SCIENCE NEWS of the week

Yohkoh: A New X-ray View of the Sun

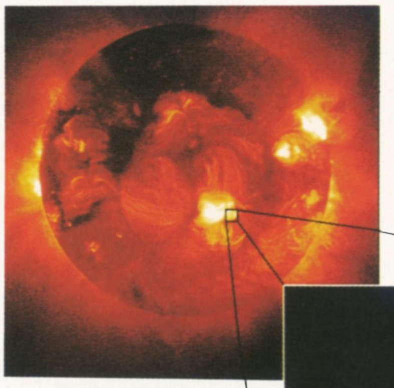
High above the spinning sun, the solar atmosphere seethes with X-ray energy unleashed when dense magnetic field lines, twisted like taut rubber bands, suddenly snap or change their structure. Vast areas of the atmosphere erupt without warning; gases heated to millions of degrees Celsius send out spectacular flares that glow like fire at X-ray wavelengths, forming giant arches and spewing out jets and ribbon-like streamers into space.

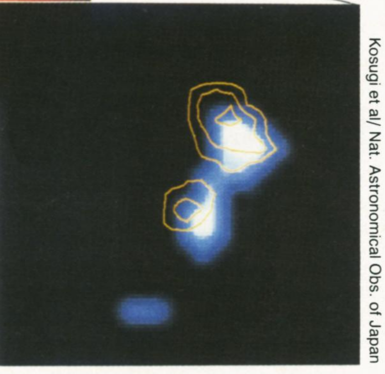
That's the violent, X-ray view of the sun as seen by Yohkoh, a Japanese-built satellite launched last August. A team of U.S. and Japanese researchers last week presented still images and videotapes from the mission, culled from thousands of photos made during Yohkoh's first eight months in orbit. And judging by their audience's reaction last week, the videos would be sellouts at any rental outlet.

Many short-term rocket flights and a few satellites, including the Solar Maximum Mission, have previously observed the sun's X-ray output, notes Keith Temple Strong of the Lockheed Palo Alto (Calif.) Research Laboratory. But Yohkoh has recorded more images of X-ray activity and traced the evolution of individual upheavals in the solar atmosphere in more detail than any other mission, he adds. Strong, his Lockheed colleague Marilyn E. Bruner and their collaborators presented their findings last week at a meeting of the American Astronomical Society in Columbus, Ohio. They say the results are already providing researchers with new data for understanding the magnetic structures believed to trigger outbursts in the sun's outer atmosphere, or corona.

Comparison of visible-light and X-ray images taken by Yohkoh confirms previous observations that clusters of sunspots — turbulent, optically dark regions of intense magnetic activity on the solar surface — coincide with the location of bright X-ray flares in the corona, says Bruner. Images of the corona taken with the satellite's two X-ray telescopes indicate that flares eject huge volumes of mass, comparable to the amount carried away in the same time period by the flow of charged particles known as the solar wind, notes Hugh S. Hudson of the University of Hawaii in Honolulu.

Rather than dying out rapidly, many of the observed flares last as long as half an hour, Bruner says. The Yohkoh images, she adds, suggest a mechanism for sustaining these outbursts, which trace out the looping patterns of magnetic field lines. Some newborn flares resemble arches that researchers suspect follow the path of tightly curved, stressed magnetic field lines that loop into and out of the corona like rubber bands near the breaking point. But as time goes on, the flares change shape, appearing as longer arches high in the corona. That transformation, says Bruner, suggests that the taut magnetic field lines have "uncoiled," releasing some of their energy and providing flares with a kind of pilot light to continue burning at X-ray wavelengths.





Kosugi et al/ Nat. Astronomical Obs. of Japan

Inset of X-ray image of solar corona shows X-ray emission (white) and visible light (yellow contours) associated with a flare. X-rays mark the two "footpoints" where magnetic loops enter and exit the corona.

A small, single flare may also trigger a chain reaction. Using Yohkoh's "hard" X-ray telescope, which records X-ray energies greater than 15,000 electron-volts, Takeo Kosugi of Japan's National Astronomical Observatory in Tokyo and his colleagues have found evidence that flares prompt adjacent magnetic field loops to unleash their energy. The finding indicates that a small group of flares may expand over time, involving larger volumes of the corona by progressively tapping the energy of larger magnetic loops at higher altitudes in the solar atmosphere, Kosugi says. — *R. Cowen*

Forging links between mathematics and art

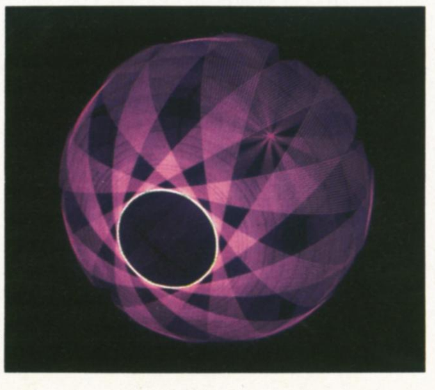
To many people, art and mathematics appear to have very little in common. The seemingly rigid rules and algorithms of mathematics apparently lie far removed from the spontaneity and passion associated with art. However, a small but growing number of artists find inspiration in mathematical form, and a few mathematicians delve into art to appreciate and understand better the patterns and relationships they discover in the course of their mathematical investigations.

To prove the remarkable fruitfulness of such links, more than 100 mathematicians, artists and educators gathered last week at the Art and Mathematics Conference (AM '92), held in Albany, N.Y. Organized by mathematician and sculptor Nat Friedman of the State University of New York at Albany, the meeting represented his attempt to find people with whom he could share his deep interest in visualizing mathematics, whether in geometry, sculpture, computer art or architecture.

Attempts to visualize such mind-bending mathematical transformations as turning a sphere inside out without introducing a sharp crease at any point during the operation demonstrate how mathematics and computer graphics can lead to valuable insights that are potentially useful to both scientists and artists.

In 1959, when Stephen Smale, a mathematician at the University of California, Berkeley, first proved this particular operation possible, no one could readily visualize how it happens. By gradually simplifying the steps involved in turning a sphere inside out, mathematicians eventually found ways of picturing the entire process (SN: 5/13/89, p.299).

François Apéry of the University of Upper Alsace in Mulhouse, France, has now captured the essence of the process,



Apéry

Near the midpoint of an eversion, a sphere's meridians have flipped over the coincident poles to double up into a smaller sphere, with an open end (yellow circle) marking the equator's new position.

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