Far Far Out!

Ancient Tales on the Celestial Sphere

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Editorial

"The history of astronomy is the history of receding horizons." - Edwin Hubble

The history of humanity is inextricably linked with the history of astronomy. We are a curious species, and we have certainly expanded our horizons since time immemorial. Our ancient ancestors, surviving at night by the light of their fires, pondered their existence and place in the universe as they gazed at the night sky. In that star-studded celestial dome, they preserved their traditions in the form of constellations and stories. These stories, the mythology of our species that come from a time long before writing, is still preserved in the oldest form of record we have: our night sky.

Understanding our past is crucial to moving into our future as a species. Our ancestors communicate to us, and we must listen carefully to the message. Learning how to communicate with them will help us figure our place on Earth and in the universe. Carl Sagan says it best:

"Today we also are seeking messages from an ancient and exotic civilization, a civilization hidden from us not in time, but in space. Today we are searching for a message from the stars. We have not found it so far. We have as yet no Champollion. But we are just beginning. Perhaps those who will discover and decipher the first interstellar communications are alive at this moment somewhere on the planet Earth."

In this issue, the last of our first volume of FarFarOut!, we end the year, and begin a new one, with ancient tales on the celestial sphere. We will discover the mythology and cosmology of ancient civilizations; investigate an ancient philosopher's story of a cataclysm of nature; embark on a tour of those mysterious planetary wanderers of the night sky; learn of the ancient Chinese astronomers and their interpretation of comets; hear a Native American tale of a girl with seven brothers; conclude with winter events, sky maps, and mythological monsters.

Wishing you clear skies,

Richard Camuccio
Editor-in-Chief

Content

Featured Art

Carol's Corner of the Cosmos

Carol Lutsinger

A successful hunt for constellations and asterisms means knowing the general directions; if you stand facing the sunset region that will be the general direction of "west". How soon this the month, do you think Venus to leap into your vision as the sky darkens? Allow your gaze to drift trying to locate the pentagon shape known as Capella in Auriga. Capella is a nanny goat draped around the neck of Auriga the Charioteer. He also has her two kids under his arm as he barrels his chariot down the skyway. And you worry about the texting SUV driver in the school zone. Capella and Venus are the two brightest points of light in the sky as full darkness falls. Once it is fully dark, then you will be able to see the Summer Triangle in the north-northwest as the Northern Cross slowly drifts down toward the horizon.

If you are out for an evening run or walk, then look east for a column of three stars standing vertically, enclosed on both sides by twin pairs of stars on either side. This is the famous Orion the Hunter constellation. The trio of stars creates Orion's Belt and a slender chain of light streams to the right of the belt that forms Orion's sword that contains the famous Orion Nebula, which contains the Horsehead Nebula and the Trapezium asterism.

Above Orion look for the V shape of Taurus which is also horizontal during the early evening hours. Look for the Pleiades star cluster above Taurus. In dark sky territory the view is awesome. Treat yourself to a few minutes of stargazing during the next clear night.

Even when it is cold die-hard sky watchers head out on clear winter nights to scan the skies above them for the magical glittering across the dome of heaven. The 88 familiar constellations are imaginary pictures, a celestial dot-to-dot if you will. Many ancient cultures connected a variety of stars into everyday objects, such as plows, serpents, water dippers, and mythological characters. Even casual research done via the internet will share some interesting stories from different corners of earth relating to the same groups of stars.

Aside from the North Star, I suppose the most talked about star is the star of Bethlehem. “Why a Star?” is an informative book written by Bodie Thoene related to it. I will not try to explain that wonderful star but she does a great job of it. Looking up at the glittering stars that fill the sky does make us ponder our place in things.

Directly overhead now, the Great Square of Pegasus is drifting westward as earth eternally rotates on its axis from west to east. Low in the west the bright star Altair in the Eagle constellation is nearing the horizon. In the southwest, Venus will emerge from behind the Sun to gleam in the western sky by the end of December slowly drifting into the horizon, followed by faint Saturn and bright Jupiter. Have you been making mental comparisons to the changing distances between them?

Very low in the south-southwest the lonely star Fomalhaut is a beacon marking the constellation Pisces Austrinus. A waning moon makes it easier to locate these stars since there is less of its reflected light added to our ubiquitous light pollution from all the glaring parking lots around us these days.

By full dark the V shape of the Hyades asterism within Taurus the Bull will be well-placed for us to explore the region with a decent pair of binoculars; of course, most folks want a telescope to explore, but that is not absolutely necessary. Finding your way with your unaided eye is a great way to increase your viewing expertise. And if you asked Santa for a Christmas telescope and need help using it, be sure to contact the South Texas Astronomical Society folks via the Facebook page.

Weather is naturally unpredictable so if you have been experiencing foggy or cloudy nights, Clouds again? Well, that means internet searching for NASA's Astronomy Picture of the Day, or the http://currentsky.com/ webpage for what's up there. Don't deprive yourself of reading about the stars and other wonderful objects in space. Visit the library and check out some of the books about the subject. A good family book written by H. A. Rey, the author of the Curious George series, is available in the children's section. One title is "The Stars, a New Way to See Them;" the other one is "Find the Constellations." With the dot-to-dot drawings of the constellations and easy-to-read explanations you may find yourself developing better star-gazing skills in spite of yourself.

When the skies are clear be sure to get outside and check out the position of the Big Dipper as it rises higher each night in the north off the eastern side (to the right) of Polaris. Over a period of weekly observations, you will come to realize there is a steady repeatable pattern in the motion of these stars. Moving counter-clockwise about Polaris, the North Star, Ursa Major wears the Dipper stars like a saddle on its back, with the handle forming a sort of vertebrae for the Bear.

Polaris is the last star in the handle of the Little Dipper, and the bowl is low in the sky as the Big Dipper rises and empties its contents into the smaller dipper. The two upper stars of the Big Dipper are known as "finder stars" because an observer can "draw" a line from them straight to Polaris.

Incidentally, the reason this star is so vital is that it is as many degrees above the horizon as whatever degree of latitude a viewer in the Northern Hemisphere is standing. This is how Lewis and Clark, and Eric the Red, among others, were able to wend their way across miles of sparsely inhabited land or uncharted waters and to begin the process of mapping this planet. In the Southern Hemisphere another standard was used, triangulation of three stars, and the ancient Polynesians even made maps out of shells, fiber and wooden frames to guide their travels.

Have you ever seen the International Space Station traveling across our skies? Check out https://heavens-above.com/ for specific times. Use the time on your phone because if the time is 6:43:15 that is exactly what it means. No "sort of close" with space time.

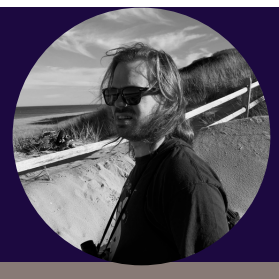
A colleague mentioned that he and his family made a point to rent a place at Port Mansfield last year to observe a meteor shower. The peak of the Quadrantids will be January 3 and 4 in the predawn hours. He said the viewing was great. Perhaps you might want to try that yourself for the next meteor shower time frame. April will be the next meteor shower event for the Lyrid meteors. That gives you plenty of time to think about whether you want to do that or not.

The observatory from the university is open for visitors at the Resaca de Las Palma State Park and World Birding Site. Be sure to check with the park office about observing nights. You will want to take your family and introduce them to how things look through a modest telescope. Members of the physics and astronomy classes share smaller good telescope views as well. Until next time, KLU. ★

Biography

Carol Lutsinger is the founder of the South Texas Astronomical Society. She spent 40 years as a teacher, serving students from Pre-K through college. Carol attributes her astronomy enthusiasm in part to her experience in the American Astronomical Society's AASTRA program from 1994-96, and her space excitement from serving as a Solar System Educator, and later Ambassador, for the NASA/JPL program. She has been writing the Stargazer newspaper column since 1998, which is carried in the Brownsville Herald and the Valley Morning Star. Retired from formal education since 2020, she still makes every opportunity to share meteorites which she carries in her purse and to ask folks in parking lots if they know what that point of light is.

Cosmos Aeternus: The Universe of the Ancient Romans



Mike LaTourette

Today we might take for granted our understanding of what we see when we look up at the night sky. We know why the Sun and Moon rise and set. We understand our solar system, the orbits of Earth's fellow planets. We know why there are stars in the night sky, and where we are in the Milky Way galaxy. Technology has made it possible for us to see high resolution photographs of far off celestial objects that our ancestors couldn't imagine in their wildest dreams. But before our modern knowledge of the nature of the universe, people throughout history have had to form their own understanding of their place in the cosmos. Few ancient civilizations had more influence on the modern world than ancient Rome, and the cosmology of the people whose gods our planets are named after may provide insight on our own view of our place in the stars. Ancient Romans formed their view of the cosmos through an ever-changing exchange of ideas between hellenistic astronomy, frontier geography, paganism and christianity, and national identity.

Throughout the Roman Republic and Empire, the Romans by-and-large subscribed to a geocentric model of the solar system developed mainly by Greek thinkers over hundreds of years from the time of Plato and Aristotle. Roman astronomy attempted to understand the movement of heavenly bodies and the place of Earth among them through this hellenstic astronomical tradition, and in the second century AD Claudius Ptolemaeus ("Ptolemy") standardized this model in the *Almagest*, a work that wouldn't be surpassed in influence on Roman astronomy until Copernicus's *De revolutionibus orbium coelestium* in 1543 [1]. Ptolemy described the Earth as the "center of a systematic universe, surrounded by rotating planets, sun, and moon...[and the] Romans were sure that their Empire was at the center of the cosmos... the assumptions of this cosmology permeated all Roman thinking about their world" [2].

The geocentric model of the cosmos aligned with the Romans' worldly view of their civilization. *Urbs Aeterna* (the eternal city), Rome stood at the head of an Empire at the center of the world, surrounded by a systematic cosmos designed by gods. This cosmology elevated Rome to a position of universal importance. Pagan and christian Romans alike "envisioned divine powers holding together the system of the cosmos" [2], and pagan Romans believed the god Terminus stood at the physical boundaries of the Empire, which separated Rome from the barbarians. One piece of late Roman art depicts the Roman Empire as a mediator between Christ in Heaven, and the barbarians outside the borders. The symbol of a sphere, or globe, important in Ptolemaic cosmology, was often associated with Roman emperors, representing their domination over the land and sea of the Empire [2].

However, other schools of cosmological thought existed throughout the history of ancient Rome. In book 5 of his work *De Rerum Natura* (On the Nature of Things), written circa 59 BCE, Lucretius lays out a view of the cosmos that is surprisingly modern. Breaking from the ideas of an ordered, divinely maintained universe, he offered natural explanations for the workings of the cosmos. He describes an impermanent, transitory cosmos: "So all have birth and perishable frame / Thus the whole nature of the world itself / Must be conceived as perishable too. Sky above / And earth beneath began of old in time / And shall in time go under to disaster" [3]. This view seemingly contradicts the typical Roman idea of a structured universe, held together by divine power with Rome at its center. Lucretius further differs from other Roman cosmology by disputing the idea that the realms of the gods and humans are connected: "Likewise, thou canst ne'er / Believe the sacred seats of gods are here / In any regions of this /

mundane world; / Indeed, the nature of the gods, so subtle, / So far removed from these our / senses, scarce / Is seen even by intelligence of mind." If supernatural divine beings exist, according to Lucretius, they exist beyond the realm and understanding of humans, and therefore cannot be responsible for maintaining the order of a structured cosmos.

It would be impossible to condense the cosmology of a continent-spanning civilization lasting thousands of years into a few paragraphs, but the influence of the Romans on modern astronomy speaks for itself. No matter how far our scientific knowledge advances, there will always be unknowns that humanity must face. Even though today we understand our cosmos in a way that the ancient Romans could never imagine, we haven't escaped that fundamental aspect of the human experience. By looking at how the ancients navigated the unknown, maybe we can learn something about ourselves. ★

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Biography

Mike LaTourette is a graduate of Franklin and Marshall College ('16), where he received a Bachelor of Arts in Economics and Governmental Studies, minoring in Latin, and taking any astronomy related courses that were possible to fit into his schedule. He currently works as an operations specialist for SEI Investments. He is a life-long astronomy and space enthusiast, and enjoys recording music, camping, drinking six cups of coffee daily, and video games.

A Geological Testimony

Jaqueline Peña

Just past the Pillars of Hercules, nearing the Strait of Gibraltar, lies the vastity of an ocean once deemed to host this island of utopia. Ornate in gold, embraced with jewels, and adorned with bronzed orichalcum, Atlantis is the story of hubris swallowing a city whole, quite literally.

The lost city of Atlantis is a famous tale. Its epic rise and fall encompasses the Spartans and mythological gods, aka the perfect equation for ancient awesomeness. Looking up the name, you'd be pointed to a catalog of historical narratives, lots of conspiracy theories, and absolute whirlwind of cinematic obsession. Now, before you whip out the tabletop maps and declare yourself Indiana Jones, understand this lost city has been sought for over 2,400 years [1]. And it seems what we look for never existed, or rather, we cannot find its remnants in the unforgiving Atlantic.

When tracing back the vine of origin to Atlantis, the only independent sources you will find be its first mentions in Plato's dialogues *Timaeus* and *Critias*.

Saga of ancient he-said-she-said because humans haven't changed much throughout the years...

> *So the rundown goes something like this: the Athenian, Solon, travels to Egypt in 590-580 BC. He had a conversation with a priest from the Temple of Neith in Sais in which they discussed the lost city and its fate. About 150 years after Solon's death the story continues to be spread through oral tradition. How do we know of any of this having happened? Because Plato wrote down all of it.*
>
> *Having heard the tale from his mentor, Socrates, Plato documented in "Critias" the journey of Solon and his big mouth about the matter.*
>
> *If you scale this range of historical gossip, Plato would be the equivalent to a modern man writing about George Washington's rumored adventures in the Amazon Rainforest* [3].

Now, Plato had a funny little quirk with speaking in allegories, enough so that his pupil, Aristotle, called bluff on the existence of Atlantis, and instead regarded it as a magnificent tale of human error and godly punishment.

Not to take away the mayhaps intended fact of moral contribution, but the story of Atlantis, if just its disappearance, may embark as truth... well at least in accordance to the harder-to-deny geological record of the time.

According to the dialogues of "Critias" the destruction of Atlantis occurred 9000 years before it was being told to Solon (about 11600 years from today). This window coincides with the Younger Dryas, a period that consisted of a spike in globral temperatures and a rise in sea level.

The Younger Dryas took place during the end stages of the ice age, or what is also known as the Pleistocene epoch [4]. The abrupt warming of the globe led to major meltwater increases from the ice sheets. Oscillations of climate caused the water levels to reach 40 millimeters per year and proved insatiable with the recurrent association to glacial period termination [4].

There is speculation the Younger Dryas could have been caused by a catastrophic event. In this case, an extraterrestrial impact.

The Younger Dryas Impact Hypothesis, otherwise known as the Clovis Comet Hypothesis, is a speculated reasoning to the sudden glacier melting [5]. Evidence of an asteroid impact at the time could be seen by the appearance of impact debris such as

"black mats" in soil and nanodiamonds [7, 8]. The impact itself was speculated to cause large biomass burning leading to an abrupt global warming.

So we believe there was an asteroid impact due with the time period, correct? And we have a missing city? Let's look at the second dialogue, "Timaeus."

> *There have been, and will be again, many destructions of mankind arising out of many causes; the greatest have been brought about by the agencies of fire and water, and other lesser ones by innumerable other causes. There is a story, which even you have preserved, that once upon a time Paethon, the son of Helios, having yoked the steeds in his father's chariot, because he was not able to drive them in the path of his father, burnt up all that was upon the earth, and was himself destroyed by a thunderbolt* [9].
>
> *Although formed in the state of a myth, this excerpt would allude to heavenly bodies above the earth crashing down in a blaze. The burnt up destruction was compared to a thunderbolt, a flash, and a quake.*
>
> *At such times those who live upon the mountains and in dry and lofty places are more liable to destruction than those who dwell by rivers or on the seashore* [9].
>
> *Here the priest is explaining the formation of the Nile to Solon. This further inclines there was a mass flooding from water levels rising having had affected civilization near the sea.*
>
> *It is not quite odd to speculate these two events go hand in hand: the disappearance of Atlantis in the sea, the appearance of the Nile, evidence of extraterrestrial impact. There must have been some unexpected event that intervened with the glacial reserves, and it would perfectly align to the city "falling" in the sea.*

Maybe Plato's writings were not all metaphorical. The dialogues of "Timaeus" and "Critias" describe geological events occurring within the timeframe of the Younger Dryas, and the added Easter egg passage of a bright mass declining from the sky proves interesting. If the story passes as permissible, excluding the mythological turnovers, the fate of the land mass might have been deemed by an asteroid impact.

For now we sit piecing together parts of an old man's ramblings. This ancient, unfinished writing has been inquired about over centuries and perhaps in beyond its decadent end we can look at something solid in record: its coinciding geological reflection. ★

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Biography

Jaqueline Peña is a senior at James Pace Early College High School. She is president of the school's SkillsUSA Drafting chapter and an ambassador for the South Texas Astronomical Society. She wishes to pursue a career in aerospace engineering.

As it is the Sky it is the Earth: Mapuche Astronomy

Dr. Mario Díaz

When our distinguished editor asked me to write a column for this issue, the marching orders were: this will be an issue about Ancient Astronomy. My first reaction was close to disappointment: I know very little about Ancient Astronomy. And it is old, isn't it? Why bother then? But I did not want to disappoint him and decided to make an effort and write something complying with the request. And paraphrasing what the great American physicist John Wheeler said about learning something (if you want to learn something, teach it), I decided to learn a bit about Ancient Astronomy and write about it.

After all, when I led the effort to build what is now the Cristina Torres Memorial Observatory, I suggested at the time to name it *Nompuewenu*. This is a word from the *Mapunzungun* (also called *Mapundugun*), the language spoken by the *Mapuche* people. Mapuche are the original people inhabiting part of the South American Patagonia and the Argentine flatlands called *Pampas*. My grandmother and my mother were born in the town that was the center of the Indigenous confederation created in the 19th century to protect their lands from takeover by the Argentine central government. Eventually, like in North America, the indigenous populations were defeated and their lands taken. This plight is well reflected in the Amazon Video streaming show *The English* which evokes the plight of the *Cheyenne* and *Pawnee* in the Wyoming and Nebraska territories. A very similar sacking took place in the Pampas. In both cases a great deal of the ancestral knowledge of the original peoples of our continent was purposely erased or ignored. My grandmother died when my mother was a child and she grew up forbidden from speaking Mapunzugun.

Being cut off from my roots I always longed for knowing more about my ancestors. That was how I learned that Nompuewenu was the word the Mapuches used to name the "Cosmos". It literally means *beyond the sky*. For them, the sky was essentially the region where the clouds form. The true "sky" was beyond that.

In the Mapuche Cosmogony, people (in Mapuzungun *che* means people and *Mapu* is the Earth) are children of *Wagulen*, which is the word for Stars. *Txawun Wagulen* means meetings of stars and that is how they called the constellations. For them *Wenu Mapu* (the sky) was the same as Earth: *"Chumley ta Wenu Mapu, ka Feley ta Nag-Mapu"*. As it is the Earth is the sky. So they name the Star Meetings (Constellations) with the names of animals, birds, snakes...

Our galaxy, the Milky Way, was called *Wenu Leufu* (Sky River). But what makes the Mapuche Astronomy particularly interesting is that, being a people living roughly between 37 and 54 degrees of latitude South, they look at a different sky than the one that the Europeans and the Northern Native Americans look at. While part of the Milky Way is visible in the lower-northern latitudes, near the southern horizon, its bulk appear high overhead for southern hemisphere observers. The galactic core rises early in the morning in the east/southeast in mid-late March. Being the gravitational center of our galaxy, it exhibits the largest concentration of stars and dust. It is an outstanding sight.

The Mapuches admired also the two *"Rangko"*, water wells on the sky. These were the Magellanic clouds, the two dwarf galaxies visible as night clouds only in the Southern Hemisphere. These were the springs were the men in the sky were taking their horses to drink.

The Southern Cross is an arrangement of stars made up of the most visible stars in the constellation Crux. This group of stars is visible mainly from the Southern Hemisphere. Because of its orientation in the night sky, the Southern Cross has historically served as a navigational mark: two of its major stars form a line that points to the South Pole. For the Mapuche its name was *Namun Choyke*, the ñandu leg (the *ñandu* is a non-flying large bird typical of Patagonia and somehow similar to the ostrich but smaller).

The Mapuches have names for many other constellations and astronomical objects, but there is an aspect of their cosmogony that surprises and somehow startles me: their strong belief that as it is the Earth is the Sky.

On the other side of the Atlantic twenty centuries of human civilization were based on a distinctive belief: that the stuff the Earth was made of was not what the sky was made of. The Greek scientific thinking reached its pinnacle with Aristotle, a prolific philosopher who wrote about multiple aspects of human creativity, from arts to the sciences. He was the first to write a book expounding the first organized ideas about the way nature works, calling it Physics. But, departing from the thinking of the older Greek philosophers, for him the physics of Earth was different from the physics of the sky. Earthly objects were formed by four basic elements in different proportions: air, fire, water, and earth. A rock, for instance, in his vision, had much more earth than water, air, or fire.

But for Aristotle, and later for many philosophers and other ancient scientists after him celestial bodies were of different nature than everyday objects, that is, of the elements that make the objects on Earth. Celestial bodies were composed of a different kind of matter, one which the ancient Greeks named quintessence. They believed the heavens – understood as the sphere where the Sun, Moon and planets move – were immutable, and of a different essence than Earth. For Aristotle and the Greek school, movement existed because every object has a "natural place", moves toward it, and when there, remains still. If a rock is lifted and then released, it will inevitably fall to Earth. According to Aristotle – who did not have a theory of gravity to explain it – the reason for this phenomenon was that the stone has a much larger component of earth than water, fire, or air. Therefore when it was taken away from its natural place – the ground, or equivalently the Earth – the rock "wanted" to get back to it and stay there. For Aristotle's physics, rest was the fundamental state of physical bodies. This static and hierarchical vision of nature was influential in Western thought until the Renaissance, not only in scientific circles, but also in philosophical and religious ones. The Aristotelian version of physics dominated the Western thinking for over fifteen hundred years.

Galileo, Kepler, and Newton showed that the motion of celestial bodies follow the same laws of motion as earthly objects like stones, bullets, and rockets. At the beginning of the 19th century, Fraunhofer proved, observing the absorption spectrum of the Sun's light, that the chemical composition of it was made of the same substances we found on Earth. It took the Western civilization twenty centuries to understand that what makes the earth is the same that what the universe is made of. The same clockwork makes both the Earth and the stars tick according to the same laws and in the same manner.

I can only wonder what would've happened if, instead of departing from the disjointed Heaven and Earth model, our civilization had developed on this simple idea: as it is the Earth it is the Sky. ★

Members of the Time Domain Astronomy Group constructing the Nompuewenu Observatory in 2013

Biography

Mario Díaz is Director of the Center for Gravitational Wave Astronomy and a Professor of Physics at UTRGV. He is Director of Cristina Torres Memorial Observatory, principal investigator of the Transient Robotic Observatory of the South Collaboration, and a member of the LIGO Scientific Collaboration. He received a PhD in general relativity and gravitation from University of Cordoba, Argentina.

Wanderers

Victor De Los Santos

"We have uncovered wonders undreamt by our ancestors who first speculated on the nature of those wandering lights in the night sky." – Carl Sagan, *Pale Blue Dot*

Since the dawn of humankind, we have looked up to the stars in awe. Ancient civilizations observed the night sky and took note of how the bright specks of light moved in synchrony. However, five of these points of light – the brightest in the sky – acted quite differently from the rest. Because of their disobedience with the rest of the night sky, these distinct celestial objects were called *planetes* (pronounced "plah-neh-tess") by the ancient Greeks, which meant "wanderer" [1]. This is the origin for the word we now use for those same objects, still wandering through the night sky and within our Solar System: *Planets*.

Much has happened since our ancient ancestors first began decoding the patterns of the celestial sphere. We now know that there are not five, but eight celestial bodies that qualify as "planets" in our Solar System. Over the past half century, humans have built technologies that have allowed us to explore the mysteries of our planetary neighbors. As we embrace the discoveries of our rapidly advancing technological civilization, it is worthwhile to understand the observations and interpretations of our equally curious ancestors from which the planets are still named after.

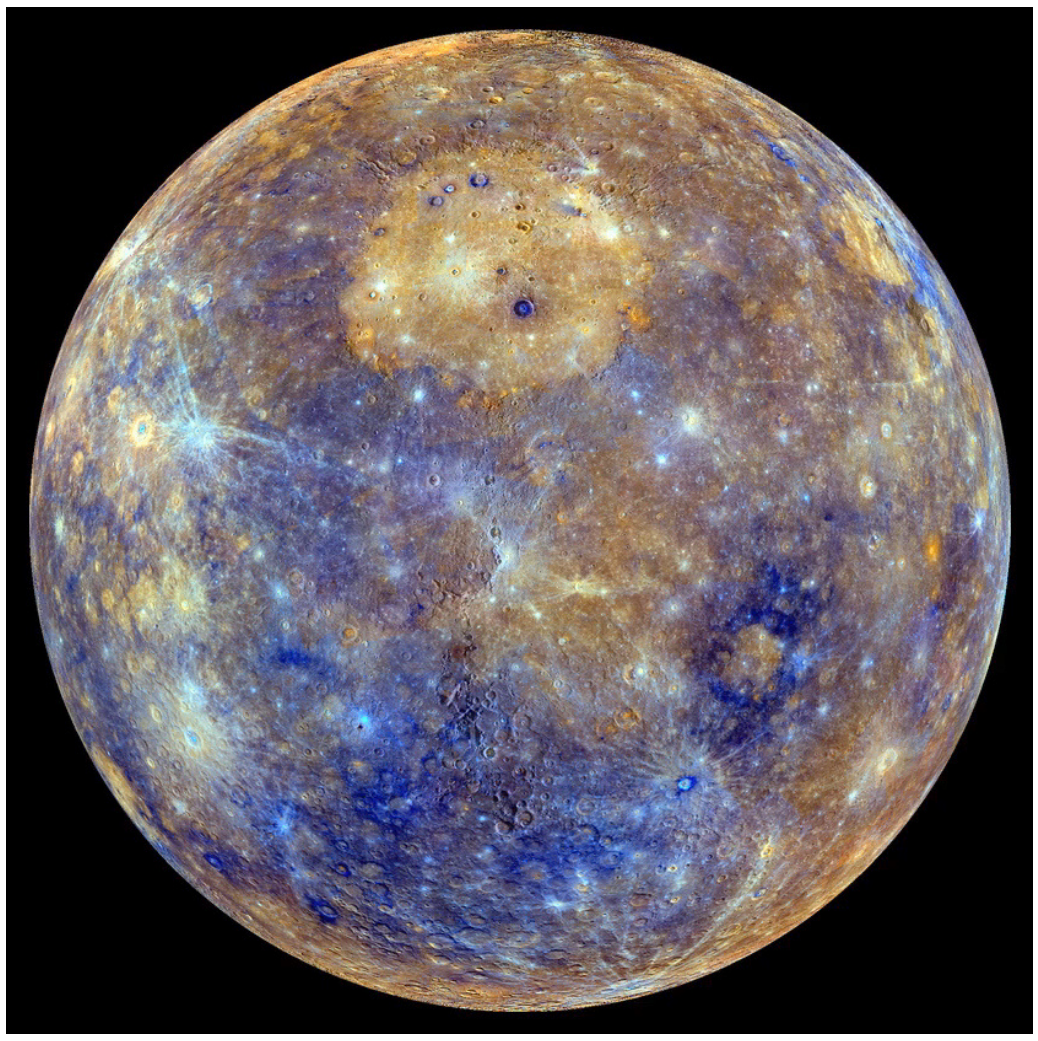


Image credit: NASA / John Hopkins University / Carnegie Institution of Washington

Mercury

Mercury is the closest planet to our Sun and was observed and documented as early as 400 BC by a Greek astronomer named Eudoxus. Because of its close proximity to our star, it can only be seen from Earth in the early morning or at dusk, right before the sky turns completely dark [2]. Nevertheless, ancient astronomers took note of how much quicker this particular planet returned to the same area of the sky compared to the other planets. We now know that this return signifies that the planet has made a complete evolution around the Sun – what we call a "year" – and that Mercury takes only 88 days to do this. Because of this quick reappearance, the Greeks named the planet *Hermes* after the fast messenger of the gods. The Romans had a similar idea and named the planet after their speedy god of trade, profit, and commerce, and that is the name we still use today: *Mercury* [3].

Another interesting quality Mercury is known for is a phenomenon called "retrograde". Retrograde motion is a term used to describe objects that seem to have reversed directions in their orbital path. Despite the negative events astrologers typically associate with Mercury's retrograde, the planet doesn't actually change directions – this is an optical illusion we experience on Earth due to the fact that Mercury aligns with the same background stars during its transition in front of the Sun, from our perspective.

This concept of "apparent retrograde" was proven in the 1500s with the demonstration of Nicolas Copernicus's Heliocentric Model of the Solar System [4].

Due to its closeness to the Sun (about 42 million miles), it is difficult to get spacecraft into a stable orbit around Mercury. Despite the odds, NASA has successfully deployed two missions to Mercury: Mariner 10 (1973-1975) and MESSENGER (2004-2015) [5]. Between the two spacecrafts' observations, scientists were able to get valuable data on Mercury's magnetic field and magnetosphere, which have been used to test theories about what Earth's fields would experience under different solar conditions, and minor traces of an extremely thin atmosphere [6]. Images of the planet obtained from both spacecraft reveal Mercury's surface to look very much like our Moon – covered with impact craters. BepiColombo, a joint mission between the European Space Agency (ESA) and Japan Aerospace Exploration Agency (JAXA), was launched in 2018 and is set to be the next spacecraft to arrive at Mercury in 2025.

Venus

Venus is the second planet from the Sun, closest planet to Earth, and brightest object in our night sky (besides the Sun and Moon). Fittingly, the Romans named Venus after their goddess of beauty, love, and splendor. The Greeks and Babylonians followed the same pattern, naming the planet after their gods of love – Aphrodite and Ishtar, respectively. (It was a non-intentional pun that Venus also turned out to be the Solar System's hottest planet, with surface temperatures ranging from about 820-900 degrees Fahrenheit [7].)

In 1761, scientist Mikhail Vasilievich Lomonosov (known as the father of Russian science) observed Venus at the University Observatory in St. Petersburg and discovered that it had an extremely thick Earth-like atmosphere [3]. Once this discovery was

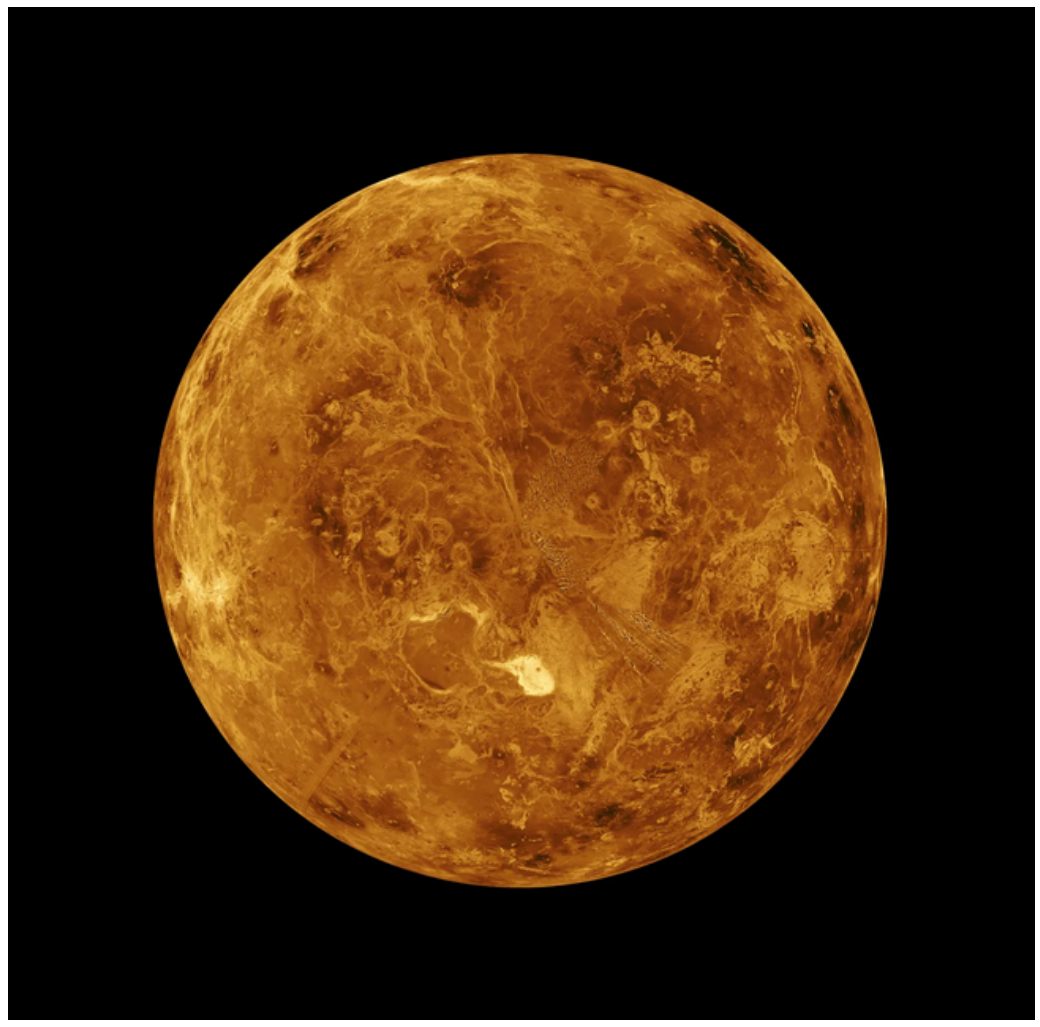


Image credit: NASA / JPL / Caltech

announced, scientists around the globe came to an optimistic yet premature conclusion: Venus was a habitable planet! The working theory was that, although Venus is closer to the Sun than Earth, its thicker atmosphere protects it from the Sun's harmful rays and solar winds. Alas, there was hope that one day, humans could migrate to one of our planetary neighbors.

However, in the 1950s, after high microwave emissions were discovered radiating from Venus, astronomer Carl Sagan proposed (through his PhD thesis on *Physical Studies of Planets*) that the planet's atmosphere was generating a "greenhouse effect", where – rather than protecting the planet – the heat from the Sun was being trapped and superheating its surface to the high temperatures we are now aware of [8]. Dr. Sagan's thesis was proven to be correct after NASA's *Mariner 2* mission successfully completed its first close-up observation of Venus (which also marked the first close-up observation of any other planet) and measured its dangerously high surface temperature, as well as an

atmospheric pressure 20 times that of Earth's [9]. As a result of the mission's observations and conclusion of his thesis, Carl Sagan provided evidence that a similar greenhouse effect was happening right here on Earth; as carbon dioxide (CO2) and other pollutants are released into our atmosphere, they absorb sunlight and other radiation which gets trapped in our atmosphere and effectively speeds up Earth's natural heating process. This is the phenomenon we know of as *global warming*, and the scientific exploration of Venus is to thank for our knowledge of this increasingly harmful process and its potential future effects it has on our home planet.

Though the planet's surface is way too hot, there has been hope for signs of life within Venus's atmosphere. In 2020, a team of astronomers in the United Kingdom discovered a chemical called *phosphine* in the atmosphere of Venus through radio observation. Phosphine is a molecule that is known to be generated only through biological activity [10], so it was quickly considered proof for the potential of life within the atmosphere of Venus – however, scientists are currently reviewing the data and conducting experimental tests before making the official announcement that this molecule does in fact point to life on another planet. Whether there are signs of life in its atmosphere or not, one thing is clear: Humans will not be able to migrate to or live on Venus anytime soon.

Mars

If you look up at the night sky and notice a bright red/orange dot, noticeably larger than other surrounding stars, chances are that it might be Mars. Often referred to as *The Red Planet*, Mars received its name from the ancient Roman god of warfare, more than likely due to its red color resembling blood (though we now know Mars's red color comes from the oxidation of iron on its surface, similar to rust). As you've probably guessed by now, the Greeks followed along as well, naming the planet *Ares* after their own blood-thirsty war god. The major

Image credit: NASA / JPL / Caltech

difference in mythologies, though, was that Ares was a destructive character who tore apart communities, while Mars's conflicts were strategic and brought upon eventual but everlasting peace [11].

If you've ever heard of Marvin the Martian or David Bowie's hit song *Life on Mars?*, you've probably figured out that the idea of aliens living on Mars is nothing new. The term "Martian" has been around since the late 14th century, meaning "of, pertaining to, or characteristic of the planet Mars". However, in the 1800s, the word received a new meaning: "An inhabitant of the planet Mars" [12]. As the notion of Earth being visited by alien lifeforms began to emerge throughout the world (but mainly in America), Mars became the number one suspect of their origin. Though there have been many Martian stories to date, the idea was originally spurred through observations by Giovanni Virginio Schiaparelli, director of the Brera Observatory in Milan. Using the observatory, Schiaparelli discovered and mapped out channels on Mars in 1877. At the time, however, Schiaparelli documented these canals

as "canali", which means "channels" in Italian, but the word was misinterpreted on a global scale to mean "canals". Unlike channels, canals are artificially-made structures, and so this discovery was taken literally by many as proof that intelligent life lives on Mars [14]. Unfortunately for the alien-lovers, we now know through definitive data that these *channels* are the result of the bodies of water that used to cover the surface of Mars before it dried up about three billion years ago.

Though there are no little green men living on the Red Planet, here's a fun fact: Mars is the only planet completely inhabited by robots. The first successful missions to land on Mars were *Viking 1 & 2*, both arriving on this foreign world in 1976. As of 2022, NASA has successfully sent five scientific *rover* missions to the surface of Mars: *Sojourner, Spirit, Opportunity, Curiosity,* and *Perseverance* [14]. (If we include all stationary landers, orbiting spacecraft, missions from other agencies, and failed missions, the list would total to about 47.) The scientific discoveries made possible through these missions is invaluable. We have characterized in great detail Mars's planetary surface, studied the geology of Martian rocks and soil, analyzed the chemical composition of the Martian atmosphere, and much more. As of late 2022, only two NASA missions actively remain roving on Mars: *Curiosity* and *Perseverance*. (The *Opportunity* mission came to an end in 2019 after Martian dust storms covered its solar panels; the rover's final farewell message translated to "my battery is low and it's getting dark" – [insert sad face emoji here]).

We've learned much about our red planetary neighbor, but we're not done learning yet. The *Perseverance* rover which landed on Mars in 2021 has been storing Martian rock samples throughout its expedition. Between 2027-2028, NASA plans to launch the *Mars Sample Return* mission, which will collect the samples *Perseverance* has been dropping and return them to Earth. Once here, scientists will be able to analyze the geological samples for biological traces in more depth than ever before (too bad we couldn't just fit an Earth-sized lab inside of a rover). Humans will stop at nothing to answer one of science's greatest questions: *Is there life on Mars?*

Jupiter

Since ancient times, the Romans, Greeks, and many other cultures and civilizations identified one of the five celestial wanderers as larger and more intimidating than the rest. Due to its obviously overpowering size and aura, the planet was named *Jupiter* after the Roman god of the sky and thunder. Jupiter is known as *Zeus* in Greek mythology.

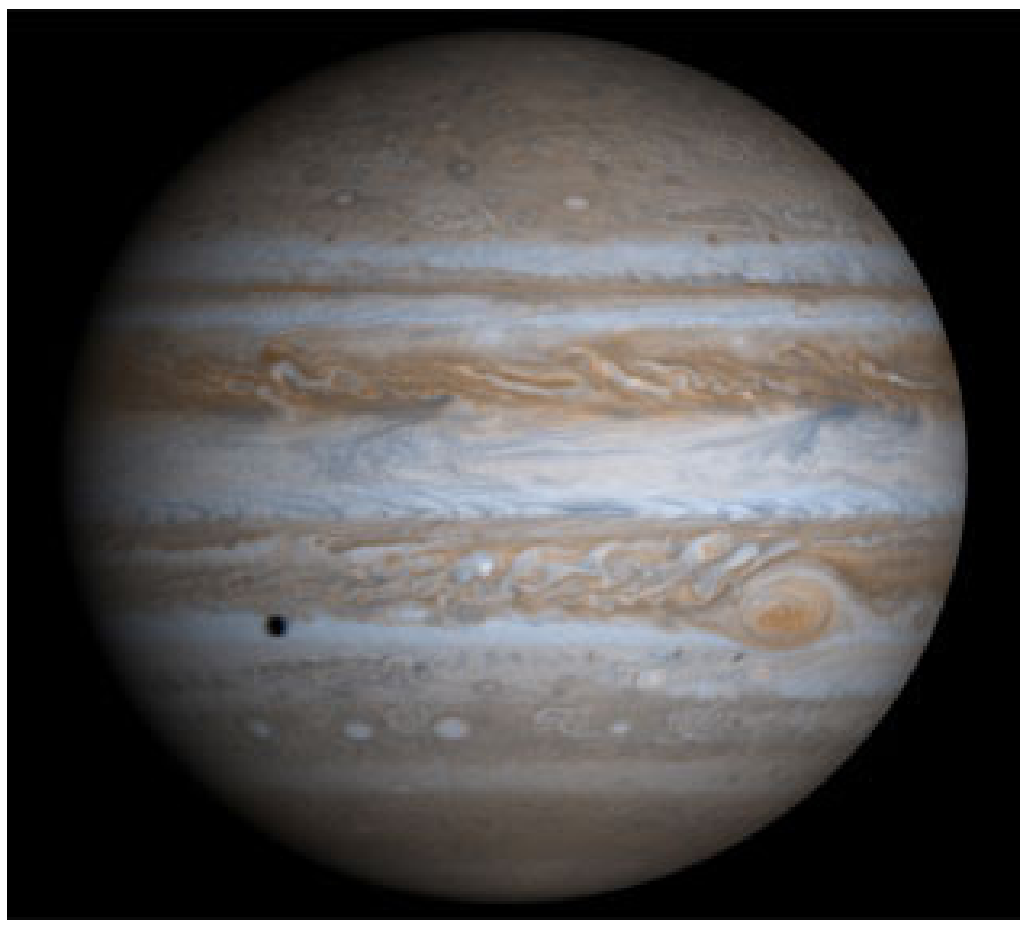


Image credit: NASA / JPL / University of Arizona

According to Roman mythology, Jupiter began as the sky god but eventually transferred over to becoming a war god. When Roman armies were victorious in battle, their victories were attributed to Jupiter, gracefully watching over them. Respect for this great and vicious god extended from the era of the Roman Republic (509-27 BC) into Rome's Imperial period (31 BC to 476 AD). During these time frames, Jupiter was presented as an obvious symbol for divine

authority: the god's image could be seen embedded on the clothes and weaponry of the highest elected officials in Rome, including the Holy Roman Emperor; when politicians were sworn into office, they swore their oath in Jupiter's name; to thank the graceful god, Roman citizens even offered him luxuries such as their finest ox with gilded horns [15].

As it turns out, the Romans were right to be thankful for Jupiter. Though Earth has definitely experienced its share of extinction-level impact events – including the asteroid that wiped out the dinosaurs 66 million years ago – astronomers have reason to believe that the rate of asteroid impacts on Earth would be much higher if it weren't for Jupiter's gravity deterring objects from our direction. More recently, scientists have been able to acquire evidence for this theory through the observation of comets caught by Jupiter's gravitational pull. Comet Shoemaker-Levy 9 was discovered in 1993 right before crashing into Jupiter in 1994. During the once-in-a-lifetime astronomical event, the comet was broken apart by Jupiter's gravity into 21 fragments that collided through the gas giant's clouds – many of them much larger than the planet Earth.

In 1779, however, an asteroid came extremely close Earth – and it turns out that Jupiter may have been to blame! British astronomer Brian G. Marsden, reporting on Comet Lexell, stated "... the comet had come streaking in from the outer solar system three years earlier and passed close to Jupiter, which diverted it into a new orbit straight towards Earth. The comet made two passes around the sun and in 1779 again passed very close to Jupiter, which then threw it back out of the solar system. It was as if Jupiter aimed at us and missed" [16].

Though its size is definitely notable, there's another reason Jupiter is so historically popular: its moons. On January 7, 1610, astronomer Galileo Galilei became the first person on record to look at Jupiter through a telescope. When he did, he discovered what appeared to be four stars near the planet. After a few nights of observation, Galileo noted the movements of these so-called "stars" and discovered that they were actually moons – natural satellites – revolving around the planet Jupiter! These four moons are now known by many as the *Galileian Moons*, and they are (in order of distance from Jupiter) *Io*, *Europa*, *Ganymede*, and *Callisto* [17]. In total, we now know that Jupiter has a total of 80 moons (23 of which are still waiting to be named) – but these four are by far the most well known for their ability to be observed using amateur-grade telescopes.

NASA has sent a total of three missions to study the planet Jupiter: *Galileo* (1989), *Ulysses* (1990), and the still-active *Juno* (2011). Another five missions have performed flybys of the planet, successfully capturing detailed images of the gas giant from a distance our ancestors never dreamed possible. Among these missions are *Pioneer 10* and *11* (1972-1973), *Voyager 1* and *2* (1977), and *Cassini* (1997). Over recent years, Jupiter's moons have caught the curiosity of scientists – mainly due to the discovery of icy water on their surfaces. Within the next few years, NASA and the European Space Agency (ESA) will send two missions specifically for collecting data on the Galilean moons: the *JUpiter ICy moons Explorer (JUICE)* (2022; focus on Ganymede, Callisto, and Europa) and the *Europa Clipper* (2023-2025; focus on Europa) [18]. Maybe there are no signs of life on any other planet in our Solar System – but what about on a planet's moons?

Jupiter cool fact: Jupiter's moon Io (typically pronounced "eye-oh" or "ee-oh") holds the record for most volcanically active world in the Solar System with a total of about 400 volcanoes of which more than 150 are active!

Jupiter funny fact: Many of Jupiter's moons – including the four Galilean moons – were named after

the mistresses of Zeus (Jupiter's Greek counterpart). In Roman mythology, Juno was queen of the gods – and jealous wife to Jupiter. So, as the pun goes... NASA sent Juno, the space probe/orbiter, to "spy" on Jupiter (planet) and his mistresses (its moons)!

Saturn

And now, we arrive at the farthest planet our ancient ancestors were able to see with the naked eye: Saturn, the *jewel of our Solar System*. Saturn was named after the Roman god of agriculture and wealth (*Saturnis*). According to the ancient tales, Saturn was the first to introduce agriculture to civilization. Saturn's Greek counterpart, *Chronos* (or *Chronus*) was regarded as the god of time. The connection made between the planet and time is not confirmed, however, many believe it may be because Saturn takes the longest out of all the other visible planets to orbit the Sun, due to its further distance [19].

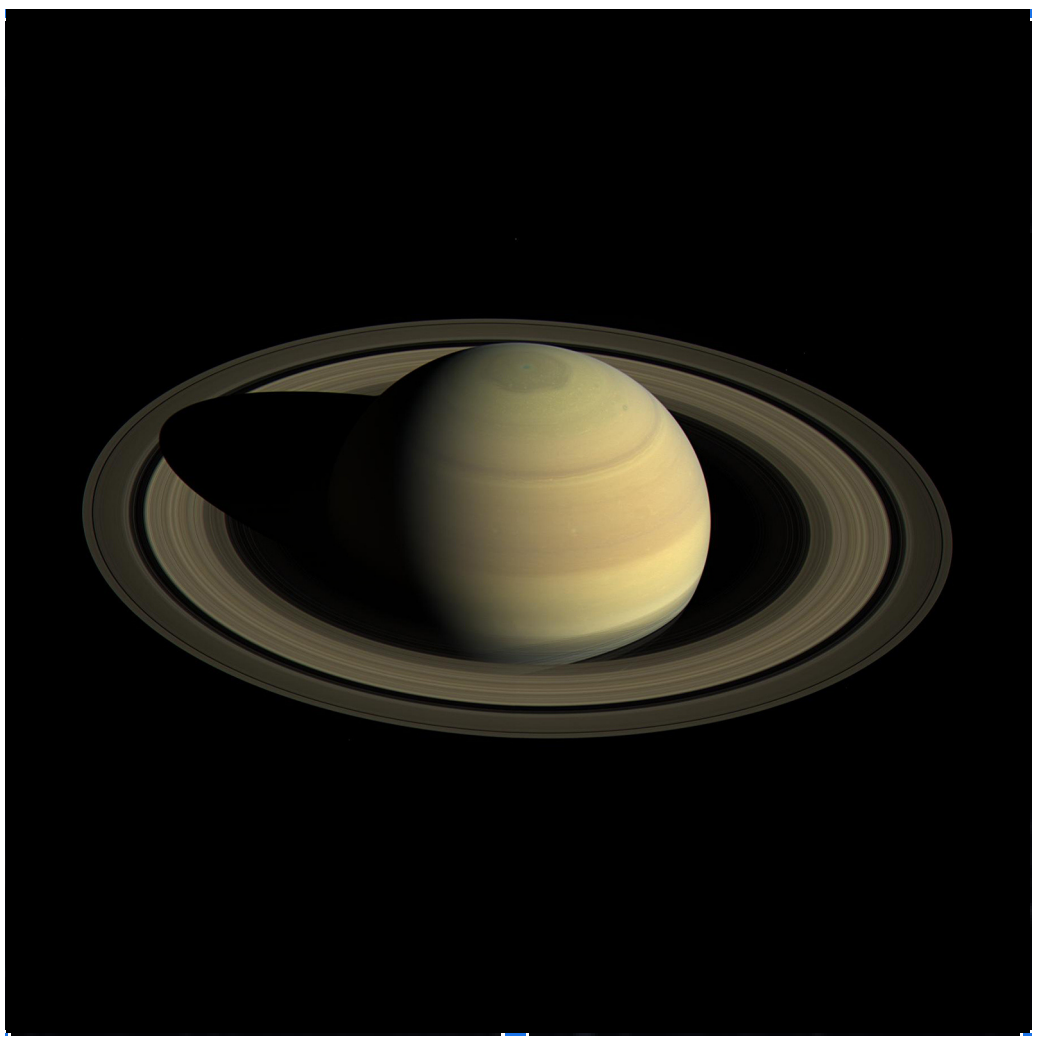


Image credit: NASA / JPL-Caltech / Space Science Institute

Though Saturn's distinct yellow color (caused by ammonia crystals in the atmosphere) and hexagon-shaped polar storm are undoubtedly interesting, the planet's ring system is what most people bring to mind when they think of Saturn (ergo Saturn's nickname, *the ringed planet*).

Saturn's rings were first noticed in 1610 by Galileo, soon after he made his famous observations of Jupiter. However, due to the limitations of Galileo's telescopes, he was not able to properly observe what these objects were – he originally thought them to be more moons, but they did not behave the same way as Jupiter's. In 1629, astronomer Christian Huygens made a quantum leap in the advancement of astronomy when he worked with his brother Constantin to design a new type of large telescope that allowed them to see farther into space than Galileo using ropes, pulleys, and their knowledge of mathematics and mechanics [3]. After more precise observations of Saturn, Huygens confirmed that the objects surrounding Saturn were not moons, but *rings,* made up of billions of small pieces of ice and rock.

Along with the ring system, Huygens also discovered Saturn's largest moon, Titan. Italian astronomer Giovanni Cassini, appointed as director of the Paris Observatory by King Louis XIV in 1672, went on to discover four more moons in Saturn's orbit, bringing the total to five by 1684 [3]. Cassini was also the first person to record precise and detailed observations of Saturn's rings; he discovered the break in the ring system (measured to be about 3,000 miles wide), which was promptly named the *Cassini Division* after him.

To solidify both astronomers' names in the sands of time (get it? Time? and Saturn?), NASA, ESA, and the Italian Space Agency launched the *Cassini* space probe and *Huygens* lander aboard the *Cassini-Huygens* mission to Saturn. The Huygens lander made its arrival on Saturn's moon Titan on January 14, 2005. Though the lander only survived about four hours on Titan, it provided scientists with enough data to keep them busy for years [20]. The *Cassini*

space probe, on the other hand, was expected to last a little more than 13 years – instead, the spacecraft orbited the ringed planet for 20 years before plunging into Saturn's atmosphere in September of 2017! During its two-decade-run, Cassini provided us with beautiful images of Saturn (especially on its way into the atmosphere), extraordinary scientific data about the planet and its ring system, and an overall better understanding of our Solar System [21].

Unfortunately, it appears as if Saturn's rings are slowly disappearing. As discovered by the Voyager spacecrafts, Saturn's magnetic field is actively pulling on the icy rocks that make up the ring system, causing them to bump into each other and eventually fall as rain into Saturn's atmosphere [22]. No reason to worry, though – observations from the *Cassini* space probe estimate that Saturn's rings will still be around for about another 100 million years. So, I'd advise the reader to take in this planetary beauty any and every chance you get – there's nothing like the experience of seeing Saturn and its rings through a telescope!

Image credit: forbes.com

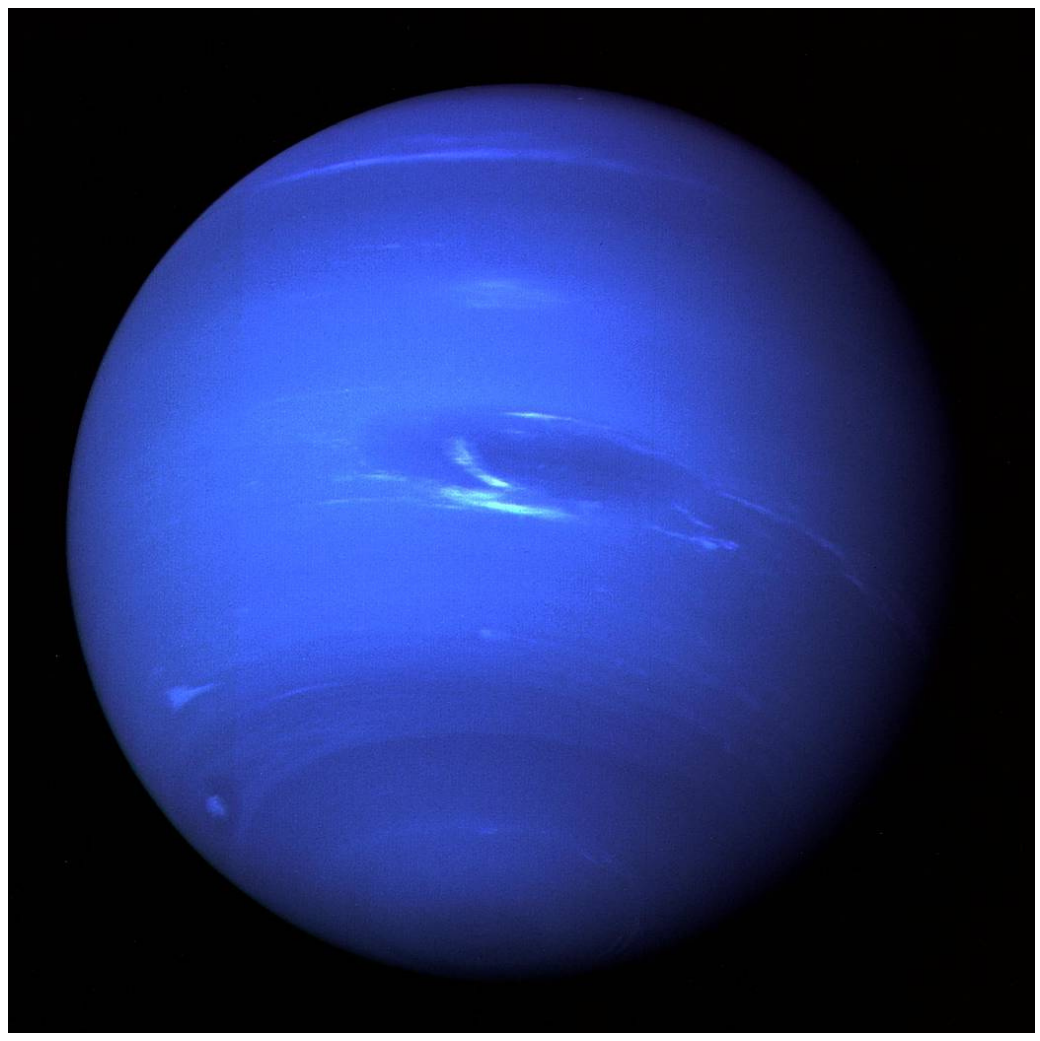


Image credit: NASA / JPL-Caltech

Honorable Mentions: Uranus & Neptune

Though they were too distant and dim for our ancient ancestors to notice, Uranus and Neptune – the 7th and 8th planets from the Sun – were still given the honor of being named after gods.

According to Greek mythology, Uranus was the great-grandfather of Ares (Mars), grandfather of Zeus (Jupiter), and father of Cronus (Saturn) [23]. The gas giant (lol) was discovered in 1781 by astronomer William Herschel, although for a while, it was thought to be either a comet or star rather than another planet. One of the most unique features claimed by Uranus is that the planet is so far tilted on its axis, it actually appears to rotate on its side. Though it is definitely an interesting planetary neighbor, Uranus has only been visited once before, during a flyby by the *Voyager 2* mission in 1986 [24].

Neptune was the Roman god of the sea (you may have heard of his counterpart, Poseidon). After its discovery in 1846, the planet's deep blue color made its namesake an obvious choice. The discovery of

Neptune was predicted after calculations of the orbit of Uranus showed movements that could only be caused if another celestial body were there, influencing it through gravitational forces. Upon *Voyager 2*'s flyby of Neptune in 1989, scientists discovered the planet's "Great Dark Spot" – similar to Jupiter's red spot, this indicates a large and powerful storm in the atmosphere of Neptune.

Earth: The Pale Blue Dot

Although Earth did not receive its name from a mythological god (it comes from the Old English/German words *eorthe* and *ertha* which just mean "ground"), we should not forget to recognize our home planet.

Image credit: NASA / Apollo 17 crew

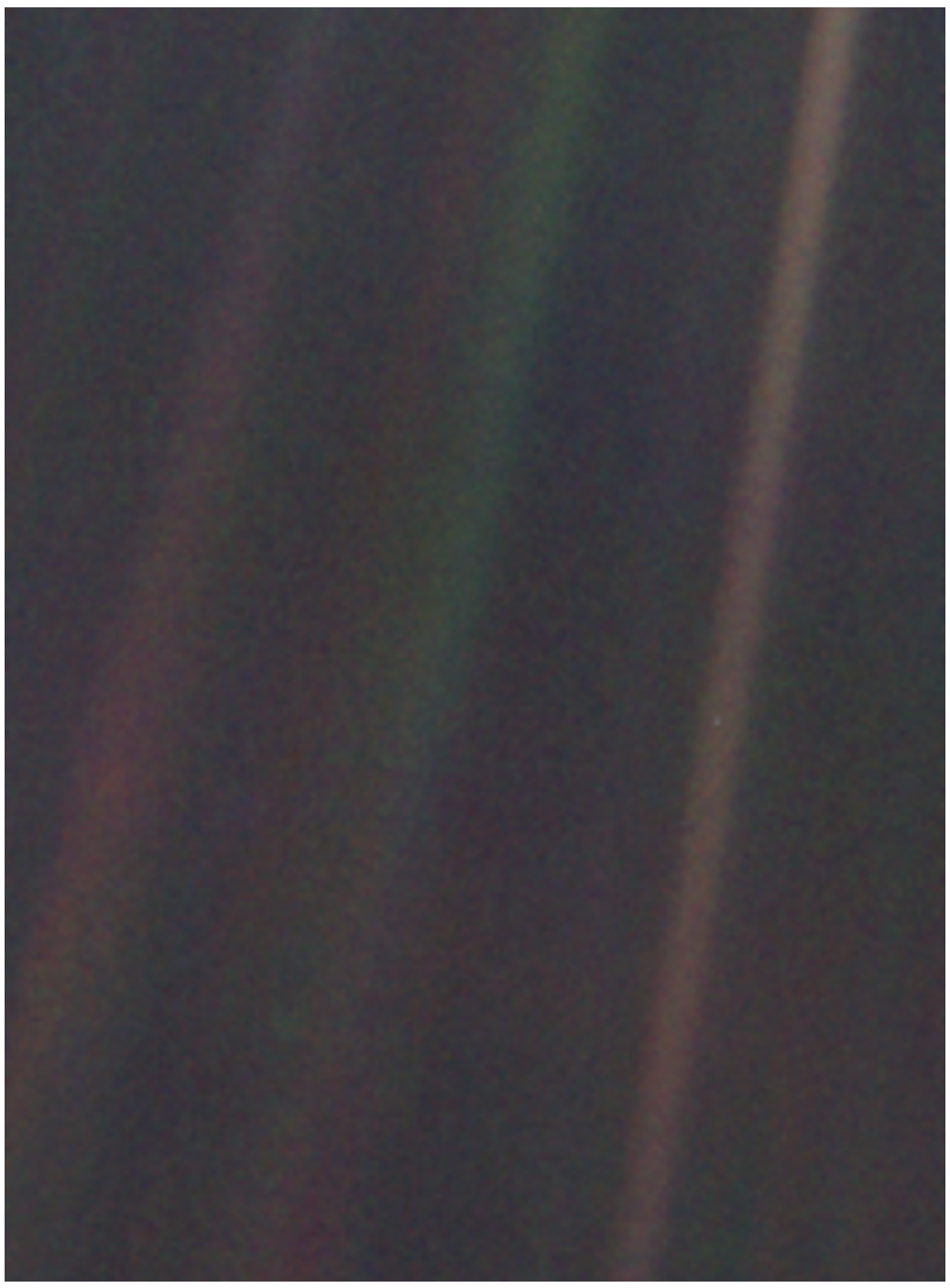
Throughout the history of humanity, we have observed the night sky from right here on Earth. Hundreds of cultures and civilizations have risen, run their course, and fallen, each of them devising their own interpretations of the celestial sphere – even if not all kept their versions documented. Over the course of modern civilization humans have built the technologies needed to not only see farther than our ancestors could have ever imagined, but to travel to the distant worlds they gazed upon and named after their gods. From their perspectives, we have reached the heavens – visited the homes of the gods.

Through space exploration missions, we have gained immense amounts of knowledge about our planetary neighbors, the space beyond our Solar System, and our own home planet. These new pieces of information have brought upon (and continue to bring) what we call *great demotions*; because at one point it was believed that Earth was the center of the Universe and everything revolved around us, and now we know that we couldn't have been more wrong. Now we know that Earth is just one planet in a Solar System of eight others. We've also learned that Earth is not that big; Jupiter is so much larger than Earth that 1,300 Earths can fit into Jupiter! (And 1,000 Jupiters can fit into the Sun!) Since first discovering exoplanets (planets that orbit stars that are not our own) in 1992, we have now discovered over 5,000 and scientists predict that each one of these stars has an average of 10 planets in their orbit; and, there are an estimated 100 to 400 billion stars in our Milky Way Galaxy alone. (Do you feel small yet?)

Well, however small this may make you feel, we can take comfort in the fact that Earth is extremely unique in one major aspect: so far, it is the only planet we know that holds life. We've now explored all the planets in our Solar System and have started observing planets in other systems, but we have not yet discovered any signs of life anywhere else. Some people believe that diamonds are the most valuable thing on Earth; however, there are some planets with atmospheric pressures so high it actually *rains* diamonds. The grass that Earth is covered in, made up of the basic elements of life with our atmosphere of breathable air, is something far rarer than diamonds or gold in the realm of the Cosmos.

On February 14, 1990, as the *Voyager 1* spacecraft passed the last planet in the Solar System, it was

turned around to face back toward Earth and take a photograph from 3.7 billion miles away. This famous image was named *Pale Blue Dot*, and in his book (also titled *Pale Blue Dot*), Dr. Carl Sagan reflected on the image and what it represents to humanity:



Look again at that dot. That's here. That's home. That's us. On it everyone you love, everyone you know, everyone you ever heard of, every human being who ever was, lived out their lives. The aggregate of our joy and suffering, thousands of confident religions, ideologies, and economic doctrines, every hunter and forager, every hero and coward, every creator and destroyer of civilization, every king and peasant, every young couple in love, every mother and father, hopeful child, inventor and explorer, every teacher of morals, every corrupt politician, every "superstar", every "supreme leader", every saint and sinner in the history of our species lived here – on a mote of dust suspended in a sunbeam.

The Earth is a very small stage in a vast cosmic arena. Think of the rivers of blood spilled by all those generals and emperors so that, in glory and triumph, they could become the momentary masters of a fraction of a dot. Think of the endless cruelties visited by the inhabitants of one corner of this pixel on the scarcely distinguishable inhabitants of some other corner, how frequent their misunderstandings, how eager they are to kill one another, how fervent their hatreds.

Our posturings, our imagined self-importance, the delusion that we have some privileged position in the Universe, are challenged by this point of pale light. Our planet is a lonely speck in the great enveloping cosmic dark. In our obscurity, there is no hint that help will come from elsewhere to save us from ourselves.

The Earth is the only world known so far to harbor life. There is nowhere else, at least in the near future, to which our species could migrate. Visit, yes. Settle, not yet. Like it or not, for the moment the Earth is where we make our stand.

It has been said that astronomy is a humbling and character-building experience. There is perhaps no better demonstration than the folly of human conceits than this distant image of our tiny world. To me, it underscores our responsibility to deal more kindly with one another, and to preserve and cherish the pale blue dot, the only home we've ever known. ★

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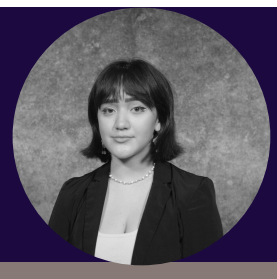
Biography

Victor De Los Santos is Executive Director and Chair of the Board for the South Texas Astronomical Society. Victor graduated from Hanna High School in 2013. He earned a bachelor of science in business from Texas A&M University - College Station in 2016. He has worked as a software development project manager since 2016.

Celestial Portents: How Comets Were Observed in Ancient China



Olivia Lincoln

Both of us, lost to the world, meeting like this; Why must we be old friends to understand each other? - Po Chu-i, *Song of the Lute* [1]

Many Chinese generations have read these sentiments from an ancient Tang Dynasty poet, originally a poem reminiscent of Halley's Comet — an intrinsically old friend of humankind, but one which sojourns our view for but a passing moment in each lifetime. Cycling past us every 75-76 years, always returning throughout the millennia, we may only meet it once. Despite its long trip away from our view, however, the solitary comet was very familiar to the collective astronomers of ancient China.

Though it was not until Edmund Halley calculated the comet's earth cycle that the world came to recognize the observations as a single comet (and gave it his name). Joseph Needham, a writer and researcher of Chinese science, credits ancient Chinese scientists with the observations that allowed for the final identification of Halley's Comet (and other transients) [9].

A Review on Comets

Before delving into ancient Chinese comet observations and their relevance to modern science, we can review what comets are and the perception of comets throughout history. To begin, the word comet derives from the Latin word *cometes*, which derives from the Greek word *kometes*, which means "long-haired star." As a result, the etymology reflects how comets appeared to the human eye — a bright, fuzzy blob with a long tail, or in past wording, long hair, stretching away from it.

So, what exactly are comets? Comets are large celestial objects or "cosmic snowballs" of frozen gases, rock, and dust that orbit the Sun. When comets reach perihelion, meaning when they're closest to the Sun, they heat up and spew dust and gas into a wispy cloud called the coma, a giant glowing head that distorts our view of the body underneath. This body is called the nucleus, and most nuclei are presumed to be 1-10 kilometers (0.6-6 miles) in diameter [8].

We often picture comets as rocky bodies with a large singular tail, but comets actually have two tails: a dust tail and an ion tail. Throughout their revolution, comet dust and gas interact with sunlight and particles called solar wind, causing distinct tails that point in different directions. Sunlight gently pushes the dust released from sublimating ice away from the comet, forming the most recognizable part, the arcing dust tail. Meanwhile, the Sun's ultraviolet rays ionize the gas emitted by the comet. Solar wind, which is the continuous flow of charged solar particles that permeate our solar system, directly pushes this ionized gas away from the comet. As a result, the ion tail always points away from the Sun. The lengths of both tails increase as the comet moves closer, due to the proximity making the comet hotter and thus spewing out more dust and gas.

Here's a simple way to remember the difference between the two tails [7]:

- Ion tail - thin, blue, linear, and points directly away from the Sun
- Dust tail - white, broad, and points generally (but not precisely) away from the Sun

Comets follow the same physical laws as all other objects when it comes to motion. They move in accordance with Newton's fundamental laws of motion and universal gravitation. As far as their orbit, comets typically take an elliptical path around the Sun. Additionally, comet revolutions often depend

on where they originate from. Short-period comets can range from yearly to 200 years, and long-period comets can take between 200 to 100,000 years to completely orbit the Sun. Short-period comets usually come from the Kuiper Belt, the name for the region of rocky bodies located beyond Neptune's orbit. Long-period comets usually originate from the Oort Cloud, which extends several thousand times farther from the Sun than Pluto.

Ancient Perception of Comets

Since the development of the first civilization, humans have looked to the sky for portents of the future. Even up until modern times, planets and stars have been used for prognostication — and so have comets. Comets have been wondrous streaks of light painting our sky since antiquity, and from ancient sources like Chinese oracle bones, we have learned that comets have caught our attention since the dawn of civilization [9]. However, before mankind explored the composition and orbital periods of comets, they mostly feared the celestial objects in early civilization, as comets were thought to be heralds of disaster or divine attacks. Before modern times, great comets were considered bad omens foreboding tragedy and turmoil, such as the passage of Halley's Comet in 1066, which was depicted as heralding the Norman conquest of England. Some cultures interpreted the tail of a comet to resemble a woman's head, with long hair flowing behind her. This was perceived as a symbol of mourning and therefore understood that the gods who had sent the comet were discontented. Other cultures perceived comets as fiery swords skewing the night sky, a traditional symbol of war and death. Such a message from the gods would imply that their wrath would visit the people of the land soon [5].

Seneca, a Stoic philosopher of ancient Rome, writes in his famous work *Natural Questions* (*Naturales Quaestiones* in Latin):

> *If a rare [comet] and one of unusual shape appears, everyone wants to know what it is and, ignoring the other celestial phenomena, asks about the newcomer, uncertain whether he ought to admire or fear it. For there is no lack of people who create terror and predict dire meanings. And so people keep asking and wishing to know whether it is a portent or a star* [11].

These words held true in the Middle Ages, as after the age of Democritus, Apollonius, Aristotle, and Seneca, medieval treatises were full of portent, omen, mysticism, and superstition, with hardly ever a view that comets might be a part of nature and not a warning to the wayward [10]. It was throughout the Renaissance and Enlightenment that comets were questioned from a scientific standpoint once more.

Rendition of comets depicted in various ages and cultures. Painted by Anne Norcia [10].

Comet Effects on Yin and Yang

While Western cultures perceived comets quite similarly in nature, ancient China believed comets signified an imbalance of yin and yang. Yin and yang is a widely used principle that all things exist inseparably and in direct contrast from a second half. Think hot and cold, light and dark, or heaven and Earth.

Scientist Joseph Needham writes:

> *The myriad of things all have their opposites; there is alternation of the Yin and the Yang, the good and the bad. When the Yang waxes the Yin wanes, when good increases evil is diminished. Far and wide is the spread of this pattern-principle* [9].

It's natural that unanticipated objects like comets were perceived as this significant imbalance. Yin is often correlated with the Sun and stars, so when a new, bright star streaked the sky unexpectedly, astronomers of ancient China believed the heavens and Earth were tilting and thus created an excess of yin. According to the *I Ching (Book of Change)*, the ever-changing relationship between yin and yang is responsible for the constant flux of the universe and life in general. When there is too great an imbalance between the two poles, catastrophes can occur such as floods, droughts, and plagues [2]. This further encouraged the close observations of transients to keep an awareness of the state of yin and yang.

Observational History of Ancient China

As we've seen before, ancient Chinese astronomy differed greatly from Western culture, especially since it was usually an activity of the bureaucratic state rather than of independent scholars. In ancient China, people in power were expected to maintain complete harmony between the Earth and the sky. This obligation was known as the "Mandate of Heaven", and the emperor was known as the "Son of Heaven". Astronomy quickly developed into a strong political tool as the stars had an astrological significance that was believed to enable predictions in both major political strategies and daily life. It was vital that the emperor could prove that he retained this right by predicting the movements of the sky accurately. As a result of this Mandate of Heaven, emperors appointed astronomers and meteorologists so they could monitor the sky and be on the lookout for astronomical phenomena that could possibly become omens.

Respectively, China is the only nation that has had continuous astronomical observation for 4000 years, a period during which many significant astronomical discoveries have been made. Royal astronomers kept accurate records of the movements of the stars and planets, recording notable comets and various eclipses of the Sun and Moon. Short-period phenomena were especially eyeballed, as special care was taken to record the appearance of any unexpected events that could forebode the imbalance of yin and yang or failure on the emperor's behalf.

The first definitive atlas of comets recorded by archaeologists is the *Silk Atlas of Comets* unearthed in South China in 1973. In an excavation of the "Number Three Tomb" in Mawangdui, archaeologists found an illustrated compilation of comet forms painted on silk. It is believed to have been put together around 300 BC as a component of a larger work on clouds, mirages, halos, and rainbows. The atlas consists of 29 comets, each of which is categorized based on appearance and the astrological omen it brings. Here are a few examples of their descriptions [10]:

- Comet with four tails represents "disease in the world".
- Comet with three tails represents "calamity in the state".
- Comet with two tails that curve to the right predicts a "small war", as well as "the corn will be plentiful".

Detail of *Silk Atlas of Comets*. Sourced from Chinese Academy of Social Sciences, Institute of Archaeology [4]

This portrayal of comets is a bit unusual when we consider the depictions themselves, which are roughly consistent with modern photographs of comets, just drawn in bolder strokes. The astronomers that observed these comets drew exactly what they saw. When we compare this atlas to Western depictions of comets, there is a notable difference in sobriety: there are no dragons, no devils, no torture; there are just comets.

Chinese astronomers took great care to accurately describe the visible stars so that events like these could be easily located. In order to create a consistent reference of location, astronomers first created lists of stars with associated numbers that matched their positions in the sky using basic tools known as armillary spheres, a combination of a sighting tube and graduated circles that allowed measurement of the positions of the stars. The armillary sphere's concentric rings were a miniature representation of the cosmos and celestial movements, and using it to reference celestial positions allowed astronomers to identify a celestial object within their sights and judge distance [4].

Modern Applications

Ancient Chinese records still hold relevance to modern science, as they help present-day astronomers deduce characteristics of ancient comets like their past orbits and brightness. Since comets do not always have consistent orbits due to surrounding gravitational pulls of planets and other objects, it is very useful to have records that can help deduce how their orbit once was. Such historical changes would have been much more difficult to determine if these records had not been available. The most notable reason why these records are widely accepted in modern science is that they are very consistent in methodology and over long periods of time.

Armillary sphere at the Beijing Ancient Observatory [4]

Ancient Chinese observations are especially important when it comes to Halley's Comet. In a study reviewing past apparitions of Halley, it was discovered that most observations dating back to 12 BC could be accurately matched to ancient Chinese records [6]. A computer calculation of Halley's past orbits using numerical integration could not continue past 837 AD because the prior orbits recorded by Western astronomers were inaccurate. The researchers in the study began with precise European measurements from 1759 and worked backward. But, because there are no accurate European records for

the comet in 837 AD, the researchers turned to Chinese records. They derived an accurate approximation of Halley's perihelion for that year, and multiple encounters prior, all from these records.

Overall, in the past, Chinese astronomers have frequently been overlooked in favor of Western contributions to the field, due largely to their use of methods that differ from those used in the Eurocentric world. Their work was more concerned with refining their observations and making more accurate measurements than developing theories. Because of this, Chinese astronomers produced fantastically accurate time measurements and charted unusual astrophysical occurrences like comets, novae, and meteor showers. Ancient Chinese records are not only the most extensive from ancient times, they are the most exact, often within half a degree of right ascension (angular distance of a particular point measured eastward). Their records remain timeless and have since spread worldwide. In modern and future astronomical studies, archaeological records like that of Ancient China will continue to improve our understanding of historical astronomical events. ★

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Biography

Olivia Lincoln is a senior at James Pace Early College High School. She is an intern and ambassador for the South Texas Astronomical Society, and she is the founder and president of the Pace Astronomical Society, a school astronomy club sponsored by STARS. After high school she wishes to study astrophysics and pursue research in gravitational wave astronomy.

The Girl with Seven Brothers

A Native American Star Story Retold by Carol Lee

Now it is night; time for telling the stories of our people from Long Ago, in the time when humans understood the silent voices speaking of the land and water animals, and the whispers carried by the breezes that moved across the grasses and through the trees, and heard the silent sounds of the mountains, and the chuckling sounds from the streams and the rivers. On the wide-open prairie in what we know today as Oklahoma and Kansas, in a tipi made from the hides of many buffalo, there lived a father, a mother and one daughter who lived together in happiness and harmony among other families who were part of the village.

Daughter listened to the many voices she heard and understood the conversations that passed into her heart. One day she began to gather the softest hides of animals that were used for making clothing for her family. She asked porcupine for the quills he did not need to protect himself and began to use them to sew onto the deerskin which she had sewn into a man-sized shirt. When she finished decorating the shirt with shells from the river creatures and the quills from the porcupine, and paints from the soils and rocks, she made a pair of soft moccasins to match and set them aside in a rawhide pouch.

At once Daughter began to work on another shirt and moccasins for a man. Mother wondered at this and asked Daughter why she was making clothing for men when she had no brothers and no young man was courting her to be his wife.

Daughter simply replied that she was making the clothing for her brothers. Mother raised her eyebrows and wondered what message daughter was hearing but she did not reply to her daughter's surprising reason. Daughter went on cutting the skins with her sharp rock knife and sewing with her thin bone and sinew needle and thread until she had completed six man-size shirts and moccasins. Then she made one smaller set.

When Mother asked her why a small shirt and moccasins, Daughter replied it was for her youngest brother.

When all the shirts and moccasins were ready, Daughter told Mother that she was going to the lands of the pine trees to find her brothers and take them their beautiful gifts.

Mother decided to go along to see what was going to happen. The two wrapped the gifts in a buffalo hide and loaded the bundle on a travois which was to be pulled by their two dogs. There were also baskets with corn, squash, and beans to cook. Dried pemmican was also taken for the group to eat as they traveled. Big Dog and Little Dog were happy to pull the load because they were strong and willing workers. Daughter carried the gift for Little Brother on her back. As Sun rose to walk across the sky world, Mother and Daughter, along with Big and Little Dog began to walk towards the pine tree land to the north.

As they walked, Daughter listened to the messages from the wind, the water, the rocks, and all the animals that they passed. After many moons, the travelers arrived at a wide river. Daughter told her mother that Mother should return home because she was now at the place where her brothers lived. Mother looked at Daughter and saw that this was in her heart to do and so she raised her arm in farewell and begin her journey home. Daughter sent the dogs to follow Mother home and guard her well on her walk back to the family.

Daughter waited by the river with her bundles of gifts until a young boy waved to her from the far side of the river. He pushed a canoe into the river and paddled across the rushing waters to the other side where Daughter and the gifts were waiting.

"Sister," called the Boy. "We have been waiting for

you many moons. I am glad to see you at last! Our brothers were beginning to worry that you would not be able to come. It is well that you are here, for winter is coming."

When Sister climbed into the canoe with the bundles from the travois, Younger Brother paddled the canoe to the campsite on the other shore and unloaded the bundles while Sister prepared a meal to be ready when the other brothers returned from hunting buffalo.

When Sister opened the bundle of gifts, Younger Brother was so excited to see the beautifully decorated shirt and moccasins he put them on right away and strutted about proudly down to the edge of the river to admire himself.

When the other brothers returned to the campsite from their hunt, they asked Younger Brother where he got his beautiful shirt and moccasins. "Our sister brought them to us today. She made some for you as well". The seven brothers were thankful for the gifts and pleased to see their new sister. They dressed themselves in the beautiful new shirts and moccasins she had made for them. Each item fit each young man perfectly.

That evening they sat around the fire eating a good buffalo stew that Sister had made from the meat the brothers had brought, and the corn and squash and beans Sister had brought. Each brother rubbed his full stomach and thought, "It is good that our little Sister has come. We will protect her from all harm and she will make good things for us."

Each day the older brothers would go hunting for the buffalo while younger brother stayed behind to guard Sister. One day while Sister was busy with her work and younger brother was practicing with his bow and arrows, a young buffalo calf came running into the camp, snorting, and calling out this message. "The Buffalo People want you to send your Sister to us to be our slave to pay for using our meat!"

Younger brother shot an arrow at the young Buffalo and refused to send Sister with him. Young Buffalo called back as he turned and ran back the way he had come, "You will be sorry. My Brother will come and there will be a heavier price to pay!"

Soon a larger and more fierce buffalo came running up to the river's side and called out, snorting, and bellowing and shaking his head angrily. "The Buffalo People expect you to send your Sister to us to pay for using our meat! We have received nothing in return for our gift of meat to you!"

Once again, Younger brother shot an arrow at the Buffalo and refused to send Sister with him. Buffalo called back, "You will be sorry. The Buffalo tribe will come and there will be a heavier price to pay! You will wish you had sent your sister with us!"

As the older brothers came back to camp, Younger Brother told them what had happened. "We are not afraid of the buffalo people. We ...." And then they each felt the ground tremble and the wind passed by bringing the sound like rolling thunder and the smell of great clouds of dust.

"Run," shouted the brothers as they grabbed Sister by the hand and raced to the nearest pine tree. Frantically they climbed the lower branches trying to get out of the way of the terrible horns of the angry Buffalo people. The Buffalo people rammed their big shaggy heads into the tree, trying to knock the Brothers and their Sister down from the tree.

As the Buffalo people began to climb upon one another into the tree, Sister called to Younger Brother to shoot his arrow higher into the tree so they could reach the higher branches. As the arrows flew higher, and the brothers and their sister climbed higher, the Buffalo People climbed higher on one another. Younger Brother shot his arrows higher and the seven brothers and one sister climbed higher and higher, out of reach of the angry roars and rumbles of the Buffalo People. As the sounds grew softer, they

realized they had climbed right up into the sky. The buffalos' pounding against the tree made it fall over, leaving the seven brothers and their sister trapped in the sky, where they still remain today.

We call them the Seven Brothers and their Sister. Other ancient people long ago named them Ursa Major and Ursa Minor. YOU call them the plow, or the Great Bear and the Little Bear, or the Drinking Gourd, or even the Big and Little Dippers. If you look closely at one of the stars in the group you can see a small star beside one of the stars in the bend. That is Younger Brother and Sister who are still together, with the sister protected by her younger brother.

The seven brothers and their sister are together in the sky all the year, higher in the summer, but lowest in the autumn when the tree leaves turn red and gold. Some folks say is the blood stains from the hurts the buffalo got from hitting their heads against the pine tree. Who knows?

And that is the end of this story. ★

Cosmic Coordinates

❄ Winter 2022–2023 ❄

349 Dembowska at Opposition
Thu, 01 Dec 2022, 08:22 CST, Taurus

Conjunction of Moon and Jupiter
Thu, 01 Dec 2022, 18:56 CST, Pisces

Appulse of Moon and Jupiter
Thu, 01 Dec 2022, 20:59 CST, Pisces

Neptune Ends Retrograde Motion
Sat, 03 Dec 2022, 17:48 CST, Aquarius

Lunar Occultation of Uranus
Mon, 05 Dec 2022, 11:30 CST, Aries

Moon at Aphelion
Tue, 06 Dec 2022, 17:35 CST, Taurus

Full Moon
Wed, 07 Dec 2022, 22:08 CST, Taurus

Lunar Occultation of Mars
Wed, 07 Dec 2022, 22:13 CST, Taurus

Conjunction of Moon and Mars
Wed, 07 Dec 2022, 22:24 CST, Taurus

Mars at Opposition
Wed, 07 Dec 2022, 23:35 CST, Taurus

1 Ceres at Perihelion
Sat, 10 Dec 2022, 12:11 CST, Virgo

Moon at Apogee
Sun, 11 Dec 2022, 18:28 CST, Cancer

81P/Wild at Perihelion
Thu, 15 Dec 2022, Virgo

Moon at Last Quarter
Fri, 16 Dec 2022, 02:56 CST, Virgo

Mercury at Greatest Eastern Elongation
Wed, 21 Dec 2022, 12:47 CST, Sagittarius

December Solstice
Wed, 21 Dec 2022, 15:43 CST, Sagittarius

Mercury at Highest Evening Altitude
Fri, 23 Dec 2022, Sagittarius

New Moon
Fri, 23 Dec 2022, 04:17 CST, Sagittarius

Moon at Perihelion
Fri, 23 Dec 2022, 12:15 CST, Sagittarius

Moon at Perigee
Sat, 24 Dec 2022, 02:26 CST, Sagittarius

Conjunction of Moon and Venus
Sat, 24 Dec 2022, 05:29 CST, Sagittarius

Mercury at Dichotomy
Sat, 24 Dec 2022, 09:18 CST, Sagittarius

Conjunction of Moon and Mercury
Sat, 24 Dec 2022, 12:31 CST, Sagittarius

Venus at Aphelion
Sun, 25 Dec 2022, 17:05 CST, Sagittarius

Conjunction of Moon and Saturn
Mon, 26 Dec 2022, 10:11 CST, Capricornus

Appulse of Moon and Saturn
Mon, 26 Dec 2022, 12:25 CST, Capricornus

Conjunction of Venus and Mercury
Thu, 29 Dec 2022, 03:21 CST, Sagittarius

Conjunction of Moon and Jupiter
Thu, 29 Dec 2022, 04:33 CST, Pisces

Cosmic Coordinates

❄ Winter 2022-2023 ❄

Appulse of Moon and Jupiter
Thu, 29 Dec 2022, 06:25 CST, Pisces

Moon at First Quarter
Thu, 29 Dec 2022, 19:21 CST, Cetus

Conjunction of Venus and Pluto
Sun, 01 Jan 2023, 09:16 CST, Sagittarius

Lunar Occultation of Uranus
Sun, 01 Jan 2023, 15:45 CST, Aries

Mercury at Perihelion
Mon, 02 Jan 2023, 14:04 CST, Sagittarius

Conjunction of Moon and Mars
Tue, 03 Jan 2023, 13:36 CST, Taurus

Lunar Occultation of Mars
Tue, 03 Jan 2023, 13:51 CST, Taurus

Earth at Perihelion
Wed, 04 Jan 2023, 10:17 CST, Pisces

Full Moon
Fri, 06 Jan 2023, 17:07 CST, Gemini

Moon at Aphelion
Fri, 06 Jan 2023, 21:55 CST, Gemini

Mercury at Inferior Solar Conjunction
Sat, 07 Jan 2023, 06:53 CST, Sagittarius

Moon at Apogee
Sun, 08 Jan 2023, 03:19 CST, Cancer

C/2022 E3 (ZTF) at Perihelion
Thu, 12 Jan 2023

Mars Ends Retrograde Motion
Thu, 12 Jan 2023, 14:54 CST, Taurus

Moon at Last Quarter
Sat, 14 Jan 2023, 20:10 CST, Virgo

2 Pallas at Opposition
Sun, 15 Jan 2023, 22:46 CST, Canis Major

134340 Pluto at Solar Conjunction
Wed, 18 Jan 2023, 16:33 CST, Sagittarius

Conjunction of Moon and Mercury
Fri, 20 Jan 2023, 01:51 CST, Sagittarius

Moon at Perihelion
Fri, 20 Jan 2023, 23:14 CST, Sagittarius

New Moon
Sat, 21 Jan 2023, 14:54 CST, Capricornus

Moon at Perigee
Sat, 21 Jan 2023, 14:57 CST, Capricornus

Jupiter at Perihelion
Sat, 21 Jan 2023, 23:53 CST, Pisces

Conjunction of Venus and Saturn
Sun, 22 Jan 2023, 13:36 CST, Capricornus

Appulse of Venus and Saturn
Sun, 22 Jan 2023, 16:13 CST, Capricornus

Uranus Ends Retrograde Motion
Sun, 22 Jan 2023, 17:23 CST, Aries

Conjunction of Moon and Saturn
Mon, 23 Jan 2023, 01:22 CST, Capricornus

Conjunction of Moon and Venus
Mon, 23 Jan 2023, 02:19 CST, Capricornus

Mercury at Dichotomy
Tue, 24 Jan 2023, 09:12 CST, Sagittarius

Cosmic Coordinates

❄ Winter 2022-2023 ❄

Conjunction of Moon and Jupiter
Wed, 25 Jan 2023, 20:03 CST, Pisces

Appulse of Moon and Jupiter
Wed, 25 Jan 2023, 21:30 CST, Pisces

Mercury at Highest Morning Altitude
Thu, 26 Jan 2023, Sagittarius

6 Hebe at Opposition
Thu, 26 Jan 2023, 10:46 CST, Cancer

Moon at First Quarter
Sat, 28 Jan 2023, 09:19 CST, Aries

Lunar Occultation of Uranus
Sat, 28 Jan 2023, 21:28 CST, Aries

Mercury at Greatest Western Elongation
Mon, 30 Jan 2023, 03:05 CST, Sagittarius

Conjunction of Moon and Mars
Mon, 30 Jan 2023, 22:24 CST, Taurus

Lunar Occultation of Mars
Mon, 30 Jan 2023, 22:27 CST, Taurus

96P/Machholz at Perihelion
Tue, 31 Jan 2023, Aquarius

Moon at Apogee
Sat, 04 Feb 2023, 02:54 CST, Cancer

Full Moon
Sun, 05 Feb 2023, 12:28 CST, Cancer

Moon at Aphelion
Tue, 07 Feb 2023, 02:59 CST, Leo

Conjunction of Mercury and Pluto
Fri, 10 Feb 2023, 23:04 CST, Sagittarius

Moon at Last Quarter
Mon, 13 Feb 2023, 10:01 CST, Libra

Conjunction of Venus and Neptune
Wed, 15 Feb 2023, 06:19 CST, Aquarius

Mercury at Aphelion
Wed, 15 Feb 2023, 14:00 CST, Capricornus

Saturn at Solar Conjunction
Thu, 16 Feb 2023, 10:38 CST, Aquarius

Moon at Perihelion
Sat, 18 Feb 2023, 12:53 CST, Capricornus

Conjunction of Moon and Mercury
Sat, 18 Feb 2023, 14:52 CST, Capricornus

Moon at Perigee
Sun, 19 Feb 2023, 03:05 CST, Capricornus

New Moon
Mon, 20 Feb 2023, 01:06 CST, Aquarius

Conjunction of Moon and Venus
Wed, 22 Feb 2023, 01:55 CST, Pisces

Appulse of Moon and Venus
Wed, 22 Feb 2023, 03:41 CST, Pisces

Conjunction of Moon and Jupiter
Wed, 22 Feb 2023, 16:00 CST, Pisces

Lunar Occultation of Jupiter
Wed, 22 Feb 2023, 16:57 CST, Pisces

Appulse of Moon and Uranus
Sat, 25 Feb 2023, 06:13 CST, Aries

Moon at First Quarter
Mon, 27 Feb 2023, 02:06 CST, Taurus

Cosmic Coordinates

❄ Winter 2022-2023 ❄

Lunar Occultation of Mars
Mon, 27 Feb 2023, 22:11 CST, Taurus

Conjunction of Moon and Mars
Mon, 27 Feb 2023, 22:31 CST, Taurus

Cosmic Coordinates

❄ Winter 2022–2023 ❄

Definitions

Appulse – the minimum apparent separation in the sky of two astronomical objects.

Apsis – the farthest (*apoapsis*) or nearest (*periapsis*) an orbiting body gets to the primary body. Plural is *apsides*. Special terms are used for specific systems: *aphelion* and *perihelion* is for anything orbiting the Sun; *apogee* and *perigee* is for the Moon orbiting the Earth.

Conjunction – when two astronomical objects or spacecraft share the same right ascension or ecliptic longitude as observed from Earth. For superior planets, conjunction occurs when the planet passes behind the Sun (also called *solar conjunction*). For inferior planets, if the planet is passing in front of the Sun, it is called *inferior conjunction*; if behind, it is called *superior conjunction*. Conjunctions are the worst time to view a planet with a telescope.

Dichotomy – the phase of the Moon, or an inferior planet, in which half its disk appears illuminated.

Occlusion – when one astronomical object passes in front of the other. An *occultation* is when the foreground object completely blocks the background object. A *transit* is when the background object is not fully concealed by the foreground object. An *eclipse* is any occlusion that casts a shadow onto the observer.

Opposition – when two astronomical objects are on opposite sides of the celestial sphere. Opposition only occurs for superior planets, and is the best time to view a planet with a telescope.

Meteor Showers

❄ Winter 2022-2023 ❄

--- **Major Meteor Showers (Class I)** ---

Quadrantids (QUA)
Peak: Jan 04, Dec 26 - Jan 16
Radiant: Boötes, α = 15:20, δ = +49:42
Speed: 40 km/s
Max ZHR: 120

--- **Minor Meteor Showers (Class II)** ---

α Centaurids (ACE)
Peak: Feb 08, Feb 03 - Feb 20
Radiant: Centaurus, α = 14:04, δ = -58:12
Speed: 59 km/s
Max ZHR: 6

--- **Weak Meteor Showers (Class IV)** ---

January Leonids (JLE)
Peak: Jan 02, Dec 27 - Jan 07
Radiant: Leo, α = 09:50, δ = +23:54
Speed: 52 km/s

α Hydrids (AHY)
Peak: Jan 05, Dec 15 - Jan 22
Radiant: Hydra, α = 08:32, δ = -08:24
Speed: 43 km/s

o Leonids (OLE)
Peak: Jan 09, Dec 20 - Jan 22
Radiant: Cancer, α = 09:11, δ = +09:36
Speed: 42 km/s

ξ Coronae Borealids (XCB)
Peak: Jan 15, Jan 09 - Jan 20
Radiant: Hercules, α = 16:40, δ = +30:00
Speed: 46 km/s

γ Ursae Minorids (GUM)
Peak: Jan 18, Jan 09 - Jan 20
Radiant: Ursa Minor, α = 15:13, δ = +69:12
Speed: 29 km/s

Meteor Showers

❄ Winter 2022-2023 ❄

January ξ Ursae Majorids (XUM)
Peak: Jan 19, Jan 14 - Jan 21
Radiant: Ursa Major, α = 11:20, δ = +32:24
Speed: 41 km/s

η Corvids (ECV)
Peak: Jan 21, Jan 07 - Feb 05
Radiant: Corvus, α = 12:42, δ = -17:42
Speed: 68 km/s

α Coronae Borealids (ACB)
Peak: Jan 27, Jan 26 - Feb 05
Radiant: Corona Borealis, α = 15:24, δ = +28:06
Speed: 57 km/s

α Antliids (AAN)
Peak: Feb 02, Jan 22 - Feb 06
Radiant: Sextans, α = 10:33, δ = -09:54
Speed: 44 km/s

θ Centaurid Complex (TCE)
Peak: Feb 04, Feb 02 - Feb 06
Radiant: Centaurus, α = 13:16, δ = -42:00
Speed: 60 km/s

π Hydrids (PIH)
Peak: Feb 06, Feb 06 - Feb 09
Radiant: Virgo, α = 14:00, δ = -21:00
Speed: 55 km/s

γ Crucids (GCR)
Peak: Feb 14, Feb 11 - Feb 15
Radiant: Crux, α = 12:48, δ = -56:00
Speed: 56 km/s

Meteor Showers

❄ Winter 2022-2023 ❄

Definitions

Activity - the range of expected dates over which a meteor shower event is observable.

Class - an intensity scale for meteor showers developed by Robert Lunsford

Major Meteor Shower (Class I) - annual, stronger meteor showers with ZHRs of 10 or greater

Minor Meteor Shower (Class II) - consistent, weaker meteor showers with ZHRs between two and 10.

Peak - the date on which the highest ZHR for a meteor shower is expected.

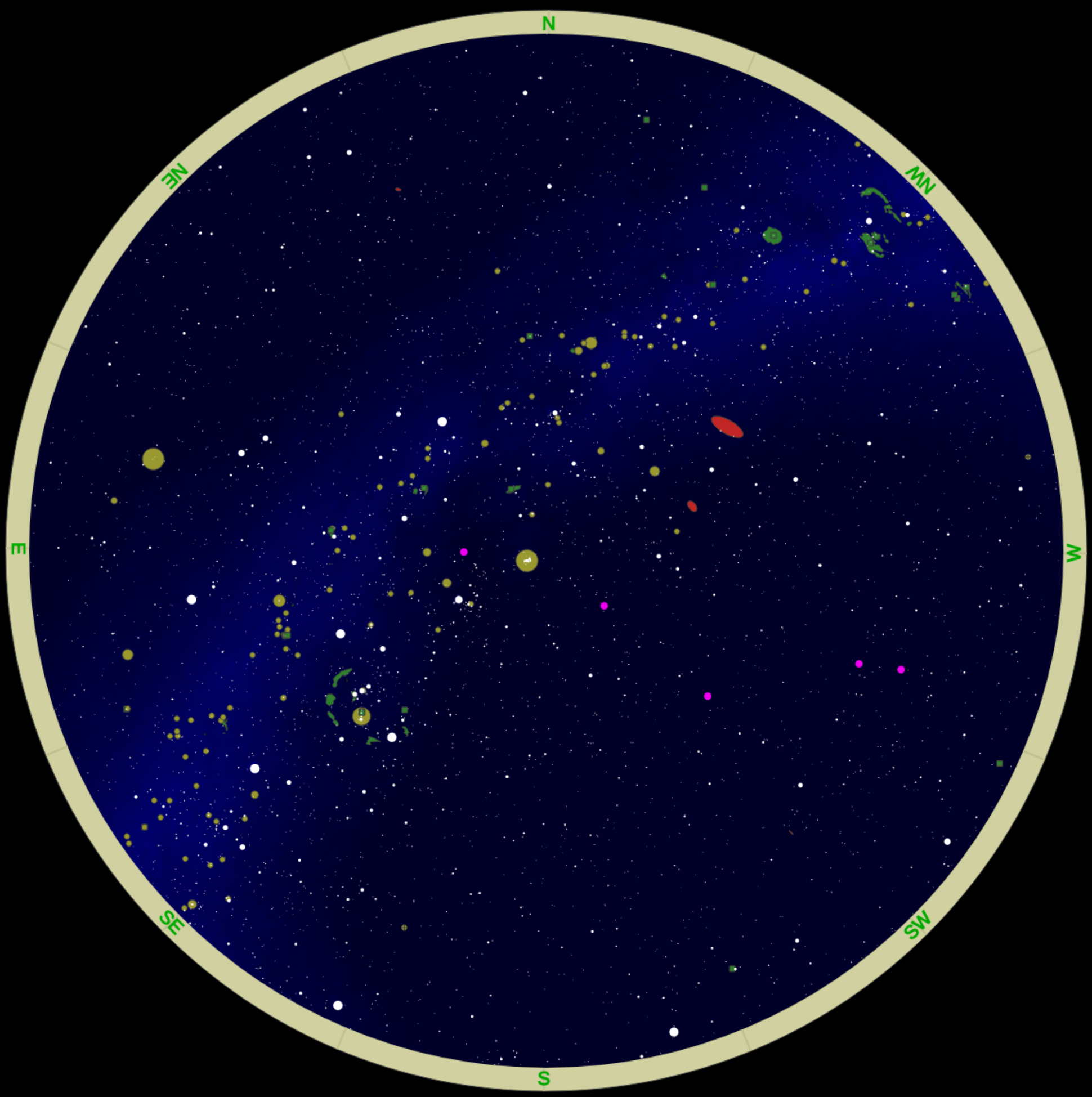
Radiant - the point from which a meteor shower appears in the sky. Here it is defined as two sky coordinates: right ascension (α, hh:mm) and declination (δ, dd:mm).

Speed - average speed of meteors as they enter the atmosphere.

Variable Meteor Shower (Class III) - inconsistent, yet potentially spectacular meteor showers

Weak Meteor Shower (Class IV) - weakest meteor showers reserved for observers seeking a challenge, with ZHRs less than two.

Zenith Hourly Rate (ZHR) - the expected number of observed meteor events per hour if the radiant of the shower was at zenith and observed under ideal conditions (limiting magnitude of +6.5).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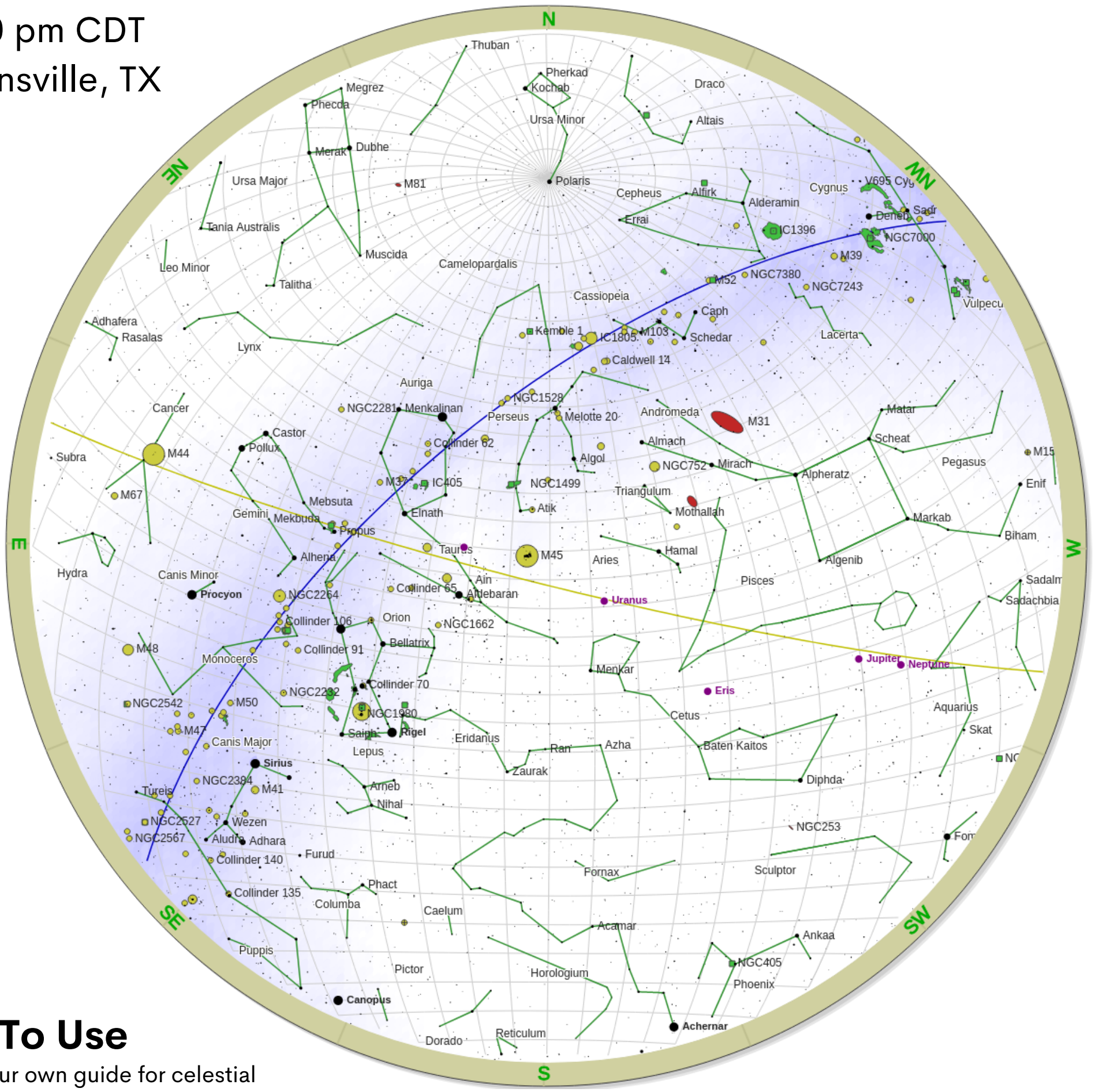
Sky Map

21 December 2022
10:00 pm CDT
Brownsville, TX



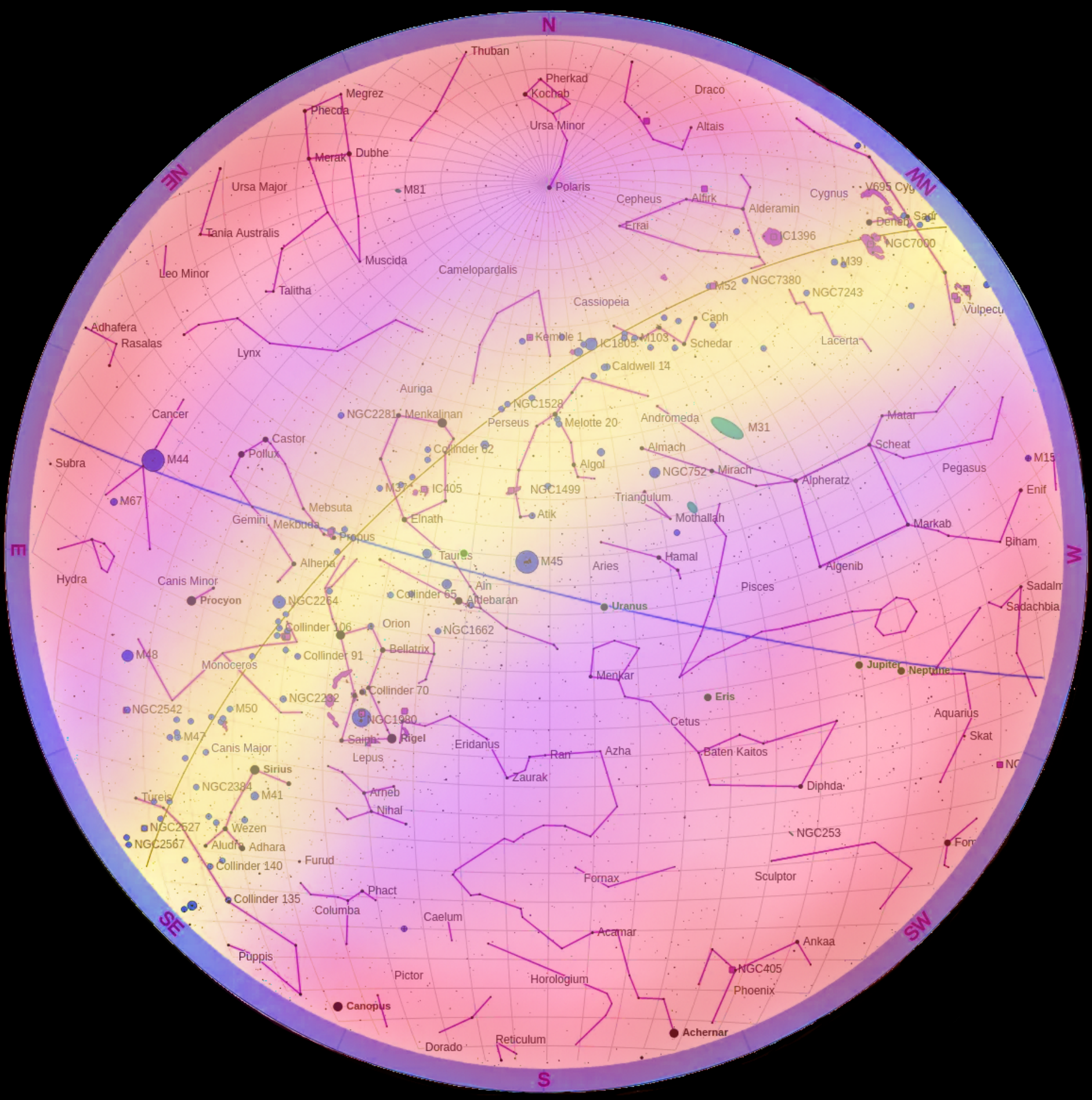
How To Use

Here is your own guide for celestial navigation: your very own sky map, allowing you to select and observe the finest of cosmic objects. If you find yourself within the Rio Grande Valley, this map will be accurate to help you along your celestial journey. Good luck, and clear skies! [Source: In-The-Sky.org]

Sky Map Legend

The Equator
Ecliptic Plane
Galactic Plane
Galaxy
Bright nebula
Open cluster
Globular cluster

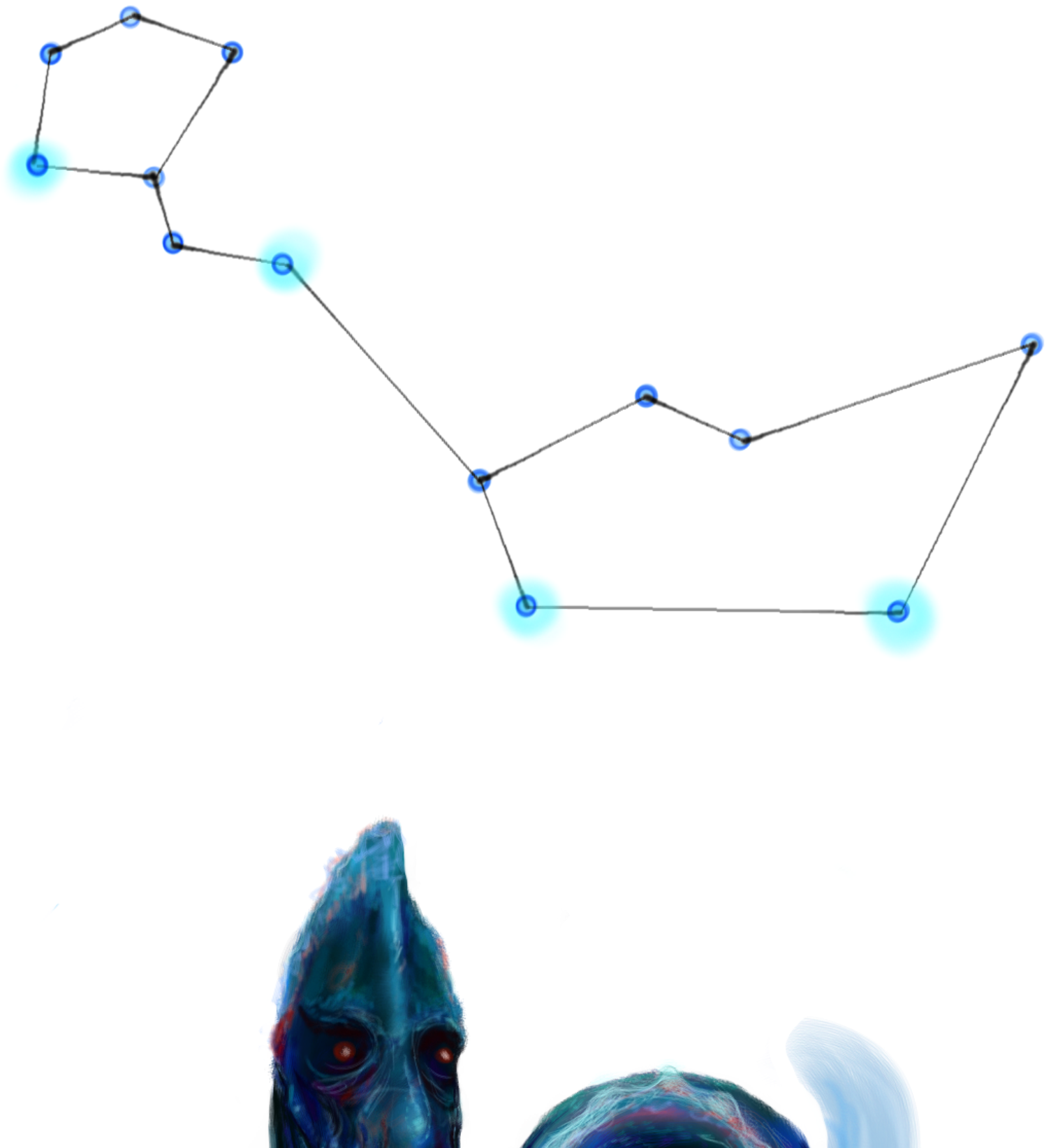
Those who first invented and then named the constellations were storytellers. Tracing an imaginary line between a cluster of stars gave them an image and an identity. The stars threaded on that line were like events threaded on a narrative.



Imagining the constellations did not of course change the stars, nor did it change the black emptiness that surrounds them. What it changed was the way people read the night sky. – John Berger (2014)

Sky map by Gabrielle Camuccio

Constellation of Cetus



Cetus

A sea monster in Greek Mythology

Illustrations by Gabrielle Camuccio

Artist: Myra Rose
Medium: Acrylic on canvas

El Caracol, located near Mexico City, is the biggest structure shown to represent ancient observatories. This beautiful abstract building was created by the Maya. The woman on the left represents an ancient astronomer painting the sky. The astronaut sitting on the right represents astronomers and scientists today holding a telescope. The wavy lines and abstract shapes on the building represent earth life, so I used nature's elements: fire, wavy lines to be the water, and the green vines all around the building reaching to the sky. In my style of this piece I used glow paint to exaggerate what I see and bring a fun childlikeness to learning about science and astronomy. I imagine more of the world will be glowing one day as technology advances new ways to add to nature and bring to light the things in the dark yet to be discovered.

Instagram: @myraroze

Colophon

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Submissions

We encourage submissions from anyone interested in contributing to our newsletter. Any readers with ideas for our newsletter, or who are interested in submitting their own articles, illustrations, or other content, please contact the Editor-in-Chief at: richard.camuccio01@utrgv.edu

The South Texas Astronomical Society (STARS) is a nonprofit organization connecting the Rio Grande Valley community to space and science.

Our Mission is to ignite curiosity in the RGV through space science education, outreach programs, and by developing pathways to STEM for community members.

Our Vision is that STARS nurtures the innate human desire for exploration and discovery by fostering connections to science and the cosmos across the RGV.

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