

## PROLOGUE

Almost 14 billion years ago, everything burst out of nothing. Our universe pricked into being as an unimaginably hot, dense, tiny point, then almost instantaneously exploded outwards, the very fabric of space expanding faster than the speed of light, until all of existence was roughly the size of a grapefruit. After that, the universe continued to expand and cool, and the first matter formed. Within the first second, a dense soup of particles – neutrons, protons, electrons, photons, neutrinos – jostled in a smashing, searing heat that scattered light like fog.

By the time it was about 380,000 years old, this cosmic bubble had expanded to tens of millions of light years across and cooled to a few thousand degrees, mild enough for atoms to hold together, and for the first time the universe became transparent to light. There was an initial flash of illumination, then darkness fell. It took several hundred million years for the attractive force of gravity to work on subtle density variations, inexorably collapsing clumps of gas to form the first stars and galaxies, and one by one, the celestial lights switched on.

Most guides to cosmology tell some version of this sequence of events. Mysteries remain: Was this Big Bang really the start of everything, or is our universe just one inflating bubble in a much larger multiverse? What is the epic force that still pushes space apart? Will it keep expanding for ever, or eventually collapse again in a Big Crunch? But the general nature and story of the universe is agreed. Reality has been revealed as a vast and sophisticated machine, composed of physical particles and forces governed by mathematical equations and laws.

This book tells a different story. The scientific account of the universe is a pinnacle of our modern civilisation, a vision so powerful that its rivals have been all but obliterated. Cosmology – the study of the cosmos – once described the broad philosophical and spiritual

endeavour to make sense of existence, to ask who we are, where we are, and why we're here. It is now a branch of mathematical astronomy. So what happened to those bigger questions? Is there nothing else about the universe we need to know?

Instead of detailing the latest astronomical developments, this is a guide to the long history of knowledge that people have gleaned from the stars. It's about what their view of the cosmos told them of the nature of reality and the meaning of life; about the gods and souls, myths and magical beasts, palaces and celestial spheres that we've discarded; about how the scientific view came to dominate, and how in turn that journey still shapes who we are today. It's a tale about people – of priests, goddesses, explorers, revolutionaries and kings – and it starts not with the Big Bang, nor even with the birth of science, but with the very first humans who looked to the stars, and the answers they found in the sky.



Why bother about the celestial beliefs of the past? Archaeologists and historians often don't. We know that science was built on attempts to understand the heavens, but this is rarely a focus for scholars tracing human progress more generally. I think this has created a huge blind spot in our understanding of where we came from. In fact, the patterns people see in the sky have always governed how they live on Earth, shaping ideas about time and place; power and truth; life and death.

We see this in the ancient past: with the eclipse-obsessed Babylonians; the Egyptian pharaohs who built pyramids to guide their souls to the stars; the Roman emperors who fought under the banner of the sun. Ideas about the cosmos have shaped the modern world, too. These influences are still deeply ingrained in our society – even if we've forgotten their origins – in our parliaments, churches, galleries, clocks and maps. Beliefs about the sun, moon and stars played a central role in the birth of Christianity, and in Europe's exploration and domination of the planet. They guided the rebellious lawmakers who founded the principles of democracy and human

rights, the economists who developed the frameworks on which capitalism depends, and even the painters who produced the first abstract art.

Today, as light pollution envelops our planet, the stars are almost gone. Instead of thousands being visible on a dark night, in today's cities we see only a few dozen – and astronomers fear these will soon be vastly outnumbered by artificial satellites. Most people in the US and Europe can no longer see the Milky Way at all. It is a catastrophic erosion of natural heritage: the obliteration of our connection with our galaxy and the wider universe. There has been no major outcry. Most people shrug their shoulders, glued to their phones, unconcerned by the loss of a view treated as fundamental by every other human culture in history.

Yet we're still trying to work out our place in the cosmos. Science has been wildly successful: today's five-year-olds know more about the history, composition and nature of the physical universe than early cultures managed to glean in thousands of years. But it has also dissolved much of the meaning that those cultures found in life. Personal experience has been swept from our understanding of reality, replaced by the abstract, mathematical grid of space-time. Earth has been knocked from the centre of existence to the suburbs; life reframed as a random accident; and God dismissed altogether, now everything can be explained by physical laws. Far from having a meaningful role in the cosmic order, we're just 'chemical scum', as physicist Stephen Hawking put it, on the surface of a medium-sized planet orbiting an unremarkable star.

Critics have fought this mechanistic view of humanity for centuries, often rejecting science wholesale in the process. But now even high-profile scientists are voicing concerns that until very recently were taboo. They are suggesting that perhaps physical matter isn't all that the universe is; all that we are. Perhaps science is only seeing half of the picture. We can explain stars and galaxies, but what about minds? What about consciousness itself? It's shaping up to be an epic fight that just might transform the entire western worldview.

With the battle lines drawn, I think we need a shift in perspective; an overview. Here, then, is a book about the cosmos, not a

scientific guide but a human one. Rather than give an exhaustive account, I've chosen twelve moments – stepping stones, if you like – that tell us something about how people through history have seen the sky. In particular, these twelve stories follow the rise of the western material universe and how this model of the cosmos came to dominate our lives. The stories trace a path from humanity's earliest expressions in cave paintings and stone circles; through the birth of great traditions such as Christianity, democracy and science; to the hunt for alien life and our recent flights into actual – and virtual – space.

It's a journey that helps to explain who we are today, and can perhaps also guide a future course. It can be hard to see the limits of something when you're embedded in it. I hope that zooming out to survey the deep history of human beliefs about the cosmos might help us to probe the edges of our own worldview and perhaps look beyond. How did we become passive machines in a pointless universe? How have those beliefs shaped how we live? And where might we go from here?

# I

## MYTH

There's a curious pattern of dots that recurs in art around the planet and throughout history. The number varies, but commonly it's a close-knit group of six circular spots, distinctively arranged in lines of four and two. This motif is seen in far-flung communities, from holes pierced into the gourd rattle of a Navajo tribe to a painting on a Siberian shaman's drum. It even appears in the logo of the Japanese car manufacturer Subaru.

In all of these cases, the dots represent one of the most characteristic features of the night sky: the star cluster Pleiades. This clutch of six or seven stars (the exact number depends on viewing conditions) appears close to the sun's annual path through the sky, and features in multiple myths and legends: in Cherokee myth, these stars are lost children; the Vikings saw them as the goddess Freyja's hens. They are also a distinctive part of the constellation Taurus. The Pleiades sit just above the shoulder of this celestial bull, with its thrusting horns, prominent eye – the red giant Aldebaran – and another star cluster, the Hyades, splashed in a 'V' across its face.

The frequent appearance of this six-spot pattern demonstrates the importance of the Pleiades in societies around the world, as well as the shared human desire to capture aspects of the starry sky in art. But there is more to this story – another example of these dots that seems, frankly, impossible. The cave of Lascaux in southwestern France is famous for its wealth of Palaeolithic art: paintings and engravings of animals, thought to be 20,000 years old, from the dawn of humanity. Scholars have argued over their meaning for decades. Meanwhile, barely noticed on the ceiling of its grand entrance hall, are six plain spots that match the Pleiades perfectly. Neatly painted in red ochre, they float above the shoulder of a majestic aurochs bull.

At 5.2 metres long, 'Bull No. 18' is the largest and perhaps most recognisable painting in the entire cave. Its striking similarity with the modern Taurus – it even has V-shaped spots on its cheek – has

been known for years. Yet it goes unmentioned in guidebooks and is rarely discussed by mainstream archaeologists. Taurus is one of the earliest constellations to be described: it can be traced back through written sources nearly 3,000 years, to Babylonian priest-astronomers who saw the Pleiades as a bristle on the back of a heavenly bull. But could its true origin be a star map invented by the supposedly primitive hunter-gatherers of Lascaux? The idea was not so much rejected as not talked about at all.

In the last few years, however, experts in anthropology, mythology and astronomy have begun to argue for a radical reassessment of our Palaeolithic ancestors' skills, and the lasting influence of the stories they told. So in this history of humanity's relationship with the stars, let's start with the mystery of Bull No. 18. We'll explore whether the artists of Lascaux could really have painted constellations, and ask why they may have cared so much about the sky. It's a journey that takes us to the heart of what the universe meant to the very first humans who had the ability to imagine, remember, explain and represent. The cosmos they created still shapes our lives today.



On 12 September 1940, seventeen-year-old Marcel Ravidat, an apprentice mechanic, walked with three friends into the hills near his village of Montignac in southwest France. According to village legend, there were caves beneath the hills – during the wave of executions that followed the French Revolution, the Abbé Labrousse, owner of the nearby manor, supposedly hid in one – and Ravidat wondered if they might hold treasure. A few days before, he had started to unblock a promising hole in the ground. Now, armed with a knife and a makeshift lantern, he planned to finish the job.

The boys' target was a basin-shaped depression in the ground surrounded by pine trees and junipers, and full of brambles. At the bottom was a small opening that led to a narrow, near-vertical shaft. The boys cleared the thorns – and the remains of a donkey – and dug with their hands to widen the hole to about 30 centimetres across. They dropped down stones, and were surprised by how long

they rolled and the resonance of the sound. Those brambles had been hiding something big.

Ravidat, the oldest and strongest of the group, dived in head first and wriggled several metres through the earth before landing on a conical pile of clay and stones. He lit his lamp, which he'd made from a grease pump and a coil of string, but almost immediately lost his balance and slipped all the way to the bottom. He found himself in a large hall, about 20 metres long, and called for his friends to follow.

They crossed the limestone cavern in near-darkness, dodging shallow pools of water on the floor, until they reached a narrow corridor with a high, arched ceiling, like a cathedral vault. Only here did Ravidat raise his lamp, and the boys found their treasure. Covering the white walls was an explosion of life; images from the birth of our species, pulled back into view for the first time in 20,000 years.

First, they noticed coloured lines and strange, geometric signs. Then, moving the lamp around, they saw the animals. There were horses everywhere, golden with black manes, as well as black-and-red bulls, ibexes, and a bellowing, antlered stag. Herds climbed the walls and tumbled across the ceiling, some defined and multi-coloured, others ghostly, as if falling through fog. The boys didn't understand the full significance of what they had found, but they knew it was special, and they celebrated with leaps and cries in the trembling light.

Lascaux cave (named for that nearby manor) now ranks as one of the most spectacular archaeological discoveries in history. It is just one of hundreds of caves in southern France and northern Spain decorated between 37,000 and 11,000 years ago by anatomically modern humans who first migrated into Europe from Africa around 45,000 years ago, during the last ice age. It's a period called the Upper Palaeolithic, named for the stone tools in use at the time, and it seems to have hosted an explosion in human creativity. Rock art from around this time is known elsewhere, too – in Indonesia and Australia, for example – and the practice almost certainly originated even earlier, in Africa. But thanks to the complexity, exquisite preservation and sheer volume of its paintings and engravings – nearly 2,000 of them – Lascaux is one of the finest examples.

The artists here used plant-based brushes or swabs of hair, and a palette of iron and manganese minerals, kaolin clay and charcoal sticks, to cover corridors and chambers reaching 100 metres into the rock. Their creations provide a rare and hauntingly beautiful insight into the prehistoric human mind. Who were these early people? What did they care about, and what triggered them to create art? What was it, in effect, that made them human?

In the decades since the boys' discovery, scholars have come up with a rich parade of answers to these questions. An early idea was that the mysterious figures were simply decoration, 'art for art's sake', without any special meaning. Another suggestion was that the animals represented different clans, and that the paintings showed battles and alliances between them. Some experts thought that the paintings were intended as magical spells, to boost the success of hunting expeditions or ward off evil spirits. In the 1960s, scholars took a statistical approach, recording how different types of figures were distributed in the caves, and building theories around the patterns they saw, for example that the horses and bison symbolise male versus female identity.

Then there was Norbert Aujoulat, who perhaps came to know the paintings more intimately than anyone else. A cave enthusiast, he described himself as 'an underground man'. He would disappear for days at a time on solitary excursions into the French mountains, and helped to discover dozens of subterranean chambers. But he never forgot the first time he saw Lascaux, one winter afternoon in 1970. Since its discovery the site had opened to the public and closed again: the breath exhaled by thousands of visitors per day, and the germs they tramped in, were damaging the precious paintings. Aujoulat, a twenty-four-year-old local student, joined a private tour guided by Jacques Marsal, one of the four friends who had discovered the cave three decades before.

To reach the paintings, Marsal led them down a slope through a series of stone-lined entrance halls and doors, built for security, which made Aujoulat feel as if they were approaching the sacred, inner space of a temple. The last door was made of heavy bronze and decorated with polished stones. Aujoulat spent only half an



hour exploring the treasures beyond that door, but it was enough to set the course of his life. He was bewitched by the overwhelming sense of human presence inside the cave, powerful enough to stretch across so many thousands of years, and he set his sights on understanding how and why the paintings were created.

It was nearly two decades before Aujoulat was able to fulfil his dream. In 1988, as head of the French culture ministry's Department of Parietal Art, he began a monumental, decade-long study of Lascaux cave, from the great bulls circling the ceiling of the entrance cavern to the dense, entangled engravings in a smaller chamber called the Apse. Whereas other scholars had focused on the art, Aujoulat approached Lascaux as a natural scientist, studying every aspect of the cave, from the geology of the limestone to the biology of the animals on the walls. He came to the conclusion that everyone else had missed a crucial dimension: time.

When he studied overlapping paintings where horses, aurochs and stags appeared together, he found that in every case the horses were painted first, then the aurochs, and then the stags. What's more, the animals were always shown with features corresponding to specific times of year: the horses with bulky coats and long tails corresponding to the end of winter; the aurochs during the summer; and the stags with prominent antlers, characteristic of autumn. For each species, that was their mating season.

Aujoulat described his findings in a 2005 book called *Lascaux: Movement, Space, and Time*. By showing the fertility cycles of important animals, he argued, the cave should be understood as a spiritual sanctuary, intended to symbolise creation and the eternal rhythm of life. The cycle of creation represented by the paintings wasn't just an earthly one, however, relating to animals and the weather. It extended to the entire cosmos.

The annual re-creation of life taking place in the Palaeolithic world was mirrored, of course, by the cycles of the stars: each season is marked by the passage of the sun as well as the appearance of characteristic constellations in the night sky. Aujoulat believed this was central to the artists' vision; they were showing, he concluded, how biological and cosmic time were entwined. He compared the

cave, with its overhanging walls and paintings that crossed the ceiling, to ‘the celestial vault’, and suggested that the animals weren’t being shown on the ground, but in the sky.

That could explain why the animals often appear to be floating – painted at all angles, without any ground-line, sometimes even with hanging hooves. If Aujoulat is right, Lascaux cave is as much about cosmology as it is about biology: rather than copying their immediate surroundings, the artists were synthesising all of the changes – on the Earth and in the sky – that defined their existence. It was an ode, if you like, to their universe, representing humanity’s first ideas about the nature of the cosmos and the origins of life.

Aujoulat was at the heart of the French academic establishment, and his work has been hugely influential. Even so, his ideas about the sky are rarely discussed; without direct evidence, archaeologists find it easier to accept the paintings as a celebration of nature than as a vision of the sky. There are some scholars, though, who think he didn’t go far enough, that rather than simply imagining animals in the sky, the artists of Lascaux were painting maps of the stars.



In 1921, a French prehistorian called Marcel Baudouin came across a fossilised sponge that was shaped like a penis. The fossil, found in Beynes in north-central France, had a vibrant red patina which some ancient artist had chipped off in places to create a series of yellow, hoof-shaped dots. ‘It is the first time I have seen work like this!’ Baudouin wrote in excitement. In a paper called ‘The Great Bear and the Phallus of Heaven’, he argued that the pattern matches the northern constellation of Ursa Major (the Great Bear), even down to brighter stars being represented by larger dots.

It wasn’t possible to date the dots, but he concluded that they were carved in Palaeolithic or Neolithic times. Because of the Earth’s rotation, the stars of the northern hemisphere appear to circle around a stationary point in the sky directly above the North Pole (known today as the north celestial pole). Baudouin suggested that the fossil was intended to show this pole as a celestial penis, and that the

carved dots represent nearby Ursa Major rotating around its shaft.

He was one of the first to see stars in prehistoric art; throughout the 1920s and '30s, several scholars, including Baudouin, reported constellations in the concave depressions, called cup marks, dug out of stone monuments and cave walls in locations from southern France to Scandinavia. Their claims were impossible to prove and are now largely forgotten, but decades later, the US archaeologist Alexander Marshack popularised the idea of Palaeolithic astronomy in his influential 1972 book, *The Roots of Civilization*.

Marshack used a microscope to examine markings on bone fragments made by people in the Upper Palaeolithic. One of the first he studied was a 30,000-year-old piece of bone from the Blanchard rock shelter in the Dordogne region of France. It is engraved on one side with 69 disc- or crescent-shaped pits, arranged in a snaky line. Marshack showed that the pits were created using 24 different types of stroke, suggesting they were carved in groups on 24 different occasions. Rather than simply doodling, someone was keeping track of something; Marshack thought it was the changing phases of the moon. He surveyed similar patterns on a range of bones, stones and antlers, and argued that the people of the Palaeolithic were routinely tracking the sky, using lunar calendars to mark the passing of time.

With Marshack's ideas about Ice Age astronomy widely taken seriously, if not proven, it wasn't long before researchers started to look again for prehistoric star constellations, in particular in the chambers of Lascaux. German astronomer Michael Rappenglück first heard about the idea as a student at the University of Munich in 1984, when he attended a lecture suggesting that Lascaux's paintings might contain star maps. 'I was fascinated,' he says. Now director of the Adult Education Centre and Observatory in Gilching, Germany, and a former president of the European Society for Astronomy in Culture, Rappenglück has been investigating the theory ever since.

One of the scenes he studied was Bull No. 18. Over long periods of time, constellations shift in the sky because of a wobble in the axis of Earth's rotation; individual stars also follow their own trajec-

ories. So to test how well it matches Taurus and the Pleiades, Rappenglück calculated how these stars would have looked around 20,000 years ago and compared this with measurements taken from photographs of the cave wall. He found that when the bull was created, the Pleiades were slightly higher above the bull's back and that Aldebaran (the bull's eye) was more clearly framed by the Hyades – an even closer match to the painting than they are today.

He's convinced that isn't a coincidence, arguing that our constellation Taurus (which once represented an entire bull but lost its hindquarters over the centuries to make room for a new constellation, Aries the ram) has its origins in a far older star grouping – let's call it 'Aurochs' – inspired by the giant bulls that the people of the Ice Age hunted for food.

Rappenglück supports his ideas with evidence from anthropology. Societies throughout history have used the Pleiades as a calendar, he points out. Stars circle around the north and south celestial poles each night, but our orbit around the sun means they follow an annual cycle too; different stars and constellations 'rise' or 'set' (first become visible above the horizon at dawn or disappear from view at dusk) at particular times of year. As a distinctive star cluster close to the ecliptic – the sun's path through the sky – the Pleiades mark the seasons particularly well.

Today, farming communities from Lithuania to Mali to the Andes still mark their agricultural year according to the visibility of the Pleiades. Native American peoples such as the Blackfoot traditionally synchronise their lives with these stars and the life cycle of the bison: when the Pleiades set, it is time to hunt. The Teton Sioux and Cheyenne even name some months after the bison life cycle: November is 'the moon of the fertilisation of the buffalo cows', while January is 'the moon when the coat of the young buffaloes takes on colour'.

Rappenglück suggests that the artists of Lascaux could have developed a star calendar, with the Pleiades similarly marking key moments in the life cycle of the aurochs bull. He calculates that at the time Bull No. 18 was painted, the Pleiades would have appeared just before sunrise in mid-October, reached their highest point in

the sky at the start of spring, and disappeared at the end of August. That means the disappearance and then reappearance of the Pleiades would have defined the mating season of the aurochs, which lasted between August and October. From there it was perhaps a natural step to associate the stars around the Pleiades with the image of a bull. It would have dominated the spring sky to the west of the hilltops that surround Lascaux cave; a giant, celestial creature with a twinkling red eye and glittering hairs on its back, ready to toss the Milky Way with its horns.

Rappenglück sees possible astronomical associations in other caves too. Another aurochs, nearly 4,000 years older than Bull No. 18, in the Tête-du-Lion cave in the Ardèche, has a group of seven dots on its body that he thinks might represent the Pleiades. And in El Castillo cave in Santander, Spain, there's a mysterious group of seven ochre discs dating from 12,000–11,000 BC, arranged in a downwards-pointing curve and close to a striking 5-metre-long frieze of red hand stencils.

After calculating how the sky would have looked at the time, Rappenglück concluded that the dots are a close match for a constellation called the Northern Crown, and suggests that the nearby strip of hands might represent the Milky Way. In 12,000 BC the Northern Crown never set, but – as the Palaeolithic equivalent of Polaris, our pole star – rotated around the northern celestial pole, so would have been important for marking the direction north. Like the Pleiades, the Northern Crown also features prominently in mythology. A Celtic myth describes it as the star goddess Arianrhod's home, an icy castle set on a magical, rotating island in the northern sky. Might elements of the myth date from the Palaeolithic, when these stars really did trace a circle in the heavens?

Sceptics insist that these ideas can't ever be proved. There are just too many possible combinations – too many sets of dots in European caves and too many stars in the sky. But others argue that the various features of Bull No 18 in particular would be an extraordinary coincidence if not intentional. And Rappenglück isn't the only one linking the caves of the Palaeolithic with the stories we tell about the stars.



It's a long-standing mystery why similar myths often exist in apparently unrelated cultures in different places. Take the story of the Cosmic Hunt, in which an animal is chased into the sky and transformed into a star constellation. Variants of this tale – featuring different stars, hunters and prey – are found all over the world.

In one Greek version of the myth, Zeus tricks the princess Callisto, companion of goddess Artemis, into giving up her virginity and she gives birth to a son, Arcas. An incensed Artemis turns Callisto into a bear. Arcas grows up to be a hunter and almost kills his mother with a spear, but Zeus intervenes, turning Callisto into the constellation Ursa Major and putting Arcas next to her as Ursa Minor, the Little Bear.

Meanwhile the Iroquois of the northeastern US tell of three hunters who wound a bear in a forest; its blood stains the autumn leaves. The hunters then follow the bear into the sky and together they become Ursa Major. Among the Siberian Chukchi, the constellation Orion is a hunter who chases a reindeer, Cassiopeia, whereas for the neighbouring Finno-Ugric people, the pursued animal is an elk.

French archaeologist and statistician Julien d'Huy probes the origins of such stories using the principles behind phylogenetics, a technique developed to glean evolutionary relationships between species by comparing their DNA sequences. Biologists use computer software to analyse similarities and differences in the DNA and construct family trees showing the most likely relationships between species. D'Huy does a similar thing for myths.

Instead of studying DNA, d'Huy analysed 47 versions of the Cosmic Hunt from around the world, splitting them into 93 individual components, or 'mythemes', such as 'the animal is a herbivore' or 'a god transforms the animal into a constellation'. For each myth, he coded the presence (1) or absence (0) of each mytheme to give a string of 0s and 1s, then used phylogenetic software to compare them and construct the most likely family tree. His results, published in 2016, suggest that the myth originated in northern Eurasia. One

branch then spread to western Europe and another reached North America when humans migrated across the Bering Strait, which once connected the eastern tip of Russia with Alaska. That means, he says, that the story must date from before about 15,000 years ago, after which that land bridge became submerged.

The original Palaeolithic version of the Cosmic Hunt, concludes d'Huy, most likely involves a lone hunter pursuing an elk. The hunt moves into the sky, but before the animal can be killed, it transforms into what we know as the Big Dipper, or Plough (the tail and flank of Ursa Major). Elk were the dominant mammals in the forests of northern Eurasia during Palaeolithic times, crucial for hunting, and there's evidence that they were important culturally too. A 2017 study of hundreds of animal-tooth pendants discovered in Estonia, for example, found that elk was the most common mammal represented in the Mesolithic and Neolithic periods (8900–1800 BC), before gradually switching to bears. As the story of the Cosmic Hunt moved around the planet and through history, different peoples would have adapted the tale to fit the animals and constellations most important to them.

Other tales analysed by d'Huy seem to date back even earlier, spreading out of Africa with the first waves of human migration more than 40,000 years ago. He has compiled a core of 'protomyths' that he thinks early humans brought with them as they migrated north and east. Not all of these involve stars. There are dragons: giant, horned serpents that guard water sources and can fly, form rainbows, and produce rain and thunderstorms. But they also include the Pleiades, often as a woman or group of women set against Orion as man, and the idea of the Milky Way as a river, or a road travelled by the dead.

In other words, the star myths we tell today are not just stories. They're cultural memories passed through generations for thousands of years, that sometimes do reach back to the Palaeolithic. D'Huy calls them a 'glimpse into the mental universe of our ancestors'. That glimpse doesn't directly link the Pleiades to an aurochs bull. But just like the paintings of Lascaux, it overwhelmingly tells of living beings imprinted on the sky.



For the native Chumash people of southern California, the universe consisted of three disc-like worlds, floating in a great abyss. At the bottom was the Lower World, inhabited by deformed, malevolent beings. The Middle World, where humans lived, was supported by two giant serpents that triggered earthquakes when they moved. Above that, the Upper World was held up by a great eagle, whose wing movements caused the phases of the moon.

This cosmos was ruled by the sun, an old widower who lived in a quartz-crystal house in the Upper World and dined on human flesh. Each day he travelled across the sky, carrying a torch and wearing only a feather band around his head. At night, he gambled against Sky Coyote (probably Polaris, the North Star) to determine the fate of the people below. Not surprisingly, the Chumash watched the sun very carefully. But their knowledge of the Upper World didn't just come from tracking the sky. They knew about it, as we'll see, because they had travelled there themselves.

A few centuries ago, the Chumash thrived along the south-central Californian coast, and their journeys give us one more insight into what prehistoric people like the artists of Lascaux may have thought about the heavens. That's because the Chumash lifestyle appears to have been very similar in complexity to that of Upper Palaeolithic Europe. They had round grass houses, beautifully carved wooden bowls, fine baskets and plank-built sea canoes which they used to catch swordfish weighing up to 270 kilograms. The men wore body paint and feather headdresses, the women had skirts of deer or otter skins, and they used shell beads for money.

There were perhaps 15,000 of them before the Spanish arrived in the eighteenth century. The soldiers who made first contact in 1769 described large towns with roofs piled high with barbecued fish. In the following decades, however, the population crashed, as the Chumash succumbed to the colonisers and their infections: typhoid, pneumonia and diphtheria.

By the beginning of the twentieth century, the Chumash culture and language had almost disappeared. But some traces survive,



thanks to a linguist called John Peabody Harrington, who worked for the Smithsonian Institution. He dedicated his career to tracking down elderly speakers of dying languages across North America, persuading them to share everything they could remember about their heritage.

Eccentric and obsessive, Harrington worked alone. After his death in 1961, Smithsonian curators discovered hundreds of boxes that he had stored in warehouses, garages and even chicken coops throughout the western United States. Mixed with Native American-made flutes and dolls, dead birds and tarantulas, dirty laundry and half-eaten sandwiches, was what came to be known as 'the Harrington gold mine': photographs, sketches, notes and recordings detailing the words and beliefs of cultures that had been thought lost – including the Chumash.

A few years later, Travis Hudson, a curator at the Santa Barbara Museum of Natural History, used thousands of pages of Harrington's notes to reconstruct the most detailed account of astronomical beliefs for any hunter-gatherer community in the world. In his 1978 book, *Crystals in the Sky*, Hudson concluded that the Chumash knowledge of the sky was far richer and more sophisticated than western scholars had ever thought possible.

The Chumash elders interviewed by Harrington spoke of an Upper World filled with powerful, supernatural beings. The pole star, Polaris, was Sky Coyote, father of mankind and the being around which the rest of the sky revolved. The stars Castor and Pollux (the Gemini twins) were the sun's female cousins, while Aldebaran was another coyote, who followed the Pleiades maidens across the sky. Orion's Belt was 'Bear', and the Milky Way was a ghosts' road.

The movements of these deities were intertwined with life on Earth. The Chumash knew that when the sun rose or set at a certain location on the horizon, or when particular stars appeared in a dawn or twilight sky, certain seasonal changes were about to take place on Earth: seeds would ripen, deer would migrate, the rain would come. The winter solstice, the point in the dead of winter when the sun reaches its furthest point south and days are shortest, was

seen as a critical time for the cosmos. If the sun couldn't be persuaded to return, darkness would fall and life on Earth would be snuffed out. The Chumash made careful observations to predict the solstice, and on the crucial morning conducted rituals, often in caves, planting quartz-tipped sun sticks into the ground to 'pull' the sun back onto a northern course.

This knowledge, however, was not for everyone. These celestial secrets were held by an elite group of astronomer-priests called the *'antap* who formed what was essentially a secret society led by the sun-priest. They never shared their knowledge with commoners, and wielded great political influence, claiming that they were the only ones who could understand and influence the cosmic system around which Chumash life revolved.

The priests acquired their detailed astronomical knowledge from countless nightly observations, but also with the aid of hallucinogenic plants from the genus *Datura* (part of the nightshade family) that they used to go on 'vision quests'. This allowed them to visit the Upper World, where they could contact supernatural guardians such as Coyote, predict and influence the future, and communicate with spirits of the dead.

It's a practice called shamanism. The term comes from Siberia, where western travellers in the seventeenth century encountered religious leaders called *saman* among Tungusic peoples, but similar practices and beliefs exist in traditional hunter-gatherer societies all around the world. Shamans enter trance states to visit an alternate reality or spirit world. During such journeys they meet and gain power from spirit guides, and this allows them to fulfil a range of roles such as foreseeing the future, harming enemies, controlling the weather and animals, and healing the sick. Trances are induced in different ways – sometimes by hallucinogenic plants such as *Datura* or ayahuasca; by meditation, fasting or sensory deprivation; or by rituals such as drumming or dancing.

Western anthropologists initially rejected shamanism as not even worth studying, dismissing its practitioners as either conmen or mentally ill. But the Romanian historian of religion Mircea Eliade changed that with his seminal study *Shamanism: Archaic Techniques*

*of Ecstasy*, first published in English in 1964. Eliade surveyed the practice of shamanism throughout history, arguing that it is ubiquitous among hunter-gatherer societies from Siberia to North America to Tibet. Because these traditions are all so similar, he argued that they must descend from a common source in the Palaeolithic, which spread as people migrated around the planet, just like the myths studied by d'Huy. Shamanism, in other words, was humanity's first religion.

Scholars have since questioned some of Eliade's assumptions. But his work triggered a wave of popular and scientific interest in shamanism. There are now several lines of evidence suggesting that shamanic trances aren't a purely cultural (or imagined) phenomenon, but represent a universal capacity of the human brain. Neuroscientists have measured characteristic patterns of brain activity in shamans undergoing spirit journeys which share some features with hypnosis and meditation, suggesting that they aren't acting but really do enter a distinct, altered state of consciousness.

Meanwhile anthropologists have documented the experiences of thousands of westerners in such trance states, mostly triggered by drumming, and found that even when people have no idea what to expect, they report very similar experiences to traditional shamans. Western shamans argue that this is because the spirit worlds they visit are real, but scientists tend to see it as evidence that the human nervous system has the ability to generate specific kinds of visions and hallucinations. Both traditional shamans and westerners undergoing spirit journeys often meet and communicate with animals, or transform into an animal themselves. Another key feature is the experience of tunnelling down into the ground, or flying up into space, often passing through membranes or barriers to move from one layer to another. These types of visions are commonly reflected in the cosmological beliefs of hunter-gatherer societies: a tiered cosmos, with lower, middle and upper worlds, as seen by the Chumash, is an almost universal theme. Shamans in many different communities believe that they can contact the spirits of the Upper World, for example, by flying up to a specific constellation or star. So it may have been altered states of consciousness, rather than

simple stargazing, that helped to create humanity's first models of the universe.

In their 1998 book *The Shamans of Prehistory*, the South African rock-art specialist David Lewis-Williams and the French cave expert Jean Clottes applied ideas about shamanism to Palaeolithic sites such as Lascaux. Lewis-Williams had previously studied nineteenth- and twentieth-century rock art of the nomadic San people in South Africa. The San explicitly relate their art to shamanic vision quests, describing the figures as shamans in animal form, for example, or spirit guides.

Lewis-Williams followed up with a bestselling 2002 book, *The Mind in the Cave*. All human beings have the same nervous system, he argues, and the people of the Upper Palaeolithic were anatomically the same as us, so it's probable that they would have experienced the same kinds of hallucinations. In modern western society, he points out, we tend to dismiss trance states and visions as abnormal or suspect. We value logical, rational thought. But studies of shamanism show that shifting states of consciousness exist, and are highly prized, in pretty much every traditional society on the planet. By seeing cave art only through our own literal lens, perhaps we are missing the point. Entering the deep, narrow caves of France and Spain would have been just like penetrating the nether spirit realm, so perhaps the shamans of prehistory went into the caves on vision quests – just as Chumash shamans did 20,000 years later – and painted what they saw onto the rock walls.

The theory would help to solve several mysteries about the paintings in Lascaux and other Upper Palaeolithic caves. First, it might explain the abstract, geometric patterns that are common, such as dots, grids, zigzags and wavy lines. Such optical effects are commonly seen during the first stages of trance, points out Lewis-Williams (people suffering from migraines often see them too). The Tukano people of South America, who induce trances using *yajé*, a brew made from a psychotropic vine, often paint the geometric symbols they see during visions onto houses or bark.

It would also help to explain the bizarre hybrid figures seen in Palaeolithic art, such as a bison man at Chauvet cave in southeast

France; or the Sorcerer at Trois-Frères cave in the southwest, which has the ears and antlers of a stag, athletic human legs and haunches, a horse's tail, and wizard's beard. In deep trances, people often report seeing images of animals, people and monsters, and can feel as though they are blending with them.

Finally, Lewis-Williams's ideas make sense of images in which the artists incorporated features of the cave walls, as well as cases where people often touched and treated the walls: making hand stencils, finger trails, or even filling cavities with mud and piercing it with fingers or sticks. If caves were seen as portals to the underground spirit world, then the cave walls would have been the boundary between the two realities, a membrane through which spirits could appear. 'The walls were not a meaningless support,' he says. 'They were part of the images.'

In essence, during such spirit journeys, the physical reality of the cave became entwined with the spirit worlds that existed in the shamans' minds. Each informed the other. People would have entered the cave and painted the visions they saw, physically transforming the walls. At the same time, paintings left by previous visitors would have primed and shaped their own visions. Reality was being revealed to them at the same time as they were helping to create it.

Lewis-Williams focuses on caves as a metaphor for the underground realm; he doesn't talk much about the sky. But the evidence from more recent communities suggests that journeys to the Upper World were crucial too, and were also represented on cave walls. The Chumash priests regularly decorated caves with celestial features, including the sun and moon; the Tukano painted parallel chains of dots to represent the Milky Way. Rappenglück argues that interpreting symbols in caves like Lascaux as resulting purely from hallucinations is missing something. They were part of an overall 'cosmvision', in which the caves represented not just the Lower World, but the cosmos as a whole.

We can't ask prehistoric shamans directly what that cosmos was like, but after studying the astronomy of the Chumash, Travis Hudson concluded that their universe was 'inextricably linked to man and filled with vast sources of powers which influenced all things'; an

endlessly recurring cycle of reincarnation 'in which matter was neither created nor destroyed, but transformed into life or death'.

The beliefs of modern-day western shamans seem to fit that interpretation. Sandra Ingerman, a practitioner and author based in New Mexico, describes the altered states of shamanism as revealing a different view of reality, in which other living beings are seen 'not as objects but as a web of life, where all of life is communicating'. It's a web that includes not just animals and plants, she says, but the sun, moon and stars. Meanwhile Jo Bowlby, who qualified as a shaman among the Q'ero elders of Peru and now runs a healing practice in London, recalls her first experience with ayahuasca. At a night-time ceremony in the Amazon rainforest, under a blanket of stars, she was offered half a mug of 'putrid' drink. At first, she was horrified to see her hands transforming at lightning speed into every type of animal foot imaginable, finishing with a lobster claw, but then she became overwhelmed by a feeling of pure ecstasy. It was everything and nothing, she says, like being in outer space. And the lesson she learned has stayed with her ever since: 'You realise how huge and amazing this universe is. It's an experience of connection, of feeling part of something. We are not separated or isolated. The same energy that feeds the trees feeds you.'



In September 1940, Marcel Ravidat and his friends at first told no one of their startling discovery at Lascaux. The next day, 13 September, they returned to the cave with better lamps and a rope, setting off at ten-minute intervals to make sure they weren't followed. After further widening the entrance, they explored every corridor until, far into the cave, just past the densely engraved Apse, they came across a vertical shaft too deep to see down. The boys paused. Who would go first?

Again, it was Ravidat who took the plunge. Heart racing, he climbed down the rope, nervous not because he doubted his own strength but because he feared his younger friends might drop him. When his feet touched the bottom, 8 metres down, he raised his

lamp to the walls and saw one of the strangest scenes in all of cave art.

It features a stick man with a bird head and prominent penis – the only human figure in the cave. Often described as ‘the Dead Man’, he lies at a 45-degree angle with his head back and his arms and fingers splayed. Bearing down on him is a bristling bison, head low, horns thrust forwards, with a black spot on its shoulder and a series of loops hanging beneath its belly, as if its guts are falling out. Directly beneath the man is a bird perched on a vertical staff.

This bizarre tableau has mystified generations of scholars. But d’Huy and Rappenglück both suggest that the secret to understanding it may lie in the sky. With a slight shift in perspective, it is the man who stands vertical, looking to the heavens as the bird stick and bison follow him upwards. D’Huy suggests that the scene might show the Cosmic Hunt, as hunter and beast rise into the sky to become constellations. That would explain why the bison, despite its aggressive position, doesn’t appear to be charging forwards. The black spot on its withers might be a star, and black marks on the ground beneath could be the bloodstained leaves of the hunted animal, signalling the onset of autumn.

It is no more than ‘a plausible hypothesis’, d’Huy admits. But the shaft scene does look strikingly similar to a Neolithic rock painting from the Maia river in Siberia that is thought to represent an early version of the Cosmic Hunt, in which a hunter takes aim at an elk with the sun hanging under its belly. Perhaps the loops beneath the Lascaux bison, too, represent not its intestines but the sun.

Rappenglück, meanwhile, thinks the birdman is a shaman with a staff, and that the bison is his spirit-helper, guiding his journey to the sky. Similar scenes appear in the art of modern-day shamanic cultures, such as the ecstatic shaman in flight to the sky, penis erect and bound to a celestial bull, that appears on a tipi of the Oglala people in North America. Rappenglück further suggests that the eyes of the Lascaux bison, birdman and bird correspond to Vega, Deneb and Altair – the ‘Summer Triangle’ – among the brightest stars overhead in summer. Twenty thousand years ago, this trio never set but rotated around the northern celestial pole, indicating

the time of night like a giant sky clock. Perhaps the people of Lascaux imagined this constellation as a celestial shaman (the Palaeolithic equivalent of the Chumash's Sky Coyote), turning each night around the axis of the cosmos. Surrounded by spirit-helpers, he ruled and fertilised the sky. Rappenglück interprets the scene as an image of the sky, but also a map for an earthly shaman's own voyage to the celestial pole.

It won't ever be possible to prove what the artist really intended. But the different strands of evidence do seem to converge on one explanation: that this prehistoric scene, far underground in the deepest part of Lascaux cave, represents a journey to the stars. Similarly, the various lines of enquiry described in this chapter – Bull No. 18, the Dead Man, the Cosmic Hunt – seem to me, despite the uncertainties, to add up to an overwhelming broader conclusion: that if we want to understand where we come from as a species, to reach the source of humanity's earliest beliefs and identity, then we have to include a consideration of the wheeling night sky.

Seeing those repeated celestial cycles – night to night, season to season – surely helped to stimulate the very first ideas about who we are and about the nature of reality; ideas that survive in hunter-gatherer communities today. 'They had the same questions,' Rappenglück says. 'What is birth? What is death? Where does the sun go? What is behind the world?'

The universe that our ancestors came up with in answer to those questions was a quintessentially human one, inspired not just by the sky but by the shifting states of consciousness that our brains can produce. In it, there were no boundaries between living and non-living, humans and nature, Earth and stars. It was a cosmos that created us as we created it; in which internal experience and external reality were inextricably entwined. We've been trying to separate ourselves from it ever since.