

## Chapter 2

# The Americas

### Cahokia

The mounds scale out over the horizon almost as far as one can see across the plain. Climbing to the top of the Monk's Mound, the largest mound of the complex, one rises well above the trees, and can see for many miles around. You can see the famous Gateway Arch of downtown St. Louis in the distance, and the Mississippi Valley for many miles in both directions. And most clearly and distinctly, you can see the *sky*. The entire dome of the sky becomes visible atop the enormous mound, with the all-important horizon discernible and unobscured. One of my first thoughts when I scaled the stairs leading to the top years ago and glanced out at the view was "this place would be a great spot for astronomical observation!" The scope of this present complex is amazing, even in its dilapidated state after so many years since its precipitous abandonment in the mid 14th century CE. At its height the city must have been a thriving metropolis. But the question continually arises—what was the purpose of these grand areas, the mounds, the astronomically aligned structures around the entire city? The people of Pre-European America understood and had a great concern for celestial phenomena. The movements of the sun and the planets were of enormous import to them, as they were for civilizations elsewhere in the world. But what was their specific concern with the sky? How did they understand its significance, and what role did it play in their thinking about themselves, their place in the world, and their destiny? Clearly, the people who built and maintained Cahokia had a greater concern for and care about astronomy than do those in contemporary urban society, for example (Fig. 2.1).

When Euro-Americans first saw Cahokia in what is today the Illinois plains of the Mississippi Valley, it had been abandoned for years. This massive complex was a ghost town. It didn't take long to uncover the amazing extent of this ancient city. It had been a metropolis—and it was now empty. Henry Marie Brackenridge, a lawyer, author, and later judge and US Congressman from Pennsylvania, was the



**Fig. 2.1** Monk's Mound, the largest of the structures at Cahokia, still stands tall even after hundreds of years of neglect and wear. The mound likely began as a burial mound in its earliest days, and its ceremonial significance led to its “repurposing” as a focal point for ceremony and the ruler. The residence of the ruler of Cahokia once stood atop the mound, and many major ceremonies of the city were performed from there. The name ‘Monk's Mound’ is completely unconnected to the Mississippians, rather it derives from the Trappist monks who inhabited the site of Cahokia for a few years in the early 19th century. (Photo credit: Cahokia Mounds State Historic Site)

first known to write about the site, in a letter to former president Thomas Jefferson in 1813. Brackenridge writes in effusive prose about the site he visited in 1811:

Nearly opposite St. Louis there are the traces of two such cities, in the distance of five miles, on the bank of the cohokia [sic], which crosses the American bottom at this place. There are not less than one hundred mounds, in two different groups; one of the mounds falls little short of the Egyptian pyramid Myrcerius. When I examined it in 1811, I was astonished that this stupendous [sic] monument of Antiquity Should have been unnoticed by any traveller... (Looney 2009)

It had been as if the ancient American equivalent of New York City emptied out and was abandoned, to be regained by the earth and the overgrowth of years. When these explorers and archaeologists first saw the gigantic mounds dotted throughout the city, they assumed they must be either burial mounds or have some kind of religious or political significance—perhaps the living areas of the rulers of the city? Cahokia was, and in many ways remains, a mystery.

Cahokia was not the only megalopolis to emerge from the reclamation of the earth in the Americas. Nor was it the only one with a key concern with and link to astronomy, the observation of the cosmos. But Cahokia has a particular interest in its link with the heavens, as it was an unusual and itself strange celestial event that led to a major change in its society and life.



**Fig. 2.2** Artist's rendering of what “downtown” Cahokia may have looked like at the city’s peak, with Monk’s mound in the upper right. (Photo credit: Cahokia Mounds State Historic Site)

Archaeologists, having worked on the Cahokia site for years, determined that a major restructuring of society in the Mississippian town took place in the mid 11th century CE.<sup>1</sup> The “old city” of Cahokia that existed on this site prior to this period had been more a village than a city—a small hamlet of perhaps a couple thousand people at most. Something happened in the mid 11th century that caused people in the region to radically transform their city. They built enormous mound pyramids and other earthen structures in a very short time, and the population exploded almost overnight. Cahokia went from sleepy Mississippi Valley village to massive urban center. And the planners had intended just this—the construction of the new city of Cahokia was a planned urban project unlike anything that had been seen anywhere in North America. The growth of Cahokia was not the slow and natural growth of a city that comes with steady migration. Rather, it was a centrally planned decision. The builders of the new city of Cahokia had every intention of constructing a new metropolis (Fig. 2.2).

Of course, there are many pressing questions. Where did the builders of Cahokia come up with or learn the idea of massive urban ceremonial centers? How did they

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<sup>1</sup>There is still disagreement about just what kind of restructuring took place and how it did, though there is more agreement about the time period within which it took place. Timothy Pauketat’s view lines up most closely with the hypothesis I consider here. He discusses this “Big Bang” view of Cahokia’s rise in Pauketat (1997, 2009).

attract a population so quickly? How did the idea of the large earthen pyramid develop? Was it an independent regional discovery, or were the Mississippian peoples influenced (whether directly or indirectly) by the pyramid-building peoples of Mesoamerica? Perhaps an even greater mystery surrounds the startling date of the construction of the new city of Cahokia: The years surrounding 1050 CE.<sup>2</sup> Archaeologists determined through carbon dating of the features of the new city that it was around this date that the massive transformation of Cahokian society took place. This date may seem meaningless to most of us, but some familiar with astronomy will recognize the nearness of this date to a very famous astronomical event: the great Supernova of 1054 CE.

Only one account of the massive celestial explosion that took place in 1054 comes down to the modern day—that of the meticulous observers in the court of the Chinese Song dynasty.<sup>3</sup> Strangely, there is no written account anywhere else in the world of the massive 1054 supernova. We know today that the event must have been obvious to those in the northern hemisphere with clear enough skies—the 1054 supernova would have been the brightest object in the sky behind the Sun and Moon—but there are no European or Middle Eastern accounts of the event. The “new star” may indeed have caused a stir in the Americas, though. While much of the discussion of the significance of the 1054 supernova in the Americas is speculative, and it will likely be impossible to ever know just how significant the event was for the various peoples of the continent, there are some suggestions that it was seen as important. A number of still existing etchings and paintings in the American Southwest are believed by some to depict the unique event, including a painting at Chaco Canyon in modern day New Mexico of the state of the night sky in the year of the supernova’s appearance,<sup>4</sup> and a number of pottery pieces from the Southwest (Mimbres Valley, New Mexico) that date to around 1050 seem to illustrate the supernova. Other possible depictions elsewhere in North America, including a possible alignment to the object in the famous Serpent Mound in southern Ohio, attest to the fact that not only did the people of this region take likely notice the startling celestial event, but that they may have taken it to have an unusual significance (Fig. 2.3).

And why wouldn’t they? Naked eye visible supernovae, the brightest and/or closest of exploding stars, often so bright they are visible during the day when they

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<sup>2</sup>About A.D. 1050, the American Bottom experienced the political and economic equivalent of the Big Bang... The event brought about the abrupt and large-scale transformation of community order, the physical landscape of Cahokia, and the entire northern expanse of the American Bottom floodplain. (Pauketat 1997, 31–32).

<sup>3</sup>The appearance of the supernova is recounted in two sources, the *Song shi* (“History of Song”) and the *Song huiyao jigao* (“Compendium of Documents of Song”).

<sup>4</sup>Scholars disagree over whether these inscriptions depict the 1054 supernova, rather than some more ordinary object such as the planet Venus.



**Fig. 2.3** Detail of the petroglyph from Chaco Canyon (New Mexico), representing what some suggest may be the supernova of 1054 CE, beside a crescent moon and the “Hand” constellation. The hand constellation, a common grouping of stars among the indigenous peoples of North America, consists of what many westerners know as the “Orion” constellation, including Orion’s belt, the feet, and the Orion Nebula

explode in our galaxy, are among the rarest events in the skies.<sup>5</sup> There have only been a handful of such events in all of recorded human history. No one alive today has ever seen such an event, nor have even any of our great-great grandparents. The last time such an event happened was 1602. Some lucky generations, however, were showered with an embarrassment of riches. Many people who witnessed the great supernova of 1572, for example, would have still been alive when the supernova of 1602 appeared in the sky. Johannes Kepler, often considered the father of modern astronomy, lived through both of these events, even though he was a mere infant in 1572. Kepler himself thus didn’t have much to say about the 1572 supernova. This supernova is often associated with the man who would become his mentor and predecessor, Tycho Brahe, whose measurements of the supernova definitively demonstrated to the western world (as we will see later) that Aristotle’s theory of the perfection and (thus) unchangeability of the heavens was false. Kepler himself played a large role in the analysis of the 1602 supernova, which is today often referred to as ‘Kepler’s Supernova’. Kepler’s observations of this “new star” were recorded in his book devoted to it, *De stella nova in pede Serpentarii*, of 1606.

When supernovae happen in our galaxy, they are hard to miss for anyone with even the most rudimentary familiarity with the night sky. And they are so rare and magnificent that people tend to remember them, memorializing them in things like pottery and cave paintings, astronomical books or detailed court records (as in the case of the Chinese astronomers, who we will meet in the next section).

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<sup>5</sup>Although it is still somewhat curious that the 1054 supernova would create such a stir, given that there had been an even brighter supernova, indeed the brightest in human history, that had appeared in the skies of the northern hemisphere a mere 48 years before, in 1006 CE.



The people who inhabited Cahokia are known today as the “Mississippian” people—a name that would not have been used by these people themselves, but that was given to them much later by scholars because of their range of cultural diffusion in the wider Mississippi Valley region. Cahokia was the core of this civilization, a megalopolis that would have dominated the wider culture and politics of the region and the people throughout this part of the continent. The mystery of Cahokia is almost irresistible to those with an interest in pre-Columbian America, or just anyone with a curiosity about seemingly inexplicable phenomenon. Not only this, but Cahokia, its meteoric rise, and its puzzling abandonment may, if we learn the facts about its ultimate fate, be able to teach us important lessons about urban population, growth, rise and decline in our modern world. These are lessons that no doubt will be of utmost importance, given the 7 billion plus population of our increasingly urban world.

I like to believe, although I certainly don’t have irrefutable evidence for this, that the story of Cahokia’s rise and that of Mississippian culture in its larger scope in general, is a story at least in part about astronomy.<sup>6</sup> And astronomy, of course, often has its basis in the religious, philosophical, and cultural life of a people. It is certainly not unheard of in pre-Columbian American civilizations for astronomy to hold a central significance. Ultimately, regardless of the cultural impact of SN 1054 (if any), in various cultures in the “New World” we see well-documented concern with celestial phenomena, well before any visitors from Europe arrived.

## Mesoamerica

Astronomy in the Americas has a rich history, as the detailed observation and study of celestial phenomena took place in almost every inhabited area of the two continents. The most well-known and perhaps best developed (or at least best recorded for posterity) astronomy of the ancient Americas was that of the Mesoamerican empires, particularly the Maya and the Nahua (Aztec). One can still see well-preserved astronomical artifacts from both cultures throughout Central America.

The Maya are perhaps best known to many of us for the so-called doomsday prediction of the end of the world on December 21, 2012—the apocalypse that wasn’t, as I’m sure you remember. Unfortunately for the doomsayers, but fortunately for the posterity and good name of the Maya astronomers, this prediction was not only misinterpreted, but was actually never even made by the Maya at all. No Maya astronomical calendar makes any such prediction of the end of the world, on

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<sup>6</sup>Timothy Pauketat, an archaeologist at the University of Illinois, and some other scholars, agree. Pauketat writes “The latest radiocarbon dating places the construction of New Cahokia at about 1050. The closeness of that date to the appearance of the supernova in 1054 has prompted some archaeologists and historians to question whether the astronomical event could have caused or somehow contributed to the momentous changes that took place in the Mississippi River valley.” (Pauketat 2009, 23).

any date.<sup>7</sup> In addition, later popularizers of the “end of the world” claim both misunderstood Maya astronomy, and also basically invented the idea that the end of a *baktun* cycle in the Maya calendar corresponded to a claim about the end of time. On the contrary, the Maya view of cycles of time is one of *repetition*, following the cycles and sequences we witness throughout nature. Indeed, it would not be a *cycle* at all if it did not repeat. The Maya no more held that the world would end at the finish of *baktun* cycle previous to the present one (not December 21, 2012, as some misinterpreted, but close) than a contemporary would hold that the world will end at the end of this calendar year (the end of our 12 month cycle which then begins anew) (Fig. 2.4).

The beginning of the last *baktun* cycle in the Maya calendar, and its related ancestors following the “Long Count”, was August 13, 3114 BCE, a date with almost mystical significance in Mesoamerican culture, due to the profound events associated with this date.<sup>8</sup> There is some similarity here to our own Common Era (CE) count—or *anno domini* (AD), depending on one’s ideology or preferred calendric terminology, generally held to correspond with the birth of Jesus. There have been arguments that the first civilization to adopt the Long Count calendar was the Olmec civilization centering around what is today La Venta in the state of Tabasco on the Gulf Coast of southern Mexico. According to this view, Olmec culture formed the basis of later Mesoamerican imperial culture, influencing the cultures that later became the Maya and last the Aztec civilizations, both of which adopted similar calendric systems.<sup>9</sup> Others contend that the calendar had its beginnings not on the Gulf Coast, but further south, on the Pacific Coast in the region of current day Oaxaca.

The mysterious city of Teotihuacan in modern day central Mexico (about 30 miles outside of Mexico City) is constructed such that it’s main avenue, the Avenue of the Dead (*avenida de los muertos*, a Spanish translation of the Nahuatl *Miccoatl*) was aligned to correspond with sunset on the day of August 13.<sup>10</sup> I call this city mysterious because it is unknown exactly which peoples were associated with the site in its earliest stages, even though it later fell within Aztec influence—and indeed, the name ‘Teotihuacan’ itself is an Aztec name, given to the city long after its original inhabitants had abandoned it (for still unknown reasons). There are varying

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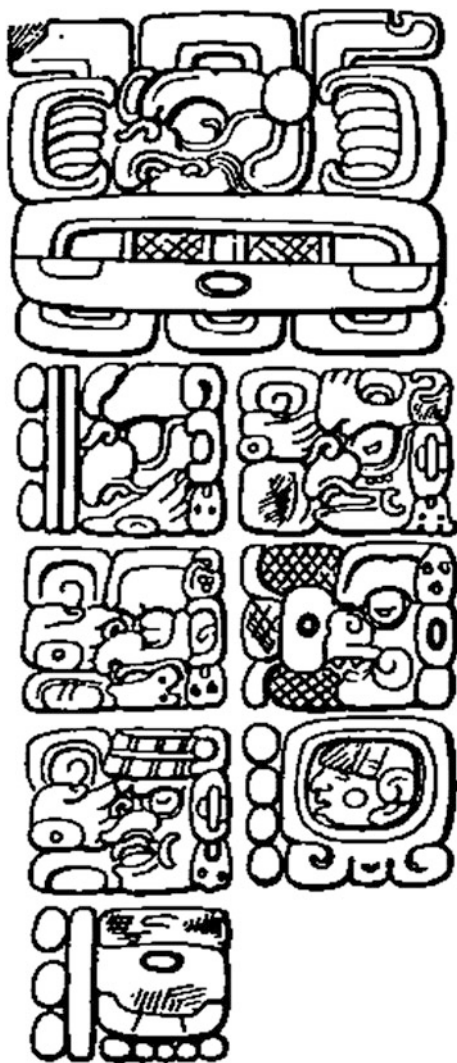
<sup>7</sup>(Schiele and Friedel 1990) make short work of this fictional end-of-time claim concerning 2012, as do a number of other Mayanists.

<sup>8</sup>This is based on the proleptic Gregorian calendar and the Thompson calendar correlation. According to the Goodman-Martinez-Thompson correlation, the date is August 11, 3114 BCE in the Gregorian calendar. In the Julian calendar, the dates are September 8, 3114 BCE (Thompson) and September 6, 3114 BCE (GMT), Julian Day 584285, where Julian Day is defined as days elapsed since January 1, 4713 BCE (Julian).

<sup>9</sup>Diehl 2004. While the Aztecs *did* not use the Long Count calendar, they did use an equivalent to the *tzolk’in*, called the *tonalpohualli*, which along with the 365 day *xihpohualli* calendar (roughly equivalent to the Maya *haab*), formed the “calendar round” of 52 years.

<sup>10</sup>Vincent Malmstrom convincingly argued for this position against previous views according different alignments to the Pyramid of the Sun (Malmstrom 1978).

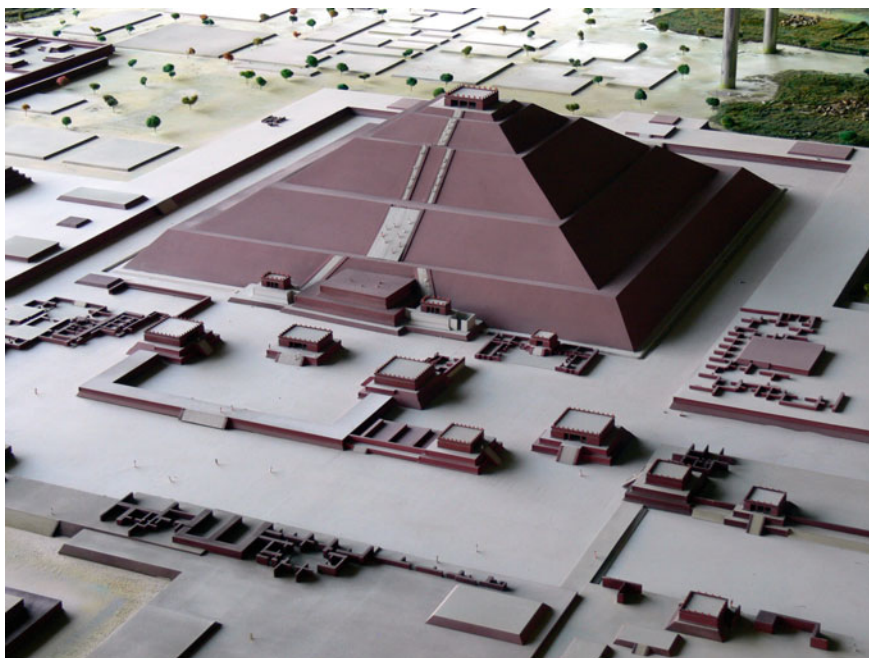
**Fig. 2.4** Depiction of a initial Series from Quirigua Stela C. The topmost glyph is referred to as the Initial Series Introduction Glyph (ISIG), and the glyphs below record the date in the Long Count as well as the *tzolkin* and *haab* calendars. The date shown here is 13.0.0.0.0, 4 Ahau 8 Cumku, corresponding to the Gregorian calendar date of August 11, 3114 BCE—the purported (mythical) origin date of the calendar and beginning of the 13th baktun, which ended in December 2012



views about the identity of the original inhabitants of the city, as well as its cultural influence and forebears. Still, the August 13th alignment seems compelling (Fig. 2.5).

Clearly, this date was important to the civilization at Teotihuacan as it was for the later Mayans and Aztecs. As to why this date was selected as the beginning of the current era of the Long Count, we can only speculate. The view of Olmec origins of the calendar is controversial, and any purported importance of August 13th in that culture would be even more speculative. However, presumably many different Mesoamerican peoples saw the date as a highly significant one, given that it dictated not only the beginning of their calendar, but also the design of their cities.





**Fig. 2.5** A model reconstruction of the “Pyramid of the Sun” at the ancient city of Teotihuacan (just outside of current day Mexico City). The pyramid was a major ceremonial center for the people of Teotihuacan (whose identity is still debated). The pyramid, built around 100 BCE, appears to be aligned along its main stairway and altar with the point of sunset on August 13, the origin date of the last series of the Long Count calendar. Credit: Wolfgang Sauber

August 13th would come to have a less auspicious significance in much later years, as it signaled the end of the dominance of Aztec culture in Mesoamerica, when the Spanish explorer, man at arms, and *conquistador* Hernan Cortes and his troops captured the Aztec capital of Tenochtitlan (at the site of current day Mexico City) on August 13th, 1521, and took captive the Aztec emperor Cuauhtemoc, who was later executed. This signaled not only the end of the Aztec empire, but also the end of native rule in Mesoamerica (except for pockets of indigenous rule and resistance in the Maya region for years afterward), and the beginning of European colonialism.

When we consider the question of the astronomical alignment of major structures and city plans, of course, we must be careful, because in our fervor to discover astronomically significant alignments we may determine that completely accidental arrangements, or arrangements made with some non-astronomical purpose in mind, were purposefully astronomically conceived. There are only  $360^\circ$  in a circle, and on the horizon, after all, and thus even with completely random choice, there is about a 1 in 360 chance that any structure will be pointed toward any given significant celestial event along the horizon. This ratio increases significantly when we take into account all of the different significant celestial events that might be recorded along the horizon. And certainly even a people very concerned with astronomy in

general might have different principles guiding them in building their cities and structures.<sup>11</sup> There are a number of reasons that we can take the peoples of Mesoamerica in general to have had a deep astronomical concern, one that translated into the way they laid out their cities and organized their lives. This concern was shared in North and South America as well. The philosophy of nature underlying and grounding the concern with the heavens that we see in Mesoamerica is one we tend not to share today, and one that allows us to draw a heavy line between the sky and other aspects of our lives, between humanity and nature, and between disciplines and kinds of knowledge, for example. The cultures we investigate in this book thought, for the most part, very differently about nature, and the skies.

The Mesoamerican people most closely associated with the Long Count calendar by the rest of the world, of course, are the Maya, whose astronomical and general intellectual culture was perhaps the most highly developed of all the early Mesoamerican peoples. The Maya civilization, even though in some form it continues to exist today,<sup>12</sup> flourished mainly between 100 and 1100 CE, and was at its creative and technological peak during the so called “Classic Period”, in the years from 250–900 CE. It spread from what is now southern Mexico, including the Yucatan peninsula area (also famous because it was just offshore from this peninsula, millions of years before that the massive asteroid that caused the extinction of the dinosaurs landed), south through Central America. The center of power of the Maya civilization was in the area of what is today the Mexican Yucatan and northern Guatemala, where we still today find the remains of such once magnificent cities as Tikal, Chichen Itza, Uaxactun, and El Mirador.<sup>13</sup> Maya culture reached a remarkable sophistication, equal to any of its contemporaries in the “old world”, including sophisticated understanding of astronomy, and the creation of astronomical, political, religious, and philosophical texts. Sometimes

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<sup>11</sup>As an example of accidental astronomical alignment, we can take the example of the layout of the city of Chicago, IL. Downtown Chicago’s streets are laid out along east to west lines, and the buildings were constructed along the blocks following this pattern. Because of this, along with the fact that on the equinoxes the sun sets exactly due west, it turns out that on the equinox days, one standing along an east-west Chicago avenue will see the sun emerge from behind buildings and align perfectly with the avenue at sunset. Having fun with this coincidence, some have called it “Chicagohenge”. But certainly the designers of the city of Chicago did not purposefully align their streets to correspond to sunset on the equinoxes—they were just working on a grid based on the cardinal points, and it just happens to be the case that the equinoxes are also correlated with the cardinal points.

<sup>12</sup>The Maya still live in the land of their ancestors, though they have largely adopted Spanish culture and have been subsumed into the nation-states formed in the breakup of the Spanish colonial empire of New Spain, such as Mexico and Guatemala. There are also many others throughout the region and elsewhere in the world with Maya ancestry. The height of Maya civilization may be past, but the Maya survive.

<sup>13</sup>The original names of these cities were different from those we know today. This is obvious in the case of El Mirador, but the Mayan names given to other sites do not match their ancient designations either. The city we know as ‘Tikal’ was most likely called ‘Mutul’ in the Classic Period, for example, and the city of Copan, in present day Honduras, was likely called ‘Xukpi’.

people are surprised to hear the fact that the Maya possessed both writing and texts. Part of the reason for this is likely because most of the examples of Mayan language and writing we have access to today come from engravings on buildings or other stone objects.

Unfortunately, there are very few Mayan<sup>14</sup> texts remaining, including the glyphic texts etched on stelae and buildings, or painted on pottery and in a number of books, which are still not well understood due to the lack of additional material. But it did not have to be this way. The Maya once had a robust literary culture, much of which was destroyed by Spanish invaders in the name of religion and colonialism. Maya priests and elites (most likely) compiled a number of books on various topics, which were generally kept, as such texts tend to be in just about every culture, in places of political and religious significance in great cities. During the early years of Spanish colonization, Christian missionaries purged most of this material, in the belief that they were somehow saving the backward and blasphemous peoples of the Americas by consigning thousands of years of their learning, knowledge, and culture to the flames. The most egregious example of this was carried out by the Franciscan monk Diego de Landa, who had been sent to the Americas in 1549, after the Spanish conquered the Yucatan, to convert the natives to Christianity, and was made bishop of the new Archdiocese of Yucatan. Landa was upset and frustrated by the fact that many of his Maya converts continued to practice the religious rituals of their ancestors—which they apparently did not see as inconsistent with adopting Christianity. The situation was similar to that of the native north American peoples as well, as it had been with Europeans when they adopted Christianity about a thousand years earlier. Converted Europeans in the early years of Roman Christianity continued to celebrate festivals such as the *Dies Natalis Solis Invicti* (Birthday of the Unconquered Sun<sup>15</sup>) on December 25th, which church leaders decided to absorb rather than to resist, because people had a way of ignoring church injunctions to give up habits, festivals, and cultural practices they'd always known in order to please God. Thus, the Christian holiday of Christmas is celebrated to this day on December 25th. Similar situations can be seen in the earliest Christian transmission to gentiles in the relaxing of strict Jewish laws concerning circumcision, strictures against eating certain kinds of food, and even injunctions concerning sexual mores and divorce.

Regardless, Bishop de Landa saw the Maya refusal to abandon their historical practices as highly offensive to Christianity and in need of rectification. Part of his response to this was an *auto-da-fe* at Mani in 1562 in which a massive number of ancient Mayan texts and artistic images were burned, thus destroying a large part of

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<sup>14</sup>I follow the convention here of referring to the people as 'Maya', and the language and texts of these people as 'Mayan'. Generally the latter refers to languages, such as the "Mayan language family".

<sup>15</sup>A Roman god associated with the return of the sun to the highest skies, and thus appropriately celebrated close to the winter solstice. The emperor Constantine, famous convert to Christianity, identified himself, and Christ, with Sol Invictus, and the imagery he adopted throughout his reign suggests this triune association.



**Fig. 2.6** The Dresden Codex, one of only four extant codices in the glyphic language of the pre-Columbian Maya, contains the most information of any of the codices on astronomy, including a venus table and lunar series

the cultural heritage of an entire people. Few texts survived the persecutions of de Landa and other likeminded Spanish missionaries, and today there are only four known texts to survive,<sup>16</sup> known to us today by the cities in which they are kept: the *Dresden Codex*, the *Madrid Codex*, the *Paris Codex*, and the *Grolier Codex*. For our purposes here, the Dresden Codex is the most interesting, as it contains astronomical material and also gives us some insight into the Maya view of the heavens and their significance.

While Maya glyphic writing and the early Mayan language of the Classic Period have still not been completely deciphered, much of it has been. There is a wealth of information about the Maya just within the extant codices, and we are only left to wonder what a magnificent amount we could have known about Maya culture (including astronomy) had the early colonialists been interested in preservation rather than religious conversion. Especially unique in the Dresden Codex is the role of the planet Venus in Maya astronomy. Venus seems to have had unique significance in a number of Mesoamerican cultures. There has even been disagreement as to whether the cave paintings, inscriptions, and other representations throughout the Americas seeming to depict the 1054 supernova may instead represent Venus (Fig. 2.6).

As mentioned above, the most famous astronomical association many make with the Maya is the Long Count calendar, which actually pre-dates the Classic Period Maya. The Long Count was likely created by a Mixe-Zoque people such as the Olmec, as the earliest known use of the calendar was in this area. The exact line of transmission is not known. The Long Count may have been known at Teotihuacan as well, given the site's alignment to the formative date of August 13.<sup>17</sup> Although the calendar was not created by the Maya, the Maya did *perfect* the calendar that

<sup>16</sup>Although there are other partial, damaged, or minor works discovered.

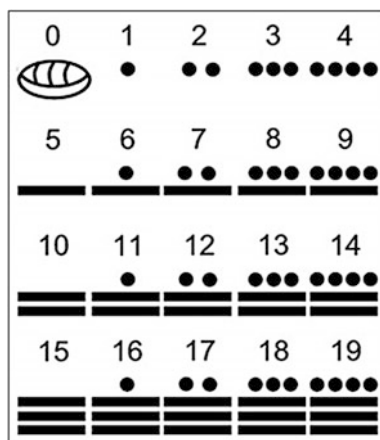
<sup>17</sup>The significance of August 13 as a formative or otherwise important date of course may be wider in the larger Mesoamerican region than the Long Count calendar.

they adopted from other peoples. In addition to their extension and development of the calendar, they invented an ingenious mathematical system used in the count, based in a *vigesimal* numeral system, rather than the more familiar *decimal* system used in the majority of societies today.

This requires some explanation. A *decimal* system of numbers is one in Base 10, that is, in which the basic collection is ten numbers, after which a new unit is began. So, for example, we count one through ten, and then after ten we begin to count the *next* group of tens, eleven through twenty, and so on. The decimal system of numbers counts based on powers of ten. So we have 10, 20, 30, 40, and so on, beginning a new count of 10s for every ten. Although we are so familiar with this system as to completely take it for granted, there is no particular reason we *need* to count in a decimal system. It is believed that the reason many societies adopted a decimal system is the rather obvious one—we have ten fingers, and thus grouping numbers into units of tens is very intuitive when one is using fingers to count. But say we had eight fingers, or we just decided to adopt a different system. We could perfectly well adopt a Base Eight system of numerals, or any other Base for that matter. Base Eight would take each unit or place to have eight numerals, such that our counts would look like this:

1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13, 14, 15, 16, 17, 20, ... and so on (Fig. 2.7).

The Maya mathematical system used for the Long Count was *vigesimal*, or Base-20. Thus there were 19 numerals before a new numeral place would be reached. The numeral writing system allowed this with much more ease than our own decimal system does (since we have fewer basic numerals than the Maya). The



**Fig. 2.7** The Maya numeral system was a Base-20, or *vigesimal* system, in comparison to our Base-10 (decimal) system. The system contained 19 distinct numerals, based on a *dot* signifying *one* to the *dash* signifying *five*, and a glyph of a shell, representing *zero*. The concept of zero was a necessary for the ability to shift places, as we do in our own decimal system. Without it, one has a clunky numerical system that is difficult to use for calculation, like that of the Romans (Photo credit: NASA)

Maya system used a dot to represent one, and a dash to represent five. Thus, three dashes and four dots would be the final numeral in the initial series before movement to a different place, with 20. The way this worked was similar to how our own place system works, but the Maya numbers were written vertically from top to bottom (similar to the classical Chinese), rather than left to right as in our own system, or right to left as in Semitic languages such as Arabic and Hebrew.

The bottom line is the 20s place, representing 1–19. The next line up represents the second 20s place (or 400th place), containing numbers 20–399. The next line up from there is the third 20s place (or 8000th place), containing numbers 400 (twenty 20s) to 7999 (where 8000 is twenty 400s). And so on, each place being a new multiplicand of 20. Thus, the numeral is equivalent to our numeral 1705, reading from the top line down thus: 1600 (four 400s) + 100 (five 20s) + 5. One possibility is that there may be numbers with *zero* units in any given place, and for this the Maya needed a conception of zero in order to make sense of this. Thus, we see the development in Maya (and earlier) mathematics of the concept of zero, which some scholars believed developed even before the discovery of the concept of zero in India, a region which is commonly accorded the credit for discovery of the concept.

These numbers were used in the unique and important “Long Count” calendar to keep track of days, months, and years, in a sequence beginning in what we know as 3114 BCE and continuing to 2012 CE.<sup>18</sup> The previous *baktun* sequence of the Maya Long Count calendar, in use during the Maya Classic Period, came to an end on a winter solstice day—December 21, 2012.

The Maya maintained two other calendars as well—the 260 day ritual calendar, or “short count” (*Tzolk'in*), and the 365 day solar year “vague” calendar (*Haab*).<sup>19</sup> While it may at first seem strange to us to have multiple calendars, when we think about what this really amounts to, as well as our own practices, we will see that it makes sense. Academic calendars are a good example, familiar to most of us—those who work in academia, as well as those of us who have gone to the university at some point. The academic calendar runs alongside the Gregorian calendar we use to determine years, but is not the same as this calendar, and has different beginning and ending dates, different holidays, etc. The academic calendar generally (for an institution running on semesters) has 9 months rather than 12 (as any academic who is paid on a 9 month contract is acutely aware), has years which begin not in January as do the Gregorian's, but instead in late August, and end not in December but in early or mid May. For those of us who live and move in academia, the academic calendar has as much, if not more, significance than the Gregorian calendar, which we also use. In my own life, then, I have at least two significant calendars, the academic and the Gregorian. It is easier for me to organize years of my own life in terms of the academic calendar than the Gregorian. When I think of

<sup>18</sup>The Long Count does not perfectly correspond to the vigesimal system, likely in part due to the fact that the relationship between days and years does not work out correctly. The 20 day *Winal* fits into the 360 day year (*Tun*) 18 times rather than 20. Higher counts of years follow the vigesimal system.

<sup>19</sup>Just as with the Long Count, the Maya did not invent these calendars, but adapted them.



2008 in the Gregorian calendar, for example, this is usually somewhat vague for me until I consider it in terms of two distinct academic years, the '07–'08 academic year, and the '08–'09 academic year. My memory of something that happened in 2008 can sometimes turn out to be something that happened in 2007, but was fixed in my mind to the '07–'08 academic year, which I associate with 2008. Most people who have at one time been students (which is just about all of us) thought in the same way while students. In addition, we see smaller scale calendars independently used. Our 7-day week count is independent from our month and year, even though we operate using all of these calendars. If today is a Wednesday, it may be Wednesday July 3 or Wednesday April 2. And July 3 may be in the year 1982 or the year 2015.<sup>20</sup> So we can see that use of multiple calendars is not foreign to us after all!

The Maya calendars, like our academic, Gregorian, and other calendars, played different roles in the community. The Long Count, 365 day solar calendar and the 260 day *Tzolk'in* calendar were often linked to one another (just as our academic and Gregorian calendars are linked). The operation of the 365 day calendar will be simple to anyone reading this, as our own calendar is a version of such a solar calendar. The Mesoamerican version did not include the conception of the “leap year” to calibrate the calendar every four years. The need for a leap year day, of course, arises from the fact that the full tropical year, which can be defined based on position of the sun in the sky, from solstice to the same solstice,<sup>21</sup> is not exactly 365 days, but 365.2422 days.<sup>22</sup> This means that every four years, a 365 day calendar will be a day behind the tropical year. With enough years passing without calibration, the calendar will slowly creep backward, and the seasons will diverge from the calendar. If we begin with December 21st marking the winter solstice, after 120 years, the calendar will be off by a full month, with January 20th marking the solstice (Notice also that since the discrepancy between the tropical year and solar calendar is not exactly 0.25, occasionally leap *seconds* have to be added to our calendar as well). It is unclear why the Maya 365 day calendar did not contain a calibration leap-year day or any other such device, even though the Maya were aware of the 1/4th day divergence between the year and the solar calendar. Perhaps the ritual integrity of the calendar, containing the same count of days each year, trumped whatever benefit may have been seen in including a calibration. As long as one knows and can keep track of the shift in the calendar, one can still track important dates such as the solstices, equinoxes, and zenith passages of the sun.

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<sup>20</sup>Thanks to a reviewer for pointing out this additional fact about our calendars. Note that Wednesday, July 3, 2015 is an impossible date, on our calendars!

<sup>21</sup>Winter to winter or summer to summer. It could also be defined as the time between two of the same equinoxes.

<sup>22</sup>This is distinct from the *sidereal* year, which is based on the return of the earth to the same spot with reference to the background of the stars. The sidereal year is slightly different than the tropical year—it is 364.25636 days. This difference is due to precession of the equinoxes, which is discussed further below.

The 260 day ritual calendar is one of the most unique calendars of the Mesoamerican world, and an interesting and complex one. This was the calendar (along with the 365 day) used by the Aztecs, who did not adopt the Long Count so prized and perfected by the Maya. The 260 day calendar was broken into 20 named days (following the Maya vigesimal series of 20), starting with *Imix*, continuing through the series of 20, then starting with the next set. Along with each day, one of a set of 13 numerals was attached. Thus, each day of the calendar would be fixed with a day sign and a numeral, beginning with 1 *Imix*. The following day would be 2 *Ik* ('Ik' being the second day sign), and so forth, until the set of 20 days completed and returned to *Imix*, the 21st day. Because each day gets 1 of 13 numerals, the second appearance of *Imix* would not be 2 *Imix*, but 8 *Imix*. The next appearance of *Imix* after that would be 2 *Imix*, then 9 *Imix*, and so on, until every day sign had 13 rounds, after which the calendar would be completed, until the inauguration of the next ritual year.

There is some question of the reason for the establishment of this seemingly odd calendar. Why 260 days? There are a couple of possibilities here, both having to do with astronomical phenomena. One possibility is that the 260 day period corresponds to a distance between zenith passages of the sun. At the latitude of the southern Maya region, in which early developments in the formative Preclassic Period took place in cities such as Izapa and Kaminaljuyu,<sup>23</sup> the sun passes through the zenith on two days a year that are separated by 105 and 260 days respectively. Perhaps the calendar is meant to correspond to the latter period. But if so, why focus on this particular number, rather than the 105 day period? Another possibility has to do with an object we know had enormous significance in Maya culture and its predecessors: the planet Venus. The appearance of Venus as "morning star" is roughly 260 days (from its first appearance as morning star to its disappearance until its return as evening star).<sup>24</sup> However, this is not exact, as Venus is visible as the morning star for 258 days, and so it makes such a count curious as adopted by the astronomically highly proficient Maya (even if the calendar was created by a predecessor culture). Anthony Aveni (Aveni 2001) suggests that the calendar was meant to link the Venus appearance to the synodic period of the moon. The two will take longer to correlate than a single period of visibility as the morning star, and this follows the pattern of interlocking calendars popular in Mesoamerica. Whatever the reasoning behind it, the ritual calendar was an important part of Maya culture, and important dates are often given in both their ritual calendar, solar, and long count dates.

In addition to their interest in precision of dating, the Maya were also concerned with planetary motions, especially those of Venus. The Dresden Codex contains elaborate and detailed Venus tables, demonstrating the amazing accuracy with

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<sup>23</sup>14.8° N. Kaminaljuyu is slightly south of this.

<sup>24</sup>A number of scholars link the *tzolk'in* to Venus' visibility, including Susan Milbrath (1999, 158). Floyd Lounsbury (1982, 163) proposes that the retrograde motion of Venus also held significance for the Maya.

which the Maya observed, charted, and predicted the motions of our neighboring planet. The question of course naturally arises—why were the Maya so interested in maintaining a detailed calendar and schedule for the risings, settings, and movements of Venus?

The first question may be easier to answer than the second. Any agriculture-based society, including our own, will have a need to determine with some degree of accuracy the seasonal changes. This requires having a calendar accurate enough to enable a society to determine when the warm and cold seasons will begin, in order to determine when to plant or harvest. But, we might ask, does this need necessitate a detailed and long-reaching calendar of the type maintained by the Maya? After all, a simple knowledge of which stars rise at sunset at a certain point of the year, such as the Pleiades, will suffice for general agricultural purposes. And indeed we see across the globe that many pre-modern peoples used just such a system, with success, to determine times of planting and harvest. You will not gain any more or better crop yield if you determine the point of the year with greater specificity than these simple techniques allow. In addition, if agriculture is the primary concern, there is no need for a “long count” that will fix a given year in context of a count stretching multiple thousands of years. Our own calendar is an example of such a system. We can locate events thousands of years in the past or thousands of years in the future on our own calendar. We know that a supernova was visible in the northern hemisphere in 44 BCE, and that a total solar eclipse will be visible in North America on September 14, 2099, for example. There is no need for such an expansive calendar to aid in agriculture alone. What happens in 44 BCE or 2099 CE is irrelevant to my planting or harvesting crops. Indeed, what happened *last year* or what will happen *next year* is also irrelevant. And this is just why we find that many of the cultures that adopted simpler forms of determining planting and harvesting seasons and who were mainly interested in the calendar from an agricultural perspective did not tend to have calendars that tracked time beyond a year—the main (and only) relevant unit for purposes of agriculture.<sup>25</sup> This fact makes it difficult for contemporary historians to precisely date certain events recounted in the texts of such cultures.

In the case of the Aztec calendar, there is a related difficulty. This calendar has distinct days for a cycle of 52 years, at which point the cycle begins over again (unlike the Maya long count, which has distinct days for thousands of years). This makes it difficult to determine the dates in terms of our calendar, as we can know what year within a 52 year cycle an event happened, but not *which* 52 year cycle the event happened within. The 52 year cycles were not themselves organized into a longer system and ordered, so the third day of the second month of one cycle would be indistinguishable from the same day of a new cycle. Given the lifespan of people during the time of the use of this calendar, this makes practical sense. Hardly

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<sup>25</sup>Even though the Maya, based within the tropics, did not have to worry about the issue of warm and cold seasons, as those of us in temperate regions do, they still took close note of the solar calendar, as it marked for them the critical wet and dry seasons, which, like the northern (and southern) warm and cold seasons, determined their periods of growing and harvesting.

anyone would live to see two instances of the calendrically identical day in two different cycles, so every day of one's lifetime would have a unique calendric marker, and one could refer to or fix events within a lifetime on the basis of this calendar. Of course, this calendar would make impossible a certain kind of deep history, in which events are precisely marked from past cycles. Should we conclude that cultures such as the Aztecs had no concern for history? Not necessarily. Our own contemporary way of thinking about history is not the only way humans can think about history, and the Aztec way represents one method of historical thought we certainly see elsewhere in the world as well.

Why, we might wonder, do we need an exact dating of certain events in terms of a contemporary calendar? A society may have a conception of history based in the succession of events, such that they may know that event *x* happened before event *y*, or even a conception of history in which the succession of events is not important at all. Indeed, we might put the question to our own conception of history—why is it important to know that some event happened in 44 BCE? What could 44 BCE mean to us more than “a really long time ago”, given that we have no experience of anything even close to such a time? Having a context in which to place important events is key, of course, but this can be done in the absence of a detailed calendar tracking back thousands of years, even with such a calendar as the Aztec calendar. On many views of history, it is not important so much exactly when an event happened in connection with the current day, but its historical significance in general, consistent with it being something that happened “in days of old”. Just *how* old becomes irrelevant after a certain amount of time.

So, given the compatibility of agricultural and historical aims with a less detailed calendar, there must have been specific, additional reasons behind the development and use of the Maya calendar, just as there are reasons behind the development and use of our own calendar. One strong possibility is that it was somehow due to the role of time and temporal context in Maya religion and philosophy, as well as due to the details and intricacies of Maya religious cosmology. Let's consider some of the features of Maya cosmology, before returning to think about time and the calendar more broadly.

## Maya Cosmology

There is no doubt that the sky played a major role in Maya religion. The K'iche' Maya text *Popol Vuh*, written after the Spanish conquest in the southern region of contemporary Guatemala, recounts what purports to be a Maya creation story—an account of the creation of the world, leading down to humanity.<sup>26</sup> While there is likely Christian influence in the work (which seems obvious when one reads

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<sup>26</sup>see Tedlock (1996)—this translation of the K'iche' original includes an introduction discussing influences.

through the first book, though the clear Christian parallels seem to taper off the deeper one gets into the text), it is also likely that this work preserves some much earlier features of Maya religion. Some of what we find here are likely beliefs that would have been held by the Maya of the Classic Period, during which the Maya intellectual project flourished, and the Maya people developed a complex language and textual tradition, formed a thriving empire, constructed majestic temple cities (even though they were never to become the kind of urban constructionists that their cultural predecessors in Teotihuacan were or the later Aztecs would become), and revolutionized astronomical observation and prediction.

In this text, we find a link between the sky and the other realms. The road to the underworld, *xibalba*, is said to be the dark rift apparent within the Milky Way galaxy, which trails across the night sky as a dim glow. One interesting feature of the night sky in tropical locations (among others) is that more of the Milky Way's path will be visible in the sky, and it will be higher in the sky as well. In more temperate regions further north, the Milky Way not only appears differently, but in the contemporary world we have the additional problem of rampant light pollution, all but blotting out our view of the path to *xibalba*. With modern cities and towns taking over our geography, even in some of the darkest sky sites available, the Milky Way cannot be seen from much of the United States or densely populated regions elsewhere in the world (Figs. 2.8a, b).

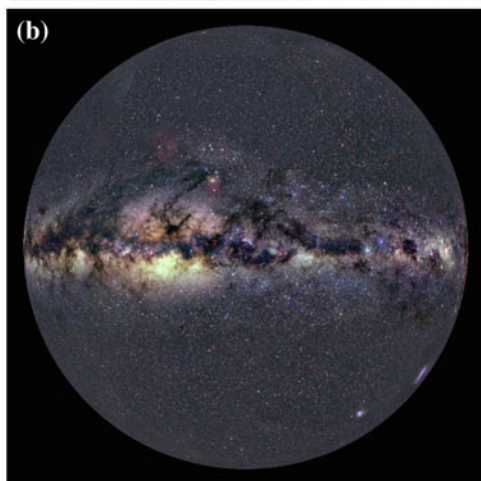
The Milky Way has an additional association in Maya thought—in addition to containing the path to the underworld, it is also associated with the “world tree” of creation.<sup>27</sup> It is unclear to what extent the K'iche' view of the Milky Way involving *xibalba* is shared by or comes from Classic Period Maya beliefs, but it does seem to be the case that the “world tree” view represents Classic Period Maya views, as it seems to be represented on inscriptions from urban constructions from the period.

As mentioned above in connection with the *tzolk'in* calendar, the planet Venus seems to have had enormous significance for the Maya. The Dresden Codex includes a Venus table, charting with startling accuracy the movement and the phases of Venus.

Many cultures have noted the significance of our sister planet Venus. It is, second only to the moon, one of the brightest objects in the night sky, and it is linked closely with the sun. In many cultures Venus is seen as both chasing and fleeing the sun. There are a number of interesting features of Venus that the naked eye astronomer will notice, features that are almost impossible to find in other planets, for a number of reasons. Venus, the second planet from the sun, is one of two other planets in our Solar System, along with Mercury, whose orbit is inside of that of the Earth. That is, Venus along with Mercury are closer to the Sun than is our own planet, and thus their orbits are both shorter and within the track of our own. This causes a few noticeable effects even for those observing the sky without the aid of a telescope. First, the movements of Venus (and Mercury) will appear to

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<sup>27</sup>Friedel, Schele, and Parker (1993) argue for the association of the Milky Way with both the road to Xibalba and the “world tree” of the Maya.



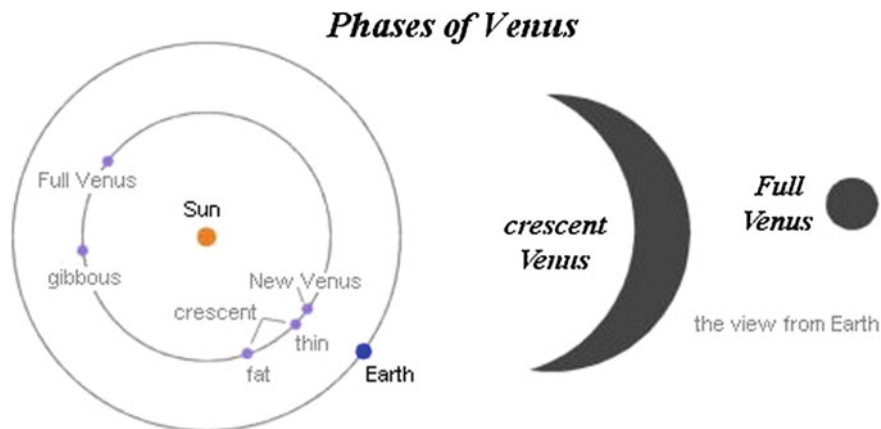


◀ **Fig. 2.8** The Maya associated the view of the Milky Way galactic plane across the night sky with both Xibalba, the realm of the dead, and also the World Tree, representing the cosmos as a whole. The first illustration is from the tomb of the ruler Janaab Pakal in Palenque, depicting the king's descent into Xibalba, from which the World Tree grows. The Milky Way was a familiar nighttime sight in the pre-Columbian world, just as were Venus and the Moon, but today there are few heavily inhabited places from which the band of the Milky Way is visible, due to rampant light pollution drowning it out (Photo credit: NASA)

us as closely linked to the sun. Neither planet will ever appear in the sky very far from the sun—although of course Venus can appear further from it than Mercury—and thus Venus only appears in the early evening or the early morning. It is from this that Venus gets its identity as both the “morning star” and the “evening star”. The movement of Venus through its orbit causes this effect. When it appears on one side of the sun from us in its orbit, Venus appears in our night sky as a star, coming into view just after the setting of the sun in the west, as the glow of the sun fades. As it moves further in its orbit, passing us and (from our perspective) continuing around the sun (remember that Venus moves more quickly through its orbit than does the Earth, as all planets closer to the sun move faster through their orbits), Venus becomes invisible to us for a period of days when it is too close to the sun from our perspective to be seen. Then, as it moves to the other side of the sun, it once again becomes visible in our sky as a “morning star”, trailing behind the sun and revealing itself just before the rising sun. It of course follows that Venus can only rise, that is, appear above the horizon, as a morning star, while as an evening star it makes its first appearance with the dwindling of sunlight, already above the horizon. This rising of Venus as morning star was a significant event for the ancient Maya.

Another feature of Venus due to its orbit within that of the earth is that, like the moon, Venus undergoes phases. Of the planets from our perspective on earth, only Venus and Mercury do this. The reason is that due to their interior orbits, we see these planets at different positions relative to the sun, just as we see the moon, and so we observe different parts of the planets lit up at any one time. Similarly to the moon, if we observe Venus from a 90° angle, we will see it in its “quarter” stage. There are though a couple of key differences between Venus phases and those of the moon. The moon orbits the earth directly, rather than the sun, so we are able to see all of its phases except for the new moon, when the sun renders it invisible. With Venus, we can never see a full phase, because when it would appear to us full, it is on the opposite side of the sun from us, which would make it visible only during the daytime, during which of course we cannot see it with the naked eye. Of course, there are today sophisticated astronomical tools that will allow one to observe Venus even in this phase, but absent such technology, it cannot be seen. Certainly no one in the Classic Period Maya world, or anywhere else before the advent of contemporary solar telescopes, would be able to see it (Fig. 2.9).

One interesting and perhaps counterintuitive feature of the phases of Venus is that Venus appears brightest in the sky not when it is in its fuller phases, but instead in its less full phases. Why might this be? Remember that, because of Venus' interior



**Fig. 2.9** Because its orbit is within that of the Earth (that is, it is closer to the Sun), Venus can be seen from earth to undergo *phases*, similar to the moon. Unlike the moon, however, Venus is brightest in apparent magnitude when it is in its crescent phase, rather than its full phase. The reason for this is that we only see Venus as full when it is directly opposite the sun from us. It is only in this position, however, when it is on the other side of the sun from the earth, which is the furthest distance from the earth possible for Venus. In fact, we never directly observe (with the naked eye at least) a completely full Venus, as the planet is too close to the sun from our vantagepoint to be visible in this phase. In its crescent phase, Venus is on the same side of the sun as the Earth, and as close to it as possible. Thus, while we see less of the full disk of Venus lit, its apparent magnitude is greater because of the proximity of this light (Photo credit: NASA)

orbit, it will be closest to the Earth when it is in its “new” phase (where Venus is between the sun and the Earth), and furthest from Earth in its “full” phase. This means that the closest visible pass to Earth by Venus is when it is in a waxing or waning crescent phase. It is just in this phase when we see the largest amount of area of Venus relative to the area on the celestial dome it takes up, rather than in terms of the amount of lit space on Venus from our perspective. This translates into a brighter appearance in phases in which less of Venus is visible. This is why, strangely enough, Venus is brighter as a crescent than it is when it is in the fullest state in which we can observe it, at which point it is closer to the opposite side of its orbit from the earth (we cannot, of course, observe Venus in its full phase with the naked eye, as its proximity to the sun from our perspective drowns out its light).

Venus’ brightness, especially in those early phases, is remarkable, and people have been fascinated with it since ancient times. Indeed, in the modern world, where many people have lost the connection with the sky that humanity used to have, the brightness of Venus during especially bright phases has sometimes caused alarm. Authorities, news stations, and professional astronomers always claim (and often complain) that when Venus is bright they will receive a large number of calls asking the identity of that bright light in the sky, thinking it might be a stationary satellite, an experimental government aircraft, or something even more incredible.

The significance of Venus for the Maya was many-fold. It could be linked to their agricultural seasons in a certain way, and could also be linked to the power of the ruler, to understand and predict aspects of nature. The kings of the Maya world wielded enormous power, in part based on their abilities to predict, and thus control, the motions of heavenly bodies, especially the sun, moon, and Venus—the three brightest objects in the sky. In the Maya Classic Period, rulers of Maya city-states were also shamans and astronomers, and their authority in part derived from their ancestral connection to Venus.

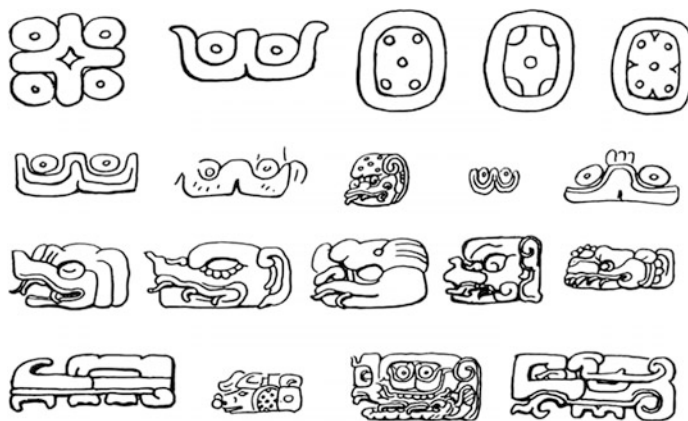
In the Venus tables from the Dresden Codex, Venus is represented in monstrous guise, and illustrations are included beside the descriptions of the rising, phases, and setting of the planet. During the Classic Period, Venus was associated with one of the two culture heroes of the Maya world, Hun Ahaw and Yax Balam (called Hunahpu and Xblanque in the *Popol Vuh*). Venus was Hun Ahaw, a name that may be linked with a particular day on which Venus appears in the sky in the early texts. Hun Ahaw is also a calendar date, the first day (*hun*) of the month *Ahaw* (the word *ahaw* also means ‘lord’ in the Classic Maya language). The rising of Venus perhaps then signified the return to life of Hun Ahaw and his twin Yax Balam (represented by the moon), returning from the underworld *Xibalba*, where demons attempted to destroy them as they did their father, according to the *Popol Vuh*. Venus also had additional associations in the Maya world. It, like the sun, may have been linked to rulers and founders of lineages (Milbrath 1999, 196–197), as well as to the god of storms, *Chac*.<sup>28</sup>

Venus also had military significance for the Maya. It was seen as a patron or talisman of war, aiding the Maya in their battles. This perhaps can also be linked to the Hun Ahaw and Yax Balam myth. Venus, after disappearing, rises again as the morning star, and represents in a fundamental way the idea of rebirth and triumph at the heart of the story of the hero twins and their return to life and subsequent defeat of the Xibalbans. This would be powerful imagery and ideology in war, the Maya forces taking themselves to represent this power to overcome the darkness of the underworld and attain victory. This is a particularly interesting recent discovery, given the earlier view by some scholars that the Maya were a completely peaceful and sedentary people. It turns out that the Maya, like every other advanced civilization in the world, engaged in warfare quite regularly. And Venus (Hun Ahaw) was its patron (Fig. 2.10).

It is the Maya observation of Venus and their recognition of its patterns of motion that is the most impressive aspect of their astronomy concerning the planet. Determining the regular motions and orbital patterns of Venus is much more difficult than determining that of the sun or the moon, for example (although those were equally important). This is because, while the orbits of planets such as Venus are regular and elliptical around the sun, from our perspective on the Earth it is

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<sup>28</sup>While *Chac* and *Tlaloc*, the Aztec god of storms, have commonly been identified as the same god, with *Tlaloc* simply the Aztec version of the god called *Chac* by the Maya, this has come into question by some scholars, including Milbrath (1999, 199–200) and Karl Taube (1992, 22).



**Fig. 2.10** A number of different Maya glyphs referring to the planet Venus. One interesting (and confusing) feature of Maya glyphic writing is that a word could be written in many ways, often very different from one another, as seen in this drawing from “A Study of Maya Art” by Herbert Spinden, 1913

irregular, because we are not watching it from a static point. Rather, we are moving in our orbit outside that of Venus while it moves along its orbit. Since Venus is closer to the Sun than the Earth, it moves more quickly in its orbit, and so passes us by as we go on our yearlong round of the Sun. This makes it much more difficult to discover the regularities in the apparent motion of Venus in our sky—though such regularities *can* be found, for those skilled and patient enough in observation. Fortunately, the Maya astronomers were both.

There was one celestial object even more important to the ancient Maya than Venus and the moon—the almighty Sun. The Sun, as giver of life, warmth, and light, is at the core of human existence, in every culture. Indeed, without the Sun our planet would not exist, and if the Sun were to disappear, our planet would go cold, unable to support life. The surface of the Earth would become a frozen rock, not very different from Pluto. Humans have always recognized the supreme importance of the Sun, and it has been revered in most civilizations throughout our history. We recognize that the patterns of the Sun’s movement correspond to seasonal changes, to fertility and barrenness of the ground. When the sun reaches solstice at its highest point in the sky, the growth of crops are rampant (although one should not wait this late to plant them), and the Earth is green with plenty. When the sun hangs at solstice in its lowest point in the sky, in the winter, the earth is barren, cold, and dry. Or at least such is the case for those of us in the temperate zones outside the tropics in both the northern and southern hemispheres. For those in the tropics, such as the Maya, the sun has a different, although no less, significance. In the Maya world, the critical agricultural determination was not when the warm and cold seasons, summer and winter, would be, but instead when the rainy and dry seasons would take place. The key was to plant crops so as for their growth to coincide with the

rainy season, which would then make the crop yield abundant. Then, harvest would take place before the onset of the dry season, to avoid the shriveling and dying of one's crops. Observation of the Sun played a critical role in this, just as it does in determining when to plant relative to warm and cold periods in temperate climates. Given that it is through observation of the Sun (along with that of the stars) that one can tell where one is in the year, then if one knows at what point in the year the rainy season begins, observation of the Sun (and stars) will help them determine when to plant crops, relative to this prediction.

The Sun had an additional significance for the Maya, a significance that the Sun had in many other cultures as well. Given the centrality of the Sun in human culture, there has been a tendency to draw a parallel between the importance and life-giving supremacy of the sun and that of the ruler. All across the world, in various ages, we see such an image projected, of the ruler as akin to the sun, or in some cases *identical* with the Sun. As we have seen in Roman culture, the sun was worshipped as a god, *Sol Invictus* "The Unconquered Sun", and during the Empire this god came to be associated with the Emperor. *Imperator*, the Latin term for 'emperor', was originally Augustus' attempt at giving himself a "humble" military title, basically equivalent to 'general'. The position of the Emperor began, then, adopting the symbolism and imagery of the humble servant of the people. With the decline of the Empire and the chaos of the various experiments in rulership, the imperial image began to change, and with the unification and rise to power of Constantine, the identification of the Emperor with a god, in this case the Sun, became explicit. Even after his conversion to Christianity, Constantine represented himself on coins and elsewhere in the guise of *Sol Invictus*.

Maya kings were also associated with the sun. There are many illustrations and stone inscriptions at Maya urban sites that identify kings with the sun. The title *K'inich Ajaw* ("Sun Eyed Lord", or "Radiant Sun Lord"), associating the king with the Sun or the Sun God, was often applied to rulers.<sup>29</sup> At the recently uncovered Temple of the Night Sun at the site of El Zotz in Guatemala, there is sun imagery linked to the person of the ruler.

The ruler, associated with and seen as having a power over the movements of the Sun, and gaining his own power from the Sun, naturally would have taken it as important to both have accurate skywatchers charting the movement of the Sun, from solstice to solstice through the year, and also to build monuments commemorating the Sun, which was also himself. Perhaps the grandest of these Sun temples is in the late Maya-Toltec city of Chichen Itza in the northern part of the Yucatan peninsula in modern day Mexico. The pyramid of Kukulcan (identical to the better known Aztec god Quetzalcoatl, "plumed serpent", whom, so the story goes, the Aztecs mistook the Spanish conquistador Hernan Cortes for when he first appeared with his fleet off the coast of the island city Tenochtitlan), is today referred to in Spanish as the *Castillo* (castle). While solstices and equinoxes are often

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<sup>29</sup>Colas 2003 discusses *k'inich* as Sun God as well as the link between the Sun and the ruler in Classic Maya imagery and texts.

marked by sunwatching cultures, and these passages of the sun are important events in the annual calendar, those within the tropics experience an additional phenomenon of the sun that those outside the tropics in the north and south do not. At exactly two points in the year for equatorial observers, the Sun will pass through the zenith. The Sun will on each of these days mark noon directly overhead, at the center point of the dome of the sky. In temperate regions, such as the entire United States, Europe, and most of Asia, the sun never reaches the zenith, and the further north you go, the lower in the sky is the sun's highest point, at the summer solstice.

The Kukulkan pyramid was aligned to the dates of the Sun's zenith passage. At noon on the days of zenith passage, when the Sun hangs directly overhead at the summit of the sky, its light shines in a direct line, or at a right angle of  $90^\circ$  with the ground. One interesting result of this is that during this noontime, objects will cast no shadows, being completely bathed in direct light from above. On the pyramid itself, the construction is such that at the equinoxes, a row of shadows is created by the effect that processes down the stairwells of the pyramid, linking the top to sculptures of the head of the plumed serpent god at the bottom of the pyramid. This creates the magnificent effect of a serpent descending from the top of the pyramid-Kukulkan descending from his throne. The descending serpents point in the direction of the sacred cenote at the site, a massive sinkhole of the type common in the Yucatan, which collected essential water in the dry region.<sup>30</sup> Elsewhere in the Chichen Itza site, narrow pillars set up for the purpose mark the zenith as the perpetual shadows they cast disappear in the noontime sun. This was clearly an event of central importance at Chichen Itza and elsewhere, and there is much more attention paid to this marker point in the sun's yearly journey than there is to either of the solstices. The site of the Caracol in Chichen Itza has been determined to be an astronomical tool, the use of which enabled the Chichen Itza astronomers to accurately track the positions of the Sun, the Moon, and Venus especially, but ultimately any celestial event they wished to (Fig. 2.11).

We find throughout the Mesoamerican world, in Maya sites as well as others, of the Aztec, and the earlier Olmec, the construction of sites, sacred as well as secular (although in the ancient world here and elsewhere, the two were not distinguished so starkly as we tend to make them today), that are oriented to some important direction based on the sky—whether this is the simple cardinal points orientation that we find in sites like the Cahokia mounds in Illinois, or a more elaborate orientation to some specific celestial event, such as at Teotihuacan, or at the Anasazi sites at Chaco Canyon in current day New Mexico. In the culture of the Aztecs, one of the inheritors of many of the features of Maya learning, the Sun had enormous significance, perhaps even greater than it did for the Maya. The Aztecs seem to have had a concern about the constancy of the Sun, seeing it as a god that needed to be propitiated in order to consistently perform its life giving role. They believed that it was necessary to make human sacrifices to the sun, in order to please it and to

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<sup>30</sup>Thus the imagery of Kukulkan descending may signify the coming of the rainy season in May, which corresponds with the May zenith.





**Fig. 2.11** The pyramid of Kukulcan in Chichen Itza (in the Mexican Yucatan Peninsula) is often called ‘El Castillo’ today, the Spanish name given to it during the modern period. The pyramid was designed so that on the equinox days, the shadow created by the corners of the pyramid at sunset would fall on the staircases. The shadow made was meant to represent the descent from heaven of Kukulcan (the “plumed serpent” god known to the Aztecs as Quetzalcoatl). In this photo, the head of Kukulcan can be seen at the base of the pyramid, linked to the staircase and the equinoctial shadow forming the serpent body of Kukulcan, descending from the *top* of the pyramid

ensure its continued rise each day. The great extent of Aztec human sacrifice is well known—although the Maya also performed human sacrifice, as did other cultures in central and South America, including the Inca in the Andean region of South America.

The Maya had a similar practice of human sacrifice, although the Maya sacrificial rite is not linked directly to the sun as is the Aztec rite. The Aztec sacrificial ceremony involved a priest cutting the heart out of a still living person, and offering it in a ritual to the sun. Archaeologists have found both Aztec and Maya ceremonial stone vessels that held the hearts of sacrificial victims. The *living* heart was particularly pleasing to the sun, and it was for this reason that the victim’s heart would be removed while alive, rather than killing the victim first and then removing the heart.

Human sacrifice is by far the most controversial and startling aspect of the pre-Columbian cultures of Mesoamerica. Some have tried to soften the horror of human sacrifice by pointing out that victims often saw sacrifice as a great honor, their deaths ensuring them the enjoyment of some sense of immortality. And while

this is true in some cases, it is not the whole story. The Maya and Aztecs both tended to sacrifice not important people in society, which one might expect if they truly believed it to be an unqualified honor, but prisoners and captives in battle. While there are exceptions to this, it may be the case that rival nobility, rather than a group or city's own, were sacrificed. One unique feature of warfare in Mesoamerica is that very often battles were not waged in order to produce or maximize casualties on the other side, but primarily in order to attain prisoners, who would then be used for the human sacrifice that ensure the continued patronage of the sun. These prisoners would hardly have seen it as a good thing to have their hearts cut out ceremonially on a platform of the pyramid of a rival city. There was, however, a relationship of mutual benefit between any two cities. While one belligerent sought to take prisoners from the other for sacrificial purposes, the other side equally sought such prisoners. It was this mutual need that ensured that warfare remained primarily aimed at capture rather than destruction (and perhaps that left the Aztecs unprepared to deal with the armies of the very much destructive-minded Spanish in the 16th century).

There are a number of theories as to why the Mesoamerican cultures adopted human sacrifice, which range from population control to military reasons. There is also, of course, the reason that they perhaps actually believed in their religion, and thought that sacrifice was necessary to ensure the proper working of the cosmos, however it had first been practiced. It is unclear how and why they would have noticed a link between the sacrifice of a human and the continuation of the world, but it seems clear that this became the belief.

As mentioned before, the Sun played a central role in the religious apparatus of human sacrifice, and indeed the Sun was a somewhat fickle and ambivalent life-giver that, in the Maya context, could easily take life away as easily as it could give it. While we in the temperate zones of the northern hemisphere, in the modern world in which we are not dependent on local agriculture, might have a hard time understanding why a people might think the Sun needs to be propitiated, it makes more sense when we consider the features of the Maya world. First, in their dependence on local agriculture (they could not have food air-shipped from thousands of miles away), conditions of drought would have enormous effect on their ability to produce food. Second, given the seasonal patterns of the region, they did not experience a warm summer and cold winter, as people in the temperate regions do, but instead experienced a rainy season and a dry season. The dry season was ruled by the Sun, which parched the land and made it infertile. Thus the Sun could sometimes be the giver of life, and sometimes the destroyer of life. It was important to the Maya (as well as other Mesoamerican peoples) to ensure that the Sun continued to bring benefit to the people and avoided destroying them. And it was, in part, human sacrifice, that made this possible.

## 1054 for the Maya: Some Speculations

Did the supernova of 1054 have any impact in the Maya area? Felix Verbelen proposes that the scribes of Chichen Itza recorded the supernova of 1054 in the Venus Tables of the Dresden Codex, as the supernova may have appeared as a “second Venus” in the sky over the Yucatan.<sup>31</sup> While Verbelen’s conclusion is controversial and relies on calendar correlations that are not generally accepted by most scholars,<sup>32</sup> we might imagine that the 1054 supernova would have been an event of significance for any skywatcher concerned with Venus. Whether or not the Dresden Codex records the supernova, there are still interesting questions surrounding the event. Did the Toltec-Maya of Chichen Itza find any significance in the cataclysmic celestial event hidden to us today, which they clearly must have observed? Perhaps the supernova coincided, whether purely coincidentally, or purposefully, with some major event in Chichen Itza society. If so, what might such an event have been? It is very likely that if some important event was correlated to the 1054 supernova, it would have been a military conquest of some kind. Venus, as we have seen above, was taken seriously as the patron of war, and its position often had a hand in determining the timings of invasions and other military maneuvers. If the record of the 1054 supernova was contained in the Venus table, it too likely would have been connected to some militarily significant event.

What could that event have been? There are a number of possibilities, but perhaps two that are most interesting. Yaxuna and Coba, two Maya cities slightly to the south of Chichen Itza in the Yucatan,<sup>33</sup> went into decline in the late 10th and early 11th centuries. It could be that Chichen Itza had a role in conquest of those cities—perhaps the people of Chichen Itza had finally overcome these cities decisively following the 1054 supernova, and this had been seen as a significant omen worthy of memorialization. An even more wildly speculative but interesting possibility is that the supernova corresponded with connections between the Toltec-Maya and their neighbors not to the south, but rather to the *north*, across the Gulf of Mexico, in North America. Today archaeologists note the startling similarities between the cultural renaissance in North America, such as that of the Mississippians, and the cultures of Mesoamerica, including the Maya and Aztec.<sup>34</sup>

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<sup>31</sup>Verbelen 2000 proposes that the 1054 supernova corresponds to a date given in the Venus tables of the Dresden Codex, but his proposed date of May 10, 1054, conflicts with archaeological evidence for the date. Especially since the *tzolk'in* date, 4 Ajaw 8 Cumku, was an important *tzolk'in* date that inaugurated new periods. (Kelley and Milone, 2005).

<sup>32</sup>The most widely accepted calendar correlation is the Goodman-Martinez-Thompson (GMT) correlation. Verbelen is careful to mention this discrepancy at the beginning of his article, and maintains that his reading may be falsified by further evidence.

<sup>33</sup>Yaxuna is closer and almost directly south of Chichen Itza, whereas Coba is further to the southeast, closer to the Atlantic coast of the peninsula.

<sup>34</sup>A number of archaeologists, including Timothy Pauketat of the University of Illinois, who works on Mississippian culture, and Gerardo Gutierrez, Mesoamerican specialist, and Stephen Lekson, Southwest specialist, both of the University of Colorado, argue for a robust connection between

As we will see below, this new flowering of culture in the north, so similar in form to the culture of the Maya, begins seemingly as if from nowhere, in the years surrounding 1050 CE.

## Mississippian Culture

One cannot help but have a visceral and profound feeling of the pull of time when standing atop one of the pyramids of the Maya, or the ceremonial mounds of the Mississippian peoples of North America. In addition to this, there is the additional sense of deep mystery when one enters the sites of the mound building peoples of North America. Who *were* these ancient people, one wonders. What was the significance of what they built? What were their beliefs, their relationships, and their understanding of the sky? While all of these questions will of necessity be much harder to answer than they are for cultures such as the early Maya, they can be answered to some extent.

Why are these questions more difficult when we come to ask them of the Mississippian peoples? There are two major reasons for this. First, the Mississippian cultures, although they built ceremonial centers, pyramids, and majestic cities every bit as large in scale as those of the Maya (and Aztecs), they did not build with stone, but instead with earthen materials, which are naturally less long-lasting than stone. In addition, one cannot carve inscriptions on the earth, or at least inscriptions that will last much longer than one season. Thus, we do not find the elaborate inscriptions that we do in the Maya world, which tell us a great deal about Maya culture, history, and astronomy. Secondly, the Mississippian peoples appear not to have developed a *textual* culture. There was no system of writing that we know of, and thus no texts. As mentioned above, in the Maya case, there are only four texts that we know of available today because of the routine destruction of Maya texts by the Spanish—and it is impossible to avoid reflecting on what kind of amazing discoveries concerning the Maya could be made if only we have access to the many other texts that have been lost. But in the case of the Mississippian culture, we have no texts at all to give us a description or even clues as to how people lived, thought, or understood their world. Without texts, writing, and distinct architecture, then, we have to rely on other materials and things to try to gain some sense of the world of the Mississippian peoples.

Studying sites such as Cahokia and numerous smaller sites in the region, both in their orientation as well as the artifacts that can be found there, is one way to approach the problem of answering who these people were, and most importantly for our purposes here, how they understood the sky. Another way is to look to the

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(Footnote 34 continued)

North American and Mesoamerican cultures in the early years of the 11th century, coinciding with the beginnings of Mississippian culture and those of the Southwest including the Anasazi.

historical and contemporary peoples who are the descendants of the Mississippian peoples. When we find broad similarities among a number of different descendent groups, this may be some indication that these aspects of culture trace back to the Mississippian peoples like those who lived in the city of Cahokia.

The astronomical culture of the Cahokians in many ways must have been similar to that of the Maya. However, there were a number of key differences in astronomy of North America, and of Mississippian culture in particular. As with the Maya (and many other cultures throughout the globe), time-keeping was a major consideration of the astronomy of north American cultures. There was also likely religious and governmental significance of the sky. Finally, there is a great deal of evidence that the Mississippian peoples were, just as the Mesoamerican cultures, close watchers of the sky. Indeed, there is some reason to believe that the flowering of Mississippian culture was influenced by Mesoamerican culture. Astronomy was central in the lives of this people, just as it was for the Maya (as well as a number of other things, including human sacrifice—although this never reached the extent in the Mississippian region that it did in Mesoamerica). At numerous sites throughout the wider region of the Mississippian peoples, observatories can be found at central locations, suggesting that not only did these people watch the sky, but that it had a profound and central religious significance for them. In our own contemporary scientific culture, although we are able to watch and understand the sky with much more precision and accuracy in certain respects than people in the days of Cahokia due to our modern technology, astronomy occupies nowhere near the significance to us that it did to our ancestors anywhere in the world, but particularly in North America.

On the southern edge of the city of Dayton, Ohio rests an archaeological site on the west bank of the Great Miami River. This site was, archaeologists believe, occupied by a prehistoric group referred to as the “Fort Ancient” people—once thought to be a branch of the wider Mississippian culture, but now generally accepted as descendants of earlier Woodland peoples. The Fort Ancient culture was named after the much larger site about 20 miles southeast of this village, along the Little Miami River in Warren County, Ohio (we don’t know what they would have called themselves). The Fort Ancient site itself was a ceremonial earthwork high above a steep gorge, and was likely built by a distinct and earlier people, today called the Hopewell (also named after a site near Chillicothe, Ohio).

This village in Dayton was constructed in an interesting way. It consisted of thatch and daub huts, built in a circle around a central point, in which there would have been a large pole marker. Archaeologists who have uncovered and worked on the site showed that this site was not only a settlement, but was also used as an observatory. And in a particularly ingenious display of elegance and efficiency, the huts themselves serve astronomical purposes in addition to their purpose as homes. The village itself is an observatory. The site was named “SunWatch Indian Village” in recognition of this purpose, and archaeologists in collaboration with the local natural history museum Ohio are reconstructing the site, which has been opened as a museum and park.

One of the oldest and simplest forms of positioning objects in the sky, especially on the horizon, is to use *sight lines* along the ground. We have already encountered this practice, in both the alignment system of construction of Teotihuacan, and the Caracol observatory in Chichen Itza, for example. There are many other ancient observatories that work on this principle, including Stonehenge in southern England, and let's not forget the ancient city of Cahokia, to which we will soon return.

There is an additional feature in use at the SunWatch observatory—one just as old and revered as the method of using sight-lines: use of the *gnomon*. The central pole in the village consisted likely of a tall wooden pole, at least 50 or so feet high (the higher the better, for gnomonic purposes). Because the sun occupies different positions in the sky at different points in the day and also at different times of the year, the shadow that this large central pole casts will change. This is the basic idea behind the sundial, an idea we will discuss at length in chapter three. Because of this feature, one can use a gnomon to construct a kind of clock. When the sun rises in the east, the pole will cast a long shadow to the west, as the sun is shining directly onto the eastern-facing side of the pole. As the sun rises in the sky, the shadow will slowly move to the northeast, finally pointing north at noon when the sun is at its highest in the sky, then gradually moving to the southeast as the sun sets, before ending in exactly the opposite position from its position at sunrise, as the sun sinks beneath the horizon. Knowing this, one can roughly (or more accurately, with some additional knowledge and tweaks) tell the time at any given point in the day. We know that when the gnomon's shadow is cast directly north, it is noon. If we are near one of the equinoxes, we know that when the shadow is at 45° northeast, it is 3 o'clock pm. There are of course some complications, because the path of the sun through the sky does not remain constant year-round, of course (Fig. 2.12).

And this fact leads to an additional use of the gnomon. One can use the gnomon to determine the solstices. At the winter solstice (in December in the northern hemisphere, June in the southern), the sun will reach its lowest extent in the noontime sky, and thus the shadow cast by the gnomon at noon will be longest at this point than at any other time of the year. If one has marked, for any given gnomon shadow, the point at which the shadow reaches its longest extent (a solstice line), then one can determine the winter solstice by noting when the shadow reaches this line at noontime. The same goes for the summer solstice, at which the gnomon's noontime shadow will reach its lowest extent, corresponding with the sun's highest ascent. Of course, all of this holds only for astronomy in the northern or southern hemisphere. The situation is much more complicated in the tropics, in which, as we've seen, the sun crosses over the zenith. There will be two days of the year that a gnomon will cast no shadow at all, just as we see with the pillars in the Temple of the Warriors in Chichen Itza, and because of the crossing of the zenith, shadows will be on different *sides* of the gnomon at different parts of the year. In addition, gnomon shadows will never register very much seasonal change in the tropics, as the sun never shifts very far from its overhead path. And due to the shift of the sun across the zenith, this will also make using the gnomon as a timekeeper





**Fig. 2.12** A model of the Fort Ancient village today called SunWatch (Dayton, Ohio), as it may have looked in the 13th century CE. The central pillar was used as a gnomon and as a sighting point, on the same principle as the “Woodhenge” site of Cahokia. The entire layout of the village served as a calendar, on which significant risings and settings along the horizon could be marked, using the central pillar and homes as markers. (Photo credit: Dayton Convention and Visitors Bureau)

much more difficult. It was likely for these reasons that the gnomon was a much more central feature of North American astronomy than it was of Mesoamerican astronomy.

In addition to its gnomonic uses, the central pole also marked the position from which an observer would use sight lines to determine the positions of rising and setting of certain important celestial objects, such as the sun and moon, Venus and other planets, and the Pleades star cluster. Once the cardinal directions are found and marked (north, south, east, and west), one can continue on to add additional points between the cardinal directions, in a circle (there are also other ways to do this as well so as to increase precision, but this is the way things were done in most ancient sites as well as at SunWatch and Cahokia). In particular, one would want to mark the position of certain important risings or settings, such as the rising or setting point of certain stars corresponding to particular points of the year. Most ancient cultures, and most cultures in the Americas as well, used the Pleades star cluster in this way, to determine when to plant crops and when to harvest.

With the central pole as the observing point, and a sufficient number of posts or other markers around the circular perimeter, one can determine the position of some celestial object or event relative to the apparatus of the observatory. If a group knows already in what direction certain important events will happen, such as sunrise or sunset on important days like the equinoxes or the solstices, one can

build posts, huts, or other markers so as to line up with this event when viewed from the central post. At SunWatch, the huts making up the perimeter surrounding the central post were built in just this way—as the sun rises on the morning of the equinox, for example, it shines directly through an intentionally placed gap between two of the huts. The genius of SunWatch is that the huts themselves play the role of posts, marking the cardinal points as well as the rest of the circle, and marking in various ways the important annual events.

This may have been knowledge transmitted by the culture of the builders of Cahokia. There were connections between Fort Ancient and Mississippian cultures for many years, especially the years between 1300 and 1500 CE, during which the SunWatch site was constructed.<sup>35</sup> At Cahokia there was a similar construction, labeled “Woodhenge” after the European site of the same name, but where the role of peripheral markers was not played by houses or huts, but by wooden pole markers, smaller than that of the central point. Cahokia’s Woodhenge was devoted completely to astronomy, located outside of the heart of the city, including the ruler’s palace on the largest earthen pyramid, today referred to as “Monk’s Mound”. Perhaps because of the massive size of the city, in comparison with SunWatch, the Cahokians could afford to build and maintain an observatory purely devoted to astronomy. There was also an additional gnomon pole in the central area of the city (“downtown” Cahokia, if you will) that likely served as a religious-ceremonial point, aligned with Monk’s Mound, while at the SunWatch site, the central pole plays both roles. Necessity is the mother of invention, of course, and the people at SunWatch found an ingenious way of realizing multiple functions—astronomical observation, living areas, and religious center—with one single complex. SunWatch shows us an excellent local and consolidated expression of the astronomical knowledge of the Mississippian peoples as found in their metropolis and cultural center, Cahokia.

The city of “New Cahokia”, as archaeologists refer to it, was built over top of an older city, referred to (creatively) as “Old Cahokia”. Old Cahokia was a village of the type one may have seen many of in the region, large for the area but not magnificently so. Old Cahokia was home to around 1000 people, and did not have massive mound structures or observatories as we see in the new city. Around 1050 CE, the city of New Cahokia was built, and it was envisioned on a massive scale. This was not a city that slowly grew into a major metropolis. It was *intended* to be such, from the moment it was built. As remarked above, some have believed there was a connection between the 1054 supernova and the new city of Cahokia. While there is no direct evidence to establish this, there is certainly some plausibility to the view, especially when we note the new features of Mississippian culture that seem to become dominant with the rise of New Cahokia. The rise of enormous mounds like Monk’s Mound at the northern edge of “downtown” Cahokia, as well as the devoted “Woodhenge” observatory site and the central city gnomon all seem to

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<sup>35</sup>Scholars have shown that use of certain forms of pottery in Mississippian culture were adopted by Fort Ancient peoples during this period (Cook and Fargher 2008).

suggest that astronomical observation was a major aspect of this new city and culture born at Cahokia. The rise of New Cahokia is the dawn of Mississippian culture, and these central astronomical aspects of Cahokian culture are shared elsewhere in the region, including later sites like SunWatch built by people likely influenced by the Mississippian culture. Was it an astronomical event that sparked this shift? 1050 CE is suspiciously close to 1054. Might it have been an amazing supernova that caused this shift?<sup>36</sup>

We thought about Mesoamerican astronomy above, and its unique features. Some experts believe today that there may have been connections between the Mesoamerican cultures and those of North America like the Mississippian. There are undeniable and startling similarities between the cultures of the Maya and Aztecs and northern cultures like the Mississippians and the Pueblo. Archaeologist Timothy Pauketat writes:

There are strong suggestions that the Cahokians, in building their vision into the landscape, drew on Mesoamerican models. Their possible descendants or those of their allies or enemies practiced Mesoamerican-style human sacrifice, incorporated obelisklike posts into their worship, relayed stories of superhuman men and women who wore distinctive garments and ear ornaments, used Mesoamerican-type flint daggers, and understood the cosmos in ways occasionally parallel to Mesoamerican notions. (Pauketat 2009, 7).

Thinking of their astronomy in particular, the new developments we see at Cahokia seem startlingly similar to those of the Mesoamericans, especially the Maya. The building of pyramids as both ceremonial altars as well as platforms for astronomical observation, aligned with important risings and settings along the horizon, was a major feature of both Mississippian culture and Mesoamerican cultures. The largest such structure at Cahokia, today called Monk's Mound (after the French Trappist monks who owned the land in the 19th century, lived near it and grew crops on top of the large mound), played both of these roles, and also served as the place of residence for the leader of the Cahokian community. The ruler's house was built atop the mound, and it was from there he and presumably his astronomers as well, could completely see the horizon, above the trees. The problem of how fully observe the horizon was an important one for cultures in places where trees and other vegetation were thick. In the Maya world, astronomical interest and civilization first developed in the region in which it was most difficult to see the horizon, as it was most densely populated by plant life. In the central highlands of modern day Guatemala sit the ruins of the ancient Maya city of Tikal—a city that thrived during the Classic Period, and whose political rise is associated with the beginning of the Classic Period and the Maya renaissance. As any visitor to the region around Tikal will understand, it will quickly become an issue to figure out how to get any view of the horizon. Tikal is in the middle of a tropical rainforest, with enormous trees and thick vegetation. There are really only

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<sup>36</sup>A number of scholars have considered the possibility of the 1054 supernova's causal role in the construction of New Cahokia, Cahokia's "Big Bang". Timothy Pauketat discusses this position in (Pauketat 2009).

two options in such a region—either try to clear as much of the forest as you can, so as to have the trees so distant from your observing point that they do not obscure your view of the horizon, or instead build *upward*, creating structures to try to get above the treeline, and thus observe the total horizon from there. Although the former option is theoretically possible, the labor involved would be truly immense, and it would be of more use to turn any such cleared fields into agricultural area. It is much less labor intensive comparatively, and uses much less space (so space can be devoted to other important things like agriculture) to build a structure that can get one atop the treeline for observation. This, combined with a somewhat cleared area, will give one a much better view of the horizon.

This is just what the people of Tikal did. And one can still today see the pyramid tops with their platforms jutting out atop a sea of tropical forest (though the forest almost certainly did not encroach on the city during its period of use as it does today). It is an amazing sight, and shows both the ingenuity of the builders of these structures, as well as their commitment to astronomy, and its deep significance to their lives. At more northerly cities like Chichen Itza in the Yucatan Peninsula, thick forests were not a problem. The Yucatan is a uniquely excellent place for following horizon astronomy. It is flat, dry, and thus sparsely populated with plant life. Of course, these same features make it much more difficult to thrive and survive than it is further south in the rainforest. It may have been in part for this reason that the Toltecs, who originated further west in the Valley of Mexico, were able to conquer the Yucatan region and thrive in this environment. They knew how to make the most of what such land offered.

The pyramids at Cahokia were not exactly the same as those as that one finds at Tikal or Chichen Itza. Because they were earthen structures, they do not today seem as majestic and imposing as the Maya or Teotihuacan structures, which are older than the Cahokia mounds but have lasted longer because of the nature of the material with which they were constructed. The mounds at Cahokia are still impressive, no doubt, but they do not quite invoke the overwhelming awe one experiences when seeing the pyramids of Tikal or Teotihuacan. They must have been much the same in their day. As I mentioned above, one can walk to the top of Monk's Mound, and from there you get a sense of how truly massive it is. Ascending other pyramids in the Mississippian region is very similar. They are often very steep, and appear larger than they look from the ground.

One interesting feature of Monk's Mound is that it was the quintessential "multi-purpose" structure. In addition to the features I mentioned above, being the home of the ruler, astronomical observation point, and ceremonial center, it had also originally been a burial mound. There have been remains found toward the base of Monk's Mound, and it seems that it was used in the standard burial mound sense that we find throughout North America far before the creation of New Cahokia. It is possible that Monk's Mound began its existence as a burial mound in the older community that inhabited Cahokia, and when New Cahokia was built, it was re-purposed and renovated. It seems to be the case that it continued to be used as a burial mound on occasion, and it may have been rulers and relatives of rulers who were buried here after the construction of New Cahokia.

There seems to be an interesting feature of burial mounds across the Mississippian region that corresponds to one of the uses of Monk's Mound, and can help make sense of the combination of the burial and ritual features. Many ancient burial mounds seem to be built on relatively high ground, and thus perfect for astronomical observation of the horizon. In the town of Miamisburg, Ohio sits the well-known Adena culture (800 BCE–100 CE) site referred to as the Miamisburg Mound. The mound itself, a 70 foot high conical mound that is the tallest such mound in the state, and one of the tallest in the country, rises from a point that is already the highest point in the city of Miamisburg, and one of the highest points in the entire valley of the Great Miami River, atop a hill jutting out from the countryside 100 feet above the valley. Walking to the top of the Mound, one can see over fifteen miles in the distance in every direction. It is easy to see downtown Dayton about 12 miles to the northeast, and far beyond, and the astronomical advantages of the site from the top of the mound are stark and obvious to those climb to the top (Figs. 2.13a, b).

Miamisburg Mound was first excavated (very sloppily) in 1869, and there were a number of burials found at the higher levels of the mound, but none further below. An earlier age of archaeology was not as careful with artifacts as is this one. While one may expect this because of the relative newness of the higher layers, such that the bodies have had less time to decompose, one very interesting feature was found near the bottom of the mound. There was a hollow area, some kind of chamber or room. This could have been the burial site for an important leader, or could have been an older ritual chamber, or meeting site. I think it is likely, and would be consistent with cultural features we find in later Mississippian culture such as that at Cahokia, that the Miamisburg Mound was also used as an astronomical observatory and ritual center. Another very interesting feature of the mound, particularly in comparison to Mesoamerican constructions, is that at one layer of the mound, a stone surface has been discovered—about 25 feet deep into the present mound. This means that at one time, people in the region decided to face the mound with stone, thus creating a lasting monument more akin to those in the Mesoamerican region. This also shows that the peoples of North America understood that stone could be used to construct ritual or living centers, but that they preferred using earth and wood, more (relatively) temporary materials. This was shown definitively in the mound itself, which was covered back over in successive layering with earth and wood. Earth and wood material for building would have, of course, been preferable for a people who had reason to think they might be on the move, and we do seem to see this much more in North America than in Mesoamerica. The weather patterns in the north are much more harsh, with longer and colder winters, and people in the north would likely have to move in search of food in ways the Mesoamericans never did. For whatever reason, the Adena peoples and the Mississippians after them decided that earthen materials were the way to go—even the necessarily sedentary peoples of New Cahokia.

But the Miamisburg Mound site predates the birth of the Mississippian culture at New Cahokia, by about one to two thousand years. The mound was built by a people referred to today as the Adena culture, named after the estate of the once





◀ **Fig. 2.13** The Miamisburg Mound, in Miamisburg, OH along the Great Miami River, was built by people of the Adena culture during the mid first millennium BCE. It was not constructed at once into its current form, but was built up in layers over many hundreds of years as a burial mound. It may have begun as a ceremonial center. The vantagepoint of the top of the mound offers the best natural view of the horizon available anywhere in this section of the Miami Valley region. It seems plausible that it would have been used for astronomical observations at some point. Photos by the author

Governor of Ohio, Thomas Worthington, in Chillicothe, OH on which a prominent mound was discovered and excavated. The Adena culture presents a mystery of its own, as it abruptly seems to disappear around 400 CE. Mounds such as Miamisburg which have been excavated have been shown to date to around 800 BCE, and indeed it is the beginning of construction of these mounds that archaeologists have used to mark the beginning of Adena culture (Just as the building of New Cahokia marks the beginning of Mississippian culture). The Adena culture seems to have existed in Ohio for a long period, from its beginnings in 800 BCE until 1200 years later in 400 CE.

Seemingly the Adena had a similar fate to the people of New Cahokia in the early 15th century. The abandonment of this once great city of Cahokia was abrupt, dramatic, and complete. One day there was a thriving and robust metropolis, and seemingly the next there was a vast ghost town. What happened to Cahokia? This is a question that has exercised archaeologists since they first began work on the site, and there have been a number of different views, ranging from internal warfare to droughts and other means of food shortage. Maybe the simplest explanation is also one that now seems most likely, given new evidence: flood. The fatal flaw of many of the Mississippian cities and towns that grew up alongside of major rivers is that, while they were perfectly placed to take advantage of the superb agricultural benefits offered by placement in the floodplain of a river, they were also perfectly placed to feel the full brunt of the destructive force of that river on those times it overflowed its banks and flooded the surrounding countryside. Cahokia is located in a perfect spot to be decimated by a particularly bad flood—the kind of “hundred-year flood” we hear about occasionally taking place along major rivers like the Mississippi, and which wreak havoc on riverside communities. There is new evidence that just such a flood took place along the Mississippi River in this region during the period Cahokia was abandoned.<sup>37</sup> What started with a bang (SN 1054), ended with a fizzle.

There was a similar abandonment at the SunWatch site in Dayton SunWatch as it stands today is even *more* exposed to flood danger than Cahokia, as it sits 200 yards from the Great Miami River, which is particularly flood-prone in the Dayton area, where it intersects with the Mad River. In early spring of 1913, the city of Dayton was devastated in one of the worst floods in American history, which left all of downtown and the surrounding areas completely underwater. The area occupied by SunWatch was completely submerged. It may have been just such a flood that

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<sup>37</sup>Munoz, et al. 2014.

led to the abandonment of the SunWatch site (though there is currently no evidence for this, and there are many other possibilities for its abandonment as well). Indeed, the natives of this region, with the benefit of hindsight, did not have settlements in what is now the Dayton area when Euro-Americans moved into the region to establish homes. A number of natives apparently warned early Euro-American settlers in the Dayton area that it was not a good place for settlement, because it was flood-prone. Dayton learned this the hard way in 1913. Today, there are tall levees alongside the Great Miami across its span through the city.

Is it possible that the Mississippian culture that developed on the banks of the Mississippi River, and had expressions in branch cultures throughout the eastern half of the current United States, was influenced by Mesoamerican culture, as some archaeologists believe? This is certainly far from impossible. If we are looking for the most likely sources of influence, there could be many. Trade, of course, is always an incentive to travel, and trade happens between cultures who otherwise never contact one another. Mexica artisans in Teotihuacan trade with groups further north, which themselves trade with Puebloans, and the artifacts of the Mexico valley end up in Chaco Canyon (current day northern New Mexico), for example. This is a standard story about influence. There is also more direct influence. The Maya city of Chichen Itza, for example, spent the greatest part of its existence (and its highest achievement as cultural center) not as a Maya-controlled city, but as a Toltec-Maya city, controlled by Toltec invaders from the western city of Tula in the Mexico valley. The Toltecs arrived in the northern Yucatan peninsula not by the (longer) land route, but by sea, sailing directly across the Gulf of Mexico that separates the Yucatan from the mainland. There are images at Chichen Itza and elsewhere depicting the Toltec in boats, surveilling the Yucatan shore, which they attacked from the sea. The Toltec people were clearly adept sailors. It is not a huge leap to think that perhaps such a seafaring people may have also sailed north on the Gulf of Mexico and landed along the Gulf Coast of the modern day United States. While the “Toltec Mounds” in modern day Arkansas, which were originally thought by some to be constructed by the Toltecs (and thus took the name ‘Toltec’) are not in fact Toltec at all, it may be possible that there was such northern influence. And if not by sea, then perhaps by land.

If there was Mesoamerican influence in the Mississippian area, this would be one explanation for the centrality of astronomy in ritual culture in both areas, as well as the similarity of a number of other cultural features.

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