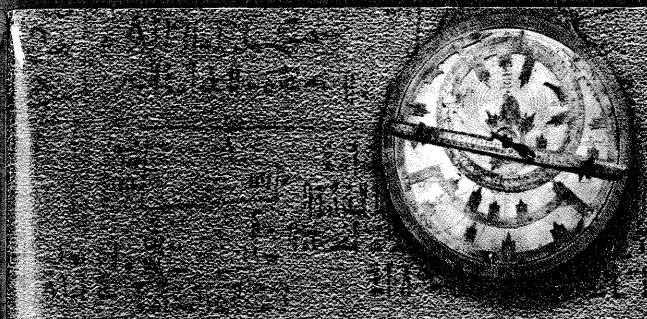

LOST DISCOVERIES

The Ancient Roots of Modern Science —from the Babylonians to the Maya

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The solar zenith plays a central role in all Mesoamerica. On the day (usually June 21) the sun arrives at its summer solstice point—that is, when it crosses the overhead point, or zenith—something special happens at a latitude of 23.5 degrees north. Unlike in more temperate latitudes, in the tropics the sun reaches a true overhead position at noon two times a year. Since most Mesoamerican cities were located south of this latitude, their citizens could observe the sun directly overhead during the time it traveled over their latitude. Zenith passage observations are possible only in the tropics (that is, between 23.5 degrees north and south latitudes) and were unknown to the Spanish conquistadors who descended upon the Yucatán in the sixteenth century.[11] Early Mesoamericans were certainly aware that the zenith varied subtly as they traveled north and south. Early architectural complexes showed orientations keyed to the local horizon position of the sun on the zenith date.[12]

For all Mesoamerican societies the sun was the ruler of time and space. Pre-Columbian peoples fashioned their architecture to integrate time and space. Astronomers used fixed locations in temples and pyramids to track the rising and setting of the sun and other celestial bodies. They marked solar events by placing sets of crossed sticks along lines of sight on buildings' terraces and ramparts. The precise direction of the sun at sunrise was a prime orientation.

A common system of Mesoamerican knowledge included not only prediction of expected solar and lunar eclipses, but also intense observation of the seasonal rising and setting of Venus and, possibly, Jupiter, Mars, and Saturn, as well as the marking of the dates of significant conjunction of planets, the moon, and bright stars and constellations. These events were recorded on monuments from as early as the first century A.D.[13]

Of all the ancient timekeepers, the Mesoamericans (especially the Maya) developed the most complex and intricate calendrical systems. The oldest Mesoamerican calendar inscriptions date from 600 B.C. They devised a 260-day calendar called the sacred count, used for divination, astrology, and religious record keeping. This calendar gave each day a name, much like contemporary days of the week. There were twenty day names, each represented by a unique symbol. The days were numbered from one to thirteen. With twenty day names, after the count of thirteen was reached, the next day was numbered one again. The 260-day sacred-count calendar was in use throughout Mesoamerica for centuries, probably before the beginning of writing. No other cultural groups in the world have used a 260-day calendar. No one knows just when, how, or why the Mesoamericans decided upon a period of 260 days. Their shared geographical location and weather patterns and the agricultural cycles of the northern tropics probably influenced its development. Its design may tie together several astronomical events, such as the configurations of Mars, appearances of Venus, or eclipse seasons. Contemporary Mesoamericans, who still use the 260-day calendar for ritual events, have suggested that the 260-day count is based on the length of the human gestation period.

The planet Venus plays a central role in Mesoamerican culture, especially in the timing of warfare. The Venus warfare cult, recognized at many Mesoamerican sites by the images of a goggle-eyed deity known as Tlaloc, apparently originated in Teotihuacan, and can be traced at least as far back there as the sixth century A.D.[14]

In the centuries between A.D. 200 and 900, the period of the so-called Classic Maya, astronomical, calendrical, and timekeeping powers reached an apex. The Maya took all these elements and pushed them to a level of originality and brilliance. The Maya were probably the most sophisticated astronomers and mathematicians of their era.

If you visit the ruined plazas of the Classic Maya cities, you will still see carved stelae inscribed with effigies and the exploits of kings and queens. You will read of their royal descents from the gods. All of this is offered side by side with complex calendrical dates fixing the time of

year of the event and its position in the ubiquitous 260-day ritual calendar. The royal doings are also accompanied by the correct phase of the moon, its position in the zodiac, the count of the days since the time of Maya creation and even since mythic times predating creation—a number of days running into millions. All were precisely cued to each royal personage or occurrence.[15]

During their Classic Period, the Maya developed a Venus calendar accurate to one day in five hundred years, as well as an eclipse-warning table that still functions in the twenty-first century. They created their own zodiac as well as tables to follow Mars, the moon, Venus, and possibly Jupiter and Mercury. To make all this work congruently, they devised a sophisticated mathematics to facilitate the computations. They projected their astronomical tales hundreds of years forward and backward, even to eras preceding the creation of their contemporary version of the universe. Maya astronomy reached a level comparable to that achieved by the Babylonians and surpassing in some ways the Egyptians'.[16] Almost as remarkable as the precision and scope of Mayan astronomy was their drive to elaborate upon it, a preoccupation with celestial accounting that developed into an unparalleled obsession.[17]

Of the thousands of texts in which the Maya recorded their findings, only four survived the Spanish book burnings. It is as if, observed Mayanologist Michael Coe, the only things the future knew of us were based on three prayer books and *Pilgrim's Progress.*[18]

The Dresden Codex (the names of the codices indicate where they were or are kept, thus the European names) is the most beautiful of the Maya folding-screen texts. It is eight inches high and, when folded out from its accordion-like form, eleven feet long. Written on a long strip of bark paper coated with fine stucco or gesso, it is primarily concerned with the 260-day ritual counts divided up in several ways, the divisions being associated with specific gods.[19]

The Madrid and Paris Codices are less perfect in execution. The Paris Codex is very fragmentary but suggests specific timetables for prognostications of astronomical events. The Grolier Codex (named after the Grolier Club in New York City, where it was exhibited in

1971) is also in bad condition but comprises one-half of a twenty-page table concerning the Venus cycle. The radiocarbon date of A.D. 1230 is now considered accurate, thus making it the earliest of the manuscripts by about twenty years.

Venus is the planet of primal religious significance for the Maya, who made extensive calculations of its multiple apparitions. Unlike the Greeks of the Homeric age, however, the Maya knew that the evening and morning stars were the same object. To chart Venus's synodical period (the time it takes for the planet to return to the same position relative to the earth's orbit around the sun) the Maya used the figure of 584 days (the actual figure is 583.92, nearly too close to call). They divided this number into four periods of varying length; Venus as the morning star was one. The second was Venus's disappearance at superior conjunction—the point when the planet is invisible as it passes behind the sun. The third was its reappearance as the evening star; the fourth, its disappearance again at inferior conjunction—when it is obscured by its passage in front of the sun. Venus's first and last visibilities were of great concern, with the first being especially important in the Dresden Codex.

In 1982 Yale University linguist Floyd Lounsbury brought to light how strongly the Maya linked Venus with warfare, demonstrating that war imagery is associated with the first visibility of Venus in the morning and evening sky. The timing indicates that the highly important war events of the Maya clustered in the dry season, the preferred time for waging battle. Scholars have concluded that war was avoided during times when Venus was invisible in superior conjunction.[20] The visibility of Venus as the evening star on December 3, 735, for instance, set off an attack on the southern Peten site of Seibal, in present-day Guatemala, leading to the capture of its ruler the next day. This unfortunate, says Coe, was kept alive for twelve years, finally being sacrificed at a ritual ball game timed for an inferior conjunction of Venus.

The stationary point (at the end of retrograde period) of Jupiter apparently signaled accession to the throne, or inaugural rituals at Palenque. Ball games and associated bloodletting events seem linked

with Jupiter's retrograde period. The accession at age forty-nine and apotheosis twenty-one years later of the great Palenque ruler Kan Balam was set by Jupiter's second stage.[21]

Stars were the "eyes of the night" to the Maya. The Pleiades, as they were named in the Old World, were important calendar stars. Astronomers used a window in the Caracol at Chichén Itzá, in Mexico, to view the Pleiades as they set at dusk in late April, and again before the onset of the rains at the time of the first solar zenith in late May. The Maya visualized Scorpius as a scorpion, and temples were oriented toward the setting points of its stars. There was a long-standing association between the period of Orion's conjunction and maize planting.[22]

Aveni and his colleagues determined that the Maya used buildings and doorways for astronomical sightings, especially of Venus. At Uxmal, the tenth-century capital of an ancient city-state in western Yucatán, all the buildings are aligned in the same direction, except the Governor's Palace. There Aveni discovered that a perpendicular measurement taken from the central doorway reaches a solitary mound 3.5 miles away. Venus would have risen precisely above this mound when the planet reached its southerly extreme in A.D. 750.

In 1975, Aveni determined that the building's orientation and sight lines might approximate this southernmost rise of Venus, an event that takes place only every eight years. In the mid-1990s, David Rosenthal, an explorer, photographer, and Mayan enthusiast, spent months attempting to photograph Venus's southernmost rise at the palace, which is richly adorned with Venus gylphs. After much trial with fog and clouds, Rosenthal finally saw the event one morning in January 1997. And he described something more than the astronomical detail:

> Accounts also indicate the Yucatan climate hasn't changed significantly in the last 1,000 years or so, and this is particularly true in sites as far away from urban areas as Uxmal. Chances are the ancient Maya might have been subject to the same problem I'd experienced.
>
> But was it really a problem? The mist-enshrouded early-

> morning horizon seen from a promontory like the Palace of the Governor appears as the shoreline of an endless ocean. This view is very similar to a Mayan cosmological construct where the edge of the world meets an infinite sea, which in turn constitutes the surface of Xibalba, the Underworld. Like other rising celestial objects, Venus emerges from this mysterious realm to sail across the sky. Could it be that my perspective of this brilliant traveler surging free from shadowy darkness was the very one sought and shared by priest-astronomers more than a millennium before?[23]

With his collaborator Sharon Gibbs, Aveni showed that at around A.D. 1000 the entire Caracol, a round tower with windows at Chichén Itzá, was aligned with the northerly extremes of Venus. Another diagonal sight line through the windows matched the planet's setting position when it attained its maximum southerly position.[24] The Classic Period Castillo at Chichén Itzá dramatically expressed the Maya sun-monument-ritual relationship in its orientations and its four staircases of ninety-one steps per side (which when added to the temple platform as the final step totals 365 steps). At sunset at the equinoxes, shadows formed by the nine levels, or stages, of the pyramid create a great slithering snake design all along the serpent balustrade on the north side of the Castillo. Today, thousands of people come to witness this event.

The habit of incorporating the year's beginning at the winter solstice within the architecture plan of a ceremonial center was the first phase in Mesoamerica of astronomically aligning the city as a whole. Built before the birth of Christ and already abandoned for several centuries during the European Dark Ages, Teotihuacán was carefully planned. The fifty-square-mile ceremonial center was laid out in an east-west axis and grid—approximately 15.5 degrees to the east of north and the west of south.

Further, if you could travel back two thousand years and stand by a marker on the Street of the Dead and look over a petroglyph on the western horizon at the right time of year, you'd see the setting of the

Pleiades star cluster. When the Pleiades reappeared in the east after having been invisible in the light of the sun for forty days, they did so on the precise day of the sun's zenith. Here, says Aveni, was a highly visible, convenient timing mechanism to signal the start of the new year. Tying the sun to stars was different from beginning the solar calendar by marking the sun's northern- or southernmost passage. "The Pleiades, being both prominent and in the right place at the right time, became the new celestial timer of choice" to the astronomers of Teotihaucán.[25]

The Aztecs believed they were the children of the Teotihuacanos, whom they considered gods. When the Aztecs built their capitol, Tenochtitlán, around A.D. 1325,[26] it was with Teotihuacán in mind. The great Templo Mayor in Tenochtitlán was positioned so that the rays of the dawning sun on the spring equinox (usually March 21) would fall in the notch between the twin temples, the shrines of Tlaloc and Huitzilopochtli, on top of the flat pyramid. Measuring the temple ruins, Aveni found that it is skewed nearly 7 degrees south of true east to match the sun's path over the elevated twin temples on equinox day.[27]