# Astronomy

*Ron Cowen reports from Columbus, Ohio, at a meeting of the American Astronomical Society*

## Sunny findings: Solar gas flow . . .

Astronomers have found evidence that gases flow steadily across the visible surface of the sun, rising up from the interior at the solar equator and moving toward the north and south poles. David H. Hathaway of NASA's Marshall Space Flight Center in Huntsville, Ala., says the surface flow may offer new insight into the sunspot cycle.

Since the flow probably carries with it the high-intensity magnetic fields that trigger sunspots and solar flares, the circulation pattern may help explain the changing distribution of these intense eruptions, Hathaway says. This large-scale flow sports another feature: Although most of it reaches the poles, some of the gaseous material sinks at middle latitudes—about 30 degrees above or below the equator—where sunspots most often form. Other researchers had previously found that the middle latitudes of the sun have a weak jet stream and cooler temperatures — phenomena that migrate toward the equator, along with newly formed sunspots, as the sunspot cycle progresses. Hathaway suggests that the sinking gas he found at middle latitudes also moves toward the equator during the sunspot cycle.

Hathaway and his colleagues made their observations in 1989 and 1991 at the National Solar Observatory facility at Kitt Peak, Ariz., using a prototype of a new filter and telescope system called the Global Oscillations Network Group (GONG). GONG measures the speed of hot gases in visible light as they flow along the solar surface, toward or away from the telescope.

To identify a general circulation pattern on the sun's surface, Hathaway's team had to first account for several complicating motions. These include radial pulsations of the sun, which make the solar surface contract and expand like a ringing bell. In addition, the boiling motions that release heat at the solar surface cause gas to rise and fall rapidly, also confounding attempts to measure gas flow. Hathaway estimates that the flow his team has identified moves with a speed no greater than 60 meters per second.

Hathaway's team has not observed all faces of the sun. To ensure that gases have a similar flow everywhere on the solar surface, researchers may need to take several measurements during one complete revolution of the sun — about 27 days.

## . . . and perhaps a longer solar cycle

The sunspot cycle may be part of a longer solar activity period, says Richard Altrock, a U.S. Air Force scientist stationed at the National Solar Observatory facility at Sacramento Peak, N.M. He adds that successive solar cycles may overlap.

Altrock bases his conclusions on 19 years of data gathered at the NSO. The studies indicate that a full solar cycle may last nearly two decades. Moreover, the cycle may embrace other types of magnetic activity besides visible sunspots.

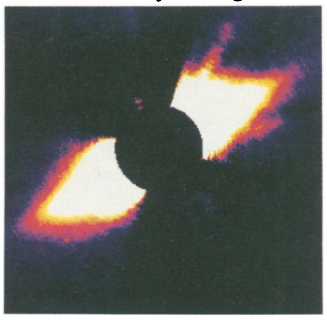
The sunspot cycle, determined by the number and position of the spots, typically has an 11-year period. Increased sunspot formation at middle latitudes marks the beginning of each cycle. But other types of magnetic activity, which take place at higher latitudes — closer to the poles — precede sunspot formation, Altrock asserts.

Researchers had previously speculated that the solar activity cycle begins closer to the poles and then migrates to lower latitudes, Altrock notes. But high-latitude features on the surface of the sun are difficult to observe from Earth because the angle of sight distorts them or makes them invisible. To overcome this problem, Altrock and his colleagues restricted their observations to the corona, the region above the sun's visible surface. Since bright coronal features correspond to magnetic activity on the surface, the researchers could deduce the location of magnetic features on the sun.

Using a coronagraph to block the overwhelmingly bright light emitted by the solar surface, Altrock and his team measured faint emissions from the inner corona. Observations during the past 19 years by Altrock and others indicate that magnetic activity preceding the current sunspot cycle began at high solar latitudes in 1979. The full cycle is expected to last through 1998. The NSO studies also show that the next solar cycle, which should produce a peak number of sunspots just after the turn of the century, began in 1990 at a latitude of 70 degrees, overlapping the current solar cycle. This cycle may also last about 19 years.

## Probing the disk of Beta Pictoris

Located some 53 light-years from Earth, Beta Pictoris is the best-known example of a star surrounded by a disk of gas and dust — a possible solar system in the making. Researchers believe that such a disk once encircled our sun, giving rise to the planets and their moons some 4.6 billion years ago.



Golimowski, Mark Clampin, Samuel T. Durrance

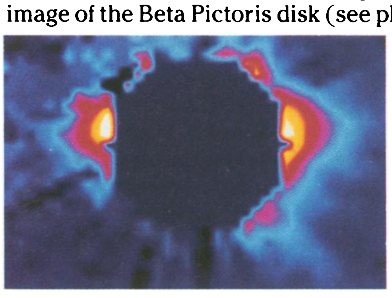
This visible-light photo is the sharpest image ever taken of Beta Pictoris' dusty disk. David A. Golimowski of Johns Hopkins University in Baltimore and his colleagues took the image last December using a 2.5-meter telescope at Las Campanas Observatory in La Serena, Chile.

A coronagraph blocked out the bright light emitted by the star so that researchers could record its faint disk. This novel coronagraph contains a mirror that flexes as needed to compensate for image distortion caused by Earth's turbulent atmosphere, enabling astronomers to resolve features as small as 1 billion kilometers across. Viewed edge-on, with the blocked-out star in the center, the disk's highest-intensity regions appear brightest in this false-color portrait. Bright spots at the top and bottom of the darkened star are artifacts.

Another team of researchers reports that the inner regions of the disk contain the same type of dust as comets and Earth rocks. Sergio B. Fajardo-Acosta of the State University of New York at Stony Brook and his colleagues analyzed the infrared spectra of light from the disk at NASA's Infrared Telescope Facility in Hawaii. Some of the light emissions, they find, stem from particles of crystalline silicate—the same mineral spewed out by Comet Halley in 1986 as it encountered the intense heat of the sun.

Fajardo-Acosta and his co-workers say this suggests that the inner part of the Beta Pictoris disk contains many cometary bodies too distant for a telescope to image; these bodies would shed silicate dust when they pass near their parent star.

Other astronomers have now produced the first infrared image of the Beta Pictoris disk (see photo), using the 1.5-meter telescope at the Cerro Tololo Inter-American Observatory in La Serena, Chile. The colors and reflectivity of the light from the outer part of the disk indicate its composition may be similar to that of the icy moons of Jupiter, Saturn and Uranus, report Melissa L. Nischan of Franklin and Marshall College in Lancaster, Pa., and two colleagues. Thus, the outer part of the disk may contain material left over from the creation of bodies similar to those in the outer solar system.



Nischan, Dana Backman, Ben Zuckerman