, they are about one-fifth as bright. Their apparent darkness is only in contrast with the surrounding solar surface.

The energy of the sun comes from **nuclear fusion**, a process where the cores of hydrogen atoms (**nuclei**) are fused together to make larger helium nuclei. This process releases a tremendous amount of energy, but it can only take place at enormous temperatures and/or pressures: much higher temperatures than the 6,000 °K at the surface of the sun. The surface of the sun is not where the most important reactions are taking place. These take place much deeper in the core of the sun. The ways in which this energy makes its way up to the surface, and its effects on the great mass of overlying gas, are complicated. Many details are not yet fully understood.

Sunspots give us many clues to work with, though. When sunspots are observed for several days, they are seen to move across the face of the sun. This means that the sun is rotating—and fairly quickly—at about once every 25 days. That might not seem fast, since the Earth spins around in only one day. But the sun is more than 100 times as big, so the "speed" of a spot on the surface of the sun is more than four times that of a spot on the surface of the Earth.

Tracking the movements of sunspots shows that the sun does not rotate as one solid object. Different parts rotate at different speeds. Also, the number of sunspots grows fewer, and then larger again, about every eleven years. That indicates that something fundamental is changing under the surface during this eleven-year cycle, since individual spots only last from a few days to a month or so. Sunspots result from the sun's huge magnetic field, caused by the complicated rotating-boiling motions of highly charged gases. From time to time, kinks and knots form in the field. When these knots work their way to the surface, they can "pop out" along with large amounts of solar gases or **plasma**. When seen from the side (at the edge of the sun's disc), we call these events **prominences**, **flares** and **mass ejections**. From the top the ejected gases are hard to see against the bright sun. But we can see the footprints of these flares. Magnetic fields of flares have been traced back to connect to the surface of sunspots.



The Sunspot Cycle

There is a lot of interest in understanding sunspots and flares, since when this ejected material reaches the Earth, satellites may be destroyed or parts of our electric power network knocked out. Understanding and predicting sunspot activity will continue to be of great importance, as our presence in space increases in the future.

***Warning!** Never peer at the sun directly. Prolonged exposure, even through homemade protection like "smoked glass" or photographic negatives, can lead to permanent eye damage.

