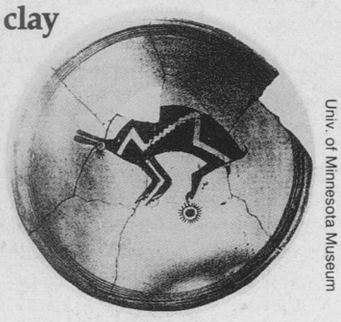
Astronomy

Ivars Peterson reports from Albuquerque, N.M., at a meeting of the American Astronomical Society

A supernova story in clay



Univ. of Minnesota Museum

Supernova bowl

The Mimbres people, who lived in southwestern New Mexico about 1,000 years ago, are famous for their exquisite pottery, and particularly for the vividly patterned, shallow bowls they used mainly to cover the faces of deceased tribe members who were buried beneath the floors of their adobe houses. A careful study of bowl patterns now reveals that the Mimbres people also made astronomical observations, following the movements of the moon and apparently recording the 11th-century A.D. supernova that created the Crab nebula. According to astronomer R. Robert Robbins and student Russell B. Westmoreland of the University of Texas at Austin, a Mimbres artifact now described as the "supernova bowl" is the most certain record of that supernova yet discovered outside of China and Japan.

Robbins and Westmoreland examined about 800 bowls from the Mimbres village of Galaz. Many of these white, earthenware bowls sport geometric designs and fanciful figures painted in black on their inside surfaces. The researchers repeatedly encountered stylized representations of a rabbit — a common symbol for the moon among many indigenous cultures in the Southwest and in Central America. Other markings on the bowls appear to correspond to the number of days it takes the moon to complete a single orbit around the Earth relative to the stars, and the number of days it takes the moon to go through all its phases. The supernova bowl features a rabbit clutching a circular object from which 23 rays emerge.

The Mimbres would have first seen the supernova on the morning of July 5, 1054 A.D., with the waning crescent moon rising in the east, followed by the supernova, which would have been five or six times brighter than Venus at its brightest. The bowl's curled rabbit, representing the dark areas visible on the lunar surface, and the supernova image are positioned so that the relative orientations of the lunar crescent and the supernova correspond to the astronomical observations made that morning. Asian records indicating the supernova was bright enough to be seen during daylight hours for 23 days offer a possible explanation for the 23 rays emanating from the Mimbres supernova image.

"The bowl provides us with the best-supported historical record from the Western Hemisphere of the supernova that created the Crab nebula, and it goes far in telling us about the sophistication of a group of southwestern Indians," Robbins says. The fact that all the bowls of astronomical significance came from just two locations in the village suggests that astronomy held a special status among the tribe, perhaps signifying that someone held the rank of official astronomer or calendar priest.

Shooting through sheets of galaxies

Like a searchlight slicing through the mist, light from a bright, distant quasar can illuminate whatever lies directly between the quasar and Earth. Intervening galaxies, hydrogen clouds and intergalactic material intercept the light, absorbing certain wavelengths while allowing others to pass through unhindered. But interpreting the resulting spectra is no simple matter. Sometimes, the spectra are so complicated there's no telling where the light has been.

In 1987, astronomers noticed striking similarities between the spectra from two separate quasars, designated Tol 1037 and Tol 1038, approximately 4 billion light-years from Earth. As seen in the sky, these quasars appear separated by an angle equivalent to two-thirds the diameter of the full moon, or by a distance of at least 15 million light-years at the quasar locations. The closely matching spectra suggested that the line of sight to each quasar apparently cuts through four separate, strongly absorbing regions located at the same positions along both lines. Because the probability of finding so many matching absorption regions by chance is small, a number of astronomers concluded that the two lines of sight intercept a single supercluster of galaxies at least 15 million light-years across and 45 million light-years deep.

A fresh look at the light from the two quasars, however, now reveals fine details in the spectra, clearly indicating a less-than-perfect match and the presence of additional light-absorbing regions. Laura Ferrarese and J. Christopher Blades of the Space Telescope Science Institute in Baltimore and Stefano Cristiani of the University of Padua in Italy report that although the positions of the light-absorbing regions are roughly comparable along both lines of sight, the patterns of light absorption are significantly different in three of the four cases. The team tentatively interprets these observations to mean that light from the two quasars traverses three or more "sheets" of galaxies, with each line of sight poking through different galaxies or clouds in the same cluster. The sheets appear to sit about 12 million light-years apart along both lines of sight.

Magnetic bottles in a solar junkyard

Even in "quiet" regions far from sunspots, the solar surface shows a remarkably complicated web of magnetic fields. By combining data from several sources, Ronald L. Moore of NASA's Marshall Space Flight Center in Huntsville, Ala., and his collaborators have uncovered direct evidence of small, closed magnetic loops and other previously unrecognized magnetic features spanning much of the sun's surface. The findings indicate that the intricate structure of the magnetic field in quiet areas develops from decayed sunspot regions and from magnetic loops continually bubbling up through the surface. This jumbled magnetic field takes the form of many short loops linking adjacent clumps of opposite polarity — in effect, a magnetic "junkyard" thickly strewn with "magnetic bottles."

Other observations reveal that these closed magnetic bottles often explode, releasing magnetic energy in a microflare. The researchers say such localized magnetic explosions may prove the source of much of the heating that causes the temperature of the solar atmosphere to rise steeply to more than 1 million kelvins in the sun's outermost layer, or corona. Moreover, the pattern of mysterious, transient strands called spicules, which thread the solar atmosphere, seems to trace the small magnetic loops found on the sun's surface.

Maser bursts from the sun

For the first time, solar astronomers have observed bursts of coherent radio waves coming from a specific location on the sun's surface. The bursts emanate from a maser (the radio-wave equivalent of a laser) operating in the intense magnetic field of a large sunspot. The emissions are generated when high-speed electrons, whipped up in a solar flare, enter a nearby region in which converging magnetic field lines trap and reflect some electrons while allowing others through. This solar maser produces short pulses of electromagnetic radiation about 0.1 to 0.2 second long and billions of times brighter than radiation of the same wavelength produced on the sun by other processes, report Dale E. Gary and his colleagues at the California Institute of Technology in Pasadena.