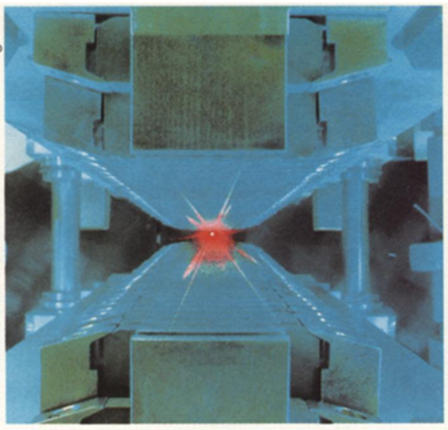
Argonne



tight, snaking path. Each change in direction produces an intense burst of high-energy X rays with a well-defined wavelength, which can then be directed to the specific sample.

The Advanced Photon Source allows as many as 35 research teams to conduct experiments simultaneously. Each research group has access to two X-ray beams, one from a corner and the other from the undulator magnets of a straight section of the storage ring. By adjusting the magnets, the researchers can tailor the X-ray beams to a particular experiment.

A light beam simulates the passage of charged particles through an array of magnets called an undulator. In the Advanced Photon Source, undulators cause the paths of speeding positrons to zigzag, generating an intense burst of high-energy X rays with each change in direction.

Groups already preparing experiments plan to take advantage of this unique X-ray source to do highly detailed protein crystallography; obtain new views of enzymes, toxins, viral proteins, and other biological molecules; and produce movies of changes in atomic and molecular arrangements as polymers or semiconductors form. —*I. Peterson*

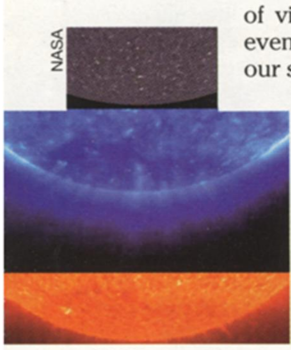
SOHO views the sun in a new dimension

Fiery plumes shoot millions of kilometers above the poles. Streams of charged particles rush into space. Miniflares dot the solar disk like tiny Christmas lights, and gases seethe just beneath its visible surface.

And they call this the quiet sun.

To the surprise of many solar astronomers, a recently launched spacecraft has documented sustained, global acts of violence on the sun—even though the star of our solar system is now at its most quiescent, poised at the minimum of its 11-year activity cycle.

NASA



SOHO images show magnetic fields on the sun's surface near the south pole (top), an ultraviolet image of hot plumes high above the pole (middle), and an ultraviolet image of the atmosphere closer to the surface (bottom).

The fireworks are just one of the findings uncovered by the Solar and Heliospheric Observatory (SOHO), a NASA-European Space Agency mission launched last December. For more than 4 months, the craft has stared unblinkingly at the sun, probing its outer atmosphere, its visible surface, and regions several thousand kilometers beneath.

Together, SOHO's images and spectra have begun to paint a more unified portrait of the sun, directly relating the release of high-energy radiation and the expulsion of material in the hot outer atmosphere, or corona, to turbulent motion and changes in magnetic field patterns far below. "We've never had a [craft] that can just sit up there and see what's going on" in so many different regions at the same time, says Harold Zirin of Big Bear (Calif.) Solar Observatory.

Researchers reported the first SOHO findings May 2 at press briefings in Paris and Washington, D.C.

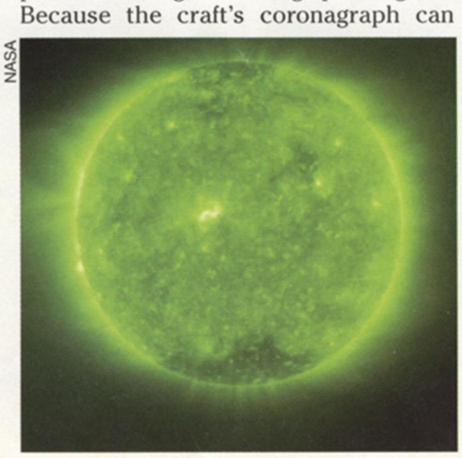
Ultraviolet movies compiled from the craft's images reveal the source of flaming plumes that extend more than 15 million km into interplanetary space from the poles of the sun. Each plume's base, about 1.5 times wider than Earth's diameter, is anchored in turbulent gases and wildly gyrating magnetic fields.

Magnetic fields guide the motion of charged particles in the sun. Rapid changes in these fields "may represent the release of significant amounts of energy on the sun and . . . contribute to the heating of the corona," says SOHO investigator Joseph B. Gurman of NASA's Goddard Space Flight Center in Greenbelt, Md. The magnetic fields often appear as loops, which can sometimes break, forming jets that may propel charged particles upward.

SOHO researchers are attempting to determine whether the plumes contain high-speed outflows of gas. If they do, these plumes could be the source of an unusually fast-moving component of the solar wind—the stream of charged particles blown out by the sun—that the Ulysses spacecraft observed when it passed over the sun's poles in 1994 and 1995.

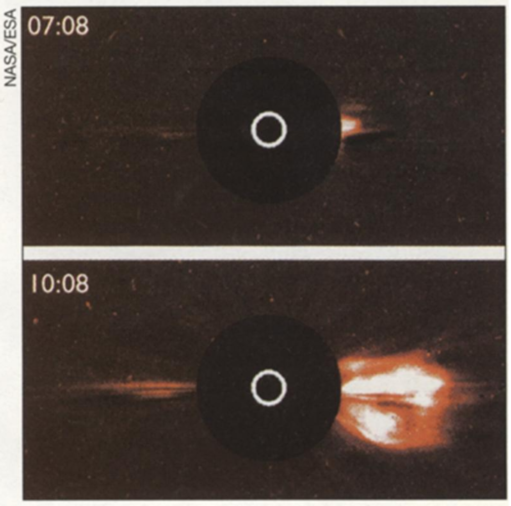
In another SOHO study, visible-light images of the solar corona depict the sun spewing out billions of tons of gas. Such events, known as coronal mass ejections, can trigger electrical storms on Earth powerful enough to damage power grids. Because the craft's coronagraph can

NASA



SOHO's ultraviolet view of the sun's corona shows gas at 1.5 million kelvins.

NASA/ESA



Images taken 3 hours apart show a coronal mass ejection. To reveal the corona, disks were used to blot out the sun.

view the atmosphere lying as close as 1.4 million km from the sun's surface and as far away as 15 times that distance, researchers can track the evolution of these violent events.

"I believe that for the first time we can see the sun preparing itself for a mass ejection," says Guenter E. Brueckner of the Naval Research Laboratory in Washington, D.C. In the days preceding an ejection, he told SCIENCE NEWS, SOHO images show that looping magnetic fields in the inner corona expand, transporting material to the outer part of the corona. The bulging fields exert enough pressure to blow the lid off material trapped by existing magnetic fields in the outer corona, hurling tons of gas into space.

Brueckner notes that if further SOHO observations confirm this admittedly sketchy model, scientists would gain advance warning of destructive outbursts from the sun. SOHO has already demonstrated, he adds, that coronal mass ejections are widespread. Their global nature suggests that these events could be the long-sought origin of most components of the solar wind, Brueckner says.

—*R. Cowen*