STARS, SKY AND CULTURE

From the Pawnee of Nebraska to the Quechua of Peru, archaeoastronomy is providing insights into how early New World peoples integrated astronomical knowledge into their lives and social systems

BY KENDRICK FRAZIER

As astronomers reach outward to explore the frontiers of the physical universe, some among them have joined with archaeologists, anthropologists, architects, art historians ("just to mention the A's," says one) and others are looking backward to the astronomies of early peoples in the New World. The idea is not just to record the often-surprising astronomical knowledge of native Americans (although that is a fascinating part of it), but to better understand the workings of their minds and cultures. It's not an exercise in sterile history, but an effort to come to terms with the way early people's lives and thoughts were integrated with the sky and heavens. As such it can tell us a lot not only about our predecessors in the Americas but also something about ourselves.

The Conference on Archaeoastronomy in the Americas, on the hilltop campus of St. John's College in Santa Fe, N. M., in June amply demonstrated both the accelerating interest in this interdisciplinary activity called archaeoastronomy and the amazing diversity of ways in which American Indians monitored and lived by the day and nighttime sky. It was only the third such conference ever held (the first was in Mexico City in 1973, the second at Colgate University in 1975). The number of papers has doubled since the first conference, and this year's presenters came from more fields of intellectual inquiry than anyone bothered to count. "In the past 10 years we have witnessed a remarkable growth of interest in traditional astronomies," noted astronomer and conference organizer Ray A. Williamson, understating the case if anything.

We now know that native Americans were keen watchers of the heavens. Their observations were integrated into their total conceptual framework. In sharp contrast to our Western-oriented, scientific astronomy, theirs was, as Williamson puts it, "more down to earth, less abstract, and closely linked with natural earthbound cycles." Such knowledge was important in their agriculture, religion and rituals, to be sure. It played a vital role in their lives.

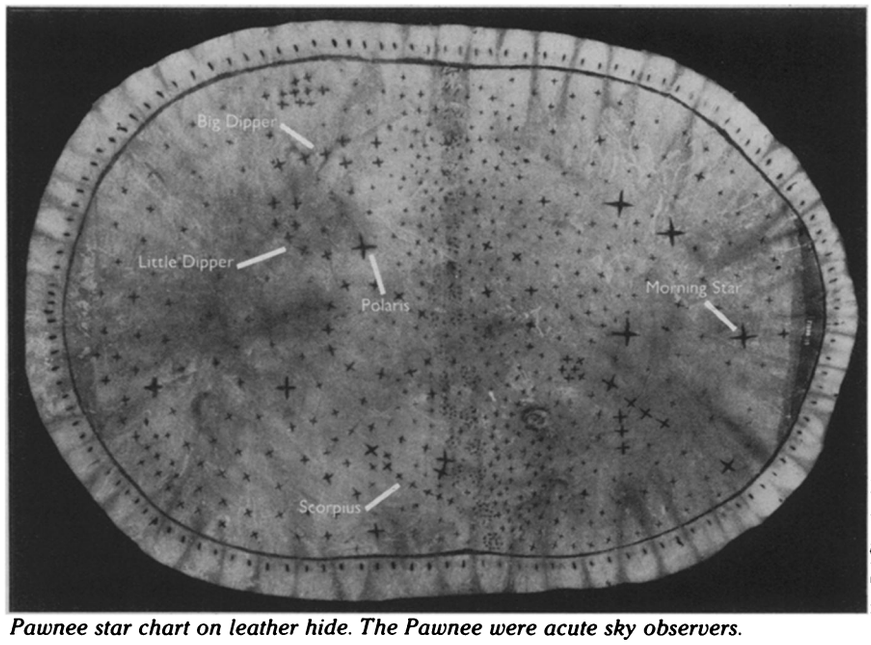
Yet it isn't limited to just that. "It's the nature of human nature to organize time and place," says E. C. Krupp, director of the Griffith Observatory in Los Angeles. "You all need to know who you are, when you are, where you are. You need to know how you fit into the world." The point is that the search for human context in the physical universe also motivated early astronomical practice, just as it motivates much of our own interest in astronomy and cosmology today.

A variety of new findings and analyses illustrate the abundant knowledge Indians had of the sky and its links to their culture.

The Pawnee Indians of Nebraska made star charts, one of which survives today on a piece of leather hide in the Field Museum in Chicago. Astronomer Von Del Chamberlain of the Smithsonian Institution recently studied the star chart and other materials about Pawnee culture. He finds they lived under a complex religious system based upon interpretation of observed natural phenomena.

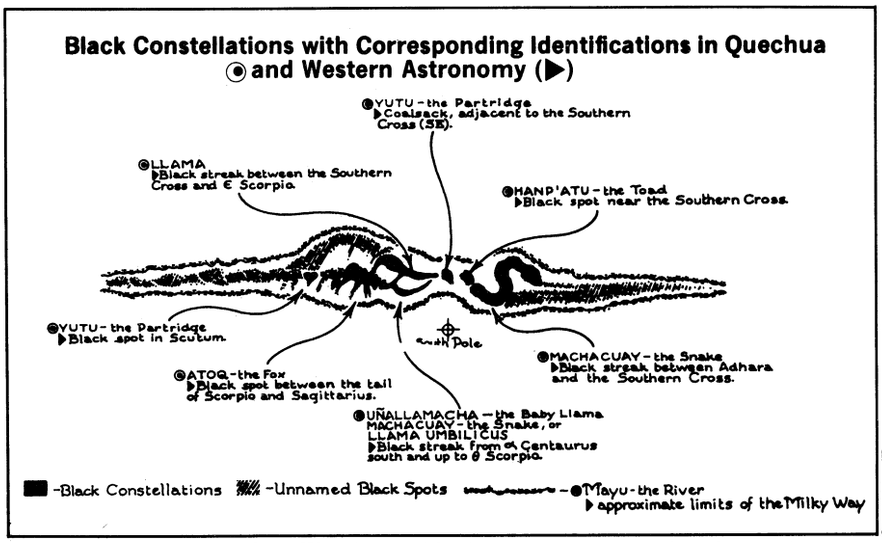
The star chart itself clearly shows the Big and Little Dippers, the Pleiades and the Hyades. Other Constellation groupings are less certain, but Chamberlain says surviving lists show the Pawnee (specifically the Skidi branch) had a well-developed system of labeling objects in the sky. At least 5 planets, 26 stars and 17 constellations have been mentioned in records of the Skidi Pawnee. "The Skidi were among the few native tribes known to have made charts of the sky," says Chamberlain.

Their priests were acute observers.



Von Del Chamberlain

Pawnee star chart on leather hide. The Pawnee were acute sky observers.



Gary Urton/Ethnology

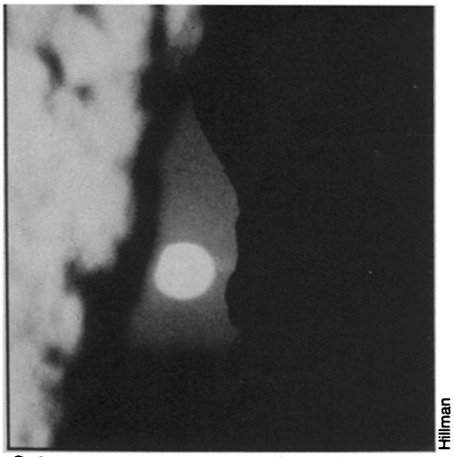
Quechua Indians used Milky Way, here with black constellations, for observations.

They noted the heliacal risings (first rising with the dawn) of certain stars, observed the rising and setting directions of objects, noticed the relative positions of the planets, and made observations through smoke holes and east-oriented entranceways in their earth lodges.

The Pawnee based their calendar on a carefully determined combination of astronomical and meteorological phenomena. Most important, says Chamberlain, were two stars known as the Swimming Ducks. These, he feels certain, were Lambda and Upsilon Scorpii, a pair of stars that in our lore form the stinger of Scorpius. The heliacal rising of the Swimming Ducks followed by the first springtime thunder set the beginning of the ceremonial cycle and the summer half of the year. Also important was the South Star (Canopus). Winter began with its heliacal rising.

The Pawnee were also very concerned with directions and used the stars to determine them. It seems likely, says Chamberlain, that they oriented their lodges by critical astronomical observations.

J. D. Stewart of Lakehead University in Thunder Bay, Ontario, has also studied



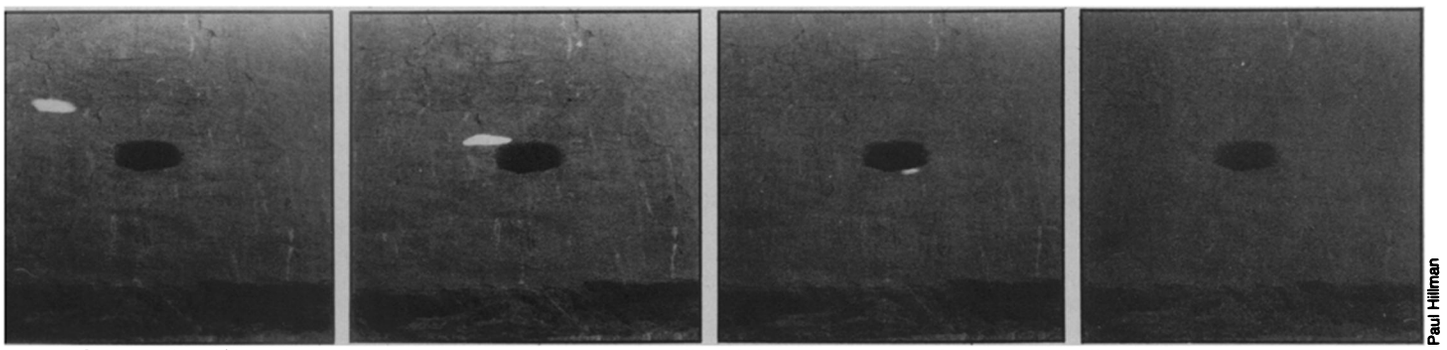
Hillman

Solstice sunset framed at Casa Grande.

but did leave field notes, in this case a set of 1929 notes based on an interview under the stars with a Zuni. One Zuni group of stars was called Chief of the Night. It includes many of our constellations and is so large it stretches across the entire night sky and cannot all be seen at one time. The Zuni word for the Little Dipper contains within it the stem for the direction north. One Zuni constellation is known as "Hand Game Gamblers," representing players in a Zuni ritual game. Names for other constellations are more or less descriptive: Orion's belt is "Be in a row." The close-clustered Pleiades, our "Seven Sisters," are "pinon seed in a bunch." Pegasus is "Four big one," Cassiopeia is "Stars zig zag," and the Big Dipper is called simply "Seven." Young is spending this summer with the Zuni to gather more information on their star lore.

At Casa Grande National Monument between Phoenix and Tucson (a 600- to 800-year-old Hohokam Indian site) astronomer J. H. Evans of the University of Wisconsin at Oshkosh and civil engineer Harry F. Hillman of the University of Arizona have been studying the probable astronomical uses of the four-story prehistoric structure there. Oral tradition has it that the early Indians looked out of observation holes to salute the sun. One window in the west face of the blocky structure's four-foot-thick adobe walls was quite clearly a solstice marker, Evans and Hillman have found. It exactly framed the setting sun on the day of summer solstice in June 1978.

More intriguing is evidence that openings on the west side could have been used to plot the moon's 18.61-year nutation cycle. The moon's orbit is tilted 5 degrees to the earth's orbit about the sun (the ecliptic). The points where the two orbits intersect are called nodes, and due to earth's gravitational perturbations of the moon in its orbit, this line of nodes precesses, with a complete retrograde cycle taking 18.61 years. The cycle is visually manifested on earth by the changing north-south position of the moon in the sky. Over this period the northernmost extreme of the moon moves from a maximum to a minimum and back to maximum again over 18.61 years. The same is true for the southernmost extreme. Patient observation of the position of moonrise or moonset on the horizon can elucidate this cycle, and this is what Evans and Hillman think was done at Casa Grande. In 1978 the northern and southern extremes of moonset were at their maximum in the 18.61-year cycle, Hillman says. At the time of northernmost extreme, an odd-shaped opening (circular at the outside of the wall changing to rectangular on the inside) facing northwest exactly framed the setting moon. A similar alignment was noticed through another opening for the southernmost extreme of the moon.



Paul Hillman

Light at Casa Grande passes through openings in outer wall and disappears into hole on inner wall at equinox sunrise.

On the east side of the building, a pair of holes were found to mark the equinoxes, the midpoint position of the sun on its north-south path. As photographed by the investigators at sunrise at the autumnal equinox in September 1978 and the vernal equinox in March 1979, light passing through a small hole in the outer wall "pops down into a hole" on an inside wall. This happens only on one day around the time of equinox — two days after it. Evans and Hillman are studying whether ground subsidence or other earth shifts might account for the two-day discrepancy.

The links between culture and the stars overhead are intriguingly illustrated by a comparison of cosmologies in northern, tropical and southern latitudes. In the lands that lie between the Tropic of Cancer and the Tropic of Capricorn the sun twice a year stands straight overhead (the zenith). Thus the sun's passage through this point marks an important time to some of these cultures. In northern temperate latitudes such as the United States, the sun and stars make large curving arcs through the

Pawnee astronomy. He says they intercalated a thirteenth month every now and then to bring their calendar back into phase with the seasons.

The Skidi Pawnee also understood that meteorites came from the sky, says Chamberlain. There are good indications they had seen a meteorite fall, then recovered the pieces. It is obvious, he says, that they had observed meteor showers and they were aware of the 1833 Leonid shower. They considered meteorites sacred and kept them in or with medicine bundles.

Chamberlain also feels the importance of Canopus to the Pawnee indicates that they had migrated to Nebraska from farther south, where Canopus would be higher in the southern sky.

Research like this might be called ethnoastronomy. Another example is the work of M. Jane Young of the University of Pennsylvania. She reports on tentative identification of Zuni Indian star groupings, based on recently discovered documents in the J. P. Harrington papers on Zuni in the Smithsonian Anthropological Archives. Harrington was a famous Smithsonian ethnologist who published little

sky, but in tropical latitudes they rise perpendicular to the eastern horizon, move through the sky in east-west lines and then set perpendicular to the western horizon. The intersection of this east-west axis with the up-down zenith-nadir axis creates the potential for systems of astronomy based on opposing or symmetrical left-right and up-down conceptions, according to anthropologist Gary Urton of Colgate University. Urton reports he has found evidence of such systematic oppositions in both the cosmologies and in the social systems of many Amazonian tribes.

R. Tom Zuidema of the University of Illinois and Anthony F. Aveni of Colgate University have found that the Incas kept track of the date of the sun's passage through the antizenith point, on the opposite side of the world, as well as of its zenith passage. The Incas also observed the solstices, using alignments from the sun temple in the capital city of Cuzco. The dates of the four zenith-antizenith points happen to be close to dates of agricultural interest to the Incas. Also, in the two times of year when the sun goes through antizenith the full moon at midnight comes closest to the zenith. The general importance the Incas gave to the moon for agriculture may have been another motivation for recording antizenith solar passage, Zuidema speculates.

There are other distinguishing characteristics of the southern hemisphere skies that lead to intriguing differences in the way South American cultures perceived the heavens. The coincidence of a fairly bright star very near the north celestial pole (Polaris, the North Star) provides northern hemisphere cultures with a firm fix on north from which the cardinal directions can be established. As early as the fourth century B.C., cities in the northern hemisphere were laid out in a grid pattern with a north-south axis aligned to the celestial north pole. There is no comparable "South Star" over the south celestial pole. What then, is the stellar basis for a system of directions among southern hemisphere Indian cultures?

Urton has found that among the Quechua-speaking Indians of the southern Peruvian Andes the Milky Way serves this purpose. The Milky Way is the bright band of stars we see when looking along the plane of our galaxy. The Milky Way is especially bright and spectacular from points in the southern hemisphere. This is because the direction of the center of the galaxy, where stars and clouds of gas are particularly dense, appears directly overhead in the southern hemisphere.

Urton has shown that the Milky Way serves as the Quechua celestial plane of orientation, even though it is oriented about 90 degrees to the plane of the ecliptic. (The ecliptic is the apparent path of the sun and the planets. We use the ecliptic in connection with the cardinal directions as our means of celestial orientation.) He believes these findings also apply to the Incas, who were Quechua-speakers and occupied roughly the same territory as the Quechua of today.

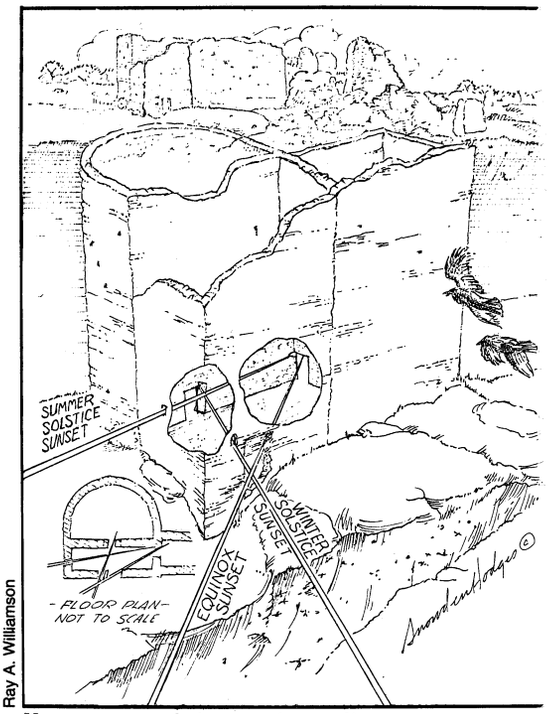
The prominence of the Milky Way affects the way the Quechuas think about spatial organization. Whereas the constellations of our zodiac are those in the plane of the ecliptic, the constellations of the Quechua zodiac run along the length of the Milky Way (which they call Mayu, "the river"). They've given them such names as the Eyes of the Llama (Alpha and Beta Centauri), the Great Cross, the Sacred Cross, the Storehouse and the Bridge. The Quechua have two distinct types of constellations, Urton has discovered — white and black. The white ones are star-to-star patterns, like ours, including those just named. But clouds of interstellar dust blot out certain portions of the stars of the Milky Way visible from the southern hemisphere. The Quechuas consider these clouds "black constellations." The black constellations are generally named for animals or plants: the Partridge (the Coalsack nebula), the Toad, the Llama, the Snake and so on.

Since the plane of the Milky Way is inclined between 26 and 30 degrees with respect to the earth's rotational axis, at one time the Milky Way runs northeast to southwest; 12 hours later, from northwest to southeast. The cross thus formed in the sky and in the inclined plane position at rise and set are important, named positions, says Urton, even in modern communities in the Department of Cuzco, Peru, today. When the Milky Way rises, it is called the inclined cross. At zenith it is called the Cross of Calvary.

The center of the Quechua celestial sphere, says Urton, is the star Alpha Crucis, a bright star in the Southern Cross. The Incan city of Cuzco is organized along imaginary lines radiating from the Temple of the Sun to the horizon. One of these lines, says Urton, points to where Alpha Crucis rises. "Since the south celestial pole is not marked by a bright star, the Inca took the rise of Alpha Crucis as the marker for southern orientations," concludes Urton, "thereby incorporating the center of the celestial sphere into the layout of the city of Cuzco, the Incaic capital and center of the terrestrial sphere."

Casa Grande: Moon cycle monitored?

National Park Service



Ray A. Williamson

Hovenweep solstice, equinox alignments.

Urton also shows that the Milky Way could have been used for the orientation of time as well as space. Specifically, it could have been used in several ways to calculate the solstices. And the heliacal rise and set dates of Alpha Crucis closely approximate the limits of the Incan agricultural season (September to April).

Back in North America, scientists continue to find a seemingly endless variety of ways in which early Indians monitored the skies. From California to Vermont (where many stone chambers and standing stones show possible alignments), the evidence accumulates. Along the east slopes of the Rockies in the northern plains, "medicine wheel" stone patterns have been found in abundance. The most famous is the Big Horn Medicine Wheel in Wyoming, which astronomer John A. Eddy showed had spokes aligning to the summer solstices and to the heliacal rising of the bright stars Sirius, Aldeberan, and perhaps Rigel (SN: 6/8/74, p. 366). A close twin of it is the Moose Mountain Medicine Wheel of southeastern Saskatchewan. When Eddy and archaeologists Thomas Kehoe and Alice Kehoe studied the site in 1975, they found the alignments best fit the positions Alderberan and Sirius in around A.D. 100 to 300. This seemed like quite an early date. But since then the Kehoes have managed to carbon-date some charcoal found beneath a cairn in the center of the Moose Mountain wheel. The date it yields is 2,000 years before the present, around A.D. 0. So now the astronomical date has received strong support from the carbon-14 date. The wheel was apparently in use nearly two millennia ago.

In the Southwest, Ray Williamson has

shown that the Anasazi (the "ancient ones") structure known as Hovenweep Castle on the Utah-Colorado border has ports that align to the sunsets of summer and winter solstice and the equinox. In each case the light comes through a different opening and strikes a doorway corner.

And other studies performed through 1978 of the slab-and-spiral-petroglyph arrangement atop Fajada Butte in Chaco Canyon, N.M., have now shown it to mark not only midday of summer solstice, as we reported a year ago (SN: 8/26/78, p. 148), but also the equinox and the winter solstice. It is the first ancient midday solar marker of the seasons.

With so much already accomplished, where is archaeoastronomy going? For that matter, exactly what is it? A new scientific specialty, a new discipline? Some have started to speak of it as a discipline in itself. "I regret that," Williamson told the Santa Fe conference. "It is interdisciplinary," he said, a truly broad, cooperative activity, not a narrow specialty. As E. C. Krupp said, "There may be archaeoastronomy, but there are no archaeoastronom*ers*." Instead, there are people who draw upon the knowledge and skills of workers in a diversity of fields. Anthony Aveni, organizer of the two previous conferences, called for stronger links between archaeoastronomy and cultural anthropology. And he hopes to work toward funneling results into the mainstream of the history of science, which until now has dealt only with the written astronomical record. But the conference leaders seemed unanimous in cautioning against over-institutionalizing the subject, such as creating a new scientific society.

"There's a consensus that it's not a good idea to create a formal structure," Krupp, author of *In Search of Ancient Astronomies* (Doubleday, 1978), said in an interview. "There's a danger of creating an identity for yourself that not only others misperceive but that you misperceive." He says until just recently there was concern that the field was becoming too ingrown, the same small cadre of people talking to each other — a "risk of growing isolated." The Santa Fe conference, he says, has dispelled that concern. Attendance was strong and discussions were brisk. "There are a whole lot more people out there than I thought."

"This conference has been genuinely interdisciplinary," Krupp approvingly told participants in a concluding talk. And that, he advised, is the best future route. "In this field it's not who you know, but what who you know knows that's important. It's not easy being interdisciplinary. But let's do it. Be it. Get in and make it happen. Archaeoastronomy is alive and well...."

Its goals? Nothing less than to understand how people used the stars, the sun, the sky to orient their own lives and worlds. "We want to know how people think," says Krupp, "how they organize time and place. We all have to take the sky in. We have to 'live the sky.'" □