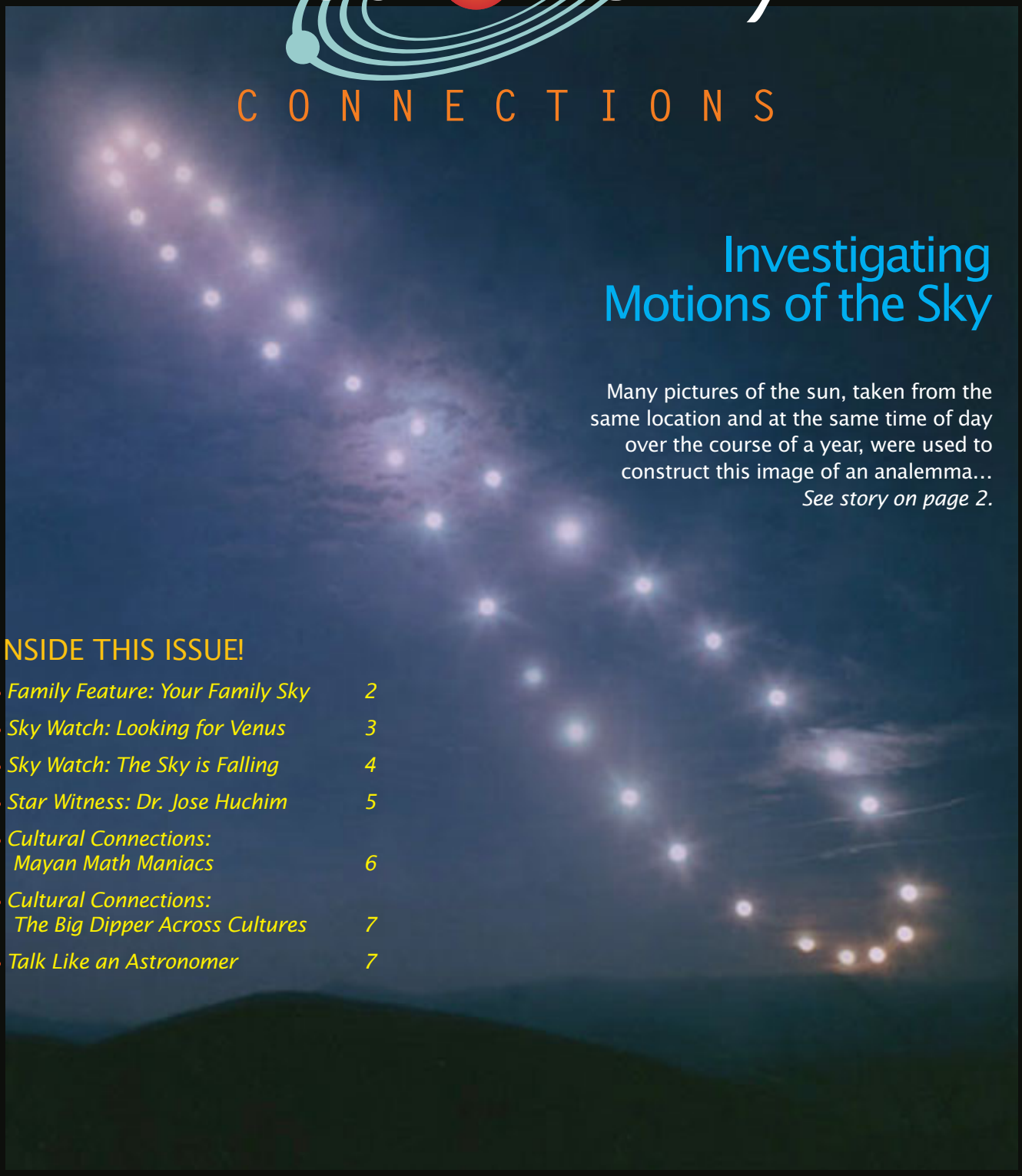
FOR THE FAMILY OF: _____

INVESTIGATING Astronomy CONNECTIONS



Investigating Motions of the Sky

Many pictures of the sun, taken from the same location and at the same time of day over the course of a year, were used to construct this image of an analemma...
See story on page 2.

INSIDE THIS ISSUE!

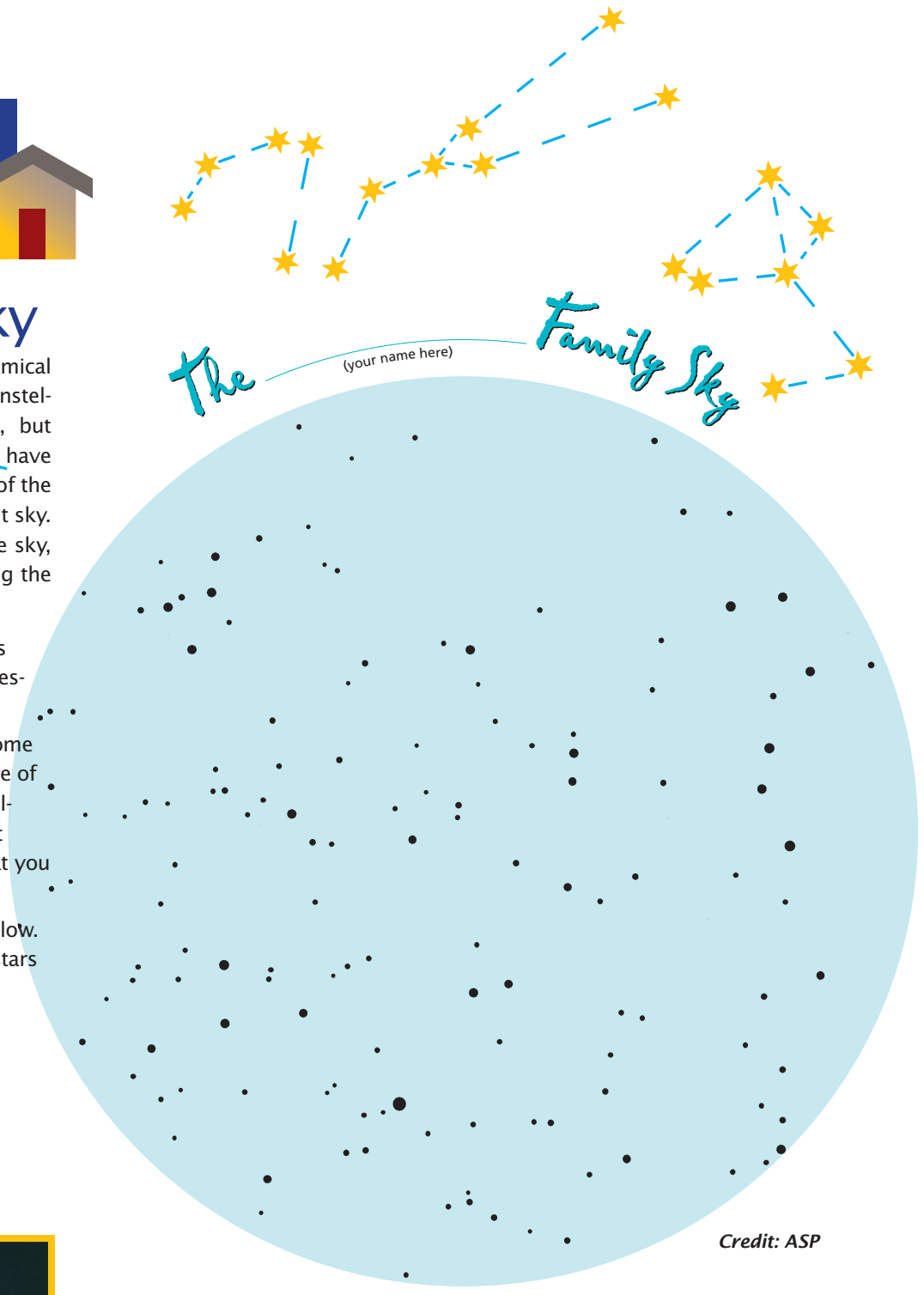
TERC NSF Astronomical Society of the Pacific NOAO

Family Features

Your Family Sky

In 1930 the International Astronomical Union designated the "official" constellations with names and borders, but we also know that many cultures have unique ways of making sense out of the chaos of scattered stars in the night sky. So we'd like you to personalize the sky, making it your own by customizing the chart below.

1. Spend some time sharing stories about heroes, relatives, and ancestors.
2. Decide how you might depict some fun, historic, or memorable piece of family history in the sky. Constellations are not strictly dot-to-dot figures, but use the patterns that you see there for inspiration.
3. Add the patterns to the chart below. You could even give the bright stars new and original names.



Credit: ASP

On the Cover

Since Earth's axis is tilted 23.5˚ relative to Earth's orbit around the sun, the sun appears in different positions in the sky over the course of a year. If you take many pictures of the sun from the same spot at the same time of day and combine them, you will produce an image that results in a figure called an **analemma**. The highest end point is where the sun is positioned on the first day of summer; the low end is the position of the sun on the first day of winter. (Credit & Copyright: Vasilij Rumyantsev, Crimean Astrophysical Observatory)

Sky Watch

Looking for Venus?

When it's visible, Venus is hard to miss, as it often outshines everything except the sun and moon in the sky. In fact, in many cultures, Venus was considered to be a companion to the sun, either leading the way, rising in the East just before the sun appeared in the morning sky, or watching its back, shining brilliantly in the West after sunset.

Venus was sometimes given two different names, depending on whether it was visible in the morning or evening sky. Based only on how Venus appears in the sky, this is not such a crazy notion. But with our understanding of how the planets orbit the sun, and that Venus orbits closer to the sun than we do, we have a slightly different perspective. Of course, Earth is also in orbit around the sun, but for simplicity's sake, in the drawing below we will only move Venus, examining it from four different positions relative to the sun and Earth.

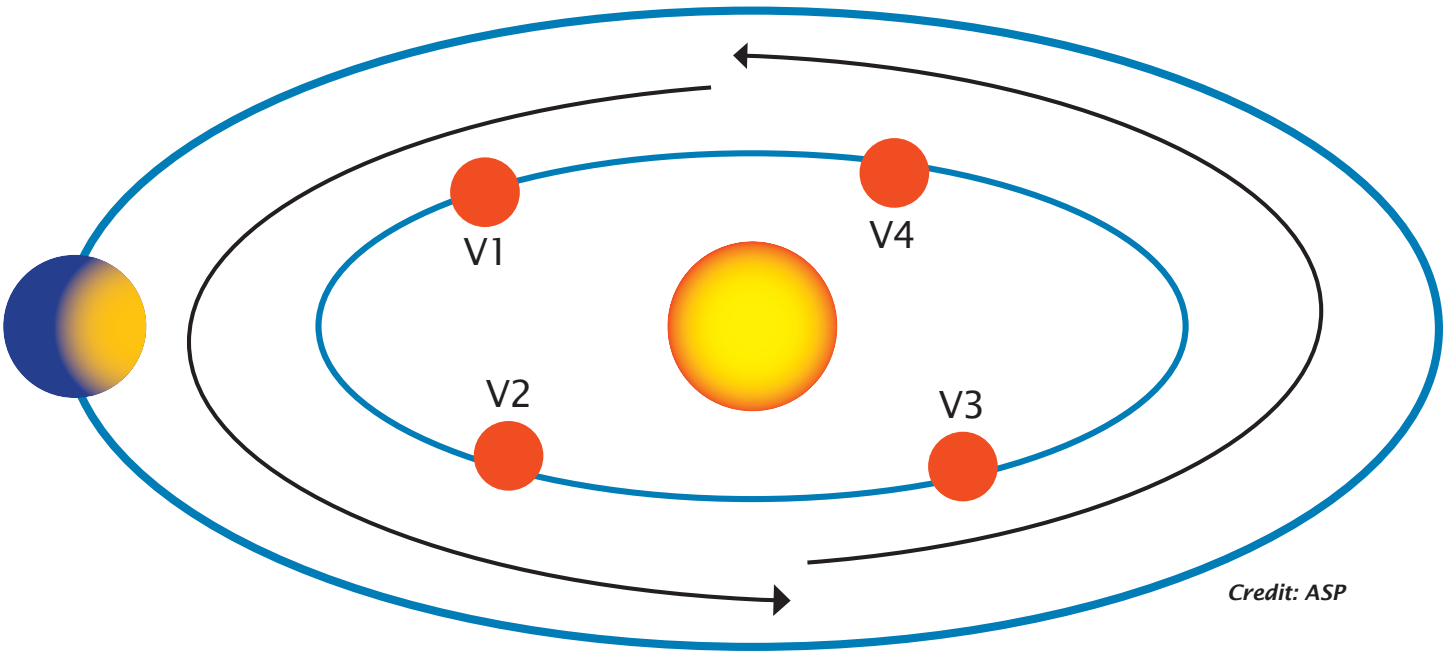
First, take a few moments to determine which is the daytime and which is the nighttime side of Earth and then of Venus. Then consider that since Earth rotates counterclockwise, which edge between light and dark would represent sunrise and which would represent sunset. Now include Venus in the picture.

When would Venus be visible in the morning sky, just before dawn (V2 and V3), and when would it be visible after the sun sets (V4 and V1)?

In 2006 and 2007, you can watch Venus move from the evening sky to the morning sky and back to evening as it orbits the sun.

This brief table gives a summary of Venus's visibility. In early to mid-January, when it is not visible, it is passing between us and the sun, moving from the evening sky to the morning sky, or from V1 to V2. In late September when it is again lost in the glare of the sun, it is moving behind the sun, or from V3 to V4.

Date	Time	Direction
March - April 2008	Before sunrise	East and SE
October 2008 - February 2009	After sunset	West and SW
May - September 2009	Before sunrise	East and SE
February 2010	After sunset	West and SW



Credit: ASP

Sky Watch

The Sky is Falling!

A Guide to Meteor Showers

Shooting star, falling star, meteor. What's the difference? Nothing, really. All of these are names for small pieces of rock from space that burn up when they hit our atmosphere. Most of them come from comets and are the size of a grain of sand. Occasionally, though, a gravel-sized rock will put on a really bright show.

What Is a Meteor Shower and Will I Get Wet?

No, you don't need an umbrella to observe a meteor shower! A shower of meteors occurs when our planet moves through a swarm of little rocks and dust out in space. If the swarm is an especially thick one, you might see as many as one shooting star or meteor every minute. Such swarms are left over from comets that move around the sun in their orbits again and again. A good example is Halley's comet. Comets are dirty ice balls that orbit the sun. On each trip around, some of the ice melts, leaving a trail of little rocks behind.

During a meteor shower, the meteors all seem to come from the same point in the sky—the radiant. (Credit: NASA)

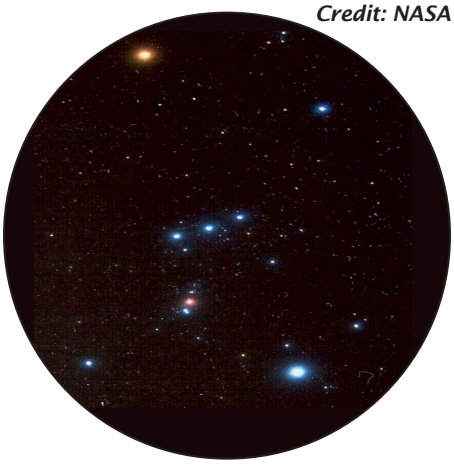
Why Can We See Such a Little Thing?

As the little piece of rock comes crashing through Earth's atmosphere, the air is rubbing against the rock and the rock is rubbing against the air. They both get so hot that not only does the rock heat up, but it vaporizes, and the air around it gets so hot that it glows, too. (When you rub your hands together, what heats up? Your right hand? Your left hand? Or both?) So even though they are tiny, we can spot these little guys and the glowing air around them when they are burning up at 60 miles (100 km) above Earth's surface. If it's big enough to survive the trip through the air and hit the ground, we call this leftover rock from space a meteorite.

How Many Meteors Will I See?

On any moonless night, you can see a few meteors each hour if you are away from city lights. Many more can be seen during a meteor shower, because these are large swarms of materials that Earth is passing through. It can take days for Earth to pass through the swarm, so meteors from the shower can be visible for many nights. If you look on a night other than the best night, you still might see more meteors than usual.

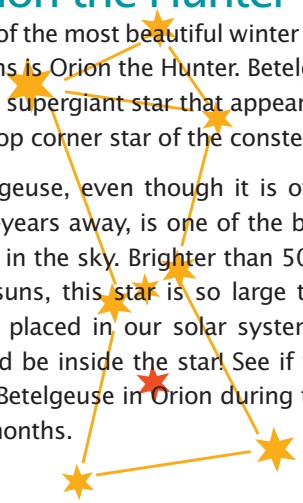
Credit: NASA



Orion the Hunter

One of the most beautiful winter constellations is Orion the Hunter. Betelgeuse is a red supergiant star that appears as the left top corner star of the constellation.

Betelgeuse, even though it is over 400 light-years away, is one of the brightest stars in the sky. Brighter than 50,000 of our suns, this star is so large that if it were placed in our solar system, Earth would be inside the star! See if you can find Betelgeuse in Orion during the winter months.



Hot Link

This web site has great information about this year's meteor showers.
http://www.theskyscrapers.org/meteors/index.php/year/2006

Credit: J. Huchim

Star Witness

Mayan Investigators

Interview with Dr. Jose Huchim

Dr. Jose Huchim is a Mayan archaeologist who works in the Yucatan peninsula of Mexico.

IA: How did you get interested in archaeoastronomy?
JH: Well, I am an archaeologist, and around 1980 I ran into an old friend of my family who is an archaeologist as well, Mr. Victor Segovia-Pinto. He was learning about astronomy, and he said that the pre-Hispanic buildings were related to the sun and other celestial objects. However, back then everybody thought that he was crazy. On a trip to Quintana Roo, Mr. Segovia told me about the research he was doing and that other cultures in the world worshiped the sun. During the first years of my professional work, and with the influence of Segovia, I discovered the equinox in the Seven Dolls Temple of Dzibilchaltun, which is located 15 km (9.4 miles) north of the city of Merida (capital of the state of Yucatan, Mexico). Since then I got interested in learning more about astronomy and how to relate it to my specialty.

IA: Why do you think that the study of archaeoastronomy is important?
JH: The recovery of this knowledge allows us to better understand the social implications, the methods of agricultural production, and the entire ideology suggested by the wide knowledge of the Mayan priests. Today, this knowledge is getting lost and I think that it is vital to communicate it so that the children of today take care of nature from the perspective of this ancient Mayan legacy.

IA: What can we learn from the methods of the ancient Maya who studied astronomy?
JH: We can learn many things, among them we can get to know better how it is that the Maya kept track of time through their calendars. For example Haab y Tzolki'n, which is one of the most accurate calendars to date. We can also get a deeper understanding of the knowledge of the agricultural cycles, which were related to the apparent movement of the sun. We can better understand how the ideological and ritual life was related to significant dates such as solstices and equinoxes. In other areas, ancient Mayan knowledge allows us to understand how the urban pattern of the ancient cities is related to the maximum declinations of celestial objects, and what the religious meaning was during the pre-Hispanic days. We can even see that the social behavior of some local communities today goes back to these pre-Hispanic origins and these religious perspectives related to astronomy.

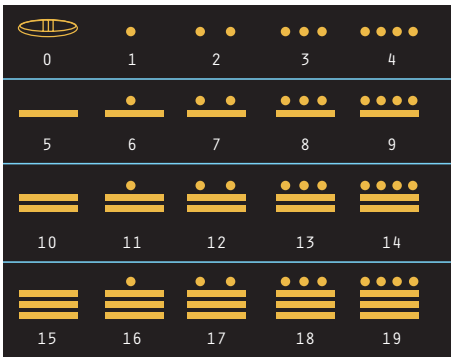
IA: How has the method of studying astronomy changed from the ancient Maya to the present culture?
JH: During the pre-Hispanic epoch, knowledge was obtained through observation of alignments and the use of some very simple objects to observe the "marks" of the important points in the sky. In those days the stars were thought to govern everyday life and aspects related to the gods, death, and earth life. Today, technology has allowed not only the observation of celestial objects but even the possibility of traveling to them [Mars for example].

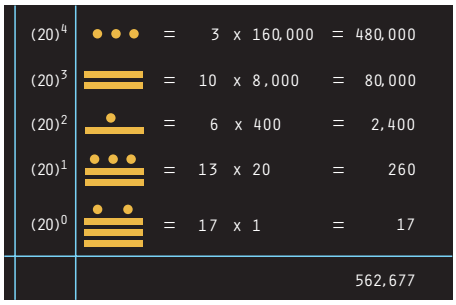
IA: Do you think that the Maya shared or share their vision of the sky with other cultures?
JH: I think that many ancient cultures produced knowledge from universal objects such as the sky and the stars, since these objects are represented in the architecture as well as in ceremonial objects and other objects used by the upper classes of society. Today, some of the beliefs that remain in our culture are part of the pre-Hispanic cultural heritage, which, from my point of view, is getting lost.

Cultural Connection

Mayan Math Maniacs

The Challenge in the *Investigating Motions of the Sky* Module relates to a fictional site inspired, in part, by cities and structures built by the Mayan people. From much research, we know that Mayan priests were skilled sky watchers, record keepers, and mathematicians. Their documentation of what they observed was possible because they had a sophisticated number-and-counting system, one that is very different from ours.





The three main differences are:

1. The symbols: they used a unique symbol for zero, dots for 1-4, and bars to represent 5, instead of the Arabic numerals, 0. 1. 2. 3...,
2. Our counting system is based around the number 10, presumably because we have ten fingers. The Mayan people, however, based their counting system around the number 20, possibly including their toes when creating it.
3. Rather than writing horizontally with each digit in a column, they stacked their digits. We have the ones column on the right; the Mayan people had the ones row on the bottom.

The Mayan people, using 20 as their base number, went up in rows, from bottom to top, from ones, 20s, 400s, 8000s, 160,000s, and so on. (20 x 20 = 400; 20 x 20 x 20 = 8000; etc.) This is not how we're used to calculating, so it may seem odd at first, but take a look at the system below and to the left.

The bars and dots are pretty straightforward, until you get past 19. This is where it gets a little tricky, and from a math standpoint, more sophisticated.

To translate a Mayan base 20 number to a base 10 number: Take a look at the example to the left. Each row is translated separately and then the results are added together.

To translate a base 10 number to a Mayan base 20 number: Start by dividing the number by largest Mayan division (i.e., 20, 400, ...). Represent it by the appropriate number of bars and dots. Divide the remainder by the next lower division, and represent that by the appropriate symbols and continue until your remainder is less than 20. Be sure to place your symbols in a column (stacked).

For example, to convert 566 into Mayan symbols, note that 566 is greater than 400, but less than 8000. Your first divisor will be 400.

566/400 = 1 remainder 166, and in Mayan a 1 is represented:

166/20 = 8 remainder 6, and in Mayan an 8 is represented:

6/1 = 6 remainder 0, and in Mayan a 6 is represented:

So this stack of three sets of dots and bars is the Mayan number 566!

Now try translating these numbers: 15, 307, 824

Challenge: Write your birth date in the form: mm/dd/year and translate that into Mayan symbols. What would your street address look like?

Hot Link [http://www.hanksville.org/yucatan/mayamath.html]

Cultural Connection

The Big Dipper Across Cultures

Many of us recognize a pattern of stars called the Big Dipper in the northern part of the night sky. The Big Dipper is actually a part of a constellation called Ursa Major, or the Big Bear. The Micmac Indians of Canada and many other North American tribes also saw the Big Dipper as part of a bear. Other cultures described the same pattern of seven stars very differently. Here are some samples:

- Ancient Chinese – The Chariot for the Emperor of Heaven
- Mayans – The Parrot (Seven Macaw)
- Hindu – The Seven Wise Men
- England – The Plow
- France – The Sauce Pan
- Pawnee Indians – The Stretcher That Carries a Sick Man

In the 19th century, this pattern of stars became a symbol of freedom to runaway slaves who followed the "Drinking Gourd" to travel toward the northern states.

Credit: NASA/APOD/ Philippe Moussette (Obs. Mont Cosmos)

Talk Like an Astronomer

Archaeoastronomy: The study of the knowledge, interpretations, and practices of ancient cultures regarding celestial objects or phenomena.

Constellation: A group of stars that make a figure or design, usually one of 88 recognized groups named after characters from classical mythology and various common animals and objects.

Meteor: A bright trail or streak that appears in the sky when a meteoroid is heated to incandescence by friction with Earth's atmosphere.

Meteorite: A stony or metallic mass that has fallen to Earth's surface from outer space.